CHAPTER 11

Production and Profitability of Rice Cultivation in Sri Lanka under Different Water Regimes — a Trend Analysis

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INTRODUCTION

RICE CULTIVATION CONTINUES to occupy a vital place in the Sri Lankan economy. Rice, the major staple food, accounts for over one third of per capita calory as well as protein consumption of an average Sri Lankan. Rice-grown areas stretch over a large extent in the country and in most of these areas it is the major economic activity. Rice-growing areas can be divided into three categories based on the source of water supply: cultivation under major irrigation schemes, under minor irrigation schemes and under rain-fed conditions. In 1990, rice was cultivated in 735,000 hectares (ha) and this was 41 percent of the total agricultural land use (Central Bank of Sri Lanka 1991). Over 80 percent of the total output comes from the irrigated rice areas. In the recent past, major irrigation schemes have become increasingly important in respect of area covered, productivity per unit of land and in the overall contribution to national production.

Attainment of Self-Sufficiency in Rice

The successive governments of Sri Lanka, as in many other countries of South and Southeast Asia, have followed a policy of achieving food self-sufficiency. Instruments employed to attain the objectives of self-sufficiency included a complex range of policies that appears to have had a significant impact on various aspects of rice production. Some of the measures that have been taken in the past are: the agricultural credit scheme which was introduced in 1948 and which has been operated as the New Agricultural Credit and Comprehensive Rural Credit Scheme since 1967; the Fertilizer Subsidy Scheme introduced in 1951; the Paddy Lands Act of 1958; the Crop Insurance Act that gave legal sanction to the Crop Insurance Scheme which was initiated in 1958; the Irrigation and Land Expansion Policy of successive governments through construction/maintenance of major and minor irrigation schemes; the guaranteed price scheme started in 1948; and the introduction of high-yielding varieties (HYVs) of crops associated with efficient research and extension services. As a result of these measures output enhanced and rice imports have gradually declined. During the last four decades, Sri Lanka has accomplished substantial achievements in rice output. These achievements are best illustrated by the changes in the rate of self-sufficiency in rice during this period. Just after independence in 1948, the country produced only 40 percent of the total rice requirement and the remaining 60 percent was imported. By 1985, self-sufficiency in rice reached a level of more than 90 percent. Rice imports, which increased to over 0.7 million metric tons of rough rice in the mid-1960s, decreased to about 20 percent of the peak level by the mid-1980s (Aluwihare and Kikuchi 1991). In 1985, domestic rice production was 2.660 million metric tons and rice imports were 0.22 million metric tons. However, in 1990, the total production was 2.538 million metric tons. Sri Lanka failed to surpass the levels achieved in both yield and production thereafter.

Productivity, Yield Gap and Contribution of Water

In 1983, the average productivity of rice in Sri Lanka reached a record level of about 3.6 mt/ha, but this is far below the level that could be reached as demonstrated by research scientists (approximately 10 mt/ha in 4–4$^1/_2$-month-age and 3–3$^1/_2$-month-age classes of HYVs). In this particular year, the yields obtained in an "irrigated district," namely Polonnaruwa, were 4.2 mt/ha and 4.5 mt/ha in *maha* (wet) and *yala* (dry) seasons, respectively.

The Future Demand for Rice

Despite the fact that Sri Lankan agriculture has managed to attain a higher degree of self-sufficiency in the major staple, population growth, urbanization and rising affluence (at least in certain strata of the population) will increase the demand for rice in the future. Even though the growth rate of the population of Sri Lanka is low by "Asian standards," the population may not be stabilized in the next few decades. Despite the increased emphasis on nonrice food crops, the demand for rice will continue to grow for sometime.

Future Supply

Future increase in rice production will depend mainly on: a) the scope for area expansion, b) yield increase and c) increasing cropping intensity (or time productivity). Profitability will also depend on these factors and the prices,of inputs and output.

As explained elsewhere, in order to increase production, successive governments have relied primarily on rapid expansion of the area under cultivation. Nevertheless, the potential for future expansion is very much limited and the cost of capturing and developing new sources of water is escalating.

The cropping intensity in irrigated areas has been fluctuating in the range of 1.0 to 1.4 over the past two decades. It would be useful to analyze the factors influencing the cropping intensity and examine whether the farmers have achieved the maximum possible levels.

In the late 1970s, scientists believed that there is a significant amount of "untapped yield potential" in irrigated production systems, especially in Asia. Moreover, they observed that much of this could be captured by improvements in crop management in general and in water management in particular. Surprisingly, by the end of 1980, some researchers have observed a stagnating or declining trend in productivity of major food grains grown mainly under irrigation.

For rice, the major crop under irrigation in most Asian countries, recent studies indicate that the technological yield frontier[63] has stagnated and shows signs of long-term decline (Pingali, et al. 1990; Flinn and De Datta 1984). Evidence of farm-level decline indicates that farmer yields are catching up with the yield frontier and that further exploitation of the yield gap is not economical (Pingali et al. 1990). Incremental costs of achieving further yield gains exceed the incremental returns (Pingali 1990). Similar trends in declining rice yield have been observed in other experiment stations in India, Thailand and Indonesia (Pingali 1990).

It would be useful to examine the relevance of these findings to the Sri Lankan situation. If these are true for Sri Lanka, then the policymakers will have to turn to alternative solutions in supplying the major staple in sufficient quantities.

Moreover, as there are plans to allocate a significant portion of the country's rice fields to grow nonrice crops (other field crops) during the dry season, it is important to analyze: a) how this could be done while maintaining rice production at acceptable levels; and b) economics of rice production in sufficient depth.

The relationship between the rate of rice production growth and the in-demand growth is critical. If a higher production growth rate continues for a much longer period it could lead to a surplus production resulting in drastic price reductions or in forcing the government to introduce a subsidiary system. Such price reductions may force the farmer to use minimum inputs resulting in low production in the irrigation system. On the other hand, if growth in production fails to meet the growth in demand, strenuous efforts will have to be made to increase rice yields as almost the entire production growth will have to come from the yield growth and possible increases in cropping intensity since further opportunities for the expansion of area to be cultivated are minimal.

In addition, it is important to find out whether the rate of price escalation of inputs is consistent with that of the market price of rice in the recent past. The removal of the fertilizer subsidy, depreciation of the currency (Rupee), increases in fuel costs, etc., have affected input prices to a great extent over the years. In Sri Lanka, it is customary to provide hired laborers with free food under informal work contracts. Consequently, increases of food costs directly influence the crop budget. Also, cash input prices along with the cost of labor are likely to continue to rise in the years to come.

This condition will be further aggravated because the percentage of farmers engaged in rice cultivation on small landholdings is very high and they have limited "roots" in off-farm income sources. The opportunities for conventional alternatives such as "chena" cultivation are fast disappearing. At present, Sri Lanka lacks a strong sector of agro-based rural industries which can act as the interface between the peasant farmer and the industrial world. Such an interface might help convert the surplus agricultural labor, if any, to productive entrepreneurs or industrialists. Also, the capability of the industrial sector to absorb the marginalized farmers is still almost negligible. Under such a situation, it is of paramount importance to improve the productivity of existing rice areas, especially that of irrigated production systems. Hence, a study analyzing the trends of production, productivity and profitability of the land under the major staple in irrigation systems is crucial.

Unfortunately, in Sri Lanka, since the mid-1980s, there is a dearth of studies analyzing the performance of the main crop that is grown in irrigation systems. Accordingly, a proper understanding of the recent trends in production, cost of production, and profits with regard to rice cultivation under irrigation is indispensable. A comparison of the performance of the rice crop

63 In this paper, "frontier" indicates the distribution (or the trend) of the highest average crop yield obtained by farmers *over time*. Similarly, a "technological yield frontier" may represent the highest yields obtained at experimental fields. An average frontier function may be derived by taking the crop yields obtained by the top 5-10 percent of farmers in each season/year.

with irrigation and without irrigation is necessary to comprehend whether the use of irrigated water for rice cultivation has made an economically significant contribution.

Under these circumstances, it is of paramount importance to address such research issues as:

a) How did the growth of rice production change over the years? Is Sri Lanka (as a whole or in different water regimes) undergoing stagnation or decline at the technological yield frontier? And what are the causes behind these changes?

b) What are the trends in the cost of rice production, the composition of input costs, and their rates of change in recent years? Also, what are the reasons for the trend in the cost of rice production?

c) How did rice profits vary in the recent past? Is the current local market price realistic? Could we anticipate any changes in the price of rice in the near future? And what is the thrust behind the outcome?

Study Objectives

The specific objectives of this study were:

1) To appraise trends in production, the cost of production and profits in rice cultivation in relation to water availability; this study attempts to examine the relevance of the International Rice Research Institute (IRRI) findings to the Sri Lankan situation — more specifically to check if there is stagnation or decline at the technological rice yield frontier in Sri Lankan irrigation systems.

2) To analyze the trends in input use in different water regimes. This analysis includes the composition of input costs and the rate of change as well.

By doing so, this study, which is similar to studies undertaken in other countries, has made an attempt to fill the vacuum prevailing in Sri Lanka. Provision of a sound base for future researchers and making a contribution to our practical knowledge were the other objectives of the study.

Methodology

Multiple sources of evidence were used in the study and included a review of recently conducted studies. The main secondary sources of data were the Department of Agriculture, Department of Census and Statistics and the Central Bank of Sri Lanka. This study focused on the period from 1980 to 1991 and follows a study by Attanayake and Wijayaratna (1986 [Mimeo]), which provided a detailed analysis on the same problem up to the mid-1980s. Also, international sources such as IRRI studies (Pingali, Moya and Velasco 1990 and Rosegrant and Pingali 1991) were used to learn about the work done on this subject in other Asian countries.

Sample. The study first analyzed the trends in production, costs and profits at national level. The next step was a brief examination of the differences in production between areas under major and minor irrigation schemes and rain-fed areas.

The next level of the analysis was an investigation of production performance of the rice crop in three districts belonging to different water regimes. These districts, namely Polonnaruwa, Kandy, and Kurunegala, represent the dry zone, the wet zone, and the intermediate zone, respectively. Availability of water was an important criterion for grouping the districts. This is because there are complex interactions between the use of the other inputs and the availability of water.

The selection of a district as a unit of analysis coincided with the criterion adopted by the Department of Agriculture in generating its cost of production data for different crops. Also, Attanayake and Wijayaratna (1986 [Unpublished]) had used the same criterion and had selected the same districts for their study. Hence, the selection of these districts ensured the continuity of the efforts.

Besides, variability within a climatic zone is too broad to be considered as a determinant of water availability. For instance, in spite of higher rainfall, most of the wet-zone areas face water shortages at times owing to: 1)the poor distribution pattern of rainfall; and 2)the lack of appropriate water control measures.

Polonnaruwa District, which belongs to the dry-zone low-country 1 (DL1) agro-ecological zone, has about 90 percent rice lands with reliable sources of water for cultivation. Kandy District, which falls within the wet zone, covers mainly the wet-zone mid-country (WM), and partly wet-zone upcountry (WU), and intermediate-zone low-country (IL) agro-ecological zones. It is important to indicate that there is little difference between irrigated and rain-fed areas in the Kandy District because of the well-distributed and sufficient rainfall in the rain-fed area. Kurunegala District is in the intermediate zone and consists mainly of intermediate low-country 1 (IL1) and intermediate low-country 3 (IL3) agro-ecological zones. Major irrigation schemes with reliable water sources are few while the outstanding feature of Kurunegala District is the predominance of numerous minor tanks that characterize risky cultivation. This places Kurunegala District below Polonnaruwa District, as far as water status is concerned, despite the higher rainfall recorded by the former.

Analysis. The following basic steps were involved:

1. Deriving the trends in productivity using regression techniques, ($y = a+bx$), where,

   y = dependant variable (productivity) (kg/ha),
   x = time variable,
   a = intercept term,
   b = average annual change in y.

2. Estimation of total cost of production per unit of land in terms of nominal and real prices by calculating the costs of items classified in terms of input type, total labor (family and hired), farm power, fertilizer, pesticides, seed rice, etc. The computation of real values will be done by two alternative approaches:

   (i) By using the Colombo Consumer Price Index (CCPI) to deflate the cost of production of rice in other districts, it is easy to comprehend the outcome as the CCPI is a widely used indicator.

   (ii) By employing the producer price of rice to treat the input costs and cost of production in order to express them in rice equivalents. The base year for this too will be 1985. Since interdistrict variation in costs of different items is negligible, it is hoped that comparison of costs will give an indication of input use under different production situations.

3) Comparisons of gross returns and net returns to unit of land, family labor, and capital investment in terms of nominal and real values.

Limitations

Due to nonavailability of a suitable indicator for selecting two water regimes at district level, the alternative of "rain-fed" versus "irrigated" conditions has been used. The rationale for using rain-fed/irrigated conditions of districts as a selection criterion is discussed here.

The Department of Agriculture has not published cost-of-cultivation data for 1988 and 1989 owing to the unsettled situation that prevailed in the country during that period. Therefore, the years 1988 and 1989 have not been included in the detailed analysis on cost of production. Also, the Department of Agriculture has changed its selection criteria of districts to represent rain-fed and irrigated areas. Since 1989, only a limited number of districts have been selected to represent each agro-ecological zone. Only those districts with a significant extent cultivated to rice have been selected to represent a given agro-ecological zone. A specific study area within a given district was then located to represent the most important water regime under which rice was being cultivated in the district. This selection criterion has removed some water regimes in the districts under consideration. For instance, the Department of Agriculture does not publish data on rain-fed areas in Polonnaruwa District. However, in this analysis we treat Polonnaruwa as an irrigated district.

Organization of the Paper

This paper is organized in four sections. Following the introductory section, the second section (Production Trends) describes the changes in production and productivity and examines policy as well as other factors contributing to such changes. In the third section (Trends in Cost of Production and Producers' Profit Margins), an attempt is made to analyze the cost of production and its structure with special emphasis on identifying the components of the cost structure, especially those accounting for high proportions of the total cost. The same section also examines the profitability of rice farming through returns to some selected factors of production. Analysis of farm costs and returns are converted to *real terms* using rice prices as the adjusting factor. This methodology is described in detail in the third section. Apart from this, in the third section, an attempt is made to contrast cost-effectiveness of rice farming under different production situations or water regimes. The last section (Policy Implications) presents a summary of findings and policy implications of trends observed in the rice sector over the recent past.

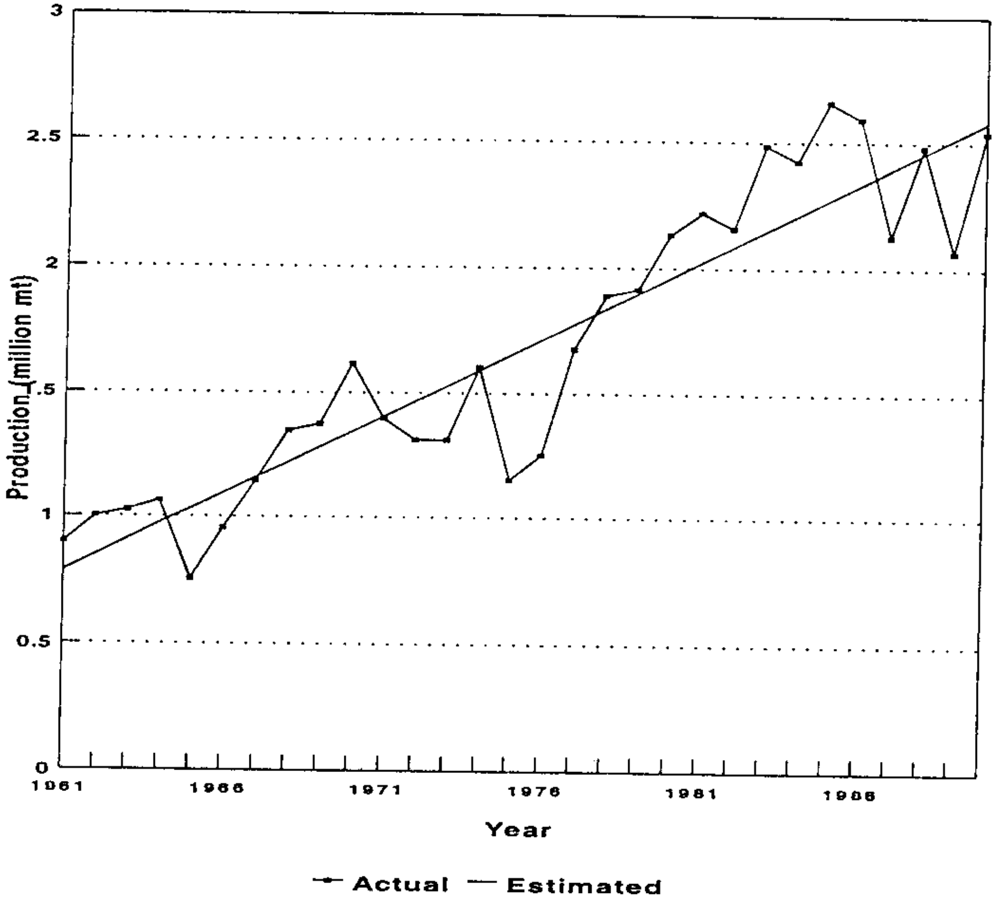
PRODUCTION TRENDS

The objective of this section is to review the trends in rice production with a comparison of districts that represent different water regimes. Besides the data related to selected irrigated areas, national-level data and the data related to rain-fed areas will be analyzed in order to see the magnitude of the difference in the levels of production between irrigated and rain-fed areas. The discussion deals with the changes that have occurred in production and productivity since the 1980s and briefly investigates policy as well as other factors that have contributed to such changes. In addition to the analysis of current trends, it attempts to look for their associated causes. These, in turn, will also be helpful in understanding the level of success of the services rendered by the state to the farmers in irrigated agricultural production systems. More emphasis is given to the period since the mid-eighties. Whenever necessary, reference has been made to important previous periods such as the early sixties, when the green revolution emerged.

National-Level Production Trends

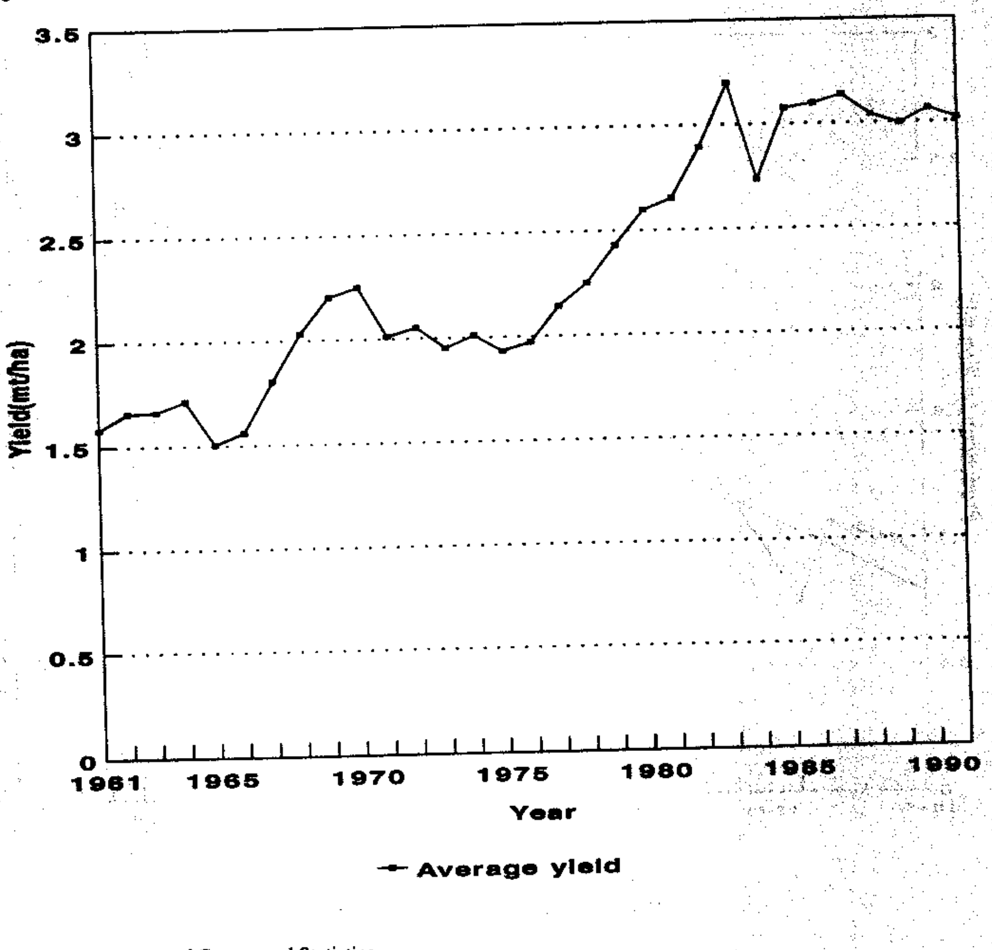
In the three decades beginning with 1960, during which the spread of new high-yielding varieties was prominent, the total output of rice increased substantially from 897,000 metric tons in 1960 to 2.389 million metric tons in 1991 (Aluwihare and Kikuchi 1991 and Department of Census and Statistics 1991). Figure 11.1 shows the trend of rice production between 1961 and 1990. Rice production showed a significant increasing trend and a maximum annual increase was displayed just before 1985.

Figure 11.1. Trend of rice production, 1961–90, Sri Lanka.



The highest annual rice production, 2.66 million metric tons, was reported in 1985. There was a 3.8 percent annual increase between 1980 and 1985. Apparently, 1985 is a turning point in the recent history of rice production in Sri Lanka. The post-1985 period does not show a significant change of annual rice production. The area cultivated to rice and the national average of rice yield also "remained" at their peak levels reached by the mid-1980s. The highest rice yield per hectare (3.606 mt per ha) was reported in 1983 (Figure 11.2). However, the following year was dissatisfying and the yield dropped to 3.076 mt per ha. The excessive rains and floods which prevailed during the early parts of 1984 were mainly responsible for this yield drop. The total national rice production, which reached the highest level in 1985, suffered a slight setback in 1986. The drop of production was mainly evident in the reduced 1985/86 maha harvest. As the Central Bank of Sri Lanka Annual Report (1986) indicates, a very significant decrease in output was reflected in the rice producing districts of the Northern and Eastern provinces. The high incidence of crop failure and the breach of the Kantale Dam may also have affected the rice cultivation, particularly in the Trincomalee District. These, in turn, would have contributed to the low output in these areas.

Figure 11.2. Trend of rice yield, 1961–91, Sri Lanka.



Source: Department of Census and Statistics.

Rice production in 1987 dropped by 18 percent over the previous year. The prolonged drought that prevailed in most of the major rice producing areas was mainly responsible for the production decline in 1987. The shortage of water not only delayed the commencement of cultivation and reduced the extent sown but also led to a reduction in fertilizer application (see under Cropping Intensity, p 291) and in the extent harvested which, in turn, resulted in a lower production. However, it is important to indicate that even though the total production declined, the productivity or the average yield per hectare in 1987 increased by two percent over the 1986 yield owing to the performance of major irrigation systems. The highest average yield per hectare in the maha season, 5.97 mt/ha, came from the Uda Walawe area, which was a 17-percent increase over the previous season. Also, System H in the Mahaweli Project recorded the second highest yield of 5.27 mt/ha. The total gross extent harvested in 1987 recorded a 19 percent decline over the previous year. Furthermore, the difference between the extent sown and the gross extent harvested in 1987 was fairly large; harvested extent in 1987 amounted to 102,479 ha or 13 percent of the gross extent sown.

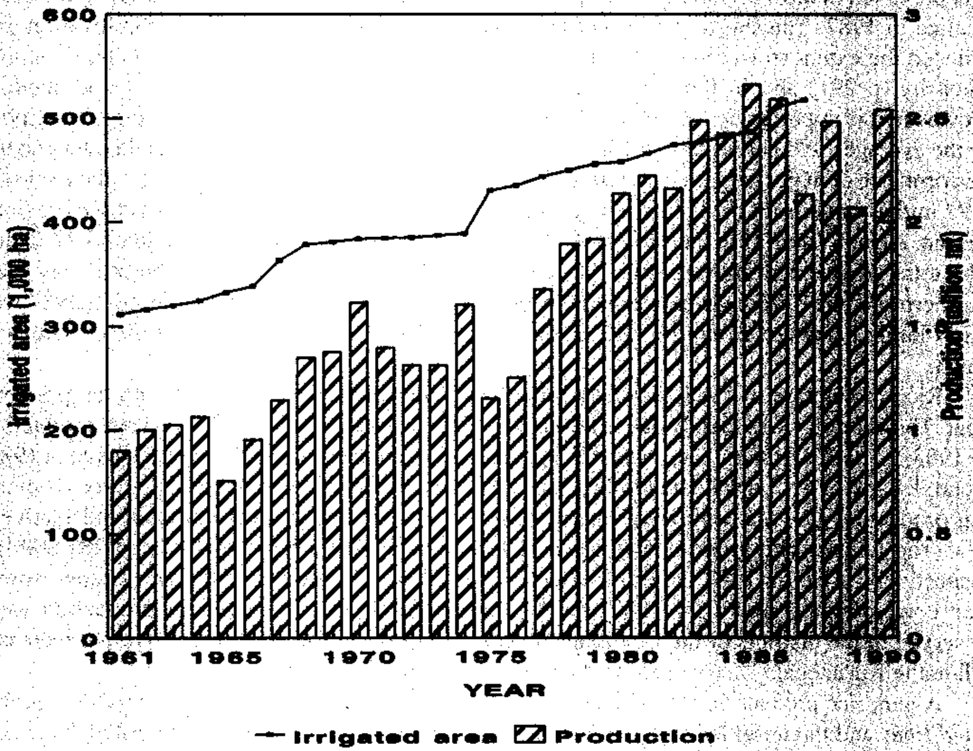
Rice production in 1988 showed a remarkable recovery when compared with the previous year. This recovery was mainly due to the ending of the drought. However, the total rice production in 1988, 2.5 million metric tons, was still 6 percent less than the production level achieved in 1985. Central Bank of Sri Lanka data (1988) shows that despite a decline in average yield per hectare, this production gain was achieved primarily as a result of increased gross extent sown and relatively low crop failure. The gross extents sown in 1988 and 1989 were 865,000 ha and 781,000 ha, respectively. Also, in 1988 the gross extent harvested was 94 percent of the gross extent sown. The corresponding figure for 1987 was 87 percent. Substantial increases in production were observed in the districts of the Dry Zone. Vavuniya District recorded a nearly fivefold increase, while the Kurunegala District recorded a more than threefold increase.

Again, rice production suffered a severe setback in 1989 due mainly to *unfavorable weather conditions* and the unsettled situation that prevailed in the country. The area harvested decreased to 690,000 ha and the average yield dropped to 3.37 mt per ha. **The determination of the extent of the contribution of soil degradation to the apparent drop or fluctuation in production was not attempted due to the inadequacy of data. However, it is clear that other factors such as weather conditions and other hazards have contributed to the fluctuations of production in the recent past.**

Rice production in 1990 was 2.54 million metric tons, showing a substantial increase of 23 percent over the production in 1986. Both maha and yala seasons contributed to the higher rice production, showing 23 and 24 percent increases over the respective seasons of the previous year. This production increase was mainly due to the improved security situation in the country and favorable weather conditions. In any case, the 1990 rice production was 5 percent lower than the highest production recorded in 1985.

According to the Department of Census and Statistics (1991), rice production in 1991 was 2.39 million metric tons, which was a 5.9-percent drop over the previous year. The rice production of 1.56 million metric tons recorded in the 1990/91 maha season was a 5.68-percent decrease compared to the previous maha season. This drop in the production could be attributed to the decrease in the sown area. The total sown area during the maha 1990/91 season was 500,509 ha. This is a 5.69-percent decrease over the previous season; decreases in sown area have been reported from Amparai, Ratnapura and Matara districts. Contrary to the decline in sown area, the rice yield per hectare showed a 1.6-percent increase in maha 1990/91. The Mahaweli System H area and the Uda Walawe area have recorded the highest average yields. There is little difference between the gross harvested extent of yala 1991 and that of yala 1990, but the average yield per hectare in 1991 dropped by 6.6 percent over the yala 1990 yield. Accordingly, there has been a 6.3 percent drop in the rice production in 1991 yala over the previous yala season.

Figure 11.3. Trends of rice production and irrigated area, 1961–90, Sri Lanka.



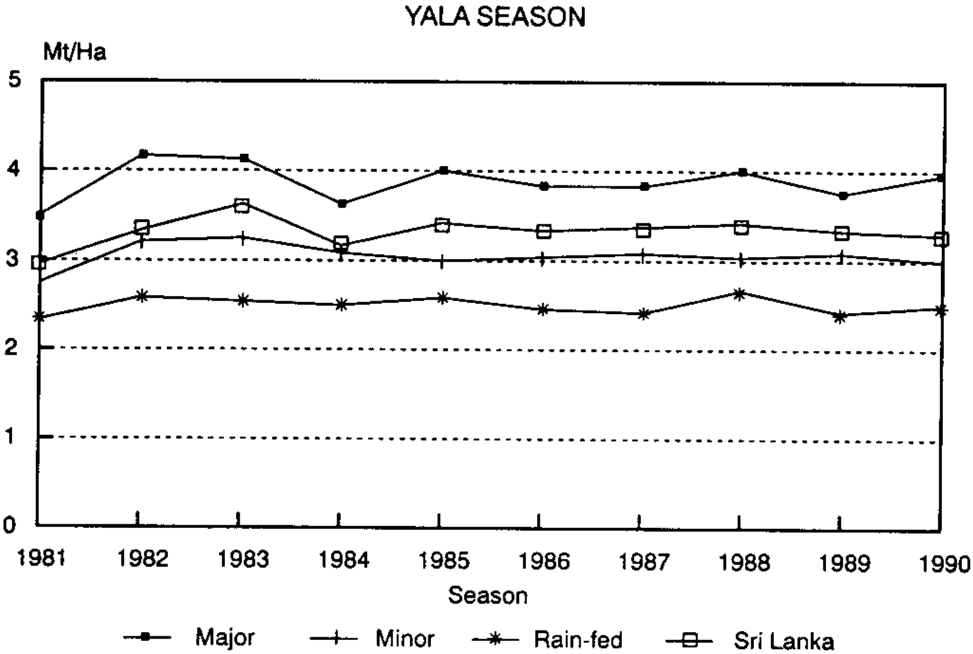
Trends under Different Water Regimes

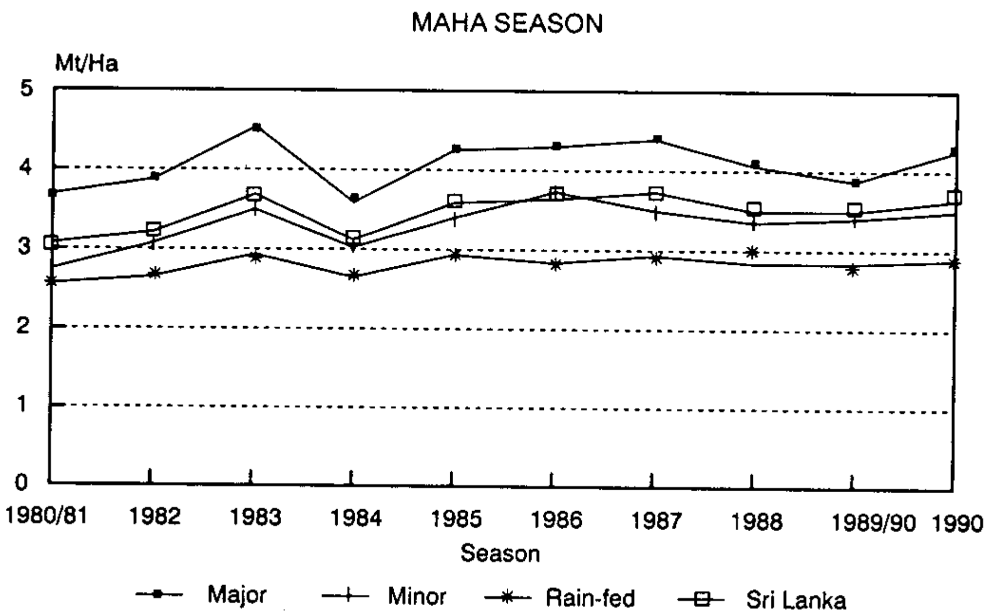
Figure 11.4 shows changes in the rice yield per hectare between 1980 and 1990 for areas under major and minor irrigation schemes, rain-fed areas, and the total cultivated area (national yield level). Major irrigation systems have been recording the highest yield levels, around 4.00 mt/ha, throughout the period. The national yield levels are somewhere between the yield levels for the major irrigation systems and the minor systems. Obviously, the rain-fed areas have recorded the lowest yield levels. Under rain-fed conditions, yala season yields have been significantly lower than the maha season yields. Generally, national yield levels remained at the same level throughout the decade from 1981 to 1990.

The Area under Rice Cultivation — Recent Trends

The area harvested, which was only 564,000 ha in 1960 increased to 886,000 ha, in 1984, which is the highest recorded so far. In 1991, the extent harvested was, only 741,000 ha. The annual variation observed was mainly due to different weather conditions that prevailed in the respective years. The increasing trend observed until the mid-1980s changed mainly because the total irrigated area did not increase significantly. This can be explained by looking at both the extent sown and the extent aswaddumized.

Figure 11.4. Changes in rice yield between 1980 and 1990.

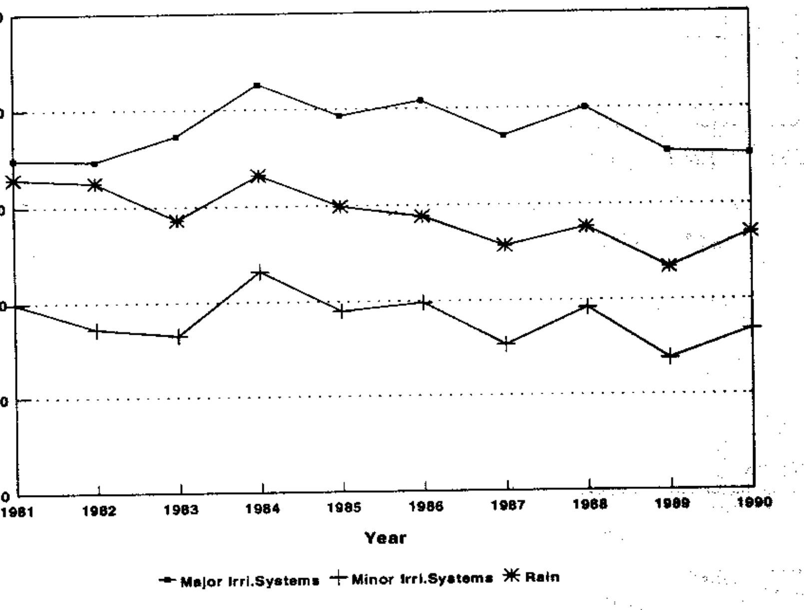




Source (of primary data): Department of Agriculture.

According to Aluwihare and Kikuchi (1991) the total irrigated rice land area had increased from 253,000 ha in 1950 to nearly half a million ha in 1985, and 90 percent of this increase was due to the increase in the irrigated land area that had come under the major irrigation systems. The area under major irrigation systems was less than that of minor systems until 1966. The contrast of land expansion between major and minor irrigation systems is outstanding over the years: the areas that came under the major and minor irrigation systems were 81,400 ha and 159,000 ha, respectively, in 1948 and they increased to 310,522 ha and 179,311 ha, respectively, by 1990 (Department of Census and Statistics 1991). Major irrigation systems received a prominent place in the state development programs. However, by the late 1980s the construction phase had come near to an end (Figure 11.5).

Figure 11.5. Area cultivated to rice by type of irrigation.



Source (of primary data): Department of Census and Statistics.

Trends of Yield and Their Determinants

The average yield level achieved by the mid-1980s seems to be low when compared with the yield potentials of new, improved varieties. However, the average yield recorded in the mid-1980s represents an expansion of productivity by about 92 percent in relation to the level of 1960. The expansion of irrigation facilities and associated technologies such as the wide diffusion of high-yielding varieties associated with improved water conditions and increased levels of fertilizer application are basically responsible for this achievement.

The total increase in rice production between 1952 and 1985, and contributions of variety, fertilizer, and irrigation, according to Aluwihare and Kikuchi (1990), are summarized below:

	(1(000 mt)	(%)
Total increase	2,087	100
Increase due to:		
variety	861	41
fertilizer	561	27
irrigation	665	32

Rice Yield and the Contribution of Irrigation Facilities

With the expansion of irrigation facilities to a greater extent of rice lands that fall within the dry zone, the average yield of the crop has increased remarkably. This occurred, to reiterate, through increased and timely availability of water which is considered a major limiting factor of rice production, along with the seed-fertilizer technology. Response of rice plants to water differs from that of tropical upland crops, and this difference has important implications for irrigation as well as for varietal improvement.

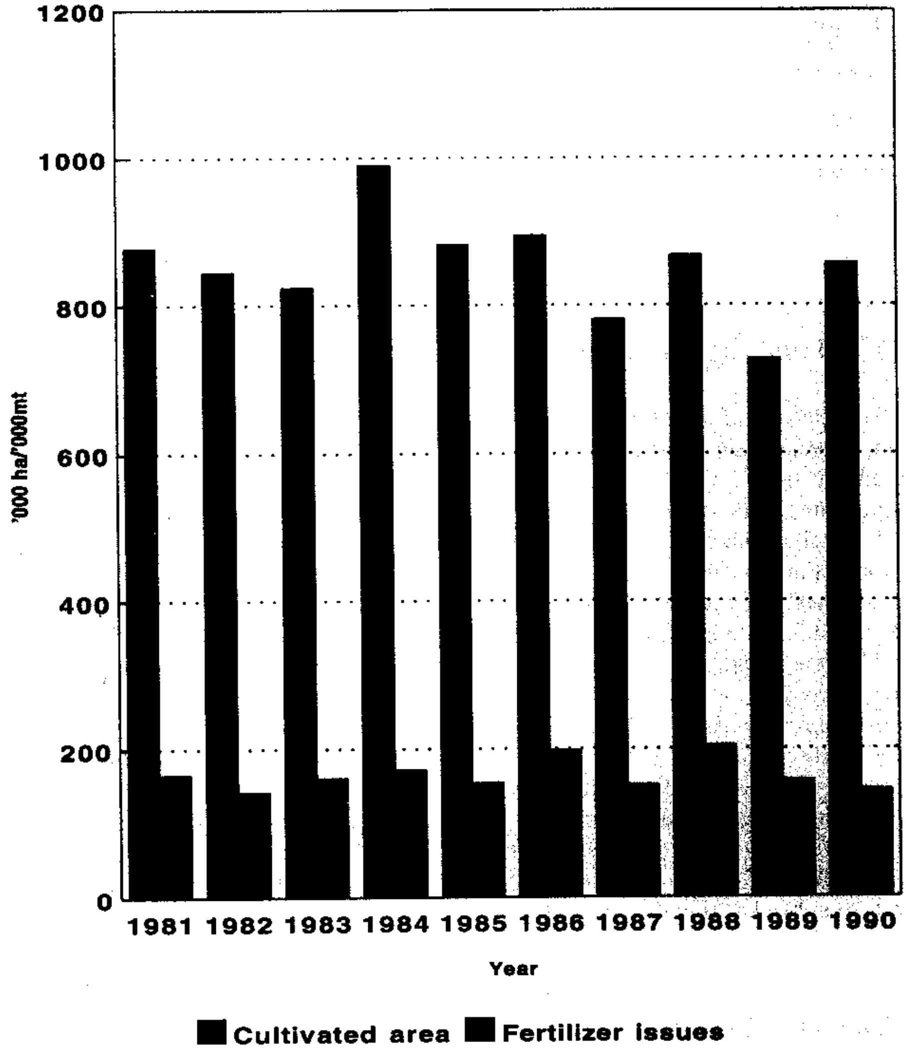
The highest average yield, 3.6 mt per ha, was reported in 1983. After 1983, the average yield varied around 3.0 mt per ha, without demonstrating any significant change. In 1991, the average rice yield in the island was 3.02 mt per ha (Department of Census and Statistics 1991). This is a 17-percent less than the 1983 average yield per hectare.

It is important to indicate that a high level of adoption of new, high-yielding varieties can be achieved easily because this is an innovation which does not involve much expenditure; any farmer can get some rice seeds from a neighbor without making a cash payment. However, that does not mean that a higher level of adoption of new varieties of rice ensures a higher yield level because these new varieties require excessive inputs, such as fertilizer and improved management techniques. Besides higher yield potential, diffusion of short-aged varieties offer higher crop intensification by changing the cropping pattern from single to double cropping.

Rice Yield and Fertilizer Use

There has been a tremendous increase in the use of fertilizer since the early 1960s. The amount of fertilizer used has increased from a mere 9 kg per ha in 1960 to 168 kg per ha in 1990 (Central Bank of Sri Lanka 1991). However, as Figure 11.6 shows, there has not been a significant increase in fertilizer use in the 1980s. The increase of fertilizer prices which came into effect with the removal of the subsidy at the beginning of 1990 seems to have adversely affected the fertilizer issues in 1990 and thereafter. The fertilizer issues in 1990 amounted only to 143,565 mt, representing a drop of 8 percent over the previous year. The drop in the fertilizer use is significant, because in 1990, the area cultivated to rice crop has increased by 18 percent over the previous year. In other words, the average quantity of fertilizer issued per ha cultivated to rice has decreased by 22 percent, from 0.22 mt/ha in 1989 to 0.17 mt/ha in 1990.

Figure 11.6. Annual fertilizer use and area cultivated, 1981–90.



Source of primary data: Central Bank of Sri Lanka, 1990.

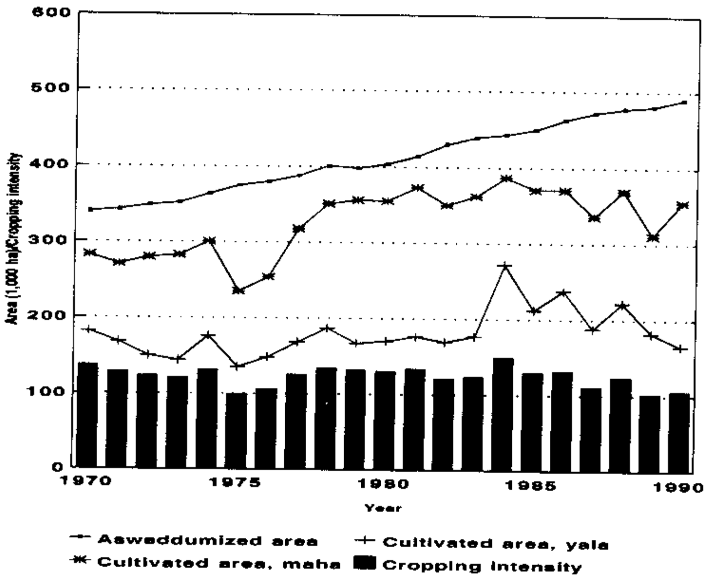
A distinct feature of Sri Lanka with respect to fertilizer use in the rice sector is that the price ratio between fertilizer and rice has been low because of heavy subsidies given to farmers to buy fertilizer. The nitrogen-rice price ratio has been far below 2.0 except in 1960. Consequently, the optimum levels are very close to the respectable maximum nitrogen levels that correspond to the maximum attainable yields. The actual levels of nitrogen per hectare were lower than the optimum levels. The gap between these two levels, however, have become narrower over time, and by 1985 the actual nitrogen use per hectare for each category reached a level that was 70.5 percent of the respective optimum level.

Aluwihare and Kikuchi (1990) conclude that the yield impact of fertilizer subsidy withdrawal would be small in the long run, in the order of 1 to 2 percent. Such a small impact is due primarily to the fact that the price elasticity of nitrogen demand is quite low because of the high nitrogen intensity before the withdrawal of the subsidy.

Cropping Intensity

Contrary to expectation, the cropping intensity has not shown a significant increase even by the late 1990s. The cropping intensity which was 136 in 1960 reached 145 in 1985, the highest recorded so far (Figure 11.7).

Figure 11.7. Cropping intensity, 1970–90.



Note: Major and minor categories included.

Source (of primary data): Department of Census and Statistics.

Expanding the "effective irrigated area" by increasing cropping intensity would be a more economical option, especially in areas where further expansion in the irrigated land frontier is constrained due to financial constraints, limits in water sources or supply, etc. Cropping intensity (or cropping index) is usually defined in terms of number of harvests per year from the same area of land. In order to eliminate the problem of differential characterization of long-season and short-season crops, and to reflect the degree of utilization of sunlight, Levine et al. (1988) suggest the use of *hectare-days.* This combines the area factor and the proportion of the year during which a particular crop could be in a stage of active crop growth. This may be improved further by incorporating a profit factor — profit per unit of water per year or profit per unit of land per day, etc.

Examples cited in the earlier sections of this paper included instances where management strategies or interventions resulted in substantial increases in the cropping intensity. This can be done effectively in several ways. Among them are:

- Introduction of short-age crops thereby increasing effective area under cultivation per unit of time.
- Multiple and relay cropping.
- Cultivation of 2-3 crops per year by adopting water saving techniques.

Staggering of land preparation, planting and other cultivation methods are common phenomena in many irrigation systems. Even though staggering may not be completely avoided due to some constraints (e.g., limitations in labor and farm power, water supply, etc.) "planned staggering" of cultivation may be helpful both in saving scarce water resources and in increasing the number of crops cultivated annually.

Disparities in Production among Districts

Data used for the analysis are those published by the Department of Agriculture and the Department of Census and Statistics. However, data for 1988 and 1989 are not available because the Department of Agriculture could not collect reliable data as a result of the unsettled situation in the country. The Department of Census and Statistics has covered 1988 and 1989 but its record does not give many details.

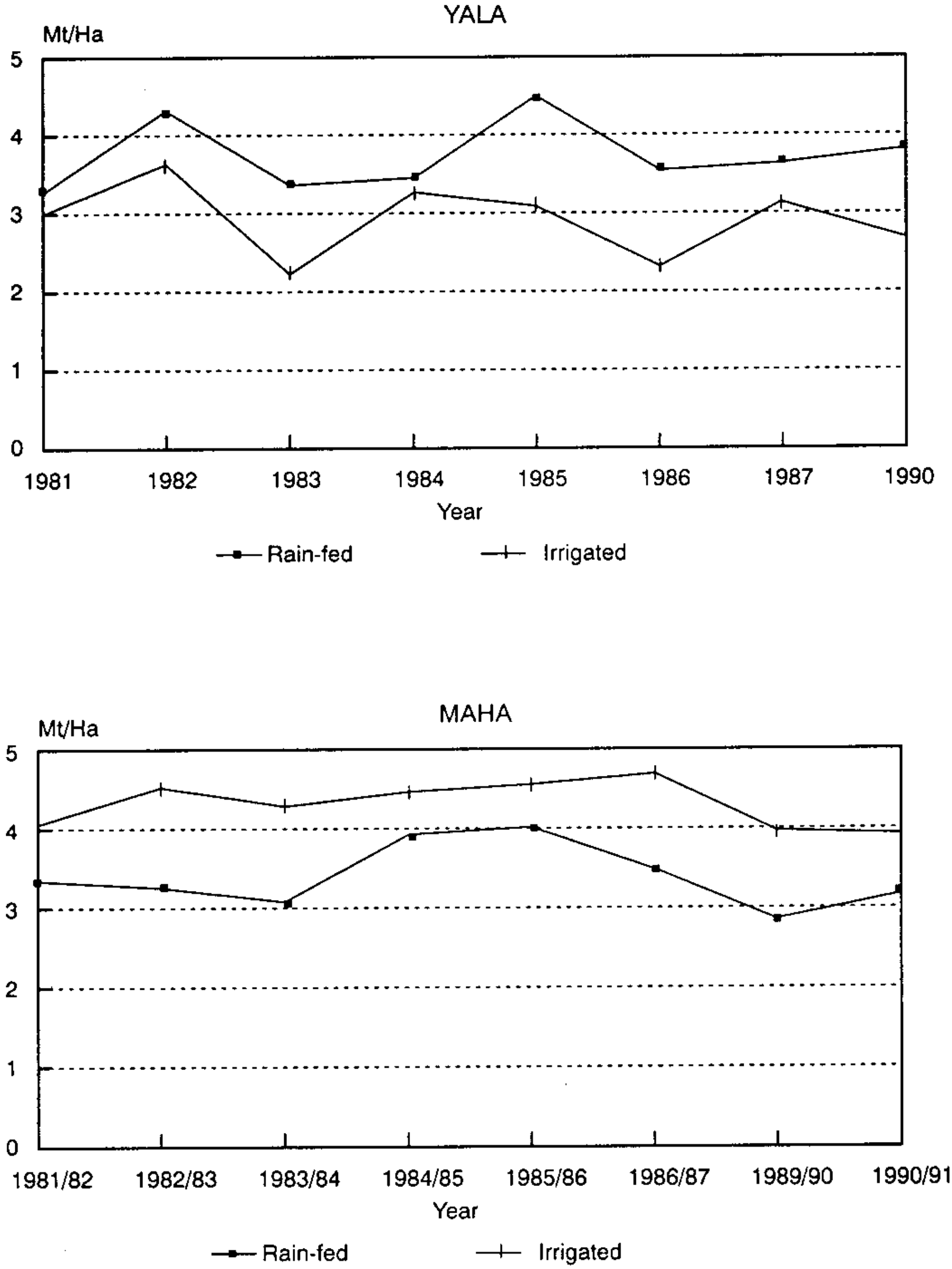
Apparently, the 1980s do not show a clear yield increase in the different water regimes under consideration. The yield levels recorded under irrigation are higher when compared with those under the rain-fed conditions, but they are far below the yield potential of modern rice varieties. This yield gap implies the importance, in regard to rice yields, of factors outside those of water.

However, this analysis at aggregate level does not represent the real picture at irrigation-system level. Within irrigation systems, a significant portion of gap may be existing and the gap could be explained by water inadequacies arising out of management problems.

Kurunegala District recorded the highest yala and maha yields in 1982 and 1985/86, respectively under rain-fed conditions. Under irrigation, the highest yala and maha yields were recorded in 1985 and 1985/86, respectively (Figure 11.8). Farmers who grew rice in rain-fed areas in Kandy District reported higher yields in yala seasons in the late 1980s when compared with the early 1980s (Figure 11.9). On the other hand, after the mid-1980s, farmers who grew rice in maha seasons received yields that were lower than the yields of the early eighties. Irrigated rice farms in Kandy and Polonnaruwa districts did not show any significant changes in the average yields in the 1980s (Figures 11.9 and 11.10).

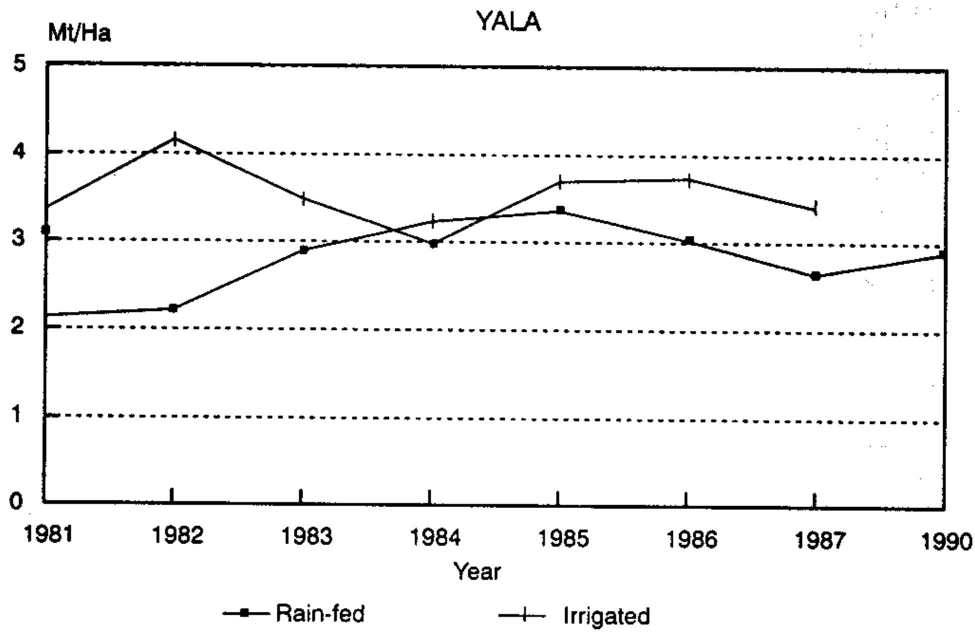
In yala 1986, all three districts under consideration experienced severe crop failures. Kurunegala District experienced the highest crop failure in the island in 1986 and the extent harvested was only 54 percent of the gross extent grown. The drought that prevailed during 1986 yala continued during 1986/87 maha as well. Except for Polonnaruwa, which maintained the production level achieved in 1985/86 maha, the other two districts experienced significant drops in production during the 1986/87 maha season. Kurunegala was among the districts which recorded substantial declines in the extent sown during 1986/87 maha (a decline to 56,580 ha from the 71,604 ha cultivated during the previous maha season). The highest crop failure during both

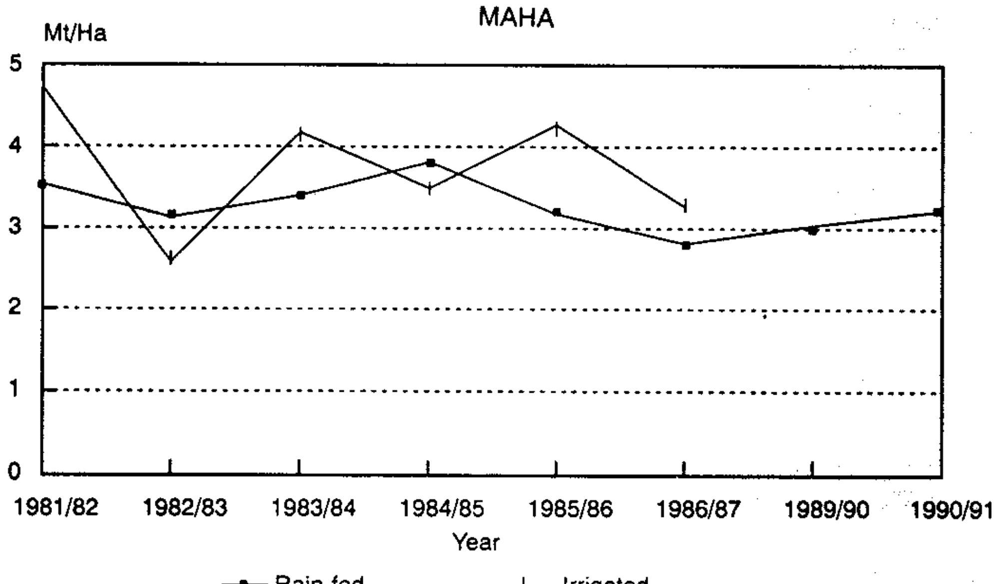
Figure 11.8. Changes in yield, Kurunegala District, 1981–90.



Source (of primary data): Department of Agriculture.

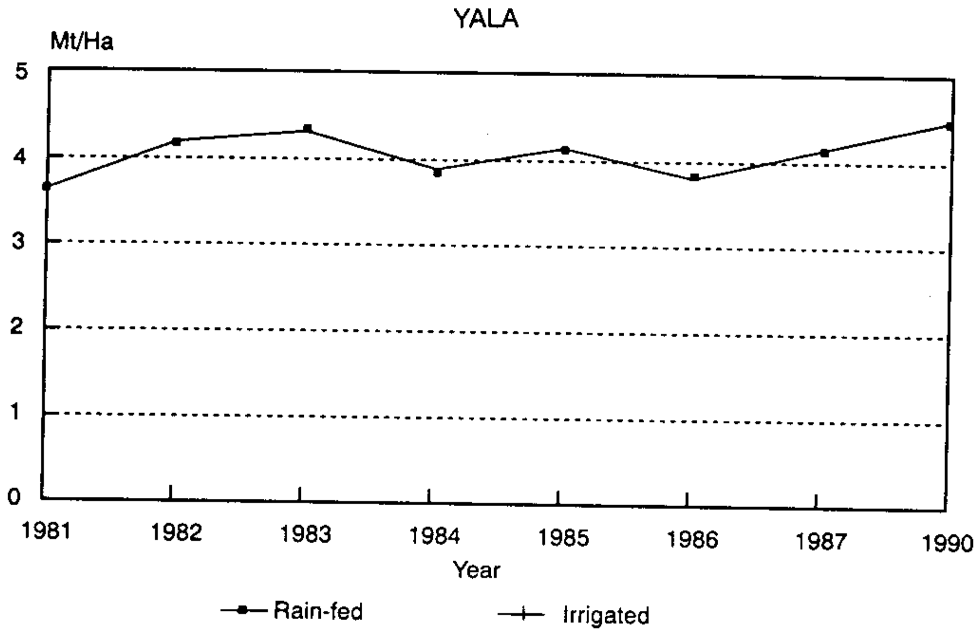
Figure 11.9. Changes in yield, Kandy District, 1981–90.

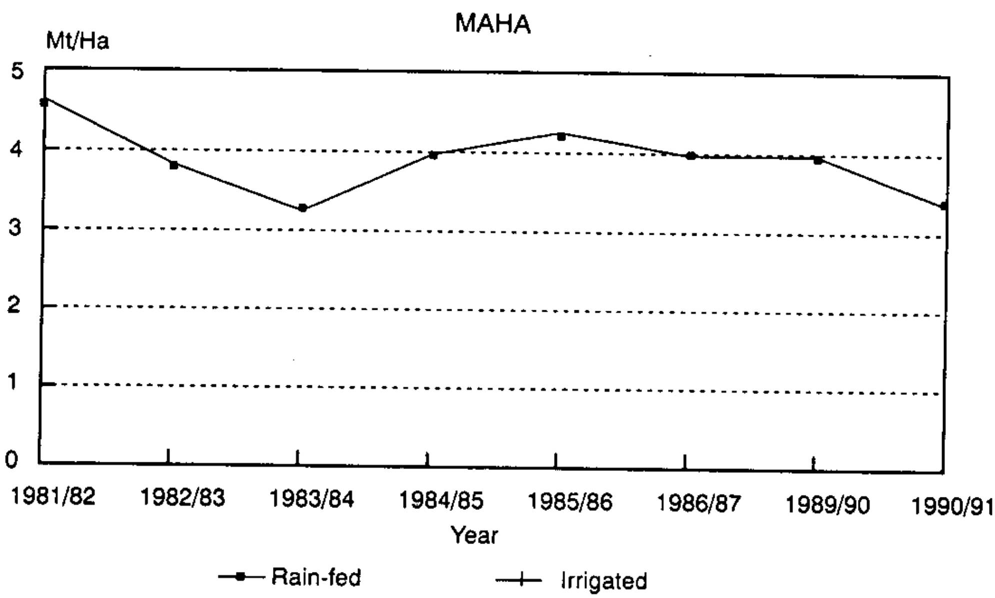




Source (of primary data): Department of Agriculture.

Figure 11.10. Changes in yield, Polonnaruwa District, 1981–91.





Source (of primary data): Department of Agriculture.

seasons was in the Kurunegala District, which experienced the most severe drought conditions. The area harvested in the Kurunegala District was only 32 percent and 53 percent of the area sown in 1986/87 maha, and 1987 yala, respectively. The extent totally damaged by the drought in the Kurunegala District was about 50 percent of the gross extent sown in maha and 33 percent in yala.

In 1990, both Kurunegala and Polonnaruwa districts recorded substantial increases in the production of rice. These increases were achieved in spite of marginal drops in the yields per hectare, mainly as a result of substantially increased area sown and the increased area harvested due to favorable weather conditions (Figures 11.8 and 11.10). Kurunegala and Polonnaruwa districts along with those of Anuradhapura and Amparai, and the Mahaweli H area accounted for about 67 percent of the total increase in production during yala 1990.

The Gross Extent Cultivated. Kandy and Kurunegala districts do not show any increase in the extent cultivated to rice during the 1980s. The areas sown in 1981 and 1990 in Kandy District were 36,433 ha and 35,257 ha, respectively. The areas sown in Kurunegala District were 109,637 ha and 108,000 ha in 1981 and 1990, respectively. Polonnaruwa District shows a difference of about 38 percent in the area cultivated in the 1980s. The areas sown in 1981 and 1990 in Polonnaruwa District were 56,666 ha and 78,350 ha, respectively. It is evident from these figures that Polonnaruwa District has benefited from new irrigation development projects. The increase of the area from 51,457 ha to 76,178 between 1981 and 1990 is significant under the major irrigation systems..

Total Production. A comparison of data reported between the early eighties and the late eighties shows that among the three districts under consideration only Polonnaruwa has recorded a significant increase in the total production. If the decade 1981-91 is divided into two subperiods, 1981-85 and 1986–91, the average total production in Polonnaruwa District in the subperiod 1986-91 shows a 27 percent increase from 207 mt to 264 mt. Average total production in the subperiods 1981–85 and 1986–91 in the Kurunegala District were 347 mt and 348 mt, respectively. (The years 1987 and 1989 were not included as these years experienced severe drought). Average total production in these two subperiods in Kandy District were 85 mt and 87 mt, respectively.

As Attanayake and Wijayaratna (1986) indicate, in the light of (a) large investments that have been made towards improvement of irrigation facilities and the consequent improvements in water availability; and (b) relatively high yield levels such as in Polonnaruwa District, "a big jump" in the yield level may not be expected in these "well-watered" areas. However, it is prudent to investigate the gap between high-yielding and low-yielding farms in these areas and explore the possibility of bridging the gap. In this regard, it is very important to consider non-water factors and their management because these factors may determine yield levels when water is not a constraining factor. Also, diverting a major proportion of further investments to improve other more suitable areas which are already under rice cultivation, with the main emphasis on the cost-effectiveness of such investments, seems to be more appropriate.

TRENDS IN COST OF PRODUCTION AND PRODUCERS' PROFIT MARGINS

The changes that have occurred in the cost of cultivation of rice mainly since 1985 in different water regimes are dealt with in this section. The analysis of the cost of cultivation of rice follows an investigation of the changes in farm income that have taken place during the same period. The changes in costs and returns of rice production help evaluate the trends in the profit margins of the rice cultivation under different water regimes. Data used are from the Department of Agriculture (DA) and it is important to reemphasize that the DA has not published its cost-of-cultivation data in 1987 and 1988 due to the unsettled situation that prevailed in the country. Consequently, 1987 and 1988 data are not included in some analyses.

Changes in the Cost of Production

The production costs under all the water regimes have increased over the years, with districts that have better water conditions showing higher costs. The farmers have spent more money on cultivation in irrigated lands irrespective of cultivation seasons. The average costs of rice cultivation during maha seasons between 1985/86 and 1989/90 under irrigation were Rs 9,173/ha, Rs 10,01 3/ha, and Rs 13,804/ha in Kurunegala, Kandy and Polonnaruwa districts, respectively. The respective figures for the three districts for 1981/82 maha season were Rs 7,769, Rs 7,373, and Rs 6,770. The price increases were 18, 36, and 104 percent, respectively. Under rain-fed conditions, there have been a 78-percent and a 110-percent increase in the cost of production. The lack of a reliable water source may have been responsible for the little difference in the total costs in the Kurunegala District over the years. In Kandy District, rain-fed farming seems to be more expensive than irrigated farming.

Factors Responsible for Variations

The main reason for the variations observed in the cost of production could be the technology associated with high-yielding varieties of rice and better water conditions, provided that the consequences of inflation are common for all districts. In determining the reliability of water supply in each district, the area under irrigation has been considered as the major criterion.

In spite of the low average annual rainfall and its higher variability (Table 11.1), Polonnaruwa District has the best assurance of water where the irrigated rice crop is concerned. This is because the area fed by the major irrigation systems in Polonnaruwa District is 97 percent against 20 percent in Kurunegala District. Table 11.1 gives a summary of comparisons of reliability of water supply and annual average rainfall along with data on cost of production. According to the average annual rainfall they receive, rain-fed areas can be ranked as Kandy, Kurunegala, and Polonnaruwa in descending order. These analyses show a close link between the level of investments and the assurance of water availability. Therefore, it can be concluded that, to a large extent, reliability of water supply determines the level of investments of rice production.

Table 11.1. Comparison of water status in selected districts and their average cost of production.

District	Annual average rainfall (1981–90	Standard deviation	Area fed by different sources of water as a % of area sown in 1990			Cost of production 1989/90 (Rs/ha)
			Major Irri. Sys.	Minor Irri. Sys.	Rain	
Kurunegala	1,577	305	19.7	36.3	44	9,173
Kandy	2,601	418	22.5	40.23	37.2	10,013
Polonnaruwa	1,485	327	97.2	0.7	2.0	13,804

Attanayaka and Wijayaratna (1986) have summarized many studies which deal with the direct and indirect influence of water on rice yields. Herath (1981) points out that the lack of proper water control measures and the resulting uncertainty in water availability make it less attractive for producers to take the risk of investing in the full package of inputs recommended for the new varieties.

Risks associated with rain-fed farming in Sri Lanka stem mainly from excess or insufficiency of water. Problems associated with floods are mainly confined to the wet zone, while both wet and dry zones experience water insufficiencies during the yala season. The basic problem accompanying irrigated farming appears to be the inadequacy and unreliability of water distribution. This may happen due to inefficiencies in irrigation system performance and/or shortages in the aggregate supply from the main source of water. Inefficiency in system performance may be caused by "software" (management) or "hardware" (physical infrastructure) problems. Shortages in the aggregate supply may even lead to complete crop failures.

As Barker et al. (1985) have stated, water is a major limiting factor in rice production in the tropics where the dominant monsoon weather patterns create pronounced wet and dry seasons. Water in appropriate amounts at the correct time in the growth cycle is crucial to high rice yields. Therefore, irrigation directly influences the crop yield. In addition, there is a complementary technical relationship between irrigation and other modern inputs in terms of their effects on the ultimate crop yield. Barker (1985, p103) shows that favorite water conditions result in an upward shift in the fertilizer production and vice versa.

Also, water supply could change farmers' behavior which may have an indirect influence on yields. For instance, reliable distribution of water may lead to its increased use by some farmers. Such behavioral changes could be more prominent under small farmers' production environment because these farmers have been classified as risk averters by many researchers (Walgin 1975; Weins 1976; Herath 1981).

This implies that the effect of water distribution on the contribution of fertilizer in the derived production is not only a technical one, but also a behavioral one.

The questions central to this issues are: To what degree has irrigation been able to remove the risks faced by the small framer? Does the favorite complementary relationship that exists between irrigation and other inputs compensate enough for the rising costs of these inputs?

The potential of high-yielding varieties could be realized only if these are grown with recommended packages of inputs such as fertilizer, water, and chemicals for control of pests and diseases, etc. Therefore, in areas with (relatively) poor water supply, farmers may not try to reach the full potential of high-yielding varieties by adhering to the recommended packages, whereas in areas with assured irrigation, farmers incur high costs for the input packages due to price escalations. Also other factors, such as farming skills, attitudes, resource endowments, etc., could influence the effectiveness of application of these inputs directly used in the production process.

Effect of Inflation

In addition to the intensification of rice production, which is usually associated with better water conditions, increases in total cost of production may have taken place as a result of several other factors. These may include the increasing rate of inflation in the country which, in turn, influences the prices of major inputs and services required for rice production. Also, replacement of certain operations by certain capital-intensive innovations could result in both increased costs and changes in the composition of the cost structure.

The rate of inflation has risen remarkably over the recent years. For instance, the year 1990 saw a sharp upsurge in the general price level. On an annual average basis the Colombo Consumer Price Index (CCPI) moved up by 21.5 percent during the year 1990. The increase on a point-to-point basis (December 1990 over December 1989) was slightly lower at 19.6 percent (Central Bank of Sri Lanka 1990). The acceleration in price change was also reflected at the primary market level with the Wholesale Price Index (WPI) registering an annual average increase of 22.2 percent between 1989 and 1990. The comparison of unadjusted cost/income data over time is not realistic owing to significant price changes that have occurred during the last few years. Such a comparison may distort the apparent trends which, in turn, would result in a misleading measurement of economic performance of the producer. Therefore, it is necessary to convert the price value to a standard for a meaningful comparison.

Index Used in Calculating Deflation

The CCPI or WPI do not seem to be appropriate deflators for costs related to agricultural production methods. And the indices based on the fixed base weights method become less efficient as the base periods get more and more remote and the input mix as well as the relative importance of individual items vary over time. Therefore, the price of the product (price offered by the private dealers, or the open-market price) is considered to be appropriate as a larger share of the production has been purchased by the private dealers compared to the government dealer, namely, the Paddy Marketing Board, which has purchased a smaller share at a guaranteed price. The Department of Agriculture gives selling prices for respective districts. This method, which was introduced by Barker (Barker et al. 1985), has been used in several other studies (Attanayaka and Wijayaratna, 1986: Abeysekara 1986).

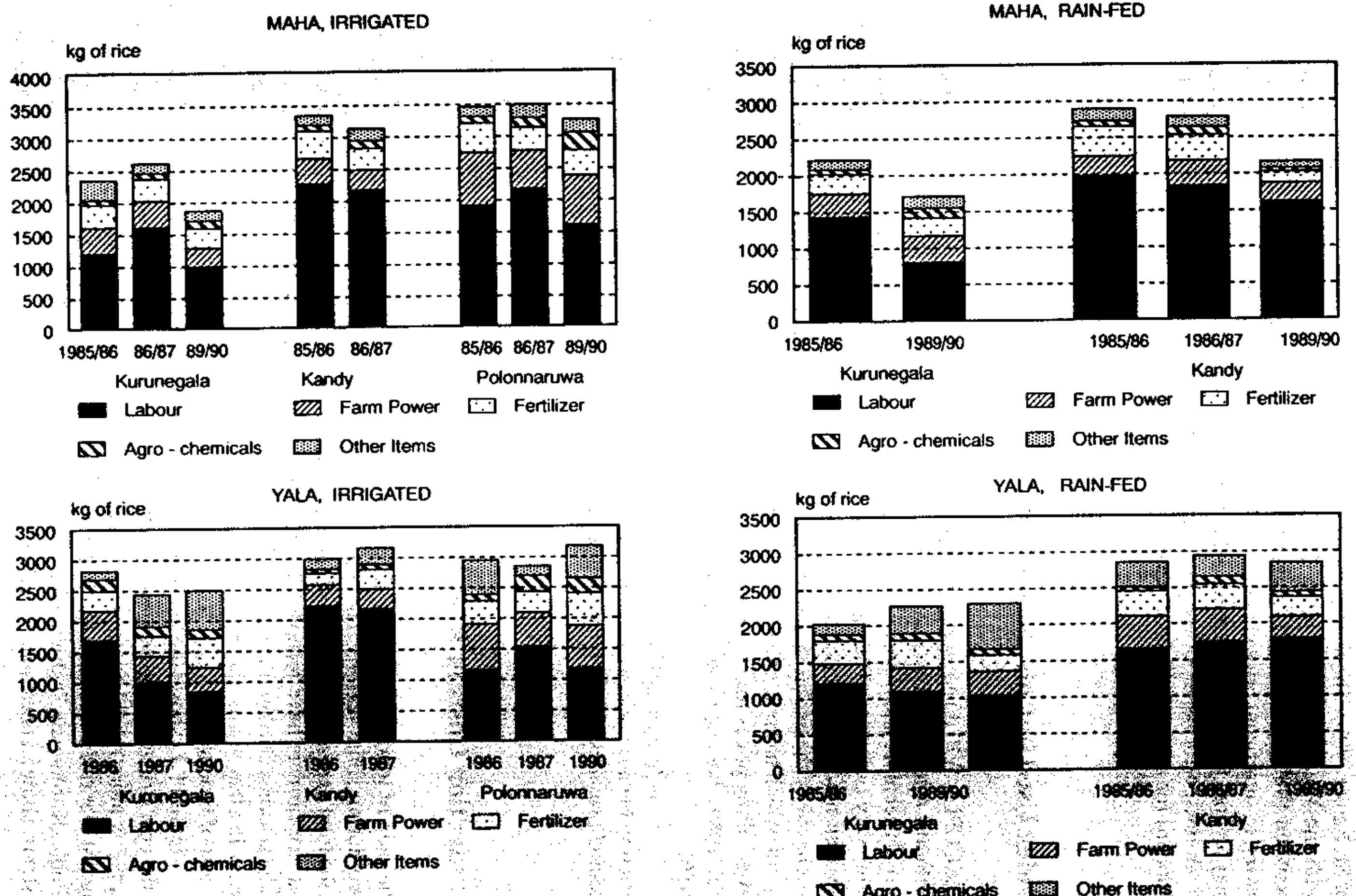
This method cannot be considered as entirely compensating for price changes stemming from inflation because prices of rice may change in relation to other items. Despite this limitation the method provides a more clear picture of the price changes over the years.

Production Costs in Real Terms

The ratio of total cost of production to market price of rice tends to increase in all the districts, at least during some seasons. The increase in the cost of production implies that the rate of change in the total expenditure has been higher than that of producer price of rice over the years. The price that rice farmers have received during recent yala seasons has been higher than that during the maha seasons. Further, in yala seasons, there is an increasing trend in the cost of production in real terms. In other words, the rise in the market price of rice has failed to compensate for the increase in cost of production.

Figure 11.11 shows the total cost of production in real terms and the share of major input items in the cost structure. A more prominent trend can be seen in Polonnaruwa District where the water supply is more reliable compared to the other two districts. The results in Polonnaruwa District suggest that rice cultivation has become capital-intensive in areas where the water supply is more reliable. Kurunegala District, which has only 20 percent of rice lands belonging to major irrigation systems, shows a decreasing trend in the costs except for yala seasons under rain-fed conditions.

Figure 11.11. Cost of production in rice equivalents.



Source (of primary data): Department of Agriculture.

Paid-Out Costs

Paid-out costs can be roughly calculated by deducting the value of family labor from the total cost of production. As Table 11.2 shows, the total paid-out cost seems to be higher in areas where rice is produced with a reliable supply of water. Irrigated areas in Polonnaruwa District have the highest paid-out-cost values.

Kandy District, where rain-fed areas have a reliable water supply compared to Kurunegala District, records values of paid-out costs which are higher than those for the Kurunegala District.

Table 11.2. Total paid-out cost for rice production under different water regimes (in kg of rice).

Season	Kurunegala		Kandy	Polonnaruwa	
	Irrigated	Rain-fed	Irrigated	Irrigated	Rain-fed
1985/86 maha	2,370	2,201	3,366	3,414	2,913
1986/87 maha	2,588	NA	3,067	3,463	2,792
1989/90 maha	1,825	1,670	NA	3,249	2,180

Note: NA = Not available

Cost Structure and Its Relative Composition

Figure 11.11 gives the composition of production costs during both yala and maha seasons under irrigated and rain-fed conditions in all the three districts under consideration. Labor, farm power, fertilizer, and agro-chemicals occupy about 90 percent of the total cost of production. Of the items that are responsible for a major share of the cost of production, labor accounts for the largest portion irrespective of the season or the district concerned. The share of the labor component is about 50 percent.

Though an increase has been registered in the total cost of production, a clear trend in the composition of the structure cannot be identified in the period concerned. However, the composition of the cost structure is characterized by the specific situation in the districts. For instance, the portion that has been occupied by farm power has always been higher in Polonnaruwa District. Since the majority of the population draws its main income from rice cultivation, there is relative scarcity of labor in Polonnaruwa District during peak demand periods. Consequently, farmers hire machines to supplement a considerable portion of labor in the cultivation process. Despite the higher percentage spent on farm power, labor is responsible for a higher percentage of cost of production in the irrigated areas. Farmers in the Polonnaruwa District spend about 1,244 kg rice equivalents on hired labor compared to 352 kg rice equivalents spent by farmers in the Kurunegala District in maha seasons with irrigation facilities.

Table 11.3 shows that labor requirement in rain-fed areas in Kurunegala District is lower than that of its irrigated areas, whereas in Kandy District, rain-fed areas require more hired labor for rain-fed cultivation. The physical setting and its limitations for the use of machinery may necessitate farmers in Kandy District to hire more labor. The necessity to use more labor is clear since farmers in Kandy District have spent only a small portion on farm power.

There is no clear increase in the expenditure on fertilizer over the years. In fact, the proportion spent on fertilizer under rain-fed conditions tends to decrease over years in Kurunegala and Kandy

Table 11.3. Hired labor requirement in rain-fed areas of districts as a percentage of the hired labor requirement of their irrigated areas.

Season	Kurunegala	Kandy	Polonnaruwa
Maha			
1985/86	44	92	NA
1986/87	NA	60	NA
1989/90	65	NA	NA
Yala			
1986	12	119	NA
1987	90	51	NA

Note: NA = Not available

districts except for 1989/90 maha in Kurunegala. The absence of a clear increase in the expenditure on fertilizer is rather alarming since the price of fertilizer has increased considerably over the years. This is because it indicates that farmers are not prepared to spend more on fertilizer at the cost of other inputs which should be used in the specific amounts recommended by the Department of Agriculture.

Major Contributors to the Increase in Factor-Costs

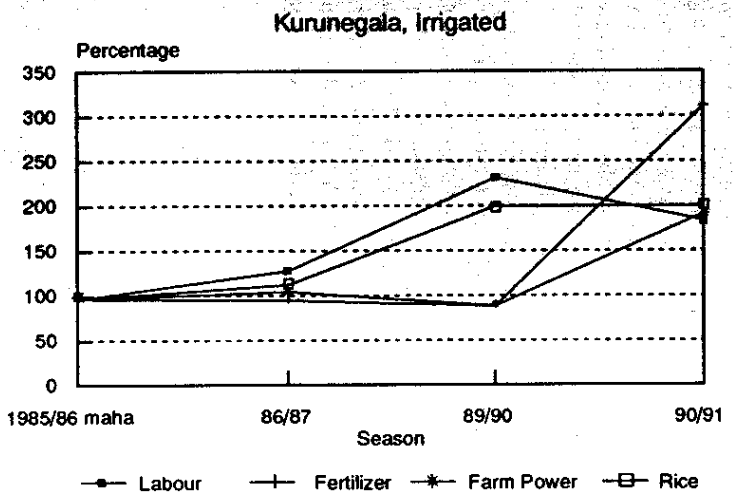
Of the four major items that have been identified as contributing to a major share of production costs, labor and fertilizer seem to be the most significant components in pushing up the total cost of production. The impact of farm power on increasing costs also could be considered as substantial but it is not as consistent as those of labor and fertilizer.

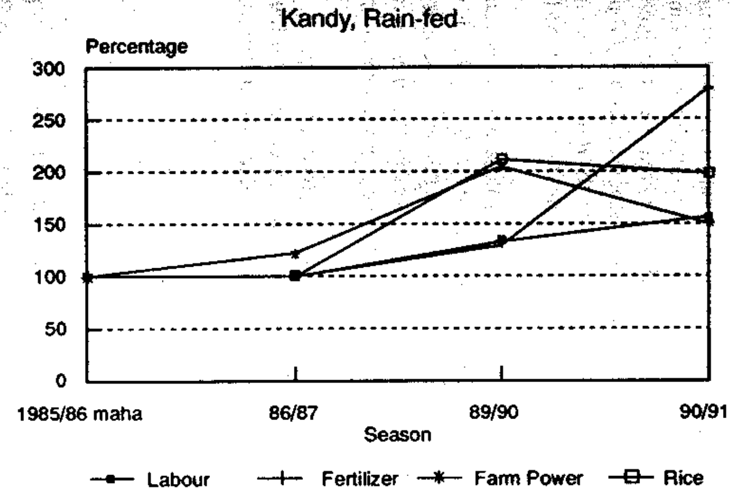
Figure 11.12 gives the price changes in labor, fertilizer and farm power along with the market price of rice in relation to the base year 1985/86. Here, the average fertilizer price was calculated by dividing the values of basal dressing, urea, and Top Dressing Mixture. The price of fertilizer has almost trebled between 1985/86 maha and 1990/91 maha in all the districts under consideration. The prices of labor and farm power have increased by 50 percent to 100 percent during the same period. For instance, the price of fertilizer that stood at Rs 3.07 per kg in 1895/86 in Polonnaruwa District increased up to Rs 9.28 (a 302 percent increase) by the 1990/91 maha season. The market price of rice that stood at Rs 3.32 per kg in 1985/86 maha in Polonnaruwa District increased only up to Rs 5.18 (a 56 percent increase) by the 1990/91 maha season.

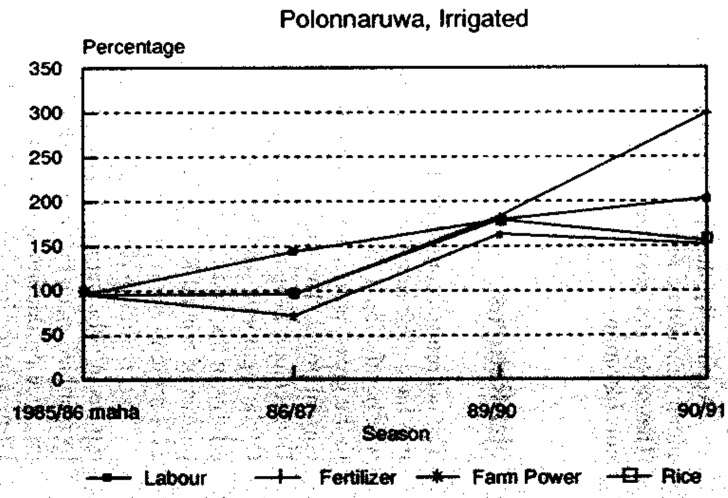
Changes in the Producer Profit Margins

On the basis of primary data of the Department of Agriculture, gross income of the farmers has increased remarkably in each water regime. The increases of the gross income between 1981/82 maha season and 1989/90 maha season were about 12,500 Rs/ha and 12,000 Rs/ha, respectively, in the irrigated areas in both Kurunegala and Polonnaruwa districts. The gross income per cultivated ha had increased by Rs 2,850 in Kandy District between 1981/82 maha and 1986/87. Similarly, farmers in rain-fed areas in Kurunegala and Kandy districts recorded 6,674 Rs/ha and

Figure 11.12. Price changes in inputs and outputs.







8,041 Rs/ha increases in gross returns, respectively between 1981/82 maha and 1989/90 maha. The increase in the gross return is mainly due to the increase in the price under the Guaranteed Price Scheme (GPS). This is because there has been no significant increase in the yield or production of rice since the mid-1980s. The GPS price of rice which stood at Rs 40.00/bushel (1 bushel = 29 kg) in 1990 rose to Rs 110/bushel by 1990 (a price increase from Rs 1.82/kg to Rs 5.00/kg). In the meantime, the price received by the farmers or the farm gate price has always been a little higher than the GPS price.

Also, it is important to look at the performance of the rice crop during yala seasons. The returns recorded in yala seasons will help make decisions on growing nonrice crops in the rice lands with proper drainage facilities. The farmers in the irrigated areas in the Kurunegala and Polonnaruwa districts recorded Rs 21,009/ha and Rs 18,198/ha (respectively) increases in the gross returns between 1981 and 1990. The farmers in the Kandy District increased their gross returns from Rs 5,207/ha in 1981 to Rs 10,238 in 1987.

Apparently, the gross returns from the rice crop seem to have increased over the years. The picture should be further studied taking the changes that have taken place in costs and inflation. Therefore, the next section will deal with the net returns, taking the impact of inflation into consideration.

Net Returns

The net returns constitute the difference between the gross returns and the value of all the inputs that have gone into the rice production including family labor. This indicator gives an idea as to whether the inputs have been increasing at the same rate as the farm gate price of rice. Compared to the gross returns, net returns per unit of land have increased only marginally even in terms of current prices. The situation is further critical when real values are considered. Farmers in Kandy District have been recording very low net returns under both the irrigated and rain-fed conditions. Of the eight yala seasons since 1981 (except 1988, and 1989), three seasons recorded negative net returns in the rain-fed areas in the same district. The areas under irrigation also recorded low net returns of around Rs 2,000/ha with one season experiencing negative net benefits as well. Table 11.4 presents net returns in terms of current price and real values (rice equivalents).

Net returns in Kurunegala and Polonnaruwa districts have been at a higher level. Though gross returns in Polonnaruwa District are higher than those of Kurunegala District, the net returns in the former have been rather low. This is because in the Kurunegala District the inputs that have gone into rice production are less than those of the Polonnaruwa District. For instance, in 1990 yala, farmers in the irrigated areas in the Kurunegala District received net returns of Rs 15,247 against a total cost of Rs 16,005 (Benefit/Cost ratio [B/C] =1.95) while the Polonnaruwa counterparts received only Rs 10,479/ha against a total cost of Rs 18,718 (B/C=1.45). Under rain-fed conditions also Kurunegala District recorded somewhat attractive results (comparative data are not available for the Polonnaruwa District).

Table 11.4. Changes in net returns.

Water regime and season	Kurunegala District		Kandy District		Polonnaruwa District	
	Current price (Rs/ha)	Real value (kg of rice)	Current price (Rs/ha)	Real value (kg of rice)	Current price (Rs/ha)	Real value (kg of rice)
RAIN-FED						
Yala						
1986	3,018	809	1,025	304	NA	NA
1987	3,060	836	–1,309	384	NA	NA
1990	7,665	908	1,874	284	NA	NA
Maha						
1985/86	7,130	1,654	445	136	NA	NA
1986/87	NA	–313	92	NA	NA	
1989/90	6,999	1,167	5,899	838	NA	NA
IRRIGATED						
Yala						
1986	5,204	1,591	2,224	652	3,173	909
1987	4,875	1,304	476	142	4,132	1,126
1990	15,247	1,875	NA	NA	10,479	1,648
Maha						
1985/86	6,561	2,116	2,193	941	4,966	1,496
1986/87	6,571	1,861	272	83	3,427	1,045
1989/90	13,361	2,112	NA	NA	8,484	1,473

Note: NA = Not available

Comparison with Nonrice Crops

It is interesting to note that nonrice crop cultivation in these areas yields significantly high levels of profit margins while rice farmers are facing a situation of eroding returns to a unit investment. A comparison of production costs and returns according to various factors of production for cultivation of rice and chili in Kurunegala District is given in Table 11.5. (The Department of Agriculture has not published data on nonrice crops for the other two districts.) Data available suggest that returns to all factors of production are higher in chili cultivation while the most striking indicator seems to be the total profit margin per unit of land of chili over that of rice. Also, nonrice cultivation eases the problem of underemployment since most nonrice crops require labor throughout the season. Another way of comparing the performance of the rice crop with those of nonrice crops is through their water productivity, which can be calculated in a crude way as returns to a unit of water that was consumed by the crop. Table 11.5 shows that in terms of water productivity, the chili crop records remarkable high yields over the rice crop.

Table 11.5. Production costs and returns to selected factors of production for rice and nonrice crops under irrigated conditions in Kurunegala District, 1990 yala.

	Rice	Chili
Cost of production (Rs/ha)	16,005	25,262
Gross returns (Rs/ha)	31,253	79,627
Net returns (Rs/ha)	15,247	54,365
Labor requirement (days)	160	320
Profit per labor day	95	170
Profit per Rs 100 investment (Rs)	95	215
Water productivity (Rs/m^3)	1.89	5.10
Assumed water requirement* (m^3)	16,500	15,600

Note: Water productivity = Gross returns/ Total water requirement

* Water requirement was assumed using the data available for other study locations since specific data are not available for Kurunegala District.

POLICY IMPLICATIONS

Rice cultivation will continue to play a vital role in the Sri Lankan economy. Investments in irrigation and associated technologies such as high-yielding seed varieties and fertilizer, together with management inputs had contributed to the significant increase in rice production and productivity in the past. The area cultivated to rice and the national average of rice yield had reached their peak levels by the mid-1980s. Apparently, 1985 was a turning point: key determinants of total production such as yield level and area cultivated did not show clear rates of growth under any one of the three regimes of water considered in the analysis. The cropping intensity, which had been stagnating over a longer period, also did not show any significant improvement. It is clear that unfavorable weather conditions and certain other "external factors" have contributed to this state of affairs. The study did not analyze the possible contributions of declining soil fertility or increased incidence of pests and disease attacks, etc. on the recent decline in the growth rates of production and productivity. It would, however, be difficult to quantify such contributions to rice production during the period 1985-91, because: a) cultivation in many areas has been affected by such external factors as unfavorable weather conditions and civil disturbances; and b) the time period under consideration is too short to establish such trends, especially due to the lack of a proper data set including "controlled" conditions.

The rise in the market price of rice has failed to compensate for the increase in the cost of production. Rice cultivation, especially in "well-watered" areas has become a more capital-intensive venture. The price of fertilizer for instance, has trebled between 1985 and 1991, and costs of labor and farm power have increased 50-100 percent in the three districts included in the sample. The market price of rice, on the other hand, had increased by about 55 percent during the reference period (Figure 11.12). The net returns per unit of land in real terms have not shown a significant improvement in any one of the areas studied.

In the context of uncertain (world) prices for rice, declining growth rates of production and eroding profit margins, it would be prudent to analyze the potential for future increments in productivity of scarce factors of production and increasing cropping intensity, while checking the cost of production which is an equally important factor.

The analysis in this study did not include an in-depth enquiry into the differences between (a) production areas such as different irrigation schemes or (b) farms in the same area. For instance, there is a *need to analyze the gap between the high-yielding farms and low-yielding farms, in similar production systems.* Both water and non-water factors may be responsible for such gaps. And, such gaps, perhaps, may be reduced by low-cost management techniques.

In the long term, research may be conducted to explore the possibility of raising the technical ceiling of crop yields. Research into appropriate crop management techniques should also investigate the comparative long-term productivity of the continuous cropping of rice versus alternative rice-based cropping patterns. Providing crop rotation in a rice cropping system helps to maintain or regenerate soil fertility, reduce weeds and pest buildup, and provide more diversified options to sustain farm incomes (Westcott and Mikkelsin 1988). Grain legume crops such as mungbean or cowpea, leguminous green manures, or vegetable crops may be particularly suitable rotation crops with rice.

Improving yields through increasing input-use efficiency. In addition to improved water management, other input-saving technical changes can also be considered. These may take several forms and the following are a few examples: integrated pest management, integrated nutrient management, direct seeding techniques in place of transplanting, and more efficient water use.

Cropping intensity. Nearly one half of Sri Lankan rice lands are cultivated to anything but a single rice crop per year. Is there a potential for increasing the intensity of cultivation on these lands? Technically, double cropping of rice on the favorable lowland areas is possible with early maturing varieties and more determined research on the management constraints. However, the real potential for increasing cropping intensities lies with the expansion of nonrice crop production in irrigation systems.

However, to be successful in irrigation systems that have a diversified cropping pattern, collective action is needed to: i) ensure adequate water supply; ii)regulate timing of water supply; and iii) prevent excess water for the nonrice crops. The timing of water flow for nonrice crops is different from that of the rice crop and in-season regulation of timing of water is important. Also, the water flow has to be regulated to prevent excess water into the nonrice crop lands. Therefore, the necessity for collective action for water control is more important in irrigation systems where nonrice crops are grown.

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