

# FARM LABOUR INPUT IN THE DRY ZONE

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AGRARIAN RESEARCH AND TRAINING INSTITUTE  
P. O. Box - 1522  
Colombo 7  
Sri Lanka



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By  
R. S. FIELDSON

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Agrarian Research and Training Institute  
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## FOREWORD

It is now recognised that labour in the small farm sector is not as abundant as was once thought, and that in some areas at certain times of the year labour shortages can be a severe constraint on production. Such shortages are already evident in much of the dry zone of Sri Lanka and may become even more acute as the pace of development, especially under the Mahaweli Programme, increases.

Although many studies (some of them by A.R.T.I.) have touched on aspects of labour use in Sri Lanka farming, none has provided a general overview of the factors influencing the farmer's decision-making in this important area. This study attempts to fill this gap by analysing and comparing data on labour application from a number of different sources, confining its attention to small-scale farming in the dry zone.

In addition, the implications of the results for the planning of future dry zone colonisation schemes are drawn out. Such an exercise is inevitably very tentative, but it is felt that it is important to consider the macro-economic implications of research results.

The study was conducted by Mr. R.S. Fieldson, who was attached to the Institute as a researcher under the Natural Resources Post-Graduate studentship Scheme of the Overseas Development Administration in U.K. My thanks are due to him and the others who made this publication possible.

T.B. Subasinghe.

DIRECTOR

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R. S. Fieldson

A. R. T. I.

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## S U M M A R Y

Irrigation and colonisation of the dry zone is an important component of Sri Lanka's development strategy, contributing to a reduction in unemployment and landlessness and an increase in food output. While some of the variables important to the success of such a strategy are amenable to government control, others are an outcome of decision making at the farm level and so can be influenced only indirectly by project planners and management. An important example of the latter is the input of labour to the farm. The object of this study is to investigate the farmer's decision-making with respect to labour use, and also to draw out the implications of the results for the Mahaweli Project as a whole.

Data were drawn from a number of existing studies of dry zone settlements so that (a) a representative picture could be obtained without the need for extensive new field work, and (b) the results of past fieldwork could be more completely analysed. There were certain differences between the studies in the techniques of data collection, the sample sizes, the operations covered, and the coefficients used to aggregate different types of labour (i.e. man, woman, and child labour), but after the elimination of any suspect figures the data used are felt to be fairly reliable. They are subject to the limitation that they are averages for locations rather than farm level figures, but this should not prevent a general picture being obtained.

The average figures for labour input per acre of paddy per Maha season showed a large variation between locations ranging from 35 mandays per acre to 92 mandays per acre. While a small part of this may be due to differences in survey techniques or uncontrollable factors such as weather conditions in the years of study, it is hypothesised that much of the variability is due to differences in the circumstances with which the farmer is faced when deciding how much labour to apply. Thus, certain selected variables are examined in an effort to establish whether they influence the level or composition of farm labour input.

(1) Farm Power. A review of the literature suggests that mechanisation

ion leads to a significant fall in labour input per acre, and that there may be different effects on family and hired labour-use, though evidence is conflicting on the exact nature of these effects. By comparing locations with different levels of tractor-use attempts are made to assess the effects of the degree of mechanisation on labour-use, though other influences cannot be fully eliminated. The locations for which data have been obtained are categorised into "high", "medium", and "low" tractor-use groups according to the land area cultivated by tractors and by animals (hand cultivation was unimportant), and average labour input figures are calculated for each group. This is done for both total labour input, and labour input into land preparation alone, as this is the operation most likely to be affected by mechanisation.

It is found that locations in the high tractor-use category clearly used less labour on average than those in the lower tractor-use categories. It is difficult to quantify the difference attributable to mechanisation alone, but 9 mandays per acre seems to be a reasonable estimate.

There is no evidence of a systematic relationship between the degree of tractorisation and the input per acre of hired labour, either for all operations or for land preparation, but the input of family labour is higher at those locations with low tractor-use than in the higher tractor use groups. This is consistent with the hypothesis that mechanisation displaces family rather than hired labour. Possible reasons for, and consequences of, this are briefly discussed.

(2) The Level of Returns. One would expect an association between the level of net returns and the input of labour, a high expected level of returns encouraging the farmer to apply more labour, and higher labour application resulting in higher returns. While it is not possible to isolate the returns to labour alone, the relationship between the overall net return and the labour application is examined (on a per farm and a per acre basis) with the aid of scatter diagrams and linear regression.

It is found that there is a clear positive correlation between the total input of labour per farm and the net return per farm, and between the input of hired labour per farm and the net return per farm. These relationships are weaker, though still positive, on a per acre basis. There is little correlation between family labour input and net return on either basis. It seems that while decisions on the use of hired labour are taken largely on economic grounds, family labour use is affected by a host of non-economic as well as economic factors e.g. variations in family size, off-farm employment opportunities, and leisure preference.

(3) Holding Size. In spite of the importance of the relationship between holding size and labour input to the successful achievement of the aims of dry zone colonisation, only a modest amount of empirical work on this has been done. The data collected here are used to investigate the relationship : the per acre labour input figures are plotted against the average area of lowland paddy per farmer for each location. The following conclusions can be drawn.

There is no evidence of any relationship between total labour input per acre and the average area of paddy cultivated. Possibly the range of holding sizes is too small for such a relationship to emerge. However, there is limited support for the hypothesis that the input of family labour per acre declines with farm size, the scatter diagram for these variables showing a weak negative correlation. When only those locations with a reliable Maha water supply are examined the relationship is slightly stronger, suggesting that variations in water supply may have partly concealed the relationship between holding size and family labour input (there is some tendency for smaller holdings to be associated with poor water availability). There is a stronger correlation (positive) between the hired labour input per acre and the area of paddy, suggesting that larger allocations of land will lead to higher requirements of hired labour.

So the trend towards lower farm sizes on dry zone colonisation schemes may have had more impact on the composition of labour input than on

the total amount applied.

(4) Water Availability. This is a variable which, though it is likely to have an important influence on labour use, is difficult to measure in precise terms. Nevertheless, there is sufficient information on water supply conditions in the locations to allow them to be classified into four broad categories: "village tanks", and "low", "medium" and "high intensity" systems.

Labour input figures are far from homogeneous within groups, but still there is a clear tendency for the total labour input per acre to be higher where the water supply is reliable. The same is true of hired labour input, but family labour input shows no systematic variation. For the village tanks hired labour input is at a low level and family labour much more important.

It seems that where water supply is poor, both the risks of paddy production and the incentive to concentrate on chena crops (which may compete with paddy for labour at certain times) are higher. This could account for the lower total labour input, and the lower use of hired labour (which requires cash payment) at such locations.

(5) Non-paddy Crops. In spite of farmer preference for paddy, other enterprises are important in many areas and are likely to receive increasing emphasis as self-sufficiency in paddy is approached and the need to economise on water becomes more pressing. Most of the data obtained relate to paddy only, but for some locations data on labour inputs into chena and highland crops are also available.

In most cases labour input per acre is much higher on these other enterprises than for paddy, and the input of family labour is also at a much higher level. Conversely, hired labour use is lower on chena and highland crops than in irrigated paddy cultivation. The returns per manday were found to be much higher in paddy cultivation, perhaps partly accounting for the farmer's preference for paddy.

High labour-use in chena and highland cultivation can be attributed to the high labour demands of certain operations (especially as mechanisation is often not feasible) and also to the use of family labour during slack periods in paddy cultivation when opportunity costs are very low. Low returns per acre will militate against the use of hired labour.

Having looked at the effects of these individual variables, <sup>the</sup> attempt is made to bring them together so as to give an overall view of their influences on labour input. This cannot readily be done by multiple regression because of problems of multi-collinearity, non-quantifiable variables, and differences between the sources of data. However, a matrix is constructed which shows the levels of the variables at each location (classified as high, low, or medium) and the relationships between these variables and the different types of labour input (family, hired and total). By establishing at what levels these variables are likely to be on Mahaweli settlements, the matrix can be used as an aid to predicting labour inputs under Mahaweli.

It is concluded that if the high projected output targets are to be met, hired labour input will have to be at a level significantly above what is at present planned. Broad extrapolations to the project level suggest an additional demand of around half a million seasonally hired workers per Maha for the Accelerated and Balance Programmes.

It is likely that, as at present, much of the demand for hired labour in the dry zone will be met by seasonal migration from the wet zone. As other writers have shown, there is a large supply of underemployed workers in wet zone villages to whom work in the dry zone is a valuable source of income. However, the work provided is of a short-term and unreliable nature and entails considerable <sup>disruption</sup> <sup>life</sup> of family, and also problems of recruitment and accommodation. An alternative strategy would be to reduce the average holding size slightly and make some changes in the cropping pattern so that there would be less need for

hiring labour. This would reduce the amount of seasonal employment available, but would increase the number of families which could be settled permanently on the new colonisation schemes.

## I N T R O D U C T I O N

The task facing the planners of the Mahaweli Ganga Development Project is huge, not only because of the scale of the undertaking but also because of the diversity of aims which it is expected to achieve simultaneously. The aims are social and political as well as economic, and include the improvement of food output, the reduction of unemployment, the relief of landlessness and poverty, the reduction of imports of agricultural products, and the creation of "growth centres" (Abeygunawardena, 1979)

The achievement of these diverse and often conflicting aims is of major importance to the country as a whole. The need for employment creation is shown by the high numbers currently out of work in Sri Lanka, estimated at almost 900,000 or 15% of the labour force in 1978 (Central Bank, 1980). As well as being a waste of productive potential, this means that many people (particularly the young) are deprived of the opportunity of constructive and fulfilling work. Many others, especially in agriculture, are severely underemployed. Although the government is having some success in attracting industry to Sri Lanka, the capital costs of providing jobs in this sector are high and it employs a relatively small proportion of the total workforce. There is only limited scope for expanding employment in the service sector, so it is inevitable that the agricultural sector, which currently employs about 54% of the workforce (Central Bank, 1979), will have to shoulder the main burden of employment creation in the foreseeable future. The impact of the Mahaweli Project will be huge: it is estimated that under the Accelerated and Balance Programmes about 160,900 and 144,000 families respectively will be settled, providing employment for over 750,000 people directly (Abeygunawardena, 1979).

The other main aim of Mahaweli development is to raise output of agricultural goods, both via colonisation of formerly low productivity lands, and via provision of supplementary water to areas where irrigation is at present inadequate. In 1976 Sri Lanka imported 534,000 tons of rice, the staple food, and in 1978, though imports had

declined somewhat, they still cost the economy Rs.689m (Central Bank, 1979). Imports of subsidiary crops were also sizeable, representing a severe drain on foreign exchange, especially as there are no climatic reasons why many of them could not be produced domestically.

The opening up of new areas of land to cultivation is bound to lead to an increase in output of such crops, but in addition to increasing the acreage cultivated it is important also to increase the intensity of cultivation. Many other Asian countries apply much more labour per acre of paddy than is common in Sri Lanka, and achieve much higher levels of yield (Ishikawa, 1974) though as other inputs are often also at higher levels, this improvement in output cannot be attributed to the rise in labour input alone. Several writers have seen the intensification of Sri Lankan agriculture via the raising of labour input as a major opportunity for achieving both higher output per acre and a higher labour absorption. For instance, the ILO report on employment in Ceylon suggests that application of appropriate labour intensive techniques & inputs can "increase employment, save foreign exchange, get the fastest rise in output sustainable with Ceylon's resources, and probably reduce rural income inequality" (I.L.O., 1971, page 100).

The achievement of these two main objectives of higher employment and higher food output (and of any additional aims) depends not only on a large and carefully planned investment by the government, but also on the response of the farmers to the incentives provided. The actual decisions on levels of labour application, types and extent of crops grown, use of purchased inputs, and so on, are taken at the farm level and so are not amenable to direct control by the planners.

However, many aspects of the environment in which the farmer makes his decisions are amenable to control e.g. the size of the holding and type of land provided; the availability of farm power; the availability of water, etc. There should be scope for adjusting these variables in such a way as to elicit those responses from the farmers which are consistent with project aims. This cannot be done precisely

as different farmers will react differently to a particular set of incentives. But by observing how farmers on established dry zone settlement schemes respond to varying holding size, provision of tractors, levels of return, and so on, one can build up an understanding of what behaviour to expect under given circumstances.

The object of this paper is to investigate how certain selected variables affect one particular aspect of the farmer's decision-making: the input of labour into the holding. The input of labour obviously has important bearing on how successfully the aims of the project, as discussed above, are achieved, and an attempt is made later in this paper to draw out the implications of the results for the Mahaweli project as a whole.

The methodology which has been adopted is to consider a number of variables which seem likely to have an important influence on the input of labour, and to compare different locations at which these variables are at different levels so as to see whether there is any apparent relationship between the variable under consideration and the amount of labour applied. Rather than undertaking extensive new fieldwork in an effort to cover satisfactorily the range of conditions which exist in the dry zone, data have been drawn from a number of existing studies (described in detail in Appendix A). Although the emphasis of these studies has often been on aspects other than labour, they have all involved the collection of quite detailed labour statistics. However, no attempt has been made previously to synthesize the fragmented data so as to get a broader picture of the influences on labour input. Such an approach suffers from various difficulties over the comparability of data, but nevertheless a number of useful conclusions emerge which justify the adoption of such a methodology.

To summarise briefly the layout of this study, Chapter 1 discusses some of the conceptual problems inherent in a study of labour application, and also examines the difficulties encountered with the data used. Chapters 2 to 6 look in turn at the selected variables and

consider separately the responses of family labour & hired labour. Finally, in Chapter 7 an attempt is made to bring together the evidence of earlier chapters, and the results are used as an aid to predicting the labour requirements of the Mahaweli programme.

## CHAPTER 1

### BACKGROUND TO THE DATA

#### 1.1 MEASURING LABOUR INPUT

The type of data on labour input which is available is in many ways a compromise between what one would ideally like and what can be readily collected. It is not easy even to define farm labour input accurately. If one were studying urban industrial employment it would not be difficult to see when someone is involved in work when not. The tasks are well-defined and the hours regular. But things are very different in smallholder agriculture where it is often quite hard to distinguish between farm and domestic activities (many of the housewife's tasks may be indirectly related to production), or even between work and leisure (visiting the market can have social and economic purposes).

There are also difficulties in quantifying work. Work involves the application of both time & effort, and if a simple time measure of labour application is used differences in effort will not emerge. An hour spent on guarding the crop would not be distinguished from an hour spent in digging with mamoty, though the latter involves much more exertion.

However, it is usual and perhaps necessary on practical grounds to ignore these problems and to limit records of farm labour input to observation of the number of hours spent on field operations. This has been done in all the studies discussed below. There are some slight differences in the operations which are included. For instances some studies include figures for the processing and transport of the harvested crop, whereas others do not record any labour input after threshing. Activities such as "bird-scaring" and "irrigation" are recorded in certain studies but not in others. But the effects of such differences are likely to be small, and no adjustment has been made for them.

## 1.2 DATA COLLECTION

In reality one is lucky to get even a reasonably accurate estimate of the total number of hours worked as there are problems with the collection of data. The exact techniques used in each study are discussed in Appendix A, but they can be divided into three broad types:

1/ The Single Visit Survey. The farmer is asked to estimate the input of labour on his farm for the previous season or year. This imposes great demands on the farmer's memory, especially if he is expected to distinguish the input of each type of labour (family, exchange, and hired) into each operation of cultivation, or if he is asked about labour input for crops other than paddy. In general it seems that a farmer whose main crop is paddy will be able to give a fairly accurate record of hired labour input, for which he has to pay in money, but his estimate of family labour input may be less reliable.

2/ The Frequent Visit Survey. An investigator visits the farmer at regular intervals (often weekly, but may be more or less frequently) and collects information on the input of labour since the previous visit. The farmer is therefore not required to remember details of labour application for longer than the interval between visits, so the data should, *ceteris paribus*, be more reliable than if a single visit survey is used. It is still possible that farmers may give misleading information if they are suspicious of the use to which the data will be put (they may, for instance, inflate the costs of production by exaggerating the amount paid to hired labour). This can only be overcome by careful explanation of the study aims and is helped by the development of trust between farmers and investigators which should occur with regular contact.

3/ Farm Record Books. With this method of recording, the farmer is expected to write, in specially designed record books, details of

his inputs, sales etc., on a regular basis. Although this could potentially lead to very accurate data, it relies on the enthusiasm, literacy, and ability of the farmer to fill in the books properly - conditions which will not be met in many cases. There is the danger that, in an effort to ensure that records are well kept, the more able and therefore untypical farmers will be selected.

Although it seems that method (1) is less likely to result in accurate data than (2) or (3), it is in fact widely used, mainly because it is simpler and less demanding of investigators' time. Ranatunga and Abeysekera, who have experience with both single visit surveys and record keeping, conclude that "experience gained..... indicates that not only the costs but also the supervisory effort needed to obtain satisfactory results from a record keeping exercise are substantially higher in relation to that of a single-interview questionnaire survey. In respect of data collection using farm records, the experience of this study suggested that a properly executed single interview survey would be equally reliable except in specific instances where close monitoring of input use is needed" (Ranatunga & Abeysekera, 1977, page 6). The necessity for detailed and time-consuming supervision of investigators with the frequent visit technique has been borne out by the experiences of the A.R.T.I./Reading University "Farm Power and Water Use" Study.

So it can be concluded that the survey techniques used, while not always the most accurate possible, should be capable of giving reasonably reliable data, though the family labour input figures are more likely to be subject to error than those on hired labour input.

### 1.3. AGGREGATING LABOUR DATA

Having collected data on farm labour input, one is faced with the problem of how to aggregate different types of labour e.g. male, female, and child labour. The ability to do different types of work and the efficiency with which it is achieved will vary from group to group. Most of the studies used have tried to make

allowance for differing levels of efficiency by using conversion ratios to change "woman-days" and "child-days" into "man-days", the levels used varying slightly from study to study. But Farrington(1975) in a paper which includes a thorough examination of this topic, has pointed to various drawbacks in the standard labour unit approach. It is based on the assumption that there is a reasonable degree of homogeneity within types, and that the relative efficiency of the various types does not vary significantly between tasks. These assumptions are clearly unrealistic. For instance, a woman may not be able to work as efficiently as a man in a physically heavy task, but in something involving dexterity, such as rice transplanting or tea-picking, she may be more efficient. Furthermore, the use of relative wage levels as an indication of relative efficiency is not justified if there are labour market distortions. A detailed work-study of paddy operations would allow an accurate assessment of the efficiency of each type of labour in each operation, but in the absence of such a study there is little alternative but to use the simplified approach of standard man-days.

Of course it is preferable if all the studies use the same co-efficients to convert child- and woman-days into man-days, but while most studies accepted a value of 1 child-day = 0.5 man-days there is some variation over the valuation of woman-days (levels of between 2/3 and 0.8 mandays are used). It is not possible to convert the figures on a standard base as disaggregated values are not always given, but although some bias may be introduced, the distortion is unlikely to be large.

So inspite of the deficiencies of a simple time measurement of labour input, the problems of accurately measuring labour use, and the difficulties involved with aggregating different types of labour, suitable simplifications can be made which will not result in a significant loss of accuracy. Such simplifications are made in virtually all the studies used. The nature of these studies, and the resultant data on labour input, are now examined.

#### 1.4. SUMMARY OF THE DATA

The list of locations for which data are available is given in Table 1. Reference is also given to the study from which the information was obtained, and the dates of the surveys are listed. For precise information on any particular location, the reader is referred to Appendix A, but some of the main points are brought out here.

Average labour input figures are given for 12 different locations, all of them in Sri Lanka's dry zone. The size of the area to which they relate varies considerably, from a small village tank (Walagamba huwa) to a large area with a highly developed irrigation system (Polonnaruwa). Also the purposes of the studies from which the data are taken range from benchmark studies for areas expected to undergo significant change (e.g. studies A, B, and H) to cost of production studies (e.g. D and E), and studies of particular aspects of a location (e.g. C and F).

Sample sizes vary from over 400 farmers in the case of study G down to only 12 for one of the locations in study E. While this prevents the use of rigorous statistical techniques, as discussed in Chapter 7, its effects are reduced by the fact that at those locations for which the sample size is small, the techniques of data collection seem to have been particularly thorough (often involving maintenance of record books).

All the surveys were undertaken in the ten-year period 1970-1979 and it seems reasonable to assume that there have been no fundamental changes within agriculture over this period which might affect any relationships emerging from cross-sectional analysis. However, there may remain some differences (e.g. due to variations in weather between years) which have resulted in unpredictable variations in labour input. Only data for the Maha season are included as this was the period to which most available data related. While this means that the results are not representative of the year-round labour situation, as Maha is the season when labour is most likely to be constraining

(the paddy acreage being considerably higher than in Yala) it is felt that the most important period has been chosen.

Also listed in Appendix A are several studies the results of which are not included in the analysis for one reason or another. In some cases the labour input figures, either for total labour input or for specific operations, were so far out of line with those for other locations that it seemed likely that an error had crept in. In other cases, although the labour data were reasonable, there was no information on the factors which might be considered as explanatory variables of labour input. In others, the period to which data related was inappropriate.

After the elimination of any questionable results, the data which are retained should be of reasonably good quality. Some of the figures (notably where sample sizes are large and survey techniques thorough) will be more reliable than others. Also, as pointed out earlier, it is likely that hired labour input will be more accurately recorded than family labour input, and also that details of operation-wise labour application may sometimes be subject to error. However, it will be seen in subsequent chapters that in several cases where a particular relationship is expected between labour input and a specific explanatory variable, such a relationship is evident (e.g. between the level of net return and the input of labour, and between the size of the paddy holding and the input of hired labour). This tends to confirm that there are no marked anomalies in the data used.

Having discussed the origins of the data a few comments will be made on the levels of labour input observed. Table 1 gives figures for each location on the input of labour per acre of paddy in man-equivalent days, with separate figures for hired, family, and in some cases exchange labour. As will be seen later, figures were also available for labour input by operation.

TABLE 1 : LIST OF LOCATIONS, LABOUR INPUT FIGURES, AND SURVEY DATES

Location	Source study (see Appendix A)	Total labour input per acre of paddy (man-days)	Hired labour input per acre of paddy (man-days)	Family labour input per acre of paddy (man-days)	Exchange labour input per acre of paddy (man-days)	Date of survey (Maha season)
Mahawilachchiya ✓ R	A	52.1	8.9	43.2	included in family	1976/77
Mahakanadarawa ✓ R	A	45.8	14.1	31.7	"	1976/77
Pavatkulam ✓	A	35.0	19.0	16.0	"	1977/78
Usgala						
Siyambalangamuwa	B	61.3	18.0	43.3	"	1972/73
Kandalama	B	40.0	14.2	25.8	"	1972/73
Kaudulla	B	61.3	32.1	29.2	"	1972/73
Minipe	C	68.4	22.6	39.1	6.8	1970/71
Polonnaruwa (1)	D	91.8	60.8	31.0	0	1976/77
Hambantota (1)	D	50.7	35.2	15.5	0	1976/77
Hambantota (2)	E	52.1	44.9	7.2	0	1972/73
Polonnaruwa (2)	E	69.4	53.8	15.6	0	1972/73
Elahera (1)	E	67.7	42.7	24.6	0.4	1972/73
Walagambahuwa	F	55.0	6.7	40.6	7.8	1977/78
Elahera (2)	G	55.0	25.6	29.5	N.A.	1970/71
Kala Oya	H	52.0	14.0	34.0	4.0	1977/78

An initial inspection of the figures reveals a huge variation between locations in average total labour input per acre which ranges from 35 man-days to 92 man-days. Variation in both the major components of the total is also large, though hired labour exhibits the greatest fluctuation (ranging from 6 to 55 mandays per acre). Of the figures on family labour input 11 are in the range of 24 to 44 man-days with just 4 lower values, so the variability is not so great.

It is difficult to comment on the input of exchange labour as many of the figures are not available. In some locations it is not reported at all though it is quite important in three cases.

#### 1.5. THE STUDY

The object of this paper is to try to explain, as far as possible, why such large variations in labour input occur. It is not disputed that some small part of the differences can be attributed to the different survey techniques and to slight differences in the operations measured. Also weather conditions vary from year to year, and farmers may possess different levels of industry and management ability (though the use of average figures will remove much of the effect of variation between individuals).

Nevertheless, it is hypothesised that much of the variability will be due to differences in the circumstances with which the farmer is faced when he decides how much labour to apply. He will have a reasonable knowledge of what sources of farm power are available to him, of approximately what level of returns he will achieve at different levels of (family and hired) labour input, of how much land he has to cultivate in total, of how reliable the water supply is to his particular farm, and of the labour requirements of his crops other than paddy. In the following chapters these different aspects of the farmer's decision-making environment are examined in turn to see how far they help to explain the observed levels of labour use.

## CHAPTER 2

### THE INFLUENCE OF THE FARM POWER ON LABOUR APPLICATION

#### 2.1. INTRODUCTION

One factor which is likely to have a marked effect on the amount of labour which is applied to the farm is the sources of farm power which are available to the farmer. It is not suggested that this is a one-way relationship, as the availability of labour may be an important determinant of the type of farm power that is adopted, where a choice is available to the farmer. But still a close association between type of power used and amount of labour applied seems likely, especially for "power-intensive" operations such as land preparation and threshing.

It is generally thought that mechanisation, representing the substitution of capital for labour, will result in a decline in labour input. Tractors are at present used mainly as direct substitutes for animal power in land preparation and threshing, and their ability to perform these tasks more rapidly than animals tends to confirm the impression that less labour will be needed. (See, for instance Farrington & Abeysekera, 1979).

However, it is also possible that mechanisation may ease seasonal labour bottlenecks and so allow different crop mixes or cultural practices which, over the season as a whole, raise the labour input. Also mechanisation may bring about higher yields in some cases, and so more labour would be needed for harvesting and processing. A further possibility is that mechanisation may permit an extension of the cropped area which would probably increase employment, but this cannot be examined here as only per acre data are available.

So the employment effects of mechanisation are not clear and it will be useful to examine the evidence of past studies, both as a yardstick against which to test the reliability of the data used in the subsequent analysis, and as a way of formulating hypotheses which can be tested

against the data.

There are two broad approaches to the study of mechanisation. One may adopt a cross-sectional analysis, comparing farmers or locations with different levels of tractor use in an attempt to establish a correlation between the level of labour input and the degree of mechanisation. Or one may use time-series analysis, studying how labour input for the same farmer or location changes over time as the level of mechanisation changes. In either case there are problems in isolating the effects of mechanisation alone, as many other factors are likely to vary both between farmers or locations and also over time. The adoption of mechanical cultivation will probably be correlated with the use of other advanced inputs such as fertilizers, pesticides and so on. In spite of these problems, a number of studies have sought to investigate the effects of farm mechanisation in Sri Lanka, and their results are reviewed below.

## 2.2. EXISTING LITERATURE

A useful summary of the main issues concerning mechanisation and employment is provided in Farrington and Abeysekera (1979). This is a preliminary publication of the A.R.T.I./Reading University Project on Farm Power and Water Use in the Dry Zone of Sri Lanka, and while it does not report any original research findings, it reviews various published and unpublished studies from which broad conclusions are drawn. A displacement of some 6-10 mandays is suggested as a likely consequence of the mechanisation (using 4-wheel tractors) of land preparation, and employment generation resulting from expansion of the acreage etc., is considered to be small. When the results of the Project's field-work become available they will make a valuable contribution to the understanding of the process and effects of mechanisation.

Perhaps the most detailed examination of the mechanisation of rice cultivation in Sri Lanka which is currently available is the Ph.D. thesis by Marilyn Carr of the University of Sussex. (Carr, 1975).

From data collected in the dry & intermediate zones Carr deduces that "the average farmer using a 4-wheel tractor for land preparation and all post harvesting operations required (with all other things held constant) 12.75 mandays less for each acre of paddy than the average farmer using only buffaloes. On average a 2-wheel tractor (assuming the use of a 4-wheel for threshing) destroyed 10.75 mandays of work per acre." (page 279). However, as Carr acknowledges, these figures are likely to be overestimates as all else will not be equal between mechanised and unmechanised farms. She suggests that: first, many farmers using tractors for the first ploughing still used buffaloes for certain of the remaining tasks of land preparation, mainly because use of tractors alone seems to result in an inferior tillage;

Secondly, tractors, though they "destroy" work in some activities, may generate it in others. Damage of field bunds often requires extra labour for their repair, and as tractor cultivation is generally less successful in destroying weeds there may be an increased demand for labour for weeding.

Thirdly, threshing by driving the tractor around over the paddy does not lead to much of a fall in labour requirements (though if threshing machines were used a much larger fall would result).

Further interesting points are that it did not seem that paddy yields and therefore harvest labour requirements were significantly affected by the introduction of tractors, or that tractor users were more likely to adopt transplanting (which is very labour intensive) than buffalo users.

Finally, and particularly relevantly in the present context, note is made of the composition of labour which is displaced by tractors. Carr states that many farmers gave as one of their reasons for starting to use a tractor, the fact that it reduced their reliance on hired labour which was seen as having a "nuisance value". This attitude towards hired labour may not seem consistent with the high amounts of labour hired even on quite small farms, but Carr attributes

the reliance of small farmers on hired labour to the reluctance of young educated family members to do manual work on the farm (a situation which she does not consider to have been significantly eased by mechanisation).

Another study which examines the effects of mechanisation is Sri Lanka, as part of a wider investigation of technological change in agriculture is that undertaken by Yudelman et. al(1971) under the auspices of the OECD Development Centre.<sup>1</sup> A case study was made of the Minipe Colonisation Scheme which, although rather dated (the survey was carried out in Maha 1969-70), is very useful as it gives figures separately for tractor-using and buffalo-using farmers. The figures were in a form comparable to the data used in this study and so have been included in the analysis in the section below.

From a larger original sample, 25 farmers were selected who used only tractors for cultivation, and 15 who used only buffaloes. Of the tractor-using farmers, 9 used 4-wheel and the remainder 2-wheel tractors.

The main points which emerge from the study are:

First, that tractor-using farmers apply almost 8 mandays less labour per acre than the buffalo-using farmers. This difference was found to be significant at the 5% level.

Secondly, in absolute as well as relative terms the buffalo-using farmers rely more on family labour and the tractor-users on hired labour. While these results apparently conflict with those of Carr noted above, it must be emphasised that at least part of the difference could be due to differences in farm size, the average size of buffalo using farms being 2.9 acres, compared to 4.8 acres for the tractor-users. As revealed in chapter 3, the larger the area of paddy the larger the input of hired labour per acre is likely to be.

<sup>1</sup> Based on data collected by the University of Ceylon, Peradeniya.

Thirdly, looking at the individual operations, there were statistically significant differences (at the 5% level) between the mean values of labour input for the 2 groups in the operations of ploughing, puddling, and bunding. This is as one would expect, with the labour saving effects of mechanisation in field operations being partly offset by the extra work created by the damage caused when tractors cross field bunds (bunding is a very labour intensive operation).

So overall quite weighty evidence is provided that tractors are likely to reduce labour input, but judgement must be reserved on the effects of mechanisation on the composition of labour input because of the effects of farm size.

Amarasinghe (1975) takes a rather different approach to the question. Linear programming is used to investigate the effect of the availability of mechanisation on the optimum farm plan, under various assumptions. Referring to an earlier work (Amarasinghe, 1974) it is suggested that mechanisation of preparatory tillage will result in a displacement of 8 mandays per acre and one manday per acre for threshing in the case of paddy production, but it is concluded as a result of the L.P. exercise that in a multiple enterprise situation mechanisation may result in a higher overall input of labour. In particular, family labour input may be higher (partly, it is suggested, because if the drudgery of farm work is reduced farm families will be willing to work longer). but the result may be due more to the relative costs assumed for family and hired labour in the analysis which may not accurately reflect the farmer's valuations.

Although these results are interesting, their conclusions cannot really be tested by looking at the figures for paddy labour alone as much of the suggested increase in labour input would occur on the highland plots.

The above brief review of some of the literature on the subject has thrown up various important issues which the data collected under the present study can be used to examine:

- i/ Labour input declines as tractorisation increases. All the studies agree on this though the size of the decline is disputed. Farrington and Abeysekera suggest that a decline of between 6 & 10 mandays per acre is likely, and the other results fall within this range (Carr's higher estimates should be modified to allow for the factors working in the opposite direction, as noted above).
- ii/ Most of the decline in labour input will be concentrated in the land preparation stage, though there may be some fall in labour input for threshing (most other operations do not use tractor power, though may be slightly affected due to changes in the farming system).
- iii/ The decline in farm labour input may have differential effects on family and hired labour. On this issue there is disagreements, with Carr pointing to the "nuisance value" of hired labour which farmers hope to reduce by using tractors, and Yudelman showing an increase in the proportion of labour which is hired, due largely to the obligation to hire the driver as well as the tractor.
- iv/ The full impact of mechanisation on labour input may not be seen simply by looking at the change in mandays per acre resulting from the introduction of tractors. There may be dynamic effects, with further falls in labour input as more advanced implements are introduced, and also consequences on the rest of the farm and even non-farm activities as labour released from paddy cultivation is put to other uses.

### 2.3. AVAILABLE DATA AND RESULTS

Going on to look at the data available here, if the effects of differing levels of mechanisation are to be assessed, some method must be obtained of measuring the relative importance of tractors and buffaloes at each location. Even if farmers used either tractors or buffaloes this would not be straightforward as, for instance,

one could consider the percentage of farmers using each power source as the relevant measure or the percentage of the area cultivated by that power source. In view of Yudelman's finding that at Minipe, the average area of paddy per tractor-using farmer was considerably higher than that per buffalo-user, there could be a significant difference between the two measures.

In fact, it is quite common for farmers to use a mix of tractor and buffalo cultivation, perhaps because they feel that a better tillage is ensured if the final land preparation is done by animal. In such cases the assessment of the relative importance of the two power sources becomes more difficult.

The difficulty is compounded by the absence of the relevant statistics in some of the studies used.

So the approach which was finally adopted was to estimate as accurately as possible the percentage of the total acreage (first ploughing, second ploughing and puddling/levelling) at a location which was cultivated by the two main sources of power, tractors and animals.<sup>1</sup> As it was not possible to obtain precise figures in all cases, it was decided to divide the locations into three groups: those with high tractor use, where the proportion of land cultivated by tractor in the survey year is estimated to exceed two thirds of the total; those with medium tractor use where the estimated proportion is between one third and two thirds; and those with low tractor-use, where the estimated proportion is less than one third.

In most cases it was fairly obvious in which of these categories a location would lie, but in some cases additional information was sought on a particular place so as to ensure that it was put in the right category (as far as possible ensuring that the additional information related to the same year as the data being used).

<sup>1</sup> Cultivation by hand was found to be unimportant in the areas studied.

Because categorisation of locations by degree of mechanisation is in the form of three broad groups, the results are simply presented in tabular form so as to reveal any major differences between groups (Table 2). More sophisticated analysis does not seem justified.

Looking first at the average total labour input per acre for each of the three categories of tractor ownership, it can be seen that, as one would expect, the figure for the high tractor-use group is much lower than for the groups with lower tractor-use. However, rather surprisingly the figure for the medium tractor-use group is slightly above that for the low groups. This may be partly explained by the fact that the medium tractor-use group includes the two figures for Polonnaruwa and one for Minipe, and both these locations have a reliable water supply and fairly advanced agriculture so that labour input may be expected to be high. But even if the relative values of the medium and low groups cannot be fully explained, the difference between them and the high group is pronounced at 13-18 mandays per acre. This is higher than the studies discussed above suggested, and attempt must be made to explain this.

In part, it can be attributed to extreme values which have undue effects on the group averages.<sup>1</sup> In fact, if just two values - those for Pavatkulam and Polonnaruwa (1) are excluded, the range between the group averages falls to only about 10 mandays per acre (the averages are: high, 49.2; medium, 59.4; low 59.6). This is much more in line with what one would expect. Of course, one cannot simply eliminate inconvenient values so as to make the results more acceptable, but the exceptional features of the two locations were pointed out earlier. Pavatkulam with its poor infrastructure, poor water availability, and very low yields per acre, is at the other extreme to Polonnaruwa where input availability is good, management standards high (88% of the area is transplanted), and returns very high.

<sup>1</sup>When extreme points have a large influence on the mean value it is possible that the median is a better indicator of the group "average". In fact the median values were examined and found to be quite close to the group means, and so are not given here.

Even at around 10 mandays per acre the difference between the high and low tractor use groups is at the top of the range suggested in Farrington & Abeysekera(1979). In an attempt to understand more fully the causes for this, the input of labour into land preparation alone will be examined. There are some surprising differences between figures in the same tractor-use groups, even between figures for the same location. This could be due partly to differing definitions of land preparation between studies, and partly to differences between the years in which the surveys were undertaken e.g., climatic differences or some changes in the techniques of cultivation. But one would not expect such differences to be large.

While such variations are at least partly unexplained, the difference between the average labour input for land preparation between the high tractor-users and the other groups remain apparent at about 5 to 5½ mandays per acre. This is much lower than the differences observed for total labour input, and suggests that some of the variation in labour input attributed to mechanisation above may have been due to other differences between the groups. For instance, 4 out of the 5 locations in the high tractor use group relied on broadcast sowing on at least 60% of their acreage, and this means that their labour application for the planting process would on average be lower than where transplanting was more widespread.

Because of these effects of other variables on total labour input it will probably be more accurate if the aggregate effect of mechanisation on labour input is obtained using the operation-wise figures as a starting point. Figures on land preparation and threshing labour input are more likely to show the undistorted effects of introducing tractors as they are less influenced by, for instance, the planting method, the use of labour for fertilizer or insecticide application and weeding (though there could still be secondary effects e.g. the planting method may influence the quality of land preparation which is required, and the level of fertilizer application may influence the amount of labour needed

for threshing via its effects on yields).

So the 5 to 5½ mandays per acre reduction in labour input for land preparation will be taken as a starting point. This does not indicate the difference between no tractor-use and full tractor-use, as even in the low category some mechanical cultivation was undertaken and in the high category some animal cultivation. An arbitrary adjustment must be made if the labour displacing effect of a change from buffalo to tractor cultivation is to be obtained, and an increase of 1/3 in the original figure seems reasonable, taking it to about 7 mandays per acre. This is only an approximation but is consistent with the evidence presented here and in line with what previous studies would lead one to expect.

Unfortunately, it was not possible to get figures for each location on labour inputs into threshing, the other operation where one would expect the effects of mechanisation on labour input to be large, as the labour input for this operation was often grouped with harvesting or with other post-harvest operations. However, Yudelman reported a difference of almost 2 mandays per acre between labour input on buffalo-using and tractor-using farms at Minipe, which will be assumed to be a reasonably representative figure.

So the combined effects of mechanisation of land preparation and threshing seems to be a reduction in labour requirement of about 9 days, all else being equal. While this is well below the 15-20 days suggested by the figures for all operations, it is felt that it is more likely to be accurate, as extraneous factors should be more fully eliminated. The way that this reduction is distributed between family and hired labour will be considered next.

The relevant figures are again given in Table 2. There is no clear relationship between the level of mechanisation and hired labour input per acre, the range of values within groups being so large that it does not seem valid to attach much significance to the small differences which exist between group averages.

However, the situation is different when one considers family labour input as here quite a definite relationship can be seen. The average levels of family labour input per acre are about 16 mandays for the high tractor-users, 30 mandays for the medium tractor-users, and 35 mandays for the low tractor-users. The percentage of family labour in total labour input for the same groups are 36, 52, and 60 so in this case differences between the medium and low groups are apparent, as well as between the high group and the other two. Some part of the differences may be due to the lower use of transplanting on the high tractor-use farms, as hired labour is especially important in transplanting, but the differences in area transplanted between groups were not so large as to account fully for the differences in labour input observed here.

Much the same picture emerges from the figures for land preparation alone. Those for hired labour show only small variation, not linked systematically with the degree of tractor-use. But the figures on the input of family labour increase markedly from about 5 mandays per acre for the high tractor-use group to 9 mandays per acre for the medium group and 11 mandays per acre for the low tractor-use group.

A check was made to ensure that the results obtained were not influenced by variations in farm size between the tractor-use groups; and it was found that such differences were small and unlikely to have much effect.

These results give substantial backing to the hypothesis discussed above that mechanisation is likely to displace family labour, and conflict with Carr's hypothesis that it will be the input of hired labour which falls as tractors are introduced. Although this is out of line with conventional wisdom on the subject (most writers, not specifically for Sri Lanka, suggest that mechanisation displaces hired labour) it seems to be fairly widely accepted as reflecting the situation in this country.<sup>1</sup> The reasons for this seem to be (a) that

<sup>1</sup> When this point was discussed at the ARTI Seminar "Research, Development, and Rural Workers", April 1980, several experienced participants confirmed that they would expect tractors to replace family rather than hired labour in Sri Lanka.

TABLE 2: LABOUR INPUT CLASSIFIED BY TRACTOR USE CATEGORY

Tractor use category <sup>a)</sup> and location	Total labour input into paddy mandays/acre	Hired labour input into paddy mandays/acre	Family labour input into paddy mandays/acre	Percentage of total labour input into paddy which is hired	Total labour input for land preparation mandays/acre	Hired labour input for land preparation mandays/acre	Family labour input for land preparation mandays/acre	Percentage of total labour input for land preparation which is hired
<b>HIGH</b>								
Pavatkulam	35.0	19.0	16.0	54.3	8.0	3.0	3.0	37.5
Kandalama	40.0	14.2	25.8	35.6	12.1	4.2	0	34.8
Hambantota (1)	50.7	35.2	15.5	69.4	11.1	7.3	3.7	65.8
Hambantota (2)	52.1	44.9	7.2	86.2	11.7	10.1	1.6	86.3
Minipe (3)	54.1	38.9	15.2	71.9	14.1	7.8	6.3	55.0
Average	48.4	30.4	15.9	63.5	11.4	6.5	4.9	55.9
<b>MEDIUM</b>								
Mahakanadarawa	45.8	14.1	31.7	30.6	15.5	4.0	11.5	26.1
Kaudulla	61.3	32.1	29.2	52.4	15.5	7.4	8.1	47.9
Minipe (4)	68.4	22.6	39.0	33.1	20.4	5.4	11.5	26.3
Polonnoruwa(1)	91.8	60.8	31.0	66.2	25.3	15.3	10.0	60.5
Polonnoruwa(2)	69.4	53.8	15.6	78.7	10.3	8.5 <sup>b</sup>	1.8 <sup>b</sup>	82.5
Kala Oya	52.0	14.0	34.0	26.9	16.0	6.0 <sup>b</sup>	10.0 <sup>b</sup>	37.5
Average	64.8	32.9	30.1	48.0	17.2	7.8	8.8	46.8
<b>LOW</b>								
Mahawilachchiya	52.1	8.9	43.2	17.1	15.0	3.2	11.8	21.4
Usgala Siyamba	61.3	18.0	43.3	29.3	17.9	4.7	13.8	26.0
Minipe (3)	61.9	28.4	33.6	45.8	20.1	6.9	4.9	34.4
Elahera (2)	67.7	42.7	24.6	63.1	10.6	5.6	11.6	52.8
Elahera (5)	55.0	25.6	29.5	46.5	19.7	8.1	11.6	41.0
Average	59.6	24.7	34.8	40.4	16.7	5.7	10.9	35.1
a: See text for definition	(1) From Ranatunga & Abeysekera	(3) From Yudelman et al.	(5) From Jeyaratnam					
b: Estimated values	(2) From Izumi & Ranatunga	(4) From Amerasinghe						

tractor drivers often have to be hired along with the tractors, whereas buffaloes can usually be handled by family labour (a gang of labour may have to be hired with the tractor for threshing), and (b) that farmers may prefer to use the reduced labour requirement resulting from mechanisation to cut down on family labour input, rather than to reduce hired labour input: a reduction in drudgery is preferred to an increase in the net return.

The precise nature of the labour displacing effects of tractor-use have important implications for the economics of mechanisation. It is possible that family labour released from paddy cultivation is (a) used for crops other than paddy, (b) employed in non-farm activities or (c) used to increase the family's "leisure" time. However, Carr found no evidence that tractor-using farmers increased the acreage of highland crops above what they had cultivated when they relied on buffaloes, (Carr, 1975, page 259) though it is possible that the per-acre input of labour increased. Also it seems unlikely that there will be sufficient off-farm work opportunities in most agricultural areas for farmers to spend more time on such activities. Thus much of the family labour released by mechanisation may not have been used productively, but instead the family has been able to increase its "leisure". Part of such an increase may be illusory as farmers often have to spend a lot of time in trying to arrange for the tractor to come at the time required, and in supervising the work of the tractor driver so as to ensure that a good job is done. Such "work" is probably not recorded in the surveys. And part of the increase in leisure may represent the withdrawal from the labour force of children and housewives who were formerly helping out through sheer necessity. These suggestions are tentative; it is not really possible to go further with this subject on the basis of the data available here.

So to summarise the findings of this chapter:

- (i) There is a clear reduction in the total input of labour per acre associated with an increase in the proportion of land cultivated by tractor. The extent of this reduction is

difficult to quantify because of other influences on labour input, but 9 mandays per acre seems to be a reasonable estimate.

(ii) There is no evidence of a systematic relationship between the degree of tractorisation and the input per acre of hired labour, either for all operations or for land preparation alone.

(iii) There is a clear tendency for the input per acre of family <sup>labour</sup> to be lower on the more mechanised farms. This trend is apparent from both the total operation and land preparation figures. So the evidence is consistent with the hypothesis that mechanisation displaces family rather than hired labour .

## CHAPTER 3

### LABOUR INPUT AND RETURNS FROM FARMING

#### 3.1. SOME THEORETICAL ASPECTS

One would expect that the amount of effort which a farmer and his family apply to their holding will depend, in part at least, on the return that they can expect from their holding. This is based on the reasonable assumption that work has a disutility and that "although (a man) may enjoy work for its own sake, his main reason for working is to produce goods and services or the cash needed to buy them". (Upton, 1976, page 242) So there will be a trade-off between time spent in working, and time spent on leisure or other "non-work" activities.

Each farmer makes a decision according to his individual preferences and values on the amount of family labour to apply to his farm, given the returns which he can expect at different levels of input (which in turn depend on his resource endowment), and the cost in terms of the disutility of leisure time foregone. Likewise, the decision on how much hired labour to apply will be determined by the costs and expected returns. In this case most of the cost will be in the form of wages paid to the hired workers (i.e. a money cost) but there may in addition be disutility connected with the hiring and supervision of hired workers which makes the real cost to the farmer higher than the money wage.

If all farmers had the same resource endowment and were operating on the same production function, and if the cost of labour (both the wages paid to hired labour, and the subjective cost of family labour) were the same to all farmers, then the optimum, profit-maximising, level of labour input per acre would be the same for all farmers. If it could also be assumed that there were constant returns to scale, then the optimum per acre labour input would be the same even with varying holding sizes. Of course the assumption that marginal product is equated with marginal cost may not be valid

for peasant farmers. Other objectives, such as security, may be more important than profit maximisation. Even if profit maximisation were the chief objective, one would still expect considerable variation in labour inputs. In spite of some superficial homogeneity between small farmers in the dry zone, there are important variations in resource endowment. Land holdings vary in size (see Chapter 4), family size varies, availability of capital and physical inputs is far from constant, and water supply shows considerable variation between localities. Further, the cost of labour is unlikely to be constant across the dry zone. Wages of hired labour vary according to the availability of workers and the level of alternative employment. Also the value placed on the time of the farmer and his family is a subjective, culturally and psychologically determined factor, which varies from person to person as well as from place to place.

To clarify this discussion, the division of the farmer's decision making process developed by Mellor (1966) is useful. He distinguishes five stages in the transformation of leisure into goods and services.

- i/ The transformation of utility from leisure into labour. This depends on the relative values put on them, and is partly culturally determined.
- ii/ The transformation of labour time into agricultural output. This depends on resource availability, technology, and management quality.
- iii/ The transformation of agricultural output into money. Farm prices and marketing efficiency are important here.
- iv/ The transformation of money into goods and services. This will be influenced by marketing efficiency, availability etc.
- v/ The transformation of goods and services into utility. As with (i), this is a cultural and psychological factor which may well change over time.

This helps to show that what is observed as a simple relationship between the amount of labour applied and the returns to that labour is in fact a result of the interaction of a complex of economic,

cultural, technical, and psychological factors. So it is important not to draw simplistic conclusions from any results obtained by examining the relationship between income and labour. For instance, if farmers appear to be unwilling to raise significantly the hours worked when the return to their labour rises, this may not be due to idleness but, say, to poor availability of goods and services on which an increase in earnings could be spent.

In the rest of this Chapter, an attempt is made to examine the relationship between the inputs of family labour, hired labour and total labour (i.e. family plus hired) into paddy and the net returns from paddy farming. Of course the link between the return obtained and the amount of labour applied is not one-way. The input of labour will be an important determinant of the return which is actually achieved. But the existence of such a two-way causality does not prevent the study of the association between the two variables and the formation of tentative conclusions from the results. But before going into greater detail on the methods used and the results obtained, mention will be made of the problems connected with the aggregation of data, both between different areas and across time.

a) Aggregation of results from different farmers and different areas. There is no guarantee that different farmers within an area, or farmers in different areas, are operating on the same supply schedule. Personal factors will influence the value put on leisure, on goods and services, etc., and such things as the availability of consumer goods and the cost of hired labour are also likely to vary to some extent. It is hoped that such factors will not be large: they will be minimised by concentration just on farmers in dry zone colonisation schemes.

b) Aggregation of results from different years (and use of past results as a basis for projections into the future). Farmers' attitudes and market circumstances may change over time in such a way as to change their response to a particular level of expected income, or changes in technology or practices may alter the income

associated with a given level of labour input. This again should not be too serious as all the data are taken from a 10-year period 1970-1979, though as the pace of Dry Zone development accelerates labour market conditions may change increasingly rapidly.

### 3.2. MEASURING THE RETURNS TO LABOUR

There are numerous inputs into the production process of which labour is just one (others include land, capital, water, and management). The outcome of production is simply a crop, the yield of which depends on the levels of all these inputs, and on exogenous factors such as the weather. To isolate the effect of any individual input on the level of output is difficult. One may try to observe a number of different farms where the levels of all other inputs are more-or-less equal but where the input in which one is interested varies, but this is very difficult to achieve in practice. Alternatively one can use data from farms with all the inputs at varying levels and try to estimate a production function which expresses the simultaneous effects of all the variables on output. However, this requires good quality farm level data and is not attempted here (but see Abeysekera, 1980).

So the best that can be achieved here is to use figures for the overall net return (i.e. the total value of the paddy crop minus the costs of purchased inputs), though it is realised that this is not necessarily a good indication of the returns to labour alone. It includes the return to all the factors of production, and so <sup>the</sup> attempt is made to take these into account as far as possible. The effects of varying the area of paddy (i.e. the input of land) are examined in Chapter 4, and the effects of varying levels of water input are considered in Chapter 5. Management is very difficult to measure and will only be discussed in general terms. It is likely to be correlated with the input of capital, with good managers more likely to adopt modern practices which often demand a capital input. In fact multicollinearity between all the different inputs will be a problem, so their individual effects cannot be fully isolated.

If the net return is accepted as a reasonable proxy for the returns to labour, the decision still has to be made whether or not it is appropriate to deduct the cost of hired labour or whether one should regard the wages paid out as part of the returns to labour. The farmer will be interested in hiring labour only if he feels that the additional value of output resulting exceeds the wage he will have to pay. So it is <sup>the</sup> size of this surplus value which will affect his decision making. But the part of income which goes towards paying wages is still a component of the total output resulting from the input of labour, so that if one is interested in the relationship between labour input and net return then the wages should not be subtracted.

The argument may seem unnecessarily pedantic in view of the fact that only such an approximate estimate of the returns to labour is being used. However, it seems logical not to deduct the cost of hired labour when one is examining the returns to all labour (family plus hired), or when one is looking at just the returns to hired labour, but in the case of family labour input, the return net of the cost of hired labour seems more appropriate. In fact, empirically it made very little difference whether hired labour costs are subtracted or not. The various relationships were also examined under the alternative assumptions on whether the cost should be deducted, and found to be basically the same.

The other major decision which has to be made is whether to consider the relationship between net return and labour input at the farm level or on a per-acre basis and the issue is complicated by the possible existence of economies or diseconomies of scale. Although the per acre labour input gives a better impression of the intensity of farming, the whole farm is the relevant decision making unit, and so may seem to be the more appropriate choice. But in view of the relevance of both these measures, the relationship was examined using both sets of figures as discussed in section 3.3. below.

Data on the returns from paddy farming were fairly readily obtained,

as even if they were not obtainable directly from the studies used, there were usually figures on the yields per acre of paddy which allowed the gross returns to be calculated by multiplying by the G.P.S. price. The farmer may not actually sell all his produce, but one must value produce which is consumed domestically at the price for which it could have been sold. Some inaccuracy may be introduced when the farmer actually sells his paddy for less than the G.P.S. price which he may do because he prefers to trade with a local merchant rather than a cooperative, e.g., because of speed of payment, or lower standards of quality control. This is difficult to avoid. Further details of how the figures were obtained are given in Appendix A, and the final figures used are in Table 3.1.

An adjustment has to be made to bring the price and cost data for different years to a common base. Unfortunately, no wholly satisfactory price indices are available for Sri Lanka, and the best that could be done was to use the Colombo Consumers Price Index published by the Central Bank. The commodities included in the index are not all relevant to the rural sector and there are several minor problems with the index which together with the alternative indices considered are discussed in Appendix C, but it should still prove a reasonable way of removing the effects of inflation, allowing the data for different years to be compared directly by converting them all into 1978 rupees.

### 3.3. THE RESULTS

The results are presented in the form of scatter diagrams to bring out any association between the figures on labour input and return, although it must be emphasised that they are not intended to indicate simple causality. First the diagrams for the whole farm data (Figs. 3.1, 3.2, and 3.3.) are considered.

Figure 3.1 shows a fairly strong positive relationship between the total labour input per farm and the net return from paddy per farm,

TABLE 3.1 INPUTS OF LABOUR AND RETURNS, PER FARM AND PER ACRE

Location	Total labour input per acre in mandays	Hired labour input per acre in mandays	Family labour input per acre in mandays <sup>1</sup>	Total labour input per farm in mandays	Hired labour input per farm in mandays	Family labour input per farm in mandays <sup>1</sup>	Returns per farm net of all purchased inputs Rs. 1978	Returns per farm net of all purchased inputs except labour Rs. 1978	Returns per acre net of all purchased inputs Rs. 1978	Returns per acre net of all purchased inputs except labour Rs. 1978
Mahawilachchiya	52.1	8.9	43.2	146.0	25.0	121.0	2383	2626	851	938
Mahakanadarawa	45.8	14.1	31.7	68.0	21.0	47.0	1773	1991	1194	1341
Pavatkulam	35.0	19.0	16.0	98.0	53.2	44.8	2232	3027	797	1081
Usgala Siyambalan-gamuwa	61.3	18.0	43.3	172.9	50.7	122.2	2882	3271	1022	1160
Kandalama	40.0	14.2	25.8	111.6	39.7	71.9	2268	2542	813	911
Kaudulla	61.3	32.1	29.2	166.8	87.4	79.4	2611	3112	960	1144
Minipe	68.4	22.6	45.8	236.8	78.3	158.5	3470	4093	1003	1183
Polonnaruwa (1)	91.8	60.8	31.0	354.3	234.7	119.7	5794	8446	1501	2188
Hambantota (1)	50.7	35.2	15.5	196.7	136.6	60.1	4493	6026	1158	1553
Hambantota (2)	52.1	44.9	7.2	250.6	216.0	34.6	4954	7066	1030	1469
Polonnaruwa (2)	69.4	53.8	15.6	275.5	213.6	61.9	4796	6963	1208	1754
Elahera	67.7	42.7	25.0	169.4	170.0	99.5	5321	6818	1337	1713
Walagambahuwa	55.0	6.7	48.3	100.7	12.3	88.4	2834	N.A.	1549	N.A.
Kala Oya	52.0	14.0	38.0	92.6	24.9	67.6	2973	3245	1670	1823

<sup>1</sup> Includes exchange labour

the regression equation being:

$$Y = 0.032 x + 34.3$$

and the value  $R^2 = 0.72$ .<sup>1</sup> This positive relationship is what one would expect in light of the earlier discussion: the higher the returns the more willing the farmer will be to raise the labour input, and the higher the labour input the higher the returns are likely to be.

The same relationship emerges in Fig. 3.2 between the net return and the input of hired labour per farm. In this case the regression equation is:

$$Y = 0.036 x - 58.8$$

and the value of  $R^2 = 0.94$ , showing a close correlation between net return and hired labour input.

However, Fig. 3.3. reveals no such correlation between the input of family labour per farm and the returns to paddy farming, with a virtually random scatter of points (the value of  $R^2$  for the regression line was only 0.0086). This conflicts with the behavioural pattern hypothesized above where it was suggested that the farmer and his family are likely to work a higher number of days on the paddy land if a high return is assured.

Going on to look at the relationship between per acre return and per acre labour input, while interesting to see what patterns emerge from the diagrams, it is not so clear what sort of a relationship one would expect. With the farm as the relevant decision-making unit and with possible variations in wage-rates and returns to scale between locations, it would be difficult to predict the relationship between per acre labour inputs and returns even if all farmers were

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<sup>1</sup> It is recognised that in this and subsequent regressions the estimators obtained are not unbiased, due to the use of average figures from samples of varying size. However, they remain a helpful, if approximate, guide to the degree of correlation.

behaving as profit maximizers. Thus, it is not surprising that no strong associations are visible in Figs. 3.4 to 3.6.

In fact weak positive relationships are observable in Fig. 3.4 and Fig. 3.5, the values of  $R^2$  being 0.43 and 0.54 respectively. In Fig. 3.4 (for total labour input per acre) the relationship depends largely on the values for Polonnaruwa and Kandalama. Figure 3.5 (for hired labour input per acre) shows a clearer trend from which only two locations with very low hired labour inputs deviate. Finally, Fig. 3.6 shows virtually no correlation between the input of family labour per acre of paddy and the net return per acre, the value of  $R^2$  being only 0.058.

Comparing Figs. 3.1 & 3.4 it can be seen that while both exhibit a positive correlation between total labour input and the level of returns, the relationship is much weaker on a per acre basis than on a per farm basis. It was noted that there are stronger theoretical grounds for expecting the relationship to emerge at the farm level, but a deeper understanding will perhaps result if the separate components of labour input are considered in turn.

Figs. 3.2 & 3.5 show fairly clear correlations between the levels of hired labour input and the net returns (per farm, and per acre). The points which diverge from the trend in Figure 3.5 (those for Kala Oya, and to some extent Mahakanadarawa) are locations with poor water availability, and the fact that the Kala Oya survey included many small village tanks may also tend to reduce the levels of hired labour input observed. For locations with better water availability the relationship holds more strongly.

But family labour input shows virtually no correlation with the levels of return either at the farm level, or on a per acre basis. Several reasons can be put forward for this.

First, in view of the complex of factors influencing the transfor-

Fig. 3.1

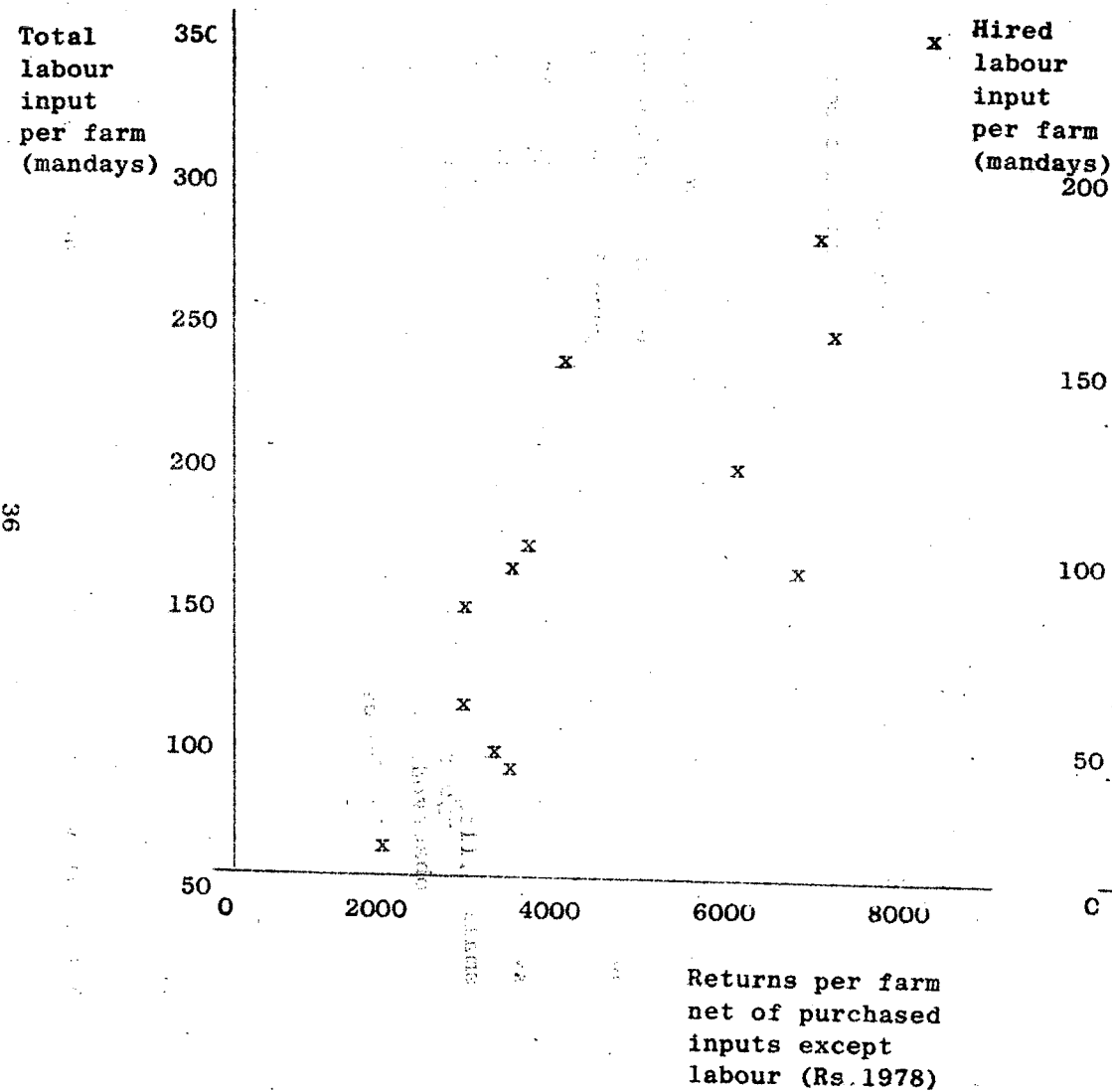


Fig. 3.2

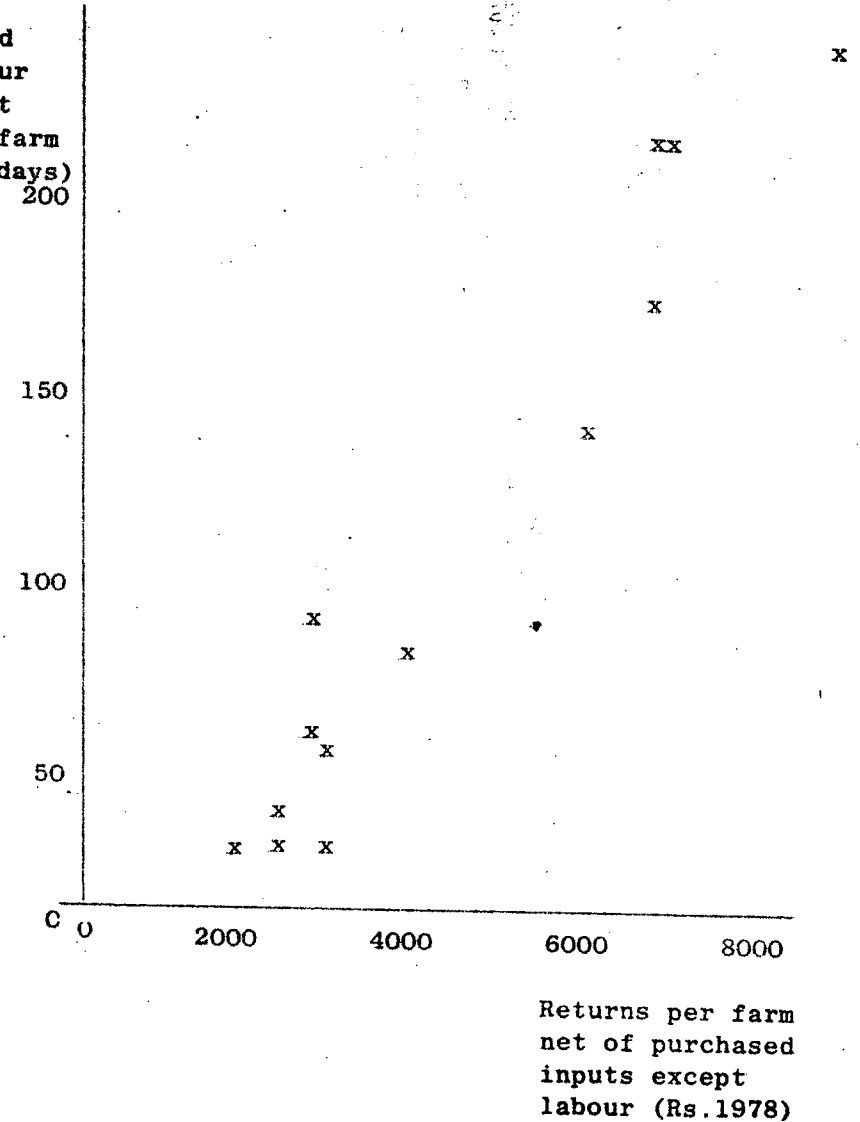


Fig. 3.3

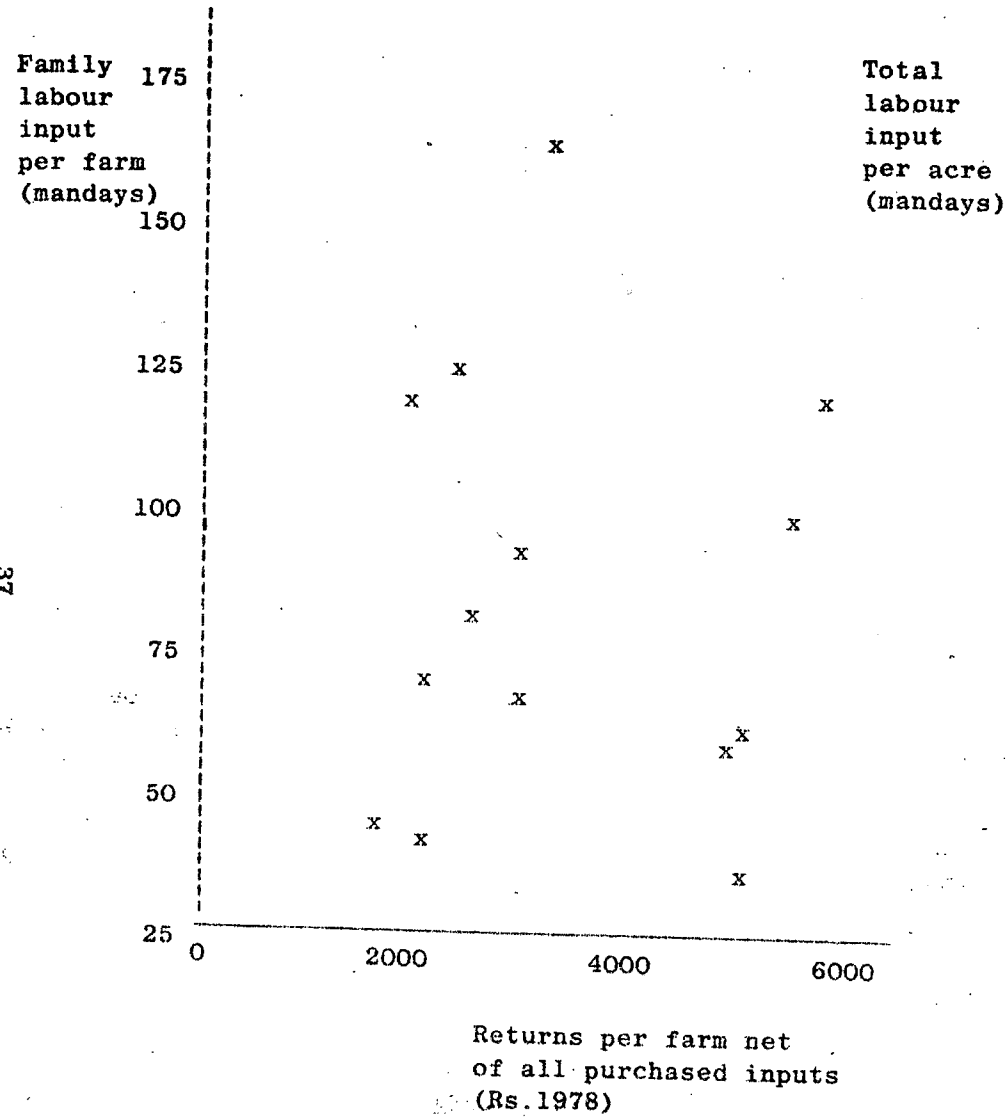


Fig. 3.4

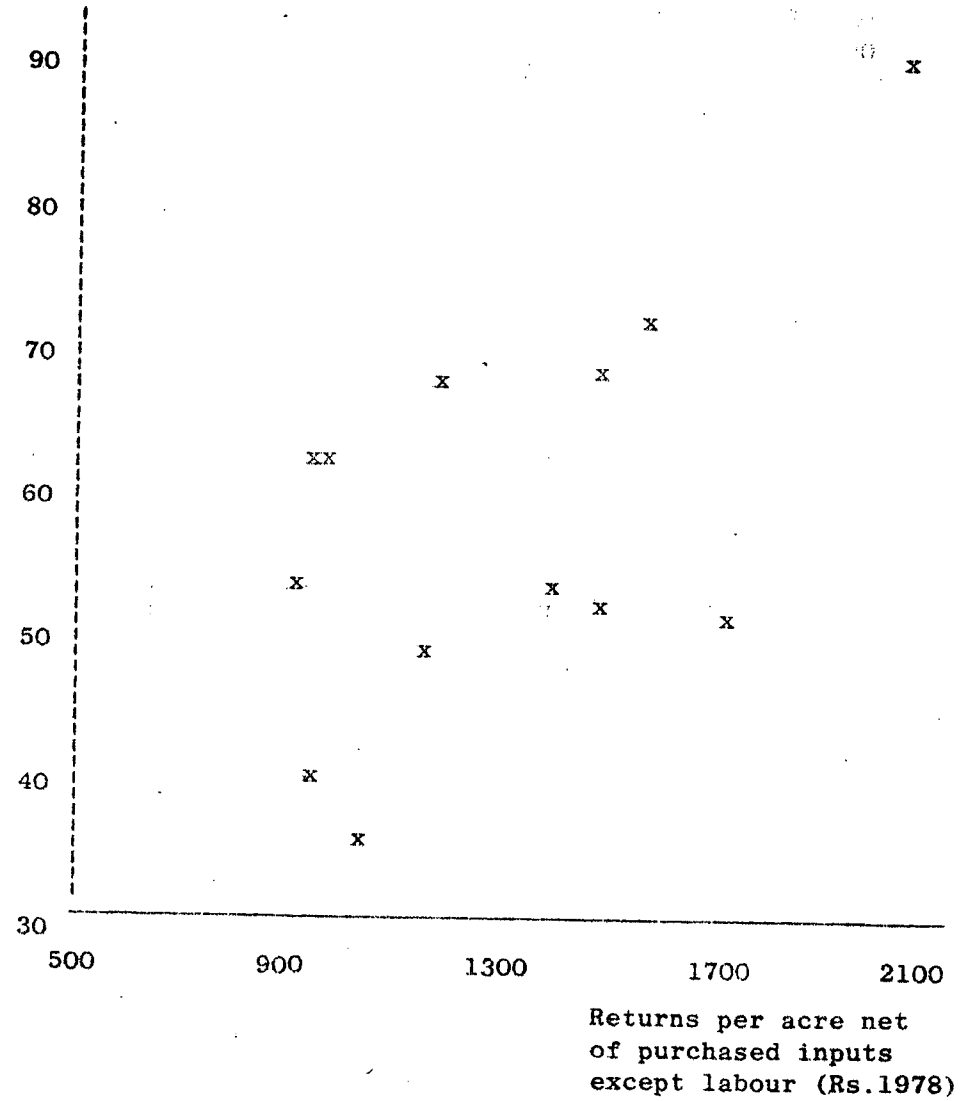


Fig. 3.5

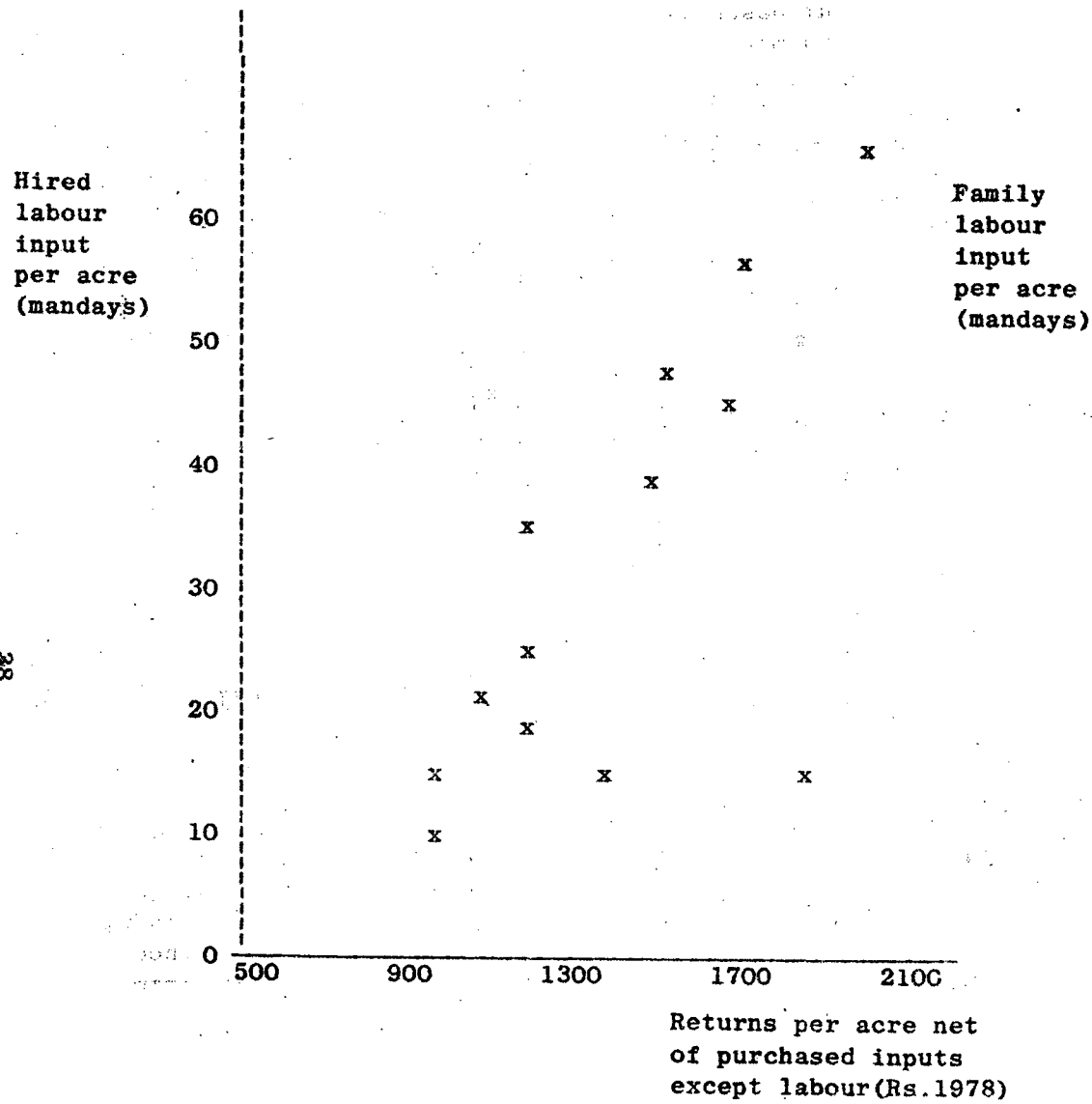
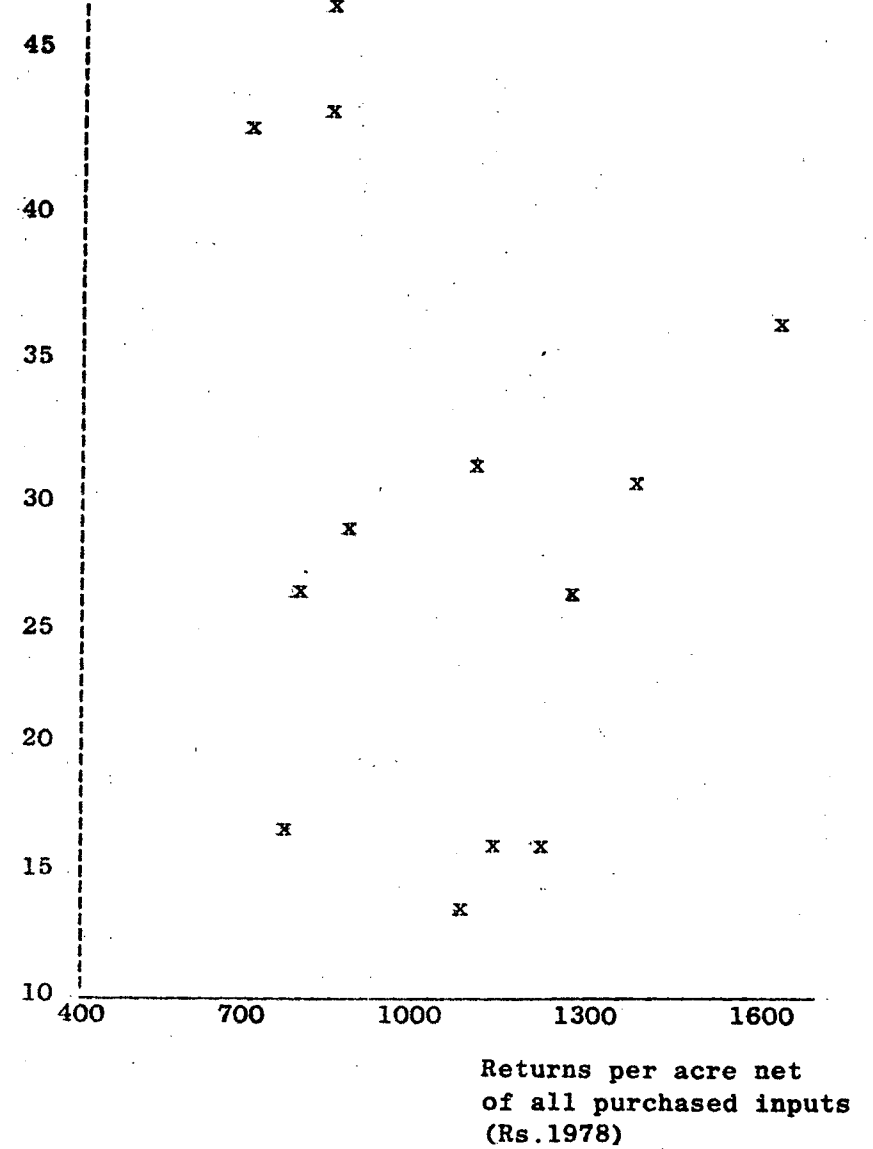


Fig. 3.6



mation of leisure into goods and services listed earlier, it is not surprising if the labour input corresponding to a particular level of return varies from area to area. For instance the availability of consumer goods will not be the same in all areas (thus influencing the incentive to earn a higher income) and the level of technology (important in determining what level of output is achieved for a given labour input) also varies substantially. Chapter 2 shows how more highly mechanised areas tend to use less family labour and there is some tendency in Fig. 3.3 for the locations with high mechanisation (such as Hambantota and Pavatkulam) to be those with a lower family labour input than one would expect for the level of return, and those with low mechanisation (e.g. Mahawilachchiya and Usgala Siyambalagamuwa) to have a high family labour input. This does not provide a complete explanation as there are anomalies but it seems to be important in some cases.

Another possibly important factor is that as expected return rises there are conflicting pressures on the farm family: the incentive to work in terms of material return is higher, but it is also possible to achieve a given level of income with a lower input of labour. Thus, if the "leisure preference" of the family is high, they may prefer to apply a relatively low level of labour to the farm and settle for a level of income below what it would otherwise have been. While it is not possible to examine this question thoroughly with the data available a few comments can be made.

First, the existence of a high leisure preference cannot be assumed to be a general phenomenon as there are some locations where the input of labour is relatively high at quite high levels of return (for instance Polonnaruwa, Elahera, Minipe).

Secondly, other explanations can in some cases be given for the low family labour application in locations where the return is quite high. This is particularly true in the case of Hambantota where the level of family input is perhaps largely a reflection of the pattern of land ownership found there. Ranatunga & Abeysekera

(1977) point to the presence of affluent cultivators owning large extents of land, who rely almost exclusively on hired labour for field work. Such affluent landowners, often involved in other business as well as farming, are largely peculiar to the District, and their existence, together with the high degree of mechanisation of cultivation, goes a long way towards explaining the low level of family labour input found there.

It could also be argued that there are special circumstances which reduce the family labour input in Pavatkulam below what one would expect, as water availability for domestic, as well as agricultural use, is so poor that many farmers live off the scheme, and travel in only to undertake major operations on their crops.

A further possible reason why there is no apparent relationship between family labour input and the net returns is that there may be variations in family size, or at least in the number of family workers available for work on the farm. Some of the studies give data on this (see Table 3.2). It can be seen that there is a range of 5.9 to 7.9 in the average size of family, and there is also some tendency for the locations with larger family size to have higher labour input (e.g. Usgala Sityambalagamuwa, Minipe and Elahera) and those with smaller family size to have lower labour input (e.g. Kala Oya, Pavatkulam and Mahakanadarawa). The results for Kaudulla and Kandalama do not fully conform with this pattern, but with other factors of importance it would be surprising if a completely consistent relationship between family size and family labour input were to emerge.

TABLE 3.2 AVERAGE SIZE OF FARM FAMILY FOR STUDY LOCATIONS  
( WHERE AVAILABLE)

<u>Location</u>	<u>Average family size</u>
Kala Oya.	5.9
Mahakanadarawa	6.5
Pavatkulam	6.6
Kaudulla	6.7
Mahawilachchiya	6.9
Elahera	7.4
Minipe	7.4
Kandalama	7.5
Usgala S.	7.9

As well as the size of the family, the numbers employed in other activities are relevant. In general, agriculture provides the bulk of employment. For instance, at Mahawilachchiya only 6% of males find primary employment outside agriculture (ARTI, 1979a), and for Kala Oya non-farm employment is described as "almost negligible" (ARTI, 1979b). Figures are given in some of the studies for the size of the family workforce actually engaged in agriculture. There are problems of definition and comparability which make these figures of only limited use, but the following comments can be made. As was pointed out above, many farmers in the Hambantota District are engaged in other business activities which is likely to reduce the supply of family labour available for agriculture. Also it is stated in the report on Kandalama (Jogaratnam, 1974) that opportunities for employment on the state farm there at the time of the survey may have reduced the proportion of family members working full time on their farm. This could help explain why the labour input at Kandalama is rather low considering that the family size at 7.5 is high. There was quite a high proportion of male family members (about 30%) at Mahakanadarawa who reported engaging in non-agricultural activities as a secondary operation, but farming remained by far the most common primary activity. In all other cases work on the family farm is the dominant primary occupation, with hired labouring on other farms sometimes emerging as a major

secondary activity.

So it has been shown that, in some cases at least, the size of the family and the availability of off-farm work may have influenced the amount of family labour which is applied to the holding.

Another possible factor, linked to the previous one but perhaps worth separate mention, is the age of the colonization scheme. In many cases, the settlers on new schemes are younger people who do not yet have a large family. Even if they have children they will often be too young to work. But as the scheme matures, the average family size will perhaps tend to rise and the proportion of family members of working age increase. In fact there is little evidence from the data to support this hypothesis, with no obvious link between average family size and age of the scheme. However, Amarasinghe (1972) points out that at Minipe the use of seasonal hired labour has declined "due to the family labour force expanding and the demand for hired labour being minimised", and this might be true elsewhere.

In conclusion while there seems to be a clear positive correlation between the total input of labour per farm and the net return per farm, and between the input of hired labour per farm and the net return per farm, these relationships are weaker (though still positive) on a per acre basis. There is little correlation between family labour input and net return on either basis, and some of the reasons for this have been examined.

It was suggested above that farmers would apply each type of labour until the marginal return was equal to the marginal cost. While the data on returns used here are not adequate to allow this to be examined closely it is unlikely that this has been true for family labour. Partly this is because the cost of family labour is not at a more-or-less fixed level as is that of hired labour. So if there are differences between locations in the subjective cost of family labour, there will be differences in the optimum levels of use. Also because hired labour involves a cash payment whereas

family labour does not, there is more pressure on the farmer to ensure that the former is applied at an optimum level than is the case for the latter. Perhaps if, on certain farms or at certain times of the year, family labour is in abundance, it will be applied to levels at which the marginal product is very low.

## CHAPTER 4

### VARIATION IN HOLDING SIZE AND THE INPUT OF LABOUR

#### 4.1 BACKGROUND TO THE ISSUES

It is widely thought that both labour absorption and output per unit of land will vary according to the size of holdings which are allocated. It seems reasonable a priori that smaller holdings will induce a more intensive input of labour, perhaps with greater reliance on family rather than hired labour, and that this should result in a higher per acre output. The argument is summarised by Farmer (1960): "Paddy is a crop which responds particularly well to intensive methods easily acquired by the peasant. Nearly all of the standard methods of increasing yields (transplanting, instead of broadcast sowing, weeding, pest control, application of fertilizer, and so on) are essentially labour intensive in character stimulated by a small holding rather than a large." A similar attitude led the 1971 ILO Mission to Ceylon to emphasize the importance of reducing farm size by land redistribution as a means of both easing unemployment and raising food output (ILO, 1971)

The idea that smaller holdings create more jobs and more food is reflected in changing government policy towards holding size in new colonisation schemes.<sup>1</sup> In the early years of modern colonisation schemes (the 1930s and 1940s) the typical allotment size was 5 acres of lowland and 3 acres of highland, and the main concern seems to have been that fragmentation might reduce holdings to less than "economic units". It was felt that this size of holding provided an amount of land which could be cultivated by family labour alone, at the same time providing an adequate livelihood to settlers. From the early 1950s, 3 acres of lowland plus 2 acres of highland became the norm, and more recently allocations have

<sup>1</sup> This paragraph draws heavily on Andarawewa (1965).

been as small as 2 acres of paddy and 1 or 2 acres of highland. Plans for settlement under the Accelerated Mahaweli Programme envisage the allocation of  $2\frac{1}{2}$  acres of lowland and  $\frac{1}{2}$  an acre of highland per settler (Fernando, 1979). The aim of the reduction in holding size has been to reduce the per capita costs of development, and to try and improve the rates of return achieved by such projects. These have often been very low in the past (Corea, 1974).

In spite of the importance of the relationship between holding size and labour input to the successful achievement of project aims on settlement schemes, the amount of empirical work which has been undertaken on the subject is small. Three of the main contributions in this field are discussed below.

Amarasinghe(1977) criticizes the "rule of thumb procedure adopted hitherto and the lack of any scientific basis for allocating holdings to settlers" and attempts a quantitative approach to the determination of holding size. He uses parametric linear programming, so that the area of the holding can be parametrised and the optimum level found given a constraint on the labour availability (under several assumptions), a minimum income constraint, and a minimum employment constraint. The programme is run for three different family sizes ( 8 members, 6 members, and 4 members), and for paddy farms, highland crop farms, and mixed farms. For the paddy producing farms the optimum sizes were 6 acres, 4 acres, and 3 acres for the respective family sizes, and for the mixed farms they were 4 acres of lowland plus 3 acres of highland, 3 of lowland plus  $2\frac{1}{4}$  of highland, and 2 of lowland plus  $1\frac{1}{2}$  of highland, respectively. So holding sizes are advocated which in most cases are well above those commonly allocated at present, and stress is also put on the need to vary the holding size according to the size of the family settled.

It is not clear how labour is costed in the study (is family labour given an imputed cost? If not, its use may be at levels above what would be applied by the farmer). Nor does the minimum employment requirement of 240 mandays per year per man-equivalent seem realistic,

as many peasant farmers work less than this now and may be unwilling to increase their labour input to such an extent. The assumption of fixed input/output coefficients excludes the possibility that labour intensity of production may vary with farm size, and also the proposal that allotment size should be varied according to family numbers seems impractical (family size will change over time so that an initially optimal allocation will soon cease to be so). But while details of the study can be criticised such a quantitative approach seems to be a step in the right direction.

Another paper which discusses holding size will be mentioned here, and referred to again later, as it gives some idea of current thinking by those actually planning the Mahaweli Scheme. Abeygunawardena (1979) recognises that small farms may not provide incomes high enough to attract "technologically advanced farmers", and that their marketed surplus will be smaller. At the same time, larger farms are seen to limit the number of settlers, demand higher managerial and technical skills, and require more hired labour which may not be readily available. The M.D.B. used evidence from earlier settlements and from pilot settlement projects set up at Maha Illuppalama and Pelvehera before deciding upon the allocation of  $2\frac{1}{2}$  acres of paddy and  $\frac{1}{2}$  acre of highland. At Pelvehera holdings were 2 -  $2\frac{1}{2}$  acres while at Maha Illuppalama they were around 5 acres, and it was observed that "in the latter case extensive rather than intensive agricultural practices were adopted on the project, demonstrating that the farm holding size was too large and unmanageable with family labour, thereby resulting in underutilization of the scare resources, water and land." (Page 99)

Wickramasekara (1980) touches briefly on the relationship between holding size and labour input. Regression is carried out to examine the effects of various variables on the input of labour, and the results reveal a consistent negative relationship between the size of the paddy holding and the total labour input per acre for all areas, supporting the view that labour intensity is higher on small farms. However, when the regression was tried for hired labour alone a positive relationship was found only in 3 of the 5 areas. Also the relationship between holding size and yield was not clear

cut with large holdings producing the highest per acre yields in 2 of the locations.

Although these various works contribute to an understanding of the effects of holding size on labour application, knowledge about this vitally important relationship remains fragmentary. While limited by the fact that the available figures are at the location rather than farm level an analysis of the data collected here should shed further light on this.

#### 4.2 THE AVAILABLE DATA

The data used in this Chapter relate to paddy acreages rather than whole farms, so the relationship between the area cultivated and level of labour input will be examined for paddy only. This could be a source of bias, as it is possible, say, that a farmer with a small paddy holding may cultivate a lot of chena, so that low labour application per acre of paddy may merely reflect concentration on the other crop or vice versa. An attempt is made in chapter six to draw inferences from the limited amount of whole farm data which is available, but the evidence presented here will be just for paddy.

Figures are available (see Table 1) for 15 different locations on labour input per acre in man-days, divided into family (usually including exchange) labour and hired labour. This is useful, as it could be hypothesised that the relationship between cultivated area and per acre labour input will be different for hired and family labour. For family labour, one would expect that the per acre input would decline as acreage increases, as available workers spread their efforts more thinly over a larger area. But for hired labour the opposite relationship seems more likely, as on small farms family labour may be adequate so that no hired labour is needed, whereas with increasing size it becomes less possible for the farm family to manage alone, and the share of hired labour in total labour input may rise.

TABLE 4. AVERAGE ACREAGE OF PADDY CULTIVATED AT SURVEY LOCATIONS

Location	Average acreage of paddy cultivated in sample
Mahawilachchiya	2.8
Mahakanadarawa	1.49
Pavatkulam	2.8
Usgala Siyambalangamuwa	2.82
Kandalama	2.79
Kaudulla	2.72
Minipe	3.46
Polonnaruwa (1)	3.86
Hambantota (1)	3.88
Hambantota (2)	4.81
Polonnaruwa (2)	3.97
Elahera (1)	3.98
Walagambahuwa	1.83
Elahera (2)	4.21
Kala Oya	1.78

Figures are also available for the area of paddy cultivated. See Table 4 (i.e. not the area of the whole farm but the actual area planted with paddy). The relationship between this area and the inputs of the different categories of labour are presented in the form of scatter diagrams.

#### 4.3. THE RESULTS

In Fig. 4.1. the total (i.e. family + exchange + hired) labour input per acre in man-days is plotted against the cultivated extent of lowland paddy (in acres). There is no strong relationship, with most points in a cluster between 40 and 70 man-days per acre, and one value above and one below the cluster. For the range of cultivated acreages observable here (which includes the possible allotment sizes for the Mahaweli Scheme) there is certainly no evidence to support the contention that small farms are likely to be formed

more labour intensively than larger ones. If that were the case then there should be a negative correlation on the scatter diagram and there is no sign of this. On the contrary, the relationship appears weakly positive, the regression equation being:

$$Y = 5.42 x + 40.12 (R^2 = 0.15).$$

Looking a little more closely at the 2 values which diverge from the main cluster, the low value (35 man-days per acre) is for Pavatkulam. There are several factors which will tend to depress the labour input here, such as the almost universal reliance on tractor cultivation and broadcast sowing, but most important is the effect of shortages of water (both for irrigation and domestic use). Shortage of irrigation water makes paddy cultivation risky and so is a disincentive to raising labour input, and shortage of domestic water has resulted in some farmers living off the scheme and just travelling in to undertake the various cultivation operations, a situation which no doubt militates against a high labour input.

The "high" value of 92 man-days per acre was for Polonnaruwa where the net returns are also very high and water availability good, suggesting that where farmers are sure of getting a good return they are willing to apply extra labour (though the causal relationship will not be simple).

Going on to consider family labour input (Fig. 4.2) it is again clear that no strong relationship exists, although there is a weak negative correlation, which is what one would expect in the light of the earlier discussion. Simple linear regression produces a coefficient with the correct sign, but the value of  $R^2$  is only 0.32. So it must be concluded that the evidence from the studies provides only limited support for the hypothesis that family labour input per acre will be higher on small farms.

Fig. 4.3 showing the effect of paddy area on per acre input of hired labour, reveals a firmer relationship than either of the other two

**Total labour input per acre (mandays)** **Fig. 4.1.**

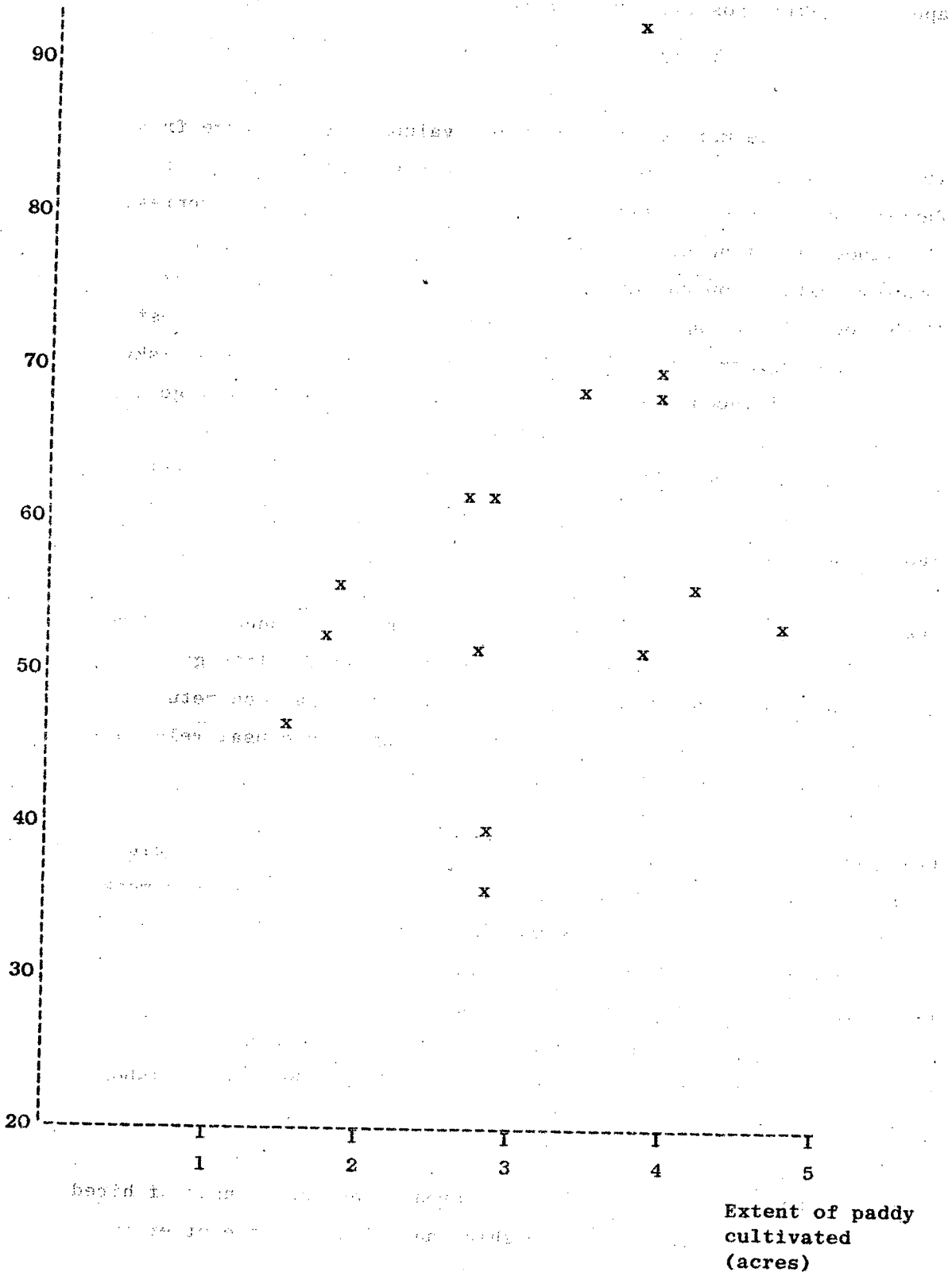


Fig. 4.2

Family labour  
input per acre  
(mandays)

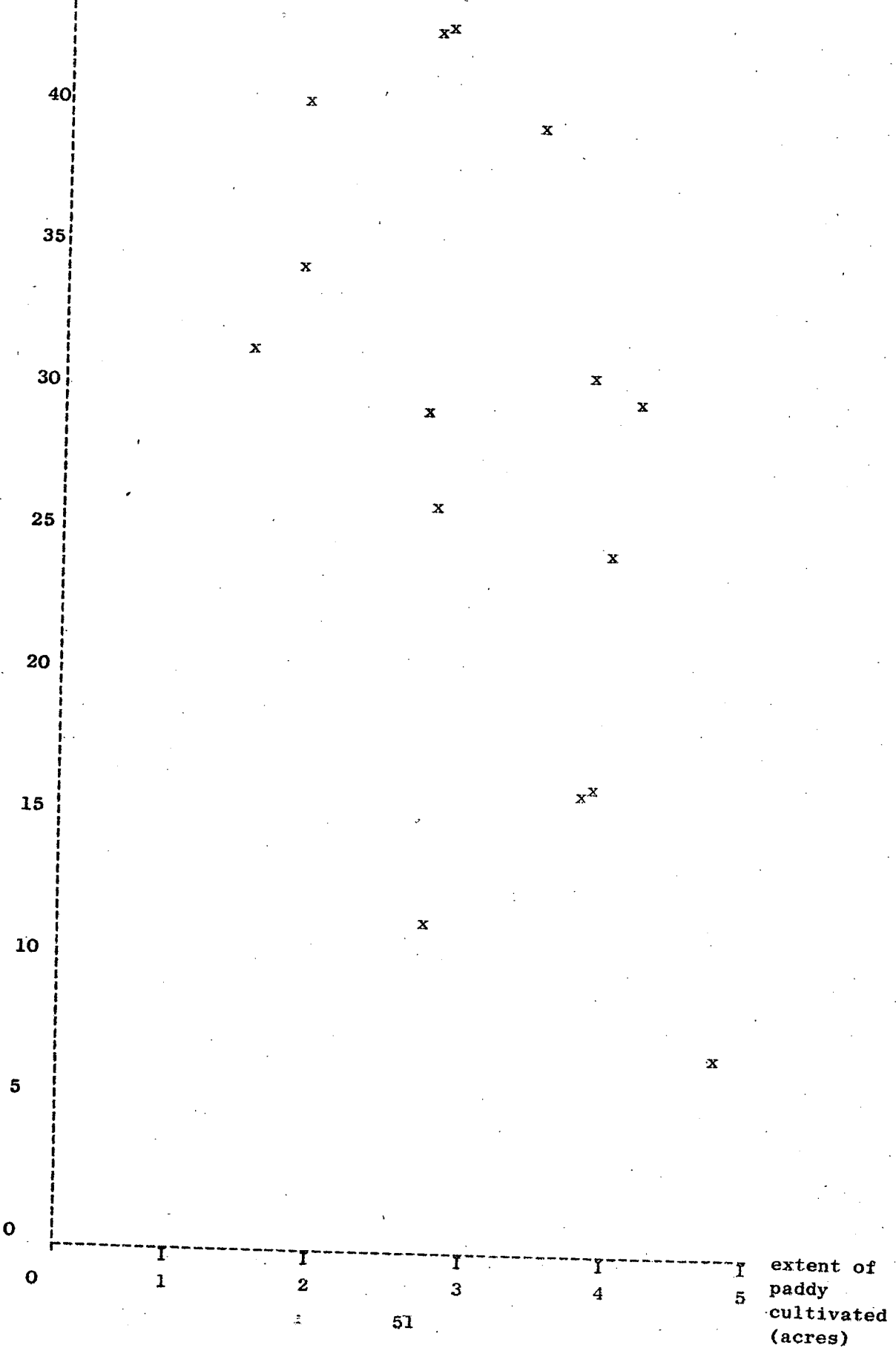
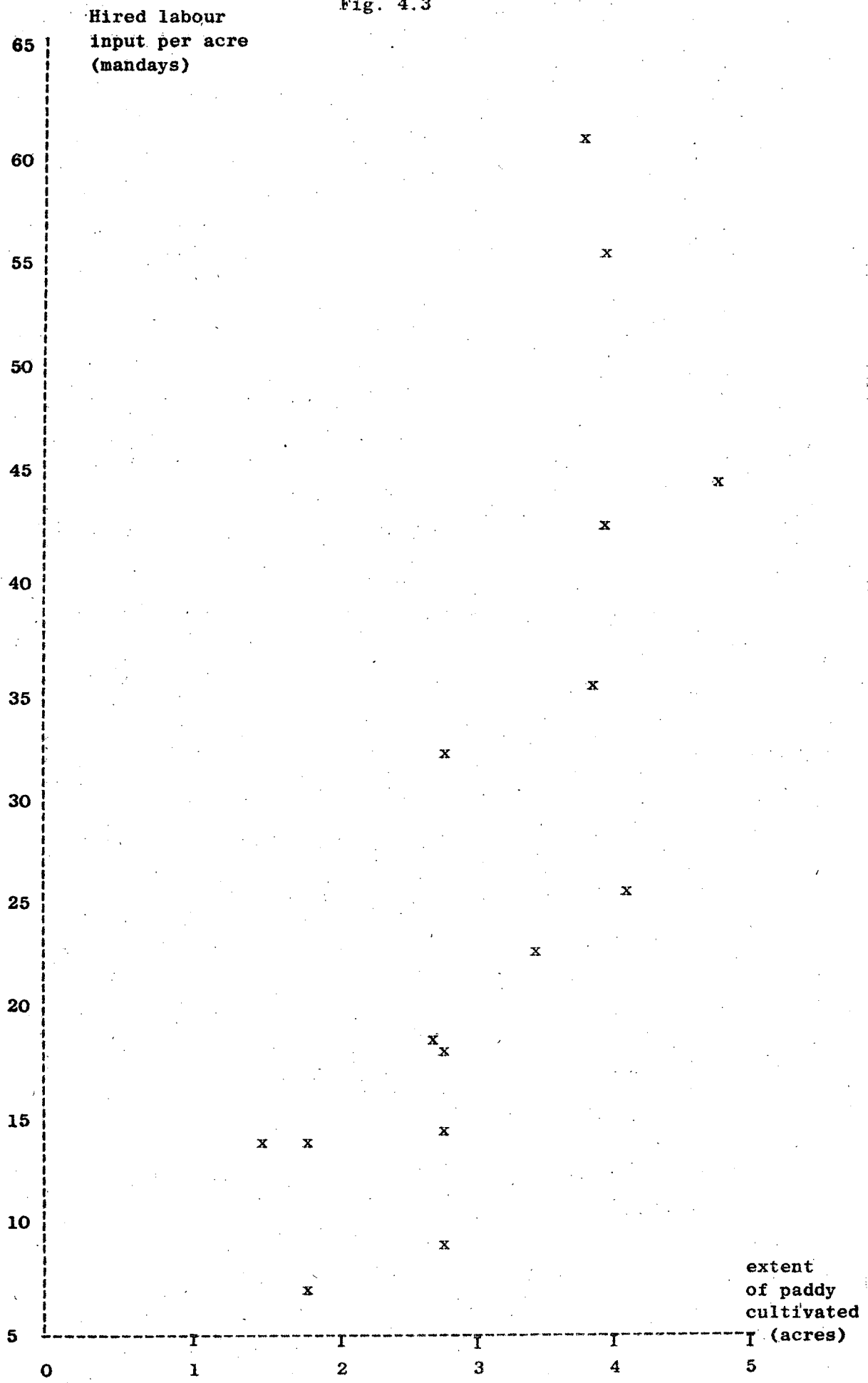


Fig. 4.3



scatter diagrams. Linear regression gives a positive coefficient and the value of  $R^2$  is 0.56. The addition of further points as they become available might confirm the relationship which is emerging, but at present one can suggest that there is some evidence that the per acre input of hired labour will increase as the size of the paddy holding increases.

Of course it is possible that there is an underlying relationship between paddy area and labour input per acre which is obscured by other influences on labour input and which would only emerge if they could be held constant. For instance, it seems that many of the locations with smaller average paddy holding sizes also have poor water availability (e.g. Mahakanadarawa, Kandalama, Kala Oya, Mahawilachchiya, and Pavatkulam). So this might result in lower labour inputs than would be the case if water availability were better. In an attempt to get round this problem, the relationship between labour input and paddy area was examined just for those locations with a reliable Maha water supply (those in the "medium" and "high intensity" categories of Chapter 5). However, not only does this reduce the number of observations from 15 to 9, it also significantly reduces the range of average holding sizes covered to only about 2 acres (2.72 to 4.81 acres). In fact there is not much improvement in the relationships resulting from the elimination of the poorly watered locations: no correlation is seen between the figures on total labour input per acre and holding size, and although the relationship for family labour and holding size improves slightly (the value of  $R^2$  increasing from 0.32 to 0.48) that for hired labour deteriorates. However, the clearer negative correlation between family labour input per acre and holding size may be significant as this is the sort of relationship one would expect (and it is in line with the findings of Wickramasekara, 1980). So to recapitulate on the main results:

i/ There is no evidence of any relationship between aggregate labour input per acre and the average area of paddy cultivated, with the per acre labour inputs generally falling into a

cluster between 40 and 70 mandays .

- ii/ There is limited support from the data for the hypothesis that the input of family labour per acre declines with farm size. When only those locations with a reliable water supply in Maha are examined, the relationship is slightly stronger.
- iii/ There is evidence that the input of hired labour per acre, increases as the extent of paddy cultivated increases. Further observations would help to confirm this relationship.

#### 4.4 POLICY IMPLICATIONS

If these findings are generally applicable to the dry zone of Sri Lanka, it would seem that the trend towards smaller farm sizes on colonisation schemes may have had less impact on the total input of labour per acre than is sometimes thought, with various other factors exerting a more powerful influence. The hypothesis that smaller farms will generate a higher input of labour per acre may be true for countries such as Pakistan where the range of holding sizes is much wider than is common in Sri Lanka, but does not seem to be so relevant over the small range studied here.

However, the farm size does seem to have a marked influence on the composition of labour input. While some hired labour is used even on small farms (because of the pronounced seasonal peaks in paddy labour requirements) the input per acre increases rapidly as the average holding size rises. At the same time the per acre input of family labour declines, so that larger farms use a much higher proportion of hired workers than do small farms. While this provides employment for hired labourers, it will be of a seasonal and short-term nature. Also it is uncertain whether adequate supplies of labour will be forthcoming if large areas of new land are colonised with holdings of such a size as require much hired labour.

These questions will be returned to later in the paper when projections of hired labour requirements for the Mahaweli Project area are made.

## CHAPTER 5

### WATER AVAILABILITY AND LABOUR INPUT

#### 5.1 THE INFLUENCE OF WATER SUPPLY ON THE USE OF LABOUR

The availability of water is likely to have an important effect on the level of labour input. To some extent this will operate via the effect of water supply on the returns to labour, and this has already been examined. But there are reasons why water supply deserves separate consideration. For instance, in the earlier chapter only the observed levels of net return were considered whereas in fact it will be the expected return which influences the farmer's decision. And the observed return may not be a good indicator of the expected return if the water supply is subject to inter-year fluctuations. Therefore, this chapter tries to determine the quality of water supply at each location and discover whether this has any systematic effect on labour use.

There are 3 main ways in which water availability can be postulated to affect farm labour input:

First, the amount and timing of the water supply within a season will significantly affect the labour required for various operations. For instance, land preparation can be performed more speedily in wet conditions; weed control is made easier where continuous flooding is feasible (only a limited number of species can grow and compete with rice under flooding); and the effects of water supply on yields (both via the water requirements of the plant itself, and via the effects of flooding on improving availability of nutrients, notably nitrogen and phosphorus) will influence the amount of labour needed for operations such as harvesting and threshing.

Secondly, the total water availability will determine how many crops can be grown within a year, and indeed whether a full Maha crop can be grown.

Thirdly, inter-year reliability of water supplies will make it more worthwhile for farmers to adopt improved techniques of production such as transplanting, application of fertilizers and pesticides, etc., which demand labour themselves and are also likely to raise yields and so have indirect effects on labour demand. This is because it reduces the risk of the investment being lost due to crop failure.

## 5.2. MEASURING WATER AVAILABILITY

However, although water supply obviously has an important effect on labour input it is difficult to measure the relationship in precise terms because of problems in quantifying "water supply". One could try to achieve this by asking farmers how often (e.g. "How many days in the previous week?") they have experienced water shortages. But answers may not be a reliable guide to the adequacy of water supply if the farmers' desire for water is higher than the actual requirements of the crop. One could have some sort of metering system to check in physical terms the quantity of water supplied, but this would be a difficult business if the sample size is large.

In fact in view of the difficulties of measuring water availability, it is not surprising that many of the studies covered here do not get beyond mentioning that water availability problems existed. In one case (Izumi and Ranatunga) farmers were actually asked for their opinion on the water supply conditions, classifying them simply as either "good" or "bad". But in most cases it is necessary to infer from other statistics or comments something about the water supply condition. For instance, figures are often given on the percentage of area cultivated for the Maha season studied and also perhaps for the preceding Yala season. One might assume that if both of these figures are high there is no shortage of water, as otherwise it is likely that the acreage planted would have been reduced so as to ensure a reasonable supply of water for the crop.<sup>1</sup>

<sup>1</sup> On the other hand it is possible that, as there is a trade-off between the area of paddy which can be planted and the supply of water per acre with a given water supply, the availability of water per acre will be lower where the area irrigated is large. However, this does not seem to be consistent with experience in most locations.

Details of just what information was available on the water supply situation at each location are given in Appendix D. In most cases it was possible to get a reasonable impression of the conditions which existed from figures or comments in the reports, thus allowing the locations to be divided into four broad categories according to water availability. In one or two cases it was not entirely clear into which category a location should be placed, but in general the divisions should be satisfactory. See Table 5.

The categories used are "Village Tank", "Low intensity system", "Intermediate intensity system", and "High intensity system". The intensity of the system refers primarily to the paddy cropping intensity, though to some extent also reflects the importance of paddy to the farming business - chena is generally of more importance at the low intensity locations than at the high intensity ones.

The figures on labour input at each location are listed so that it can be seen whether there is any tendency for this to vary in a regular pattern between groups.

### 5.3 THE RESULTS

For several reasons the effects of water availability on labour input cannot be fully observed from the figures in Table 5. For one thing, they are only for the Maha season so that differences in labour input in Yala are not shown, although it is in Yala that inadequacy of rainfall will make water shortages more critical. This makes difficult the comparison of locations in groups (iii) and (iv) both of which have reasonably assured water supplies in Maha but divergent water supply situations in Yala.

A second difficulty is that because of characteristics specific to individual locations there is considerable variation between figures within groups as well as between them. For instance, the figures for Hambantota are much lower than one would expect for a relatively well-watered location and the input of family labour



at Pavatkulam is also much lower than is typical in that group. The reasons for these divergences are discussed elsewhere. But the point to stress here is that they mask the effects which the water supply alone would have.

Thirdly, it is difficult to say much about the two "village tank" locations, where one might expect farmer behaviour to differ in some ways from that on the colonisation schemes. This is mainly because (i) two samples are not enough for a reliable pattern to emerge (ii) the locations are in some ways untypical (especially as Walagambahuwa is receiving much attention under the Sri Lanka - I.D.R.C. Cropping Systems Research Project.)

But inspite of these problems a number of interesting observations can be made from the data.

There is, as one would expect, a clear tendency for the input of labour per acre to be at a higher level where the water supply is more reliable. The average total labour input increases from 43.2 mandays/acre for the low intensity system, to 61.3 mandays/acre for the intermediate group, and 66.5 mandays/acre for the high intensity group. The village tanks at 53.5 mandays/acre fall between the low and the intermediate group results.

There is also a tendency for the per acre input of hired labour to increase in the same way, but family labour input shows no systematic variation. For the village tanks, hired labour input is at a low level and family labour much more important.

The differences between the low intensity group and the two higher intensity groups is more pronounced than the difference between the intermediate and high groups, which is as one would expect given the reasonably assured supply of water in Maha in both of the latter. So it seems that where there is a significant difference in water availability, there is generally a significant difference in labour application. Not only is this a result of the lower returns to labour in paddy production which can be expected when the water supply

is poor, but also of the fact that chena is often an important alternative activity at such locations, resulting in competing demands for labour between paddy and chena at certain times of the year.

The lower level of hired labour input at the poorly watered locations also seems to be a rational response to the high risk of production: farmers will avoid cash expenditures and concentrate on family labour use. The same behavioural pattern was observed in the study of two villages in Kurunegala District with contrasting water supply situations undertaken by Sirisena and Fieldson (forthcoming).

So, in conclusion, it seems that well-watered locations will have a higher total input of labour, and a higher proportion which is hired. More detailed effects cannot be detected because of the familiar problems of isolating the effects of one particular variable in cross-sectional analysis.

## CHAPTER 6

### AN EXAMINATION OF LABOUR INPUTS INTO NON-PADDY CROPS

#### 6.1 INTRODUCTION

So far only the input of labour into paddy has been examined, but plans for different systems of the Mahaweli include various other crops in an effort both to economise on water and to raise output of other commodities, often presently imported, with a view to the day when self-sufficiency in paddy is achieved.

In fact for several reasons consideration of labour input into paddy may be of even wider relevance to Mahaweli than it at first appears. First, there seems to be a tendency when detailed project appraisals are undertaken for the share of paddy included to be increased at the expense of other crops, as the returns from rice may be more certain <sup>than</sup> those of crops of which farmers have had little previous experience, and the costs in terms of processing and marketing are often less (the input/output infrastructure for paddy is well developed in most areas). Secondly, even if other crops remain in the project plan, the farmers may not be willing to grow them to the planned extent, and the well-known preference for rice will exert itself. This has been the case in Uda Walawe where the Asian Development Bank envisaged almost 10,000 acres of cotton by 1977. In fact only 820 acres were grown in that year for a host of reasons including poor water and input availability, and inadequate enforcement of cropping regulations resulting in the widespread cultivation of paddy on highly permeable soils (Farrington, 1979). Thirdly, the introduction of other crops with different labour requirements is no guarantee that such labour requirements will be met, and past labour input may be a much better guide to future labour supply than the agronomist's estimates of what labour should be applied to the crops grown. And as paddy has been the dominant crop in dry zone colonisation schemes in the past, the labour applied to paddy may give some idea of the supply which can be expected in the future.

the  
Nevertheless, attempt has been made to gather together data for enterprises other than paddy to see whether the farmer's decision-making with respect to other crops differs from that for paddy alone. One might expect that in view of the importance of paddy as a subsistence crop it will receive "preferential treatment" with operations on other enterprises fitting around the paddy work, but if irrigation is unreliable the farmers may concentrate on the dryland crops.

Unfortunately, the sources of data which have been used throughout this study are not generally able to give much detail on non-paddy cultivation. In view of the great importance of rice in Sri Lanka, it is understandable that many studies should confine themselves to paddy production, especially as in some areas (e.g. Polonnaruwa) paddy makes up virtually the whole of the farming business.

But in a few cases it was possible to get some idea of the inputs of labour for all farm enterprises, as described below. These locations are not altogether typical so it may be difficult to draw any widely applicable conclusions. Walagambahuwa is a small village tank but production will be affected by its selective treatment under the Sri Lanka/I.D.R.C. cropping systems research project; Mahakanadarawa and Mahawilachchiya are medium sized tanks but with water availability problems; and only Minipe has a reasonably good water supply. Figures are also given for the two dry zone villages studied in Sirisena and Fieldson (forthcoming) though of course the situation in these is different in many respects from that on dry zone colonization schemes.

## 6.2. THE RESULTS

A summary of the available data is given in Table 6. All figures relate to Maha seasons only as it is in this season that most rainfed cultivation is concentrated. The figures for different locations are not always directly comparable as in some cases there are separate figures for chena and highland, and in others these are grouped together. For Minipe, no distinction is made between family

TABLE 6: LABOUR INPUTS, AREAS AND RETURNS OF DIFFERENT FARM ENTERPRISES AT SELECTED LOCATIONS

	Labour input per acre						Area (Acres)			Returns per acre			Returns per man-day		
	Chena		Highland		Paddy		Chena	High land	Paddy	Chena	High land	Paddy	Chena	High land	Paddy
	Family	Hired	Family	Hired	Family	Hired									
Mahawilachchiya	74	2	71	1	43	9	4.0	0.7	2.8	463	327	851	6	5	17
Mahakanadarawa	79	8	86	7	32	14	1.8	1.0	1.5	474	692	1194	5	7	26
Walagambahuwa <sup>(1)</sup>	52	5	-	-	41	7	2.2	-	1.8	394	-	1549	7	-	32
Minipe <sup>(1)</sup>	69 <sup>(2)</sup>	-	-	-	46	23	1.6	-	2.8	317	-	1003	5	-	15
Moragaswewa <sup>(1)</sup>	57	21	-	-	22	9	1.4	-	3.6	640	-	1410	8	-	45
Heelogama <sup>(1)</sup>	25	30	-	-	11	32	1.0	-	3.1	569	-	1568	10	-	36

(1) For these locations figures for chena include highland

(2) Includes family and hired labour.

and hired labour application to rainfed crops though it is noted that "jungle clearing is usually undertaken using only family labour" (page 32) so hired labour input is probably low. In spite of these difficulties, a number of broad conclusions can be drawn.

First, the total input per acre of labour is higher in chena and homestead cultivation than in paddy cultivation at all locations except Minipe (where they are equal). One reason for this is that labour needed for specific tasks will be higher than for paddy (for instance, clearing of land for chena cultivation, and crop care, including weeding and guarding against wild animals). Another reason is that mechanisation is less feasible on highlands, where land clearing may be rough and where holdings are much more scattered than is usual for paddy allotments. Chena holdings are often distant from the village so that time is spent in travelling.

The fact that Minipe is the only location at which the per acre labour input into paddy is as high as on highland cultivation is significant. As mentioned above this is a major irrigation scheme with a secure water supply, so it seems that where the farmer can rely on his paddy crop he will put more emphasis on that. The other two locations which, while not part of a major scheme, had reasonably good supplies of water in the survey years, Walagambahuwa and Heelogama, also show a much lower labour input into chena (57 and 55 mandays per acre) than those locations where the availability of irrigation was poorer. (labour input into chena was 76 mandays per acre at Mahawilachchiya, and 78 mandays per acre at Moragaswewa).

Table 6 shows that for each location the input of family labour per acre of chena and highland is higher than that into paddy, and conversely that the input per acre of hired labour is lower than for paddy. This will be partly because chena operations are not so time-specific as those in irrigated paddy cultivation. So there is more flexibility over labour inputs, which may allow the tasks to be accomplished by family labour instead of resorting to hired

labour.<sup>1</sup> Also most chena operations can be timed so as not to clash with busy periods in paddy cultivation - land clearing and planting can be undertaken in the period before the start of Maha rains, and weeding of chena crops can usually be fitted into the slack periods of paddy cultivation (Silva, 1977). The low input of hired labour is no doubt partly due to the relatively low levels of return found on chena and highland cultivation which mean that cash expenditures are kept to a minimum. It might seem irrational to apply family labour at such high levels when the returns are so low, but much of the work will be done at times of the year when the opportunity cost of the labour is low. Silva even suggests that farmers may enjoy time spent on chena cultivation - "many farmers seem to attach a recreational value to their chena..... They certainly treat the chena as an economic enterprise, but at the same time point out that the best way to spend their slack periods from paddy is to 'go to the jungle and plant a few crops'(page 89).

Another important point to emerge from Table 6 is that as paddy gives considerably higher returns per acre than highland and chena crops and also has lower per acre labour requirements, the returns per unit of labour applied are very much higher than for the other enterprises. This provides a strong incentive for farmers to concentrate on their rice crop, especially if labour is constraining. Together with the much better established infrastructure for paddy (with respect both to provision of inputs and marketing of output),

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<sup>1</sup> In this context it is interesting to note that Farrington's study of cotton production in Sri Lanka found that a much higher proportion of the input of labour was hired in chena cotton production than is the case in most of the locations included here. This was largely a result of a high proportion of hired labour in picking, a very time-specific task, though hired labour was also used for other operations. So in certain circumstances (such as, in this case, a cash crop with time-specific labour requirements) hired labour may be applied to chena crops in larger amounts than observed above.

it goes a long way towards explaining the commonly observed preference of farmers for growing paddy where sufficient irrigable land is available.

But in spite of the low returns to labour in chena and highland cultivation, these enterprises may still provide a valuable addition to income when the returns from paddy are precarious, or the extent which can be planted is limited. Most farmers rely mainly on family labour and although the levels of input are high this is probably achieved without serious adverse effects on paddy cultivation. However, it is likely that on large-scale colonisation schemes where a satisfactory income can be made from paddy cultivation alone and where no chena land is available in the immediate vicinity of the farm, chena cultivation will be much less attractive a proposition.

## CHAPTER 7

### CONCLUSIONS AND POLICY IMPLICATIONS

#### 7.1 PROBLEMS OF MULTIVARIATE ANALYSIS

In previous chapters different factors have been examined all of which have some effect on the input of labour. But a problem which has been encountered repeatedly is that of isolating the effects of an individual variable when so many variables are acting simultaneously on the labour input. This has been done in an ad hoc manner above. For instance in looking at the effects of mechanisation on labour use attempt was made to minimise the influence of other variables by examining the figures for labour input into land preparation alone (this is where the effects of mechanisation will be most pronounced). And in other chapters attention was given to the influence of variables other than the one being studied so as to see whether this led to any divergence from the underlying relationship between the particular variable and the input of labour.

Thus in most cases a reasonably clear picture of the effects of the various different factors on the input of labour was obtained. However, such a piece-meal approach can never be as satisfactory as a rigorous multivariate analysis such as multiple regression. This allows the simultaneous influences of many variables to be calculated so that the dependent variable can be more fully explained. Indeed if all the relevant independent variables were included and could be accurately specified and measured, the dependent variable would be entirely explained.

Such an analysis has been undertaken by other writers (e.g. Wickramasekara, 1980) but numerous problems exist which prevent it from giving the complete picture which might be hoped for.

First it is virtually impossible to include all the factors which influence the farmer's input of labour. Such things as the health of the family, the weather, the availability of off-farm work, etc., all have some influence but are unlikely all to be included in the

regression.

Secondly there will be multicollinearity between many of the variables i.e. different variables move more-or-less in line, making it impossible to distinguish reliably the individual effects of each variable. For instance, the quality of the water supply may be correlated with the net return, and also perhaps with the type of technique used e.g. transplanting will probably be more common where the water supply is secure, as the chances of losing the investment in labour are reduced (See Sirisena & Fieldson, forthcoming). One might also expect farmers with large holdings to be more likely to use tractor power than smaller farmers, as this allows them to cultivate their land more quickly. Many other sources of multicollinearity could be hypothesised, all of which will reduce the ability of the regression to isolate reliably the effects of individual variables.

A third major problem is that many important variables are difficult to quantify. This problem has already been encountered. For instance water availability and farm power type could not be studied in a precisely quantitative manner as it was only possible to divide the locations into broad categories according to the levels of water availability and type of power used. In some cases this can be accommodated in regression by the use of a dummy variable (for instance taking a value of 1 when water supply is good and 0 when it is bad). But such a procedure becomes complicated when there are more than two possibilities ( in Chapter 5 locations were divided into four groups according to water supply conditions).

In addition to these more general problems, the type of data available to this study is not amenable to multiple regression. The figures are averages for locations, not farm level data, and the number of observations differs from location to location (as does the sampling technique and method of survey). This would lead to biased estimators if ordinary least squares regression were used.

So for a variety of reasons multiple regression was not used in this study.

## 7.2. A MATRIX PRESENTATION OF THE EFFECTS OF EACH VARIABLE

It is still possible to bring together all the different variables in a simple fashion. This is attempted in Table 7, which displays in matrix form the levels of the four main variables which have been examined, indicated as H(high), M(medium), or L(Low).<sup>1</sup> In the last three columns the direction of the relationship which has been shown to exist between the variable and the different types of labour input is given, so that one can see the effect that the particular variable is likely to have on each type of labour input. For instance, mechanisation has a negative relationship with family labour input, so at a location where the level of mechanisation is high(H) this variable is likely to be exerting a downward influence on the input of family labour.

In the same way, the effects of each of the major variables can be assessed, and the outcome which one would expect can be compared to the actual total, hired, and family labour inputs given in rows (v) to (vii). In some cases the actual results will be fairly consistent with the expected results, but in other cases there is not such a good correspondence. There must be other important factors operating at these locations (some of which have been mentioned in the text). To some extent, consistency between the actual and expected results is merely tautological - the actual results have been used to reveal the relationships on which the expectations are based. But the tabular summary is still useful in bringing together the results of the individual chapters, and allowing them to be considered simultaneously.

<sup>1</sup>The distinctions between H, M and L were made on an ad hoc basis, and there is not necessarily the same number of locations in each class. For mechanisation and water use the classifications are broadly those used in the respective chapters, and for net returns and farm size arbitrary divisions were made. A return per acre net of all purchased inputs of less than Rs.1000 was considered low, Rs.1000 - Rs.1200 medium, and above Rs.1200 high. The corresponding classes for farm size were less than 2 acres, 2 acres to 3 acres, and above 3 acres.

TABLE 7: SUMMARY OF THE EXPECTED INFLUENCES ON LABOUR INPUT

	Mahawilachchiya	Mahakanadarawa	Pavatkulam	Ussala Siyamba- Iangamuwa	Kandalama	Kaudulla	Minipe	Polonnaruwa <sup>1</sup>	Hambantota <sup>1</sup>	Elahera <sup>1</sup>	Walagambahuwa	Kala Oya	Mahaweli <sup>4</sup>	Relation ship with total labour input	Relation ship with hired labour input	Relation ship with family labour input
i. Water Availability	L	L	L	M	L	M	H	H	H	M	H	M	H	Positive	Positive	Unclear
ii. Net Returns	L	M	L	M	L	L	M	H	M	H	H	H	H	Positive	Positive	Unclear
iii. Mechanisation	L	M	H	L	H	M	M	M	H	L	H	M	H	Negative	Unclear	Negative
iv. Farm Size	M	L	M	M	M	M	H	H	H	H	L	L	M	Unclear	Positive	Unclear
v. Total labour input <sup>2</sup>	52	46	35	61	40	61	68	81	51	61	55	52				
vi. Family Labour input <sup>2,3</sup>	43	32	16	43	26	29	46	23	11	27	48	38				
vii. Hired labour input <sup>2</sup>	9	14	19	18	14	32	23	58	40	34	7	14				

1. Where two sets of figures are available per location they have been averaged, as it is the general picture which is of interest here.
2. In mandays per acre for Maha season (as in Table 1), rounded to the nearest whole number.
3. Includes exchange labour.
4. See text.

One of the points which emerges even before the results for individual locations are examined is that it will be difficult to predict the input of family labour. Of the possible explanatory variables examined, the only one to reveal a clear relationship with family labour input was the degree of mechanisation (inversely correlated). So it seems that the main determinants of family labour input have not really been found. This is not surprising in view of the complex factors which affect the allocation of the family's time. Some of these were considered in Chapter 3. For instance, where the returns to labour are high the family may be induced to work longer hours because it is receiving more reward for its effort. But on the other hand, it can make a given level of income with a smaller input of labour so may decide to reduce the amount of work applied. If different families respond in different ways, no noticeable relationship will emerge. Other influences which are relevant include family size, health, education, off-farm employment, and possibly also ethnic and cultural characteristics.

In contrast, the use of hired labour is more of an economic decision. It is influenced by the above characteristics in as much as the use of hired labour is partly determined by the amount of family labour applied.<sup>1</sup> But generally one would expect the farmer to consider the economics of hired labour use much more explicitly than when applying family labour.

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<sup>1</sup> Though when hired labour input per acre is plotted against family labour input per acre there is <sup>not</sup> a strong correlation, there are several cases where low hired labour input is associated with high levels of family labour use, and others where high hired labour input was observed at locations with low levels of family labour use. Mahawilachchiya, Walagambahuwa, Usgala, and Kala Oya are examples of the former, and Hambantota and Polonnaruwa of the latter.

Looking in more detail at the results of Table 7, it can be seen that the highest total labour input would be expected to occur at locations with high levels of water availability and net returns (for which the relationship with total labour input is positive) and a low level of mechanisation (for which the relationship is negative). It is unclear what level of farm size is most likely to be associated with a high total labour input. In fact no location has H, H, L in rows (i), (ii), and (iii), the nearest being Polonnaruwa with H, H, M, and Elahera with M, H, L. Next comes Usgala (M,M,L) and Minipe (H,M,M). Polonnaruwa has the highest per acre total labour input, Minipe the second highest, and Elahera and Usgala are equal third, so in this case the matrix has predicted well. The lowest total labour inputs would be expected when the matrix shows L, L H and this pattern is found at Pavatkuilam (which has the lowest labour input of any of the locations) and Kandalama (which has the second lowest).

Likewise, the high users of hired labour could be predicted from the matrix as could those with low hired labour inputs (with the exception of Walagambahuwa).

Because most relationships between family labour input and the variables studied have been unclear, it is not possible to predict the levels of family labour application from Table 7.

The accuracy of these predictions is in no way surprising because, as noted above, the labour figures in rows (v), (vi), and (vii) were used to establish the relationships of rows (i) to (iv). Nor is it very useful to be able to predict what one already knows. The value of such a matrix is in allowing past data to be used to predict into the future. In the following paragraphs an attempt is made to extrapolate from past experience so as to estimate what levels of labour input are likely under the Mahaweli scheme.

### 7.3. PREDICTION OF LABOUR INPUTS UNDER THE MAHAWELI PROGRAMME

First it is necessary to obtain information on the environment of the small farmer in the project areas, so as to find out at what level

the variables used in the prediction will lie. Most of this information has been drawn from Abeygunawardena (1979) which provides a good summary of current plans for the project. It is stated that the distribution of newly irrigated land to colonists is envisaged as being  $2\frac{1}{2}$  acres of irrigable lowland, and  $\frac{1}{2}$  acre of non-irrigable highland per farmer. Further, on the basis of the NEDECO Implementation Strategy (1978) the cropping system will be based on "Cultivation of paddy on lowland soils both in the Maha and Yala seasons" (page 102 ) so the area of paddy in Maha will also be  $2\frac{1}{2}$  acres per farmer. On the criteria noted in footnote 1, page 69, this will place Mahaweli settlements in the medium category of paddy area.

It seems that the level of mechanisation will be high. There is currently a shortage of draft animals in many parts of the dry zone so unless there is a breeding programme on a much larger scale than anything currently underway, there cannot be an adequate supply of animals for the newly colonised areas. This is recognised by Dr. Abeygunawardena who concedes that "land preparation, threshing, processing etc., therefore, must necessarily be mechanised." (page 108 ).

It goes almost without saying that the water supply should be good. The basic aim of the scheme is to provide sufficient water to allow two complete paddy crops, and water storage and distribution facilities are constructed with this in view. Some deterioration of the infrastructure is inevitable, and illicit water use by certain farmers may curtail supplies to others, but by the standards prevailing in Sri Lanka's dry zone the water supply on the Mahaweli settlements should still fall into the "high" category.

The level of net return which is likely requires some calculation. A yield of paddy is envisaged which, when converted into bushels per acre, works out at 81 bu/acre.<sup>1</sup> This may appear unrealistic

<sup>1</sup> An output of 344,000 tons is expected from 83,594 ha (Abeygunawardena, 1979, page 105). Assuming that 1 bushel = 20.9 kg, this is equivalent to 200 bu/ha or 81 bu/acre.

when compared to the island-wide average of 54.7 bu/acre for Maha 1978/79, but in fact the yield for major colonisation schemes in the same season was 65.87 bu/acre, and in some districts the figures were higher. So the target yield may be ultimately attainable, given a good supply of water and other inputs, and the use of predominantly labour intensive techniques such as transplanting and weeding. The gross return per acre at 1978 prices for Maha paddy can then be calculated by multiplying the projected yield by the 1978 G.P.S. price of paddy of Rs.40 per bushel to give Rs.3240 per acre.

While no information is given on anticipated costs of production under Mahaweli, reasonable estimates can be made. The assumed levels of hired labour input<sup>1</sup> can be costed at the approximate average wage rate for the dry zone in 1978 of Rs.13<sup>2</sup> (including allowance for meals) to give a total cost for hired labour for the Maha season of Rs.421. Data on non-labour purchased inputs for the locations studied in this paper show a range of Rs.350-650 at 1978 prices, but as a high input system is envisaged for the Mahaweli, it seems reasonable to assume that the cost of purchased inputs will be at the top end of this range - say Rs.600 per acre.

Subtracting the per acre costs of purchased inputs from the gross return per acre gives a figure for the return net of costs except labour of Rs.2640 per acre, and subtracting also the cost of hired labour gives the return net of all costs of Rs.2219 per acre. For an average farm of 2½ acres of lowland paddy, this is equivalent to returns of Rs.6600 and Rs.5548 under the respective definitions, at 1978 prices.

Comparing these figures with those in Table 3, it is clear that the

<sup>1</sup> Abeygunawardena assumes an input of 80 mandays per farm or 32.4 mandays per acre (page 109), the figures being taken from the NEDECO "Mahaweli Ganga Development Programme - Implementation Strategy Study" 1978.

<sup>2</sup> See wage data in, for instance, A.R.T.I. (1979b), A.R.T.I. (1980), and Crooks & Ranbanda (forthcoming).

anticipated level of returns under the Mahaweli is higher than those of most existing dry zone colonisation schemes, so a "high" (H) classification for net return is given in Table 7.

It is now possible to use the matrix to help predict the levels of labour input for the Mahaweli area. Table 7 shows that Mahaweli settlements are likely to have high water availability and net returns both of which will exert a positive influence on the level of total labour input, but the degree of mechanisation (also high) is likely to have a negative effect. No other location has H, H, H, in rows (i), (ii), and (iii), the nearest being Polonnaruwa (H, H, M) and Hambantota (H, M, H). The lower level of mechanisation at Polonnaruwa will mean that the labour input on Mahaweli settlements will probably be below the 81 mandays recorded there, and the lower level of net returns at Hambantota suggest that it will be above the 51 mandays of this location (especially as the unusual land ownership pattern found there will tend to reduce family labour to untypically low levels). In fact a similar level to that found at Minipe (68 mandays/acre) would seem reasonable (the level of return being lower there, but the extent of mechanisation also being more limited). The Mahaweli figure is likely to be higher than for Kaudulla (M, L, M,) or Usgala (M, M, L) and the figure for both these locations is 61 mandays/acre. So it is tentatively suggested that a total labour input of some 65 to 70 mandays per acre on the newly colonised areas of the Mahaweli project would be consistent with the evidence from other dry zone settlement schemes.

It should also be possible to indicate the general level of hired labour input. Though the effect of the level of mechanisation on hired labour use is unclear, the levels of water availability, net returns, and farm size, will all exert a positive effect. Their respective levels under the Mahaweli scheme are likely to be "high", "high", and "medium", suggesting that hired labour input will be lower than at Polonnaruwa (58 mandays/acre) where the pattern is H, H, H, but at a similar level to the 34 mandays at Elahera (M, H, H), 40 mandays at Hambantota (H, M, H), and 23 mandays at

Minipe (H, M, H). Around 35 mandays per acre would be a realistic estimate, indicating an approximately 50:50 split between family and hired labour use.

In fact these results are in quite close agreement with the figures presented by Abeygunawardena. He quotes figures of 80 mandays of hired, and 95 mandays of family labour input per farm, or 32.4 and 38.4 mandays per acre, a total of 70.8 mandays per acre. So the assumptions on labour input being used by Mahaweli planners are, on the face of it, pretty much in line with what the empirical data would lead one to expect.

However, one of the limitations of the matrix approach used here is that by classifying locations into broad categories, extreme values may not be given full weight. Thus the fact that the returns planned for Mahaweli are well above those obtained at the other locations in the "high" group does not emerge. But at Rs.2219 the return per acre net of all purchased inputs is well above the range (Rs.1208 to Rs.1670) of the rest of the group, and at the farm level the figure for Mahaweli of Rs.5548 is exceeded only by one of the values for Polonnaruwa. So it seems possible that labour input may have to be at a higher level than suggested from the matrix, as the planned very high yields will only be achievable with the use of predominantly labour intensive techniques. It must therefore be questioned whether (a) the yield targets of the Mahaweli project can be met with planned levels of labour application, and (b) if not, will the yields be lower than planned, the labour input higher, or some combination of the two?

The relationships between the returns from paddy and the levels of labour input established in Chapter 3 are useful in this context. The projected values for the Mahaweli scheme, obtained from Abeygunawardena, can be substituted into the regression equations to see whether they are consistent with the results from the locations studied.

Looking first at the relationship between total labour input into lowland paddy per farm and the net return from lowland paddy, the regression equation shows that a postulated labour input of 175 mandays is associated with a net return of Rs.4397, whereas a postulated net return of Rs.6600 is associated with a labour input of 246 mandays. So it seems that planners are anticipating a higher output than has previously been observed for the assumed levels of labour input.

Going on to consider the figures for family labour input and the net return, Fig 3.3 (page 36 ) showed no apparent relationship between these variables for the locations studied. If the point for Mahaweli (95 mandays, Rs.5548 - excluding the cost of hired labour) is added to the diagram, it falls within the wide cluster of points obtained from the other locations. In fact it would be quite close to the value for Elahera, and more-or-less halfway between the two values for Polonnaruwa ( a location where the agriculture has much in common with the high intensity cultivation planned for Mahaweli). There are several locations where the input of family labour is some 25-35 mandays higher (Usgala Siyambalanga, Minipe, Mahawilachchiya, and one of the values for Polonnaruwa) so it is possible that a higher input might be achieved.

Looking thirdly at the relationship between hired labour input per farm and the net return from paddy, the value for Mahaweli (80 mandays, Rs.6600) would again diverge from the trend ( $R^2=0.94$ ) which emerged from the other locations. A net return of Rs.6600 is associated with an input of 179 days of hired labour, and a hired labour input of 80 mandays is associated with a return of only Rs.3855. The Mahaweli situation is likely to lie somewhere between these two pairs of values because if the input of hired labour were increased the net return would fall due to the higher wage bill.

Whilst this is a static and much simplified analysis there seems no reason why the relationship between labour input and net revenue under Mahaweli should be very different from those observed here.

So, if the cost of production and gross return figures used here are reasonably accurate estimates, then it seems that the estimates of labour input are too low. There is some scope for raising family labour input per farm, but there is apparently a much more serious underestimation of the amount of hired labour which will need to be applied.

A rough guide to the extent of this underestimation is given by solving the equation linking total labour input per farm with the net return per farm, assuming:

- (a) that an additional 25 mandays of family labour can be used (as family labour input has been observed at higher levels on other colonisation schemes), and
- (b) that additional hired labour is available at a cost of Rs.13 per manday, at 1978 prices.

The regression equation was:

$$Y = 0.032X + 34.3$$

So substituting in the projected levels of net return and labour input, applying assumptions (a) and (b) and denoting the increased requirement for hired labour as Z:

$$(175 + 25 + Z) = 0.032 (6600 - 13Z) + 34.3$$

$$Z = \frac{0.032 (6600) - 200 + 34.3}{1 + 13 (0.032)}$$

$$Z = 32$$

i.e. an increase in the number of mandays of 32 mandays per farm, or 40%, for the Maha season is indicated.

No strong reliance can be placed on the exact size of this increase. But the evidence presented here does suggest that, if projected levels of output are to be achieved under the Mahaweli scheme, then labour intensive practices will have to be adopted which will result in a significantly higher demand for hired labour than is at present envisaged. The results of Chapter 2 must also be borne in mind. It was shown that while farm family labour inputs declined with increasing levels of mechanisation, hired labour inputs changed very little. So mechanisation, while on observed trends may ease the work-load of the farm family, is unlikely to bring about

any large reduction in the requirement for hired labour.

It is possible that what will in fact occur is that hired labour demand will not be at such a high level, but that the intensity of cultivation will remain at a level below that which is necessary to achieve output targets. Alternatively, if reliable water supply can be guaranteed, family labour application may be at a higher level than has been observed in the past. It is difficult to say just what combination of labour input and paddy output is most likely. But what does seem certain is that projected levels of output are unlikely to be achieved at projected levels of labour input.

#### 7.4. EXTRAPOLATION FROM THE FARM TO THE PROJECT LEVEL

It was shown in the above section that the input of hired labour per farm in the Mahaweli areas may need to be some 40% higher than the planned level of 80 mandays if output projections are to be met. Below, attempt is made to trace the implications of such a requirement for project-wide labour demand. It is more convenient to work on a per acre basis: 80 mandays per farm is equivalent to 32.4 mandays per acre, and 112 mandays per farm (the increased level suggested by the regression) to 44.8 mandays per acre. Because of the uncertainty over where in the range of labour inputs and associated returns cultivation will actually take place, the crude extrapolations undertaken below will use two assumptions on hired labour input: first, that it will be at approximately the level forecast by Mahaweli planners (rounded to 30 mandays per acre for convenience) but with output lower than expected; secondly, that it will be at the level considered necessary if output targets are to be achieved (45 mandays per acre).

The estimated net irrigable areas under the Accelerated Programme and the Balance System are 160,900 and 144,000 hectares respectively i.e. 398,000 acres and 356,000 acres (Abeygunawardena, 1979, page 107). So it is a simple task to obtain estimates of the number of mandays of hired labour per Maha season which would be required

for each Programme under the different assumptions. The results are 11,940,000 and 17,910,000 mandays per Maha season for the Accelerated Programme, and 10,680,000 and 16,020,000 for the Balance.

For these figures to be more meaningful one must try to get from an estimate of the mandays required to an estimate of the number of men required. In Abeygunawardena's paper this is done simply by dividing by 365 so as to give figures "in terms of full-time employment". But this clearly gives a misleading impression of the amount of hired labour which will be required under the scheme, as it cannot be assumed that workers work for 365 days per year - the pattern of crop labour requirements, and the physical abilities of the workers make this most unrealistic. Most of the hired labour will be concentrated into several peak periods (e.g. for land preparation, transplanting, and harvesting). While these operations may last only for a few days on each individual farm, there will be some staggering of operations between farms within a location, and even more so between locations. So a worker should be able to find employment for a longer period than the time taken to undertake the operations on a particular farm.

It is important in this context to realise that much of the hired labour used in dry zone colonisation schemes will be migratory labour travelling from wet zone villages. This subject will not be dealt with in depth here, but the reader is referred to two studies which will shortly be published by A.R.T.I. Perera and Gunawardena (forthcoming) note that there are two main cycles of migratory labour; the first lasting 4 or 5 weeks for land preparation and planting, and the second for 2 or 3 weeks for harvesting and threshing. In their survey of three dry zone locations, Crooks and Ranbanda (forthcoming) found that the average duration per visit of migratory labour was about 38 days. It is possible that locally based, non-migratory labour will work a slightly higher number of days per season, and to avoid exaggeration of the number of workers required, the assumption will be made that the average hired

labourer is employed for 50 days per Maha season. This may well be an overestimate, in which case the figures obtained for hired worker requirement will be biased downwards.

So dividing the figures in mandays by 50, one obtains estimates of the number of hired labourers required under the Accelerated and Balance Programmes of 238,800 and 213,600 respectively using the lower assumption on labour input, and 358,200 and 320,400 respectively using the higher assumption. Adding the figures for the two stages gives totals of 452,400 and 678,600 under the different assumptions. These figures are for the newly irrigated area under the Mahaweli Scheme, and are in addition to any increase in labour requirement resulting from the intensification of cultivation on those existing irrigated areas which will benefit from supplementary irrigation water under the scheme.

So it appears indisputable that if the whole of the Mahaweli area is to be farmed intensively, using techniques such as transplanting, weeding, and fertilising which ensure high yields, the demand for hired labour in the dry zone will increase very markedly. As there is at present a shortage of labour in much of the dry zone with the result that colonists in many schemes have to rely on seasonally migratory labour from the wet zone, it seems inevitable that such seasonal migration will have to increase. An additional requirement for hired labour of the order of half a million workers per season has been indicated, and while these figures are only tentative, it is clear that even with the most cautious of assumptions, a very large increase in labour migration will be necessary if the Mahaweli Project is to realise its production targets.

The forthcoming study by Crooks and Ranbanda suggests that at present there is an abundance of labour in wet zone villages which is available on hire to dry zone farmers, and, no doubt, by the time the balance programme is completed, the population of the island and the numbers of working age will have increased still further (though competition from industry, construction etc. will also rise). In addition, an

increasing number of people from the families of settlers on older dry zone colonisation schemes will be looking for employment, as the well known "second generation problem" becomes more severe. Such increases in locally available labour notwithstanding, high levels of seasonal migration are likely to be necessary for the next two decades or so, after which increased availability of labour within the dry zone may reduce the need for such movements.

It is questionable whether this reliance on migratory labour is a desirable feature of dry zone development. The beneficial effects of such a policy include the provision of employment for underemployed wet zone villagers, and the consequent transfer of income from relatively prosperous dry zone farming areas into poorer communities. As such labour movements generally occur during the slack periods of wet zone agriculture, dry zone production can be raised with little detriment to wet zone cultivation. But on the other hand, migratory labour provides only a short-term and unreliable source of income, at the cost and inconvenience of much travel and disruption of family life. There are also problems of recruiting and accommodating workers. It is possible that if the average size of holdings were reduced slightly, and perhaps some changes made in the cropping pattern, there would be less need for the hiring of labour. This would reduce the amount of seasonal employment available, but would increase the number of families which could be settled permanently on the new colonisation schemes. A decline in the average income of colonists would probably result, but the extent of this decline would be reduced by the fall in hired labour costs. And as the planned net returns for Mahaweli are higher than on almost any other settlement scheme, some fall may not be too serious. Providing that the water supply is reliable, farmers should be able to make an acceptable income from an area of irrigated land smaller than 2½ acres.

On the other hand, the results of Chapter 2 hold out little hope of reducing hired labour requirements by increasing the mechanisation of cultivation. More likely it will be family labour which

is displaced. Although this is a complex question, it seems likely that mechanical cultivation on Mahaweli will be widespread more because of lack of animal breeding programmes than due to inherent economic advantages of tractor cultivation.

Finally, it is recommended that more emphasis be put on non-paddy crops in an attempt to reduce labour bottlenecks which have in the past led to reliance on hired labour. Many other crops (such as chillies, cotton, tobacco, onions, and sugar cane) have total labour requirements for the season which are well in excess of those of paddy. But providing that much of the requirement is in the off-peak periods of paddy cultivation it may be more easily met than the (lower) labour demands of additional paddy. But it is important that attention be given to the returns per unit of labour as well as per unit of land. This aspect has too often been ignored in the past, with the result that farmers have been reluctant to change from growing paddy, in spite of official encouragement to do so.

APPENDIX A

BACKGROUND TO THE STUDIES FROM WHICH DATA WERE EXTRACTED

This appendix gives details about the studies from which data were obtained (purpose of the study, sampling size and methodology, etc.) and also gives background information on the various locations. Detail is provided on the precise nature of the statistics on labour input and returns. For the information on power use and water availability see subsequent appendices.

Finally several studies are examined which were considered as sources of data but which were for some reason not found to be suitable.

The letters against each study title correspond to those given to the locations in Table 1.

A) "A Study of Five Colonisation Schemes Prior to Irrigation Modernisation", A.R.T.I. 1979/1980.

- Vol. I Mahawilachchiya
- Vol. II Mahakanadarawa
- Vol. III Pavatkulam

The studies undertaken by A.R.T.I. under the above title are benchmark studies designed to cover the agronomic, economic, and social conditions of five tanks in the north-central area of the dry zone (the reports on Vavunikulam and Padaviya are not yet completed). It is anticipated that similar detailed assessments of the agrarian situation in the five schemes will be undertaken some time after the completion of the modernisation project currently under way, so as to allow an evaluation of the project's success.

Some background to the schemes studied and to the sampling is given in Table A1.

TABLE A1

	Years of settlement	Acreage of paddy	Units of allotment Low-High Land Land		Number of allottees	Number in sample	% sample
Mahawilachchiya	1955-8	2650	3	2	888	150	17
Mahakanadarawa							
Stage 1	1958 to late )	4020	3	2	)	)	
Stage 2	1960s )	2000	2	1	)	275 )	12
Pavatkulam <sup>1</sup>	1955-8	4356	3	1.5	1063	160	15

<sup>1</sup> Not all land has been alienated due to inadequate water supply.

The samples were selected randomly and information was collected for the Yala and Maha seasons prior to the commencement of modernization: for Mahawilachchiya and Mahakanadarawa this was Yala 1976 and Maha 1976/7 and for Pavatkulam it was Maha 1977/8 and Yala 1978. Interviews were undertaken by trained investigators, under the supervision of the researchers.

The technique of data collection is not the same for all the studies. For Volumes I and II, a single interview survey was used to obtain data for Yala (the inactive season) but for Maha weekly farm records were maintained so that details could be recorded more fully. It was hoped in this way to eliminate memory bias as far as possible, but in fact it seems that the results did not merit the considerable extra effort.<sup>1</sup> Thus in subsequent volumes the single interview technique was used for the Maha season as well as Yala. While some loss of accuracy seems inevitable (especially with respect to the division of labour between operations and by different age/sex groups) the figures should be broadly reliable. Paddy is the most important crop to farmers, so they should have a good idea of their inputs in this case (the report for Pavatkulam does not include data on labour inputs into crops other than paddy).

#### *Labour Data*

The detail incorporated in the labour data varies according to the type of recording used. In Vol. III it is limited to the specification of labour input into lowland cultivation in mandays, subdivided by operation, and by source (hired or family). But for the earlier volumes, there is in addition to the above, information on the allocation of labour (by source) to highland and chena cultivation, and the distribution of labour input by month for the 3 land types. This is supplemented by histogrammic presentation of labour allocation by 10-day periods, and by graphs showing the monthly labour input by land-type. So a very thorough presentation of labour data is achieved.

Several additional points should be noted. First, exchange labour is included under family labour, but is reported not to be significant.

Secondly, the conversion ratios for woman-and child-days are as follows:

One womanday = 0.8 mandays  
One child day = 0.5 mandays

These conversion ratios are calculated from the prevailing daily wage rates.

Thirdly, the labour input figures used are for the whole year while figures for returns and acreages cultivated relate just to the Maha season. However, in all 3 cases no Yala paddy was cultivated so the input of labour into lowland paddy is all in the Maha season.

There is no reason to expect serious bias in the survey results, though of course the single-visit questionnaires are subject to the limitations of the farmer's memory. Cooperation by the farmers seems to have been good, with virtually 100% of the sample completing the questionnaire in each case. So this, together with the fact

<sup>1</sup> See page 7.

that the administration of the questionnaire was closely supervised by the researchers, means that the results should be quite reliable, and figures for the labour input per farm have been taken directly from the reports (Table 5.2 in each volume).

These figures were converted to a per acre basis by dividing by the average area of lowland paddy cultivated per farm; 2.8 acres at Mahawilachchiya (Page 19); 2.8 acres at Pavatkulam (Page 31); and 1.491 acres at Mahakanadarawa (only 45% of the average 3.3 acre holding was cultivated due to water problems).

#### *Data on Costs and Returns*

The figures for gross income per farm from lowland cultivation are available in Table 6.7 of Vol. I, and Tables 6.6 of Vols. II and III, and for gross cash production costs per farm for lowland cultivation in Table 6.1 of each report. The average net return per farm for lowland paddy cultivation can then be obtained by subtracting cash production costs from gross income from paddy, and then converted to a per acre basis by dividing by the appropriate acreage.

- B) "Irrigated farming in the Dry Zone of Sri Lanka; An economic survey of six major colonisation schemes 1973" T. Jogaratnam, Agricultural Economics Research Unit, Department of Agricultural Economics and Farm Management, University of Sri Lanka, Peradeniya, 1974.

The six schemes included in this study (Nachaduwa, Usgala-Siyambalangamuwa, Kandalama, Giritale, Kaudulla, and Kantalai) were all to be brought under the "Special Projects" programme from 1973/74 and so a benchmark survey was requested to collect information on "resource availabilities and resource use, production capacities, levels of technology and levels of productivity."<sup>1</sup> The relevance of these schemes to the present study is enhanced by the fact that they all lie in the north central area of the dry zone, and so benefit from the Mahaweli Diversion Project.

The characteristics of the six schemes show considerable variation and are summarised in the following table.

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<sup>1</sup>Page 1.

TABLE A2. CHARACTERISTICS OF THE SIX COLONISATION SCHEMES<sup>a</sup>

Colony	Years of settle- ment <sup>b</sup>	Unit of		Number of allotees	Percentage sample
		Low land	High land (acres)		
Nachaduwa	1953-55	5	3	1008	18
Usgala	1960-62	3	2	500	22
Kandalama	1954-57	3	2	656	22
Giritale	1956-59	3 <sup>c</sup>	2 <sup>c</sup>	1350	15
Kaudulla	1958-65	3	2	1894	12
Kantalai	1950-59	3	2	2529	11

a = Taken from Table 4, page 1 of the report.

b = Approximately 75% of allotees sampled reported settlement between years indicated.

c = About 100 allotees had 8 acre allotments.

A simple random sample of farmers was drawn varying for practical reasons from 11 to 22% of the population, and details were collected by means of a questionnaire administered at a single interview in April/May 1973. Information was requested for Yala 1972 and Maha 1972/3 and covered "family size, education and employment, farm size and tenure, land utilization and cropping patterns, farm incomes and non-farm production and disposal, management practices, farm and non-farm investments, credit and indebtedness and activities of farm-level institutions".<sup>1</sup>

For various reasons (which are discussed in the report) the data are not always as complete or as accurate as one would have hoped. Farmers were sometimes reluctant or unable to give precise information on certain topics. For instance, not all farmers had completed the Maha harvest when the questionnaire was administered; some had been ill and so had not cultivated their land; some could not fully recollect their inputs or practices of the previous year; and some were unwilling to give full details of items such as crop production.

As a result, certain data are not available for the whole sample, and where necessary figures are given as an average of farmers reporting rather than an average for the sample as a whole.

#### *Labour Data*

For each scheme data were collected on the levels of input of hired labour and family labour in "work-days", and by operation, for the Maha paddy crop. The number of farmers reporting each type of labour input is also given, and the average level of input per farmer reporting. So the average per acre labour input can be obtained by adding up the operational subtotals, and dividing by the total acreage of lowland paddy.

However, in some cases there is evidence of considerable under-estimation of labour application in particular activities. For instance, in one area of Kantalai only 1/3 of farmers report the

use of family labour for preparatory tillage, and only 1/3 report the use of hired labour for the same activity. So even if no farmer used both family and hired labour, that leaves 1/3 who reported no labour input for preparatory tillage. Thus, it was decided that the labour data for Kantalai was not reliable enough to be included in the study.

A similar conclusion was reached in the case of Giritale. In this case there were no figures on family labour inputs in the tabulation sheets corresponding to those which were available for the other schemes, and number reporting the use of hired labour was much lower than the total number growing lowland paddy. So again it was decided that this location would have to be omitted from the analysis.

For the remaining four locations the proportions of the samples responding seemed satisfactorily high. However, in the case of Nachaduwa the reported levels of labour input, both for many individual operations and in total, were far above those observed at any other of the locations studied. Although it is not clear why this should have been so, the differences were so great that this location too was omitted.

So for the three locations with satisfactory data, the operational totals for family and hired labour were summed and the overall total labour input obtained. Figures are given in the report for the average extent of lowland cultivated per farmer (Table 4), and so it was possible to calculate the total extent of lowland cultivated, and hence the per acre labour input for each scheme.

#### *Data on Costs and Returns*

It is noted that some overestimation of costs and underestimation of returns seems to have occurred, but as it might be expected that all the data used will contain a similar bias, the overall relationship may not be unduly affected. Figures on the yields of paddy per acre for each location are given in Table 15 of the report, so the gross income per acre can be calculated by multiplying by the G.P.S. price. The yield figures are averages for those farmers who reported yields, and their number is well below the total sample size. But there seems no reason to expect the yields of those not reporting to be significantly different from those reported.

To get from the gross return per acre to the net return one needs an estimate of the costs of production. This is provided in Table 17 of the report which gives the average costs of purchased inputs per acre, including labour, tractors, animals, seeds, fertilizers and agro-chemicals. When these costs are subtracted from the gross returns, the net returns are obtained.

- C) " A case study of the Minipe colonisation scheme: Economic and social implications of the introduction of High Yielding Varieties of rice on settlement schemes in Ceylon". Nihal Amerasinghe (UNDP Global Research Project, Ceylon 1971-2).

This is one of the four locality studies which were undertaken as part of the UNDP Global Research Project and which are published under the title "Rice Revolution in Sri Lanka" (UNRISD, Geneva 1977). The aim of the report is to examine the impact of HYVs of rice on settlement schemes, so the representativeness of the scheme selected was an important consideration and this makes it a particularly relevant study in the present context.

Nevertheless, in some ways Minipe is less than typical of dry zone irrigation schemes. Lying in the Central Province about 40 miles N.E. of Kandy, its rainfall is rather higher than for much of the dry zone at 96 inches p.a. Also the main source of irrigation water is the nearby Mahaweli Ganga rather than the more usual tank storage. Minipe is a relatively early colonisation scheme with the first settlers arriving in 1941 and Stage I being completed by 1955. The original allotments were 5 acres of lowland and 3 acres of highland, though this was subsequently reduced (in Stage 2 allotments were 2 acres of lowland plus 1.3 acres of highland). Also much fragmentation has occurred since the initial settlement, with the result that the average area of paddy for the 3 Stage 1 communities surveyed was 2.8 acres.

As resources and time availability limited the survey which could be undertaken, it was decided to confine the study to Stage I of the scheme (there are 4 stages in total but Stage I is the longest established and best documented). Also the sample was restricted to 3 fairly homogeneous communities, represented by "cultivation committees", so that a deeper understanding of the agricultural system could be obtained than if the survey covered a wider area. Using the cultivation committee lists as the sample frame, 55 of the 261 farmers were randomly selected (21%). This is clearly a fairly small proportion of the total number of farmers on the scheme (850 were settled on Stage I alone) but is the best that could be achieved with the resources available.

It is considered that the sampling frame was relatively free of error, the sample unbiased, and the author expresses confidence about the veracity of the information "being familiar with the farming conditions of the area and also by cross-checking for inconsistencies."

The farmers were questioned between November 1971 and March 1972 by one interviewer, a graduate in agriculture with previous field experience. The survey took the form of a single-visit questionnaire, thus placing reliance on the memory of the farmer.

#### *Labour Data*

Data on labour inputs for paddy production per acre are given in Table 23 (Page 70) of the report. Figures are given for family, hired, and exchange labour input, and are subdivided into quite detailed operational classifications. Figures are in labour days though it is not clear exactly how a labour-day is defined. In the form presented in the table inputs of labour by men, women, and children have been aggregated using standard coefficients, derived from relative wage rates. One woman day was assumed to equal one

child day and to be equivalent to 0.7 mandays. But it is noted that for transplanting 1 child-day was considered equivalent to one man-day (it is unclear what value was given to a woman-day in transplanting) as wage rates were similar for this operation. Thus some attempt is made to make allowance for differing efficiency in different jobs, as discussed in Chapter 1.

#### Data On Costs And Returns

Table 29 (Page 84) gives the gross income from paddy cultivation, the costs of production (with or without the imputed cost of family labour), and the net income (again, with or without the cost of family labour). The figure for net income without deducting the imputed cost of family labour is the appropriate one for use below.

Table 30 (Page 85) also gives a breakdown of the costs of production, allowing the cost of hired labour to be subtracted and so a figure for the return net of all costs except labour to be obtained.

#### D) "Profitability and Resource Characteristics of Paddy Farming" A.S. Ranatunga and W.A.T. Abeysekera, A.R.T.I. Research Study No.23, 1977.

This study aims to investigate the costs and returns of paddy production, and levels of input use, so as to facilitate government policy making with respect to this crop, updating the results of the earlier "Cost of Production of Paddy, Maha 1972#3" (A.R.T.I. Research Study No.12). Effort was made to ensure that the 8 cultivation committees for which data were collected were as representative as possible of the rice growing conditions of Sri Lanka. So 4 dry zone cultivation committees were purposively selected (2 in Polonnaruwa District and 2 in Hambantota), a further two in the low-country wet zone (Colombo District), and 2 in the mid-country wet zone (Kegalle and Kandy Districts). Only the dry zone locations are relevant here.

In each of the 4 dry zone cultivation committees which were studied a random sample of 15% or 50 farmers (whichever was more) was selected, giving between 38 and 51 farmers to each sample. A team of trained investigators implemented the pretested questionnaire immediately after the Maha 1976#7 harvest, under the supervision of the authors. Data collected relate to Maha 1976#7. Although figures were collected for 4 dry zone cultivation committees, the results presented in the report are aggregated at the District level so that only two sets of dry zone figures are available. The original tabulation sheets were made available to the author, but it was not found possible to get back to the data at the cultivation committee level.

#### Labour Data

Labour Data is presented in Table 19 (Page 31) which gives the "distribution of physical labour input by production operations (man-day equivalents per acre)". A man day equivalent is taken as one manday, or 1.25 woman days, or 2 child-day. (the footnote to table 19 appears to be erroneous, and it is assumed that this is what is intended). Further, table 21 gives the break-down (still by operation) into hired labour and family labour. Although exchange labour is included in family labour, it is also pointed out

that it was only found in the wet zone districts, and so will be taken as equal to zero for both dry zone districts.

#### *Data On Costs And Returns*

Figures for gross and net income are given in Table 14, already converted to a per acre basis. There are several different definitions used. Paddy is valued at the G.P.S. price in each case. For the estimate of gross returns in the master table, "gross income" is used as this includes the whole of paddy output. The best figure to use for net return seems to be the "farm business income" which subtracts payments in cash and in kind (quite significant at Hambantota) but not imputed costs as is the case for the "net income" figure. None of the figures is appropriate as an estimate of returns net of costs of purchased inputs other than labour (gross value added appears not to have deducted the cost of buffalo and tractor services), but with reference to the figures on costs in Table 1 gives the per acre cost of labour classified under "cash-inputs" and under "non-cash inputs", the former being the cost of hired labour. So if this is added to the "farm business income" an estimate of returns net of all purchased inputs other than hired labour is obtained.

- E) "Cost of production of paddy: Maha 1972-3. A Study based on farm record books maintained in 5 selected districts" K. Izumi and A.S. Ranatunga, A.R.T.I. Research Study No. 12, 1974.

The purpose of this study was to investigate the costs of paddy production so as to give some insight into the patterns of resource utilization in areas with different agro-climatic and socio-economic conditions, and also to provide a basis for extension work. Data were collected for 6 areas, 3 of them in the dry zone: Hambantota, Polonnaruwa, and Elahera. The information for Hambantota and Polonnaruwa was obtained from samples of farmers throughout the Districts, and only for Elahera (actually within Polonnaruwa District) does the data relate to a specific colonisation scheme. The sample sizes were very small (between 12 and 18 in each area) and farmers were selected according to their willingness to cooperate in the project, and their accessibility to the Agricultural Instructors who collected the data. While this limits the accuracy and representativeness of the results, the techniques of the survey were thorough. Rather than relying on a single visit questionnaire, the survey took the form of farm record books, completed by the Agricultural Instructors who visited the farmers "at least 2-3 times a week" throughout the cultivation period. Thus memory bias should be eliminated. The experience gained by the A.I.s during a previous survey in Yala 1972 should have improved their ability to obtain accurate responses, and the record keeping work was supervised carefully by the authors.

#### *Labour Data*

Figures are given for the average number of mandays of manual labour used per acre, divided between hired, family, and attan labour (Table II.1, Page 6). For Hambantota, the figures are also broken down into averages for tenants and for owners, though the sample sizes are so small (10 and 4 respectively) that the results are of little help.

### *Data On Costs And Returns*

Because of the nature of the study, information on this area is quite detailed. Table III.5 (Page 14) gives figures for the estimated value of paddy produced per acre which approximates to the gross return per acre. The figures for "costs of production" per acre include imputed costs of family and attan labour, and of owned buffaloes, but a figure is also given for "expenses per acre" which excludes these values, and this is the more appropriate figure. The percentages of the various components of total expenditure are given in Table III.2 and this allows one to work out the value of hired labour, and so obtain a figure for the return net of costs other than hired labour.

### F) Sri Lanka - I.D.R.C. Cropping Systems Research Project.

Data was provided by the above project on labour input at Walagambahuwa, a traditional small village tank (about 260 acre/feet) in Anuradhapura District. The work going on there, which is in connection with the International Rice Research Institute, is designed to investigate how small tank paddy cultivation can be made more intensive in its use of water and land. Farmers have been provided with inputs such as improved seeds, tractor power, credit, and were guided in the adoption of new practices such as early sowing (before the issue of tank water) and row seeding. Inputs and outputs have been monitored by daily survey sheets so that detailed information is available. This was done for a sample of 20 farmers (about 40% of the total). The data obtained are for the cropping year 1977/8, though it was possible to derive the figures for the Maha season alone.

### *Labour Data*

A thorough picture of the labour input of the 20 sample farmers is given, with the number of manhours applied each week to the different paddy areas (Paranawela, the main tract, and Akarawela and Olagam, the subsidiary tracts), broken down by operation. The figures are also given for each type of labour (family, hired, and exchange) subdivided according to whether the worker was the owner, another male, female, or child. Figures are presented for labour input into chena and homestead lands as well as paddy.

The totals given are simple sums of the disaggregated data, so that one hour of child labour was given equal weight to one hour of adult male labour. In view of the discussion in Chapter 1, and the methods of weighting used in other studies, this is not altogether satisfactory, so the disaggregated data were revalued using the weights: 1 woman-day = 0.75 mandays, and one child-day = 0.5 mandays.

The weekly data extended for more than a calendar year and so had to be narrowed down to a Maha season, the time period to which the other studies refer. For the Olagam and Akarawela plots this was no problem as only one (Maha) crop was grown, and for the Paranawela tract it was not difficult to distinguish the period of labour application relating to Maha. So now the data for the three paddy tracts could be summed and, as they were in the form of totals for the whole sample, divided by 20 (the sample size) to obtain figures on the labour input (family, hired, exchange, and total) per farm. These were readily converted to a per acre basis by dividing by the average area of paddy per farm.

### *Data On Costs And Returns*

Figures on the returns from paddy were also quite easily obtained as figures were available on the gross returns, and returns net of cash costs, for the different paddy tracts, and these only needed conversion to a per acre basis before being of the form required. However, no information was given on the costs of hired labour, or on the average wages paid, so it was not possible to obtain a figure on the returns net of all costs except hired labour input.

- G) "Report on the Resurvey of the Elahera Colonisation Scheme in Ceylon, 1971" T. Jogaratnam, Agricultural Economics Research Unit, Department of Agricultural Economics and Farm Management, University of Ceylon, Peradeniya.

A benchmark survey of the socio-economic conditions in the Elahera Colonisation Scheme was undertaken in 1967-8, coinciding with the introduction there of the Special Projects Programme. At the end of 1970 it was decided to undertake a resurvey of Elahera in order to establish just what impact the Special Projects Scheme had had. Although the earlier survey did not include data on family labour input and so is not helpful here, the resurvey covered all aspects of labour use.

Elahera is in Polonnaruwa District, and originally had allotments of 5 acres of irrigable land and 3 acres of highland. Some fragmentation has occurred so that in Maha 1970/71 an average of about 4 acres of paddy was cultivated per farmer. Four hundred and eighteen farmers were interviewed in the survey (about 40% of the total) and the survey was conducted by students from the Department of Agriculture. Interviewing took place in Maha 1970/71, and it was intended that further information would be collected after harvest but the disturbances of April prevented this being done.

### *Labour Data*

Figures are given for the input of labour into paddy cultivation, in mandays, for Maha 1970/71. They are divided into family labour and hired labour, and subdivided according to operation. (Table 10, Page 11). Per acre figures were obtained by dividing by the average paddy area of 4.07 acres.

### *Data On Costs And Returns*

It is in this area that the data in the resurvey report are most deficient for the purposes of this study. Because it was not possible to continue the survey after the Maha harvest there is no information on the returns to the farmer from the Maha 1970/71 crop. Thus figures for Maha 1969/70 are used instead in the report. But it is stated that "more than 70% of farmers expected higher yields in 1970/71" so the income estimates derived from the previous year might be underestimates. Indeed, insofar as it is farmers' expectations of return that determine labour input, the fact that so many farmers expected higher yields may make the use of the previous year's figures invalid. Cost figures for 1970/71 are available, but this is of little help without estimates of the return.

Because of this it was decided that the data from this study could not be used in those parts of the analysis which involve consideration of the returns to labour.

- H) "An Analysis of the Pre-Mahaweli Situation in H4 and H5 Areas in Kala-Oya Basin" A.S.Ranatunga et al., A.R.T.I. Research Study No.33, 1979.

This is a benchmark study of the agronomic, economic, and social conditions in part of the Mahaweli System H area, some 10 miles South West of Anuradhapura in the North Central Dry Zone. It was undertaken immediately prior to the commencement of development work in 1978. The area is one of lowland paddy, mainly under small village tanks, with chena cultivation on the highlands. Some of the tanks receive additional waters from the Yoda Ela, thus allowing double cropping.

A sample of 512 households (about 7%) was selected randomly, and was stratified by development region. Details of the survey are given on pages 22 and 23 of the report. A pre-tested structured questionnaire was used to obtain information for Yala 1977 and Maha 1977/78. It was implemented by 15 trained investigators in single visits to farms, under the supervision of the researchers. A more detailed study was made of one particular village.

#### *Labour Data*

Figures are given in Tables 6.15 and 6.16 on the input of labour into paddy in mandays per acre, broken down both by operation and by source of labour (family, hired, or exchange). Data are presented both for Yala 1977 and the following Maha season, but only the latter is relevant here.

#### *Data On Costs And Returns*

This too is quite easily obtained. Though returns are not given explicitly, figures on yield levels are available (Page 38) allowing the returns to be calculated by multiplication by the G.P.S. price. Cash production expenses are said to total Rs.450, and the percentage composition is given in Table 6.17. Thus the cost of hired labour can be worked out, and excluded when the return net of all costs except labour is required.

The following studies were considered, but not finally used in the analysis:

- I) "Report on the sample survey of economic conditions in the Mahaweli Development Area, 1974". Economic Research Department, Central Bank of Ceylon, 1975.

This study was undertaken to investigate the conditions which existed

in part of the Mahaweli Development Area before colonisation and thus to serve as a 'base study' for the evaluation of future progress in the region. The topics for which data were sought included: demographic characteristics; employment; water resources and land-use; land tenure; costs of production; housing conditions, etc. The study concentrated on those areas of the Mahaweli Project which were scheduled to be the first to receive water i.e. Systems H, LH, D and G. Systems H and LH contained mainly purana villages and systems D and G were mainly colonisation schemes. So two separate samples were taken, one of 15 villages, and one of 5 colonisation schemes from which 10 tracts were selected. The two samples contained 875 and 1605 households respectively.

Although these sample sizes appear large, it is not clear whether the data were actually collected by visiting the whole of the sample, or whether, as was certainly the case with part of the data collection, it was obtained by the "open interview method". This involved discussion with a group of informants who tried to reach a consensus on what answer to give. Although the authors had confidence in the accuracy of the responses obtained, it seems inevitable that such a method would result in a degree of approximation in the results. This is in addition to problems with the sample frame, and with apparent over-stating of costs of production in some cases.

#### *Labour Data*

Labour input data are not in fact available for the whole of the sample of villagers. It was decided to give data just for farmers who used only tractors or only buffaloes for ploughing and threshing, and those who used both were excluded. Furthermore, results are given by village in tables entitled "Labour inputs in paddy cultivation in the sample of 15 villages where only tractors were used for ploughing and threshing in Maha 1973/4" and ditto for "only buffaloes", and as it is most unlikely that there are no cases of farmers relying on a different form of power to the majority (e.g. a "buffalo only" farmer in a predominantly "tractor only" village) it seems that such farmers must also have been excluded from the sample. The exact number of farmers excluded is not reported. The decision to exclude part of the sample, while allowing more straightforward comparison of buffalo and tractor cultivation, may lead to bias if the results are taken as typical of the village as a whole.

For the colonisation tracts 90% of farmers used tractors for both operations, and only 4% worked their fields using animals only. So no attempt was made to distinguish between farmers according to type of power, and the sample is complete.

For the samples described above data are given on the average number of mandays per acre spent in paddy cultivation. No subdivision by operation is available nor are figures given for family and hired labour input.

#### *Data On Costs And Returns*

The study did not collect data on returns to paddy production, but figures were obtained on yields per acre which allows one to work out the gross return by multiplying by the G.P.S. price. However, yield

figures appear to be rounded, as most of them are exactly divisible by five - yield figures were calculated for the whole sample, so one must assume that the yields of the sub-samples for which labour data are available are no different to the overall average.

Although information is available on costs of non-labour inputs, it is impossible to isolate the cost of hired labour as it is included with an imputed cost of family labour. So no figure can be given on the cost of production including the cost of hired labour.

A final problem is that no figure is given for the average holding size of the sub-sample for which labour data are given, making it impossible to calculate accurate per acre figures.

So it has been seen that in addition to the basic question over the reliability of the method of data collection, there are various other problems with the form in which the data are presented which make it of little help to the present study.

J) "Summary Report of the Socio-Economic Survey of Nine Colonisation Schemes in Ceylon, 1967-68" Agricultural Economics Research Unit, Faculty of Agriculture, Animal Husbandry, and Veterinary Science, University of Ceylon, in collaboration with the Department of Agriculture, Peradeniya.

Following the pattern of an earlier survey of Elahera, it was decided to carry out benchmark studies at 9 other colonisation schemes which had been selected as "Special Projects". The aims included the provision of basic information on the existing state of production and technology against which progress could be measured, the assessment of productive potential, and the pinpointing of constraints on intensification. The interviewing was done by 18 agriculture graduates from Peradeniya in September and October, 1968.

They were supervised by two officers of the Department of Agriculture. Single-visit questionnaires of farmers were supplemented by interviews with field officers, managers of cooperatives, and Cultivation Committee members. The questionnaire results were checked regularly for reliability of information and uniformity of interpretation. Analysis took place at the Agricultural Economics Research Unit of the University under the guidance of Drs. Jogaratnam and Schickele.

#### *Labour Data*

Data was collected on the number of days of labour hired and the number of days of exchange labour received, subdivided into five broad activity classes. Information was also collected on the wages paid to hired labour.

But no such detailed information was collected on the input of family labour. Family labour was considered from the point of view of availability rather than input, with questions on the number of household members available for full or part-time work. Assumptions were then made on how many labour days per annum and at peak periods could be provided by the available family labour supply. For instance it was assumed that one full time family worker would provide 260

mandays per year, and one part-time worker 130 mandays. Family labour supply for peak periods was calculated by working out the availability over 75 days. These assumptions on availability clearly be questions which it is hoped to examine above, so only the data on hired and exchange labour will be relevant to this study.

However, even for these types of labour the problem remains that no separation is made between labour input into lowland paddy, and that into other enterprises, so the usefulness of the data is limited.

#### *Data On Costs And Returns*

A similar problem emerges here to that encountered with the hired and exchange labour data. Although there are figures for the level of gross returns and the percentage of gross returns resulting from paddy cultivation (so that one can calculate the gross returns from paddy cultivation), the figures for costs are not broken down between costs of paddy production and other costs. So it is not possible to obtain figures for the net returns to paddy alone: one can only consider the farm as a whole.

So although there are many useful facts and findings in the Report the data are not in such a form as to be very helpful in this study.

- K) (i) "Farm Business Analysis of Three Agricultural Projects in Sri Lanka 1971/72" K. Sathasivampillai, Agricultural Economics Studies No.7, Government Department of Agriculture, Peradeniya.
- (ii) "A Production Economics Study of Paddy Cultivation in Mannar District 1972/73" K. Sathasivampillai, Agricultural Economics Study No.11, Government Department of Agriculture, Peradeniya.

The Division of Agricultural Economics of the Department of Agriculture at Peradeniya undertook several farm business analysis studies of which the above seemed relevant here. However, for reasons discussed below they are not in fact included in the analysis. They will be looked at in turn starting with the 1971/2 Study.

- (i) The study of three agricultural projects was intended both to try out on a fairly intensive scale the use of Farm Business Record Books by small farmers, and to gather information on the production of the various crops included. The projects selected were Rajangana, Muthu Iyankaddu, and Visvamadukulam, which had 4926, 487, and 475 settlers respectively at the start of the survey. It was intended to take random samples of 10% at the 2 smaller schemes and 1% at Rajangana, but due to manpower problems and lack of cooperation from the project administration "only 10% of the 1% sample originally programmed" was actually achieved at Rajangana, i.e. about 5 farmers. This deficiency is made worse by the fact that it was only at this location that irrigated paddy was cultivated. The data actually collected may, because of the use of Record Books, be reasonably reliable. But it is considered that so small a sample renders any results of very little relevance.

Figures are given for the "operation-wise average per acre labour-use for paddy production" divided into hired and family. The results are for the 1971/72 farm accounting year, which reduces their comparability with the majority of the other studies which give data for the Maha season. Cost and income data are quite detailed.

- ii) The objectives of the study of Mannar district were similar to those of the above study, namely to provide experience in the use of Farm Business Records and at the same time obtain data on the costs of production and physical inputs of, in this case, paddy production. Twenty five farmers were selected purposively in 8 different villages or tracts. As only those farmers who expressed willingness to take part in the study were included some bias may have been introduced, but at the same time the standards of reporting should be improved. At the end of the period of study the number of records which were considered acceptable was only 18, in 7 locations, so again the sample was quite small.

As with (i), data are given for per acre labour use in paddy production broken down by operation and status (family or hired), and so in this case figures are given separately for the Maha and Yala seasons. The figures reveal that in the Maha season only a small proportion of the total labour input was from the family, and that in Yala the whole of the labour input was hired. This is explained in the text by the fact that 50% of the farmers are "part-time operators of their farming enterprises. Their residences were not in proximity to the areas where they carried out their agricultural enterprises." This brings into question the relevance of the results to the present study. While it could be argued that such absentee farmers are not uncommon in the dry zone, it is felt that they form a "special case" and so should not be allowed to bias the results, which are intended to show the labour inputs of "full-time" farmers. Of course the distinction between part-time and full-time is not clear cut, but as this report attempts to provide guidelines for future irrigation schemes (in particular the Mahaweli) where agriculture will be the main occupation of the settlers, the exclusion of these results from Mannar seems justifiable.

So in fact data from both these reports were considered inappropriate for the current study and have not been used above.

## APPENDIX B

### SOURCES OF INFORMATION ON FARM POWER USE

Details are given below of the information which was available on the type of farm power used at each location. Sometimes this is in the form of a direct quote from the original report, and in some cases calculation was necessary. Additional information is provided for certain locations where that included in the original report was inadequate.

As described earlier in the chapter, the classification into groups is based on the percentage of the total acreage (first ploughing, second ploughing, and puddling levelling) at a location which was cultivated by tractors and animals. If the proportion cultivated by tractors exceeds  $\frac{2}{3}$  the location is classed as high tractor use; if it is less than  $\frac{1}{3}$  it is classed as low tractor use; and between  $\frac{1}{3}$  and  $\frac{2}{3}$  is classed as medium tractor use.

- (1) Mahawilachchiya: "Traditionally, in Mahawilachchiya buffalo forms the principal source of farm power in paddy cultivation, tractor assuming a lesser role, particularly in land preparation. Here, 77% of the cultivators have relied only on animal power, while exclusive use of tractors for tillage is not found within the project. Only a fourth of the farmers used tractors along with animals for this purpose." (p.27)

So Mahawilachchiya falls into the low tractor-use group.

- (2) Mahakanadarawa: "The commonest form of farm power used here for paddy land preparation and threshing are 4-wheel tractors and buffaloes.... Tractors with tyne-tiller attachments are generally deployed for first ploughing and in this connection animal power plays a minor role. Second ploughing is undertaken by both buffaloes and tractors, the former being more common." (P.31)

This is more difficult to classify, but with most of the first ploughing performed by tractor and most of the second ploughing by buffalo it seems that the medium tractor-use group is most appropriate.

- (3) Pavatkulam: "Four-wheel tractor is the principal source of farm power used in paddy cultivation in all stages of the project. Around 75% - 80% of the cultivators had relied solely on 4 wheel tractors for tillage as well as threshing. The balance one fifth or so had used both tractor as well as buffaloes for field work. Sole dependence on animal power for paddy field work is hardly seen here." (P.37)

Pavatkulam therefore falls into the high tractor-use group.

- (4) Usgala Siyambalangamuwa: The following figures were taken from the data sheets provided by Prof. Jogaratnam, University of Peradeniya :

	<u>By Buffaloes</u>	<u>By 4-wheel Tractors</u>
First ploughing	242.25 acres	59.5 acres
Second ploughing	237.75 acres	50.5 acres
Puddling and levelling	258.75 acres	20.0 acres
Total	738.75 acres	130.0 acres

With 739 acres prepared by buffaloes compared to 130 acres by tractors, Usgala lies in the Low tractor-use category.

- (5) Kandalama: (Source as above)

	<u>By Mamoty</u>	<u>By Buffaloes</u>	<u>By Tractors</u>
First ploughing	8.0	17.5	372.25
Second ploughing	34.5	30.5	430.75
Total	42.5	48.0	803.0

Kandalama is in the high tractor-use category.

- (6) Kaudulla: The source of figures is as above, but this time data is only given for the number of workdays spent in preparatory tillage by buffaloes (4155 days) and 4-wheel tractors (128.62 days).

This can be converted into acres prepared using the figures on average work rates for tractors and buffalo given by Farrington et.al,<sup>1</sup> i.e.:

Buffalo - 0.125 acres/day/pair for land preparation

4 wheel Tractor - 2 acres/day/ for land preparation

$$\text{Then, } 4155 \text{ buffalo workdays} = \frac{4155}{2} \text{ buffalo pair days} = \left( \frac{4155}{2} \times 0.125 \right) = 259.7 \text{ acres}$$

$$128.62 \text{ 4-wheel tractor workdays} = (128.62 \times 2) \text{ acres} = 257.24 \text{ acres}$$

Although there is some error introduced by using these average figures for work-rates, the results suggest that the acreages cultivated by the two techniques are about equal. Therefore, Kaudulla is placed in the medium tractor-use category.

- (7) Minipe : The following table is taken from P.27 of the report.

Method of Preparatory Tillage, Maha 1970/71 (Acres)

<u>4-wheel tractors</u>	<u>2 wheel tractors</u>	<u>Buffaloes</u>	<u>Gross extent cultivated</u>
3418	1471	2617	7506

1 "Energy in the Small Farm Sector in Sri Lanka" (draft), ARTI, 1980. (P.9).

Thus, tractors cultivate 65.1% of the total area cultivated, just less than 2/3. Although it is close to being in the high group, Minipe must be put in the medium category.

- (8) Polonnaruwa: The following table is from p.41 of Ranatunga and Abeysekera:

Pattern of draught power use in paddy cultivation

<u>Tractors only</u>	<u>Buffaloes only</u>	<u>Tractors &amp; Buffaloes</u>
7%	1%	92%

And of the 18 farmers at Polonnaruwa sampled by Izumi & Ranatunga 8 used tractors only, 6 used buffaloes only, and 4 used both.

So the picture emerging from both studies is of a mixture of buffalo and tractor cultivation, putting Polonnaruwa in the medium class. This is confirmed by the following figures collected by the Department of Agriculture<sup>1</sup> (no figures were collected for Maha 1972/3 so the results are given for Maha 1971/2 and 1973/4).

Percentage of acreage ploughed by each type of power at Polonnaruwa.

	<u>Maha 1971/2</u>	<u>Maha 1973/4</u>
Tractors	62.2	63.5
Mammoty	4.8	1.2
Animals	33.0	35.3

In either case Polonnaruwa would fall in the medium class as expected.

- (9) Hambantota: Figures from Ranatunga & Abeysekera (p.41) show that 87% of farmers used only tractors for land preparation, and that the remaining 13% used a combination of tractors and buffaloes. Izumi and Ranatunga found the same pattern with 13 out of their sample of 14 relying entirely on tractors.

Figures from the Department of Agriculture (as used above) support this:

Percentage of acreage ploughed by each type of power at Hambantota

	<u>Maha 1971/2</u>	<u>Maha 1973/4</u>
Tractors	78.2	73.0
Mammoty	5.5	10.1
Animals	16.3	16.9

Hambantota is evidently in the high tractor-use group.

<sup>1</sup> Figures provided by M.J.Ryan, ARTI.

- (10) Elahera: Izumi and Ranatunga show (p.3) that 50% of their sample use only buffaloes and 50% use buffaloes and tractors. But Prof. Jogaratnam's study gives the following more detailed figures (taken from Table 20, p.21).

		<u>% of total paddy acreage</u>
First ploughing	Tractor	35
	Buffalo	66
Second ploughing	Tractor	88
	Buffalo	12

This suggests that Elahera falls into the low group though it is quite close to the medium group. The figures collected by the Department of Agriculture confirm that Elahera should be in the low group, showing that in 1978/9 (the only year for which figures are available) 27.7% of the area was prepared by tractors. Though this relates to a later year than the study figures, mechanisation is likely to have increased rather than decreased.

- (11) Walagambahuwa: For Maha 1977/8, the season in question, mechanised land preparation was provided to all farmers in the village under the Sri Lanka/IDRC Cropping System Project. So Walagambahuwa must be placed in the high tractor-use category.
- (12) Kala Oya: "The principal forms of farm power used are buffalo and tractor. At present, they are of equal importance in primary and secondary tillage." (P.71).

TABLE 6.4 FORMS OF POWER USED, %, MAHA 1977/8

	<u>Buffalo</u>	<u>Tractor</u>
First ploughing	50	50
Second ploughing	56	44
Puddling & Levelling	88	11

So it is seen that Kala Oya falls into the medium category.

## APPENDIX C

### PRICE INDICES

Some way must be found of converting the return and cost figures for different years onto a common base. Ideally one would like a price index which reflects changes in the price levels of the goods on which the farmer spends his income, so that the value of the returns which the farmer receives are expressed in the way most relevant to him. However, no such index exists and one must instead use the best of what is available. In fact there are only two published price indices available in Sri Lanka, the Colombo Consumers Price Index and the Central Bank Wholesale Price Index. The C.C.P.I. claims to "measure changes in the cost of a fixed quantity of consumer commodities and services entering into the pattern of working class consumption in Colombo." It achieves even this limited objective only imperfectly. The weights used in the composition of the index have not been revised since 1952 despite inevitable changes in the pattern of consumption of the working class. Arbitrary adjustments have been made in the face of shortages of certain items, reducing the reliability of the index. Inadequate attention has been paid to the relative importance of prices in open and controlled markets (e.g. the index number of rents remained unchanged from 1970 to 1979 during a period of government rent controls, but it is likely that private rents had crept up noticeably over this period).

Even if the index were representative of the pattern of expenditure of a Colombo family in the 1970s, it will certainly not reflect accurately the spending of rural families. It is possible, for example, that expenditure on rent in rural areas will be lower than for Colombo families as most houses will be owner-occupied (maintenance being the main expenditure), and fuel and light may make up a smaller proportion of the budget if firewood is plentiful, and electricity not available. Not only will the weights given to different types of good vary between town and country, but also the rates of increase of prices of goods may vary. For instance food prices may rise more slowly in the country than in the town, where transport & marketing costs have to be included.

Nevertheless, the C.C.P.I. seems more appropriate than the W.P.I. This measures prices at "the primary marketing level" i.e. the first major commercial transaction in the chain of sales of a product. Generally this means the producer price of locally produced goods and import prices of imported goods. The index is not limited to consumer goods but includes all traded commodities. Thus it is inappropriate here because it does not measure price changes at the retail level, and also because the goods included are of no particular relevance to the consumption needs of the farmer.

So the C.C.P.I. was used in the calculations. The values of the index are given below.

Colombo Consumers Price Index (1952 = 100)

<u>Year</u>	<u>Index</u>
1970	138.2
1971	141.9
1972	150.9
1973	165.4
1974	185.8
1975	198.3
1976	200.7
1977	203.2
1978	227.8
1979	252.3

APPENDIX D

SUMMARY OF INFORMATION AVAILABLE ON WATER SUPPLY FOR EACH LOCATION.

- (1) Mahawilachchiya: Water problems have been so severe in Mahawilachchiya that many farmers on the colony have been unable even to produce a Maha paddy crop in the five or so years preceding the survey. From 1971 to 1976 the percentage of farmers who cultivated Maha paddy was never greater than 45%, and in 1975-6 it was 0. In the survey season the cropping intensity was unusually high at 90%. A partial Yala crop is grown on average about once in every four years. Chena is an important component of the farming system.
- So there is no doubt that, with its severe water problems, Mahawilachchiya must go into the low intensity group.
- (2) Mahakanadarawa: The picture here is very similar to that at Mahawilachchiya, with only a small proportion of farmers cultivating a Maha crop (67%, 34%, 18%, 20%, and 25% for the seasons 1971/2 to 1975/6) and even fewer able to cultivate a yala crop (20% in 1971, 7% in 1972, 6% in 1973, and 0 for each of the next 3 years). This is a direct result of lack of water. In Maha 1976/7 the "bethma" system was used, whereby an area of land near the tank is cultivated and the more distant tracts left uncultivated. About 60% of farmers practiced chena cultivation in the survey season, averaging 3 acres each.

This location too must obviously be included in the low intensity group.

- (3) Pavatkulam: Though in the survey year 98% of farmers cultivated paddy in Maha, the proportion for the previous six years never reached a quarter. Even among those cultivating paddy, crop losses were high. The highest proportion of farmers cultivating Yala paddy was 6% in 1972 and 1978, and again crop losses were widespread. Chena is not so important at Pavatkulam, but nevertheless the low reliability of water for paddy cultivation makes this a "low intensity" system.

The effects of poor water supply on labour input are compounded by the fact that domestic water supplies were so bad that many farmers lived off the scheme, just travelling in to undertake the major operations on their crops.

- (4) Kandalama, (5) Kaudulla, and (6) Usgala Siyambalangamuwa: Similar data is available for all three of these studies so they will be dealt with together. The following tables give the percentage of farmers reporting the availability of irrigation, the area per farmer reporting, and the average intensity of cropping (for Yala 1972 & Maha 1972/3).

	% of farmers reporting availability of Irrigation		Average extent per farmer reporting		Lowland cultivated as % of lowland area (Yala 1972 & Maha 1972/3)
	Yala 1972	Maha 1972/3	Yala 1972	Maha 1972/3	
Kandalama	19	95	2.8	3.2	113
Kaudulla	64	95	2.0	2.7	132
Usgala Siyambalangamuwa	49	93	2.7	3.0	153

Chena cultivation was only significant at Usgala Siyambalangamuwa.

It can be seen that, while the proportion of farmers reporting the availability of irrigation is higher at Kaudulla than at Usgala, the cropping intensity is lower, as each farmer cultivates a smaller amount of his holding. But both these locations have a high cultivation of Maha paddy and a moderately high proportion of both land and farmers involved in Yala paddy cultivation, so have been included in the intermediate intensity group.

Kandalama, on the other hand has only 19% of farmers reporting availability of irrigation water in Yala, and a cropping intensity of only 113% so falls into the low intensity group.

- (7) Elahera: Although when Izumi and Ranatunga asked their sample of 12 farmers at Elahera whether the water supply conditions were good or bad (Maha 1972/3) all responded "good", the Resurvey Study by Prof. Jogaratnam reveals various problems. Water supply was quite good in Maha, but even then 40% of farmers reported some problem or other with regard to irrigation. For Yala, only 44% of the Maha acreage was sown, and reported yields were some 50% lower due mainly to lack of water.

The adequacy of water in Maha and the moderate amount of paddy cultivation in Yala place Elahera in the "intermediate intensity" category.

- (8) Hambantota and (9) Polonnaruwa: For these two locations data is not as complete as for many of the others, but the picture which emerges is one of relatively good water availability in both areas.

They are among those areas for which Izumi and Ranatunga asked farmers about the quality of irrigation and the results are as follows:

Percentage Distribution of Cultivators by Water Supply Conditions that prevailed during Maha 1972/3.

<u>Water Conditions that prevailed</u>	<u>Hambantota</u>	<u>Polonnaruwa</u>
Good	14 (100%)	14 (78%)
Bad		4 (22%)
Total number of cultivators	14	18

The "bad" response from 4 of the Polonnaruwa farmers may be due to the inclusion of some rainfed paddy in the sample, and it seems likely that the water availability was generally good on the irrigation schemes.

Further evidence can be obtained by comparing the acreages cultivated in Maha and those in Yala.<sup>1</sup> It is seen that at Polonnaruwa the Yala acreage is in fact marginally higher than the Maha acreage, and at Hambantota it is about 60% of the Maha figure.

So this is consistent with the impression that both of these locations are quite well watered in Yala as well as Maha and so should be placed in the "high intensity" group.

(10) Minipe: Minipe is in a fortunate position as it gets its water from Mahaweli via the Yoda-Ela. Thus, as the report notes in several places there is ample water for paddy cultivation in both Maha and Yala seasons. There is some chena cultivation, but the scheme must still be considered to be a "high intensity system".

(11) Walagambahuwa: Walagambahuwa is irrigated from a rainfed village tank and the water supply conditions therefore fluctuate according to the amount of rainfall received. The year to which the survey figures relate was in fact one of very good rainfall and it was possible to cultivate two paddy crops plus a partial crop of vegetables. But this is likely to be untypical, and labour inputs can be expected to be at a level which reflects uncertainty over the water supply.

(12) Kala Oya: Although this is an area mainly of village tanks some of them receive supplementary irrigation, mostly via the Yoda-Ela. There are variations from village to village with double cropping practiced in some of the villages which receive supplementary irrigation, but many other villages not receiving adequate water for one full crop a year.

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<sup>1</sup> From "Cost of Production of Paddy, Yala 1972", Izumi, K. and Ranatunga, A.S., ARTI, 1973.

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