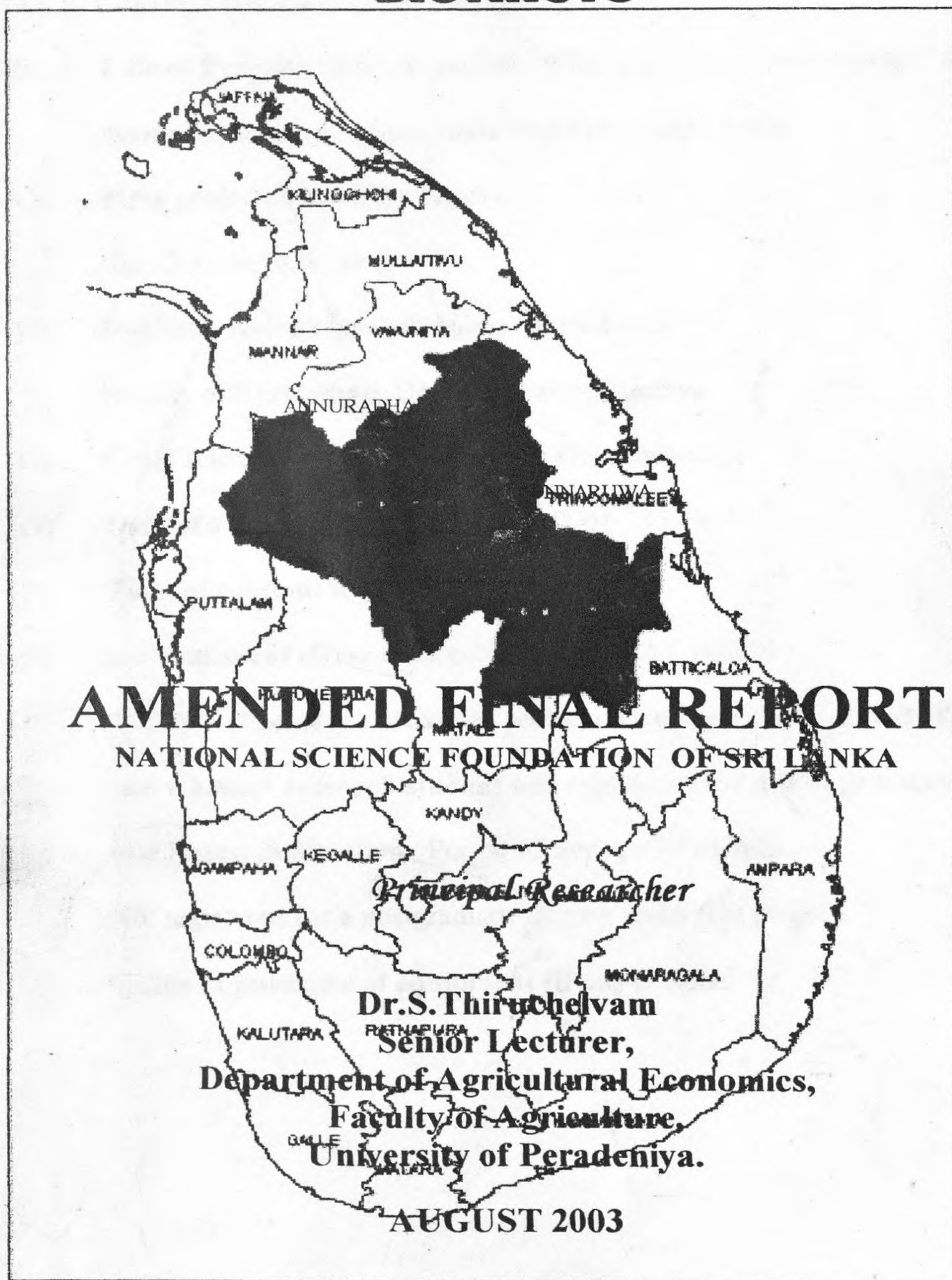


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# THE STUDY ON THE COST OF PRODUCTION OF RICE IN SRI LANKA ANURADHAPURA AND POLONNARUWA DISTRICTS



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## **The Study on Factors Affecting Cost of Production of Rice in Districts in Sri Lanka: Anuradhapura and Polonnaruwa**

### **ABSTRACT**

*This study is focussed on the factors affecting the cost of production and the potential to reduce cost of production while increasing paddy production in the Anuradhapura and Polonnaruwa districts. Specifically, this study investigated technical efficiency to explore possibility of yield increases and examined the cost of production components to find ways to reduce cost of production. Both secondary (1990 – 2000) and primary data (2000/01) were used in this study. The primary data were obtained using a multiphase sampling design and a survey of a stratified randomly selected 150 farmers in each district during the period from September to December 2001. In Anuradhapura district the areas selected for field data collection were Mahaweli System H, Rajangana Major scheme and Elayapattuwa Minor tanks. In Polonnaruwa district System B, System C and Parakramasamudra major scheme were selected for the study.*

*The analysis of secondary data from 1995 to 2000 revealed that there was an increment in the production and productivity of rice in the two districts. The study evidenced that more than half of the farmers had less than the average yield level (5 mt./ha.). Productive efficiency analysis using Maximum Likelihood estimates indicate the average technical efficiencies of paddy production were 80% and 73% in the major schemes in Anuradhapura and Polonnaruwa districts respectively. About 16% and 21% of the farmers are performing well in Anuradhapura and Polonnaruwa districts respectively, with a technical efficiency of over 90%.*

*Investigation of the cost of production with gross marginal analysis and regression revealed that overall, the majority of the farmers did not utilize the resources efficiently. There was a significant variation in cost of production between the districts. The variations in cost of production in Maha 2000/01 were Rs 29,193/ to 34,612 and from Rs 34,638 to Rs 36,727 per hectare in Anuradhapura and Polonnaruwa districts respectively. However, there was no significant difference between efficient and inefficient farmers. Labour cost consisted about 50% of the total cost of production. These indicate the potential for significant (20- 30%) increase in production by a majority (40 – 60%) of the low performing farmers with reduction in cost of production. On average, farmers in Polonnaruwa spent more (5%) on agrochemicals and depended more on mechanisation (7%) than those in Anuradhapura. Size of farm in relation to efficiency indicates the need for larger holdings (1 hectare) for efficient use of resources, as reflected in Polonnaruwa.*

*Debt level of the farmers and poor participation in farmer organization activities had a significant influence on the technical efficiency among the low performing farmers in both districts. These results suggest that increasing cost of production should be countered by improving soil fertility management, adoption of appropriate mechnaization, better extension services, strengthening farmer organizations to engage in marketing, credit and organizing cultivation in the irrigation schemes. It can be concluded that while all the factors had an impact on the yield achieved, management accounted for the main difference. This indicates the potential for increasing production while reducing cost through better management.*

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## 1. INTRODUCTION

### 1.1 Review of the Paddy Production

The agriculture sector has continued to play a leading role in the economy of Sri Lanka. It contributed 19.4 % of the total Gross Domestic Product (GDP) while paddy production independently contributed 3.5 % of the total GDP and the total rice production was about 2.86 million metric tons (137 million bushels) in Year 2000. About 36.8% of the population is involved in agriculture sector. Rice cultivation employs 1.8 million farmers, of whom over 67.3% cultivate less than the 0.8 ha (Department of Census and Statistics 2000 and 1982). An average consumer spends nearly 25% of food expenditure on rice (Department of Census and Statistics 1999). Annual per capita consumption is around 100 kg/year and production is falling behind the national requirement, consequently resulting in increased imports. During the past decade, self-sufficiency ratio varied between 85%-98%. This is mainly due to increase under cultivation and increase in yield per hectare.

The aswedumized extent, that is land available for paddy cultivation, in 1996 was 736,382 ha. Lands are cultivated in two seasons *Maha* (October - March) and *Yala*. (April – September). The major season *Maha* contributes around 65% to the annual production. Paddy is grown under all three modes of water regime: Major irrigation (471,000 ha), Minor irrigation (191,000 ha) and rainfed area (230,000 ha) (Department of Census and Statistics 2000). However, statistics show that maximum the extent sown in major, minor and rainfed water regime are 267,153 ha (57%), 129,900 ha (77%) and 165,879 ha (72%) respectively (Table 1). Average yield for major and minor irrigation schemes are 4,286 kg/ha and 3,562 kg/ ha respectively (Central Bank of Sri Lanka, 2001). Paddy cultivation in both *Maha* and *Yala* seasons was affected by drought, reducing output by 9 per cent and 5 per cent, respectively. In 2001 total production was 2.6 million metric tons, which was 8 per cent lower than in 2000. The average yield increased, reaching a new record level of almost 4 metric tons per hectare in 2001 (Central Bank of Sri Lanka 2001). Sri Lanka's average paddy yield is second to China (6,022 kg/ha) in the Asian region (FAO 1998). However it is observed Sri Lanka has achieved high level of yield at high cost.

Table 1. Sown area under paddy by mode of irrigation and total harvested Area by season: 1995 – 2000

Year	Sown area (Hectares)								Harvested area ('000 hectares)	
	Maha				Yala				Maha	Yala
	Major	Minor	Rainfed	Total	Major	Minor	Rainfed	Total		
1995	267,153	133,610	165,879	566,641	206,361	66,367	75,651	348,379	549	340
1996	238,475	106,719	153,736	498,930	149,846	41,015	58,955	249,815	425	235
1997	225,545	97,008	150,444	472,998	144,163	46,666	65,982	256,812	443	247
1998	266,142	147,883	159,823	573,845	195,098	42,237	37,084	274,419	563	266
1999	261,945	129,900	154,740	546,586	208,867	61,295	75,306	345,467	539	333
2000	264,602	129,604	155,040	549,246	216,156	54,269	57,929	328,354	520	298

Source: Department of Census and Statistics

## 1.2 Research Problem

### 1.2.1 Problems in Production and Productivity

Demand for rice is steadily increasing with time due to the increase in population at the rate of around 1.2 % annually (Department of Census and Statistics 2001). The total amount of rice needed in the years 2005, 2010 and 2020 are estimated at 3.23, 3.46 and 3.83 million metric tons respectively. Since Sri Lanka has reached to a stage where further expansion of the paddy lands area is not possible and increasing cropping intensity is also very hard, increase of yield in per unit area is the only method left to meet the further rice demand. Government policy has consistently placed a high priority on increasing domestic production of rice to attain self-sufficiency. Given the intensive nature of paddy production, investment has been oriented towards large-scale irrigation schemes, land development & settlement programmes, and free provision of irrigation water and fertilizer subsidies.

Statistics (1995 – 2000) shows that annual growth rate of paddy production has become stagnant. Table 2 shows the district wise performance of the paddy production form 1995 to 2000. It is interesting to note that about 50% of the total annual production comes form four major rice producing districts Ampara, Polonnaruwa, Kurunagela and Anuradhapura. These districts are considered as the highest potential districts and other paddy-cultivated districts are considered as the low potential areas according to the average paddy yield, total production and extent. According to Table 2, there is an increment for the paddy production in these districts form 1995 to 2000.

Table 2. District wise performance of paddy production in Mt.

Districts	1995	1996	1997	1998	1999	2000
Ampara	387,910	403,640	376,661	429,029	443,932	435,963
Polonnaruwa	355,940	300,140	325,560	338,454	347,933	393,543
Kurunagala	369,360	140,660	283,117	333,721	355,654	293,099
Anuradhapura	238,840	87,740	60,718	272,454	244,905	259,774
Sri Lanka	2,859,880	2,061,540	2,239,369	2,692,335	2,857,113	2,859,891

Source: Central Bank of Sri Lanka 2001.

Rice is planted on between 750 000 to 850 000 hectares annually. Of this, the main Maha crop (Oct/Mar) accounts for 500 000 to 550 000 hectares and the second crop Yala (Apr/Sept) for 250 000 to 300 000 hectares. On average, some 200,000 hectares (140,000 hectares in Maha and 60,000 hectares in Yala) are cultivated under rain fed conditions with the remaining area being irrigated, at least to some extent (Table 1, 2 and 3). However, the success of rice production remains dependent on rainfall, during the Northeast monsoon for Maha and during the Southwest monsoon for Yala. Rice normally requires about 200 mm of rainfall per month or the equivalent through irrigation supplies. As this amount of rainfall is not normally received throughout the Maha and Yala seasons, the crop is constantly under the risk of drought. or the crop suffers moisture stress, especially under minor irrigation and rain fed conditions.

Table 3. Paddy cultivated and harvested extent, Production and average yield in Anuradhapura and Polonnaruwa Districts in 1999/2000 Maha and 2000 Yala seasons

Description	Anuradhapura District				Polonnaruwa District			
	Major	Minor	Rain Fed	Total	Major	Minor	Rain Fed	Total
Maha 1999/2000								
Extent Cultivated (ha.)	29,665	42,180	7,450	79,295	24,645	2,910	1,005	28,560
Extent harvested (ha.)	28,748	37,599	6,005	72,352	24,519	2,711	935	28,165
Production (Mt.)	104,950	130,315	15,545	250,810	96,305	9,590	3,130	109,025
Average Yield (Kg/ha.)	4,540	4,310	3,220	4,311	4,440	4,000	3,780	4,376
Yala 2000								
Extent Cultivated (ha.)	9,975	11,410	-	21,385	23,350	1,525	-	24,875
Extent harvested (ha.)	9,722	10,407	-	20,129	23,166	1,475	-	24,640
Production (Mt.)	31,110	31,045	-	62,155	88,730	5,545	-	94,275
Average Yield (Kg/ha.)	3,980	3,710	-	3,840	4,730	4,250	-	4,325

Source: Department of Census and Statistics 1999/2000.

A large number of small-scale paddy producing farmers are in the paddy production sector in the country. There are significant differences in production efficiency and other socio economic domains, opening opportunities to improve efficiency through reallocation of current resources and introducing new technologies that target farmers. Further, it would be more advantages to concentrate on the more productive rice growing regions of the country, rather than spread out effort thin across the whole country.

### 1.2.2 High Cost of Production

At present, one of the problems faced by the paddy sector is high cost of production and low profitability. Weerahewa and Abegurnawardena (1989) showed that paddy production become no more profitable over time. Wijeyaratna and Hemakeerthi (1994) reported that the production cost has increased over the years with districts that have better water conditions. This indicates that uncertainty of water supplies detracts the level of investment of rice production to a larger extent. The average cost of production of the paddy has increased over the years due to the increase in the costs of inputs especially labour wages, tractor hiring fees and agrochemical (Central Bank, 1999). According to relative cost of production of paddy in countries in the Asian region, Sri Lanka is one of the highest costs of production in the paddy sector. According to the trade policies and with the opening of the economy protection of agriculture is increasingly difficult. Therefore the lack of competition and high cost of production make Sri Lankan farmers to face tremendous challenges for the paddy cultivation.

### 1.2.3 Ineffectiveness of the Support Services

There are several support services such as agricultural research, extension programme, agricultural credit, appropriate technology, marketing facilities and farmer organizations that are required in the paddy production. All the governments in the past have understood the importance of these supporting services in the agricultural sector. They implemented various programmes to improve these services towards increasing the production. But, these programmes were not successful. There are substantial evidences that the rice economy in Sri Lanka is not performing well despite the heavy government protection, subsidies and other incentives. The future will be uncertain because rapid structural changes together with the globalisation process will put more pressure for the rice sector to be more competitive.

#### **1.2.4 Objectives and Hypothesis**

In line with the above reasoning, the present study was undertaken with the general objective of identifying the ways to reduce cost of production and to increase the potential of paddy production. The specific objectives of the study are: -

- 1) to estimate yield potential and explore the possibilities to uplift paddy production,
- 2) to examine the components of cost of production to find methods to reduce cost of production,
- 3) to explore the socio-economic and institutional conditions such as market, credit, farmer organization etc. on why they are not following the recommended management practices.

#### **Hypothesis**

Given the high cost of production and stagnation of productivity in paddy cultivation, improving efficiency and reduce the cost of production is important to increase paddy production in Sri Lanka. There is a wide belief that it is very difficult to increase the productivity without increasing the inputs. In this context this study was carried out with the hypothesis:

“ Increase in paddy productivity can only be achieved through increased inputs”

The subsidiary hypotheses of the study are:

1. “There is no difference in resource use, productivity efficiency and cost of paddy production among the paddy cultivators”
2. “ Factors that affect such efficiencies are the same among the cultivators “

## **2. LITRETURE REVIEW**

### **2.1 Paddy Production Efficiency in Sri Lanka.**

During the last decade, average yield has not increased significantly, but was fluctuating around 3.5mt/ha (Danapala 2000). Higher yield than national average are recorded for major irrigation cultivation and much less for minor irrigation and rain fed irrigation cultivation. Rational farmers based their supply decision on prices. A reduction in price is generally responded with a decrease in area cultivated per ha. yield. It also shows that a yield reduction from 3.7mt/ha to 3.2mt/ha would have taken place with the trade liberalization (Department of Agriculture, 2000).

The literature on tenancy and agrarian contracts argues that share tenancy is not necessarily inefficient but it may represent the best contractual response to an imperfect market environment (Michael and Don Kanel, 1992). In this qualified sense share cultivation can be an efficient institution. Share cultivation may cease to be an efficient or desirable way to organise production following changes in technology or market structure (Cheung, 1968). The agrarian structure literature also admits the possibility that comprehensive tenancy reforms could in fact improve economic efficiency over that

attained under share cultivation. Studies also identify a multiplicity of reasons for the emergence of share cultivation.

Cheung (1968) has paid attention exclusively on land tenure system and agricultural efficiency on the question of how much output is likely to be produced under different forms of tenure arrangements. But, the respective merits of alternative tenure systems should not be judged solely on farm output. Rao and Huang (1973) and Walter Haessel (1978) attempted to remedy this deficiency, by using comparative efficiency of resource allocation on land tenure and owner cultivation. The later showed that when transaction costs, the role of entrepreneurship and economic incentives are explicitly introduced share cultivation improved agricultural production. Studies of Bethma in the traditional village context have been carried out by number of authors in a very descriptive manner. (Leach 1961, Perce 1987, and Abeyrathna and Perera and Ijsbrand H de Jong 1989). They paid attention to land ownership, the rights and privileges that are associated with Bethma. Thiruchelvam and Somaratne had used frontier model and showed that owner farmers performed better than tenant farmers under bethma system in Mahaweli System H.

Yotopoulos and Lau (1973) developed an operational concept of economic efficiency to measure and compare performance of farms using profit function. In Pakistan, Khan et al., (1979) have studied the effect of farm size on economic efficiency. In Sri Lanka Bogahawatte (1982) applied a similar model in a study on tenancy efficiency with respect to farm holding size. He showed that owner efficiency was related to size of operation but not in tenant cultivation. In the above two studies, the Lau and Yotopolus model on profit function was used to derive values of technical and price efficiency parameters in order to identify and isolate possible difference between owner and tenant farmer cultivation.

Several methods have been developed to determine the most efficient production frontier by different researchers (Farrell, 1957; Timmer 1960; Aigner, 1977 and Meeusen and Van den Broeck 1977). Battese (1992) proved that the econometric modelling of frontier production functions provide useful insights into best practice technology and measures by which the productivity efficiency of different firms may be compared. Despite its well-known limitations, the Cobb-Douglas functional form has been widely used in farm efficiency analysis for both developing and developed countries.

Ekanayake and Jayasooriya (1987) and Karunaratne and Herath (1989) estimated both deterministic and stochastic frontier production of Cobb-Douglas type for rice and other filed crops in the Mahaeli System H. They estimated separate stochastic Cobb Douglas production frontiers to head and tail enders of the irrigation scheme. They found no significant technical inefficiency from farmers at the head. However they found significant technical inefficiencies at the tail. From a second step analysis they found that literacy, experience and credit availability had significant positive impacts on the technical efficiency of farmers at the tail. Use of two-step procedure to examine the determinants of efficiency. Critics of this approach contend that the socio-economic variables should be incorporated directly in the production frontier model because such variables may have a direct impact on efficiency.

## 2.2 Comparative Advantage of Paddy Production.

The Domestic Resource Cost Ratio (DRC) The DRC is used to assess the comparative advantage, which gives an idea about economic deficiency of the production process in a particular commodity, when comparing different outputs produced by a system. Rafeek and Fredric Samarathunga (2000) have estimated DRC for 1990s and results are contrasting. These studies gave mixed and contrasting results. The reason was the estimates were one-time point estimates of yield, which fluctuate, significantly year-to-year. Kikuchi, Barker et al (2001) overcame these defects by dealing with a long-term trend in rice production (1980 – 1997). They showed that rice production in Sri Lanka had comparative advantage around 1980 and advantage has been eroded in the last two decades. But they emphasized that rice production in the major irrigation regime that shares about 70% of total rice production of the country is still profitable, as long as the investment costs of constructing these major irrigation schemes are treated as sunk cost. They also highlighted that the major factor that has been pushing down the comparative advantage of rice production is the increase in the agricultural wage rate. Estudillo et al. 1998 have shown that in many land scarce Asian countries also followed this trend of losing their comparative advantage of rice due to continuous increase in the real wage rate in the non rice sectors. Randolph Barker and Aid Dawe (2000) also proved that lower domestic rice price and rising wage rates made rice farming far less profitable. An increase in yield is also imperative to reduce unit cost of rice production. Hence research is needed to improve the efficiency of resource use in rice production and thereby improve the competitiveness.

Mahabub Hossain (1999) in his investigation on long term perspective of the demand supply balance for rice in Asia highlighted technological fatigue, growing scarcity of agricultural inputs such as labour, lands and water, soil degradation are the major causes for poor performance of paddy sector in Asia. He suggested maintaining a favorable balance will depend on appropriate technologies to address abiotic stress, which can help to reduce the large yield gaps in the rainfed ecosystem. Panabokke and Buniyawardena (2000), also stressed the same points in their study on rational utilization of the water and land water for rice-paddy lands that rather than spread efforts than across the whole country. It would be more advantageous to concentrate on the more productive rice growing regions of the country. Hendry Gamage (2000) examined the water use efficiency (WUE) in agriculture and suggested to identify best rice producing areas and to restrict the paddy cultivation to imperfectly rained and poorly drained soils in major irrigation projects.

In 1979/80, Anuradhapura district showed remarkable adoption figure of 98.3% (Norland 1986). The percentage share of area planted to NIV reached nearly 100% by early 1980s and apparent kink is observed in the trend of fertilizer intensity in the late 1980s. This suggests that the stagnation in rice yield per ha since mid 1980s has been associated with the exhaustion of the yield potential created by the seed fertilizer technology. However, fertilizer usage has remarkably increased from 143,000 Mt to 314,500 Mt from 1990 to 1999 (Annual Report of Central Bank, 1999). The advances made in fertilizer research frontier are adequate for meeting the local rice requirement. However the institutional and socio-economic barriers hinder achieving this target.

The present study attempts to investigate the potentiality to increase production by reducing the cost of production by agro-climatic zone and the irrigation regime zones. Further this study is unique in investigating the dynamism of commercially oriented rice production sector within the cropping system with respect to reduce the cost of production and increase in yield.

### 3. METHODOLOGY

#### 3.1 The Study area

The study area selected for survey was North Central Province of Sri Lanka and the study was carried out in Anuradhapura and Polonnaruwa, which are the major paddy producing districts in Sri Lanka (Figure 1). The coverage of the study was based on the proportionate representation of the paddy crop cultivated and irrigated regime. Total land area of the Province including inland water bodies is 1,047,200 ha and the forest area is 263,057 ha. Total population in the province is 1,141,589 in year 2000. Considering the administrative structure North Central Province has 28 Divisional Secretariat Divisions and 2,448 villages. Paddy is the predominant crop grown under the three modes of water supply, namely Major Irrigation (104,015ha.) Minor Irrigation (41,702ha.) and Rainfed Area (3,980ha) (See Table 2) and the Mahawali areas in the province, there are 48,346 ha of paddy lands. Number of Major and Minor irrigation schemes are scattered through out the province. The ability of these schemes to provide irrigation water still depends, to a large extent, on sufficient rainfall to replenish tanks and reservoirs. Only the Mahaweli Irrigation System, which was developed in the late 1970s/early 1980s has permanently available water through diversion of the Mahaweli River.

Anuradhapura district contributes 9% of the total national rice production and occupy 14% of the total extent of paddy in Sri Lanka. Total land area of Anuradhapura district is 717900 ha or 6500 Sq. km. The district consists of 5 river basins. Total numbers of Major schemes are 14 and Minor schemes are 2508. Average Annual Rainfall is 1358.4mm. There are 98443 ha of paddy land area in Anuradhapura district, which is 56074 ha under Major schemes, 46500 ha under Minor schemes and 2976 ha under Rain fed areas. Total population in Anuradhapura district is 758900 and it is fourth highest paddy producing district in Sri Lanka. In Anuradhapura district based on extent of cultivation and potential increase in production, Mahaweli System H, Rajangana major scheme and three Minor tanks in Elayapattuwa Agrarian Services Divisions were selected for field data collection.

The Mahaweli System H comprises of mainly large part of Kalaoya valley in Anuradhapura District. Irrigation water for System H is diverted from the Mahaweli Ganga at the Polgolla Dam via Kandalama, Ibbankatuwa and Kalawewa tanks. Mahaweli H system is divided in to eight blocks for easy functioning and management of the system. The total irrigable area is 31,303 ha and 31,000 farm families are settled in this system. The landscape is undulating with slopes ranging from 0 to 4% with minor watersheds. The upper part of the slope consists of well-drained reddish brown earth (RBE) while the mid slope area is imperfectly drained. The lower areas are ill drained with low humic gley soils (LHG). RBE is found to occupy around 60% of the land area in the Mahaweli system H. Out of eight blocks Eppawella Block was selected for the study in Mahaweli System H.

The Rajanganaya Scheme consists of two main reservoirs namely Rajanganaya tank and Angamuwa Wawe. Department of Irrigation in 1957 built the Rajangana tank, making a wear across the Kala Oya near the Thambuththegama town. Catchment area of the tank is 622.5 Sq. miles. Full supply capacity is 81603-acre feet while the surface area is 3,950 acres. There are 10,200 farm families under this scheme. Command area is 7,125 hectare and cultivated area under paddy is 6,072 hectare. Length of the Right Bank channel is 5 miles. There are 16 Tracks under Right Bank main channel of the Rajanganaya tank. Out of these, 4 Tracks namely 1, 2, 3 and 4 were selected for field survey.

# Study Area

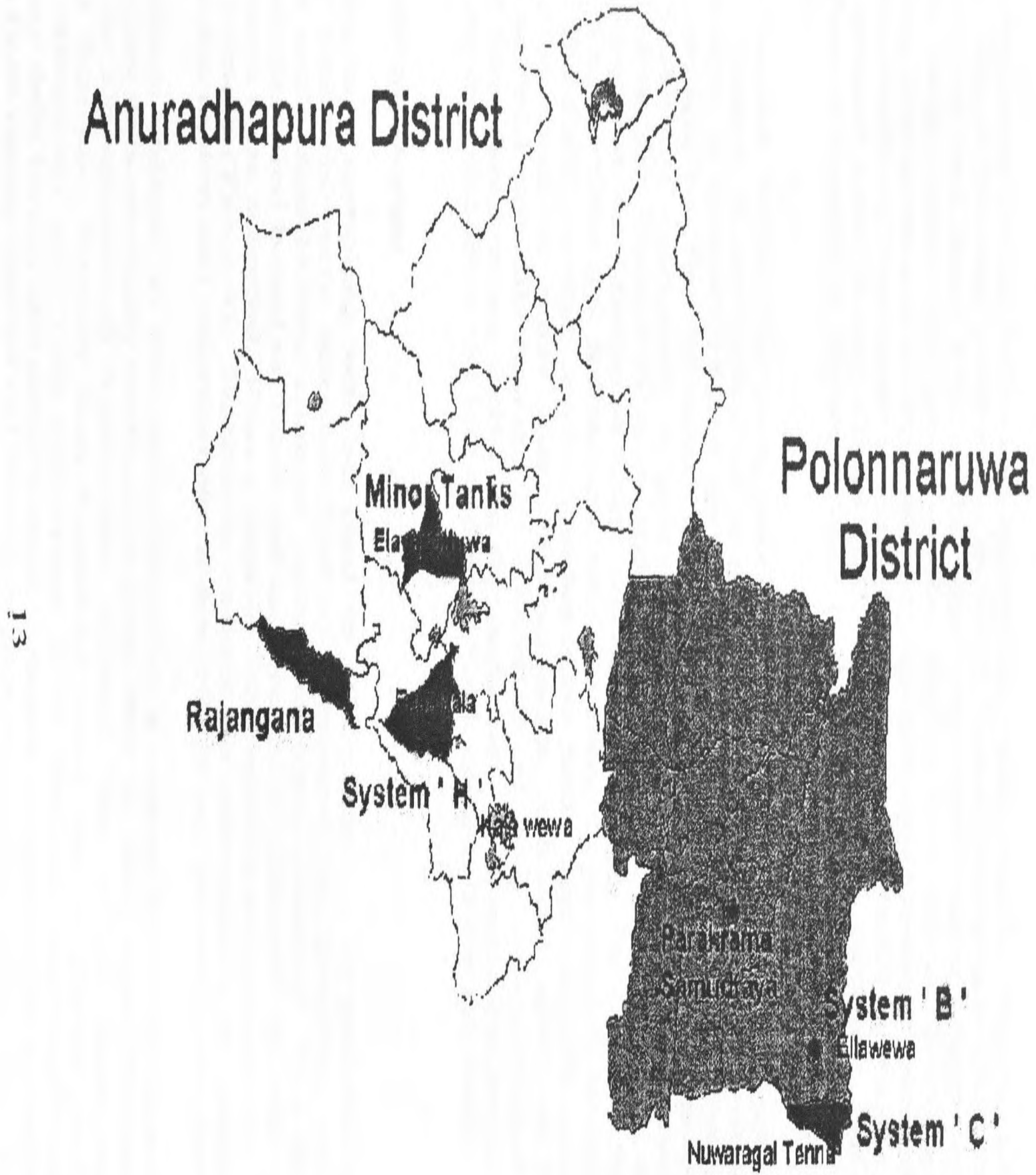


Figure 1 Map of study area - Anuradhapura and Polonnurawa Districts

Small-scale water conservation systems are commonly referred to as village tanks or minor tanks. There are about 9,500 such minor tanks scattered through out the country with an irrigation potential of over 161,000 ha. In the Anuradhapura district three minor tanks namely Wihara Kalanchiya, Wihara Bulankulama and Maha Elayapattuwa, in Elayapattuwa Agrarian Services Division were selected for the field study. Total number of farmer families in Elayapattuwa Division is 2,120. There are 78 Minor tanks with command in area of 3,693 acres in the study area.

Polonnaruwa district is the second highest paddy-producing district in Sri Lanka and contributes 14% of the total production in 2000. Polonnaruwa accounts for about 6% of the national rice area and about 12% of the total area under major irrigation is located in this district. The predominant crop grown in the district is paddy accounting for about 51,226 hectares. This district treasures with large tanks and colonization schemes. The soil in the district is essentially of two types of well-drained upland Reddish Brown Earth (RBE) and the poorly drained Low Humic Glaye (LHG) in the valley bottoms. In the Polonnaruwa district Mahawali System B, System C and Parakramasamudra major scheme were selected for the study.

In system B, water is directly supplied from the left bank channel of the Maduruoya Reservoir. System B comprises of many large parts of Polonnaruwa, Batticaloa and Ampara districts. It covers 115,368 ha of land area. Some units of System B are directly affected activities by the terrorist. In Mahaweli System B Ellewawa was selected. Mahaweli System C comprises a gross area of about 70,000 hectare along the river Mahawali below the Minipe Anicut. Irrigation water for System C is diverted from the Mahawali Ganga at the Minipe Anicut, conveyed through the Minipe Right Bank (Trans basin) channel to the Ulhitiya/ Rathkinda twin reservoir. In System C, Nuwaragala Block was selected for the field survey. Parakramasamudra tank. The capacity of the tank is around 19,000 acre. It receives water from Ambanganga, a branch river of Mahawali Ganga, Radavige Oya and rainfall. Around 25,000 acres of land are cultivated under this tank. About 5642 farm families are settled in this scheme. In Parakramasamudra Major scheme, two Elases were selected from the left and right bank channels for the study.

### **3.2 Sampling Design**

Multiphase sampling was adopted in this study. In probability sampling, two distributory channels were selected first to represent the problem and then four field channels in each distributory channel were randomly selected. Ten farmers from each channel were stratified based on head and tail end of the channel. In each study site not less than 50 farmers were selected. Thus a total of 300 farmers were randomly selected from the two study districts (Table 4). Further to collect the information on institutional aspects, a focus group discussion and informal discussions with key persons were carried out.

Database utilized in this study included a combination of secondary and primary data. Secondary data on paddy production from 1990 to 2000 were obtained from the annual reports of the Department of Agriculture, Central Bank of Sri Lanka and Department of Census and Statistic. Primary data regarding input use in paddy production for Maha cultivation 2000/2001 and Yala cultivation 2002, farmers' household information, assets level, farmers' debt levels, and participation in farmer organization activities, were collected through the field survey carried out during September to December 2001 in the study areas.

Table 4. Distribution of sample in Anuradhapura and Polonnaruwa Districts

Anuradhapura District			
Major Irrigation Schemes		Minor Tanks	Total Sample
Mahaweli System H	Rjangana Tank	Elayapattuwa A.S.D.	
Eppawella Block	Right Bank Channel	Maha Elayapattuwa	
Sample size = 50	Sample size = 50	Sample size = 50	150
Polonnaruwa District Major Irrigation Schemes			
Mahaweli System B	Mahaweli System C	Parakramasamudraya	
Ellewawa Block	Nuwaragala Block	2 -Ela Divisions	
Sample size = 50	Sample size = 50	Sample size = 50	150

### 3.3 Approach

#### 3.3.1 Analysis of Productivity Efficiency

##### Yield Gap

First, the study assessed the yield gaps. Literature on yield gaps indicates broadly two levels of yield gaps:

Yield Gap 1: the difference between research level yield in the farmers locality and the potential farm yield obtainable in a farmers' field.

Yield Gap 2: the difference between potential farm yield and the actual farm yield.

Yield Gap 3: the difference between farm level average yield and lowest farm level yield.

Usually, yield gap 2 is considered as exploitable yield gap. This study was interested in estimating the following third yield gap. The information was collected on research yield in the farmers' locality. This was compared with the average yield achieved by the well performing farmers and the average yield of all farmers in the similar location. These were estimated to explore the possibility of untapped technology potential for further increase and to find out whether there is a declining trend in yield at the farm level.

##### The Achievement Distribution in Yield

The achievement distribution in yield represents the different yield per hectare achieved by the farmers in a locality of a region. At any given quality of land, with the management skill and economic opportunity, there is an actual achievement that is lower than that would be profitably achievable. The variations in the actual achievement expressed in a distribution from the most to least successful farmers in the study area were analyzed using frequency statistics.

##### Technical Efficiency - The Theoretical Model

Analysis of efficiency in production is vital in development of policy formulation to increase paddy production in Sri Lanka. Productivity growth may be achieved through either technological progress or efficiency improvement. Technical efficiency examines the production side, in particular input use and is independent from the costs associated with production. It bears more implications on sustainability as it deals with better use of resources without moving towards advanced technology. The conventional production function approach of productivity measurements has the weakness of not taking into account inefficiency effects.

Technical efficiency of a farm is defined in terms of the ratio of the observed output ( $Y_i$ ) or input ( $X$ ) to the corresponding frontier output ( $Y^*$ ) or input ( $X^*$ ). Farrell (1957) defined technical efficiency, as the ratio of inputs required ( $X^*$ ) to produce  $Y^*$  to the inputs actually used ( $X$ ) to produce  $Y^*$ . In other words, any production process is technically efficient if output  $Y = Y^*$  and technically inefficient  $Y < Y^*$ . Thus technical efficiency is  $TE=Y/Y^*$ .

Earlier production function analyses that followed Farrell (1957) were deterministic, in that they assumed a parametric form of the production function along a strict one-sided error term (Schmidt 1976). Such forms take no account of the possible influence of measurement errors and other causes of distortions from the estimated frontier are assumed to be the result of technical efficiency. These problems were subsequently addressed to open the way to the numerous adaptations that represent the stochastic frontier function of the present day (Aigner et al. 1977; Coelli 1995).

Currently, the stochastic frontier production function is basically specified as a composed error model of the general form:

$$\ln(Y_i) = F(X_i, \beta) + \varepsilon_i \quad i = 1, 2, \dots, N \quad \varepsilon_i = v_i - u_i \quad (1)$$

Where  $Y_i$  denotes production level,  $X_i$  is input level and  $\beta$  is a vector of unknown parameters to be estimated.  $F(\cdot)$  represents an appropriate function (e.g. Cobb-Douglas, transcendental, logarithmic etc.), and  $\varepsilon_i$  is the composed error term, that equals  $v_i - u_i$ . The term  $v_i$  is a symmetric error, which accounts for random variations in output due to factors beyond the control of the farmer, e.g. weather and disease outbreak, and it is assumed to be independently and identically distributed as  $N(0, \sigma_v^2)$ . The term  $u_i$  is a non-negative variable representing inefficiency in production relative to the stochastic frontier. The distribution of  $u_i$  is also assumed to be independent and identical as  $N(0, \sigma_u^2)$  which could be half normal at zero mean, truncated half-normal, and based on conditional expectation of the exponential ( $-u_i$ ). The technical efficiency relative to the stochastic frontier  $e^{-u}$  is captured by the one-sided error component  $U_i \geq 0$ . When  $U_i = 0$ , production lies on the stochastic frontier and is technically efficient and when  $U_i > 0$ , production lies below the frontier and is technically inefficient.

According to Battese and Coelli (1995), technical inefficiency effects are defined by;

$$U_i = Z_i \delta_i + W_i \quad i = 1 \dots N \quad (2)$$

Where  $Z$  represents factors contributing to inefficiency. In this study, farming experience in years, education, part time farming, asset level and membership in farmer organizations were considered as possible factors contributing to inefficiency.  $\delta_i$  is a vector of unknown parameter to be estimated.  $W_i$  is unobservable random variables, which are assumed to be identically distributed, obtained by truncation of the normal distribution with mean zero and unknown  $\sigma^2$ , such that  $U_i$  is non negative. The efficiency indices obtained for individual farms were subsequently regressed in a second stage against some socio-economic variables. Critics on this use of the two steps procedure noted a significant problem with this two-stage approach, i.e. the assumption of independent and identical distribution of the inefficiency effects is violated in the second stage when they are made to be a number of farm specific factors with no identical distribution. In this study all parameters were estimated in a single stage Maximum Likelihood Estimate (MLE) procedure as in the computer software FRONTIER version 4.1 (Coelli 1994).

According to Battese and Coelli (1977), the variance ratio parameter  $\gamma$  which relates the variability ( $\sigma^2$ ) can be calculated in the following manner;

$$\gamma = \sigma_u^2 / \sigma^2 \quad (3) \text{ and}$$

$$\sigma^2 = \sigma_u^2 + \sigma_v^2 \quad \text{and} \quad \delta = \sigma_u / \sigma_v \quad (4)$$

Where  $\sigma_u$  and  $\sigma_v$  are standard deviations of  $U_i$  and  $V_i$  respectively and the  $\gamma$  parameter has value between zero and one. If  $\gamma$  is close to zero, the difference between a farmer's yield and the efficient yield is mainly due to statistical error. On the other hand if  $\gamma$  is close to one, the difference is attributed to the farmer's less than efficient use of the technology i.e technical inefficiency (Coelli, 1995). The estimates of  $\sigma^2$ ,  $\delta$  and parameter vector  $\beta$  are obtained by the MLE method.

Technical efficiency is measured as the deviation ( $e^{U_i}$ ) of the individual farmer from the best practice Frontier, which is assumed to be stochastic corresponding to additive two-sided error term  $V_i$  exogenous shock and one sided error term  $U_i$  represents technical efficiency or deviation in technical efficiency. It may be noted that the production function of the form  $f(X_i; \beta) e^{V_i - U_i}$  does not depict a purely technical relationship between inputs and outputs for the mere reason that input prices and expected product prices varied across the study area and influenced farmers' input use and production decisions. With the underlying influence of prices, efficient combinations of inputs are no longer a purely technical decision but also rely on economic judgment. Therefore the results of technical efficiency ultimately have to be referred to in terms of economic efficiency. The combination of technical efficiency and allocative efficiency is defined as economic efficiency, where allocative efficiency deals with the optimum use of input combinations in production.

The final model was derived by, first, fitting Ordinary Least Squares (OLS) models experimentally before estimating by the maximum likelihood methods. This procedure also helped to check on econometric problems, e.g. multicollinearity existing in the data. The estimated production function was of the form:

$$\ln(Y_i) = \sum \beta_j \ln(X_{ij}) + v_i - u_i + \sum \delta_j Z_j \quad (5)$$

Where  $Y_i$  is (the logarithm of) kilograms of production produced by the  $i^{\text{th}}$  farmer  $X_{ij}$  are the vector of (the logarithm of) inputs used by the  $i^{\text{th}}$  farmer, such as land area under paddy in acres, labour in man days, cost of seed, cost of agrochemicals and cost of machinery;  $Z_j$  are variables which may influence the efficiency of the farm, such as farming experience, part time farming, asset level and membership in farmer organizations.

### 3.3.2 Analysis of Cost of Production

To accomplish the second objective on cost of production, gross marginal analysis and tabulation analysis were used. Based on the productivity efficiency in farmers were categorized into three classes such as efficient, average and low performing farmers. The cost of production and input use were compared. To evaluate the institutional support to production, Chi square, simple tabular and descriptive analysis were used.

## 4. RESULTS AND DISCUSSION

### 4.1 Socio - Economic Conditions of Farmers

Farmers' characteristics of Anuradhapura and Polonnaruwa Districts are presented in Table 5. The information on age indicate that farmers are in their active age (less than 55 years) in both districts. Higher percentage (75%) of farmers with secondary education level in the Mahaweli Systems H, B and C indicate that farmers have the knowledge to understand the correct farming techniques. For farmers in minor and old irrigation schemes more attention on extension services on new farming techniques to be paid to due to their lower education level. On average in both districts majority of the farmers has experience of farming for more than 25 years. About 85% of the farmers in Mahaweli Systems H, B, and C were full time farmers. In minor tanks and old schemes the part time farming is as high as 39%. The average family size is higher (6.8) in Polonnaruwa than in Anuradhapura (5.6). This indicates with larger family size and many years of farming experience, more farmers in the minor tanks and old schemes are becoming part time farmers. This is an important issue that needs attention.

More than 90% of the farmers interviewed under major scheme in Anuradhapura and Polonnaruwa are owner cultivators. In contrast 62% of owner cultivation, highlights an apparent tenancy problem in the minor tanks. This shows the existence of hidden tenancy in the Mahaweli systems. Regarding the ownership of tractors, on average about 15% of the farmers in the Mahaweli systems have two wheel tractors and sprayers. Low percentage of ownership and higher level of part time farming in minor tanks indicate loosing productivity of land in the long run.

Table 5. Socio economic conditions of the farmers in Anuradhapura and Polonnaruwa Districts

Anuradhapura District			
Indicators	Mahaweli System H Eppawella Block	Rajangana Scheme	Elayapattuwa Minor Tanks
Age of respondent (Yrs.)	54	52	55
Family Size (Members)	05	06	06
Education $\geq$ Secondary level	80%	75%	50%
Experience in Farming (Yrs.)	32	28	32
Assets (2 Wheel Tractors)	18	32%	10%
Land Owners	95%	87%	62%
Part Time Farming %	14%	30%	46%
Polonnaruwa District			
Indicators	Mahaweli Sys.C Nuwaragala Block	Mahaweli Sys. B Ellawewa Block	Parakrama Samudraya
Age of respondent (Yrs.)	52	53	56
Family Size (Members)	06.5	07	6.5
Education $\geq$ Secondary level	68%	72%	35%
Experience in Farming (Yrs.)	26	24	33
Assets (2 Wheel Tractors)	14%	12%	10%
Land Owners	90%	88%	78%
Part Time Farming %	17%	12%	41%

## 4.2. Paddy Productivity

### Yield Gap

The yield gaps 1 and 2 calculated from using the survey data are shown in Table 6 and Figure 2. At a glance, it is apparent that despite the availability of new improved varieties with a yield of little above 8 mt/ha as maximum realized average yield at farmer level has been around 5.01 and 4.4 mt/ha under the Anuradhapura and Polonnaruwa districts respectively. The yield gap between the potential and realized yield at farmer level under the major irrigation scheme in the Anuradhapura and Polonnaruwa districts are little more than 6mt/ha.

There is big yield gap existing between current yield and the potential yield (yield gap I) in all the study areas. The average current yield in System H for paddy in Maha is 5 t / ha and in yala is 4.4 t/ ha. However their potential yields are 6.5 t/ha and 5.4t/ha in Maha and Yala seasons respectively. Other two study areas showed more yield gaps than system H. The sizeable yield gap exists between achievable and actual yields in both districts is a potential opportunity for raising the yield level in the long term. About 1.45 and 1.56 t/ha can be increased in Anuradhapura and Polonnaruwa respectively, through using adequate levels of inputs and following management practices adopted by the best farmers. It is evident from this study that technical knowledge is important in determining the adoption of improved practices and increased yields

Yield gap I is smaller than yield gap II indicating little scope for increased through improved crop management. Higher yield gap II indicate higher degree of instability of rice yield and risk involved in the rice production. The yield gap II could not be fully exploited because of economic factors such as low paddy prices, lack of credit facilities and low marketing margin. Yield gap II indicate that there still exists substantial yield gap with existing technology that could be exploited with improvement practices for further increase in rice production. For the poor performing farmers, extension, credit and market information are needed. These farmers are not market oriented and have not realized their potential.

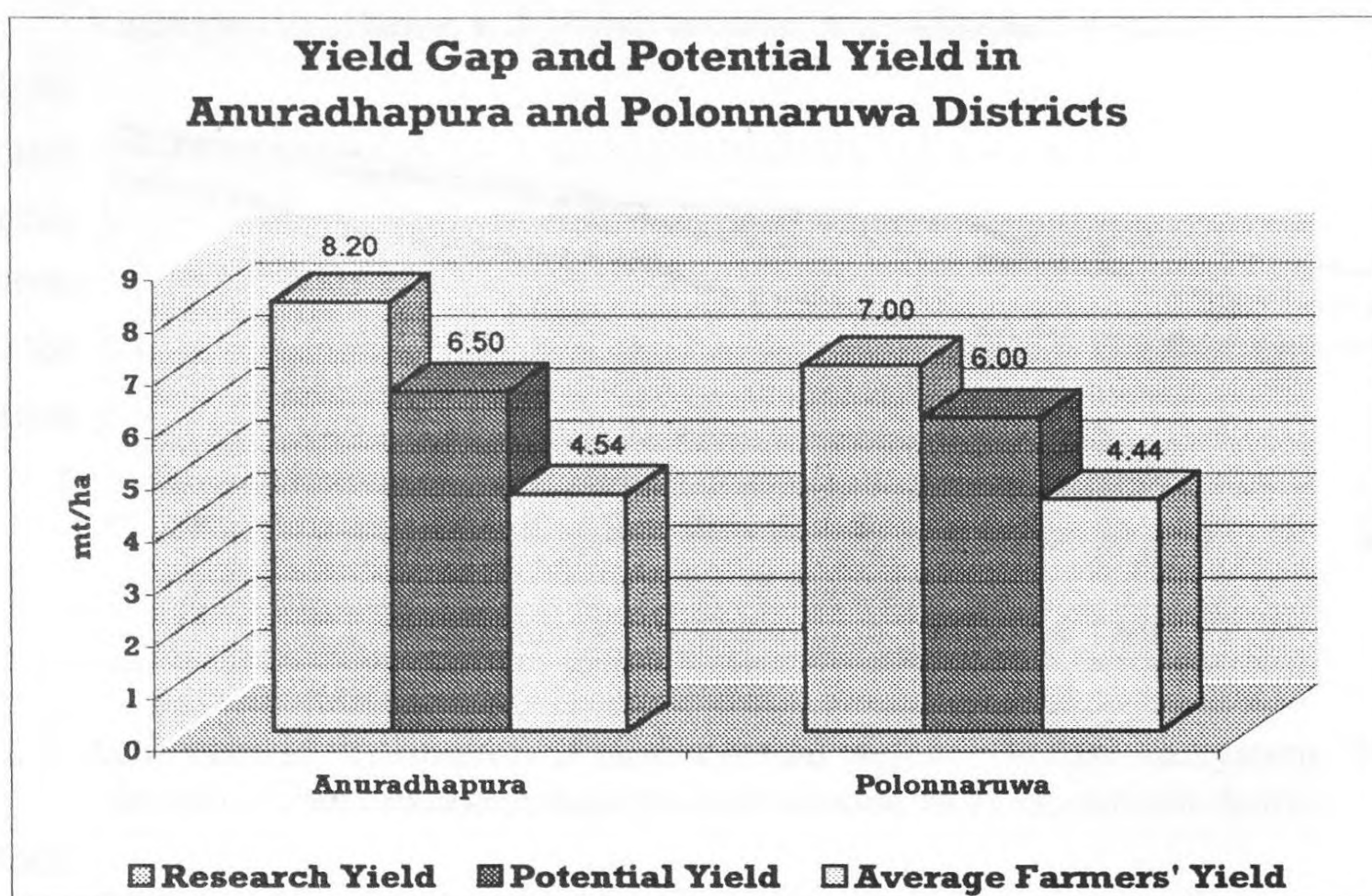
Table No.6. Yield gap and potential yield in Anuradhapura and Polonnaruwa districts

Yield	Anuradhapura		Polonnaruwa	
	Maha	Yala	Maha	Yala
Research Yield (mt/ha)	8.2 (160 bu/ac)		7 (140 bu/ac)	
Potential (mt/ha)	6.5	5.4	6.0	5.0
Yield Gap I (mt/ha)	1.7 (26%)		1.0 (17%)	
Average Farmers Yield (mt/ha)	5.05	4.4	4.44	4.32
Yield Gap 2 (mt/ha)	1.45 (28%)	1.0 (23%)	1.56 (35%)	0.68(16%)

It is also clear that there is an apparent unexploited yield potential. The yield advantage varies between locations and seasons. Further increased yield potential may pull the realized yield at farmer level up. It is also important to reduce cost of production and improve income of the farmers. Improving grain quality in rice has to be given more emphasis. Depletion of soil productivity has been identified as the main reason for the

existing yield gap. In addition, lack of varietal adoptability over diverse environments, weeds, pest and diseases and adoption of poor agronomic practices have also been identified as important factor that influence this yield gap. The investigation suggests that farmers may be able to make modest improvement in average yields by using inputs correctly. Analysis revealed that fertilizer contributes more to yield, weed control contributes second.

Figure No.2 Yield gap and potential yield in Anuradhapura and Polonnaruwa districts



**Actual Yield and Achievement Distribution.**

The distribution of actual yield achievement in Anuradhapura and Polonnaruwa are presented in Figure 3.1 and 3.2 respectively. The curve dropped increasingly downward towards the right hand end, representing more poor or skilled farmers in the locality. The curve also represents performance of the best farmers in the area. As expected the Figures indicate only few farmers were successful and obtained yield much more than others. The Figures further indicate that majority of the farmers in the study areas did not perform even to the average level that could be achieved. It was evidenced that they did not follow the profitable practices that could be applied on their farms. Difference in productivity among the farmers was also due to difference in the fertility of the land. Because of such difference in soils and in farmers' management levels, we cannot expect less skilled farmers on poor land to produce as much as skilled farmer on better land.

There is a big yield difference between the best and the inefficient farmers in the study areas. More than half of the farmers is behind the average line. Most of the farmers were facing, declining trend in their yield in the last few seasons. Over 70% of the farmers in both districts indicated that yields were less than expected. The reasons in the order of importance were fertilizer, weed, water, insect, and delayed planting. The main reason for declining in their yield was reduction of soil fertility and adverse climatic conditions. This

distribution could be raised profitably among the farmers within in the inherent differences in land and in farmers, by following appropriate set of activities effectively. . Investigation revealed that there is more room for future increase of yield under current technology and economic conditions. These farmers should be encouraged to make them aware of production increasing opportunities of which they may not have known. An efficient credit programme, dissemination of price and commodity outlook programme is important additional ways to raise their yield.

Figure 3.1 Achievement distribution of farmer actual yields in Mahawali System –H, Rajanganaya scheme and Minor tanks in Anuradhapura district

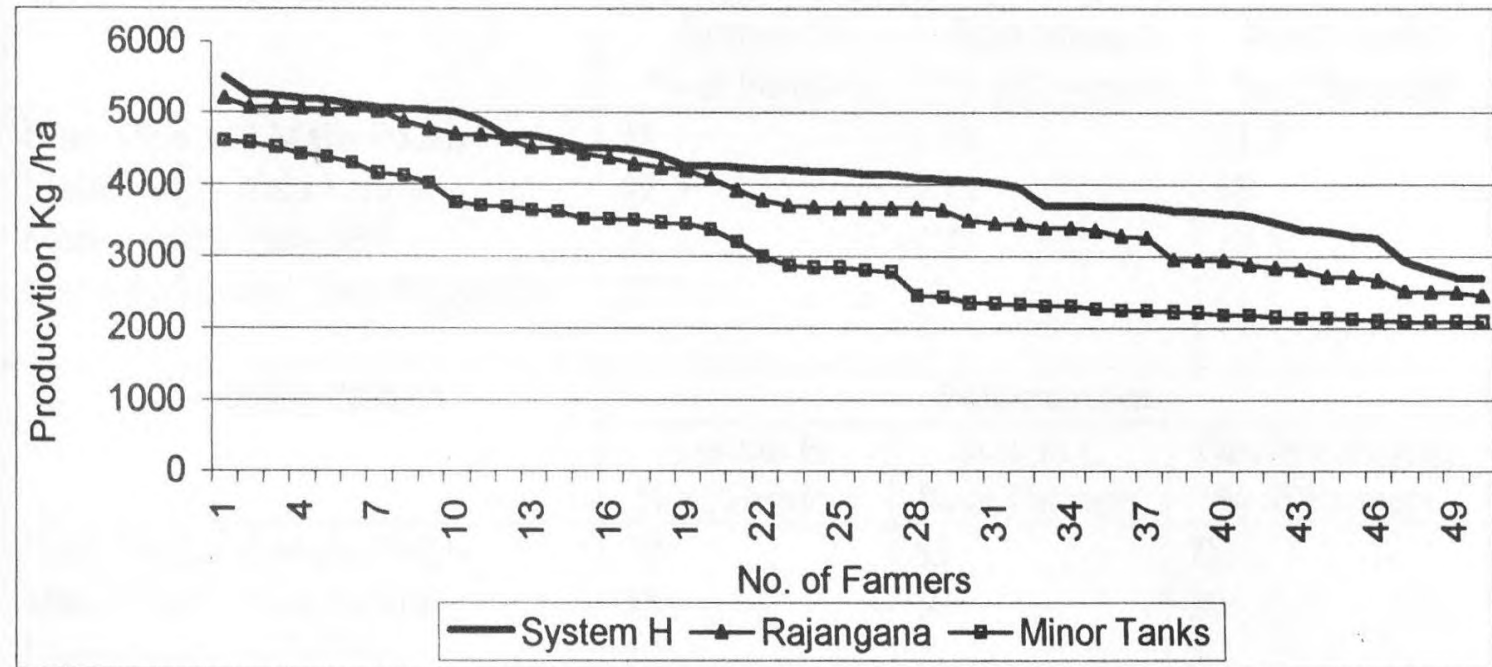
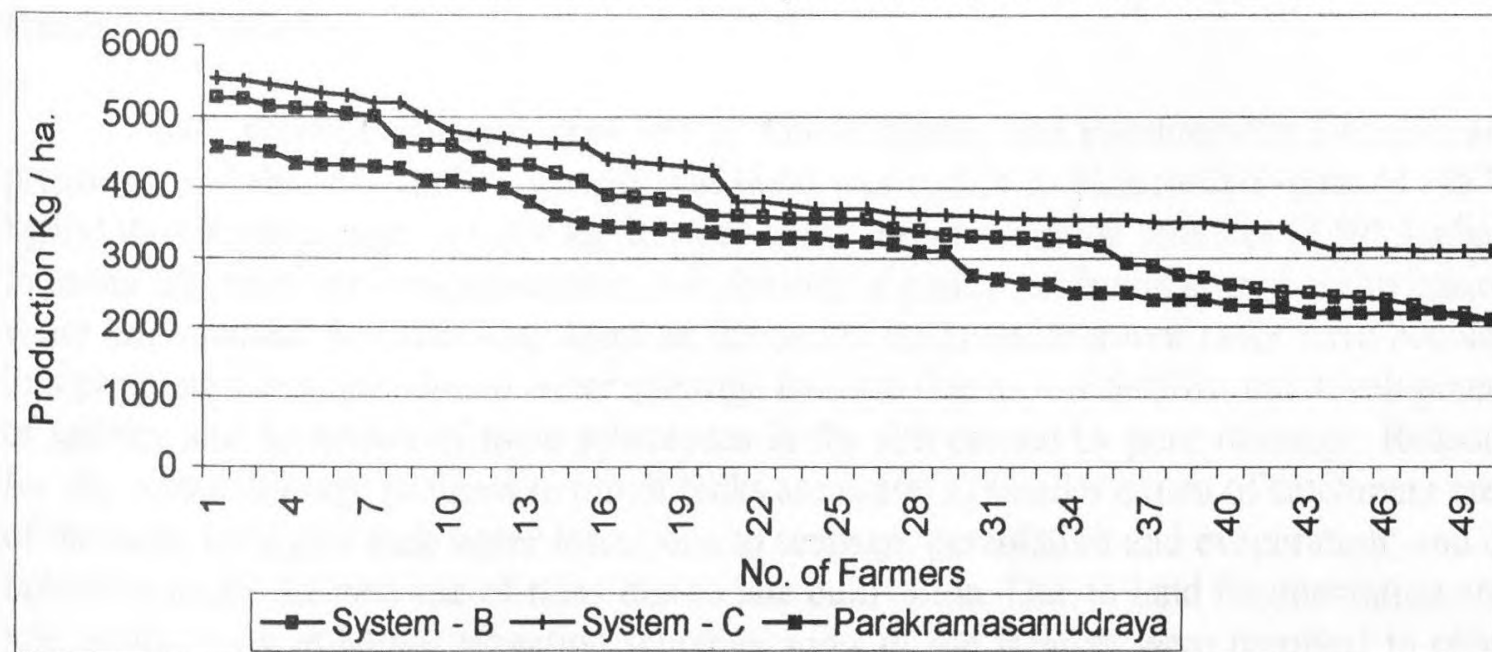


Figure 3.2 Achievement distribution of farmer actual yields in Mahawali System –B, System- C and Parakramasamudraya scheme in Polonnaruwa district



### Cropping Pattern

Table 7 shows the cropping pattern followed by the farmers in Anuradhapura and Polonnaruwa districts. Compared to Anuradhapura, Polonnaruwa cultivated more paddy in yala season. More lands are fallowed during Yala in the Anuradhapura district indicating higher water scarcity than Polonnaruwa district. During Yala more diversification of paddy land to other filed crops and vegetable had taken place in Anuradhapura district, particularly in the Mahaweli System H.

Although Polonnaruwa district is extensively irrigated, water control is a problem with farmers. Because natural surface drainage is poor, flooding is common in low lying areas during Maha and a continuous supply of water for Yala seasons is not guaranteed. Highly unreliable water supply has contributed less cultivation of paddy during Yala. Due to soil condition many farmers are cultivating paddy in both seasons.

Table. 7 Variation of cropping pattern Mahaweli System H, Rajanganaya scheme and Minor irrigation schemes in Anuradhapura district

Cropping Pattern	Anuradhapura		
	System H % of Farmers	Rajanganaya % of Farmers	Minor tanks % of Farmers
Both Yala and Maha Paddy	15	68	31.5
Maha Paddy Yala Fallow	42.5	11	50
Maha paddy Yala OFC	20	21	18.5
Maha Paddy and Yala Vegetable.	22.5	-	-
Cropping Pattern	Polonnaruwa		
	System B % of Farmers	System C % of Farmers	Parakramasamu. % of Farmers
Both Yala and Maha Paddy	79	83	75
Maha Paddy Yala Fallow	15	10	20
Maha paddy Yala OFC	5.5	7	5
Maha Paddy and Yala Vegetable.	0.5	-	-

### Paddy Productivity

Paddy productivity and input use in Anuradhapura and Polonnaruwa Districts are presented in Table 8. Table 8 reveals that yield was higher in Mahawali System H (4579 kg/ha) than Rajanganaya (4,204 kg/ ha) and in the minor irrigation schemes (3,599 kg/ha). In minor schemes, land fragmentation, low fertility of paddy fields and scarcity of irrigation water had resulted this situation. Most of the paddy lands under minor tanks have become less productive not only due to water shortage but also due to low fertility and development of salinity and formation of toxic substances in the soil caused by poor drainage. Reasons for the water shortage problem in minor tanks areas are: a) smaller extent of catchment area of the tank; b) higher tank water losses due to seepage, percolation and evaporation; and d) failure to make the best use of rains due to late cultivation. Due to land fragmentation and low productivity in Minor irrigation schemes, most of the farmers were involved in other economic activities. Further, in the minor tank area, the cultivators were less concerned with the long-term productivity of the land. This could be the reason for low productivity in the minor tank areas.

Table 8. further reveals that extent of cultivation in Polonnaruwa(1.05 – 1.28 ha) was higher than Anuradhapura district (1 ha). The yield in major tanks in Polonnaruwa was higher than that in Annuradhapura district indicating the advantages of economies of scale. Since the majority of farmers in the rice sector are small farmers, they do not have an opportunity to achieve economies of scale. This can be avoided by integrating small farmers into systems. The organizational system can be developed as farmer cooperatives, farmer companies or contract farming. The yields of Mahaweli System B (4,814 kg/.ha) and System

C (4,539 kg/ha) were higher than Parakrama samudra (3.584kg/ha). In both districts yield of Maha (4,320kg/ha) was higher than Yala (4080 kg/ha). Investigation demonstrates the potentials for increased yield in Yala in both districts. The reverse in the trend of higher yield in Yala could be maintained through better soil and water conservation practices.

Table 8. Paddy productivity and input uses in per hectare paddy production in Anuradhapura and Polonnaruwa districts - Maha 2000/01 and Yala 2001

Variables	Anuradhapura			Polonnaruwa		
	System H	Rajangana	Minor Tanks	System C	System B	Parakrama
Average extent	1.00	0.99	0.54	1.24	1.28	1.05
Land Use Intensity	1.57	1.69	0.90	1.77	1.68	1.80
Average yield						
Maha	4228	4204	3219	4539	4814	3584
Yala	3732	3147	2645	3934	4114	3170
Seed kg/ha						
Maha	127	119	107	123	125	118
Yala	109	111	103	113	116	111
Fertilizer kg/ha						
Maha	305	269	225	313	267	300
Yala	290	250	210	310	253	291
Weedicide lit/ha						
Maha	19.50	16.20	10.00	24.70	20.90	13.60
Yala	25.40	17.40	11.50	26.00	22.40	15.70
Pesticides						
Maha	14.25	10.08	10.80	13.75	12.75	11.25
Yala	15.00	11.60	1.69	17.60	14.70	13.12
Power hrs/ha						
Maha	47 & 07	49 & 06	42 & 04	41 & 12	36 & 14	35 & 12
2 & 4 Wheelers						
Yala	46 & 05	45 & 05	40 & 05	37 & 18	40 & 13	37 & 13
Total Labour						
Maha	84 (47)	90 (52)	86 (61)	75 (45)	70 (47)	74 (52)
Man days/ha						
Yala	90 (51)	90 (56)	89 (56)	72 (46)	75 (51)	77 (53)

\* Total labour includes family labour and figures in parenthesis are family labour

### Land Use Intensity

Further it can be seen that intensity of land use in Polonnaruwa district was 1.8 higher than that in Anuradhapura (1.6). This reflects the existing water scarcity problem in the Anuradhapura district. Land use intensity was higher with increase in farm experience and capital. Elayapathuwa minor tanks areas land use intensity was 0.9. This reflects the existing water scarcity problem in the minor tank areas. Renovation of minor tanks is needed for cultivation during Yala. Rehabilitation of small tanks also has to be judged on the environment and domestic reasons. Still there are number of small tanks has significant productive command area. Their production potential cannot be ignored. Increase in cropping intensity should be a major aim through better water management.

### 4.3 Input Use

#### Variety and Seed Paddy

Estimated input use per hectare for Anuradhapura and Polonnaruwa by irrigation schemes are presented in Table 8. Seeding rate was higher in major schemes than that of minor scheme. Seeding rate has been increasing, mainly because of gradual shift in crop establishment method from transplanting to broadcasting. In both districts over 95% of the rice area were cultivated with modern varieties. It was found that farmers had developed a

tendency to cultivate short duration varieties even water was abundant. However, four months varieties have a better potential in major irrigation system during Maha. Farmers complained that delay in canal water force many of them not growing long age varieties. Farmers perceived availability of good quality seed was a major problem in rice production. Public sector is capable of producing only less than 10% of the annual requirement of seed paddy. Most of the farmers used seed, either from their previous harvest or from the neighboring farmer for their requirement. Seed paddy can be stored for one year and used for two seasons but farmers were seemed to use more than one-year. Further growing same variety for a long time was found to be another problem with the farmers. Seeds have to change once in three years for keeping the varietal effect in the field.

### Fertilizer, Organic Matter and Agrochemical Use

Table 8 highlights more fertilizer uses had higher yield. Fertilizer used was less in Yala than that in Maha in all the study areas. In Yala farmers used less fertilizer because of the lack of water and uncertainty associated with water. It was revealed that the yield differences was attributed to farmers fertilizer practices both rates of application and the timing of fertilizer application. It was evident in the efficient farmers that, technical knowledge and accessibility to input were strongly associated with higher input use. Rate of fertilizer used was less in minor tanks than that of major tanks. Almost all the farmers reported using chemical fertilizer but there were wider variations in the techniques of applications. Farmers not appear to be quite conversant with the need for split application. Fertilizer use by majority of the farmers was not effective. In Polonnaruwa district major tanks farmers used 5% more fertilizer than the farmers in the Anuradhapura district. Farmers spent much more on fertilizer (Rs.7000.00/ha) than any other inputs. The amount of fertilizer use was less than the recommended level (321 kg/ha) in Polonnaruwa (267 – 313 kg/ha) and in Anuradhapura (225 – 305 kg/ha.) districts. It was found that the low performing farmers' higher use of fertilizer had no effect on yield. Basal fertilizer needs to be applied with the land leveling, but farmers apply after leveling had not effect as it gets washed off. Average farmers applied more urea because nitrogen fertilizer was cost less Rs.375/50 kg with subsidy. Murated of Potash (MOP) cost them more Rs 900/ 50 kg. Further investigation revealed that, saving cost is difficult, as it is required for higher yield and price might continue to increase. Using organic manure can reduce this problem.

Farmers also perceived that soil fertility loss. This may be primarily due to reduction in the use of organic matter, increased imbalance of NPK levels and also continuous mono cropping with increased cropping intensity. Efficient farmers found to use more organic matter than low performing farmers.

### Agro-chemical Use

Agrochemical use was higher during Yala than Maha. It was less used in minor tanks than major tank areas. Chemical use intensity was higher in Polonnaruwa than Anuradhapura district. Farmers reported that they use pesticides mainly for brown plant hopper (BPH) and leaf folder. It caused severe damage and yield losses. On average, farmers spent Rs 1,200/ha for the control of pests. Insects damage was the second to weed as important cause for the yield reduction. With regards to integrated pest management (IPM) farmers reported that IMP and organic matter application only suitable for small-scale farming.

## Labour Use

Table 8 shows that Polonnaruwa used less labour compared to Anuradhapura. Further investigation revealed that, over the years the average labour input use per hectare has decreased from 90 man days to 75 man days per hectare. Shift from transplanting to broadcasting and the substitution of two-wheel tractor for buffalo were the main reason for this. About 50% of labour input in paddy production was substituted by hired labour. There was a shortage of labour in both districts. Youth moving away from agriculture and attractive higher non-farming wage rate were reason for this. There was under utilization of family labour due to part time employment. Return to family labour was higher in Polonnaruwa (Rs 1,347/ manday) than in Anuradhapura (Rs 1,124/ man days). About 70% of the farmers in minor tanks acknowledged a labour shortage. However the shortage of labour did not affect the timing of operations. Most of the farmers solved their problem by exchange labour. There has been substitution of family labour for hired labour in both districts. Mechanization in land preparation, harvesting and threshing replaced the labour significantly (about 20%) but still paddy cultivation is labour intensive.

## Power and Machinery Use

Substitution between buffalo and wheel tractors has been apparent in both districts. Data indicate that, there was a significant increase in machinery use in Polonnaruwa. Also tractor cost has increased significantly over the years. Use of two wheel tractors was more in Anuradhapura than in Polonnaruwa. Polonnaruwa used more four wheel tractors than in Anuradhapura. Farmers complained that tractor parts were expensive. They suggested these parts should be produced in Sri Lanka and requested subsidy for machinery. Tractor was mainly used for preparatory tillage and threshing in Polonnaruwa. Tractors used for preparatory tillage was the main machinery cost in Anuradhapura. Statistical relationship between yield and level of farm power was high. But yield cannot be achieved only through power and mechanization. Mechanization can make youth interesting. It was clear that producing more marketable surplus is only feasible through the utilization of higher levels of farm power and mechanization and increase labour productivity.

Nearly 80% of the farmers used tractors for threshing paddy. It was found that efficient farmers preferred axial flow thresher due to the following reasons: Better threshing rate, cost was least, and lower labour requirement and quality of paddy was good. Threshing by tractors was less in Anuradhapura than Polonnaruwa. There was around 10% to 30% loss of production due to poor harvesting and post harvest technology. Study showed that improved post harvest technology would reduce the losses for 30% to 10%

In overall it was found that most of the farmers are not rational in using inputs and they are not optimally using the inputs. Further they are not willing to find new methods to maximize profits. In addition, farmers do not identify the production possibilities open to them. There is a wide belief that it is very difficult to increase the productivity without increasing inputs. In view of the growing competition due to open market and high production costs, production efficiency becomes an important determinant for the future of paddy production in this country.

#### 4.4. Modal Estimation -Technical Efficiencies

The Maximum Likelihood estimates for the parameters for stochastic frontier and the inefficiency model for Anuradhapura Major irrigation scheme, Elayapattuwa minor tanks areas and Polonnaruwa major irrigation schemes are shown in Table 9. The value of the likelihood ratios (LR) 25.434 and 16.406 for the major schemes in Anuradhapura and Polonnaruwa districts respectively. This value for minor tank is low. Sigma-Square ( $\sigma^2$ ) ranged from 0.103 to 0.346 and Gamma ( $\gamma$ ) values are above 0.8 for the three areas. These values indicate that the models had a good fit and that inefficiency effects of a stochastic nature exist. Parameter  $\gamma$  is close 1.0 implies that the technical inefficiency effects are significant in the stochastic frontier model.

#### Inputs Coefficients

The estimated parameters of the production function confirm with priori expectation. In Anuradhapura and Polonnaruwa districts, the models showed significant impact on paddy production in the order of land, power and labour. Out of six variables tested land was significant in both minor and major tanks. In Polonnaruwa, the higher land input elasticity of 0.651 shows that output could be increased at a larger proportion by better land consolidation and soil conservation. In the Elayapattuwa minor tank area land had low positive significant effect while seed and labour had significant negative impact on paddy production. The seed use had a negative sign indicating a need for better seed technology. These reveal the problems of under utilization of land, over use of labour and use of low quality seed paddy in the minor tank areas.

According to the results, land and labour show significant effect on paddy production in Anuradhapura Major scheme. Lower labour output elasticity of 0.0991 indicates that, labour intensification would increase the production very little. Labour use was ineffective in Minor tanks. The significant power output elasticity (0.103) in Polonnaruwa, indicates that increase power use would increase the production significantly. Agrochemical use was negatively significant in Polonnaruwa, indicating its inefficient use. Timing in application and Yaya (track) programme would improve its effectiveness.

There were noteworthy similarities and difference in inputs coefficients between Anuradhapura and Polonnaruwa districts. In both districts land showed significant effect on production while seed and agrochemical showed no effect on production. This indicates the importance of seed fertilizer technology for improvement of land productivity in both districts. Over all results of the regression show the inefficient use of resources

#### Technical Efficiencies of Farmers

Technical efficiency for each farmer was obtained from the estimated model. The means and ranges of the estimated technical efficiencies for Anuradhapura and Polonnaruwa districts are summarized in Table 10 and Figures 4.1 and 4.2. The estimated technical efficiency for Mahaweli H area was 87%. The technical efficiency levels of farmers were varying between 41% and 98% and showed a larger variation. The estimated mean technical efficiency of Rajanganaya was as high as Mahaweli H area, but the variability was less. It ranged between 62% to 97%. Rajanganaya, had 22% higher in technical efficiency efficient than the minor tank. In Elayapattuwa minor tank technical efficiency ranged from 24% to 83% with an average of 65%. The calculated mean

technical efficiency for paddy production in the Anuradhapura district was 77%. Technical efficiency levels of the farmers were varying between 24% to 98%, so it is clear that there is vast difference of production efficiency of farmers although they operate under similar conditions.

Table 9. Maximum likelihood estimates for parameters of stochastic frontier production function and inefficiency function in Anuradhapura and Polonnaruwa districts. Pooled Data Maha 2000/01

Variables	Anuradhapura		Polonnaruwa District
	Mahaweli Sys H & Rajangana (n=100)	Elayapatuwa Minor Tanks (n=50)	Mahawali Sys, B, C & Parakrama Samudraya (n=150)
	Coefficient	Coefficient	Coefficient
<b>Stochastic frontier</b>			
$\beta$			
Intercept	3.891**	0.696	6.553***
Land (ac.)	0.418***	0.265*	0.651***
Labour (man days)	0.0991*	-0.119	0.054
Power (Rs.)	-0.995	0.095	0.103*
Agrochemicals (Rs.)	-0.191**	0.198	-0.117*
Seeds (Rs.)	0.066	-0.265*	-0.041
<b>Inefficiency effects</b>			
$\delta$			
Ownership	-1.341**	0.931	-0.231**
Farming category dummy	0.185	-0.135	0.243
Age (years)	0.361	0.146	-0.257*
Debt Level dummy	0.296**	-0.346*	1.035**
F.O Participation	-0.444*	0.153 *	-0.372*
Sigma squared, $\sigma_s^2$	0.228***	0.346	0.103***
Gama, $\gamma^2 = \sigma_s^2 / \sigma^2$	0.832***	0.911***	0.873***
Log likelihood (LLF)	25.434	10.403	16.406

In Polonnaruwa district, Mahaweli System C was found to be more technically efficient (83%) than System B (72%). System C had less variation (68% - 91%) than System B (31% - 91%). A closer look into the technical efficiency of the farmers showed that Parakramasamudraya farmers had low technical efficiency of 66% and had more variation (25% - 91%). This indicates the need for relatively more emphasize to be given to Parakramasamudraya. The over all technical efficiency of Polonnaruwa was 73%. This was not deviate from Anuradhapura's technical efficiency of 77%. This indicates in both districts yield efficiency could be increased by about 25% on average without increasing the input levels. Further, the investigation evidenced that, larger farms were much more likely to appear efficient than small ones.

Based on the mean of technical efficiency, farmers were categorized into three levels: 1. low (<70% T.E), 2. average (71% <TE> 90%) and 3. efficient (>91%) and shown in Figure 4.1. Figure 4.2 show further categorization farmers in to five groups: 1. lower (TE < 60%), 2. Below average (>61% - <70%), 3. Average (>71% - <80%), 4. above average (>81% - <90%) and 5. Efficient (>91%).

Table 10. Frequency distribution of farm specific technical efficiency in Anuradhapura and Polonnaruwa districts

Technical Efficiency (%)	Anuradhapura District			Polonnaruwa District		
	Mahaweli System H	Rajangana Scheme	Elayapatuwa Minor Tanks	Mahaweli System B	Mahaweli System C	Parakrama samudraya
Low 50 - 60	00	00	20 (10)	00	00	20 (10)
61 - 70	5 (2)	10 (5)	35 (18)	17 (9)	9 (4)	40 (20)
Average 71 - 80	25 (13)	23 (11)	20 (10)	19 (9)	28 (14)	13 (7)
81 - 90	40 (20)	42 (21)	15 (7)	34 (17)	33 (17)	18 (9)
Efficient 91 - 100	30 (15)	25 (13)	10 (5)	30 (15)	30 (15)	9 (4)
Maximum	0.984	0.973	0.821	0.913	0.914	0.912
Minimum	0.410	0.722	0.24	0.312	0.690	0.250
Average	0.873	0.865	0.651	0.715	0.831	0.651
CV	6.7	5.8	13.6	3.2	4.3	4.6
ANOVA F Test	27.83 (d. f. 6,214) F. Critical Value 2.					

Figures in parentheses indicate the number of farmers

Figure 4.1 Distribution of farmer efficiency levels in Anuradhapura and Polonnaruwa districts (Low, Average and High)

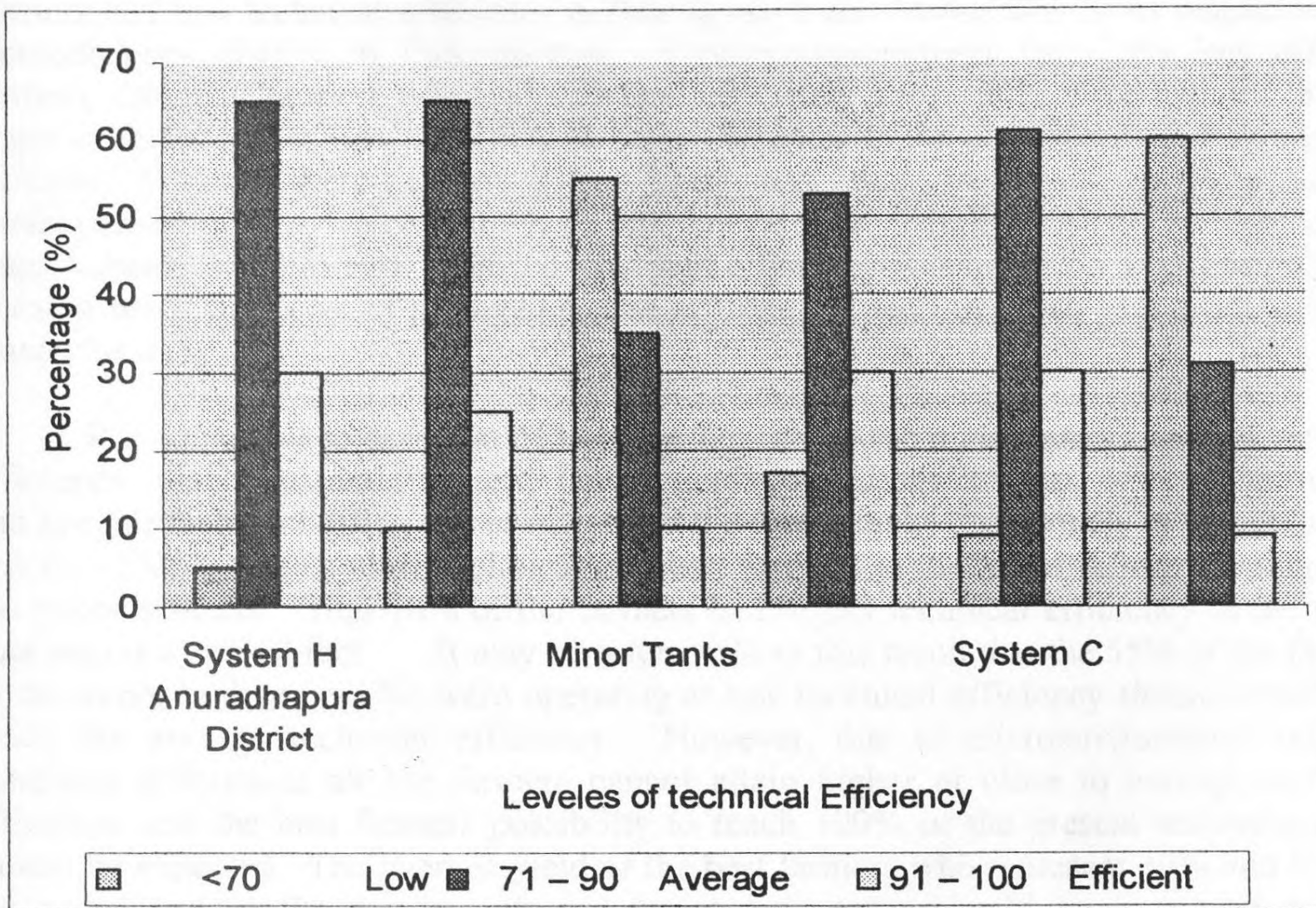
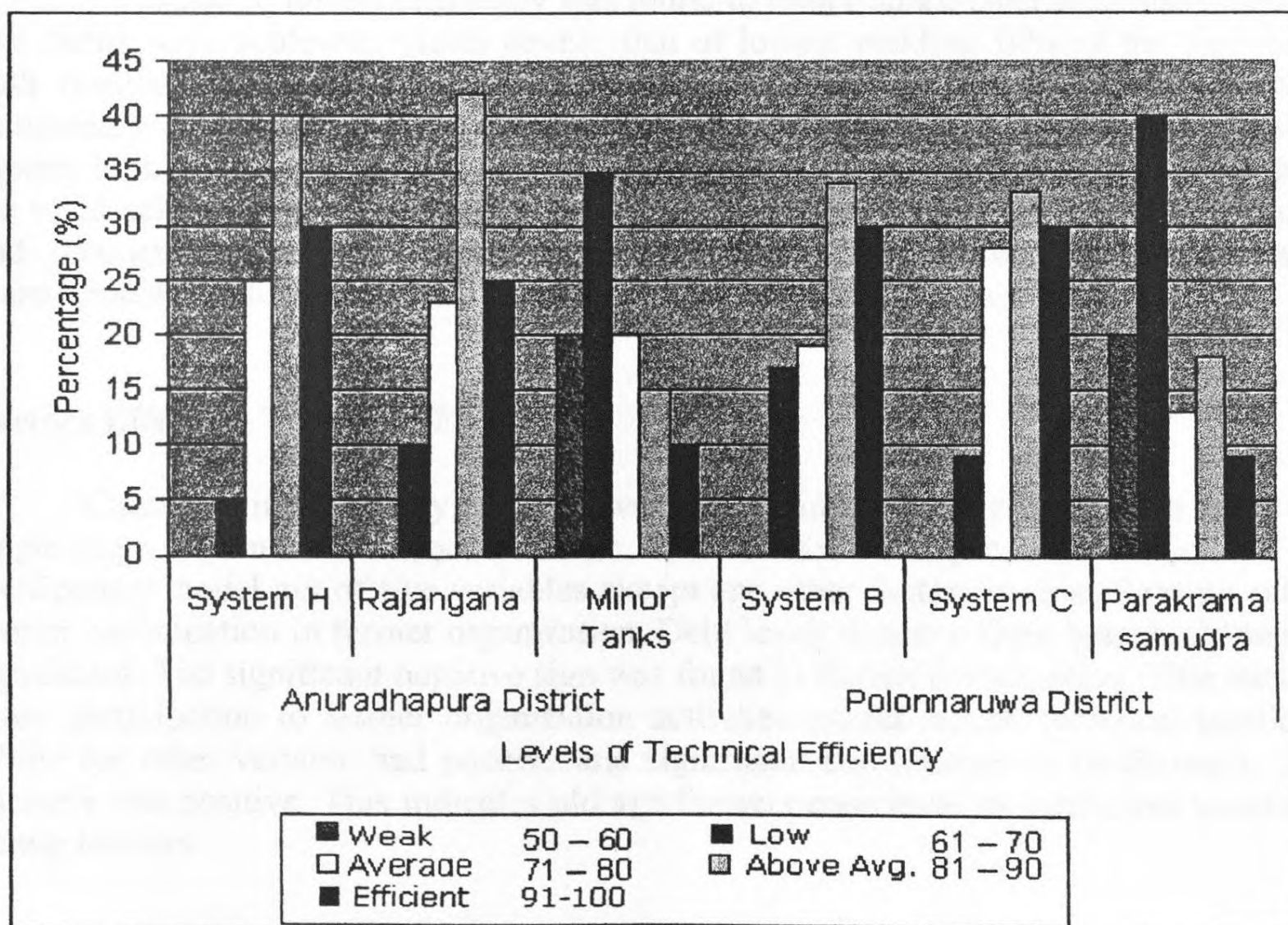


Figure 4.2 Distribution of farmer efficiency levels in Anuradhapura and Polonnaruwa districts



A closer look into the categories of farmers evidenced that 15% and 55% of the farmers had low technical efficiency in Rajanganaya and Minor tank areas respectively in Anuradhapura district. In Polonnaruwa, Parakramasamudraya had 28% low efficient farmers. Efficient farmers who had technical efficiency above 90% were higher (28%) in major schemes and it was only 10% in minor schemes in Anuradhapura. In Polonnaruwa efficient farmers were about 23%. This was due to lower performance of Parakramasamudraya, which had 9% of efficient farmers. Parakramasamudraya being an old major scheme with more experienced why their efficiency was lower? Is a serious problem. Loosing profit high cost of production, less institutional facilities than Mahaweli were the reason for this.

It is important to note that 55% of the farmers in the minor tanks area had very low efficiency, which was mainly due to land degradation. About 20% and 65% of the farmers had average technical efficiency in major and the minor tanks respectively in Anuradhapura district. This indicates more technical efficient farmers in the major scheme compared to the minor scheme. That 10% of the farmers had higher technical efficiency in the minor tank area is a critical fact. It may be inferred from this result that the 55% of the farmers in the minor tank areas who were operating at low technical efficiency should improve to reach the average technical efficiency. However, due to microenvironment and soil condition differences all the farmers cannot attain higher or close to average technical efficiency and the best farmers possibility to reach 100% of the present technology also cannot be expected. The average yield of the best farmers who represent 10% and 65% of the population in the minor tank and major tank areas should be improved through technological change in seed, appropriate mechanization and wise use of irrigation water. A two-sample t-test shows the two efficiency levels are significantly different at 5% level.

As expected lowest efficiency was found in minor tanks. Over all around 10% of the rice farms were achieving yields double that of lowest yielding 10% of the rice farms in both Anuradhapura and Polonnaruwa districts. Highest yielding 25% of farmers were achieving yields some 50 – 60% higher than that of lowest 25% of farms. More variation in System H than System C and B. It is concluded that while all the factors have an impact on the yield achieved management account for the main difference. In irrigated system yield and productivity declines appear to primarily from deterioration of infrastructure and management problems as opposed to degradation of the natural resource base.

### **Factors Effecting Technical Efficiency**

Causes of in efficiency in farms were determined with the production frontier in a single stage maximum likelihood estimate. The results are also presented in Table 9. In the inefficiency model out of five variables except age other factors such as farming category, farmer participation in farmer organization, Debt level, distance from branch channel were significant. The significant negative sign was found in farmer participation. This means that more participation to farmer organization activities would reduce technical inefficiency. While for other variable had positive and significant contribution to inefficiency. Age of Farmers was positive. This indicates old age farmers contribute to inefficient farming than young farmers

Non-significance of farming category indicates prevalence of part time farming had no effect on paddy farming as it allows more room for off farm employment. As the distance of the land from distributary channel increases it contribute to more inefficiency also indicated by its positive significant coefficient. When the increasing Chemical cost and Machinery cost, output efficiency also increases.

The results suggest that rich farmers are efficient in the major scheme but not in the minor irrigation schemes. Membership in farmer organizations as the key variable that improves the technical efficiency was also evident in both study areas. Reduction of inefficiency with participation in farmer organization activities was shown with higher and negative significance level in Rajangana, but in the Elayapathuwa area it showed a negative sign but was not significant. Further the part-time farmers were associated with higher level of inefficiency also evident in both study areas. The other variables such as education and experience in farming did not affect the variation in farm efficiency significantly.

#### **4.5. Cost Component Analysis**

Cost difference between the efficient and less efficient farmer categories in Anuradhapura and Polonnaruwa districts were analyzed with respect to major and minor tanks and are presented in Table 11. Comparing the yield levels of the poor farmer with average performing farmers highlight about 50% variation in the major tanks. There was not much variation in yield among the efficient and average performing farmers. But with the minor tanks areas there was 35% variation in yield between efficient and average performing farmers. Analyzing the variation of cost among the farmers show no significant variation. In major tanks the difference was between 5% and 10%. While in minor tanks it was close to 25%. These results indicate that the majority of the farmers did not utilize the resources efficiently in particular in the poor performing farmers. The variation of cost of production in Maha 2000/01 in major schemes ranged from Rs32,088 to Rs 33,638 and from Rs 31,822 to Rs 35,139 per hectare in Anuradhapura and Polonnaruwa districts respectively. In minor tanks the cost ranges between Rs.24, 193 to Rs 30,315 per hectare in minor tanks. The cost was lower in minor tanks than major tanks. Among the major tanks Polonnaruwa, cost was higher than in Anuradhapura. Significant difference between efficient and inefficient farmers in yield but same in cost of production, indicate the potential for significant (20% - 30%) increase in production by a majority (40% - 60%) of the low performing farmers with reduction in cost of production.

The study evidenced that, the rising cost of production in which labour cost and it accounts for 44% to 60% of the total cost of production. On average, farmers in Polonnaruwa spent 5% more on agrochemicals and depend on mechanization (7%).

Size of the in relation to efficiency indicates the need for larger operations of the retention of the allocated land is important to keep the advantage of economies of scale. Polonnaruwa has a lager size of operation. However, in the Anuradhapura district, land retention was found by around 41%, while 30% increased sizes and 29% reflected significant reduction in size. No evidence of widespread fragmentation was noted except in the minor tanks. Based on the study economies of scale require not less than one hectare. Since majority (67%) of the farmers operate in less than on hectare land and categorized as small farmers, they do not have a opportunity to achieve economies of scale, which can be used as an alternative strategy to avoid the negative impact of the trade liberalization on the producers. This can be achieved by integrating small farmers in to systems. The

organizational system can be developed as farmers' cooperatives, farmer companies or contract farming. Further, it is time to review the present tenorial legislation in order to find an alternative solution to fragmentation of agricultural land.

Table 11. Cost of production components comparison among different categories of farmers

Items	Anuradhapura.						Polonnaruwa		
	Major Irrigation Sys.H & Rajanganaya..			Minor Irrigation Ealaayapathuwa			Major Irrigation Sys.B,C & Para		
	Effi. >90% (28%)	Avg. 70-90% (65%)	Low <70% (7%)	Effi. >90% (10%)	Avg. 70-90% (20%)	Low <70% (55%)	Effi. >90% (23%)	Avg. 70-90% (48%)	Low <70% (28%)
Yield mt/ha	5567	5102 (-09%)	3253 (-71%) (-57%)	4755	3819 (-35%)	2375 (-83%) (-36%)	5210	4992 (-4%)	3384 (-54%) (-48%)
Material Rs/ha	10525 (32%)	10303 (31%)	7656 (23%)	8100 (27%)	8790 (31%)	6140 (26%)	11387 (32%)	11072 (32%)	8616 (27%)
Labour Rs/ha	15047 (45%)	16164 (48%)	19112 (60%)	16555 (55%)	14520 (51%)	14613 (60%)	15609 (44.4%)	16051 (46%)	15786 (50%)
Power Rs/ha	7100 (21%)	6831 (20%)	5100 (16.3%)	5320 (17%)	4650 (17%)	3210 (13%)	7613 (22%)	7604 (21%)	7050 (22%)
Soil con- -servation	560 (2%)	340 (1%)	220 (0.7%)	340 (1%)	298 (1%)	230 (1%)	530 (1.6%)	450 (1%)	370 (1%)
Total Cost Rs/ha	33232	33638 (-1.2%)	32088 (-3.6%)	30315	28258 (-7.3%)	24193 (-25%)	35139	34735 (-1.2%)	31822 (-10%)
Cost Rs/kg	05.97	06.59	09.86	06.96	08.78	10.19	06.75	6.96	8.95
Price Rs/kg	13.10	12.90	11.60	12.78	12.45	11.30	13.75	13.20	11.60
Net Income Including FL	39696	32178	5647	30454	19251	2645	36499	31159	7432
Excluding FL	43642	37091	15998	39592	26511	9952	43523	37710	16375
Return to FL	1897	1124	333	1584	914	269	1978	1347	512
NI / TC	1.20	0.96	0.18	1.00	0.68	0.11	1.04	0.90	0.23

\* FL = Family Labour, NI/TC = Net Income Total Cost Ratio

Figures in parenthesis are % to total cost of production and % difference to efficient farmer.

In order to reduce cost of production farmers tend to reduce the amount of input use. This leads to declining productivity and income. Nearly 98% of the land was prepared for cultivation by using tractors. This is one of the important cost components. During 1999/2000 Maha season 99% of the land was broadcasted. Transplanting was not popular due to the labour scarcity. Chemical fertilizers had been applied in about 98% at the sown extent. However the use of organic fertilizers were at very low level. Insecticide had been applied in about 65% of the sown extent. In application of weedicides (88%) many farmers used Nomini weedicide. Hand weeding was 10%, not weeding 2.2%.

Higher expenditure on seeds resulting from buying higher quality, combined with expenditure on agrochemical and other inputs that confirms the notion that higher input use could lead to higher productivity resulting from positive interactions among inputs especially when they are of improved quality.

There was significant difference in per kilo cost of production among the different categories of farmers and between districts. The variation in per kilo cost of production between average farmers in Anurdhapura and Polonnaruwa was Rs 6/kg and Rs 7/kg respectively. In minor tanks it was 12.45/kg. Efficient farmers' cost of production was almost equal to the market price. This means that they were producing at break even level. Paddy market price varied from Rs.11.60 – 13.10 and 11.30 – 13.75 per kg. in Anuradhapura and Polonnaruwa districts. Grade I paddy fetched higher price of Rs 13/ kg and above. Farmers sold their entire paddy in Maha and sold half of the paddy in Yala. reality cost is difficult to reduce. If farmer increase his yield up to 5000 kg/ ha and cost of production Rs 6/kg. Even if the market price stays at Rs12/kg. Farmer can make a profit around Rs 30000/ha.

Figure 5. Yield levels of different efficient categories of farmers

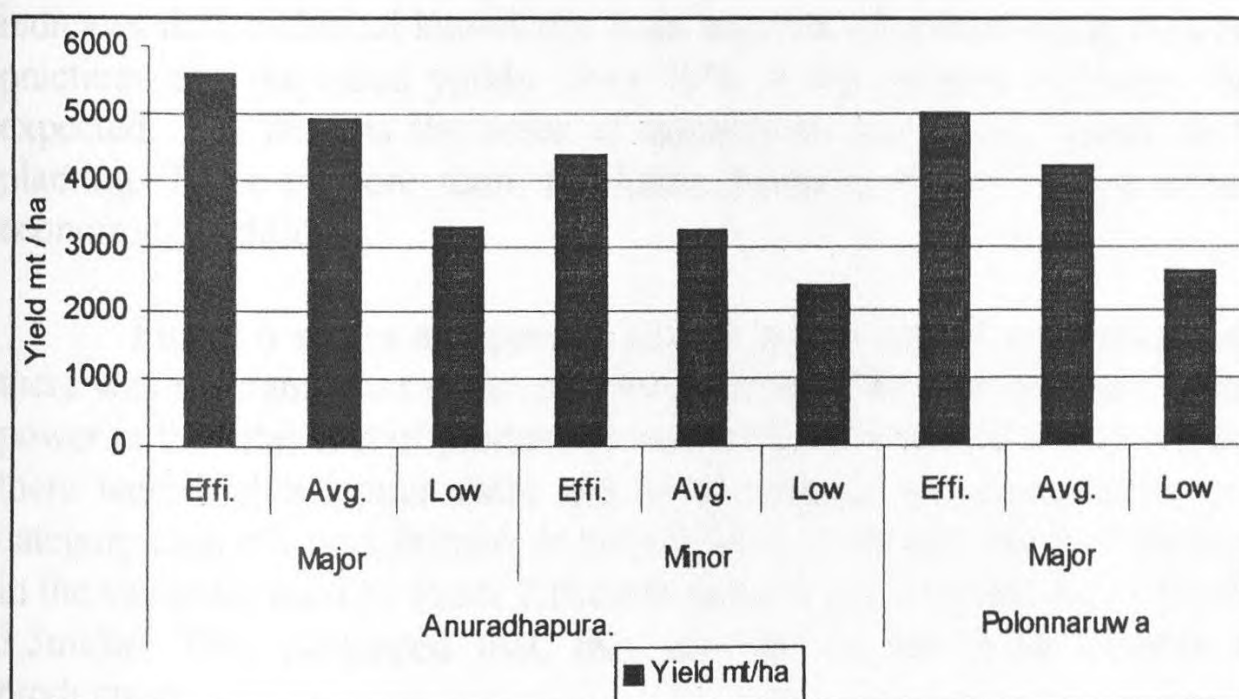
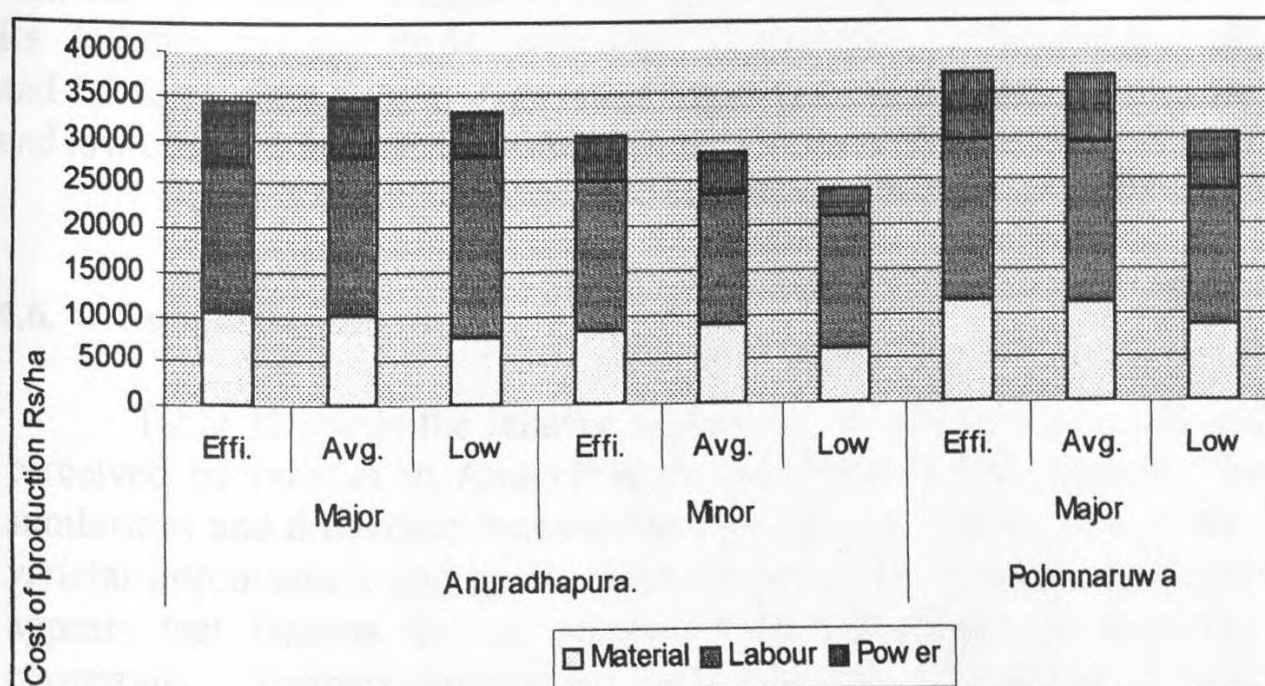


Figure 6. Cost of production of different efficient categories of farmers



The net return to total cost ratios explains that efficient farmers were well off with ratio higher than one. The average performing farmers had ratios close to one and managing to get reasonable profit. In the case of poor performing farmers it was not profitable for

them to produce paddy as their production not even at break even level. The results reveal that paddy cultivation seems to be unprofitable under minor tank areas. However majority of the farmers in the minor tank areas found to cultivate paddy mainly for home consumption purposes. Since the free trade is implemented, the domestic prices of Rice had pulled down closer to international prices. The domestic price of Rice came down and stabilized around Rs.17.84 per kg. This is a 26% reduction over the present price of Rs.24 per kg (Department of Agriculture, 2000). This would cause a downward pressure on domestic rice production.

The Figure 5 highlights that there was significant variation in the achieved yield by the different efficient categories of farmers. Poor stand establishment, imperfect weed control, inadequate and imbalance fertilizer application, negligence in pest and disease control, delayed harvesting and ignorance in post harvest operations were found to lead to a substantial crop loss among the poor performing farmers in both districts. Evidence indicates that, technical knowledge is an important in determining the adoption of improved practices and increased yields. Over 70% of the farmers indicated that yields less than expected. The reasons the order of importance was water, insect, fertilizer and delayed planting. There is more room for future increase of yield under current technology and economic conditions.

Figure 6 shows an opposite picture on the cost of production, where it shows that, there was no significant difference among them. The average share of material, labour and power in the total cost of production was 30%, 50% and 20% respectively. It was clear that, there were higher labour share and lower material and power share among poor farmer category than efficient farmers in both districts. This was due to more significant difference in the variables used by them. Efficient farmers got 5.1mt/ha and least efficient farmers got 3.3mt/ha. This evidenced that, this gap can be cut down without increasing cost of production.

The return to family labour for the efficient farmers were Rs.1,584/man day, Rs. 1,897/man day and Rs. 1,978/man day in minor tanks, and major tanks in Anuradhapura and Polonnaruwa districts respectively. It ranged between Rs 937/man day and Rs. 1,347/man-day for average efficient in both districts. In low efficient farmers, it ranged between Rs. 269/man day and Rs.512/man day. These results indicate that paddy generates 7, 4.5 and 1.5 folds more than average wage rate of Rs 250/man day, among the efficient, average and low efficient farmers respectively.

#### **4.6. Supporting Services**

Table 13 shows the relative importance of cost of production and yield constraints perceived by farmers in Anuradhapura and Polonnaruwa districts. There is noteworthy similarities and difference between the two districts. About 22% of the farmers perceived varietal improvement and quality seed important for increased production and income. It appears that farmers do not perceive pest and disease as important rice production constraints. Farmers reported low fertility of the soil and lack of fertilizer at reasonable price (10% - 15%) and weed control (10 - 14%) are important problems in both districts. Water scarcity (12%), growing labour scarcity (16%) and higher wages are reported as the more important problems in Anuradhapura district.

## Credit

It was revealed from the farmers interview that farmers' main credit source was the local merchant who supply the inputs for paddy production and consumer goods on credit. At the time of harvest farmers were compel to sell to the merchant where he charged 30% interest and bought the product at the harvesting time when the price was lower. To break this vicious cycle, measures such as forward contract could be provided with the institutional credit support.

Table 12. Relative importance of cost of production and yield constraints perceived by farmers in Anuradhapura and Polonnaruwa districts

Constraints	% of Farmers Reporting	
	Anuradhapura	Polonnaruwa
Quality Seeds	20 (29)	24 (35)
Pest and Diseases	06 (09)	07 (10)
Weeds	10 (15)	14 (21)
Fertilizer	10 (15)	15 (23)
Irrigation Water	12 (18)	04(06)
Labour	16 (24)	05 (08)
Credit	08 (12)	13 (20)
Extension Services	06 (03)	04 (02)
Profitability	12 (18)	14 (21)

## Extension

Extension services in both study areas were not satisfactory according to farmers' perception. The study found that, farmers knowledge on fertilizer and chemical applications was inadequate Agricultural practices needs to be carefully monitored so no breakout of disease. Use farmer organization to promote the adoption of improved agricultural practices requires greater emphasis. Improving factor productivity would require research to raise the yield ceiling in the long run and extension service to bridge the gap in both efficient and poor farmers and potential yield and average yield. Proactive, focused and integrated extension programmes are considered necessary to promote adoption of the available technology. Extension officers require skills in group facilitation as well as a sound technical knowledge.

## Input Supply

Only 30 % received seed paddy from the Agrarian Service Center in Anuradhapura district. Inadequate supply of quality seed paddy is the major problem for the farmers in both districts. All the farmers had used less fertilize than the recommendation, because of the high price. Ensure the availability of inputs, credit and other incentives necessary to facilitate farmer adoption of the recommended practices

the high price. Ensure the availability of inputs, credit and other incentives necessary to facilitate farmer adoption of the recommended practices

### Irrigation

Inadequate water to the tail end farmers and illegal water tapping were the major irrigation problem in all the study areas. More participation of farmers in farmer organization activities could improve the water management problem. A good farmer organization needs tail-enders representation, true leaders, and technical standard of water management and political support. A useful function that farmer organization could perform is to provide farmer education in water management. This is a vital need.

### Marketing

Farmers (12% - 14%) complained on lower prices than marketing structure. Over 90 % of the farmers sell their products to village traders. Monopoly powers of private could not be solved by moderate purchase by the CWE. Farmer organizations are too weak to undertake paddy marketing and they have purchased only negligible volume of paddy. The over all result is that in the absence of competition from government or semi government agencies, the private sector buys the farmers' paddy at a lower price. Storage credit given to farmers to not sell when the price was lower was not successful. The operation of paddy/rice market appears to be competitive at the paddy milling, rice wholesale and retail levels. But study revealed the potential problem of sale by the producer to the primary buyer. This was because of close link between rural credit and marketing of rural produce.

### Farmer Organization

The study evidenced that farmer organization performance was not encouraging enough. Farmer organization was not efficient and in many cases they had collapsed. Power groups domination, no transparency and officials get the benefit were the major complaints about farmer organization. In Mahaweli H area there are 250 distributory channel farmer organization (DCFO). Some operate well with good leadership they provided credit and market facilities to their members and took contracts on road and channels construction. Many farmer organization performances were poor. They find without government support it was difficult to compete with private on a commercial basis. .

## 5. CONCLUSIONS AND RECCOMENDATIONS

This study is focused on the economic aspects of paddy cultivation, specifically on analysis of farmer production efficiency and cost of production component returns to factors of production, in the Anuradhapura and Polonnaruwa districts. The results of this study provide information of the personal use of resources in the paddy farming. These information could be used as a knowledge base in improving paddy farming in the area.

### Yield Gap

The average yield per hectare in major irrigation areas during Maha 2000/01 was 5.05mt and 4.44 mt in Anuradhapura and Polonnaruwa districts respectively. It was 3.60mt in minor tanks. Thus yields in major irrigated areas are significantly (29%) higher than minor tank areas. The smaller yield gap between research yield and actual yield in both districts indicate importance for further research in developing appropriate rice hybrids.

### Technical efficiency.

The mean technical efficiencies of Anuradhapura and Polonnaruwa were 80% and 73% respectively. There is a scope for increasing technical efficiency by 20% and 27% among the farmers without changing the present input level. About 53% of the farmers in the minor irrigation scheme were operating at the average technically efficient level. If all adopt production technology of top 10% of the farmers about 30% increase in production can be achieved. If only average-performing farmers' yield is increased to the best performing farmers' production can be increased by 15%. Further rather than large increase in small area small increase in large area is important. Many farmers however showed potential for further increases in yield in relation to the best practice technology A suitable rate of productive growth is required in order to remain competitive. Cultivated land area, more participation of farmers in farmer organization activities and farmers' debt level were the major factors affecting the technical efficiency.

Following the hierarchy of efficiency levels revealed by the results of this study, that it could be speculated that farmers need more training to improve their farming skills than they need new technologies. Since the study indicates that participation of farmers in farmer organization is impotent in increasing technical efficiency, further research is required to study factors hindering farmers in participating in farmer organization activities.

### Cost of Production

The average unit cost of production of paddy in the Anurdhapura and Polonnaruwa was Rs 6.59/kg and Rs 6.75/kg respectively. This is also a high cost for these potential rice producing districts. Minor tanks in Anuradhapura district also shows a similar value Rs.6.51/kg this was due to low input and low out put. Among major cost components about 50 percent is for the labour. Farmers utilize hired labor mainly for harvesting purposes.

## Potentials for Reducing Cost of Production and Increasing Production

### Land Utilization

About 42.5% and 20% percent of land are cultivated in yala season in Anuradhapura and Polonnaruwa respectively. Lack of water was the major reason for low land use intensity. Yala yield was less than Maha, the major reason for lower productivity of Yala was infertility of land. By doing better soil management practices, the land may be changed into fertile land.

Land productivity could be further improved by improving water availability through rehabilitation and land consolidation programs. Seed material showed no significant effect on production in both schemes. Improving the availability of good quality seed should be emphasized to overcome the problem of seed. Power indicated positive effects on production, which indicate the potential for mechanization in paddy production in the major irrigation schemes

Considering existing yield level between efficient and low efficient farmers, the yield level of majority (40 % - 60%) of the low performing farmers could be increased by 20% - 30% respectively in Anuradhapura and Polonnaruwa districts respectively without any additional cost. This can be achieved through improved management practices in utilizing higher farm power, integrated crop protection, nutrient and water control and timeliness of activities. Farmers do not seem to identify the production possibility open to them with respect to integrated crop management and timelines of activities. Rather than more complex changes, involving integration and timeliness of all factors into crop production is important.

### Labour Utilization

Hired labour was mainly required during harvesting operations. It can be concluded that family labour contribution is one of the major factor in reducing the cost of production. Mechanizing the harvest activities could reduce labour utilization. The return to family labour indicates that paddy generates 7, 4.5 and 1.5 folds more than average wage rate of Rs 250/man day, among the efficient, average and low efficient farmers respectively. Farmers should be encouraged to adopt suitable labour saving cultivation practices like using farm machinery, broadcasting of paddy etc.

### Price and Marketing

About 95% of the farmers sold their product to private sector. Price fluctuation was very high during the season, mainly due to the absence of organized marketing system. Farmers were unable to sell their product to the Cooperatives and CWE due to quality and payment problems.

Following recommendations are derived from the above conclusion:

1. Since the majority of farmers are cultivating their own land and most of them are full-time farmers, long term measures to improve land productivity such as soil fertility, management and soil conservation practices can be introduced effectively.
2. Given the high potential for family labour use and mechanization of harvesting can reduce the cost of production substantially.
3. Better extension services should be provided to farmers because, they are unaware of using fertilizer and agrochemical and soil management practices.
4. Farmer organizations should be strengthened in order to encourage farmer group action and farmer co-operation in respect of marketing, credit, input use and organizing cultivation.
5. Private institutions were mainly involved in the paddy marketing activity. Participation of Government institutions in the paddy marketing is very important to give a better price

#### Limitation of the study

Reliability of information relating to the cost of production and returns are limited as these information were not recorded by the farmers, therefore the cost of production and returns are only a close approximation.

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**Annexure 1.**

**Department of Agricultural Economics, Faculty of Agriculture,  
University of Peradeniya**

**NATIONAL SCIENCE FOUNDATION – SRI LANKA**

**“STUDY ON COST OF PRODUCTION OF RICE  
IN MAHA 2000 / 2001 & YALA 2000  
IN THE DISTRICTS OF ANURADHAPURA AND POLANARUWA”**

**SEPTEMBER 2001**

**QUESTIONNAIRE SURVEY**

<b>District</b>	Anuradhapura / Pollanaruwa	D.S. Division		G.N. Division	
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<b>1. HOUSEHOLD INFORMATION</b>				
1.1 Farmer's Name:			Field No:	
1.1.2 Distance from Distributory Cannel				
1.2 Age (Yrs.)	1.3 Education <b>Code No. 1</b>		1.4 Family Size Number	1.5 Dependency Ratio = ( > 60 + <16 ) / ( >16 + <60 )
<b>Code No. 1</b> No Schooling    1. Cannot Read & Write    2. Can Read & Write 3. Primary (1-5)    4. Secondary (6-10)    5. Tertiary , Diploma & Degree				

1.6 Farming Experience (years)	1.7 Farming Category <b>Code No. 2</b>	1.8 Part Time Farm Income (% Total income)	1.9 Recipient of <b>Code No. 3</b>	1.10 Total Monthly. Income <b>Code No. 4</b>
<b>Code No. 2:</b> 0. Farming    1. Laborer    2. Boutique Keeper 3. Mason/Carpenter    4. Government Servant    5. Others :.....				
<b>Code No. 3:</b> 1. Food Stamp    2. Samurdhi    3. Janasaviya    4. Others				
<b>Code No. 4:</b> 1. <2000    2. <2000 - <5000    3. <5000 - <7000    3. > 7000				

<b>2. LAND OWNERSHIP</b>				
2.1 Owned (Ha.)		2.2 Rented in (Ha)		2.3 Rented out (Ha)

<b>3. ASSETS OWNERSHIP</b>				
3.1 Tractor - 2W /4W	3.2. Harvester	3.2 Thresher – Type	3.3 Sprayer - Type	3.4 Buffalo – No.
Present				

Value:				
<b>4. RICE CROP PRODUCTION</b>			<b>Maha 2000/01</b>	<b>Yala 2001</b>
4.1 Cropping Pattern Followed <b>Code No. 5</b>				
<b>Code No. 6 :</b> 1. M-Paddy – Fallow - M-Paddy 3. M-Paddy – Y-OFC – M-Paddy			2. M-Paddy - Y-Paddy 4. M-Vege. – Y-Vege. – M-Vege.	
4.2 Total Extent Cultivated (Ha)				
4.3 Variety				
4.4 Variety Choice Reasons <b>Code No. 6</b>				
<b>Code No. 7 :</b> 1. Recommended 2. Available 3.P & D Resistant 4. Market 5. Consumption 6. Others .....				
4.5 Extent Harvested Ha. %				
4.6 Less Extent Harvested Reasons <b>Code No. 7</b>				
<b>Code No. 7 :</b> 1. Weather 2. Variety 3. Pest & Diseases 4.Others :.....				
4.7 Yield (kg)				
4.8 Yield Potential / Highest				
4.9 Trend in Yield <b>Code No. 8</b>				
<b>Code No. 8:</b> 1. Stable 2. Decline 3. Fluctuate 4. Increase :.1 Low, .2 Moderate ,.3 High				
4.10 Total Yield Loss %				
4.11 Yield Loss : 1. Seed 2. Soil 3. Ferti. 4. Labo. 5. Irri. 6. P&D 7. Weed				
% -----				
4.12 Unit Price Received ( Rs. / kg )				

<b>5. COST OF CULTIVATION MAHA 2000/01 &amp; YALA 2001 Rs '000 s</b>											
Season	5.1.1 Seed Cost BC	5.1.2 Seed Cost TP	5.2 Fert. Cost	5.3 Pesticide Cost ( Inc. Weedicide)	5.4 Machinery Cost	5.5 Irrigation Cost	4.6 Harvest., Thresh., Trans. etc. Cost	5.7.1 Total H. Labour Cost	5.7.2 Total Man Days Inc.F. Labour )	5.8 Total Cost	5.9 Ways to Reduce Cost <b>Code No. 11</b>
Yala 2001											
Maha 01 /02											
<b>Labour Use</b>	EST		IC-1	IC- 2	LP	IC- 3	HTT	Total	Wag e	TC	
Hired MD											
Family MD											

<b>C. No. 9</b> : 1.Cropping Intensity      2.Timely Cultivation      3. Suitable Variety 4. Appropriate Cultivation Practices    5.Reduce Hired labour      6.Others : .....
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<b>6. PROFITABILITY IN RICE PRODUCTION</b>	<b>Maha 2000/01</b>	<b>Yala 2001</b>
6.1 Production Share % given to Owner/Others		
6.2 Stock and Consumption		
6.3 Market Disposal		
6.4 Profitability Trend <b>Code No 10.</b>		
<b>Code No 10:</b> 1. Increase in Cost, 2. Stable price 3. Others.....		
6.5 Ways to increase Profitability <b>Code No. 11</b>		
<b>Code No. 11 :</b> 1. Market 2. Quality 3. Information 4. Price 5. Stock 6. Others .....		

### 7. SUPPORTING SERVICES

<b>7.1 CREDIT</b>	Rs.	%	Rs.	%
Amount borrowed and Interest rate				
7.1.2 Source <b>Code No. 12</b>				
<b>Code No. 12</b> 1. Banks 2. Money lender 3. Friends 4. Relatives 5. Trader 6. Potential Buyer 7. SANASA 8.Others :.....				
7.1.3 Problems <b>Code No. 13</b> (Rank)	>	>	>	>
<b>Code No. 13</b> 1. Default 2. Time 3. Amount 4. Collateral 5.Others :.....				
7.1.4 Suggestions for Credit <b>C. No. 14</b> (Rank)	>	>	>	>
<b>Code No. 14</b> 1.Bank Savings 2. FO 3. Co-op Credit Society(Sanasa) 4. More Banks 5.Others : .....				

<b>7.2 EXTENSION</b>	<b>Maha 2000/01</b>	<b>Yala 2001</b>
7.2.1 Source <b>Code No. 15</b> (Rank)	>	>
<b>C. No. 16 :</b> 1. AI 2. CO 3. NGO 4. Friends 5. FO 6. Traders 7. Mass Media :R,TV,NP		

<b>7.3 INPUT</b>	Seed	Fertilizer	Weedicide.	Pesticide
7.3.1 Source <b>Code No. 16</b>				
<b>C. No. 17 :</b> 1. Own 2.Neighbour 3.DOA 4. NGO 5.FO 6. ASC 7.Others :				
7.3.2 Knowledge Input Use <b>C. No. 17</b>				
<b>C. No. 17</b> 1. Non 2. Little 3. Enough/Recom. 4. Good/More 5.Others : .....				
7.3.3 Amount Used kg				
7.3.4 Amount Used Reason <b>C No. 18</b>				
<b>C. No. 18</b> 1.Recom. 2.Not Sure 3. Own 4.Quality 5.Cost 6.Available 7 Others .....				
7.3.5 The % of Total Cost (Rs. / Ha.)				
7.3.6 problems <b>Code No.19</b>				
<b>C. No. 19</b> 1.Time 2.Quantity 3.Quality 4. Price 5.Others :.....				
7.3.7 Suggestions <b>Code No. 20</b>				
<b>C. No. 20</b> 1..FO 2. Co-op 3.DOA 4. Transport 5.Market				

<b>7.4 IRRIGATION</b>	<b>Maha 2000/01</b>	<b>Yala 2001</b>
7.4.1 Irrigation Source <b>Code No. 21</b>		
<b>C. No. 21</b> 1. Rainfed 2. Major Tank 3. Minor Tank 4. Drainage 5. Others .....		
7.4.2 Reasons for Poor Water Mgt. <b>C. No. 22</b>		
<b>C. No. 22</b> 1. Inadequate supply 2. Damaged Structure 3. Drainage Encroachments 4. Illegal Water Tapping 5. Wastage in Upstream 6. Rotation Failure 7. Prolonged Culti.		
7.4.3 Ways to Improve the Mgt. <b>C. No. 23</b>		
<b>C. No. 23</b> 1.FO 2. ASC 3.Joint Supervision 4.Training 5. Others : .....		

<b>8 MARKETING</b>		
8.1 Major Market Source <b>C. No. 24</b>		
<b>C. No. 24</b> 1.Village Trader 2. Wholesale Trader 3. CWE & Co-op 4. FO 5. Pola		
8.2 Reason for the Choice <b>C. No. 25</b>		
<b>C. No. 25</b> 1. Price 2. Transport 3. Payment 4. Quality 5. Debt 6.Others : .....		
8.3 Preferred Source <b>C. No. 24</b>		
8.4 Difficulties of Preferred Source <b>C. No. 25</b>	> >	> >
8.5 Market Selection Decision <b>C. No. 26</b>		
<b>C. No. 26</b> 1.Own Knowledge 2. FO 3. AI 4. Other Farmers 5. Others		
8.6 Storage Facilities <b>C. No. 27</b>		
<b>C. No. 27</b> 1. Non 2. Very Inadequate 3.Inadequate 4.Adequate 5. Others .....		
8.7 Knowledge On : <b>C. No. 28</b>		
8.7.1 Grading ,Packing & Storage		
8.7.2 Consumer Preferences & Colombo Price		
8.7.3 Market channel price differences		

<b>9 FARMER ORGANIZATION</b>	
9.1 Membership with FO in Yrs.	
9.2 No. of Farmers Participated in the Last season	
9.3 If Not Participated, Reasons <b>C. No. 29</b>	
<b>C. No. 29</b> 1. Not a Member 2. Did not Hear 3.No Time 4.Serves No Purpose	
9.4 Willingness to Contribute to FO Activities <b>C. No. 30</b>	
<b>C. No. 30</b> 1. Cash 2. Labor 3.Kind 4. Non	
9.5 Expectation from FO <b>C. No. 31</b>	
<b>C. No. 31</b> 1.Input Sup. 2. Output Disposal 3. Credit 4. Resolve Conflicts 5. Training & Dev. 6. Others.....	
9.6 Assistant Needed to Strengthen FO <b>C. No. 32</b>	
<b>C. No. 32</b> 1.Training 2.Legal Power 3. Avoid Politics 4. Govt. & Ins. Support	

<b>10. FARMER COMPANIES</b>
10.1 Membership and Share .
10.2 Services Satisfaction: Collection / Milling / Processing / Selling / Others <b>C. No. 33</b>
<b>C. No. 33.</b> 1. Poor 2. Good 3.Need Improvement 4. Progressing 5. Unpredictable. 6. Others
10.3 Assistant Needed to Strengthen FC <b>C. No. 32</b>

**Annexure 2. PADDY COST OF PRODUCTION DATA Maha 2000/01 and Yala 2001**

**ANURADHAPURA AND POLONNARUWA DISTRICTS**

F.No.=Farmer Number; AGE=Years; EDU=Education 1:Primary, 2:Secondary, 3:Tertiary;  
 FS=Family Size Nos. ; LOW=Land Owned ha. ; YLDM= Yield Maha kg; SDC=Seed Cost Rs. ;  
 FTC=Fertilizer Cost Rs. ; CMC=Chemical Cost Rs. ; MAC=Machinery Cost Rs. ;  
 TLC=Total Labour Cost Rs. ; TMD=Total Man Days; MDHL=Man Days Hired labour;  
 TCIFL=Total Cost Including Family Labour Rs. ; YLDY=Yield Yala kg. ; TCY=Total Cost Yala Rs.

**ANURADHAPURA DISTRICT**

**MAHAWELI SYSTEM H - EPPAWELLA BLOCK**

F.NO.	AGE	EDU	FS	LOW	YLDM	SDC	FTC	CMC	MAC	TLC	TMD	MDHL	TCIFL	YLDY	TCY
1	50	3	7	1	5260	2010	7320	2750	7600	13450	76	38	33130	4800	31290
2	49	4	4	1	4600	1750	6800	2000	8000	14000	80	48	32550	4200	32410
3	54	4	5	2	9475	3200	10160	4800	7600	28400	162	82	54160	4500	41340
4	54	3	6	3	14500	3210	10280	3678	21600	44800	256	125	83570	12000	70460
5	55	4	3	2	8800	1840	12900	2400	7630	24800	142	84	49570	7500	35050
6	52	3	6	1	4300	1600	7400	2600	6000	18720	107	83	36320	3800	27510
7	52	4	5	1	4430	1750	5310	2300	7500	14200	81	65	31060	4100	42146
8	70	4	6	1	5375	1750	7450	1700	6800	16400	94	62	34100	4790	35000
9	56	5	6	1	5225	1700	6100	1930	3000	16700	95	54	29430	5100	29770
10	43	3	3	1	5260	1400	1620	1800	6400	15460	88	49	26680	5010	28780
11	52	3	5	1	4250	1575	5700	3316	7850	13500	77	42	31940	4100	32450
12	48	4	5	0.5	2100	1800	3850	1743	5600	8450	48	23	21440	2000	22800
13	58	4	4	1	4440	1600	6480	1588	7500	15420	88	39	32590	4200	32460
14	50	4	5	1	4800	1520	6780	2366	8500	12500	71	45	31670	4100	33400
15	55	4	5	1	4210	2000	3870	1200	6000	11240	64	37	24310	4010	28540
16	53	3	4	1	5500	2800	6720	2896	4500	19450	111	78	36370	4850	37030
17	51	1	5	1	4012	2100	5730	2600	7000	16730	96	60	34160	3890	36480
18	49	4	6	1	4780	1980	6000	3056	3900	16500	94	54	31440	4500	33600
19	53	4	6	1.75	9360	3400	7650	4200	15000	25000	90	72	55250	7500	54620
20	55	3	2	1	4876	2200	2500	1590	8000	17640	101	62	31930	4500	32700
21	54	2	3	1	4800	2100	3860	1450	5600	15640	89	58	28650	4300	29300
22	51	3	6	1	4532	1925	3185	2910	6800	16850	96	60	31670	4320	32500
23	67	4	3	1	4380	1750	3300	1916	8200	12900	74	39	28070	4120	28300
24	54	5	4	1	5430	2100	4060	2000	7000	12500	71	49	27660	4580	27600
25	49	4	2	1	4500	1200	5430	3300	5000	18000	103	81	32930	4300	32600
26	52	4	8	1	4600	2000	4720	1916	6700	10100	85	42	25440	4400	26450
27	52	4	3	0.4	2300	1050	2200	1200	2200	7600	43	34	14250	2100	14500
28	50	2	4	1	4890	1750	3500	1450	8250	12400	81	51	27350	4650	28300
29	58	4	8	1	4500	1750	3025	3028	4400	12500	71	49	24700	4200	25500
30	54	4	4	1	4290	1750	4830	3146	7000	16750	96	64	33480	3890	32700
31	50	3	6	0.8	4300	1260	4800	2723	6800	15700	90	45	31280	4150	32500
32	64	1	5	0.75	4210	1900	3450	1767	5700	15150	87	56	27970	4010	23060
33	51	4	4	1	5420	1750	5220	2812	7000	13500	77	54	30280	4500	30400
34	55	3	7	1	4680	1600	3710	1916	8700	11700	87	42	27630	4320	29300
35	57	3	5	1	3435	1500	3260	1725	7655	12250	70	56	26390	3200	27400
36	52	3	6	1	4520	1750	6750	4000	3150	13975	80	67	29625	4200	31700
37	54	3	5	0.9	5320	1820	4880	694	6850	13550	77	42	27790	4800	27980
38	58	3	4	1.25	6720	2100	3500	2424	8400	13300	76	54	29720	4590	30210
39	54	2	4	1	4640	1750	3250	910	8000	13875	79	60	27785	4210	27900
40	52	5	6	1	4980	2125	5020	2014	7500	15000	86	46	31660	4560	32450
41	50	2	4	1	4890	1750	1500	1480	8250	14100	81	40	27080	4430	28950
42	54	4	8	1	4500	1890	3025	3028	4400	12560	82	37	24900	4250	25100
43	48	4	4	1	4290	1750	4830	3146	7000	16570	95	41	33300	4120	32680
44	52	5	4	1	5430	2100	4060	2000	7000	12500	81	43	27660	4860	28600
45	47	4	2	1	3451	1200	5430	3300	5000	22000	126	84	36930	2980	33500
46	61	4	8	1	4600	2000	4720	1916	6700	12600	82	45	27940	4350	27500
47	52	4	3	0.4	3400	1050	2200	794	1800	12300	80	39	18140	2790	19200
48	54	2	4	1	3120	1750	1500	464	8250	11400	75	34	23360	2980	23300
49	55	3	7	1	4532	1600	3710	1916	8700	11700	76	45	27630	4320	27800
50	60	3	5	1	3310	1500	3260	1725	7655	12250	80	40	26390	3010	27400

**RAJANGANA TANK - Track No. 1,2, 3, 4 of Right Bank Channel**

F.NO.	AGE	EDU	FS	LOW	YLDM	SDC	FTC	CMC	MAC	TLC	TMD	MDHL	TCIFL	YLDY	TCY
1	49	2	5	0.5	2064	2200	3200	1560	1750	5600	32	12	14310	1980	14500
2	62	3	9	0.8	4400	2000	3500	3200	2500	15225	87	35	26425	4100	27200
3	56	2	5	0.8	4100	1850	3500	4000	4000	13500	77	43	26850	3900	27300
4	54	2	7	1.2	4063	2190	4000	6500	2500	12000	67	23	27190	3950	25700
5	43	2	6	0.7	3642	2100	3500	4000	3500	10000	57	33	23100	4100	24500
6	49	3	6	0.4	2025	900	3245	2450	3200	5900	33	12	15695	2000	16400
7	50	3	7	0.5	3000	1080	7500	4000	2100	6400	36	18	21080	2500	22400
8	53	2	5	0.8	3375	2100	5000	5200	2300	10000	57	23	24600	3225	25120
9	51	2	6	1.2	5500	1500	7000	3000	2750	15000	80	42	29250	4500	30120
10	48	3	5	1.3	4500	3000	7000	7000	4500	20000	123	54	41500	4000	37400
11	55	3	5	0.8	4000	1600	9500	6000	3200	7000	73	41	27300	4000	26540
12	54	3	6	0.4	2100	700	2100	1200	1750	5400	31	14	11150	1950	10300
13	51	2	6	0.75	4000	1080	5000	960	2750	14500	82	41	24290	3820	25230
14	51	2	5	1	4200	2700	4000	2500	4300	13200	75	36	26700	0	0
15	53	2	6	0.75	1600	1200	2300	1760	2800	12500	71	38	20560	0	0
16	55	3	4	1	4500	1540	3060	960	3750	14900	85	46	24210	0	0
17	55	3	4	1	4480	2250	6250	2500	4310	16250	92	52	31560	0	0
18	49	2	6	0.8	4100	2000	7300	3250	3000	11200	64	31	26750	3580	25400
19	52	2	5	0.7	3140	2000	4850	2250	4000	7000	57	24	20100	0	0
20	54	2	6	0.5	2125	3100	7000	2625	6250	11300	81	27	30275	2130	31200
21	52	4	5	1	4500	1500	12000	6000	12000	12300	70	34	43800	3200	41200
22	48	3	7	1	5063	800	5000	2000	5000	17200	98	46	30000	4200	29450
23	55	2	6	1	4200	850	4500	3500	6000	13400	76	36	28250	3500	28900
24	53	2	6	1.4	7400	4000	18000	5000	40000	15200	86	44	82200	4300	75600
25	51	3	5	0.8	5250	900	3950	1975	3150	5900	46	23	15875	4600	14890
26	52	2	6	0.6	3938	480	700	1100	2500	4600	30	15	9380	0	0
27	48	2	7	0.8	2500	720	6300	2210	5000	5600	41	26	19830	2100	20120
28	50	3	7	0.8	3500	840	5800	1760	5000	9650	62	35	23050	3000	22890
29	51	2	6	1.3	5440	2100	9200	2000	5000	14700	84	36	33000	4100	32890
30	57	3	6	0.6	5500	1800	4400	2000	5200	9700	55	23	23100	3000	24010
31	54	2	6	1	4500	3400	7400	2200	4500	17450	99	63	34950	3300	33420
32	50	2	8	1.2	6325	1200	4025	1500	5000	18200	104	65	29925	5100	31090
33	54	2	5	0.4	2100	900	1500	1500	1500	5400	30	13	10800	1400	11240
34	51	3	5	1	5120	1600	4000	2500	5000	14200	81	65	27300	3260	26890
35	44	3	5	0.8	4510	1500	5000	200	1800	15200	86	72	23700	2450	22560
36	50	3	5	0.8	3038	1900	3500	3500	3000	13500	77	33	25400	2800	26700
37	54	3	6	0.5	1200	750	3000	3150	3400	7700	44	31	18000	1100	17690
38	50	3	5	0.7	4000	750	3850	4685	4800	13200	75	42	27285	3500	28010
39	59	3	4	0.4	2000	800	2325	2590	3400	5620	32	15	14735	1600	15400
40	60	2	4	0.8	4300	1000	875	435	2000	14320	81	50	18630	2150	19120
41	51	2	6	0.9	5063	2400	2500	1800	5000	14500	82	61	26200	0	0
42	51	3	5	0.8	3150	2000	3700	2500	4800	13200	75	45	26200	1910	27540
43	55	2	6	0.75	2025	1000	3700	2500	4300	12300	79	34	23800	2100	24040
44	52	3	5	1.3	6540	1600	3400	1800	4800	16200	92	71	27800	3210	26890
45	58	3	5	0.8	4500	1600	4815	900	7500	14200	81	42	29015	4050	30120
46	51	3	9	0.4	2100	900	1790	1200	2000	6500	37	18	12390	1500	11890
47	53	3	7	1.4	6750	2340	10680	4580	7450	23200	116	54	48250	4500	35600
48	56	2	8	0.4	1350	850	2650	3400	2500	4880	27	15	14280	1200	15410
49	50	3	7	0.8	3038	1900	4300	3500	3000	13500	77	39	26200	2800	25790
50	54	3	6	0.3	1200	750	2100	1520	1200	4400	29	12	9970	0	0

**ANURADHAPURA MINOR TANKS - ELAYAPATHUWA**

F.NO.	AGE	EDU	FS	OWL	YLDM	SDC	FTC	CMC	MAC	TLC	TMD	MDHL	TCIFL	YLDY	TCY
1	53	2	5	0.6	2100	750	1275	500	2500	9200	46	17	14225	1466	15200
2	54	1	5	0.5	1980	660	1700	500	3500	8000	40	18	14360	1100	14500
3	50	3	7	0.4	1300	660	1550	600	1800	9000	45	12	13610	1200	12760
4	51	3	5	0.2	800	550	1000	750	1400	4600	23	12	8300	0	0
5	50	3	4	1.4	4520	800	7140	1200	5400	22400	112	78	36940	2311	35600
6	51	2	6	0.4	1350	1100	1800	1000	2600	9800	49	15	16300	0	0
7	51	2	5	0.8	3100	1250	1750	1500	2200	17800	89	18	24500	1800	25120
8	56	2	6	0.8	2800	1400	2000	1020	2000	18000	90	18	24420	2250	25420
9	51	2	5	0.7	2120	1550	1500	750	2500	17400	87	16	23700	2180	22350
10	53	3	8	0.4	1395	900	1650	1200	3500	11600	58	14	18850	1200	19300
11	56	3	6	0.5	1935	450	900	1400	2000	8400	42	12	13150	0	0
12	48	3	4	0.5	1450	675	450	675	1500	8800	44	11	12100	0	0
13	52	3	4	0.4	1000	1100	1400	500	2200	6800	34	12	12000	0	0
14	60	1	6	0.8	1200	1040	1500	500	3400	17200	86	19	23640	0	0
15	56	2	4	0.4	1200	900	1700	1500	2200	11200	56	12	17500	0	0
16	61	3	6	0.6	1650	1200	2000	1200	3000	12000	60	13	19400	0	0
17	57	4	4	0.8	2430	1000	2375	1600	3200	17400	87	16	25575	2120	25670
18	52	1	4	0.7	2510	700	850	1000	3100	14600	73	14	20250	0	0
19	55	3	5	0.8	1125	700	1350	1350	3000	18000	90	21	24400	0	0
20	55	4	5	0.4	1350	850	3500	2000	2800	8000	40	12	17150	1200	16570
21	59	3	4	0.6	1575	890	1700	1800	1800	11800	59	12	17990	0	0
22	51	3	5	0.4	900	750	1350	1400	2000	10200	51	11	15700	0	0
23	58	3	5	1	3220	1300	1600	1600	2000	15000	75	19	21500	1300	22130
24	52	3	5	0.4	720	525	1200	1335	2000	7200	36	10	12260	0	0
25	56	1	7	0.4	1020	600	1550	1400	1800	8800	44	11	14150	0	0
26	52	2	5	0.8	3260	1450	2450	1760	2200	13600	68	15	21460	2560	22010
27	50	2	7	0.5	1350	400	1725	1600	1200	8500	42	14	13425	1200	13500
28	55	4	4	0.5	2300	800	1250	1650	1750	10800	54	12	16250	0	0
29	57	2	7	0.5	1950	800	3500	1040	2500	12000	60	18	19840	1230	20100
30	51	2	7	0.6	2500	1200	2000	1000	3000	11200	56	16	18400	0	0
31	60	2	6	0.5	2120	900	1500	1400	2500	9000	45	12	15300	0	0
32	50	2	7	0.3	1200	450	2500	900	2400	8400	42	13	14650	1100	15210
33	51	4	6	0.5	2110	700	3500	1000	2200	10000	50	17	17400	2010	16570
34	55	1	3	0.4	1980	900	3600	500	2500	8600	43	14	16100	0	0
35	51	2	6	0.5	2000	720	2300	450	2000	11000	55	12	16470	1170	15350
36	52	2	7	0.5	1250	780	1200	415	2000	8800	44	15	13195	0	0
37	61	2	7	0.4	1320	810	1200	550	2500	9400	47	18	14460	1050	15420
38	55	3	5	0.5	1160	1000	1050	400	2500	10200	51	15	15150	1030	15420
39	54	2	7	0.6	820	950	1350	1500	1000	12400	62	21	17200	600	18210
40	56	3	6	0.6	2100	900	1000	1200	2300	14000	70	24	19400	1200	20120
41	56	2	6	0.6	1375	525	1800	1360	1540	12000	60	15	17225	1200	17640
42	52	3	6	0.4	1800	700	1600	1000	1500	11000	55	18	15800	1500	14800
43	54	3	7	0.5	1525	700	1000	600	2500	9000	45	13	13800	970	12890
44	55	2	7	0.2	900	700	1600	1000	1500	4800	24	12	9600	0	0
45	57	2	5	0.6	1520	1200	2000	1500	2500	12800	64	12	20000	1200	19540
46	60	3	6	0.5	2150	700	1870	560	2200	9000	45	12	14330	0	0
47	54	2	6	0.5	1850	1250	2350	1440	1200	12200	61	16	18440	0	0
48	54	3	7	0.4	1466	1160	1800	1260	2500	7200	36	14	13920	866	12890
49	52	3	7	0.5	2300	850	2520	1025	3000	7400	37	12	14795	1750	15600
50	54	2	6	0.6	2370	525	1800	1360	1540	10000	50	17	15225	0	0

**POLONNARUWA DISTRICT**

**MAHAWELI SYSTEM B - ELLEWAVE BLOCK**

F.NO.	AGE	EDU	FS	OWL	YLDM	SDC	FTC	WDC	MHC	TLC	TMD	MDHL	TCIFL	YLDY	TCY
1	53	2	7	1.2	5810	1670	6450	2300	5430	14000	70	21	29850	0	0
2	49	2	7	1.2	6600	3100	6270	3200	4320	15400	77	23	32290	0	0
3	49	2	6	1.2	4340	3200	7650	2350	5750	16540	83	32	35490	0	0
4	50	3	8	1.2	4300	3500	6270	2050	6540	16320	82	35	34680	0	0
5	60	3	4	1.2	3300	2250	3135	2025	6540	15400	77	31	29350	0	0
6	43	3	7	1.4	7260	3400	9540	2500	5740	11800	59	20	32980	6160	34200
7	43	3	4	1.4	7840	3480	10750	2170	6350	14530	73	36	37280	5500	31200
8	51	3	6	1	4500	3250	6850	2700	5430	17600	88	42	35830	3300	27950
9	55	3	8	1	3120	1800	4140	1470	6350	13200	66	23	26960	2750	24500
10	63	3	6	2	8900	3100	8750	2300	6510	16300	82	48	36960	4400	34520
11	48	2	7	1	3800	1320	7650	2540	6530	14530	73	45	32570	3300	28950
12	78	2	5	1.3	4530	2300	3070	2100	5000	14250	72	43	26720	3300	29870
13	48	3	6	1	3300	1600	3980	3900	6540	15600	78	41	31620	3300	28950
14	53	2	6	1.5	7400	2100	9420	2300	5400	12800	64	32	32020	4400	31250
15	52	2	7	2	7430	1840	11090	2540	5000	11200	56	23	31670	3850	30210
16	51	3	5	1.5	5640	2150	11290	2500	4550	14230	72	34	34720	0	0
17	53	2	6	1.2	3750	1380	6570	1430	5450	13240	66	30	28070	0	0
18	60	2	8	1.5	6450	2500	7540	2300	5000	16300	82	47	33640	0	0
19	57	3	8	1.5	3520	1600	8650	2800	6430	13200	66	31	32680	0	0
20	62	2	7	0.5	2350	1100	3400	1200	4500	12540	63	28	22740	0	0
21	56	3	8	1.5	6430	1540	9750	1050	5400	14350	72	37	32090	0	0
22	65	3	6	1.5	7650	2500	8950	2500	6540	13500	69	31	33990	5000	34520
23	74	3	7	1	4000	1850	5400	3500	3500	12500	63	30	26750	4000	30240
24	61	2	7	1.4	4500	2800	6750	3000	7010	14700	74	29	34260	4500	32100
25	47	2	6	1	3300	2000	6500	2000	6000	15230	76	42	31730	3300	29430
26	54	2	5	1.2	4950	2400	8290	3900	2800	18750	94	36	36140	0	0
27	54	2	7	1.4	5860	2550	10310	3140	4800	16240	81	41	37040	5630	32180
28	56	3	7	1.5	7530	2400	9230	3020	4200	19540	98	45	38390	7120	39500
29	54	3	7	1.2	5260	4000	7340	2600	4500	16750	84	49	35190	5120	36780
30	46	3	6	1.2	6790	2000	7430	2600	6000	17650	88	41	35680	0	0
31	65	3	7	1.5	7320	2400	9600	2100	5000	19870	99	52	38970	0	0
32	48	3	6	2	10450	2550	12800	3210	7000	28450	142	68	54010	0	0
33	50	2	6	1.2	5470	1600	7850	2510	4000	18300	91	45	34260	4640	34600
34	59	2	7	1.2	5720	2730	6700	3755	5420	14320	72	34	32925	5500	33210
35	50	2	8	1.2	4620	2400	6540	2970	5400	17500	88	40	34810	3850	35300
36	47	3	7	1.2	4980	5600	9010	2600	5320	15200	76	35	37730	0	0
37	49	3	6	1.2	5300	2200	7320	3400	6500	14200	71	32	33620	4890	34600
38	52	3	5	1.3	6110	2200	8420	3200	6420	16500	83	26	36740	5400	35210
39	68	2	7	1.2	5320	2200	9210	360	7500	14600	73	36	33870	4920	34700
40	65	2	8	1.4	5670	2200	8800	3210	6730	19540	98	45	40480	5120	38450
41	66	3	5	1.2	4510	3000	6730	3000	6500	15400	77	32	34630	4100	35120
42	54	3	6	2	9430	2800	12010	4320	5700	25460	127	69	50290	8750	48700
43	60	3	7	1	4800	1800	7830	2310	4200	13800	69	38	29940	3980	27600
44	53	2	5	1.2	3075	2000	7430	3200	7650	16600	83	41	36880	0	0
45	43	3	7	1.2	5250	1650	8210	3210	6540	16800	84	44	36410	0	0
46	42	3	5	1.3	4780	2100	8210	1780	6450	15430	77	42	33970	4260	32700
47	65	2	8	1.2	5500	2100	9320	2150	7600	18210	91	54	39380	0	0
48	54	2	8	1.2	4840	2100	6890	2400	4530	17200	86	37	33120	0	0
49	43	2	7	2	8210	1800	12350	4500	10230	29320	147	70	58200	5400	34800
50	42	2	6	1.2	4310	2200	6500	2100	7500	16100	81	43	34400	4220	35500

**MAHAWELI SYSTEM C NUWARAGALA BLOCK**

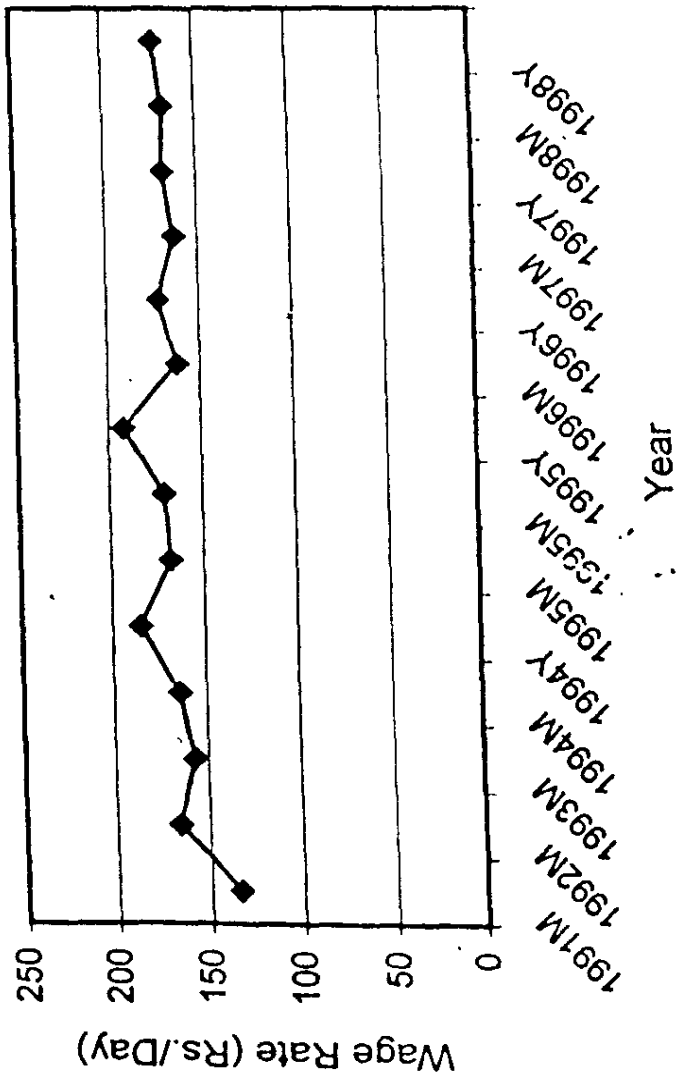
F.NO.	AGE	EDU	FS	LOW	YLDM	SDC	FTC	CMC	MAC	TLC	TMD	MDHL	TCIFL	YLDY	TCY
1	55	2	4	1.2	5330	1750	7250	3350	7500	17650	88	21	37500	0	0
1	60	2	7	1.3	5130	715	7650	3350	7500	18230	91	32	37445	0	0
2	51	2	7	1	4540	2800	6540	4250	7500	16500	83	40	37590	3990	35900
3	40	1	5	1	5120	2390	7210	2500	7500	17320	87	43	36920	3260	36200
4	63	3	7	1.4	4320	715	8530	5550	7500	21020	105	45	43315	3750	34210
6	58	3	5	1.2	5250	2000	8120	5000	7000	19300	97	35	41420	4750	42100
7	46	3	5	1	4390	2000	7280	5000	7000	15400	77	45	36680	0	0
8	50	2	7	1	4710	2300	6740	3500	7500	16320	82	43	36360	4610	34210
9	50	3	6	1.4	5060	4410	9720	3400	8510	19200	96	46	45240	0	0
10	46	2	9	1.2	4300	1920	7510	1500	2500	17300	87	56	30730	0	0
11	46	2	6	1.4	6740	1540	7870	4400	7000	22100	111	54	42910	0	0
12	53	3	7	1.3	6210	1300	6750	3600	7000	21350	107	39	40100	5670	41450
13	44	3	8	1.5	6420	2275	6650	3200	7000	23150	116	34	42275	5370	44370
14	50	2	7	1.5	8230	860	8750	2870	3250	24100	121	64	39830	6550	40210
15	43	3	7	1	4380	2370	6430	2100	7000	16540	83	45	34440	3420	33210
16	54	2	5	1.2	4620	2375	8740	3400	7000	18320	92	52	39835	4120	38750
17	56	2	6	1	5010	1500	7120	3050	7000	15400	77	35	34070	4320	35210
18	43	3	7	1	4680	1430	7120	1750	6000	16200	81	32	32500	4290	33250
19	52	3	6	1.2	5120	1900	7840	2625	6000	17200	86	32	35565	4760	36540
20	61	3	7	1.4	5050	2250	7210	3500	7500	20190	101	45	40650	4520	38670
21	48	2	7	1.4	6540	2000	9450	4000	7000	18750	94	48	41200	5120	40390
22	44	3	6	1.2	5400	2000	7540	4000	6500	16300	82	41	36340	4980	37650
23	55	2	7	1	4210	2000	6700	3700	6500	15420	77	36	34320	3950	35210
24	55	3	6	1.4	8120	1540	8210	3633	7500	18350	92	45	39233	4500	39760
25	54	2	5	1.4	7660	1320	8450	2915	7500	19320	97	47	39505	3300	40210
26	56	3	7	1.5	7850	1650	9470	5300	7500	20130	101	32	44050	3600	41200
27	52	2	7	1.4	6650	1540	8450	13080	7500	19300	97	47	49870	4400	44560
28	46	3	7	1	4390	2000	6320	5000	7000	15300	77	32	35620	0	0
29	54	2	6	1	4700	2300	7540	3500	7500	16250	81	43	37090	3760	38650
30	50	3	6	1.4	6250	4410	9650	3400	10500	19320	97	32	47280	0	0
31	46	3	9	1.4	7100	1920	9150	1500	2500	20120	101	56	35190	6430	34670
32	54	3	6	1.4	6600	1540	8290	4400	7000	19850	99	45	41080	5540	40340
33	51	2	6	1.3	6840	2800	7210	4250	7500	18500	93	51	40260	3990	39870
34	53	1	5	1.2	6100	2390	7220	2500	7500	16400	82	38	36010	5230	35400
35	63	3	7	1.5	7100	715	9140	5550	7500	20110	101	51	43015	6730	42900
36	52	2	7	1	3750	2300	6790	4000	7500	16540	83	43	37130	2750	36780
37	42	2	8	1.2	6430	2375	7240	3400	7000	17200	86	43	37215	5480	38130
38	46	1	6	1.2	6100	2100	8590	3050	7000	18230	91	54	38970	5410	39020
39	44	3	7	1.2	5600	3120	7650	1750	6000	17600	88	43	36120	4380	37560
40	52	3	7	1.2	5400	1900	7120	2625	6000	16450	82	45	34095	4980	35120
41	56	2	6	1.4	6120	2250	7650	3500	7500	19850	99	47	40750	5480	39870
42	55	3	6	1.4	7640	2000	9540	4000	7000	18450	92	48	40990	0	0
43	56	3	9	1.2	5100	1920	7650	1500	2500	17850	89	46	31420	0	0
44	46	4	6	1.4	4360	1540	8270	4400	7000	19320	97	51	40530	3210	38750
45	53	3	5	1.5	7120	1300	10700	3600	7000	20250	101	53	42850	6750	41980
46	60	3	7	1.2	4330	1760	8210	3350	7500	17200	86	43	38020	3980	37650
47	51	2	8	1	3980	2800	7250	4250	7500	16300	82	45	38100	2890	37560
48	50	1	5	1.2	5210	2390	7450	2500	7500	17540	88	56	37380	4200	36500
49	63	3	7	1	4210	1750	6400	5550	7500	15650	78	41	36850	3970	37320
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**PARAKRAMA SAUMDRA**

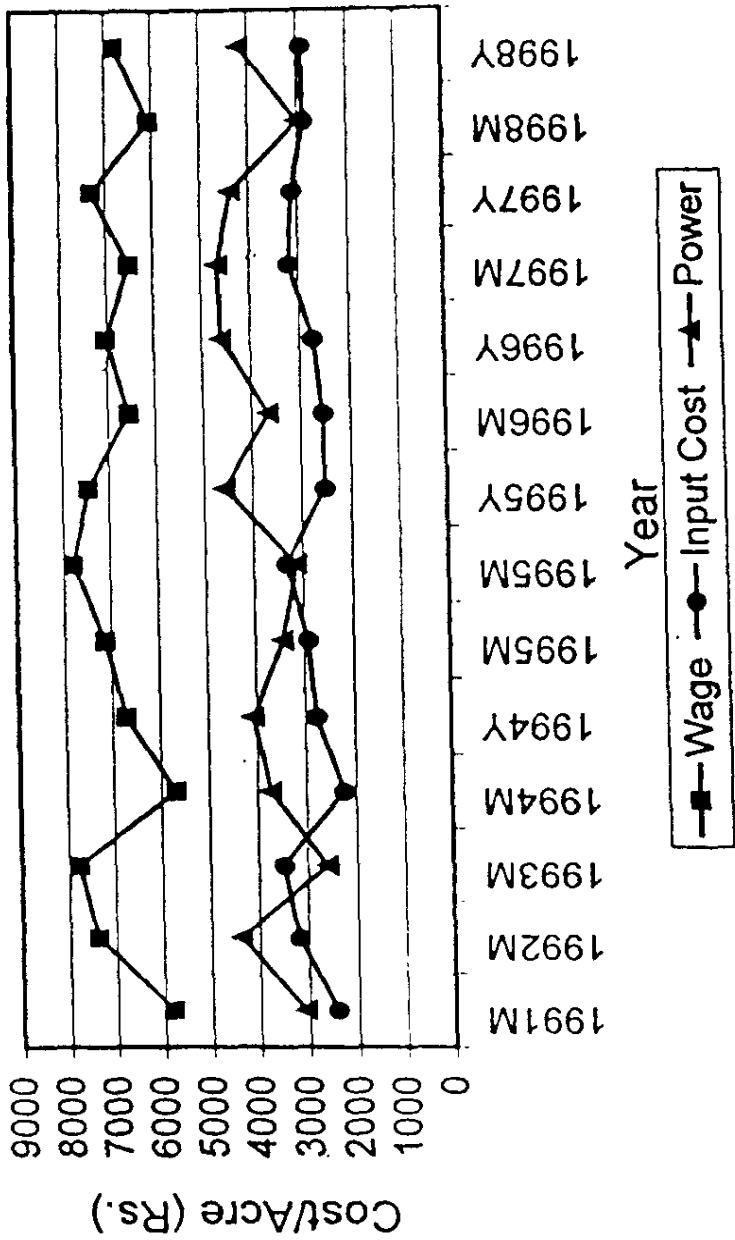
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3	41	2	8	1	4400	1700	4980	2550	5700	16300	93	43	31230	3050	30450
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5	41	1	6	1	3300	2310	3700	1350	4300	16540	95	54	28200	2960	29500
6	43	3	7	1.2	4570	1270	5700	2100	4500	17650	101	55	31220	3800	30950
7	47	3	6	1.2	4520	2400	5450	2010	5430	19600	112	39	34890	0	0
8	46	3	6	0.6	2370	1150	7650	1250	7600	7500	43	46	25150	1870	26150
9	42	2	7	1	3120	1240	4320	1240	4800	17500	100	54	29100	0	0
10	47	3	6	1	3280	2000	4320	2100	6500	18650	107	53	33570	2500	27590
11	48	2	6	1	5500	2000	7500	2070	7100	18340	105	56	37010	4570	37560
12	51	2	7	1	4120	2000	4500	2700	6500	19200	110	49	34900	3980	32890
13	42	1	7	1	3960	2000	5400	2160	7800	16780	96	65	34140	3570	31250
14	46	2	8	1.2	6420	2100	7650	2100	5400	19750	113	45	37000	4600	37500
15	47	3	6	1.2	4120	2500	6120	1950	3500	18560	106	50	32630	0	0
16	52	3	7	1.2	3075	2200	4210	2000	4200	16500	94	46	29110	0	0
17	45	3	6	1	4422	3600	3200	1750	3000	15450	88	56	27000	4100	28300
18	56	2	7	1	3880	1600	3830	2500	7500	15500	89	40	30930	3250	31560
19	54	3	5	1.2	3960	1600	2550	1700	4650	17340	99	43	27840	3750	28540
20	46	3	7	1	3300	1560	2050	1650	4500	16540	95	56	26300	3210	24650
21	47	2	8	1.4	3890	1300	4800	2200	7000	19780	113	50	35080	3560	29240
22	56	3	5	1	3210	2100	4230	2310	7650	16790	96	48	33080	3100	29450
23	51	2	6	0.5	2400	1700	2980	1200	5700	8700	77	43	20280	1050	17650
24	48	1	5	1	4125	1400	3200	2100	7650	15430	88	50	29780	3520	28890
25	60	2	6	1	3300	2310	3730	2100	3450	16430	94	33	28020	2980	29160
26	55	2	5	1.2	4120	1270	5700	1700	4500	17650	101	55	30820	3860	31400
27	51	2	7	1.2	5210	2400	7650	2010	5400	19430	111	49	36890	0	0
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37	53	1	8	0.7	3120	1400	5430	2800	6540	13700	78	32	29870	2980	30150
38	45	2	7	1	3300	2310	4350	1350	3470	15430	88	37	26910	2980	27100
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40	47	2	6	1	4210	1980	7450	2010	4500	16960	97	36	32900	0	0
41	46	1	6	1	3500	1250	5430	1350	7610	16560	95	45	32200	7875	32650
42	51	2	7	0.7	1320	1340	4890	1240	4200	14300	82	40	25970	0	0
43	47	2	6	1.2	4500	2100	7900	1560	6500	19870	114	49	37930	4210	38090
44	48	3	6	1.5	5500	2100	10870	2500	6890	20210	115	59	42570	4980	42770
45	51	1	7	1.2	4320	1540	7650	2100	6500	16780	96	41	34570	4220	35510
46	61	2	7	0.5	2370	2050	5000	2150	7500	15430	88	32	32130	1980	32520
47	52	2	8	1.2	4630	2100	8450	2100	7540	18740	107	45	38930	4350	38500
48	54	3	7	1.3	5125	2500	7540	1950	3500	16570	95	50	32060	0	0
49	52	1	6	1.2	3075	1280	6500	2100	4200	17890	102	46	31970	0	0
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Annexure 03. Cost of Production Key Secondary Data

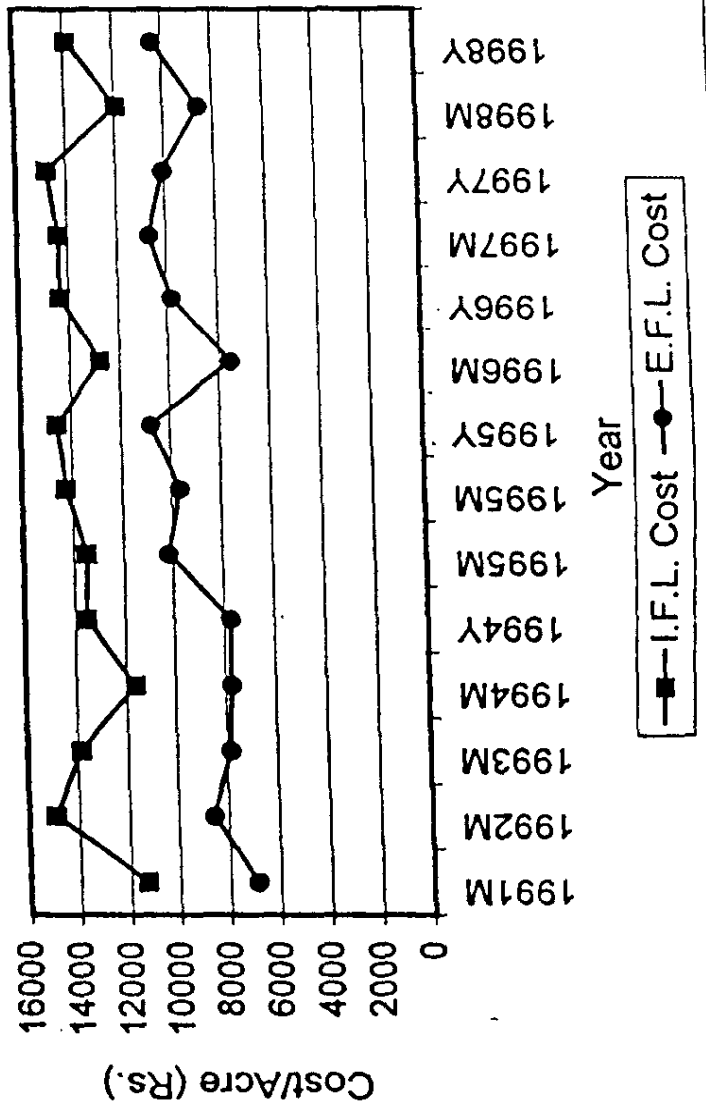
Wage Rate with Time 1991-2000 (Deflated)



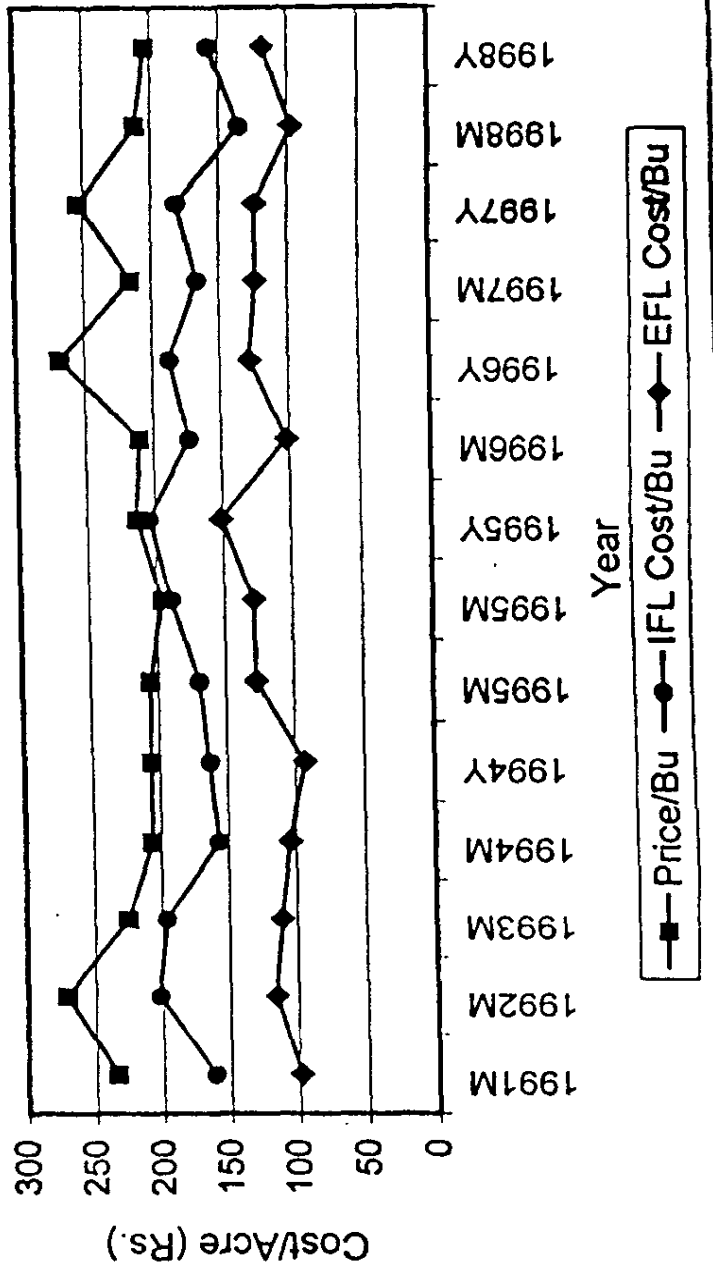
Wage, Power & Input Costs per Acre with Time 1991-2000 (Deflated)

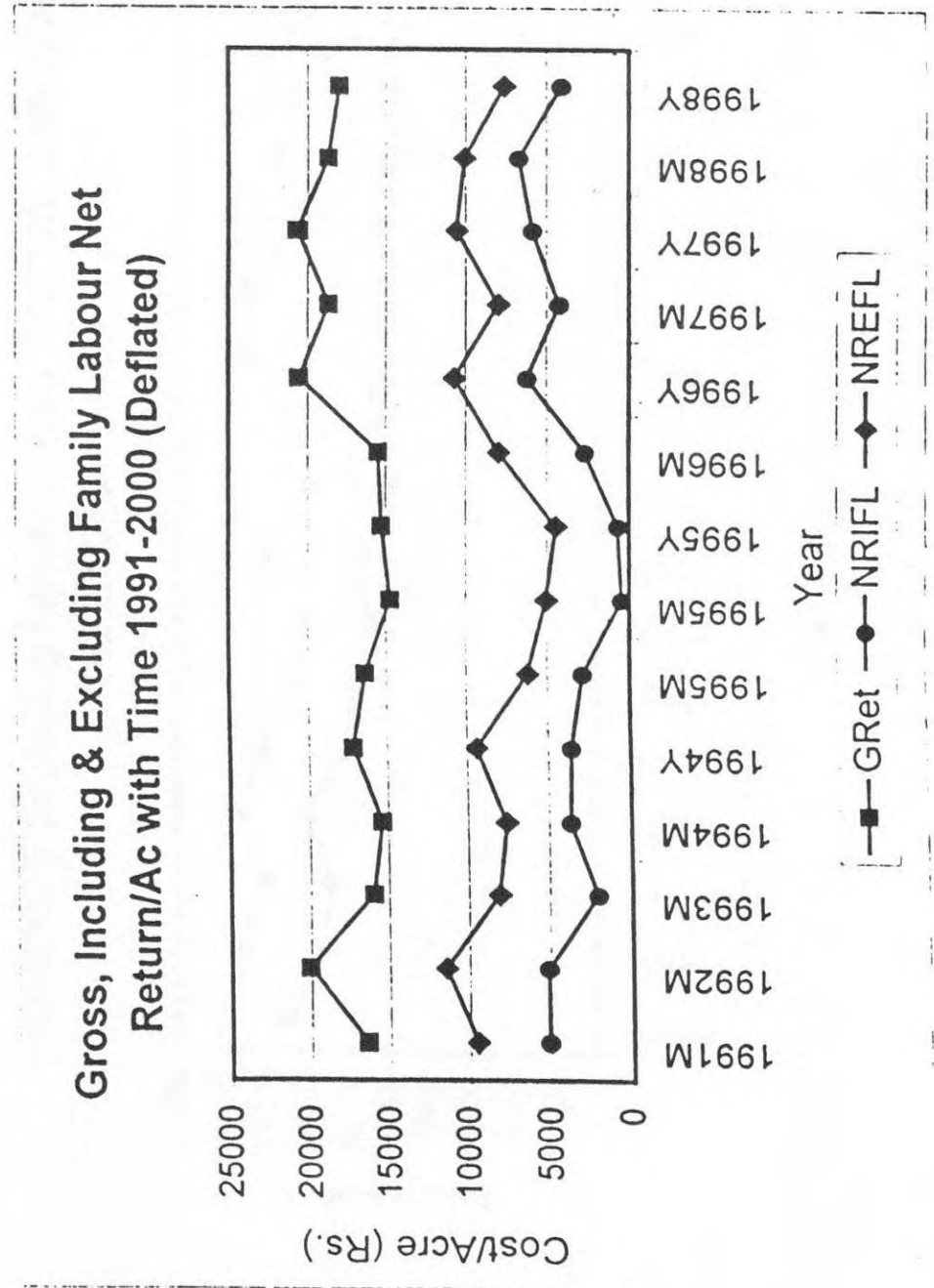
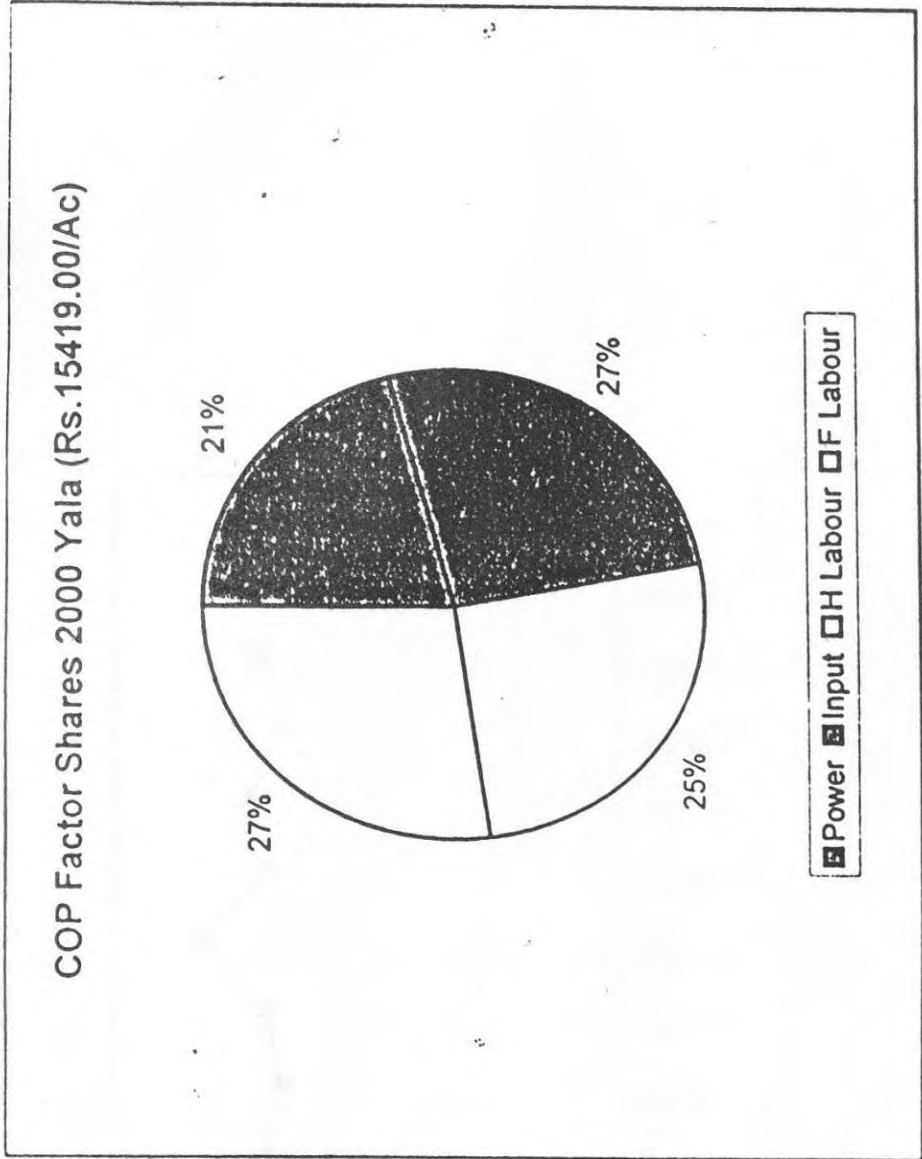
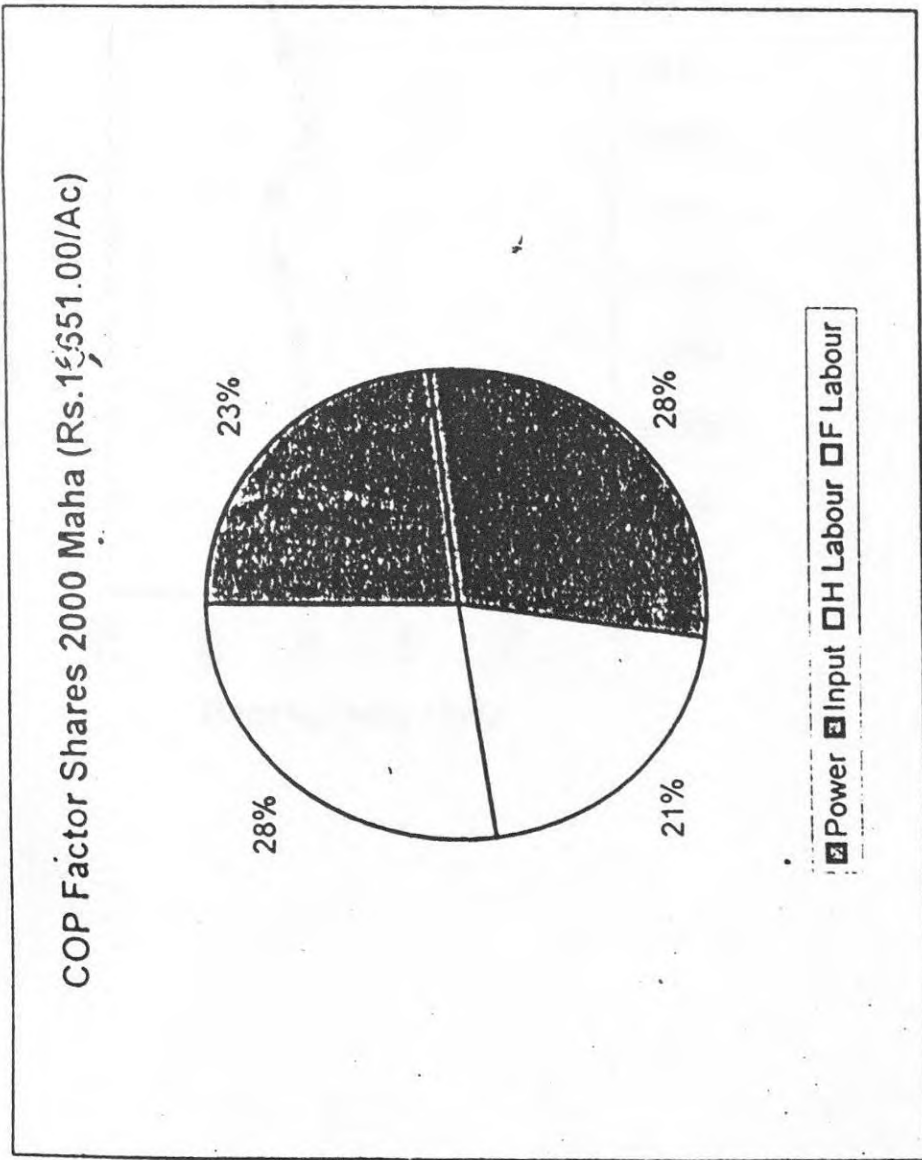


Including & Excluding Family Labour COP/ Ac. with Time 1991-2000 (Deflated)

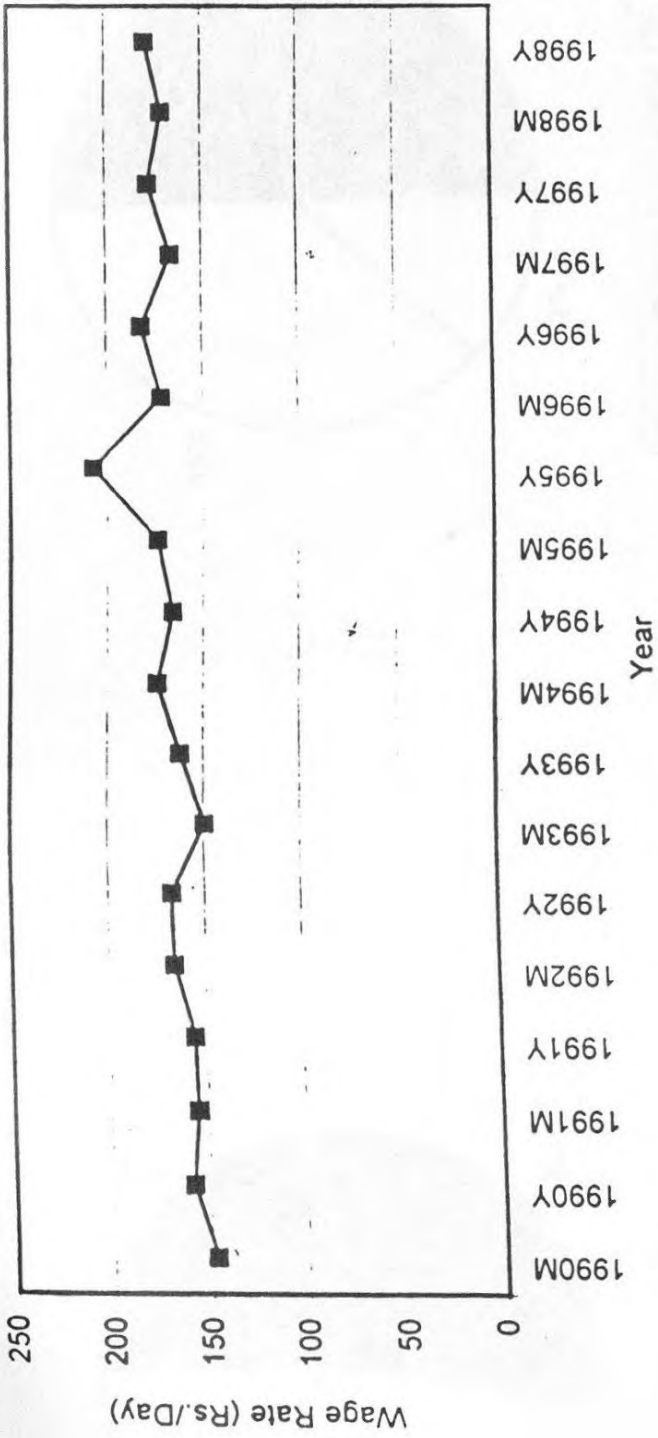


Price, Including & Excluding Family Labour COP/ Bu with Time 1991-2000 (Deflated)

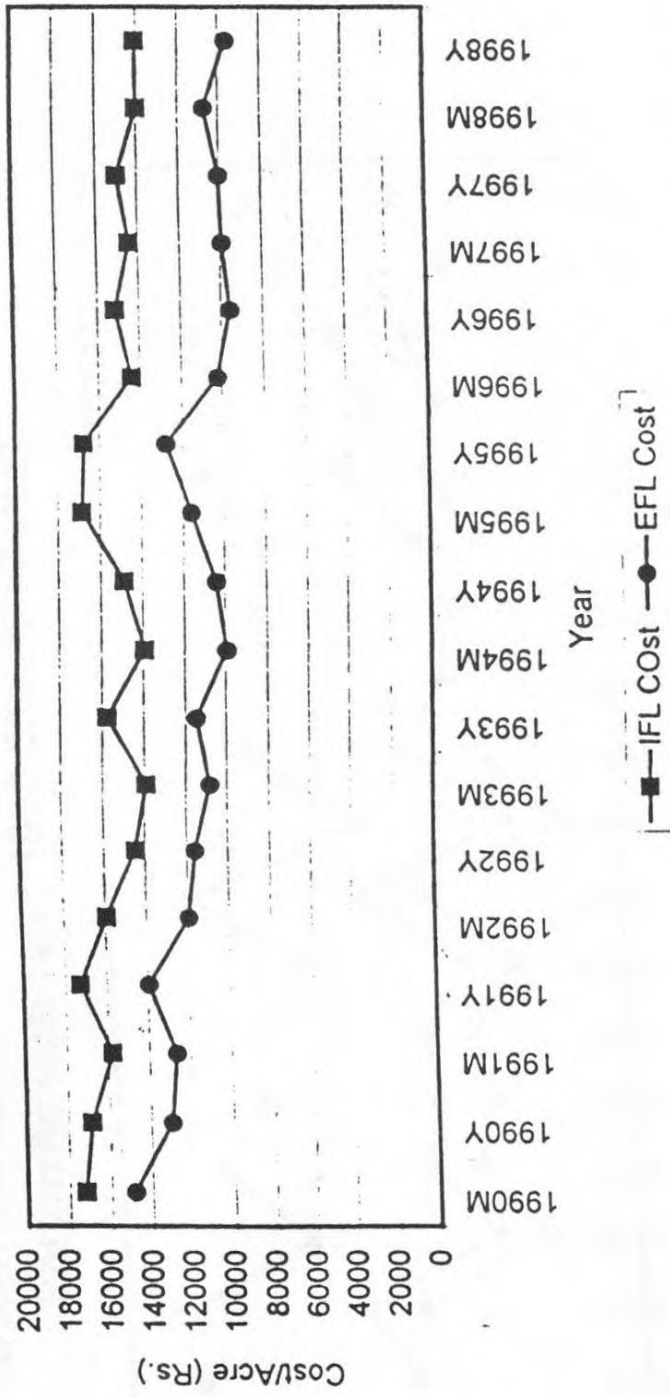




Wage Rate with Time 1990-2000 (Deflated)

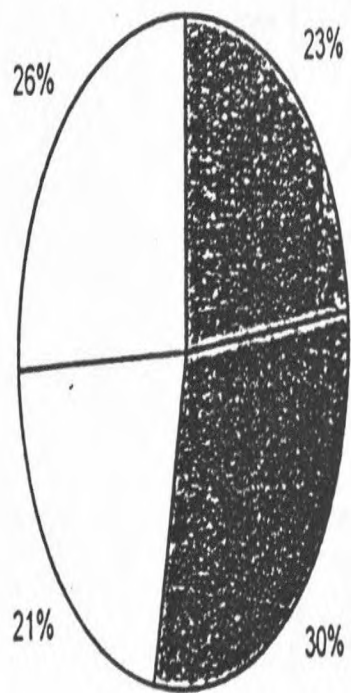


Including & Excluding Family Labour COP/ Ac. with Time 1990-2000 (Deflated)

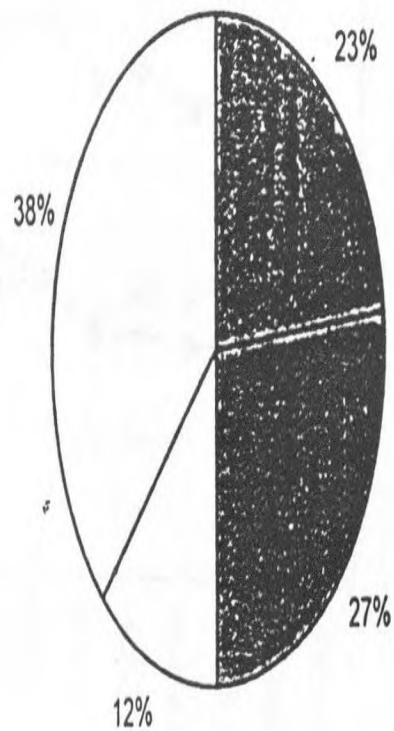


COP Factor Shares 2000 Maha (Rs.16325.30/Ac)

COP Factor Shares 2000 Yala (Rs.15605.91/Ac)



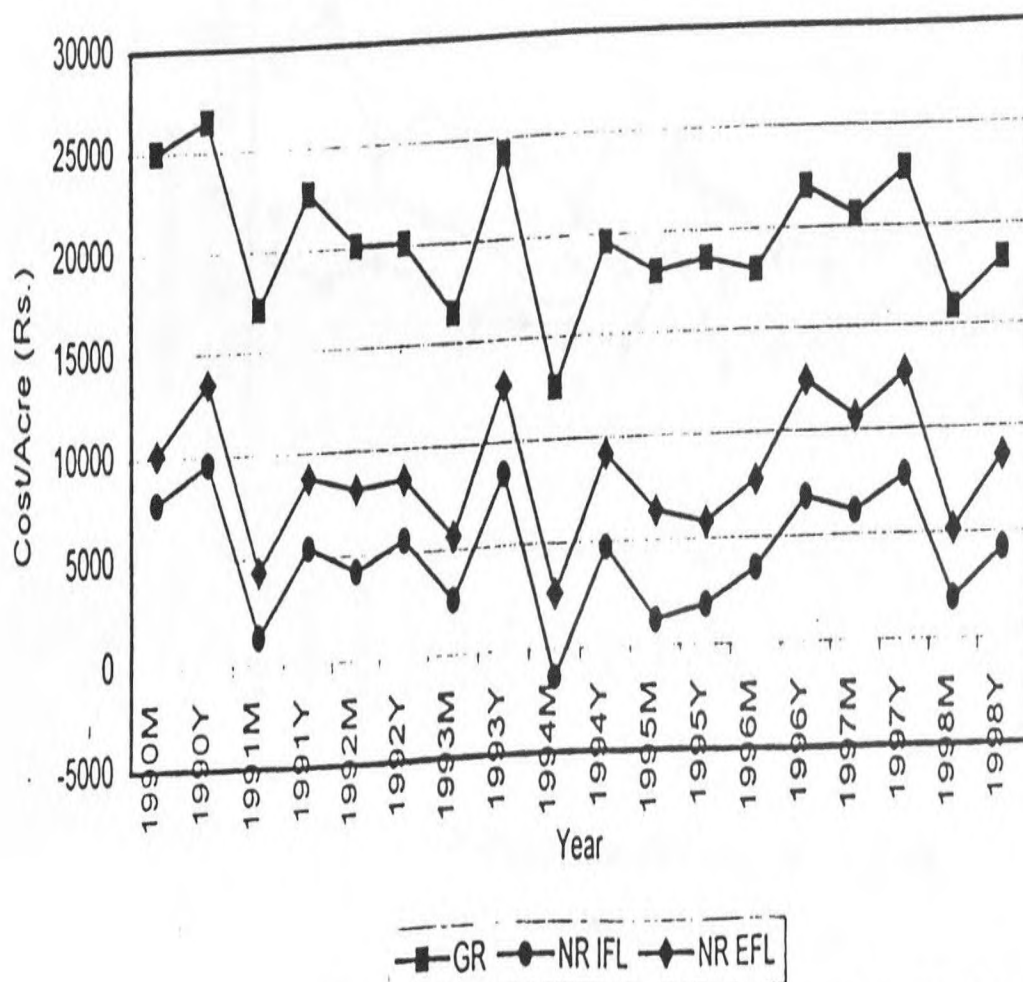
Power Input H Labour F Labour



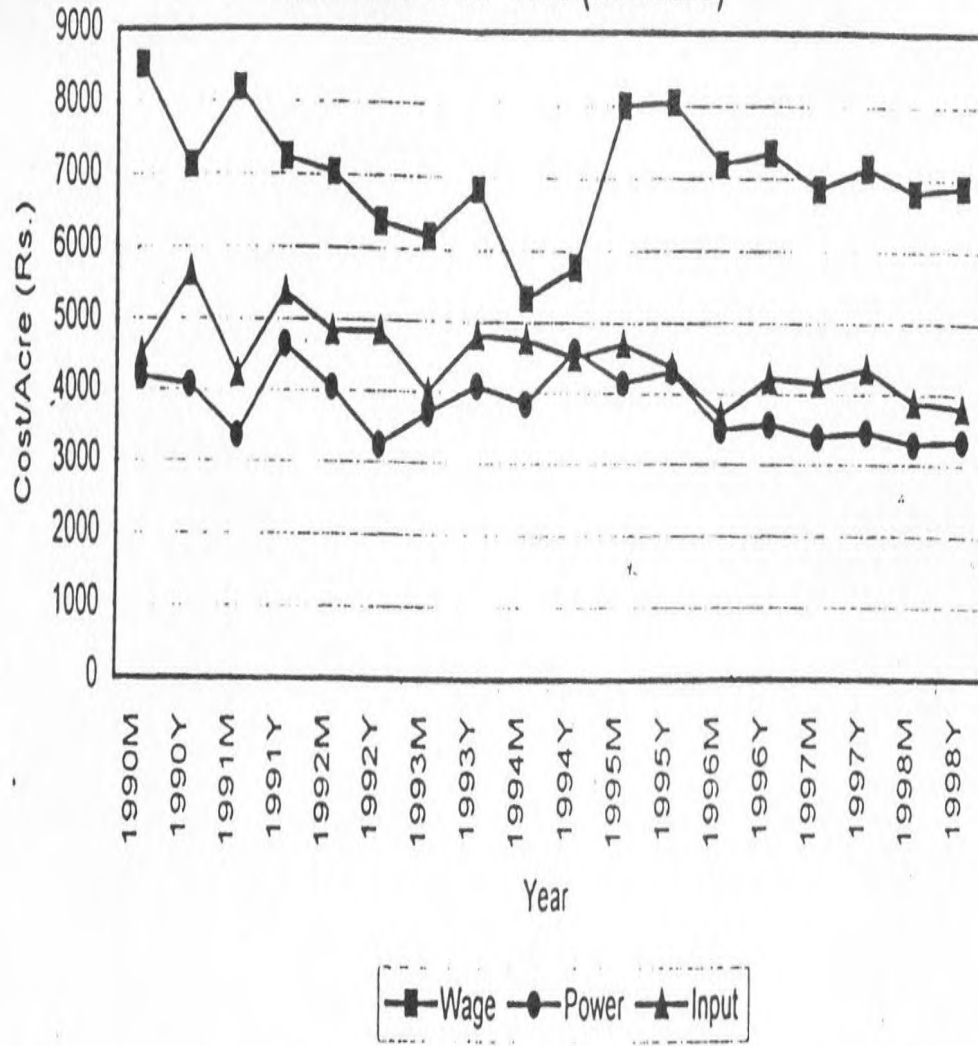
Power Input H Labour F Labour

SS

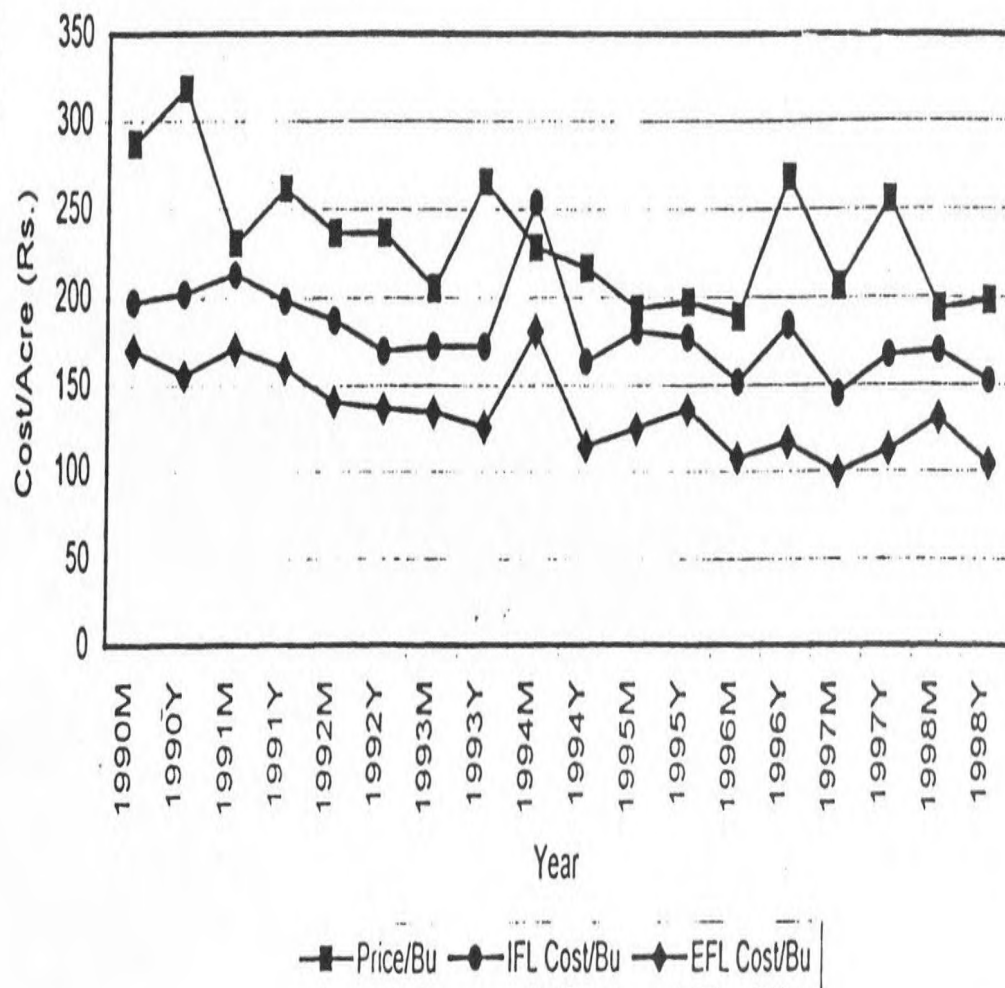
Gross, Including & Excluding Family Labour Net Return/Ac with Time 1990-2000 (Deflated)



Labour, Power & Input Costs per Acre  
with Time 1990-2000 (Deflated)



Price, Including & Excluding Family Labour COP/ Bu  
with Time 1990-2000 (Deflated)



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