KIRINDI OYA IRRIGATION SETTLEMENT PROJECT

Input Use Efficiency and Productivity of Rice Production

RESEARCH STUDY NO. 65

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AGRARIAN RESEARCH AND TRAINING INSTITUTE,
114, Wijerama Mawatha, Colombo 7.

SRI LANKA

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FOREWORD

The Kirindi Oya Irrigation and Land Settlement Project is one of the largest agriculture based development projects undertaken in Sri Lanka in recent years. The project launched in 1978 includes : the development of existing paddy land, the opening up of new paddy acreages, and the direction of irrigation facilities to them. In addition the development of highland crops is also envisaged.

The Agrarian Research and Training Institute was commissioned by the Ministry of Lands and Land Development to undertake a programme of evaluation and predictive research in the Kirindi Oya Project and its environs. As a part of its commitment the ARTI completed a pre-project survey, an assessment of the agricultural credit situation as well as nutrition and employment conditions. The current report based on a study conducted by Mr. Ananda Wanasinghe in the 1980-81 period examines the rice production patterns in the area with a view to providing a basis of assessment of changes in the future. While examining existing constraints on production the study results indicate that low productivity and high "operation costs" are associated with inferior cultivation among farmers. Consequently, the study highlights a need for effective agricultural extension education programmes and efficient support services.

Within an overall policy framework of agriculture-initiated development, this study, as a precursor of similar problem-oriented studies currently being launched by the ARTI in the Kirindi Oya project, should be of value in strengthening current and future project-based crop development programmes.

I wish to thank the researcher who was responsible for this report and all others who contributed to making this publication possible.

T.B.Subasinghe
DIRECTOR
Agrarian Research and Training Institute

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Chapter One

INTRODUCTION

The Kirindi Oya Irrigation and Settlement Project, in Sri Lanka's south-eastern quadrant, aims ultimately to develop 8,430 ha of new land for agriculture. There is provision for irrigation and land development and for the settlement of 8,300 families. The existing irrigation system, already serving 4,584 ha of rice land, will also be rehabilitated, so as to improve the supply and distribution of water.

Two phases in the development of this project were envisaged. In phase one, 4,191 ha of new land were to be developed and made irrigable, and 4,200 families were to be settled; the rehabilitation of the existing irrigation system was to be carried out in this phase. In phase two, the remaining work on the project was to be completed.

The economy of the project area is almost exclusively agricultural, and rice is the dominant crop. It provides 67 percent of all agricultural income. A crop diversification that has been planned is not likely to reduce the importance of rice in the project area. Several factors and policy measures will in fact contribute to an increased output of rice. Rice will be the sole crop on about 60 percent of the irrigated area. Cropping intensity is to be increased; in the lowland, from 76 percent at present (Wanasinghe *et al* (1983), to 200 percent. Finally, there will be an increased efficiency of production, due to improvements in the institutional basis of rice production: in agricultural extension, water management, credit and inputs supply, marketing, farmer organisations, etc.

1.1 Objectives of the Study

As a basis for assessing the prospective changes under the project, this study will examine the prevailing rice production patterns and practices in their different aspects. A second objective of the study relates to the monitoring and evaluating of the current progress of the project; would indicate shortfalls in implementation and necessary modifications of project plans.

Thirdly, the study will ascertain any inefficiencies in resource - use and their effect on agricultural production, a problem which is not specific to the Kirindi Oya area. If the farming practices are deficient, an increased production would be possible merely by improving the use of existing resources. Otherwise, an expansion in production would require a different strategy.

1.2 Methodology

During the preliminary field work for determining the benchmark socioeconomic conditions, considerable differences in rice cultivation practices and productivities were found to prevail between major and minor irrigation schemes. Significant differences were also observed between farms of different sizes. For these reasons, a two-stage random sampling design was adopted as a basis for the field survey.

At the first stage farmers were grouped according to the type of irrigation, ie. major or minor irrigation works. In the second stage they were grouped according to the size of their operational lowland holdings. Three size-categories were taken, based on the likely holding sizes in the area. Almost 47 percent of the farms were 0.81 ha to 1.62 ha (2.59-4 ac) and this was taken as the average size. The two other categories were the farms smaller than average and those larger than average. From each of these six categories farms were selected at random with equal probability of selection.

The registers of agricultural holdings maintained at the two Agrarian Service Centres in the project area were used as the sampling frame. These registers also contained information on the type of irrigation and on the size of farms. A total of 135 farmers was selected. From the average sized farms under major irrigation (about 47 percent of all farms) 35 farms were selected and 20 farms from each of the five other categories. Data were collected by six investigators. Each farm was visited by them at least once a week during the two consecutive seasons *Maha* 1980/81, *Yala* 1981.

The main characteristics of lowland and highland farms of different sizes, categorized also by the two main types of irrigation, are shown in Table 1.1.

Table 1.1

The Sample Characteristics

Sample Characteristics	Major Irrigation			Minor Irrigation		
	< .81 ha < 2 Ac	.81-1.62 ha 2-4 Ac	> 1.62 ha > 4 Ac	< .81 ha < 2 Ac	.81-1.62 ha 2-4 Ac	> 1.62 ha > 4 Ac
No. of farms	20	35	20	20	20	20
Total operated lowland area (ha)	10.0	37.5	40.0	6.4	17.4	36.4
Mean lowland Farm Size (ha)	5.0 (26.0)	1.1 (15.9)	2.0 (41.0)	0.3 (34.4)	0.9 (21.8)	1.8 (21.9)
Total operated Highland area (ha)	5.9	8.5	4.4	2.2	3.4	0.8
Mean Highland Farm Size (ha)	0.7 (59.1)	0.6 (78.7)	1.1 (35.1)	0.3 (53.6)	0.6 (81.7)	0.4 -

Note : Figures in parenthesis are coefficients of variation.

1.3 Limitations of the Study

While the patterns of rice production and the productivity of the different factors of production were the central area of enquiry in this study, certain other aspects that are of a somewhat peripheral nature were excluded; eg. marketing, agricultural extension and credit. Also, no attempt was made to impute values for family labour and the use of non-purchased inputs, though such labour and inputs were included in the computation of productivities. Most of these gaps will be filled by other studies for the Kirindi Oya Project area, already conducted or which have been proposed.

1.4 Organisation of the Report

The socioeconomic characteristics of the sample, serving as a background to this Report, are presented in chapter two. In chapter three, the nature of the production process will be examined, in terms of different cultivation practices and the types of inputs. In chapter four, estimates are made of partial productivities, production functions and returns to scale. Chapter five will discuss the main conclusions and policy implications.

Chapter Two

SOME SOCIOECONOMIC CHARACTERISTICS OF RICE FARMING

This chapter will describe some aspects of the farm households that reflect on agriculture in the area. As a prelude to the analysis in later chapters, the validity of the farm grouping will also be examined.

2.1 Household Size and Labour Availability

Household characteristics relevant to farming are mainly the size of the household and the labour availability. These data are given in Table 2.1 below:

Table 2.1
Household Data (Means)

Farm Type / Characteristics	Major Irrigation			Minor Irrigation		
	2 Ac 0.81 ha	2-4 Ac 0.81-1.62 ha	4 Ac 1.62 ha	2 Ac 0.81 ha	2-4 Ac 0.81-1.62 ha	4 Ac 1.62 ha
No. in household	5.85	6.69	6.85	6.35	6.75	6.15
Labour units	3.35	3.06	2.90	3.05	2.49	2.80
Male labour	1.80	1.66	1.65	1.60	1.45	1.70
Female labour	1.45	1.17	1.10	1.35	0.80	1.00

The total labour units differ slightly from the sum of male and female labour units available, due to a small residue of child labour units not shown separately. There are no marked variations in the household size and in the labour availability among farms.

The average size of a household in the sample is 6.4, compared with the national average of 5.6. The somewhat larger size of households in the project area is possibly due to an influx of relatives who also hoped to benefit from the project.

The labour available within a household was 2.9 adults on the average. This comprised 1.6 males and 1.3 females. The variations in these figures for the different farm categories were not statistically significant. This is to say, the demographic size and composition of the sample of farms were uniform.

2.2 Operated Agricultural Lands

Details of land use, land distribution and land tenure in the area are given by Wanasinghe *et al* (1983). The major categories of land are lowland, where paddy is grown and highland (comprising homesteads and *chenas*) on which other crops are grown.

Table 2.2

Number and Types of Farms Cultivated

Rice Farm Type / Operated Lands	Major Irrigation		Minor Irrigation	
	No.	Percent	No.	Percent
Low lands	75	56	65	44
High lands	27	20	16	12

Note: Percentages are calculated on the total sample of 135 farms

A majority of farmers cultivating highland have rice lands under major irrigation schemes. Also, while 36 percent of farmers under the major irrigation schemes engage in highland cultivation, only 27 percent of those under the minor irrigation schemes do so. The average operational lowland holding under major irrigation is 1.2 ha and that under minor irrigation is 1.0 ha. The average size of highland cultivated by a rice farmer in the major irrigation schemes is 0.8 ha and under the minor irrigation schemes it is 0.4 ha.

Farmers under the minor irrigation schemes would therefore seem to depend less on cultivation as a means of livelihood, compared to those under the major schemes. Wanasinghe *et al* (1983) suggest that farmers with relatively low income from rice tend to resort to non-farm employment rather than to the cultivation of highland crops to supplement their incomes. Non-farm employment appears to be less risky.

2.3 Ownership of Agricultural Implements and Machinery

Mammoties are the commonest agricultural implements owned by the households. The next in importance is the weeder. (The details of ownership are given in Table A 1). Excepting mammoties, the ownership of most of the implements and machines is by farmers in the major irrigation areas; and in both areas, mostly by farmers who have larger holdings. They are the larger farmers or else wealthy landed entrepreneurs. Two wheel tractors are more common than the costlier four wheel ones. Ploughs are not commonly in use. Even when land preparation is done with the aid of draught animals, mudding is practised - a form of non-inversion tillage by the repeated driving of animals over the land.

2.4 Household Income

Cash incomes of the different categories of households and the composition of income are given in Tables A3 and A4. For all categories, cash incomes are higher in *Maha* than in *Yala*, especially those from the sale of paddy. For all categories of farms, but especially under major irrigation schemes, paddy provided the biggest share of income. In both seasons, households with the smallest farms or with inadequate irrigation depended heavily on non-agricultural income. Such income, in all categories of households was higher in *Yala*, when agricultural work declines and more people probably take to wage labour.

Detailed studies are needed to ascertain the exact nature of these supplementary employment opportunities. However, construction work under the Project may have provided a considerable amount of non-farm employment during *Yala*.

Chapter Three

INPUTS IN RICE CULTIVATION

The inputs used in rice cultivation which will be examined and discussed in this chapter are labour, seed, fertilizer and agrochemicals. Since use of these inputs was relatively uniform among farms of different sizes, the analysis will be confined mainly to data classified only by the type of irrigation and by cultivation season. The data according to farm size are given in the Appendix, to enable comparisons in any future study of a similar nature.

3.1 Labour Use

In computing labour use in the various operations, man days, woman days and child days were combined on the basis of wage rates. A woman day was taken as equivalent to 0.75 of a man day and a child day as equivalent to 0.5 man days.

Table 3.1

Mean Labour Inputs in Selected Cultivated Operations
(Man days per ha.)

	Land Preparation		Sowing & Aftercare		Harvesting		Post harvest Work		Total	
	Major Irrgn.	Minor Irrgn.	Major Irrgn.	Minor Irrgn.	Major Irrgn.	Minor Irrgn.	Major Irrgn.	Minor Irrgn.	Major Irrgn.	Minor Irrgn.
Yala	21.5 (46.8)	19.2 (58.3)	47.1 (27.8)	55.6 (43.3)	17.1 (44.5)	17.6 (38.0)	10.0 (60.8)	9.0 (55.3)	95.4 (48.2)	101.4 (61.3)
Maha	21.9 (52.2)	18.5 (29.7)	51.4 (42.0)	48.7 (37.5)	17.1 (43.4)	17.4 (42.2)	11.4 (68.7	7.5 (78.4)	101.8 (43.7)	92.1 (52.6)

Note : Figures in parenthesis are coefficients of variation.
The disaggregated data are given in Appendix Tables A 5 to A 8.

3.1.1 Land preparation

Land preparation consists of an assortment of work: turning the soil, clearing of bunds and channels, plastering bunds and manual levelling. The last of these requires the most amount of labour. The mean values are not statistically significant, as is to be expected from the uniform cultivation practices between farms. Though under minor irrigation schemes land preparation might seem to require more labour on account of the dry soil, this was not the case in the project area; land preparation was usually delayed until there was sufficient rain to facilitate ploughing or mudding.

3.1.2 Nursery care and transplanting

In both seasons transplanting was confined to the areas under major irrigation and even in these areas it was done only to a limited extent. For these areas the sample had 75 farmers, only nine of whom (12%) transplanted in *Yala* and 13 (17%) in *Maha*. The labour requirements for transplanting were 59.6 and 55.6 man days per hectare in *Yala* and *Maha* respectively.

The small numbers involved precluded any statistical tests of significance for the different size categories of farms. The figures of labour use that were obtained are however comparable with some earlier estimates for the Hambantota district (eg. Ranatunga and Abeysekera - 1977).

3.1.3 Sowing and aftercare

These include sowing, weed and pest control, application of fertilizer, water management and bird scaring.

More than half the labour used in sowing and aftercare is for bird scaring. This is usually done by children. The labour used for sowing and aftercare is usually that of the family; hired labour is used for the mechanical spraying of weedicides and insecticides.

3.1.4 Harvesting

In the Kirindi Oya area, harvesting is done on contract except on the very small farms where family labour suffices. The standard unit of contract is an *alli* (one-sixth of an acre or 0.07 ha). Both men and women engage in harvesting. The labour input data given in Table 3.1 include labour for carrying the sheaves to the threshing floor and stacking them.

A lack of statistical significance in the differences among the means indicates a relative uniformity in the labour inputs in harvesting.

3.1.5 Post-harvest operations

Post-harvest operations include threshing, winnowing, bagging and transport. Threshing is most often done by four-wheel tractors and rarely by buffaloes or manually. With tractor threshing, winnowing is sometimes done by means of a fan attached to the tractor. But more often, this operation is done in the traditional way.

The difference in the labour use in *Maha* between the two irrigation types is statistically significant at the 5 percent level. This is probably due to better yields under major irrigation, raising the mount of harvesting labour. The high coefficients of variation indicate a relatively high variability in labour inputs among farms. The differences in labour use are, however, not statistically significant between the two categories of farms or between the two seasons.

The labour input figures for post-harvest operations are comparable with those of Izumi and Ranatunga (1972) for the Hambantota district, but are considerably lower than a figure of 125.2 man days per hectare given by Ranatunga and Abeysekera (1977). The difference is attributable partly to the greater use of tractors by the farmers in the sample that was used for the present study.

In case of harvesting, however, the labour use is lower than the figures reported in the two previous studies. A possible explanation for this is that in the sample used in the study, harvesting was done almost exclusively by contract labour and that such labour is more efficient. It is also possible that contract labourers have longer working hours than those paid by the day, so that the labour input expressed in man hours may not show any change.

The use of family labour in cultivation activities is shown in Table 3.2.

Table 3.2
Family Labour Participation Rates
(percentages)

	Major Irrigation		Minor Irrigation	
	Yala	*Maha*	*Yala*	*Maha*
Land preparation	29.9	32.4	16.7	35.4
Nursery establishment and care	88.3	91.6	-	-
Uprooting and transplanting	8.1	8.5	-	-
Sowing and aftercare	82.7	78.3	86.8	88.5
Harvesting	22.9	22.8	27.1	31.1
Post harvest operations	37.7	31.9	44.0	54.0
All operations	34.7	36.2	41.3	49.6

Nursery management, sowing and aftercare are carried out largely by family labour. The extended period of time available for this work makes it possible for family labour to cope with it. The other operations which are more time-bound must depend upon hired labour. In the areas under minor irrigation, a slightly higher rate of family labour participation is presumably due to the lower work intensity of these activities. However, in land preparation family labour use was lowest in *Yala* under minor irrigation. It is possible that this is because of the need to complete land preparation within a short period, due to a limitation in water availability. For uprooting and transplanting hired labour is normally employed on contract.

3.2 Use of Farm Power

Animal power has been traditionally used in land preparation and threshing and the tractor increasingly in winnowing. Fans fitted to tractors are used to blow away the chaff. Threshing was done exclusively by four wheel tractors. Tractors seem to have completely replaced buffaloes in land preparation. The use of power sprayers was not investigated in this study. The pattern of farm power use for land preparation is summarised in Table 3.3, with details in Table A 9.

Table 3.3
Types of Farm Power Used in Land Preparation
(percentages)

	Draught Type	Major Irrigation	Minor Irrigation
Yala	4 wheel tractor	57.3	58.5
	2 wheel tractor	36.4	36.9
	Buffaloes	6.3	4.6
Maha	4 wheel tractor	37.0	48.3
	2 wheel tractor	58.0	48.0
	Buffaloes	5.0	3.7

The use of buffaloes in land preparation is very limited. Only about 2.5 percent of the farmers used buffaloes each season, compared to 10 percent of the farmers in Hambantota district according to the study by Ranatunga and Abeysekera in 1977.

The use of two wheel tractors appears to be more in the *Maha* season than in *Yala*. It is possible that despite a general preference for four wheel tractors, there was an insufficiency of such tractors to cope with the expanded demand for them during *Maha*.

3.3 Varieties Cultivated and Quality of Seed

New high yielding varieties of paddy were widely cultivated, as is shown in Table 3.4 below. It is significant that not a single farmer cultivated old high yielding varieties.

Table 3.4

Extent of Use of High Yielding Varieties

	Major Irrigation	Minor Irrigation
Yala	94.7	100.0
Maha	90.4	84.0

In the *Maha* season traditional varieties were cultivated more than in *Yala*. As shown in Table A 10, this feature was pronounced among the smallest farm size categories and especially in the minor irrigation areas. Since these varieties were long-aged, they were not very suitable for the *Yala* season.

Certified seed paddy is provided only by government agencies. The advantages of such seed, it was claimed were genetic purity, high germination rates and freedom from weed seeds. Table 3.5 shows the sources of seed.

Table 3.5

Sources of Seed Paddy

(percent area)

		Major Irrigation	Minor Irrigation
Yala	Government Agencies	5.1	16.7
	Private	40.7	33.3
	Self	54.2	50.0
Maha	Government Agencies	1.4	8.0
	Private	54.8	60.0
	Self	43.8	32.0

The use of certified seed is limited. One reason for this, frequently alleged is the poor germination of the certified seed supplied by government agencies. Another reason is the delays in obtaining it. Detailed information is given in Table A 11.

3.4 Fertilizer Use

Fertilizer is generally regarded by farmers as the most important input in rice cultivation. Detailed data on fertilizer use are given in Table A 12; they are summarised in table 3.6 below:

Table 3.6

Use of Fertilizer

(Kg per ha)

	Major Irrigation				Minor Irrigation			
Yala	124.5 (23.4)	177.3 (17.7)	128.8 (31.7)	430.6 (28.9)	100.8 (22.4)	135.5 (36.5)	134.4	370.7
Maha	133.2 (21.2)	162.9 (19.6)	128.0 (27.3)	424.1 31.6)	121.5 (26.7)	139.6 (34.4)	123.3	384.4

Note: Figures in parenthesis are coefficients of variation

In assessing fertilizer use, two important considerations are the total quantity or fertilizer applied and its composition. The total quantity of fertilizer applied in the Major Irrigation areas in each season (432.5 Kg/ha) is almost that recommended by the Department of Agriculture for the long aged varieties.[1] Since none of the varieties cultivated were long aged, particularly in *Yala*, the amounts used tended to exceed the recommended dosage. In the Minor Irrigation areas the total amount of fertilizer used was considerably less than in the Major Irrigation areas. The difference is statistically significant. This underutilization is probably due to the greater risk of crop failure, owing to the uncertainty of irrigation water.

In the area under Major Irrigation, there is however a serious imbalance in the different components of fertilizer that are used. The amount of TDM used practically conforms to the recommendations, but not the relative amounts of basal fertilizer and urea. The use of basal fertilizer is much less than the amount recommended, while the reverse is true for urea. Such a pattern of fertilizer use under both irrigation types involving an over use of urea at the expense of basal fertilizer gap is suggestive of an extension gap.

While farmers do not fully appreciate the importance of basal dressing, they overestimate the value of urea. The effect of urea on vegetative growth is visually evident and basal fertilizer on the other hand is relatively costly at the time of the study it was 30 percent more expensive than the other components. In the face of such a price differential between these two types of fertilizer, a special extension effort is needed if the imbalance in fertilizer use is to be corrected.

3.5 Use of Agrochemicals

Agrochemicals were used by all farmers in each season. Information

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1 Since only 5 percent of the area was cultivated with traditional varieties, such varieties may be ignored in this analysis. The amount of fertilizer recommended for new high yielding varieties varies from 401.6 Kg/ha to 432.5 Kg/ha depending on the age of the variety.

was not obtained on the types and quantities of the different weedicides and insecticides that were used. The farmers were unable to recall this information. Data were therefore collected on the frequency of application of agrochemicals. This is given in Table A 13, a summary of which is in Table 3.7 below.

Table 3.7

Use of Agrochemicals

(No. of applications)

	Major Irrigation	Minor Irrigation
Yala	3.2 (26.9)	2.9 (30.8)
Maha	3.4 (33.7)	3.6 (31.5)

Note: Figures given in parenthesis are coefficients of variation

Usually there was only a single application of weedicides and two applications of insecticides. Generally, insecticides were applied at the early stages of the crop, after flowering and a third application was done when pests were present.

3.6 Cost of Production

The mean production costs by the different items are shown in Table 3.8 below. The costs given here are the actual cash costs, and exclude the value of non-purchased materials and of family labour.

Table 3.8

Production Costs per Hectare (Rs)

	Major Irrigation		Minor Irrigation	
	Yala	*Maha*	*Yala*	*Maha*
Machinery and buffaloes	1284	1454	1126	1343
Seed	479	504	472	514
Fertilizer	393	447	298	331
Agrochemicals	384	364	297	328
Labour Wages:				
Land preparation	413	447	292	368
Nursery preparation and care	103	108	-	-
Uprooting and transplanting	669	783	-	-
Aftercare	160	180	89	122
Harvesting	215	261	142	229
Post harvest operations	165	192	128	143
Total labour wages	1725	1971	651	862
Cost of meals (when transplanted)	828	915	-	-
Cost of meals (when broadcast)	418	491	261	349
Total cost (transplanted)	5093	5229	-	-
Total cost (broadcast sown)	3911	4338	3112	3717

The cost of farm power for land preparation is similar in the areas under major irrigation as in those under minor irrigation. It is slightly higher in *Maha* than in *Yala*, due to an increase in hire charges for tractors. Similarly the price of seed paddy is higher in *Maha*. The expenses on fertilizer and agrochemicals are greater in the areas under major irrigation, where a low risk of crop loss induces a greater use of these inputs.

Labour costs diverge clearly between the two areas and between seasons. More hired labour than family labour is used in the major irrigation areas (as shown earlier in section 3.1.6). Under major irrigation, the larger labour requirements with a larger number of workers are probably due to intensive cultivation practices. In both areas hired labour is used more in the *Maha* season than in *Yala*. The longer-aged varieties usually grown in *Maha* require higher labour inputs while a greater availability of irrigation water is conducive to intensive cultivation.

The total cost of production is considerably higher in areas under major irrigation, obviously due to the more intensive cultivation. According to the Department of Agriculture (1981), the cost of cultivating rice in the Hambantota district during *Maha* 1980/81 was Rs. 3501 per ha. The corresponding estimate in our study is higher under major as well as under minor irrigation. The disparity in the results is probably due to differences in samples and to the basis of accounting for the cost of meals provided to farm workers.

Chapter Four

PRODUCTIVITY OF RICE CULTIVATION

The productivities of the different factors of production employed in rice cultivation are examined in this chapter. An analysis of the production functions is also made to enable and understanding of some important aspects of rice farming in the area.

Given the cultivated extent (other conditions being equal), the level of agricultural production depends largely on the output per unit of land efficiency of resource use by farmers. If farmers are inefficient in the use of resources, a possibility exists for increasing production by reallocating such resources. If, on the other hand, the existing use of resources is efficient, then further growth can only be achieved by an expansion of the cultivated extent. Therefore an understanding of resource use and allocative efficiency is important for designing agricultural programmes.

4.1 Partial Productivities

The partial productivities of the factors of production for the sample of farms studies are shown in Table 4.1.

The figures show that productivity in the areas under major irrigation schemes tends to be higher than under minor irrigation schemes. This may be interpreted as an indication of the importance of irrigation water for agricultural production. Another fact that emerged is the higher productivity in *Maha* than in *Yala*. Often productivities in *Maha* under minor irrigation exceeds those of *Yala* under major irrigation indicating that the beneficial effect of the *Maha* rains is felt irrespective of the type of irrigation. All the same, it cannot necessarily be concluded that the higher productivity is directly due to the better availability of water either through irrigation or from rainfall. It seems more likely an assumed and plentiful supply of water for cultivation promotes better farming practices which result in increased production and productivity. The production potentital of improved irrigation through indirect is very significant.

Table 4.1

Partial Productivities

Indicators		Major Irrigation		Minor Irrigation	
		Yala	*Maha*	*Yala*	*Maha*
Production per farm	Kg.	3382	4365	1748	3650
	Rs.	9246	12569	4860	10450
Productivity of land	Kg. per ha	2815	3809	2319	3220
	Rs. per ha	7695	10966	6445	9219
Productivity of labour	Kg. per M.D.	33.65	38.[illegible]8	20.03	30.50
	Rs. per M.D.	91.98	110.22	55.67	87.32
Productivity of cash	Kg. per Rs.	0.79	0.94	0.59	0.84
Financial returns per rupee spent	Rs.	2.16	2.71	1.64	2.40

The data in Table 4.1 also show an annual value of production on an average farm during the study period, of Rs. 21,815 in the major irrigation area and of Rs. 15,310 in the minor irrigation area. Based on the information presented in Table 3.12, it can be shown that the minimum average costs of production per farm are Rs. 9,671 and Rs. 5,650 respectively in the two areas. Thus the excess value of production over expenditure turns out to be Rs. 12,144 under major irrigation and Rs. 8,750 under minor irrigation. In this computation no values have, however, been imputed for family labour and land rent. Thus on a monthly basis the "profits" per farm household from rice cultivation amount to Rs. 1,012 and Rs. 729 in the two areas respectively. These incomes are only slightly higher than those from agricultural labour during this period, particularly in the areas under minor irrigation. The excess of income over cash expenditure per hectare is Rs. 10,412 per year in the area under major irrigation and Rs. 8,835 per year under minor irrigation. On a monthly basis these "profits" turn out to be Rs. 868 and Rs. 736 respectively.

4.2 Resource Use

To understand the resource use patterns in rice production in the area, production function analysis was undertaken. For this purpose the Cobb-Douglas type of production function shown below was used:

$$Y = AX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4}$$

where Y is the dependant variable, X are the independent variables and b are the Partial elasticities of the independent variables. In this study the dependant variable Y represented the value of rice produced on the farm. The independent variables are labour use, tractor costs, farm size and operating costs respectively.

The rice produced on the farm was measured in terms of its value in rupees. This value was computed on the basis of the market price of rice at the time of harvesting. Labour use was measured in terms of mandays. On the basis of wages paid, a woman day and a child day were assessed at the rate of 0.75 and 0.5 of a man day respectively. Cost of tractors was measured in rupees and farm size in hectares. All costs excluding the payments for labour and tractors were aggregated under operating costs. The use of buffaloes was not incorporated separately in this analysis since only a very few farmers in the sample made use of buffaloes as pointed out in chapter three.

In this analysis the log-linear transformation of the Cobb-Douglas type production function stated earlier is used. This is:

$$\log Y = \log A + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4$$

where Y = Gross value of production (rupees)

X_1 = Labour use (man day equivalents)

X_2 = Tractor cost (rupees)

X_3 = Farm size (hectares)

X_4 = Operating cost (rupees)

When estimated in this form the coefficients turnout to be partial elasticities for the respective inputs. This equation was estimated by the method of ordinary least squares. The estimated parameters are shown in Table 4.2.

The value of R^2 in all equations turns out to be quite high. This shows that the independent variables used in the functions explain between 71 percent and 87 percent of variations in the logarithus of the gross value of rice produced.

The most important feature of the estimated parameters is that the coefficients for farm size are positive and significant in all four equations. This indicates that land is the most important input to which the output was highly responsive. Use of tractors seems to be the second important input. It is significant in one of the equations. Labour use and operating costs show low partial elasticities and are not significant. This seems to indicate that they do not reflect heavily on the production of rice.

The sum of the partial elasticities for inputs is the returns to scale in rice farming. These returns to scale were statistically tested for deviation from unity. This test showed that in all four equations the deviations from unity were not significant. This indicates that the returns to scale are constant for this sample of farms. Thus there appear to be no economies of scale in rice cultivation in the sample. This is a common feature of agriculture in South Asia as pointed out by Schultz and several others.

Table 4.2

Coefficients of Production Functions and Returns to Scale

Season	Type of Irrigation	Constant	Labour Use	Tractor Cost	Farm Size	Operating Cost	R^2	Returns to Scale
Yala	Major	7.39622	0.1029 (0.1259)	0.0709 (0.1117)	0.8434*** (0.1748)	0.0688 (0.1692)	0.829	1.0840
	Minor	4.93714	0.1347 (0.2959)	0.6447*** (0.1167)	0.5810 (0.2058)	-0.0238 (0.3882)	0.869	1.0672
Maha	Major	6.39793	0.0548 (0.0920)	0.1826 (0.2775)	0.6070** (0.2824)	-0.1593 (0.1302)	0.715	1.0037
	Minor	7.71209	0.1528 (0.3039)	0.1445 (0.2019)	0.8135 (0.3876)	-0.0482 (0.3008)	0.819	1.0626

Notes: Figures in parentheses are standard errors

*** Significantly different from zero at 1% level.

** Significantly different from zero at 5% level.

4.3 Allocative Efficiency

The estimation of the production functions for rice cultivation paves the way to an evaluation of the efficiency of factor use in the agriculture of the area. According to standard economic theory an input in production is efficiently used when its marginal value product is equal to the market price of that input or its opportunity cost. Thus a comparison of the marginal value products of inputs and their prices gives an indication of the efficiency with which they are used in production. The marginal value products were calculated using the estimated coefficient from the production function and the geometric means of the variables.

It is admittedly difficult to determine the actual market prices (costs) for the inputs used. Therefore costs had to be imputed for these inputs. The rent payable for paddy lands was used as the value of land in the area. The average value of rice given to the landlords by the tenants was Rs. 2,400 per hectare during *Maha* 1980/81 and Rs. 2,600 per hectare during *Yala* 1981. These values were taken as the market prices of renting a hectare of land in the respective areas. The mean wage rate for agricultural labour during both seasons was Rs. 25 in the area. This was assumed to represent the cost of a unit of labour. The prevailing interest rate on cash loans during this period was 10 percent per month, according to Carr and Wanasinghe (1982). They had observed that short term cash loans for cultivation were usually settled in about five months. Thus the total interest for a loan amounts to 50 percent. Hence the opportunity cost of a rupee spent in the production process was assumed to be 1.5 in the Kirindi Oya area. Though there are limitations in imputing market prices to inputs in this manner, particularly in the case of land it was adopted as any further refinements would have posed too many obvious practical problems. This type of assessment has been resorted to by Saini (1979) and Herath (1983). By way of comparison, ratios of marginal value products to factor costs were derived for the four inputs. There ratios are given in Table 4.3 below.

Table 4.3

Ratios of Marginal Value Products to Factor Costs

	Yala		*Maha*	
	Major	Minor	Major	Minor
Land	2.39	1.23	2.67	3.01
Labour	0.28	-0.18	0.21	0.49
Machinery	0.27	1.88	0.87	0.61
Operating costs	0.14	0.33	0.45	-0.12

According to standard economic theory factors are allocated efficiently only when their marginal productivities are equal to their respective factor costs. Thus ideally the ratio of marginal value product to factor cost should be one. However, the ratios derived for these samples differ considerably from unity indicating inefficiency in resource use.

The high ratios for land indicate that as a factor it is under-utilized in the resource mix. In general the other three factors appear to be overutilised. It is interesting to note that negative marginal productivities occur only in the areas under minor irrigation. Further, in that area marginal productivities of both labour and operating costs are negative in *Yala*.

Chapter Five

CONCLUSION

The general picture of rice cultivation in the Kirindi Oya Project area which emerges from this study, indicates certain aspects which are relevant to project implementation. In particular, it has been shown that there is inefficient factor allocation by farmers.

Agricultural practices and productivity did not differ significantly among farms in the different size categories. Their productivity ranged from 2,300 Kg to 3,800 Kg per hectare. (This was also borne out by the more detailed production function analysis in chapter four). This is to say there are no economies of scale in the project area, so that a mere increase in the size of allotments is not likely to improve productivity, contrary to the Oft-stated view that allotments of one hectare under the project are not an economic holding size. The mean farm size in the sample was 1.2 ha in the area under major irrigation and 1.0 ha in the area under minor irrigation. Secondly, land as a productive factor was underutilized. A similar situation has been found to prevail in agriculture in some other part of Sri Lanka and in India. The implication of this in terms of project implementation is the need for intensifying agriculture on these farms.

Thirdly, resource allocation in rice cultivation is inefficient. There was overutilisation of labour, machinery and operating expenditure. In computing the marginal value product, family labour inputs were reckoned at the market price of labour. This procedure would have resulted in an over valuation of family labour. A similar situation was also reported by Herath (1983) in an evaluation of allocative efficiency in rice cultivation under different conditions in Sri Lanka. As Sen (1966) suggests this may be due to an imperfection in the labour market where the real cost of labour in peasant farming differs from the market wage rate. However, it is not possible to totally discount the possibility that the overutilisation of labour suggested by this analysis is due the surplus of labour in the area. If this is so we can expect the productivity of labour to improve at least in the beginning, when new lands are brought under cultivation.

Machinery was also overutilised. There are two possible reasons for this. One is the smallness of many farms. The other is that the tractor hire rates are abnormally high. The latter is more likely to be the case. The payments by most farmers for tractors and machinery are in kind (paddy) at the time of harvesting and the paddy equivalent of the money value of the payment that is due grossly inflates the hire charge. Farrington and Abeyratne (1982) have discussed at length the imperfections in the power hire market and the high charges made by tractor owners. Hence we can safely conclude that the inefficiency in the use of tractors and machinery is largely due to the overpricing of these services by the owners.

An aspect related to the use of machinery is the small role played by animals in providing draught power for farm operations. Within the sample, animal draught was used on only about five percent of the land or 2.5 percent of the holdings. Within the sample no animals were used for threshing. In 1977 Ranatunga and Abeysekera reported that 10 percent of the farmers in a sample from Hambantota district used buffaloes for land preparation. There is apparently a declining trend in the use of animal draught in the area. However, sufficient evidence has been produced to show that under many conditions animal draught power is more efficient and profitable than tractor power, particularly when the farm sizes are small.

The situation where tractor use is inefficient and subject to market imperfections and animal use is diminishing, points to the need for appropriate policy. In their detailed study on farm power in the Dry Zone, Farrington and Abeyratne (1982) made several recommendations to improve and rationalise farm power use on small farms. The recommendations included restriction of tractor imports, promotion of conditions that permit more efficient use of available tractors, relocation of draught animals from areas of surplus to deficit areas, establishment of realistic medium term credit facilities for the purchase of draught animals and breeding programmes to increase the numbers of draught animals. According to these two authors it is not essential to set aside large tracts of land for maintaining animals they could be managed under tethered and stall fed conditions as currently practised in some areas of the Polonnaruwa district. Many of these recommendations are applicable to the Kirindi Oya Project area and could be profitably applied under the project with proper planning and adequate organisation.

The expenditure on fertilizer, seed paddy and agrochemicals also seemed to be excessive according to marginal productivity analysis, indicating that they were misallocated. Farmers do not obtain sufficient returns on their expenditure on these inputs. The largest component in the operating costs is the expenditure on fertilizer. The recommended quantities of fertilizer were used only in the areas under major irrigation while in the minor irrigation areas they were considerably less. Generally the composition of the fertilizer used was quite different to what was recommended - thus reducing the benefits from fertiliser use. Excessive amounts of urea were applied at the expense of basal fertilizer. The probable reason for this practice is inadequate knowledge and the relatively high prices of basal fertilizer. It probably low as to a significant extent the returns on operating costs and calls for a concerted extension effort to correct it.

Though the data do not directly indicate it, the possibility exists that agrochemicals also are not properly utilised. Farmers bought agrochemicals on the advice of other farmers and of traders, and often this advice was based on limited experience and therefore had little relevance to specific field conditions. This tended to be the case with pest control when the particular pest was not properly identified. Traders' recommendations, not infrequently, are swayed by their inventory levels rather than the actual needs of farmers.

There was also a very limited use of certified seed paddy, resulting probably in a failure to realise the full potential of available plant varieties. The low resistance of the uncertified seed to pests and diseases, in turn, contributes to high operating costs. Limited use of certified seed was due to an insufficient supply of such seed and the lack of confidence of farmers in the quality of what is available. Their previous experience in the use of certified seed issued by the government does not seem to be reassuring.

The conclusion to which we are led is that poor productivity of operating costs is due to the inadequate adoption of proper technology largely on account of poor technical know how. When cultivation costs are considered as the means of improving paddy yields, the policy implication is the need for an effective agricultural extension and education programme and the establishment of efficient support services.

Risk aversion among peasant farmers is considered to be one of the draw backs to higher levels of agricultural production. Though this was not an aspect that was enquired into at field level, evidence of risk aversion emerged during the analysis. The chief source of risk and uncertainty seems to be the problems associated with the availability of water for cultivation, resulting in differences in cultivation practices. The lack of a reliable water supply for cultivation discourages farmers from committing a higher volume of resources such as is required for raising the per hectare yields. The problem of risk is reflected in the differences in cultivation practices between the areas under major and minor irrigation works and between the *Yala* and *Maha* seasons.

Labour inputs were higher in the major irrigation areas during both seasons and in both areas during the *Maha* season. Similarly higher cash costs were incurred in the major irrigation area. More fertilizer was applied in the major irrigation zone, though there was little difference in the fertilizer use between the two seasons. Traditional varieties were also more extensively grown in the minor irrigation areas and also during *Yala*.

There is little doubt that the above are manifestations of risk aversion among farmers and that they result from attempts to avoid the risks associated with droughts or an insufficiency of irrigation water. The provision and improvement of irrigation under the project is likely to change this situation.

This analysis has shown that the farmers in the sample use the resources available to them rather inefficiently. The response in terms of policy and active intervention for improvement of agriculture is to take steps which would create a production environment that enable farmers to take decisions which will lead to higher productivity of the resources used.

A major objective of the Kirindi Oya Irrigation and Settlement Project is to achieve conditions that will permit agriculture to contribute directly to economic growth and to the welfare of farmers to be settled under the project and of those already in the region. This could only be a reality when farmers allocate their resources efficiently. Since farmers are currently inefficient in the use of resources, there certainly exists an unexploited potential for improving agricultural incomes and generating larger surpluses of rice which will be the major crop in the project area. Several reasons that contribute to inefficiency in rice production were identified during the course of this study. Modes of intervention to rectify these constraining conditions were also suggested. Such intervention programmes will require coordinated action by several agencies concerned with rural and agricultural development. This coordination might well prove to be the most difficult aspect that the project will have to face.