# POTENTIAL FOR DIVERSIFIED CROPPING

# IN THE PADDY LANDS OF SRI LANKA

*December 1994*

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# POTENTIAL FOR DIVERSIFIED CROPPING IN THE PADDY LANDS OF SRI LANKA

## CHAPTER 1 - INTRODUCTION AND OBJECTIVES

Recent trends in the agricultural development strategy of many developing countries indicate a clear **shift** from the traditional approach of expanding the supply of factors of production, such as land and water, towards improving the productivity of such factors. Increased scarcity and reduced or stagnant performance in the utilization of these inputs are the major factors that contributed to this **shift**. Irrigation water, for example, has increasingly become a scarce input in the agricultural production process. In many parts of Asia, most of economically promising sources of irrigation appear to be already fully developed. As a result, the potential for expanding the area under irrigation is diminishing rapidly. At the same time, the performance of many of the existing irrigation systems in these areas has fallen short of expectations; low intensity and inefficiencies in land and water use are evident. Consequently, the major objective of irrigation policy in most of these countries, including Sri Lanka, may be changed from the traditional one of water supply augmentation to improvements in water management in existing irrigated agricultural production systems.

Concurrently, a significant decline in investments on irrigation-- especially on new constructions-- by international donor community and recipient governments is also observed. Short supply in food grains and consequent price escalations had influenced the international donors and recipient governments in Asia to invest more in irrigation in the 1970s. A reverse trend was observed in the 1980s--for instance, the supply of rice increased worldwide, prices declined and, consequently, investments in irrigation also declined.

Since then **crop diversification** has been assigned a prominent place among the avenues available for improving land and water productivity.

It is believed that a great deal of development outside the traditional mono-crop farming is necessary not only to optimize the economic returns to scarce factors such as land and water but also to improve the living standards of the growing population. Moreover, a well-planned program of diversified cropping in some rice areas could be mutually beneficial to both rice and other crops, in the long run. However, the progress of diversified cropping is constrained by a number of technical, institutional (including financial and market- based factors) and socio-cultural factors. These include compatibility of crop mix and land, water availability and management, climatic factors, profitability, knowledge, skills, ability and willingness of the farmers, tenurial patterns, price levels and access to inputs, market factors and price levels of outputs, etc. Moreover, interactions of these factors may also influence the expansion of other field crops in the rice sector. In short, the issues related to crop diversification in this sector are multi-faceted. **The general objective of the proposed study is to examine and assess the recent trends and current status of diversified cropping, constraints and potentials for alternative uses of rice land.**

## 1.1 Specific Objectives

1. Examine the changes in cropping patterns over the past decade in the rice lands of Sri Lanka. Analysis will be extended to quantify the changes in different water regimes such as major and minor irrigation areas.

2. Contrast the extent of crop diversification with expectation: For example, in certain irrigation systems, the targeted area under other field crops has been about 40 percent of the total area, but the achievement is less than 10 percent.

3. Compare and contrast rice with other crops with special emphasis on such factors as their suitability to different soil, water and other agro-climatological conditions, cash flow, profitability and other economic aspects. A comparison among selected nonrice crops will also be attempted here. The validity of the analysis or the specific conditions under which these results can be obtained will be analyzed, for example, price, market availability, water control, soil and other climatic conditions and input levels. Here, the input profile, cost of production, the level and distribution of cash flow, productivity and profitability will be examined. For example, the returns and profits to land, labor and water per unit time, the opportunity costs (in terms of water and land productivity) of not converting various categories of rice land into other field crops (OFCs) in different seasons under different water regimes will be examined.

4. **Examine and assess the potential for expanding the cultivation of other field crops in the rice sector.** The potential for expansion and strategies to overcome constraints will be assessed at this stage. Based on this, specific guidelines will be developed. The guidelines should be sufficient enough to develop a comprehensive plan for the future. This analysis will discuss, to a limited extent, the type and magnitude of rice lands available for diversification, suitability of crops for different areas and for different water regimes, profitability of these efforts and a strategy to overcome specific constraints.

## 1.2 Study Approach

The study will be based on available data. The analysis of potential and constraints will be confined to technical, institutional (including financial and market-based factors) and socio-cultural factors. These will include the following:

*Technical*

Land suitability: Factors such as the drainage quality of the soil, local topography, irrigation system flexibility, reliability and control of water supply, agro-climatic constraints such as rainfall distribution, potential for rain water harvesting and water saving technologies in the rain-fed areas, technical aspects of groundwater utilization for cash cropping, etc.

*Economic Socio-cultural and Institutional (Including Financial and Market-Based Factors)*

Product prices, price level and access to inputs, access to credit and agricultural extension profitability and incomes, seasonal labor availability patterns, tenurial and ownership patterns, user organizations and the relations between farmers and agencies, and farmers and the private sector, level and regularity in cash flow, availability of markets, quality control standards, post-harvest technologies and facilities, scope for value added production, potential for small farmer companies aimed at commercialized diversified agriculture, theft, lack of group action, community induced constraints, farmer perception such as preference for rice, attitudes, etc.

The aim is to provide a generalized response to the objectives stated at the outset. The study will attempt to answer such controversial issues as the potential for increasing other field crop production while maintaining self-sufficiency in rice at a higher level. Also, the study will discuss, to a limited extent, the potential for different crops in different water regimes and under different modes of diversification; for example, crops for captive markets, diversification in the irrigated areas and in different seasons, the degree of specialization required, the opportunity costs of diversification under different conditions, cost effectiveness and associated risks, enabling as well as inhibiting policies and legislature, regulations and subsidies, etc.

## 1.3 Recent Trends in the Rice Sector

Rice cultivation plays a vital role in the Sri Lankan economy as rice is the staple food. The successive governments of Sri Lanka, as in many other countries of south and southeast Asia, have followed a policy of achieving self-sufficiency. During the last four decades, as a result of heavy investment in irrigation, rice research and institutional support, Sri Lanka has accomplished substantial achievements in rice production. These achievements are best illustrated by the changes in the rate of self-sufficiency in rice during this period. Forty percent (40%) of the national rice requirement was produced locally in 1948. By 1985, self-sufficiency in rice reached a level of more than ninety percent (90%). (Aluwihare and Kikuchi 1990). In 1990, 735,000 hectares (ha) of rice were cultivated and this was forty-one percent (41%) of the total agricultural land use (Central Bank of Sri Lanka 1991). According to Aluwihare and Kikuchi (1990) rice cultivation expanded at an annual growth rate of two percent (2%) during the period, 1952-1985.

The main contributing factors for this development are the expansion (32%) and introduction of seed-fertilizer technology (68%) (Aluwihare and Kikuchi 1990).

A recent analysis of rice production trends in Sri Lanka (Wijayaratna and Hemakeerthi xxxx) shows that the rice-grown area (asweddumized area)[1] has increased marginally in recent years

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[1] New land brought under rice cultivation.

(1985990) (Figure 1). Since future prospects for expanding the rice-grown area are low, it is not possible to increase rice production through expansion of the area cultivated to rice. This analysis also shows that the other two key determinants of rice production, yield and cropping intensity, are also stagnating since 1985 (Figure 2). It is very unlikely that a development of a new high-yielding variety would occur in the near future.

This analysis shows that it is not possible to expect a higher growth rate in rice production in the near future. However, the annual growth in the population will continue to be significant at least for a few more years. Rapid population growth coupled with rising "affluence" will increase the demand for rice. In this respect, diversification of rice lands should be introduced without any detrimental affects to present rice production trends.

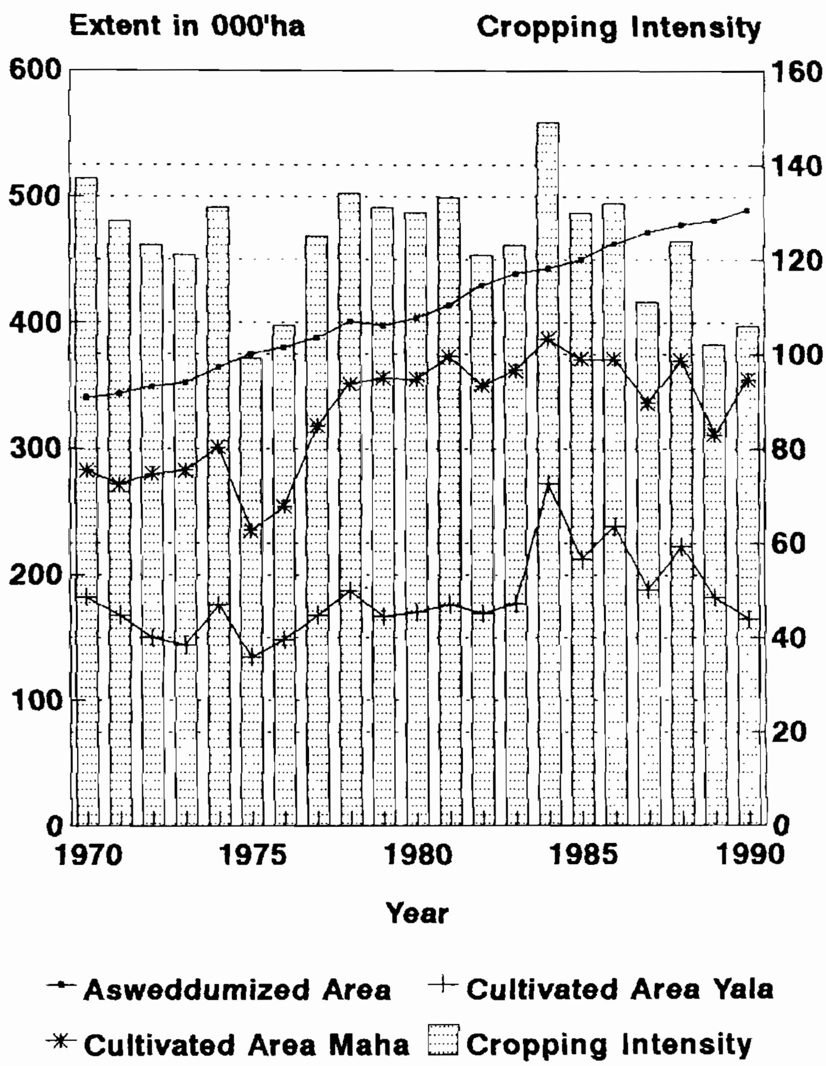
As stated earlier, the study will focus on diversified cropping in rice lands. The four factors quoted above, however, are interrelate; for instance, the primary reason for diversification is to increase productivity and profits. Diversification as an **organized effort** was first introduced in the marginal tea lands in the mid-country during the late 1960s. At the same time, it was introduced in coconut lands and in rice-based irrigation systems. However, the maximum rice area under irrigation which has been diversified has been about 40,000 ha per season and has not exceeded 10 percent of the total area cultivated during any given season (Jayawardena et al. 1993). The same source indicates that the main constraints for diversification are related to marketing, know-how and policy.

It is in this context that the study has been designed to examine the performance of and potential for diversified cropping in the rice lands.

While both an evolutionary and holistic approach has been adopted in this study on the potential for diversified cropping on the asweddumized paddy lands of this country, an interdisciplinary task force has addressed the more important critical issues in the later chapters presented within the framework of the study. These will address the main issues connected with potential and past and present performance and possible trajectories of future growth. More in-depth analysis will also be made on the profitabilities of different groups of nonrice crops, as well as other closely related issues of marketing, prices, national policies, etc.

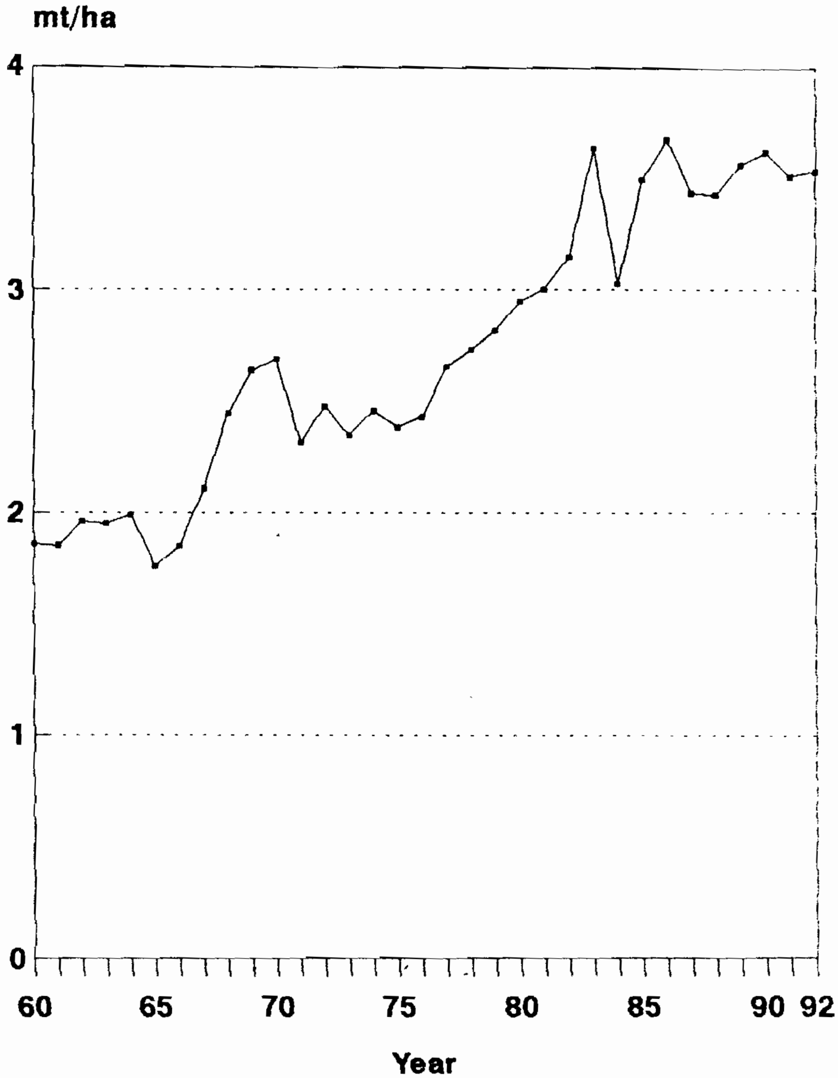
The report is organized in five chapters: Following this introductory chapter, the "Recent Trends in Diversified Cropping in Rice Lands" will be evaluated in Chapter 2. The discussion will focus on the major crops classified under other field crops (OFC), and cover the period 1982-1993. Chapter 3 will be devoted to "Agro-Ecological Factors Affecting Crop Diversification in Rice Lands" while Chapter 4 will examine the "Economic, Social and Institutional Factors Affecting Diversified Cropping." Finally, Chapter 5 will provide a summary of the study together with some concluding remarks.

Figure 1. Trends in Cropping Intensity and Area Cultivated to Rice




Note:Only major and minor categories included
Source of primary data:Census Department

**Figure 2. Trends in Maha Season Rice Yield in Sri Lanka**



## CHAPTER 2 - RECENT TRENDS IN DIVERSIFIED CROPPING IN RICE LANDS

### 2.1 Introduction

Diversified cropping in paddy land has primarily been centered around Other Field Crops (OFCs) such as chilli, onions (red and large), green gram, cowpea, black gram, soya bean, groundnut and vegetables. To a lesser extent, bananas, sweet potatoes, maize, gingelly and gherkins are gaining importance in specific areas. More recent attempts have been made to introduce newer crops primarily for export purposes and these include melons, baby corn, okra, hybrid maize, etc. Some interest is shown in new oil seed crops such as sunflower. However, for purposes of examining the changes in cropping patterns during the past decade, consideration is given to chilli, onion, green gram, cowpea, black gram, soya bean, maize, ground nut, gingelly and vegetables.

Unlike rice, for which a seasonal crop cutting/estimation survey is conducted by the Department of Census and Statistics, the production/average yield of OFCs are only estimates based on general observations by extension staff. Although chilli and onion yield estimates are the closest to accuracy, the best criteria for evaluating progress in OFCs are the extents cultivated. Hence the report that follows is based on crop extents.

Recent trends in cultivation of OFCs under irrigated and rain-fed conditions (as well as the aggregated nationwide extents) are summarized in Table A.1 in Annex 1 and are illustrated in Figure 3. The period covered is 1982-1991.

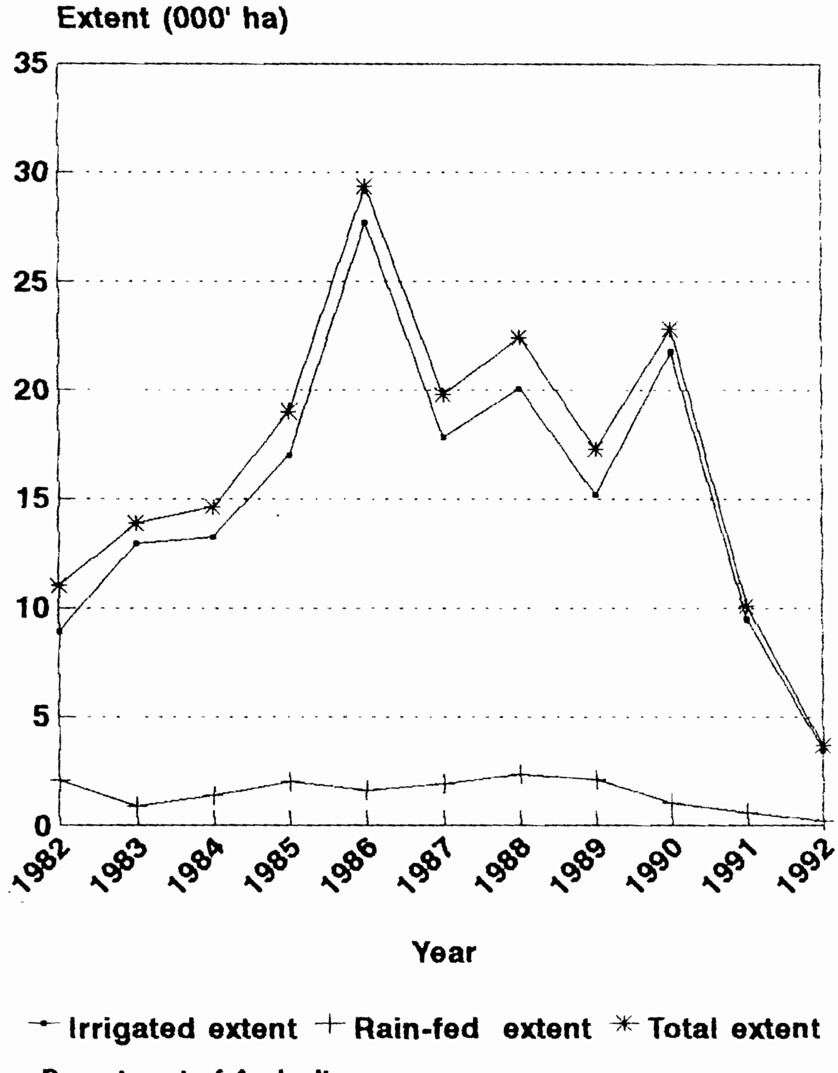
### 2.2 All-Island Coverage of Major OFCs over a 10-Year Period (1982-91)

Diversified cropping in rice lands must necessarily be viewed against the overall progress of OFC cultivation both in rice land and upland. **The all-island coverage of the major OFCs over a 10- year period, 1982-1992, is presented in Annex 1, Figures A1 to A6.** (Source: Extension and Communication Centre, Department of Agriculture). A few significant features in these trends are discussed below. For convenience, the discussion is arranged by crop.

#### Chilli

Chilli recorded the highest extent grown in 1990 and a declining trend thereafter (Figure A.1). During the decade 1982-1992, a clear shift from rain-fed to irrigated chilli in rice fields during yala season has taken place, thus increasing the yield per unit area. The yield of chilli is now stagnant mainly due to serious disease conditions such as "narrow leaf" disease, thrips damage and general dwarfing of the crop. The cost of cultivation of chilli is also on the increase due to the increased number of applications of agro-chemicals by the farmers. So far, these disease and pest problems are reported during the yala season in the rice fields. Discovery of a solution is not evident from research in spite of researchers working on this problem for over a decade. There is a strong possibility of increasing the chilli production if these diseases and pest problems are

**Figure 3. Cultivation of Other Field Crops in paddy lands, yala season**




source: Department of Agriculture

controlled because of its high productivity and net returns. With the containment of these problems, it is not difficult to reach the total annual requirement of the country, which is about 8,500 hectares, 21 percent over the present annual production.

**Big onion**

During the early 1970s, attempts were made to cultivate big onion to substitute the imports from India as the cultivation of this crop was becoming familiar to farmers during this period. Due to liberalized imports and low prices, farmers declined to grow big onion after 1977. However, since 1980, attempts were made to popularize big onion cultivation as the prices were better. Consequently, the extents under big onion cultivation increased appreciably from 1982 to 1988 (Figure A.2). The cultivation of big onion got localized mainly in Dambulla, Mahaweli System 'H' area, and Polonnaruwa and Anuradhapura districts. This was mainly due to the intensive extension programs on big onion cultivation implemented in these areas. One significant feature in the expansion of big onion cultivation during the 1980s was that, it was not as a result of new technology till around 1988. In 1988, new varieties, storage structures and herbicide usage were introduced. The resulting boost to the big onion cultivation was tremendous. The total annual extent under big onions increased significantly--almost four-fold from 1989 to 1991. While the extent increased, yields per unit area as well as profits increased. This boost was followed by the stoppage of imports during the production period thus ensuring the market and better prices. Producers were encouraged by extension to store their produce in rustic stores so that they could sell it during the lean months from November to early January. Technology to store big onion for a period of more than four months is not available locally. Efforts to grow big onion during the periods beyond the yala season have not produced favorable results. At present, and attempt is being made to produce small onions (red onion) during the months outside the yala season in different agro-ecological zones. "Creollo" varieties in the upcountry has shown some promise but big onion has to compete with other profitable crops for land in these new areas. At present, big onion produced during the yala season accounts for 63 percent of the annual requirements. Expansion of big onion cultivation extensively during the yala season should not be embarked on as it will affect the market and prices due to oversupply.

**Green Gram**

Green gram was a traditional rain-fed crop during the maha season in the Dry Zone. However, green gram cultivation during the yala season in the rice fields started expanding during the early 1980s (Figure A1.4 and Table A.1 of Annex 1) and the highest cultivated extent reported is for the 1991 yala season (13,077 ha.) followed by the highest cultivated extent in 90/91 maha season (33,448 ha.). In the past, green gram was consumed only as a boiled grain and was used in sweetmeats. However, during the late 1980s, the Cooperative Wholesale Establishment (CWE) and the private sector started making "green gram dhal." With the increase in tariff for red lentils, green gram dhal market prices were becoming very attractive to the processors as well as to the farmers; thus the increase in the cultivated extent. Inclusion of green gram in the school mid-day meal from 1991 also resulted in a better market. The extent of green gram grown increased rapidly and it became second only to maize (corn) with 43,609 ha under cultivation in 1991.

During the last few years, new technologies such as virus- tolerant varieties, short-age varieties, and timing of planting to avoid virus infestation have helped to increase green gram production.

During early 1990s, technology to produce green gram immediately after a harvest of maha rice, utilizing residual moisture with zero tillage and short-aged varieties were introduced with very promising results. However, with poor prices, farmers were reluctant to go in for this "sandwich" cultivation. This sandwich cultivation technology offers a good opportunity to increase productivity of rice fields without competing for irrigation water.

**Soya Bean**

Soya was a new crop in the 1970s and the extent grown increased rapidly to a peak in 1983 (Figure A.5). Agronomically it is a good rain-fed crop during the maha season and under irrigation in the yala season. Its advantages are better tolerance to drought and excess moisture compared to other field crops. Additionally, the harvesting cost is low as the soya bean crop can be harvested in one pick while other legumes need 3 to 4 picks.. Unfortunately poor marketing caused a drop in the extent grown after 1983. This is a crop with the potential for large-scale cultivation. The only soya oil extraction plant in the island that was capable of extracting oil by "solvent extraction" has been dismantled. Soya production for direct or processed human consumption itself may not be a profitable venture and the annual demand will be limited to a smaller amount. It can be concluded that no clear trend can be discerned in soya bean production and the marketing/price factors have influenced sudden increases in prices and shortfalls. However, there are favorable signs for better markets in the future with the entry of NGOs into the soya food processing industry.

**Cowpea**

The cultivation of cowpea peaked in 1983 (Figure A.6) and then declined mainly due to poor prices and marketing problems. In the past, cowpea dhal was popular but green gram dhal with a better taste competed for the market. There was a small boost in production during 1989-90 with the implementation of the school mid-day feeding program. Most of the lands where cowpea was cultivated got shifted to green gram during the same period. As a consequence, green gram showed a consistent increase in production whereas cowpea showed a decreasing trend.

### Yams

The intensive extension program to popularize yam cultivation during the 1970s resulted in the cultivation of sweet potato in rice fields. Potato cultivation is confined to the Godakawela area of Ratnapura District, Mawanella Rambukkana area of Kegalle District and the Rajangane major irrigation scheme in the Anuradhapura District. In some locations, farmers grow three crops during a year. In Ratnapura and Kegalle (Wet Zone), sweet potato is cultivated in minor irrigation and rain-fed rice fields. The incomes and profits are much higher than those for rice. Sweet potato was preferred by these farmers due to its high profits, local market, lower costs of cultivation, low risks, high utilization of family labor and lower levels of hired labor. However, the extent cultivated has reached a peak due to a limited market. But sweet potato could still be cultivated in the rice fields both in the wet and dry zones on well-drained soils.

### Banana

Technology of irrigated banana cultivation in the rice lands is comparatively recent and confined mainly to the Walawe Irrigation Scheme. There are indications of it spreading to other areas of the Dry Zone. Analysis of the cost of cultivation indicates that it is low, with a net income over Rs 125,000 per hectare per year. Family labor utilization in banana cultivation is very high. Data is not available to estimate the local demand. However, during early 1994, when the rainfall in the Wet Zone was very good, a good crop of banana in the Wet Zone to a fall in banana prices. This indicates that banana demand, production and prices are now reaching their peaks and any large-scale expansion may bring down prices.

## 2.3 Some Common Factors Contributing to Fluctuations in Cultivated Extent of Other Field Crops over the Years

### *(a) Rainfall*

Rainfall has a direct effect on the extent of rain-fed crops grown during a given maha season. Early and well-distributed rainfall during the maha season results in the increase of the extent cultivated to rain-fed field crops during the maha season, while a heavy rainfall will reduce the extent of OFCs. A heavy rain all during early yala will reduce the extents of OFC under irrigation. Meanwhile, a heavy rainfall during maha and low rainfall during early yala will increase the extent of irrigated OFCs.

### *(b) Market Prices*

When the farm-gate price of any OFC drops below the farmer expected price during a given season, then the extent of that crop grown during the following season drops. If the price is attractive, the crop extend increases in the following season.

The production of certain OFCs by farmers has no relevance to market prices. These crops are ideally suited to some ecological conditions, and hence they are grown. Farmers tend to cease producing non-food crops first when there are marketing problems but grow edible crops which have a local market. When farmers have experienced two or more seasons of market breakdown, they move away from those crops and choose other crops with marketing security. Market forces determine the expansion or reduction in cropping extent.

The vulnerability of the OFC market to import policies and processing capability and facilities is great. Any attempt to increase OFC cultivation under irrigation in the maha or yala seasons should be preceded by a careful review or study involving demand, prices, local processing capabilities, risks of cheaper imports, etc. Some of these important factors are examined in Chapter 4.

## 2.4 Disaggregated Data on Extents of OFC Grown for the 10-Year Period, 1982-91

(a) Information on areas cultivated to OFCs by district have been obtained from the Extension and Communication Centre of the Department of Agriculture (DOA), Peradeniya after scrutinizing individual seasonal reports of the districts. The reports since 1989 are somewhat incomplete, understandably an effect of provincialization. However, the DOA is updating this information both for yala and maha seasons. This data includes the extents under each of the major OFCs district-wise, categorized under rain-fed (upland and rice land) and irrigated (upland and rice land). A detailed interpretation of this data both at district and national levels is not attempted here. However, a graphical presentation of cultivated extents of OFCs for maha and yala, on the same basis, in respect of two major districts, Anuradhapura and Kurunegala is given in **Annex 2**.

**The matrix given below summarizes the changes that have occurred over the period under reference.**

| | Maha | | | Yala | | | |
|---|---|---|---|---|---|---|---|
| | Irr. P.L. | R.fed U.L. | IrriU. L. | R.fed P.L. | Irrig P.L. | R.fed U.L. | Irrig U.L. |
| **A'pura:** | | | | | | | |
| Chilli | - | Inc. | - | - | Inc. | - | Inc. |
| Green gram | - | Inc. | - | - | Sl/Inc. | Sl/Inc. | Inc. |
| Cowpea | - | Dec. | - | - | Inc. | Dec. | Inc. |
| Gingerly | - | - | - | - | - | Const. | - |
| Ground nut | - | (Const.) | - | - | - | - | - |
| Soya bean | - | R. dec. | - | - | Inc. | Dec. | Inc. |
| Black gram | - | Inc. | - | Inc. | Sl/dec. | Dec. | Dec. |
| **K'gala** | | | | | | | |
| Chilli | Sl/Inc. | Dec. | Dec. | Inc. | Inc. | Inc. | Inc. |
| Green gram | - | Dec. | - | Inc. | Sl/Inc. | Dec. | - |
| Cowpea | - | Dec. | - | Inc. | Inc. | Dec. | - |
| Ground nut | - | Sl/dec. | - | Inc. | Sl/Inc. | Dec. | - |

Const. - Constant; Sl/Inc. - Slight increase
Dec. - Decrease; Sl/Dec - Slight decrease
Inc. - Increase; R. dec - Rapid decrease

A few points of significance that emerge from Annexes 1 and 2 and the above matrix are:

* Extents cultivated to OFCs show an increasing trend in rice fields in yala and in irrigated uplands during yala.

* Extents cultivated to chilli and green gram in the Anuradhapura District have increased in maha too. The full maha extent is rain-fed.

* Soya bean cultivation slumped in maha

* The general reasons for these trends can be classified under several categories: climate, markets and price factors, availability of substitutes (mainly imported) and, to a lesser extent factors such as diseases, pests, technologies and crop management.

(b) The rain-fed uplands in the Dry Zone and Intermediate Zone have provided the bulk of OFC requirements in the past. Lately, irrigated uplands under lift irrigation and yala, well-drained rice land under gravity irrigation contributed an ever increasing supply of high-value crops such as chilli and onion, providing a greater part of the country's requirements. A cursory glance at cultivated extents of chilli, green gram and cowpea under different water supply systems in maha and yala seasons (based on a 10-year average) of a few important districts is given in the matrix below. It indicates that the bulk of the production in the Anuradhapura District comes from maha rain-fed uplands. However, higher yields are obtained under irrigation in the yala season. While this trend is true for Anuradhapura, it becomes less significant in Kurunegala. On the contrary, in Polonnaruwa and the Kalawewa 'H' Area, the bulk production comes from yala irrigated rice land. It is observed that diversification in rice land in the yala season has been a success under the major irrigation schemes.

**Extents Grown as Percentages of the Total for a District (based on an Analysis of 10-year Data).**

| | Maha | | | | Yala | | | |
|---|---|---|---|---|---|---|---|---|
| | R.fed P.L. | IrriP. L. | R.Fed U.L. | IrriU. L. | R.fed P.L. | IrriP. L. | R. fed U.L. | Irri U.L. |
| **Anuradhapura Dt:** | | | | | | | | |
| Chilli | - | - | 75 | - | - | 18 | - | 7 |
| Green gram | - | - | 85 | - | - | 7 | 2 | 6 |
| Cowpea | - | - | 95 | - | - | 1 | 2 | 2 |
| **Kurunegala Dt:** | | | | | | | | |
| Chilli | 1 | 4 | 30 | 5 | 9 | 10 | 23 | 18 |
| Green gram | - | - | 63 | - | 3 | 1 | 29 | 4 |
| Cowpea | - | - | 65 | - | 2 | 2 | 29 | 2 |
| **Polonnaruwa Dt:** | | | | | | | | |
| Chilli | - | - | 11 | - | - | 88 | - | 1 |
| Green gram | - | - | 15 | - | - | 84 | - | 1 |
| Cowpea | - | - | 63 | - | - | 35 | - | 2 |
| **Kalawewa** 'H' area | | | | | | | | |
| Chilli | - | 3 | 1 | - | - | 96 | - | - |
| Green gram | - | 5 | 32 | - | - | 63 | - | - |
| Cowpea | - | 8 | 37 | - | - | 55 | - | - |

## 2.5 Regional Specialization

It is evident from the ten-year annual trend (1982-91) of total land area (rain-fed and irrigated combined) under major OFCs that there is regional specialization in OFCs. It is assumed that this represents the recent trend in production as well. Examining these trends, the district priorities can be listed as follows:

| | | | | | |
|---|---|---|---|---|---|
| **Chilli:** | Kalawewa | A'pura | Jaffna | Matale | Kurunegala |
| **Red Onion:** | Jaffna | Puttalam | Ratnapura | Batticaloa | Moneragala |
| **Large Onion:** | Kalawewa | Matale | Jaffna | Polonnaruwa | Sys. 'B' |
| **Green gram:** | Kurunegala | Moneragala | Hambantota | Puttalam | Ratnapura |
| **Cowpea:** | Kurunegala | Puttalam | A'pura | Moneragala | Hambantota |
| **Black gram:** | Vavuniya | A'pura | Mullaitivu | Kurunegala | Puttalam |
| **Soy bean:** | A'pura | Matale | Kalawewa | | |
| **Groundnut:** | Moneragala | Puttalam | Mullaitivu | Ampara | Kurunegala |
| **Gingerly:** | A'pura | Kurunegala | Puttalam | Moneragala | Vavuniya |
| **Maize:** | A'pura | Ampara | Badulla | Moneragala | Matale |
| **Potato:** | N. Eliya | Badulla | Jaffna | | |
| **Kurakkan:** | A'pura | Matale | Moneragala | | |

Good growing conditions, ready markets and traditional farmer traits may have been the reasons for this form of specialization. This setting has influenced the more recent crop diversification programs in rice land. It is likely that these district ratings would change over time.

## 2.6 Trends in Production Levels of OFCs

Production levels of major OFCs are shown in Table 1. Production of these crops, estimated by the DOA, are based on average yields and extents cultivated. Data shows that there has been a steady increase in production of chilli, green gram, big onion and red onion since 1982. Production of soya bean and groundnut have declined over these years. Increases in production of these crops are mainly due to increases in the areas cultivated rather than due to yield increments. However, in the case of big onion, yield increment has also contributed for the increase in production.

**Table 1 Production of Other Field Crops, 1982-1991.**

| Crop | Production of Major Subsidiary Crops in '000M | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
| Chilli | 22.2 | 30.0 | 26.9 | 35.6 | 44.6 | 34.6 | 37.9 | 30.0 | 41.4 | 33.2 |
| Green gram | 18.4 | 16.2 | 17.5 | 15.5 | 17.8 | 23.6 | 23.4 | 19.2 | 30.7 | 36.5 |
| Bid onion | 1.6 | 2.6 | 3.0 | 2.4 | 5.6 | 4.2 | 6.8 | 11.1 | 20.0 | 22.6 |
| Red onion | 96.2 | 139.0 | 39.6 | 52.8 | 75.9 | 113.5 | 114.4 | 107.7 | 97.0 | 76.9 |
| Soya bean | 10.1 | 11.6 | 8.0 | 2.8 | 7.3 | 10.1 | 9.9 | 2.9 | 7.1 | 4.0 |
| Ground nut | 14.7 | 19.5 | 6.5 | 8.3 | 9.8 | 9.9 | 11.9 | 8.8 | 11.1 | 11.5 |

Source : Department of Agriculture

# CHAPTER 3 - AGRO-ECOLOGICAL FACTORS THAT INFLUENCE DIVERSIFIED CROPPING IN RICE LANDS

## 3.1 Introduction

At the outset itself, it should be recognized that both agro-ecological and socio-economic-institutional considerations together with their interactions ultimately determine the potential for, as well as the pace of acceptance of diversified cropping on rice lands. While this is specially so in the semi-humid and humid tropical environments of south and southeast Asia, it is quite different in the semi-arid tropics of India and west Asia where a greater flexibility of a switch between rice and nonrice cropping is possible because of the specific soil and environmental conditions that exist there.

The very wide range and diversity of agro-ecological environments across the rice-growing countries of southeast and south Asia which are located within the semi-humid and humid tropics has been clearly highlighted and brought out in two important IRRI publications, namely, (a) International Symposium on Soils and Rice (1978), and (b) Rice: Soil, Water, Land (1979). Recognition of regional specificity of the different rice growing environments, therefore, assumes a very special importance in respect of diversified cropping on rice lands.

It is now well recognized that as far as the physical potential for diversification of rice lands in the humid and semi-humid environments is concerned, the two main determinants are the landscape position and the landscape hydrology (IRRI 1979).

One of the more important distinguishing characteristics of Sri Lanka's rice or paddy lands vis-a-vis the rest of Asia is that more than 80 percent of its rice lands are located within inland valleys of varying form and size rather than on alluvial plains and terraces and various types of floodplains which make up most of the Asian rice growing landscape. This feature has a special significance as far as crop diversification in concerned.

A further complexity imposed on the rice lands of Sri Lanka is the strongly bimodal nature of its annual rainfall distribution pattern compared with the more common unimodal pattern of monsoonal Asia. This is strongly manifest in the humid Wet Zone of Sri Lanka which is subject to both the southwest and northeast monsoons in combination with convectional and depressional rains of very high intensity. Such a rainfall regime in combination with an inland hydromorphic valley environment precludes those opportunities available for diversification out of rice because of the absence of a well-defined dry season of sufficient duration. However, the opportunity for crop diversification in the semi-humid dry and intermediate zones of the country which have a more favorable rainfall regime is quite significant especially during the dry season from May to September. This will henceforth be referred to as "dry-season crop diversification."

On the foregoing considerations, it is self-evident that it is not possible to project an exclusive "across-the-board" economic approach in addressing the issues on crop diversification on rice lands of this country, without giving due consideration to the already well-recognized agro-ecological considerations and understandings that are now well grounded in this country.

## 3.2 Irrigated Agriculture--Past and Recent

Traditionally, irrigated agriculture in this country had been synonymous with asweddumized rice cultivation. The asweddumized lands located in the Wet Zone and those under minor tank systems in the Dry Zone have been in existence and continuously cultivated to rice at least since the fourteenth century, if not earlier.

By the fifteenth century, all potential land in the inland valleys of the Wet Zone had been converted to rice lands and no further expansion had since taken place. The restoration of the abandoned major irrigation schemes of the Dry Zone commenced under state sponsorship from the early part of this century and had been further enhanced during the 1930s up to independence in 1948. Almost the total extent of increase in asweddumized rice lands in this country since independence derives from both restoration of the ancient irrigation schemes as well as the construction of new schemes, both major and minor, in different parts of the Dry Zone of this country.

Irrigation development in Sri Lanka prior to the 1960s had been mainly conceived in terms of advancing the country towards a goal of achieving self-sufficiency in its rice requirements. The restoration of the ancient network of abandoned irrigation schemes together with the construction of new ones during this period was an integral part of the strategy for the attainment of self-sufficiency in rice.

The initial stages of a shift in irrigated agriculture from its traditional moorings of asweddumized rice culture took place around the early 1960s. This was prompted by the interaction of several considerations, chief among them being a recognition that water, rather than land, was the main limiting factor to a further expansion of the irrigated extent in the Dry Zone. Options other than high water-demanding rice had therefore to be properly experimented and tested.

Agronomic research on the cultivation of non-rice crops on gravity- irrigated land in the Dry Zone in the early sixties helped to firmly establish the feasibility of growing crops other than rice, namely, other field crops(OFCs), on the well-drained category of irrigated lands of irrigation schemes during the dry yala season. However, it was not until the mid-sixties, when the government took a definite policy decision to ban or reduce the imports of specific commodities such as chillies and onion that practical and realistic incentives became available to farmers to undertake the commercial productions of OFCs, mainly chillie and onion.

It should also be borne in mind that prior to the mid-sixties, all irrigation systems in Sri Lanka were primarily designed for wet season (maha) rice cultivation, and any reservoir storage that could be carried over to the subsequent dry (yala) seasons was used for irrigating a limited extent or portion of the command area again for rice. It was only the post-1970 irrigation systems, notably the Mahaweli and similar systems, that were designed for alternating wet season rice with dry season nonrice cultivation.

While Mahaweli System H has been able to achieve its full potential of OFC cultivation on well-drained lands during the yala season over the period 1979-1987, parallel developments have also been taking place on other categories of irrigation systems, namely the large and small tank systems in the Dry Zone.

OFC cultivation on the better drained rice lands or *"akkarawelas"* under small tank systems during the yala season received a further impetus from the mid-1980s by the introduction of agro-wells close to and around the *akkarawelas*. A relatively reliable supply of limited groundwater during the period April to August that could be drawn from these open dug-wells enabled farmers to cultivate a small extent of around 1.0 acre (0.405 ha) with a combination of high-value crops such as chillies, onions and vegetables which had a good market.

The highest extent of OFCs grown under Mahaweli System H, major irrigation schemes, and minor tank systems with agro-wells is given in Table 2. This is only for the Anuradhapura District and gives an average idea of the potential for OFC cultivation during the yala season in respect of one of the more important districts.

**Table 2 Extent of OFCs Grown in Anuradhapura District**

| Irrigation systems | Extent of OFCs | Season |
|---|---|---|
| 1. Mahaweli System H (Kalawewa) | 12,090 ha | Yala 1986 |
| 2. Major Irrigation Systems | 3,700 ha | Yala 1990 |
| 3. Minor Irrigation Systems + agro-wells | 1,320 ha | Yala 1990 |
| | 17,020 ha | |

While the foregoing information provides a brief overview of development over the last three decades, it would not be out of place to briefly comment on the role expected of irrigated agriculture in the forthcoming decade.

An examination of the water regimes of the different irrigation systems where dry season crop diversification has taken place over the last three decades show that it has been mainly confined to both major and minor irrigation schemes that have a deficit or inadequate irrigation supply during the dry yala season. However, because of the high year-to-year variation in this limited dry season water supply, the total extent of dry season OFCs that could be cultivated will also show a high degree of variation between years. One of the major challenges facing diversified cropping on rice lands during the dry season is how to minimize this degree of variation and ensure a certain degree of stability in OFC production over the years.

Yet another area of concern is the poor performance of diversified cropping in some of the major irrigation schemes that are well endowed with an assured irrigation supply during the dry yala season as, for example, those major irrigation schemes in the Polonnaruwa District. Because of the reliable water supply in these system during the dry yala season, they provide an ideal opportunity for the promotion of intensive, market-oriented nonrice crop commodities that should have a stable or assured market between the years.

Dimantha (1987) has estimated that there is a total extent of around 80,000 ha of well-drained land under the command of major irrigation schemes alone which he considers is well adapted for dry yala season diversified cropping. This provides a convenient future benchmark value for potential expansion of dry season diversified cropping in respect of the major irrigation schemes.

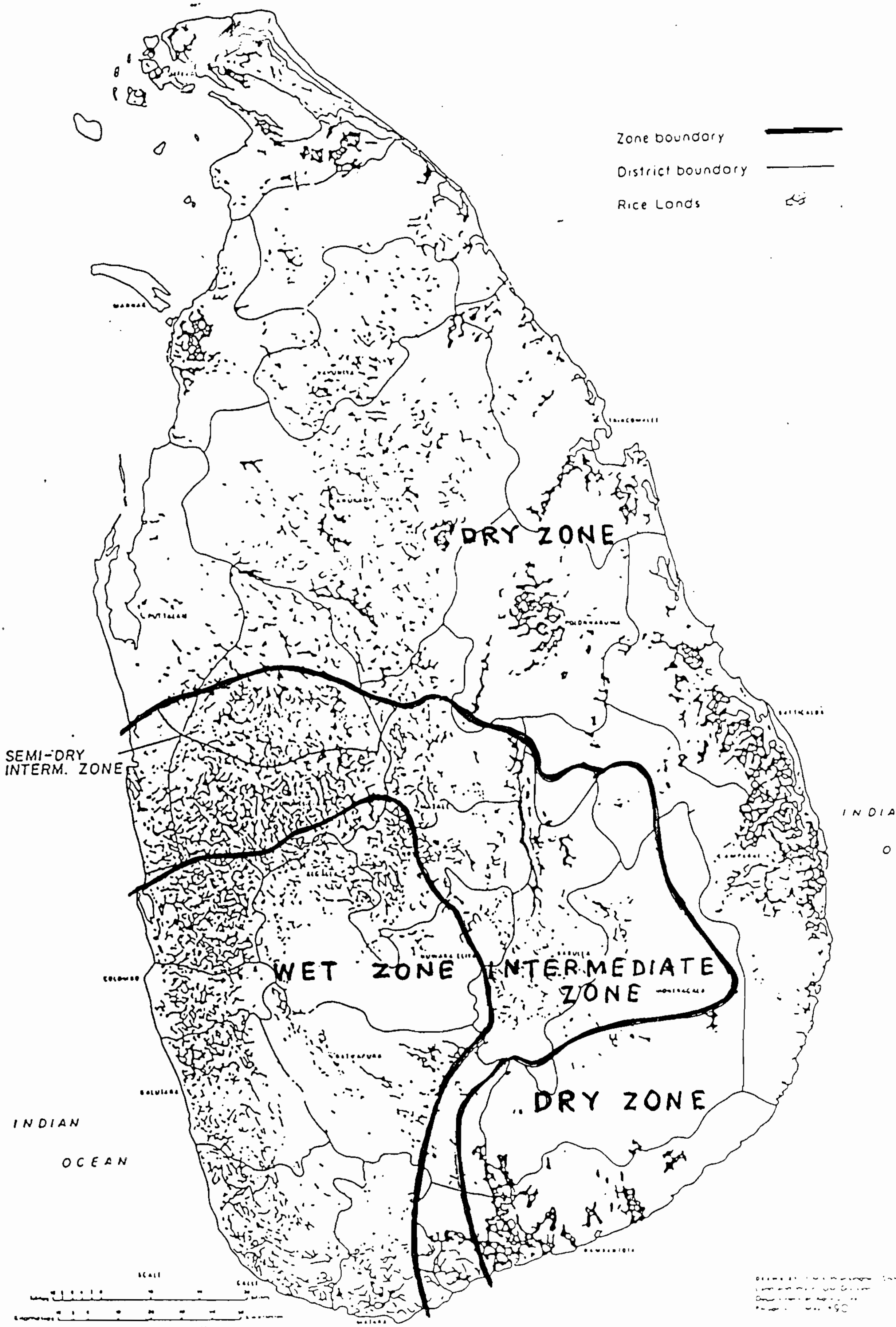
### 3.3 General Characteristics of Rice Lands in the Different Agro-Ecological Regions (AERs) of the Country and Their Suitability for Crop Diversification

The distribution pattern of rice lands in Sri Lanka is shown in Figure 4 which also shows the demarcation of the Wet Zone, Intermediate Zone and the Dry Zone of the country. The asweddumized rice lands of the wet zone are located in inland valleys of varying size and form. In view of the position of these rice lands in the landscape as well as their associated hydrology, wet lowland rice is the preferred and economically acceptable land use option for these phreatic lands. Increasing industrial and urban development in the low country regions is resulting in many of the first order valleys being transformed to the non-agricultural uses such as human settlements and industrial establishments.

There are two broad categories of rice lands in the Intermediate Zone. One category in the low country or low elevation (less than 300 meters), and the other in the mid-and-up-country (more than 300 meters) elevation. The latter category is mainly located on terraced slopes, and irrigation supply is mostly from simple stream diversions. Water supply is generally adequate for a full extent of rice during the wet maha season, while in the dry yala season intensive vegetable horticulture is practiced according to the availability of irrigation supply. No changes are envisaged in the present cropping pattern in this category of rice lands in the future, except for a further intensification of diversified production in the more advantaged areas.

The rice lands of the low-country Intermediate Zone will be discussed together with the rice lands of the low-country Dry Zone because of their broad similarities. Together they constitute more than two-thirds of the total asweddumized rice lands of the country **(Figure 4)**. These rice lands are located in broad inland valleys, minor flood plains and partly on coastal plains. The rice lands that are located in the broad inland valleys and minor flood plains are, for the most part, served by either major or minor irrigation schemes. Those in the eastern and northern coastal plains are referred to as the "*manawari*" or rain-fed lands and are not served by conventional irrigation. Only a single crop of rice is gown in these rain-fed lands during the wet maha season and they remain fallow during the rest of the yala season.

Figure 4. Distribution of Rice Lands in Sri Lanka



On the other hand, all rice lands served by some form of irrigation have the potential for growing a single crop of rice during the wet season followed by restricted cultivation of either rice or nonrice crops during the yala season. The best potential for diversified cropping on rice lands exists on the well-drained soils occurring in these irrigated lands. It is therefore proposed to examine the relative potential for dry season diversified cropping on these different categories of irrigated rice lands in the dry and intermediate zones of the country in the next section. The following broad categories have been recognized for the present.

Category 1 Major irrigation schemes with either trans-basin water diversion, or with adequate irrigation supply from within its source for both maha and yala seasons.

Category 2 Major irrigation schemes where the catchment or the source supply is situated entirely within the Dry Zone, which therefore have an adequate supply mainly for the maha season and an inadequate supply during the yala season.

Category 3 Medium and minor irrigation schemes with a moderately stable water supply that ensures at least a 75 percent cropping intensity in the maha season, and very little left over for yala.

Category 4 Minor irrigation schemes with an unstable water supply that permits between 50 and 70 percent cropping intensity in the maha season only.

### 3.4 Potential for Crop Diversification in the Four Broad Categories and Recent Performance

*Category 1: Major Schemes with Adequate Supply for Both Wet and Dry Seasons*

Because of the high stability of the irrigation supply during the dry season, the best opportunity for intensive dry season diversified cropping is surely located within this category.

Some typical irrigation systems representative of this category, together with the extent of well-drained lands within each system, and the highest extent of OFCs cultivated during the past ten years are shown in Table 3.

Table 3 **Extent of Well-Drained Soils and Cultivation of OFCs in Irrigation Schemes - Category I**

| District | Name of System | Extent of well- drained lands (ha) | Highest extent of OFCs grown and season (ha) |
|---|---|---|---|
| 1. Mahaweli | System H | 14,500 | 12,090 (Yala 1986) |
| 2. Uda Walawe | Uda Walawe RB | 4,200 | 3,060 (yala 1993) |
| 3. Polonnaruwa | P.S.S.<br>Minneriya<br>Kaudulla<br>Giritale | 1,178<br>1,031<br>655<br>372 | 648 (Yala 1990)<br>486 (Yala 1989)<br>203 (Yala 1990)<br>236 (Yala 1988) |

As could be seen in Table 3, System H of the Mahaweli had achieved almost its full potential on the well-drained soils by yala 1986. This exemplifies the degree of performance attainable when all essential support services, supplies and marketing had been provided by the Mahaweli Economic Agency (MEA) management.

In the case of the Uda Walawe RB area, approximately 75 percent of the potential extent of OFCs had been achieved by yala 1993, of which a greater proportion was made up of banana and less of chilli and onions. The management agency of this project plans to achieve a full extent of OFC cultivation on the 4,200 ha of well- drained soils by the end of 1995.

The level of performance of OFC cultivation in the major irrigation schemes of the Polonnaruwa District has been comparatively modest. This is not surprising considering the fact that these irrigation systems have had a longer tradition of maha rice followed by yala rice since their inception in the early forties. The provision of additional supply from the Mahaweli diversion for the yala season has helped to stabilize yala rice production rather than inducing OFC cultivation. Also, the percentage extent of well- drained soils within each system is significantly lower than that of the Mahaweli and Uda Walawe districts.

Yet another area with a very stable and adequate water supply during both maha and yala seasons is system C and system B of the Mahaweli. Available data show a very slow pace of adoption of OFC cultivation during the yala season. In system B it has increased from 274 ha in yala 1987 to 507 ha in yala 1992; and in system C it has increased from 308 ha in yala 1987 to 836 ha in yala 1992. The reasons for this slow pace of increase need further study.

The comparative advantage for sustained and stable production of high-value crops is best afforded in this Category I, and major focus of effort should be directed within this as demonstrated by the level of performance that has been achieved to date in System H of the Mahaweli.

*Category 2: Major Schemes with Adequate Supply for the Main Maha Season and Inadequate Supply for the Yala Season*

Some typical irrigation systems within this category, the extents of well-drained lands under each system and the highest extent of OFC cultivation achieved in the past are shown in Table 4.

Table 4 **Extent of Well-Drained Soils and Cultivation of OFCs in Irrigation Schemes - Category II**

| District | Name of System | Extent of Well- Drained Lands (ha) | Highest Extent of OFCs grown and season (ha) |
|---|---|---|---|
| 1. Anuradhapura | Rajangane<br>Padaviya<br>Huruluwewa<br>Mahavilachchiya<br>Devahuwa | 1590<br>1560<br>1050<br>450<br>430 | 1146 Yala 1988<br>502 Yala 1990<br>972 Yala 1986<br>320 Yala 1989<br>345 Yala 1989 |
| 2. Badulla | Nagadeepa<br>Sorabora<br>Mapakade | 1700 | 1238 Yala 1990 |
| 3. Mullaitivu | Muthiyankadi | 860 | 653 Yala 1986 |

Over the last two decades there has been a significant response to diversified cropping during the yala season in the above systems. However, the year-to-year variation in extents cultivated has been highly variable because of the high degree of variability of irrigation supply during the yala season.

All the above schemes within the Anuradhapura, Badulla and Mullativu districts, except Padaviya, have achieved at least a 70 percent extent of coverage of well-drained soils with OFC cultivation dependant on the amount of irrigation supply available for the particular season. This gives an indicative potential for dry season crop diversification in this category of irrigation systems.

The Kirindi Oya Irrigation Project (KOIP) is a very water-short system and it is located in the semi-arid region of the southeast of this country where diversified cropping on well-drained rice land is possible even during the maha season. A total extent of 562 ha of OFCs was grown under rainfall and supplementary irrigation in maha 1992-93 in the new command area of the project which did not receive irrigation supply for rice because of restricted water supply in the main reservoir. In the yala of 1993, a total extent of 909 ha OFCs was grown in the old command area of the project with a view to saving on the severely short water supply experienced during that season.

One of the more difficult management problems encountered within this category is the forward planning for the extent and composition of the range of OFCs that could be grown during the season because of the great difficulty in predicting the amount of supply likely to be available for the season. Even past records of rainfall and inflow do not provide a sufficiently reliable guide for such a planning exercise.

Dry season diversified cropping should therefore be mainly geared to the domestic market requirements which can absorb these fluctuations rather than to the export-oriented crops which require a more assured stability of irrigation supply.

*Category 3 Medium Schemes with Moderately Stable Water Supply - Maha Season*

These systems fall approximately within the Irrigation Departments classification of medium-size irrigation schemes. Selective statistics given below in respect of the Anuradhapura, Puttalam and Kurunegala districts provide an approximate idea of extent and size distribution of these systems (Table 5).

Table 5 **Irrigation Schemes and Command Area - Category III**

| District | Main river basin | No of tanks | Size range (ha) | Total command extent (ha) |
|---|---|---|---|---|
| 1. Anuradhapura | Malwathu Oya | 35 | 200 - 840 | 5182 |
| | Yan Oya | 20 | 200 - 480 | 2432 |
| | Moderagam Ara | 7 | 204 - 434 | 834 |
| 2. Puttalama | Mi Oya | 7 | 294 - 890 | 1447 |
| 3. Kurunegala | Mi Oya | 6 | 360 - 1036 | 2277 |
| | Deduru Oya | 10 | 201 - 476 | 1163 |
| | | | | ------- |
| | | | | 13335 |

These systems have, on the whole, an adequate irrigation supply for the wet maha season and a maha season cropping intensity of more than 75 percent. Those in the Intermediate Zone of the Kurunegala District have a higher cropping intensity because of higher rainfall.

Approximately 20 to 25 percent of the command area of these schemes is made up of well-drained soils. Available data shows a very low level of adoption of dry season diversified cropping in these systems in all the three districts covered.

It is difficult to explain the very low state of progress achieved to date in dry season crop diversification within this category of irrigation systems. It is not possible to adduce cogent reasons for this state of affairs without further studies which should receive a high priority because of the distinct potential that awaits to be exploited.

*Category 4   Minor Irrigation Schemes with an Unstable Water Supply*

These systems fall within the minor tank classification of the Irrigation Department (ID) and Department of Agrarian Services (DAS), and almost all of these are situated within the minor tank cascade systems so typical of the Anuradhapura District.

Although in terms of the quantity and reliability of water supply these minor tank cascade systems are not very well endowed, yet within each individual cascade there is a distinct differential in the hydrology of the water supply between the head end and the tail end of each cascade. This, together with the groundwater supply that is now being recognized within these cascades has enabled a very rapid expansion of diversified cropping under open dug-well program in the past ten years. As of yala 1990, the total extent of OFCs under both minor tanks and open dug-wells was 1,320 ha in the Anuradhapura District.

It should also be noted that past attempts at intensification of rice production in these systems had not proved very successful, and that the present push towards use of both surface water and groundwater supply for diversified cropping should be strongly supported. The Agricultural Development Authority (ADA) reports that a total extent of 488 ha of OFCs were cultivated in yala 1993 under the agro-well program in the Anuradhapura District. There is, however, an upper limit to the number of such agro-wells that could be permitted in the hard rock aquifer conditions that exist in this North-Central province.

### 3.5 Irrigation Management for OFC Cultivation in Rice Lands

Many studies have been carried out by the International Irrigation Management Institute (IIMI) and others on irrigation management aspects of cultivation of OFCs in rice lands. All of these studies have focused on OFC cultivation in dry yala season.

According to these studies, in general, it has been found that OFC cultivation is possible on rice lands during yala without any major modifications to the physical system. However, the delivery system should be over and above a desired physical status that would ensure a satisfactory degree of control and regulation of deliveries at different levels of the system. A research conducted by IIMI in the Dewahuwa Irrigation Scheme and Mahaweli System H, during 1985 to 1988, observed that unreliability and inequity of water supply at the turnout level due to inadequate control and regulation along the distributary and at the head of field channels. This suggests that improvements in canal regulation and monitoring of water flows are mor vital than modification of the irrigation delivery system. The former would be necessary condition for better OFC cultivation.

Since irrigation of OFCs need a larger volume of water during a shorter duration, field canals should have the capacity at least of one cusecs and larger (pipe) outlets. Modifications to ensure minimum design requirement may be necessary in some irrigation scheme.

IIMI research has also found that, with management changes in delivery of irrigation water--introduction of rotational water issues-- OFCs could be successfully grown on existing irrigation schemes during dry (yala) season. One of the major problem face by farmers is irrigation at night. Unlike in rice, irrigation of OFC at night is difficult because irrigating OFCs at night needs much care compared to rice. The other major problem is water application difficulty due to different OFCs need different schedules of rotation in terms of discharge, frequency and duration.

OFCs need different on-farm irrigation methods such as flat beds, raised beds, etc., depending on the crop. In addition to changes in land preparation method, OFCs need a good on-farm drainage system, particularly for plots in the lower part of the catena. All these modifications at the farm level would increase the cost of cultivation of OFCs.

It should be noted that, in general, water requirements due to evapo-transpiration do not significantly vary with the crop. Hence, any water savings in OFC cultivation, compared to rice, should be expected from other means such as reduced use during land preparation, change of the irrigation interval, reduction of the total duration of irrigation, etc. For instance, cultivation of a variety of crops within a single turnout may not necessarily lead to a change in irrigation frequency. Therefore, selective scheduling of crops, matching crop schedules with irrigation scheduling, etc., are of paramount importance in OFC cultivation.

**Constraints to and Potential for Better Water Management for OFC Cultivation in Rice-Based Systems**

In implementing the crop diversification program in large, gravity rice-based irrigation systems such as Kirindi Oya and Walawe, the following constraints were encountered:

1. The present procedure of aligning field channels traversing well-drained, imperfectly rained and poorly drained soils is not conducive for efficient operation when OFCs are grown during the yala season in the upper reaches of well-drained soils and rice in the lower reaches of poorly drained soils. Separate provision of parallel field channels for well-drained and poorly drained soils would facilitate better system operation, effectively intercepting the drainage flow and increasing on-farm water use efficiency.

2. In an undulating topography with well-drained soils in the upper reaches and imperfectly to poorly drained soils in the middle and lower reaches, drainage provisions now existing in rice-based irrigation systems are not adequate. The density of drainage ditches needs to be increased.

3. In rice-based irrigation systems, farmers generally prefer to use basin irrigation for OFCs also. Under such conditions, field levelling needs to be perfect; otherwise micro-depressions within the basin creates water stagnation affecting OFCs growth and yield.

4. Pipe outlets are used for letting out water from the field channel into individual farmers' fields. These pipe outlets have only limited flexibility in operation' Either it can be fully opened or fully closed. Flow to fields cannot be regulated.

This poses a constraint to control of flow and prevention of scouring, especially when large-diameter pipes, like 6-inch pipes, are used as pipe outlets.

5. With a limited water supply during the yala season, flooding has to be avoided and a controlled water supply needs to be supplied at the field. Both these operations require flow control structures and measuring devices especially at the distributory and turnout levels. In addition, there must be a greater joint management effort between farmers and agency staff; this in turn needs improved communication between agency and farmers. Changes in delivery schedules, if any, are to be communicated promptly and the reliability of water supply should be maintained.

6. Raising OFCs during yala requires detailed joint planning between the agency and the farmers for effective implementation. Better communication between the agency and farmers and periodic meeting for monitoring the progress, especially after each rotation, would considerably improve the water delivery performance at the turnout level. This in effect calls for proper organization and management for sharing water both at the distributory and turnout levels.

7. Detailed planning and implementation of scheduling irrigation deliveries in consultation with farmer groups and taking into account of farmers' practices and profitability estimates of different rainfall scenarios is very important for effective water management.

8. A wide range of OFCs, such as chili, soya bean, green gram and vegetables, are grown during yala. The optimum irrigation frequency for each of the above crops ranges from 2 to 10 days, whereas the irrigation frequency is fixed at once in 7 or once in 10 days. Growing these crops side by side in adjacent fields which are supplied by a common source of water encounters certain scheduling problems. To overcome this difficulty, some farmers have gone in for 1.5 to 2.0 m in diameter shallow dug-wells to supplement surface water when it is needed. Such supplementary sources need to be encouraged through proper planning and incentives.

9. An assured, regular irrigation supply is necessary during the crop growth period for better performance of high-value crops to encourage increased fertilizer application and use of high- yielding and short-duration varieties. A crop like chili requires a minimum of 10 waterings spread over a period of 5 months. The physical infrastructure and management efforts combined together are not able to meet fully these requirements.

10. The present demonstrated practices of raised-bed cultivation for chili and onions and row seeding of groundnut and green gram with graded terraces are found to be suitable; but because of the cost involved in preparing the bed, many farmers do not adopt the recommended practices. This affects the on-farm water use and yield performance of OFCs.

## CHAPTER 4 - ECONOMIC, SOCIAL AND INSTITUTIONAL FACTORS AFFECTING DIVERSIFIED CROPPING

As indicated earlier, economic, social and institutional factors, together with agro-ecological factors, usually dictate the adoption process of a particular cropping pattern in a particular location.

### 4.1 Local Demand Compared with Production

National demand/requirement for OFCs mainly depend on per-capita consumption and the population. Per-capita consumption of OFCs is mainly determined by the price of the product and income levels. Therefore, the annual national requirements of OFCs have been computed mainly based on these two factors. Wastage and seed requirement were considered in calculating the requirements. Seed requirements and wastage of respective crops were obtained from the reports of the Department of Census and Statistics. Projected population data was obtained from the Department of Census and Statistics.

Data on average per-capita consumption per month for different income classes were obtained from a study on consumer finance and a socioeconomic survey carried out by the Central Bank of Sri Lanka during 1986/87 (Table 6). According to the data, the consumption pattern for most OFCs, except for red onions and big onions show a marginal increase with the rise of income. Rate of increase in the consumption of onions as income increases is high compared to other commodities. These data roughly indicate that the demand for most OFCs will increase marginally with the increase in incomes.

**Table 6. Average quantities consumed per capita per month by income groups, 1986/87, in grams.**

| | Income (Rupees per month) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 801<br>1000 | 1001<br>1500 | 1501<br>2000 | 2001<br>3000 | 3001<br>5000 | 5001<br>10000 | ><br>10000 | Average |
| Chilli (Dried) | 151.8 | 151.9 | 160.9 | 166.3 | 169.3 | 175.5 | 177.8 | 161.5 |
| Chilli (Green) | 87.7 | 94.4 | 103.9 | 120.8 | 131.8 | 128.0 | 134.8 | 109.8 |
| Red onion | 240.0 | 244.4 | 265.6 | 290.8 | 317.5 | 335.7 | 386.0 | 280.0 |
| Big onion | 59.8 | 73.4 | 89.6 | 125.5 | 189.8 | 279.5 | 357.3 | 126.3 |
| Green gram | 45.3 | 44.6 | 60.3 | 64.3 | 73.6 | 83.9 | 69.7 | 59.4 |
| Soya bean | - | 0.4 | 0.7 | 0.4 | - | - | 0.3 | 0.4 |
| Cowpea | 28.8 | 21.9 | 19.9 | 22.2 | 22.5 | 12.8 | 4.7 | 20.6 |

*Source:* Report on Consumer Finance and Socio Economic Survey, 1986/87. Central Bank of Sri Lanka. Published in 1990.
*Notes:* Income groups are in current Rupees per month.

Estimated domestic requirement of selected crops are presented in Table 7. In estimating local requirements, however, changes in per- capita income in the future was not taken into account since the consumption of most of these crops, as indicated earlier, is less in response to income changes. Moreover, the annual increase in average per-capita real income would be small. Various studies give different estimates of national requirements. Department of Agriculture (DOA) estimates show a much higher requirements for 1994 ( Table 8). The DOA estimates are based on local production and imports. In this estimation, annual carry-over stocks have been ignored. Estimation of onion requirement by the Diversified Agriculture Research Project (DARP) shows a lower figure for onion requirement than the DOA estimates.

**Table 7. Estimated National Requirements of Other Field Crops, in '000 metric tons.**

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|
| Population[a] (Millions) | 17.90 | 18.11 | 18.31 | 18.51 | 18.70 | 18.90 | 19.09 |
| Crop | | | | | | | |
| Chilli | 43.02 | 43.51 | 44.00 | 44.48 | 44.95 | 45.42 | 45.88 |
| Green gram | 14.10 | 14.25 | 14.40 | 14.55 | 14.69 | 14.83 | 14.98 |
| Big onion | 35.27 | 35.67 | 36.07 | 36.46 | 36.85 | 37.23 | 37.61 |
| Red onion | 98.18 | 99.08 | 99.96 | 100.83 | 101.7 | 102.5 | 103.39 |
| Soya bean | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.54 | 0.55 |
| Groundnut | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.79 | 0.79 |

a. Population projections by the Department of Census and Statistics

*Notes:*

1. Requirement = (Per-capita consumption x Population) + Wastage + Seed requirement

2. Seed requirements were obtained from Statistical Abstracts of the Department of Census and Statistics, 1992.

**Table 8. Estimated National Requirements of Other Field Crops, in '000 metric tons.**

| | Estimated National Requirement | | | | | |
|---|---|---|---|---|---|---|
| | Estimated by DOA[a] | | Estimated by DARP[b] | | | |
| Crop | 1993 | 1994 | 1993 | 1994 | 1995 | 1996 |
| Chilli | 50 | 52 | | | | |
| Green gram | 37 | 38 | | | | |
| Big onion | 60 | 64 | 54 | 57 | 60 | 63 |
| Red onion | 135 | 139 | 101 | 105 | 109 | 113 |
| Soya bean | 55 | 59 | | | | |
| Groundnut | 12 | 12.5 | | | | |

a. Estimations are based on production, imports, seed requirements and wastage.

b. Estimations are based on a estimated demand equation.

**National Requirements and Current Production Levels**

It is relevant here to address the issue of national requirements of food items (OFCs) and the production levels estimated as achieved and planned for 1994. The figures in the table given below (Sources: Division of Agricultural Economics and Planning of DOA) compare estimated production and estimated requirements (Table 9). An immediate conclusion would be that there is little room for expansion of major OFC extents except for big onion, soya bean and maize. It is possible that with better technology, productivity and profitability can be increased in existing areas of production to meet requirements than to expand the extents cultivated.

**Table 9. Estimated Requirement and Planned Production of Major Food Items in '000 mt.**

| Food item | Requirement 1993 | Production 1993 | Requirement 1994 | Production 1994 |
|---|---|---|---|---|
| Maize | 97.0 | 88.8 | 103.0 | 89.5 |
| Potato | 115.0 | 101.3 | 118.0 | 102.0 |
| Sweet Potato | 125.0 | 125.0 | 135.0 | 135.0 |
| Green gram | 37.0 | 41.9 | 38.0 | 47.7 |
| Black gram | 15.0 | 18.5 | 15.5 | 16.0 |
| Cowpea | 18.0 | 26.5 | 19.5 | 19.5 |
| Dhal | 45.0 | 0 | 46.0 | 0 |
| Soya bean | 55.5 | 9.3 | 59.0 | 30.7 |
| Dry chilli | 50.0 | 48.4 | 52.0 | 59.3 |
| red onion | 135.0 | 138.1 | 139.0 | 157.0 |
| Large onion | 60.0 | 37.7 | 64.0 | 48.8 |
| Groundnut | 12.0 | 21.6 | 12.5 | 13.5 |

It is likely that the produce of traditional upland irrigated crops such as chilli and onion from Jaffna and Killinochchi will increase and reach the market as current disturbances cease. Projected population increases will undoubtedly increase requirements. From the foregoing it is clear that the search for newer crops with comparative advantages is becoming vital. More attention need to be paid to increase agri-business opportunities that help value adding market search and promotion, quality control and export.

However, a more accurate picture on the gaps between expectations and performance in crop diversification in rice lands cannot be predicated from available data unless such information is collected from individual project or program areas. **Both nationally and district-wise, the best method of obtaining this information that seem logical is to compare the seasonal and annual targets and** performances of OFCs documented in the annual Agricultural Implementation Programs of the Ministry of Agriculture and progress reports of the DOA. This can be done if needed.

## 4.2 Markets, Prices and Trade Policy

In Sri Lanka, markets, prices and trade policy act as key determinants of the level of adoption of OFCs. Both the profit margin and stability of income in the long run depend much on fluctuations in prices and the availability of markets and avenues for marketing.

*Markets*

Marketing is the combination of actions by which agricultural produce and raw material are made ready for consumption and reach the final consumer in a suitable form at the time and in the place she/he wants them. Unlike in the case of rice, most OFCs commonly included in diversified cropping in rice lands do not have established networks of markets or marketing mechanisms. Moreover, some of these crops are more perishable than rice and require special care in handling and storage. Thus, marketing of these crops sometimes demands a chain of activities--assembling, transport, sorting, grading, storage, packing, initial processing, taking the risk of holding the produce until and outlet is found, etc. Some common problems associated with the marketing of OFCs include:

(a) **High marketing costs** due to: unjustifiable profits to local buyers or middlemen as a result of farmer' weak bargaining power; high costs incurred by retailers and wholesalers due to inadequate storage facilities, deterioration in quality, lack of organization, etc; lack of market information; lack of competition at local levels; urgency in selling the produce immediately after the harvest; inadequacies in legislature; etc.

(b) **Transport problems :** Inadequate means of transport is often a key reason for low farm-gate prices of OFCs. Due to transport difficulties and lack of organization or group action, farmers tend to depend purely on local buyers. Losses during transport is also a common feature in the marketing of OFCs. Such losses could be attributed to: bad road conditions, bad handling and packing, irresponsibility and lack of thought, etc.

(c). **Inadequate storage facilities :** Unlike in the case of rice, OFCs are being sold for low prices immediately after the harvest mainly due to difficulties of storage. Cold storage facilities usually are highly inadequate and additional storage is restricted due to lack of organization, lack of knowledge and capital.

*Prices*

The price, particularly of an OFC, reflects the market of that crop and it also determines the profitability of the crop. As compared to rice production, OFC production generally involves more risk and uncertainty. Usually, price uncertainty is more serious for OFCs than risk associated with physical production. There could be many reasons for high fluctuations in prices such as weak marketing structures and government policies. Therefore, minimizing price fluctuations is more important for promotion of crop diversification.

Farm-gate prices for selected OFCs of major OFC producing districts are shown in Table 10. The data shows that there is price variation within districts. Despite the lack of clear information to explain this price variation between districts, it can be said that this is related to quantum of production in these districts. Prices are higher in low producing areas where products are sold in a very localized market.

Changes of national, average farm-gate prices (in 1993 prices) of major OFCs since 1988 are shown in Figures 5,6 and 7. As shown in Figure 5, real prices of green gram, soya bean and groundnut show a declining trend. This is most probably due to the increased production of these crops over the past years and hence the local supply matching the demand. If the present production trends continue with no changes in the present consumption patterns, we could expect the prices to stagnate or decline.

The farm-gate price of chilli shows an increasing trend up to 1991 and declines again in 1992. The fluctuation of the annual, average chilli price corresponds to the annual total production. This implies that the price is determined by the annual chilli production. In the recent past, the price of chilli has remained in the range of Rs 80-100 per kg.

The farm-gate price of red-onions shows a declining trend up to 1990 and increases and stabilized thereafter (Figure 7). Since the annual production is very close to the annual requirement, it is not possible to expect the price to rise in the future. Many studies have shown that there is a price decline during the harvesting period. However, this is common for other crops as well. The main reasons for low prices during the harvesting period are production gluts and poor marketing. The price drop during the harvesting period is about 20 percent. However, price drops for perishables, such as big onion, during the harvesting period are more significant compared to other pulses and chilli. Another reason is the low keeping-quality of big onion compared to that of red onion.

The price analysis shows a general trend in declining prices for most of the OFCs despite the high variation within districts. This suggests that there is little prospect for expanding the cultivation of these crops for local consumption.

**Table 10. Farm-gate prices of selected OFCs, in Rs/kg.**

| | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|
| Chilli | | | | | |
| Puttalam | 43.8 | 55.6 | 72.4 | 80.8 | 96.4 |
| Kurunegala | 55.8 | 52.7 | 74.8 | 88.4 | 103.8 |
| Anuradhapura | 47.3 | 58.0 | 65.8 | 97.5 | 99.0 |
| Polonnaruwa | 54.8 | 57.0 | 76.4 | | 106.7 |
| Moneragala | 48.3 | 57.1 | 64.5 | 97.1 | 108.0 |
| Matale | 50.3 | 52.0 | 69.9 | 104.7 | 101.7 |
| Red onion | | | | | |
| Puttalam | 10.8 | 8.0 | 28.3 | 28.1 | |
| Vavuniya | 10.44 | 9.08 | | | |
| Jaffna | 6.0 | 18.6 | | | |
| Ratnapura | 10.4 | | 34.1 | 24.5 | |
| Kilinochchi | 9.0 | 6.5 | 12.6 | | |
| Anuradhapura | 8.2 | 11.4 | 15.9 | | |
| Green gram | | | | | |
| Puttalam | 13.0 | 24.4 | 20.3 | 21.7 | 20.5 |
| Kurunegala | 13.7 | 16.9 | 20.1 | 18.9 | 26.1 |
| Anuradhapura | 9.6 | 20.7 | 17.7 | 17.4 | 19.8 |
| Polonnaruwa | 19.5 | 19.5 | 20.0 | 19.7 | 18.8 |
| Moneragala | 17.5 | 26.7 | 22.0 | 22.9 | 28.0 |
| Matale | 16.5 | | 22.0 | 22.0 | |
| Groundnut | | | | | |
| Puttalam | 8.6 | 15.3 | 16.9 | 14.0 | 15.0 |
| Kurunegala | 8.3 | 11.1 | 15.2 | 18.1 | 21.7 |
| Anuradhapura | 7.1 | 11.8 | 10.4 | 16.1 | |
| Moneragala | 6.4 | 19.4 | 18.5 | 16.5 | 20.1 |
| Hambantota | 9.8 | | 14.1 | 19.5 | |
| Soya bean | | | | | |
| Kurunegala | | | 13.3 | 17.5 | |
| Anuradhapura | 10.5 | 11.8 | 10.4 | 12.2 | |
| Polonnaruwa | 9.75 | | 9.8 | | |
| Moneragala | 12.0 | 10.4 | 22.8 | | |
| Hambantota | | | 12.1 | | |

*Source:* Data Bank, Agrarian Research and Training Institute.

**Figure 5. Farm-gate Prices of Pulses**
*in 1993 prices*

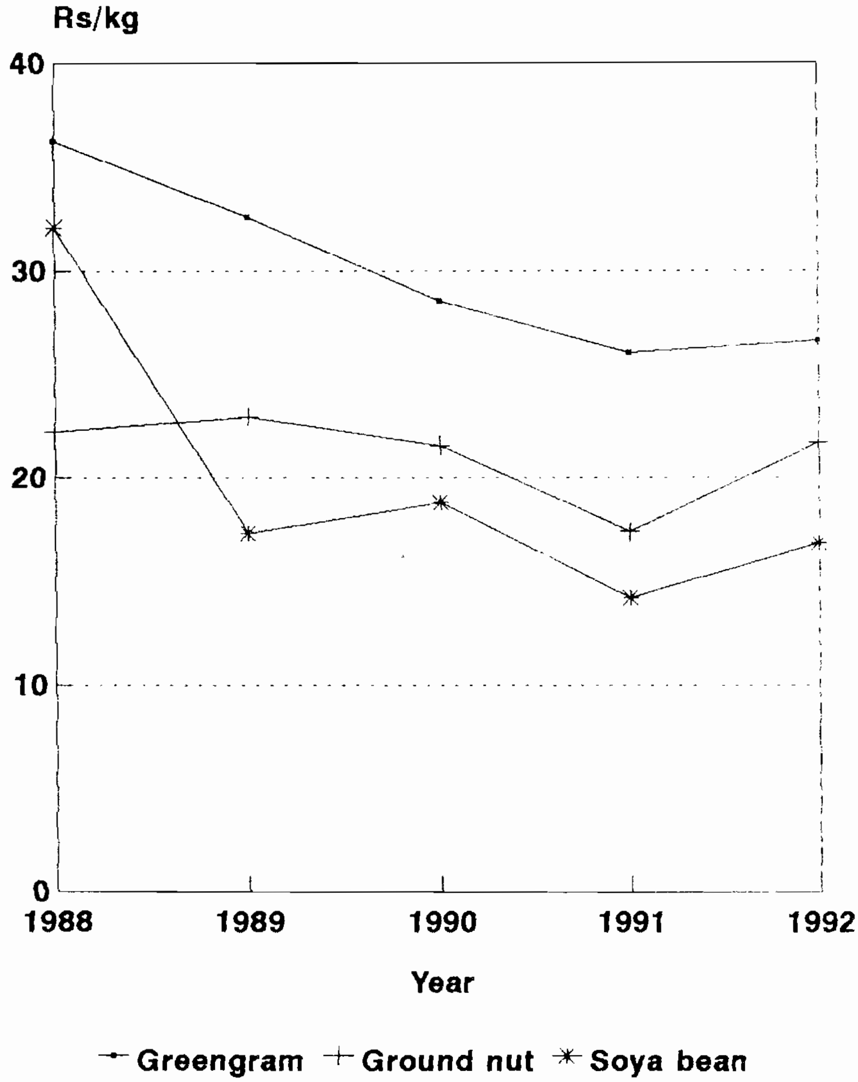


**Figure 6. Farm-gate Prices of Chilli**
***in 1993 prices***

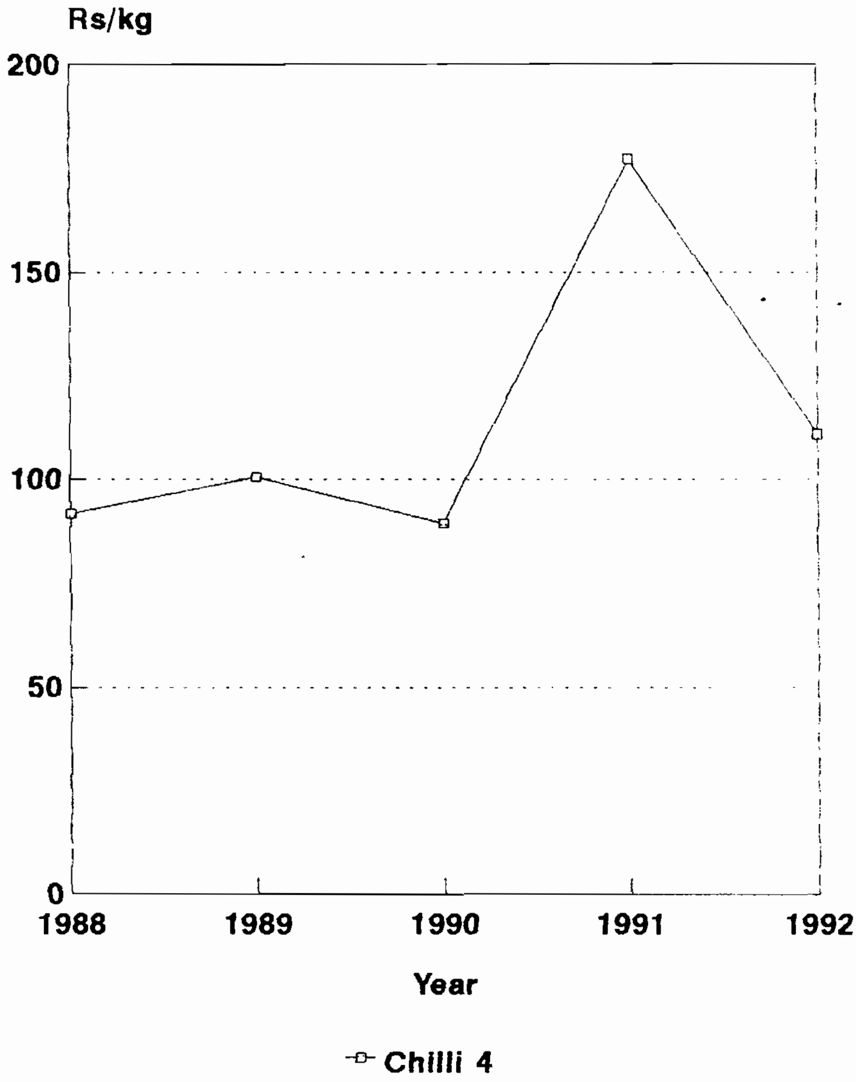
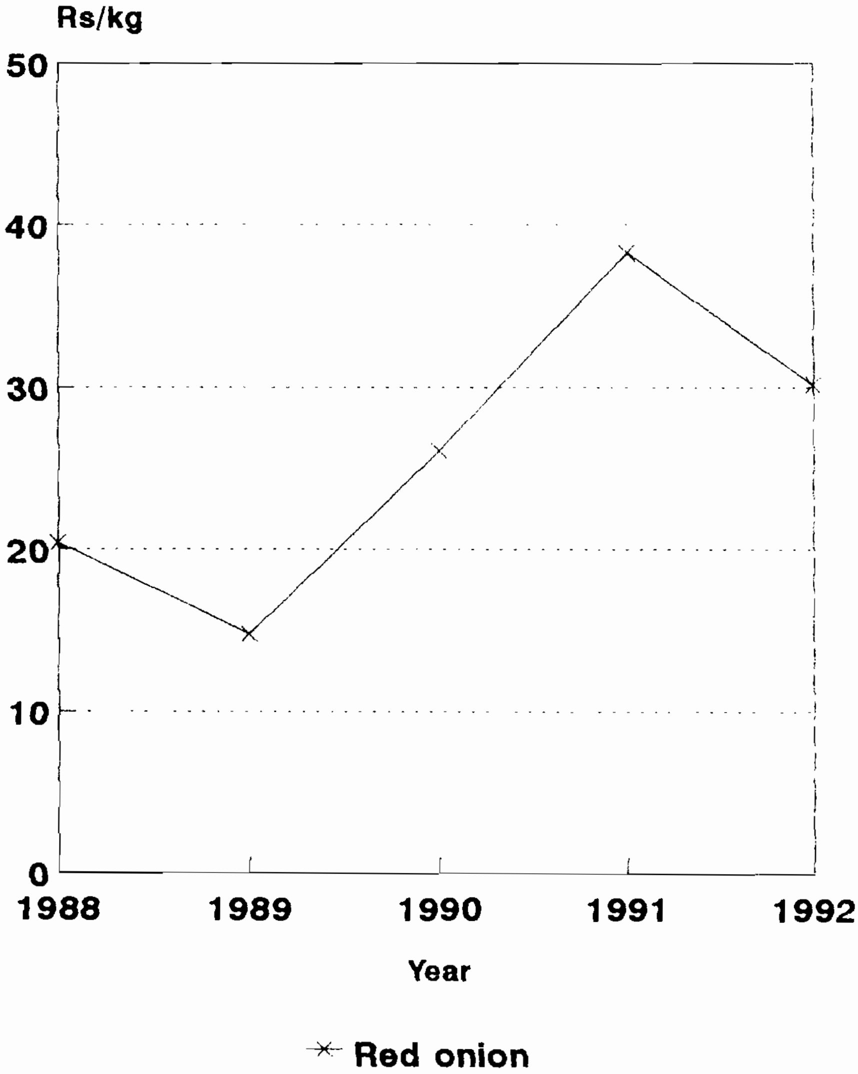


**Figure 7. Farm-gate Price of Red-onion**
in 1993 prices



*Trade Policy*

An important aspect associated with marketing at the macro level is the trade policy. For instance, it is not "uncommon" to observe that the type and quantities as well as timing of release of imports to the open market by respective state agencies/departments act as impediments to local production of the same product. Adverse effects of foreign competition on local production need to be avoided at least at the infancy of agricultural diversification. At times, the increase of supply after a ban of imports tend to be less than proportionate to the increase in prices because agricultural products are inelastic in supply in the *short run*. Thus a condition of imbalance of supply and demand may be created in the interim period. Resulting shortages may prevail for longer periods causing high prices. This, however, is a temporary phenomenon and is not prominent in most of the OFCs under consideration.

## 4.3 Demand for Labor

In Sri Lanka, "under-employment" is a common feature. In the rural areas, especially where rice culture is prominent, a significant portion of the work force is unable to find gainful employment on a regular basis. In such areas, the demand for hired labor is very much confined to peak periods in the cropping season. On the other hand, despite the fact that the growth rates are relatively low, the base population is high and population growth in absolute terms, therefore, remains at higher levels. Hence, a steady increase in surplus labor has become a common phenomenon. Yet, the rate of development (and subsequently, the capacity of labor absorption) in non-agricultural sectors--notably the industries--is not adequate. Consequently, the primary production sector should continue to play a key role in labor absorption, at least in the short run. It is in this context that demand for labor from different cropping patterns should be evaluated.

As indicated in Tables 11 and 12, labor is the most significant input constituent in crop diversification. Depending on relative profitability, OFCs could be classified into two categories: low- performance OFCs and high-performance OFCs. (Kikuchi 1990)

The data show that high-performance OFCs require much more labor compared to rice. High-performance crops require very high amount of labor compared to low-performance crops. This is almost five times as much as for rice and twice as much as for low- performance crops. Although high labor requirements provide employment opportunities for the rural people, they create labor scarcity in the area and hence increase labor wages. As a result, profitability could be reduced.

One advantage in OFC cultivation, compared to rice cultivation, is that farmers can depend more on family labor . Sixty to 80 percent of the labor requirement for OFCs can be supplemented with family labor. This is about 45 percent for rice cultivation. However, most of the OFCs require a higher amount of hired labor compared to hired labor required for rice. This is one of the constraints for crop diversification in rice lands.

Seasonal peaks in labor demand is high under cultivation of mixed OFCs. Labor peaks of different crops coincide with each other. Figure 8 shows the cropping calendar of selected crops cultivated during the 1989 yala season in Kirindi Oya. The order of seasonal labor demand for this cropping calendar is shown in Figure 9. Weekly labor requirements per hectare for selected crops are depicted. In the case of rice, the highest labor requirement of about 40 man-days is found during the harvesting period. For all OFCs listed, there are weekly peaks that exceed this standard level. The excess is large for labor- intensive crops like chilli and onion, but it is substantial even for low-performance crops such as green gram.

In addition to labor required for cultivation activities, OFC cultivation requires mainly family labor for guarding the crops, mainly at night. Since the harvesting period for OFCs is long compared to that of rice, labor for protecting the crops is required for a longer period. This makes farmers stay in fields at night. This is one of the reasons why many farmers are reluctant to grow OFCs in rice land.

**Table 11. Labor requirement for OFCs and rice (man days per ha).**

| | Family labor | Hired labor | Total |
|---|---|---|---|
| **High performance crops** | | | |
| Chilli | 286 (60) | 187 (40) | 473 |
| Big onion | 390 (73) | 141 (27) | 531 |
| Red onion | 169 (20) | 697 (80) | 866 |
| **Low-performance crops** | | | |
| Green gram | 188 (80) | 48 (20) | 236 |
| Soya bean | 107 (67) | 53 (33) | 160 |
| Groundnut | 128 (61) | 80 (39) | 208 |
| Rice | 44 (45) | 54 (56) | 98 |

*Notes:* Percentages are given in parenthesis
Averages, based on data for 1985 to 1992,

*Source:* Cost of Cultivation of Agricultural Crops, Department of Agriculture, various issues.

**Table 12. Average cash production costs (Ra/ha) for 1986 yala season crops in Dewahuwa and Kalankuttiya (1986 pr**

| Cost Item | Dewahuwa | | | Kalankuttiya | | |
|---|---|---|---|---|---|---|
| | Rice | Chilli | Green gram | Soya bean | Rice | Chi |
| Fertilizer | 788 | 2023 | 40 | 147 | 804 | 20 |
| Pesticides, herbicides | 181 | 2580 | 1053 | 381 | 420 | 21 |
| Seed seedings | 406 | 575 | 807 | 750 | 671 | 59 |
| Hired Equipment | 1323 | 1406 | 1278 | 1702 | 1930 | 15 |
| **Hired Labor** | **1345** | **6258** | **2356** | **2462** | **1432** | **48** |
| Irrigation Water* | 7 | 78 | 0 | 0 | 56 | 5 |
| Total cash Cost | 4050 | 12920 | 5534 | 5442 | 5313 | 112 |
| Gross returns | 7814 | 26265 | 12848 | 16863 | 10436 | 253 |
| Net returns | 3764 | 13345 | 7314 | 11421 | 5123 | 141 |

*Source:* Panabokke, C.R., IIMI Country paper #3 - Sri Lanka, p.50

Notes: * Payments as Irrigation fees.

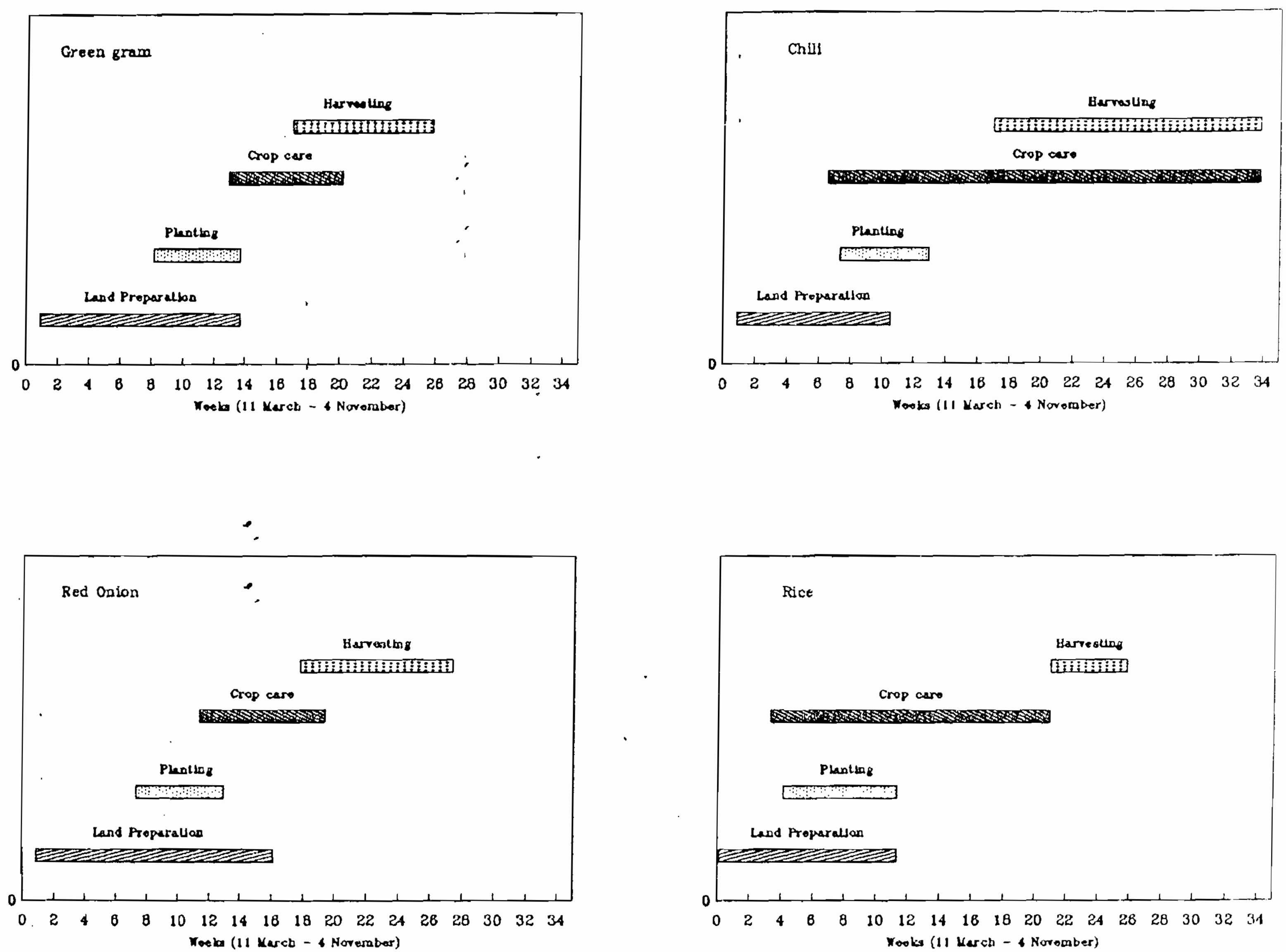



Figure 8. Crop calendar for rice and non-rice crops in 1989 yala, Kirindi Oya

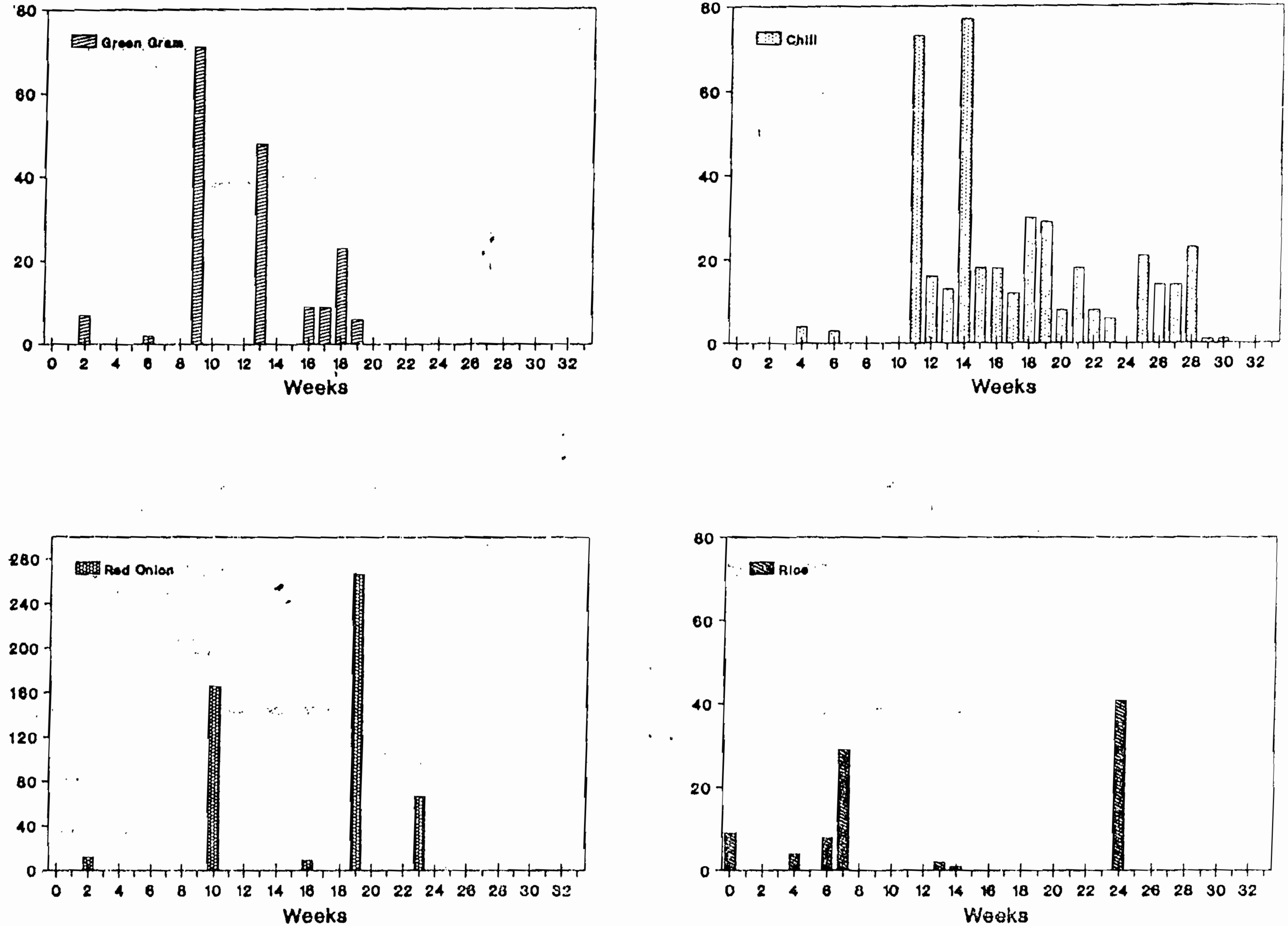



Figure 9. Weekly labor requirements per hectare, for rice and non-rice crops in 1989 yala, Kirindi Oya

Unlike rice cultivation, mechanization of OFC cultivation is limited, mainly due to ploughing activity. Most of the other activities such as planting, weeding and harvesting are carried out with manual labor. Labor requirements of different activities for OFCs and rice are shown in Table 13. For all activities, labor requirement for OFCs is high compared to that of rice. The very high labor requirement for land preparation activity of high-performance crops is one of the main problem for many farmers. On the other hand, the type of land preparation for OFCs is different compared to rice. Unlike in rice cultivation, mechanization of these activities is not possible. This suggests that labor could be one of the constraints if OFC cultivation expands in rice lands, particularly the increase in cultivation of high-performance crops.

**Table 13. Labor use (days/ha) for OFCs and rice.**

| Activity | Chilli | Red onion | Big onion | Green gram | Soya bean | Rice |
|---|---|---|---|---|---|---|
| Land preparation | 101.0 | 139.0 | 121.0 | 64.0 | 62.0 | 54.0 |
| Crop establishment | 36.0 | 176.0 | 161.0 | 62.0 | 18.0 | 13.7 |
| Crop care | 257.0 | 112.0 | 174.0 | 97.0 | 50.0 | 17.4 |
| Harvesting and post harvesting | 338.0 | 249.0 | 124.0 | 51.0 | 13.0 | 40.3 |
| Total | 731.0 | 677.0 | 580.0 | 273.0 | 143.0 | 125.4 |

*Note:* Data for OFC is for Kirindi Oya, on-farm demonstration, 1989 Yala season. Data for Rice is for Kirindi Oya 1987/88 Maha season.

Although the demand for labor and the cost of labor are remarkably high for OFCs (like onion and chilli), the opportunity cost of labor, especially of family labor, is low in many of the farming areas. A proper "crop-mix" can reduce the peak demands and achieve a certain degree of uniformity in labor demand over time.

A related issue is the potential for employment generation (including vertical expansion) in areas related to activities such as processing, packing, grading, etc. Obviously, crop diversification is associated with a much higher potential for secondary activities or linkage effects than that for rice.

As for the labor and management inputs consumed by irrigation, IIMI research in Sri Lanka and the Philippines shows that non-rice crops demand more labor for irrigation from farmers even though the irrigation interval can be broadened.

In the light of this discussion, it may be concluded that diversified cropping has a higher potential than rice monoculture in the following labor-related aspects:

I. Total labor absorption/employment generation.
II. Regularity in demand over time.
III. Employment in secondary activities (vertical expansion).
IV. Family labor utilization.

## 4.4 Capital Requirement

Capital requirement is defined as the summation of costs for current inputs, fixed capital (tractor and draft animal rentals), and hired labor. It is often said that OFCs are more cash intensive than rice. However, this is true for high-performance crops.

Average cash requirements for OFCs and rice are shown in Table 14. Among the OFCs, high-performance crops require more capital than rice. Capital requirement for high performance crops is nearly twice as much as capital needed of rice. This is mainly due to high input requirements such a fertilizer and chemicals and the high labor requirement for high-value crops. The other reason is that the prices of inputs required for high-value crops, such as seed and chemicals, are higher than the prices of inputs required for rice. Data shows that high-performance crops need twice as much capital requirement as for rice. Since capital is a constraint for most farmers, high-performance crop cultivation should be limited to a smaller extent of land.

The cash requirement for low-performance crops is less than that for rice. Low performance crops require less amounts of inputs compared to high-performance crops and input prices of low- performance crops (for inputs such as seed and chemicals) are less compared to inputs required for high-performance crops. As shown in the Table 11, in high-performance crops, the major share of the capital is taken by fertilizer and chemicals; it is roughly around 43 percent for chilli, 38 percent for big onion and about 35 percent for rice. For low-performance crops, chemicals and fertilizer takes around 12.6 percent of the total cost.

Changes in cash costs of selected OFCs and rice are shown in Figures 10 and 11. There is a clear indication that the real cost of cultivation for high-performance crops have taken an increasing trend from 1985 up to 1991 and declined thereafter, whilst the real cost of cultivation of low-performance crops has taken a decreasing trend. The increasing trend of cost of cultivation in high- performance crops could be mainly due to increases in prices of fertilizers after the removal of the fertilizer subsidy. In addition to this, chemical prices too increased after 1989 as a result of depreciation of the local currency. Impacts of these price increases on the cost of cultivation of high-performance crops are high since fertilizers and chemicals account for nearly 40 percent of the total cost.

Since chemical and fertilizer application is low for the low-value crops, the cost of cultivation for these crops did not take an increasing trend as a result of price increase in fertilizers and chemicals. However, the real cost has declined over time. The declining trend of cost of cultivation of low-performance crops indicates that the real wage rates have not increased over time, since labor takes the major share of the total cost of cultivation.

**Table 14. Costs of production of OFCs and rice, in the 1993 yala season, in '000 Rs/ha.**

| | High-performance crops | | Low-performance crop | | |
|---|---|---|---|---|---|
| | Chilli | Big onion | Green gram | Soya bean | Rice |
| Seed | 1.63<br>(4.1) | 8.82<br>(20.4) | 2.89<br>(24.1) | 1.58<br>(14.2) | 1.37<br>(7.4) |
| Fertilizer | 6.46<br>(16.2) | 13.14<br>(30.5) | 0 | 0.49<br>(4.4) | 4.92<br>(26.7) |
| Chemicals | 10.57<br>(26.6) | 3.30<br>(7.6) | 0.48<br>(4.0) | 0.92<br>(8.2) | 1.53<br>(8.3) |
| Implements | 6.50<br>(16.3) | 5.66<br>(13.1) | 1.77<br>(14.8) | 2.30<br>(20.6) | 4.38<br>(23.7) |
| Hired labor | 14.59<br>(36.7) | 12.20<br>(28.3) | 6.84<br>(57.1) | 5.86<br>(52.6) | 6.24<br>(33.8) |
| Total 1 | 39.75 | 43.12 | 11.98 | 11.15 | 18.44 |
| Total 2 | 53.19 | 54.53 | 16.51 | 17.28 | 22.02 |

*Source:* For chilli, big onion, soya bean and rice, data are from Cost of Cultivation of Agricultural Crops Yala 1993, Department of Agriculture, 1994.

For Green gram, data is from Kirindi Oya on-farm demonstration, 1989 yala season, published in Final Report of a study on Irrigation management for crop diversification, vol II, IIMI 1990.

*Notes:* Opportunity cost of family labor is valued by taking 0.7 of wage rate for hired labor.

Total cost 1: Total cost excluding family labor.

Total cost 2: Total cost including family labor.

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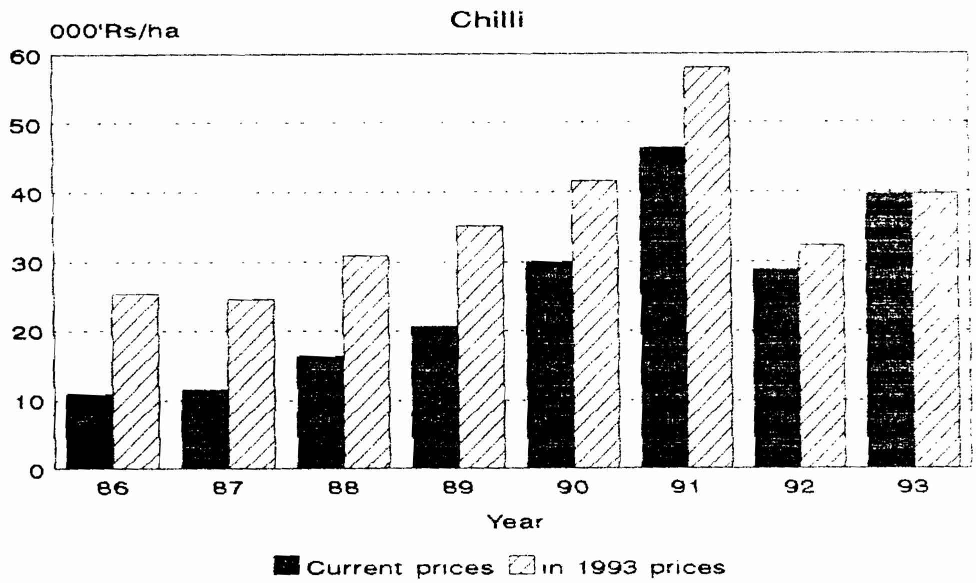
*Notes:* Opportunity cost of family labor is valued by taking 0.7 of wage rate for hired labor.

Total cost 1: Total cost excluding family labor.

Total cost 2: Total cost including family labor.

Figure 10. Cost of Cultivation of Chillie and Big onion



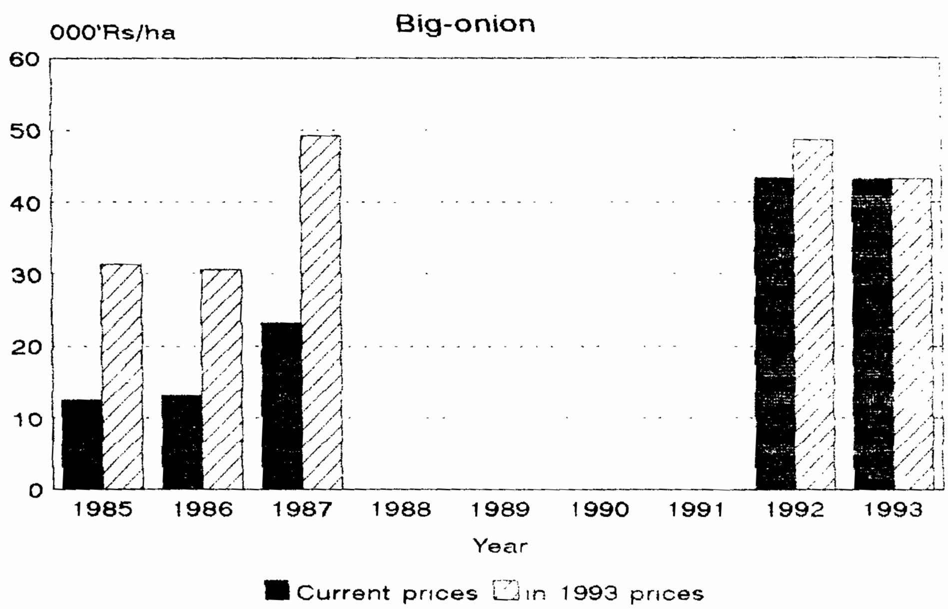
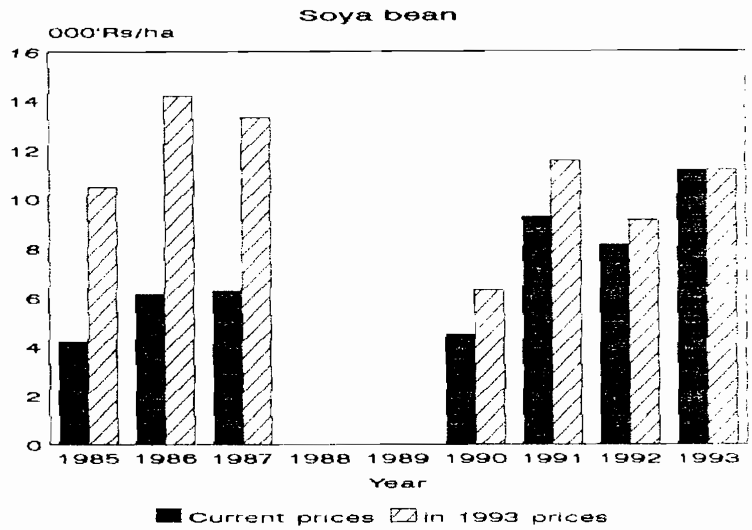
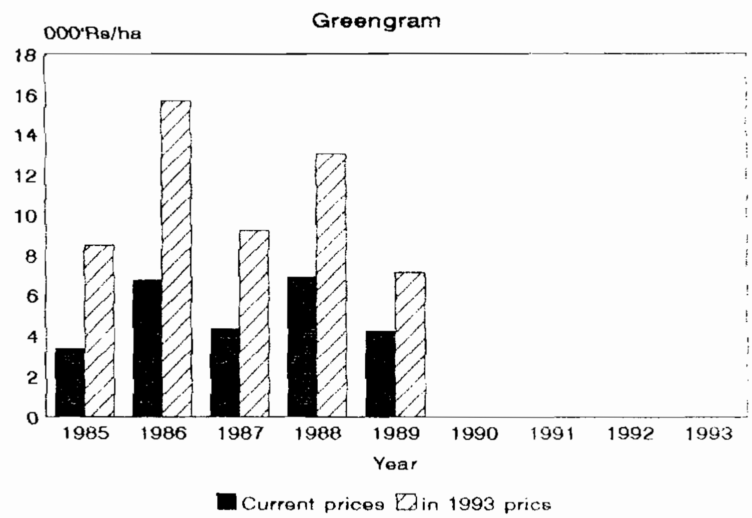



Figure 11. Cost of Cultivation of Soya bean and Greengram



## 4.5 Economic Performance of Other Field Crops

There are various indicators by which the economic performance of agricultural production can be evaluated. In this report, we use gross value added (returns to farm land, labor, and capital), farmers' net income, and returns to labor.

Table 15 provides a comparison of OFCs and rice in terms of selected financial indicators. This is mainly the profitability to the farmers. These calculations are based on the costs and returns data collected in the 1993 yala season in various districts. In the present condition, high-performance crops, except red onion, performs better than rice. Farmers could obtain twice as much income as for rice from chilli. Farmers' income from bin onion is nine times as the income from rice. Low-performance crops give incomes similar to that of rice. Since the above yield levels and price levels are good and would not increase significantly in the near future, except for red onion, the most remunerative crops compared to rice are chilli and onion. However, these results cannot be generalized since there are variations in yields, prices and costs between districts. The above data are for the districts where OFC cultivation is well established.

**Table 15. Farm Level Profitability OFC Cultivation under Irrigated Conditions, 1993 yala season, in '000 Rs/ha.**

| Crop | Yield mt/ha | Price Rs/kg | Gross revenue | Value added | Farmers income 1 | Farmers income 2 | Labor Productivity |
|---|---|---|---|---|---|---|---|
| <u>High-performance crops</u> | | | | | | | |
| Chilli | 1.02 | 76.27 | 77.80 | 57.84 | 38.05 | 24.61 | 153.14 |
| B onion | 12.86 | 13.67 | 175.80 | 149.41 | 132.68 | 121.27 | 434.33 |
| R onion | 8.59 | 13.38 | 114.93 | 23.11 | 7.93 | 4.88 | 70.76 |
| <u>Low-performance crops</u> | | | | | | | |
| Green gram* | 0.65 | 27.89 | 18.19 | 14.47 | 6.21 | 1.68 | 53.23 |
| Soya bean | 1.54 | 18.00 | 27.72 | 24.27 | 16.57 | 10.44 | 157.59 |
| Rice | 4.18 | 7.70 | 32.19 | 23.49 | 13.75 | 10.17 | 214.50 |

*Source:* For chilli, red-onion, big-onion and soya bean, data are from Cost of Cultivation of Agricultural Crops, Yala 1993, Department of Agriculture, 1994.

*Notes:* * Data for green gram from Kirindi Oya crop demonstrations in 1989 yala, published in the Final Report on Irrigation Management and Crop Diversification Vol II, IIMI, 1990.
Farmers income 1: Without taking opportunity cost of family labor
Farmers income 2: including opportunity cost of family labor.

Since profitability is the key factor that determines the adoption of OFCs, expansion of OFC cultivation would depend on the past trends in profitability. Costs and returns data collected by the Department of Agriculture is used to analyze the trends in costs and returns for selected crops. One limitation of using these data is that the location of data collection varies from year to year. These variations may be due to location-specific reasons.

Trends of profitability in OFC cultivation for chilli, onions, green gram and soya bean are analyzed from 1985 in Figures 12, 13 and 14. According to the trend analysis, profitability of all selected crops, except big onion, shows a declining trend or stagnation . This implies that incentives for crop diversification are becoming unfavorable. Although the real cost of cultivation in low- performance crops show a declining trend, profitability has not increased. This is mainly due to declining the farm-gate prices and stagnating yields. As shown in Figure 15, yields of green gram and soya bean show a declining trend. However, fluctuation of soya bean yield is high compared to green gram.

Profitability of chilli has not changed since 1991 despite a decline in cost of cultivation since 1991 and stagnation of chilli yield (Figure 16). However, higher farm-gate prices received for chilli during 1991 and 1992 compensated for the low yield levels. The average yield of chilli is far below the potential yield (dry chilli: 2,000 kg/ha). Profitability of red onion has declined drastically since 1987. This is mainly due to both a decline in yield and a decline in price. The price decline is obvious since production has reached the level of demand. The profitability level of big onion continued to remain at a high level since 1985. The main reason is the increase in yield over the past eight years (Figure 16). At the initial stage of big onion cultivation, farmers lacked experience and there had been problems in obtaining quality seeds. This situation improved after farmers gained the technology of big onion cultivation and the improvement of the seed supply. As a result, yields increased from 5 mt per ha to around 10 mt per ha. However, there has been reports that farmers in Matale suffered losses in 1991 due to low prices prevailing even one moth after harvesting. Low quality of local big onion and lack of market information to the producer are the reasons given for such price drops. However, prices show a declining trend. Prices could further decline if the production exceeds the requirement. The main problem faced by farmers in big onion cultivation is market gluts at the time of harvesting; staggered planting is difficult in the Dry Zone.

Figure 12. Costs and Returns of Chilli Cultivation, in 1993
Constant Prices

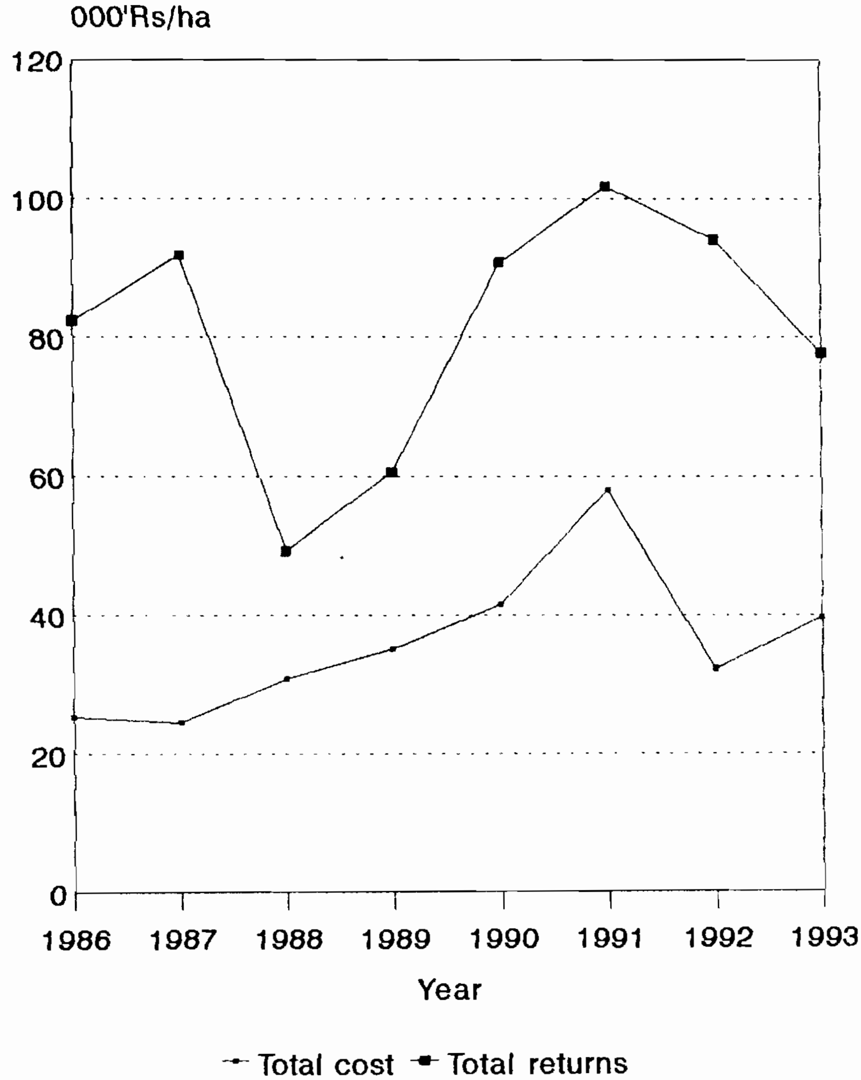


Figure 13. Costs and Returns of Onion Cultivation, in 1993 Constant Prices

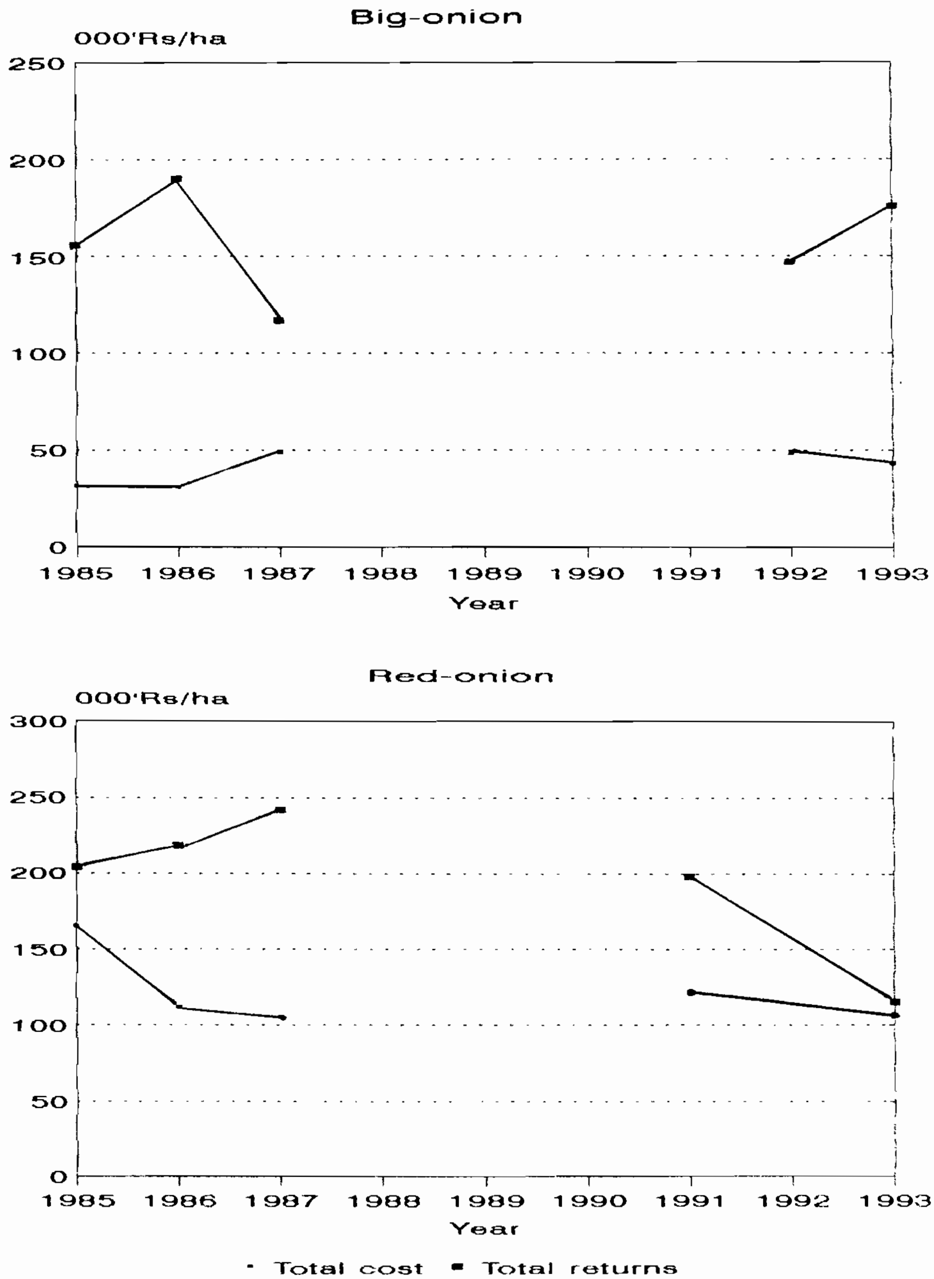
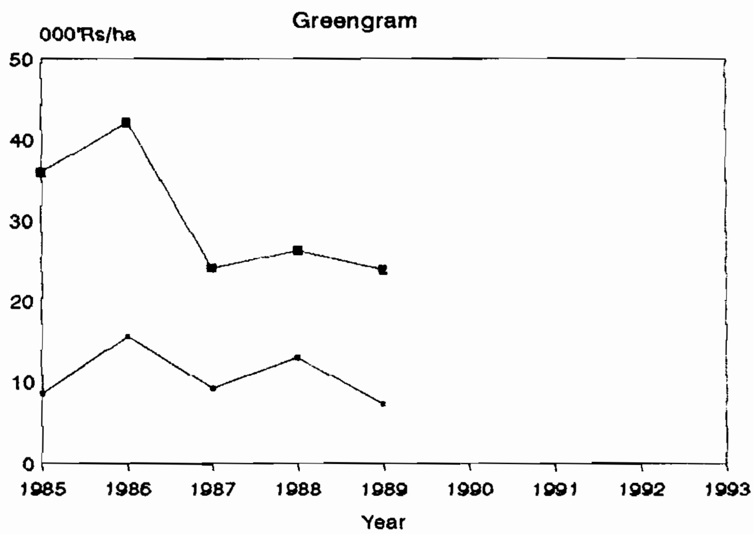


Figure 14. Costs and Returns Greengram and Soya bean Cultivation in 1993 Constant Prices



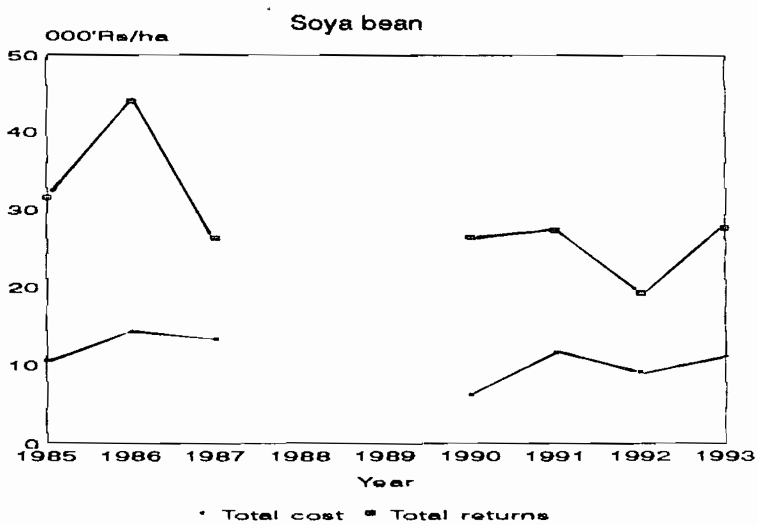
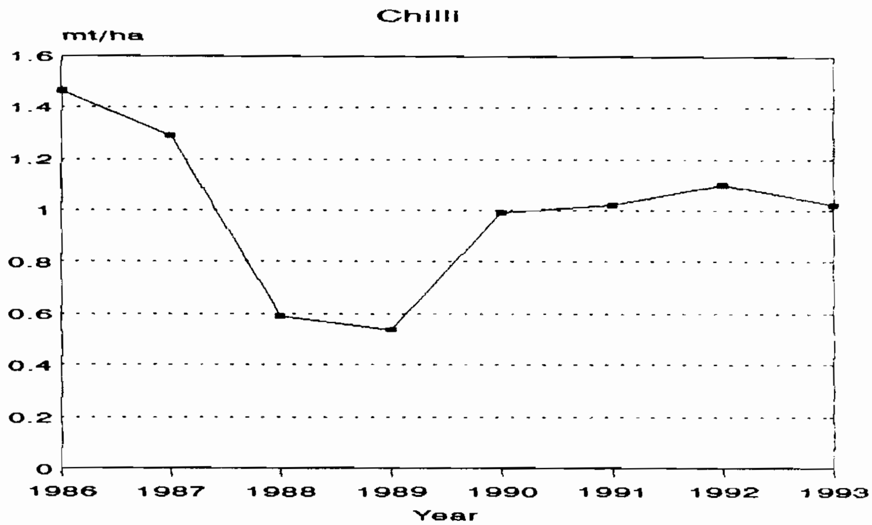



Figure 15. Yield Trends of Chilli and Onion



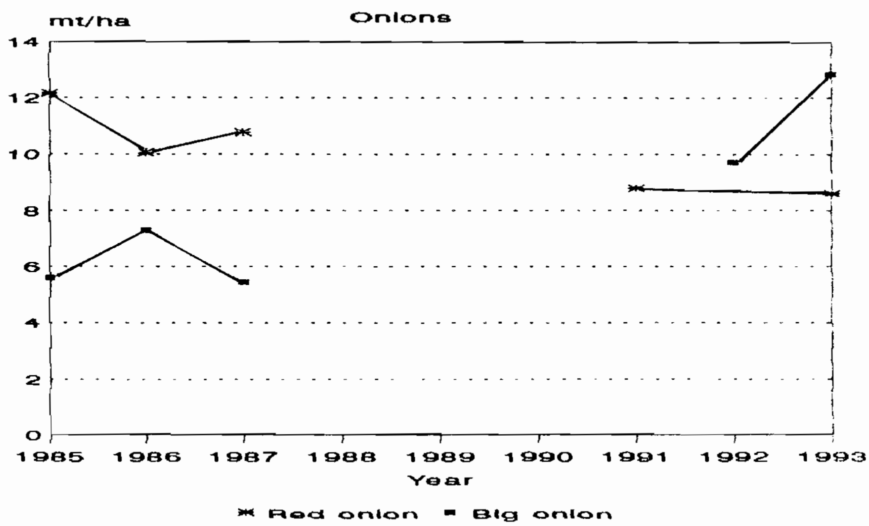
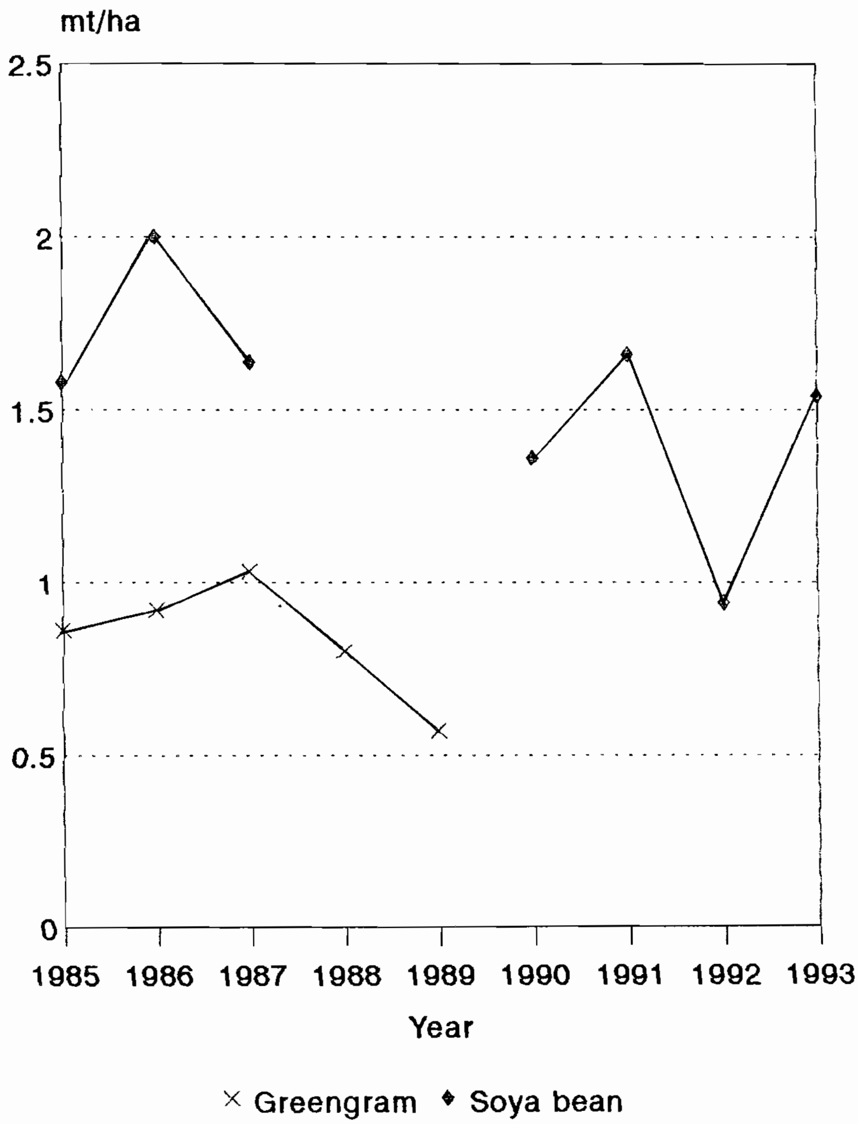



Figure 16. Yield trends of greengram and soya bean



It is important to store good quality bulbs that are being harvested at the peak of the season to avoid a market glut. However, unlike red onions, big onion cannot be stored for a longer period. The price margin required to justify onion storage for two months is estimated to be Rs 13 per kg (P. S. Pattie and Y. M. Wickramasinghe 1993). With storage facilities, big onion production could cover the market demand for five months. Storage of big- onion is possible only for 3 to 4 months under less-expensive methods. Therefore, the local production should be limited to six months' local requirement.

**Economic Costs and Returns of Rice and Other Field Crops.**

A comparison of costs and returns, in economic prices, of rice production and OFC production is given in Table 16.

Table 16. Economic costs and returns of rice and OFCs production

| Crop | Economic farm-gate * price Rs/kg | Total cost 000' Rs/ha | Total returns 000' Rs/ha | Cost of production Rs/kg | Yield mt/ha | Minimum yield mt/ha |
|---|---|---|---|---|---|---|
| Chilli | 49.25 | 42.62 | 7.62 | 41.78 | 1.02 | 0.86 |
| Big onion | 11.79 | 42.96 | 22.83 | 7.70 | 5.58 | 3.64 |
| Green gram | 15.61 | 20.86 | -2.42 | 32.09 | 0.65 | 1.34 |
| Soya bean | 18.05 | 14.39 | 13.40 | 9.35 | 1.54 | 0.79 |
| **Rice** | **7.29** | **17.03** | **13.44** | **4.07** | **4.18** | **2.34** |

*Notes:** Economic price = C.I.F price + port charges + economic transportation cost + economic handling cost + economic storage cost. Economic prices are for Anuradhapura area.

Minimum yield is the break-even yield
Economic values were obtained by multiplying financial values by a conversion factor (0.723). source: Report on Shadow Prices for Sri Lanka, Development and Project Planning Center, Bradford University UK, 1991.

It is interesting to see that economic profitability of production of rice under major irrigation is higher than the economic profitability of nonrice crops, except for big onion. Among the OFCs, big onion gives the highest economic returns. This analysis shows the comparative disadvantage of the local production of green gram. The break-even yield for green gram is 1.34 mt/ha, which is a most difficult yield to obtain. Production of chilli, big onion and soya locally is justifiable. However, the progress of diversification depends mainly on its financial profitability to the farmer, and input and market constraints for the cultivation of these crops.

### 4.6 Other Potential Crops

Vegetables are the other nonrice crops that have a potential to grow in rice lands. However, risk in cultivation of vegetables is very high compared to other nonrice crops. Price drops during the harvesting period is a major constraint for vegetable cultivation. Since good infrastructure facilities for the marketing of vegetables are not available in most irrigated areas, it could be difficult to promote large-scale cultivation of vegetables in these areas. In general, profitability of most vegetables are low compared to other nonrice crops. Table 16 shows the costs and returns for selected vegetables under irrigated condition. Profitability of such vegetables seems to be very high. However, cost of cultivation is also high in order to obtain higher profits. Another major constraint in vegetable cultivation in rice lands is the drainage and soil factors. Initial land preparation costs will be very high because conversion of land that had been prepared for rice cultivation during the maha season into land for vegetable cultivation involves a lot of work. Banana is another suitable crop that gives high profits to farmers. A significant extent of rice land in Uda Walawe has being cultivated with banana. The extent of banana cultivation in Uda Walawe increased from 136 ha in 1982 to 2,000 ha in 1994. Development of a good market in the area supported the rapid expansion of banana in Uda Walawe. A rough analysis of costs and returns of banana is presented in Table 17. Cost of cultivation for banana is a little higher than that of low-performance crops but less than that for chillies. Unlike the other OFCs, banana crops could last for about five years and give an income throughout this period. The initial cost is high in banana cultivation, which is about Rs 22,900 per ha. And the annual maintenance cost is around Rs 18,400 per ha. The advantage in banana cultivation is that the annual cost of cultivation could be spread out in a smoother way by staggered planting. Income from banana is high compared to other high- performance OFCs.

Apart from banana, the other promising nonrice crops that could be cultivated in rice lands are tuber crops. Data to evaluate the economic profitability of these crops are not available. However, the DOA extension officers reported that in places like Rajangana, farmers have obtained high returns from tuber crops such as sweet potato and *Kiri Ala*.

**Table 16  Costs and Returns of Vegetable Cultivation, in 000' Rs/ha.**

| | Bush Beans[a] | Tomato[b] | Pole beans[c] |
|---|---|---|---|
| Yield Kg/ha | 2.73 | 11.93 | 9.62 |
| Price Rs/Kg | 18.21 | 12.00 | 16.30 |
| Production costs: | | | |
| Inputs | 13.75 | 36.26 | 40.74 |
| Hired labor | 3.79 | 8.36 | 13.12 |
| Implements | 1.33 | 0 | 0 |
| **Total Cost** | 18.87 | 44.62 | 53.86 |
| **Gross revenue** | 49.75 | 143.16 | 156.81 |
| **Farmers' income** | 30.88 | 98.54 | 102.95 |

Note : Costs and returns are based on 1993 price
a. Matale district
b. Badulla district
c. Badulla district

**Table 17  Costs and Returns of Banana Cultivation, in Rs/ha.**

| | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** |
|---|---|---|---|---|---|
| Land preparation | 5000 | 400 | 400 | 400 | 400 |
| Planting | 400 | - | - | - | - |
| Manual weeding | 4800 | 4800 | 4800 | 4800 | 4800 |
| Fertilizer application | 400 | 1600 | 1600 | 1600 | 1600 |
| Earthning | 2400 | 2400 | 2400 | 2400 | 2400 |
| Harvesting | 400 | 3600 | 3600 | 3600 | 3600 |
| Others | 1600 | 1600 | 1600 | 1600 | 1600 |
| Inputs : | | | | | |
| Planting materials | 2700 | | | | |
| Fertilizer | 4000 | 4000 | 4000 | 4000 | 4000 |
| Total cost | 20500 | 16000 | 16000 | 16000 | 16000 |
| Yield Kg | 2000 | 12000 | 14000 | 13000 | 10000 |
| Price Rs/kg | 12 | 12 | 12 | 12 | 12 |
| Gross income Rs. | 24000 | 144000 | 168000 | 156000 | 120000 |
| Net income Rs. | 3500 | 128000 | 152000 | 143000 | 110000 |

Source : Deputy Residence Project Manager, Uda Walawe Project, Mahaweli Economic Agency, Embilipitiya.

Note : Costs and returns are based on 1993 prices.

## 4.7 Credit

More often than not, credit and marketing are tied together. For instance, "middlemen" finance farmers in return for the produce a-- commitment made much in advance of the harvest. It is argued that this limits the opportunity for new markets to get started and it may also lead to *inflexibilities* in marketing which hampers the free flow of goods to the best market outlets. Farmers are often obliged to sell produce to money lenders at prices substantially below those in the free market. Good characteristics of advanced competitive future markets or "forward buying" mechanisms are not seen in these transactions due to *the weak bargaining position of the farmer.*

Provision of *credit* is also crucial to the *effective use of a variety of inputs* in crop diversification. In lending to small farmers, lending mechanisms (or institutions) may have to adopt a liberal approach with acceptable procedures and interest rates. The provision of *timely and "need-based" credit* should also be closely supervised. Among other things, the following may also be considered in lending credit to these farmers:

a) Provision of credit not only for short-term or seasonal production, but also for medium and long-term investment needs associated with handling and processing of farm produce (e.g., sprayers, threshers, processing equipment, etc.).

b) Catering to the financial needs of farmer organizations and marketing institutions.

c) Instilling the habit of saving as well as motivating farmers and farmer organizations to mobilize to carry out the aforementioned functions.

d) Adequate supervision and, follow-up and concurrently, the deployment of sufficiently trained staff for supervision and extension activities.

## 4.8 Research and Extension

In spite of the importance of the role of research and extension in crop diversification, a detailed discussion on this subject is not intended here and is beyond the scope of this paper. A wealth of knowledge on different aspects of crop diversification has been accumulated over the recent past through research and development, which may be required in tackling economic, social and institutional issues relevant to diversification. *In the long run, the demand for factors of production (including water) for a given cropping patter derives not only from the nature of soil and climatic factors but also from prospective markets for crops included in that cropping pattern, the ability and willingness of the farmers to make use of the water and other factors of production, variability in income over time, etc. All these aspects need close examination.*

Farm incomes, for example, varies from time to time for one reason or another. Fluctuations of prices and weather, innovations of new technology, changes in institutions and the economic structure are some of the reasons which cause the variation of farm incomes over time.

Unplanned entry of numerous procedures from different areas in a given season may also affect the variation and stability of incomes. From a national point of view, *basic resources such as land, labor and capital must be used efficiently in all farming areas of the country; they must be distributed efficiently between alternative opportunities.* In the long run, *regional specialization based on the principle of comparative advantage may become a price consideration by respective economies.* These aspects which are related to supply and demand may be considered in formulating an agenda for research in crop diversification in the future.

## 4.9 Farmer Perception and Attitudes

Modern rice monoculture by no means should be regarded as "primitive." However, it is characterized by long-established routines with respect to all production activities. Hence, in farmer's perception, adoption of a new cropping pattern is associated with risks and uncertainties as yet "unknown." Before adoption, a typical farmer whose aim is to avert risks would look for higher profit margins, long-run stability in income, etc. In addition, risk is associated with a variety of factors: *profitability,* (crop failure) is only one. Others include: magnitude of *cash expenditure, fluctuations in prices, lack of experience, stability in markets and marketing, etc.* As discussed elsewhere, the merit of diversified cropping in relation to some of these factors, such as stability of income, markets, etc. are yet to be known. This explains farmer reluctance and the low rate of adoption of diversified cropping in some areas.

## 4.10 Group Action by Farmers

Benefits of group action by farmer participants is much higher in a *diversified cropping pattern* than in a *monocropping condition.* Different crops demand different types and quantities of cultivation practices and inputs at different times. When a group of farmers use a common source of input, say for example, irrigation water, group action is necessary to maximize the benefits to such an input, especially if it is scarce in supply. In regard to certain other inputs or outputs, group action can benefit from economies of scale.

It may not be difficult to overcome many of the problems discussed in this report, once the farmers are organized into groups. Transportation in marketing is a good example. Bulk handling could economize the cost of transportation and thereby per--farm costs may be minimized. Over-dependence on local outlets can also be reduced by group action: farmers can then look for better outlets. Furthermore, collective bargaining is usually helpful in pricing the farm produce. Likewise, many other activities in input and output marketing can be conveniently organized and handled by farmer organizations.

## 4.11 Interaction Among Participants

Throughout this paper, it was highlighted that the success of crop diversification in Sri Lanka, with large number of small-scale farmers, would depend on a large number of factors which belong to different disciplines. Hence, interactions between different "participants" are essential to achieve the success. These may include:

a) Farmer-farmer interactions (see section 4.9 above).
b) Farmer-agency interactions.
c) Agency-agency interactions.

For example, a large number of government departments/agencies (such as Irrigation, Agriculture, Cooperatives, etc.) are involved in promoting agricultural production. A close collaboration between these agencies is required to *promote crop diversification*, especially at the initial stages.

## 4.12 Impact on Living Standards

Impact of diversified cropping on the living standards of, people depend on a variety of factors. In addition to those who practice diversified cropping, may others may also the benefit from crop diversification due to linkage effects or vertical expansion; for example, *employment generation through handling, processing, expansion of input and output markets and through the increased demand for agricultural labor. It may also be argued that the increased availability of a variety of food crops, in general, would improve the living standards of hundreds and thousands of consumers.*

As *food production*, it may also be assessed in terms of *efficiency in nutrient production per unit area of land (or water) per unit of time.* One may consider protein and energy as the major factors in the diet in rural areas. Furthermore, the kind of amino acids in protein is also a crucial factor. Methionine and lysine, for example, are important in the tropical diet.

In general, *crop diversification provide foods of higher nutritive value.* For example, while a mon-culture of rice may yield a higher amount of energy per unit of land, if it is rotated with *legumes*, such a system could provide higher levels of protein as well. Moreover, the quality of proteins in legumes, usually, are superior to that of rice. Soya bean, for example, contains about 45 percent of protein with higher levels of methionine. Furthermore, the life span of most of the legumes commonly included in diversified cropping is much shorter than that for rice. In this way, it could be argued that *diversified cropping has a higher potential for improving living standards.* Especially in areas where malnutrition protein-deficit diets are predominant, due to *rice-legume combination may be a better agricultural production system.*

Factors affecting the quantity of production and profitability have been discussed earlier in this paper. Profitability influences the capacity to spend on non, food items as well. The overall impact of crop diversification on living standards of people engaged in producing those crops would mainly depend on the distribution of factors of production in respective areas. The composition of owner-cultivators, tenants, agricultural laborers, etc., is a decisive facto, in this case.

Other factors affecting food distribution would include: *economic* aspects such as price policies, income disparities, marketing problems, national and international trade policies; *demographic* factors; *cultural* factors such as social status, modernization and food benefits, and health and nutrition services. Obviously, food utilization may also vary from area to another or form person to person.

## CHAPTER 5 - SUMMARY AND CONCLUSIONS

This chapter presents a summary of the major findings and attempts to draw some conclusions focussing on suggestions for future directions for diversified cropping in rice lands.

Rice cultivation continues 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 the turning point. Since then, key determinants of total production such as yield level and area covered did not show a clear rate of growth, especially in irrigated areas. The cropping intensity, which had been stagnating over a long period, also did not show any significant improvement. Moreover, the increase in market price of rice in the recent past has failed to compensate for the increase in the cost of production. **On the other hand local demand for this basic staple food will continue to rise- at least for a few decades. Despite the low growth rate in population, annual increase in population will remain at higher levels for some more time because the base population is high. Therefore, it is crucial to explore the possibilities for improving the efficiency of rice production.** In the context of uncertain (world) prices for rice, declining growth rates of production and eroding profit margins, it would be prudent to explore the potential for future increments in productivity of scarce factors of production, increasing cropping intensity and checking the cost of production.

Research into appropriate crop management techniques should also investigate the comparative long-term productivity of the continuous cropping of rice (with high levels of agro-chemical inputs) versus alternative rice-based cropping patterns, **in areas where agro-ecological factors are conducive to such pattern.** In such cases, providing "break crops" into a rice cropping system would help regenerate soil fertility, reduce weeds and pest build- up, and provide more diversified options to sustain total household incomes. Grain legume crops such as green gram, leguminous green manures or vegetable crops may be particularly suitable rotation crops with rice. Improving crop yields (both rice and nonrice) in such systems may be achieved through improved input use efficiencies. Obviously, improving irrigation management efficiency would be the key factor. Additionally, integrated plant nutrient management, integrated pest management, etc. should also be considered.

> **Hence, future policy in this major staple food sector should be two fold : maintain a high degree of self-sufficiency in rice *and* encourage diversification in areas possessing comparative advantages for other field crops. It is argued that this "dual objective" can be achieved through a proper mix of appropriate technology, organization and resources.**

For instance, availability of water resources for crop production can be augmented through a judicial combination of surface water and ground water an by optimizing the use of rainfall through proper timing of planting operations. Depending on agro-ecological suitability, more profitable cropping patterns be established through organized groups action by small farmers.

## a. Recent Trends in the Cultivation of Other Field Crops (OFCs)

Diversified cropping in paddy lands has primarily been centered around Other Field Crops such as chilli, onions (red-onion and big- onion), green gram, cowpea, black gram, soya bean, groundnut and vegetables. To a lesser extent banana, sweet-potatoes, gingerly and gherkin have gained importance in specific areas. The rain-fed uplands in the dry and intermediate zones have provided the bulk of OFC requirement in the past. Almost all the maha season (wet season) OFC cultivation in Dry Zone is rain-fed. Lately, irrigated upland under lift irrigation and dry season well-drained paddy land under gravity irrigation contributed to an increasing supply of OFCs.

Recent trends in the production of selected major OFCs are indicated below:

- Although **chilli** records the highest extents grown in 1976/77, the production over the years, in general, has shown an increasing trend up to 1986, after which it remains stagnant. However, in the past decade (1982-92), a clear shift from rain fed to irrigated chilli in rice fields was evident with irrigated chilli reaching the peak in 1986. This, in turn, has resulted in an increase in crop yield and total production. At present, however, the yields are being threatened due to pest and disease attacks.

- In the case of **big onions**, the extents grown increased appreciably from 1981 to 1988 and thereafter there was a very rapid increase -- almost four-fold from 1989 to 1991.

- **Green gram** showed a consistent increase whereas **cowpea** showed a decreasing trend recently.

- No trend can be discerned in **soya bean** and the marketing/price factors have influenced sudden increases and shortfalls.

- Maize has remained somewhat stagnant.

- **Yam** production which grew through the 1970s, reached a peak in 1978 (due to policy interventions) decreased to a lower plateau lately under rain-fed conditions, while potato showed an increasing trend. Sweet potato has been gaining popularity lately.

The general reasons for the recent trends in OFC cultivation especially the fluctuations in supply, can be classified under several categories: climate, markets and prices, availability of substitutes--mainly imported--and , to a lesser degree, factors such as pests and diseases, and crop management. It can be concluded, however, that a substantial achievement is clearly evident in irrigated areas. While the Mahaweli H system has been able to achieve its full potential of

OFC cultivation on well-drained lands in the dry season (12,000 ha) over the period 1979-87, parallel developments have also been observed in other large systems and in small tank commands in the Dry Zone. The OFC cultivation on the well-drained rice lands in small tank systems and in uplands (under irrigation) received a further impetus from the late 1980s by the introduction of dug wells.

**The maximum irrigated area brought under OFC (in rice lands) so far in one crop season was around 40,000 ha. This has not exceeded 10 percent of the total area cultivated in any given season. The study revealed that diversification in recent times has been mainly confined to both major and minor tank systems that have deficit or inadequate irrigation supply during the dry season. However, because of the high year-to-year variation in this limited dry season water supply, the total extent of dry season OFCs that could be cultivated will also show a high degree of variation between years. Despite the fact that seasonal as well as annual variations in production are prominent, it can be concluded that the country has achieved a very high degree of self-sufficiency in regard to major OFCs: chilli, onions (red and large), green gram, black gram, soya bean, groundnut and vegetables. Irregularities in supply of these products can be reduced to some extent by: assisting farmers and farmer organizations in key producing areas (reference text for "key areas" for specific crops) to program their production, improving database and forecasting supply - demand on a seasonal basis, proper timing and adjusting of imports based on local supplies, proper storage and improved post, harvest technologies and better organization, including transport.**

b. Agro-Ecological Factors

In the context of diversified cropping, the lower level of flexibility of agro-ecological factors assumes special significance in semi-humid and humid tropical environments of south and south-east Asia when compared with the semi-arid tropics of India and West Asia. In the latter case, a greater flexibility of a switch between rice and nonrice cropping is possible because of the specific soil and environmental conditions that exist/there. ***Hence, it is not possible to project an exclusive "across-the-board" economic approach in addressing this issue of crop diversification on rice lands in Sri Lanka.***

Based on the study analysis, the present status and future potential of different categories of irrigated paddy land for diversified cropping could be summarized as follows:

*Category I* *Major Irrigation Schemes with Adequate Water Supply in Both Seasons*

(a) *Maha (Wet) Season* : all rice, except for some portions of water-deficit systems like Kirindi Oya and Huruluwewa.

(b) *Yala (Dry) Season* : only the well-drained soil areas.

*Achievement (in the best season)*

- Mahaweli H and Walawe -----> 75 - 80 % of potential of well-drained lands
- Other Systems -----> 40 - 50 % of potential of well- drained lands

Note : In Mahaweli System H, direct government intervention in the form of marketing assistance, etc., was significant.

*Potential* -----> 90 - 100% of well-drained lands.

*Category II : Major Irrigation Schemes with Adequate Supply for Main (Wet) Season and Inadequate Supply for (Dry) Yala Season*

Irrigation systems falling under this category are characterized by low stability (or high variability) in irrigation supply during the dry season.

a) Maha (Wet) Season : all rice, depending on water supply.

b) Yala (Dry) Season : only on well-drained areas.

Achievement( in best season) : average between 50% to 70% of well-drained lands.

Potential : 70 - 80% of well-drained lands.

*Category III : Medium Schemes with Moderately Stable Water Supply for Maha (Wet) season.*

- Low stability especially in the dry season supply.

The record of OFC cultivation has been very low. About 20-25 percent of the command area is made up of well-drained soils. Further research is recommended to examine the reasons for low performance. The maximum potential for OFC cultivation in the Dry Season will not exceed 10 percent of the total command area. However, with improved organization and management and through improved support services, maha season OFC cultivation too may be attempted to a limited extent. Both in maha and yala seasons, conjunctive use--combining dug well supply and tank supply--may also be attempted. The maximum extent that could be brought under OFC, however, may not exceed 25 percent of the total command area during the yala season.

*Category IV :* *Minor Irrigation Schemes with Unstable Water Supply*

- Water supply is unstable even during the maha season.

- Cultivation of OFCs has been at very low levels.

However, Dimantha (1987) also points to the possibility of growing OFCs in the Dry Zone on the 185,000 ha under minor irrigation schemes by availing of the short rainy period in April/May, and making sufficient provision for adequate drainage in case of unseasonal rains. This is already taking place in some minor tank systems in the Anuradhapura District in *combination with agro-wells as* discussed earlier (Section 3.4 Category 4). Due to water scarcity, unsuitable soil conditions and other reasons, it may not be possible to bring the entire 185,000 ha of category 4 lands under OFC cultivation in the dry season.

The close monitoring of dug wells to assess the "supply conditions," including quantities, spacing/density of wells and costs etc. This may lead to a "regulated expansion" of OFC cultivation in such systems. *This may be assigned a "high priority" on an experimental basis in the initial phase.*
An increase in overall cropping intensity may also be expected here.

**It has been estimated that the extent of well-drained land in major irrigation schemes of the Dry Zone is approximately 80,000 ha. As reported in Table 3, the highest extent of non-rice crops grown in the major irrigation schemes of Category I in the Mahaweli (Kalawewa), Uda Walawe and Polonnaruwa districts was around 16,700 ha; and in Category II of the Anuradhapura, Badulla and Mullaitivu districts (Table 4) it was around 5,200 ha. Assuming that all this is on well-drained land, there is yet a considerable extent of more than 40,000 ha of suitable land available for dry season crop diversification under the major irrigation systems of the Dry Zone of Sri Lanka.**

**In summary, it could be stated that, as far as suitable land for dry season crop diversification is concerned, there is no shortage under the various categories of irrigation systems. Water supply rather than extent of suitable land is therefore recognized as the main physical constraint.**

c. Irrigation--Related Factors

Specially in major irrigation systems designed for rice cultivation, the present procedure of aligning field channels traversing well-drained, imperfectly drained and poorly drained soils is not conducive for efficient operation when OFCs are grown in the upper reaches while rice is being cultivated in the lower reaches. Hence, separate provision of parallel field channels for "rice" and "OFC" soils would facilitate better system operation, effectively intercepting the drainage flow and increasing on-farm water use efficiency. Moreover, in such systems, density of drainage ditches need to be increased for efficient cultivation of OFCs.

In addition, OFC cultivation in rice-based systems may require seasonal adjustments in land preparation - perfect levelling, raise beds, etc. Further, when compared to rice, OFC cultivation demands more flexibility in control structures including individual farm outlets. Operationally, detailed planning and implementation of irrigation schedules and matching them with crop schedules also, are necessary for OFCs.

**However, as more flexibility exists in the "supply" side of suitable lands, these difficulties in irrigation management, to a certain extent, may not inhibit the expansion of diversified cropping in rice lands.**

d. Economic factors

**Economic factors, especially markets, prices and trade policies, can be quoted as the most important determinants in the future expansion of diversified cropping in rice lands. The price analysis shows a general trend in declining prices for most OFC, despite the high variation over time and space. According to trend analysis, the profitability of almost all major OFCs show a declining trend. Analysis of the price factor and the comparison of predicted demand/ supply conditions support this argument. As stated earlier, the study revealed that the gap between national requirements and current production levels is narrowing down or is non-existent in most of the major OFCs. This phenomenon of narrowing the gap between demand and local production coupled with the increase in cost of production explains the declining trend in profits.**

For an example, estimated requirements and expected levels of production of major OFCs in 1994 are given as follows:

| | Requirement ( 000 mt) | Estimated production ( 000 mt) |
|---|---|---|
| Chilli | 52.0 | 59.3 |
| Onion (red and big) | 203.0 | 205.8 |
| Groundnut | 12.5 | 13.5 |
| Soya bean | 59.0 | 30.7 |
| Cowpea | 19.5 | 19.5 |
| Green gram | 38.0 | 47.7 |
| Black gram | 15.5 | 16.0 |
| Maize | 103.0 | 89.5 |
| Sweet potato | 135.0 | 135.0 |
| Potato | 118.0 | 102.0 |

**In the light of this analysis, it can be concluded that, if the "supply" coming from non-rice areas remains unchanged, the rice area that should be diversified in order to satisfy local demand is around 40,000 ha. The country has reached this level in the recent past.**

**It is likely that the produce from areas such as Jaffna and Killinochchi will add on as current disturbances ease.**

It should be noted, however, that even though the income effect of demand is not that significant, the local demand will increase due to population increase. Moreover, annual fluctuations in supply in the recent past were significant. Despite the fact that the climatological influences on such fluctuations are difficult to control, regularity in supply and price levels may be attempted through a combined effort of integrated land and water management, improving database and information systems, demand an supply forecasting on a seasonal basis, helping farmers/farmer organizations in scheduling production based on expected demand/price levels, improving input use and the adoption of appropriate technologies, improved links between the farming community and the organized private sector, group action by farmers (including small farmer companies), value-added production, and improved support services including input supply, packing, grading, transport, etc.

**In the recent past, cultivation of certain new crops such as gherkin, cantaloupe, fine beans, etc. has been recorded in a small scale in certain irrigated areas. Sustainability of these ventures has yet to be evaluated. Specialized cultivation of special crops for identified captive markets should be encouraged.**

**Farm-level profits should be the major consideration in any future efforts in OFC cultivation. Because the country has approached a very high degree of "self-sufficiency" in regard to almost all the major OFCs, large-scale expansion of such crop, if not market oriented, may result in a decline in farm-level profits. Any large-scale expansion of diversified cropping in rice lands, therefore, should be focussed on "special crops for special markets." It is clear that the search for new crops with comparative advantages become vital. More attention need to be paid to increase agri-business opportunities that help value adding, market search and promotion, quality control and export.**

The study conducted a preliminary analysis of comparative advantage of OFC and rice production by comparing the economic and financial costs and returns. It was revealed that the local production is advantages for many crops (including rice). Greengram was an exception. Economic profitability of rice production under major irrigation schemes is higher than that of other OFCs included in the analysis, except for Big onion. It should be noted, however, that cost of water was not considered in this analysis.

### (e) Role of Farmers vis-a-vis the Government

With the increased emphasis on diversified agriculture, value-added production and improved linkages between agriculture and industry, the service needs of the agricultural community will be changed -- they need more intensive and varied services. The government intervention pattern should be changed--from one of nurturing and perpetuating of a dependency syndrome to one of motivating and assisting farmers to organize and manage their own system of production and support services. These may include technical and organizational assistance for planning and scheduling of crop production, storage, packing and grading, transport, and linking small farmer organizations and small farmer companies (in a legally binding and efficient manner) with commercial lending institutions and with the organized private sector in marketing and processing and in maintaining the quality and the timeliness of supply of different raw/processed commodities, based on demand. There is evidence in many developing countries that farmers, even those with small holdings, make production responses to the economic environment, especially when they can exercise greater control. This can be achieved through *collective action* -- federated farmer organizations and through *small farmer companies*.

Hence, it is obvious that there is a need for continued government intervention in diversified agriculture, mainly in *extension*, but different from the approaches adopted in the past. It should support intensified and strengthened organizational activities on the part of farmers. In this context, it is imperative to encourage group action of farmers, for example, through farmer organizations, to ensure progressive expansion of users' role in the management control of resources and services. The government and NGOs could "catalyze" or facilitate this process.

The government should also play a dominant role in appropriate research in areas such as newer crop varieties for special markets, off-season production, programming/scheduling production through group action by farmer organizations, demand and markets, market information systems, storage and post-harvest technologies, semi- processing at farm/village level, processing of value-added products/agro-based industry, transport, quality control, legal mechanisms and environmental concerns. Moreover, the government should perform a regulatory role in quality control and conservation/environmental concerns.

**It evident from the study that the database on diversified cropping--including basic information such as extents and crop yields - is weak. Inconsistencies and errors evident, and discrepancies between different sources (such as between Dept. of Agriculture and the Dept. of Census & Statistics) exist. It is essential to establish proper mechanisms to maintain an accurate spatial data base. Such a database is required for production scheduling (by farmer organizations to strike a good balance between supply and demand); adjusting imports (quantity and timing), to have a check on quality and quantity control, and last but not least, to provide information to the farming community and traders. It is proposed to develop a database using a geographic information system (GIS).**

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Table A1.1. Cultivation of Other Field Crops in Paddy lands, yala season.

| Year | Chilli | Red onion | Big onion | Green gram | Cowpea | Black gram | Soy bean | Ground-nut | Others | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Irrigated condition** | | | | | | | | | | |
| 1982 | 2,416 | 455 | 16 | 1,193 | 995 | 33 | 176 | 303 | 3,311 | 8,898 |
| 1983 | 5,581 | 614 | 133 | 636 | 948 | 33 | 1,941 | 477 | 2,610 | 12,973 |
| 1984 | 8,280 | 452 | 146 | 1,234 | 731 | 224 | 112 | 112 | 1,974 | 13,265 |
| 1985 | 10,053 | 460 | 129 | 1,508 | 1,170 | 251 | 334 | 321 | 2,790 | 17,016 |
| 1986 | 16,803 | 821 | 307 | 2,940 | 1,648 | 456 | 1,253 | 531 | 2,960 | 27,719 |
| 1987 | 5,513 | 865 | 268 | 3,138 | 1,923 | 1,639 | 954 | 735 | 2,817 | 17,852 |
| 1988 | 10,772 | 1,167 | 380 | 1,728 | 1,175 | 489 | 737 | 1,052 | 2,565 | 20,065 |
| 1989 | 5,525 | 1,041 | 612 | 3,036 | 1,514 | 39 | 603 | 371 | 2,474 | 15,215 |
| 1990 | 11,635 | 549 | 1,355 | 3,519 | 1,188 | 98 | 271 | 577 | 2,580 | 21,772 |
| 1991 | 3,083 | 637 | 1,070 | 2,047 | 873 | 2 | 512 | 192 | 1,048 | 9,464 |
| 1992 | 835 | 223 | 76 | 401 | 238 | 10 | 166 | 50 | 1,469 | 3,468 |
| **Rain-fed condition** | | | | | | | | | | |
| 1982 | 1,227 | 339 | 7 | 119 | 192 | 1 | 32 | 37 | 142 | 2,096 |
| 1983 | 370 | 68 | 14 | 40 | 100 | 14 | 3 | 13 | 287 | 909 |
| 1984 | 499 | 4 | 2 | 73 | 367 | 0 | 0 | 8 | 420 | 1,373 |
| 1985 | 965 | 42 | 2 | 251 | 160 | 2 | 46 | 52 | 501 | 2,021 |
| 1986 | 694 | 49 | 25 | 467 | 254 | 1 | 3 | 32 | 125 | 1,650 |
| 1987 | 610 | 48 | 9 | 895 | 268 | 36 | 12 | 29 | 28 | 1,935 |
| 1988 | 555 | 50 | 5 | 451 | 397 | 362 | 2 | 262 | 288 | 2,372 |
| 1989 | 521 | 136 | 12 | 383 | 289 | 2 | 11 | 26 | 727 | 2,107 |
| 1990 | 281 | 7 | 7 | 563 | 23 | 3 | 0 | 9 | 177 | 1,070 |
| 1991 | 212 | 6 | 16 | 80 | 278 | 16 | 0 | 2 | 9 | 619 |
| 1992 | 80 | 6 | 4 | 0 | 45 | 0 | 0 | 0 | 94 | 229 |
| **Total** | | | | | | | | | | |
| 1982 | 3,643 | 794 | 23 | 1,312 | 1,187 | 34 | 208 | 340 | 3,453 | 10,994 |
| 1983 | 5,951 | 682 | 147 | 676 | 1,048 | 47 | 1,944 | 490 | 2,897 | 13,882 |
| 1984 | 8,779 | 456 | 148 | 1,307 | 1,098 | 224 | 112 | 120 | 2,394 | 14,638 |
| 1985 | 11,018 | 502 | 131 | 1,759 | 1,330 | 253 | 380 | 373 | 3,291 | 19,037 |
| 1986 | 17,497 | 870 | 332 | 3,407 | 1,902 | 457 | 1,256 | 563 | 3,085 | 29,369 |
| 1987 | 6,123 | 913 | 277 | 4,033 | 2,191 | 1,675 | 966 | 764 | 2,845 | 19,787 |
| 1988 | 11,327 | 1,217 | 385 | 2,179 | 1,572 | 851 | 739 | 1,314 | 2,853 | 22,437 |
| 1989 | 6,046 | 1,177 | 624 | 3,419 | 1,803 | 41 | 614 | 397 | 3,201 | 17,322 |
| 1990 | 11,916 | 556 | 1,362 | 4,082 | 1,211 | 101 | 271 | 586 | 2,757 | 22,842 |
| 1991 | 3,295 | 643 | 1,086 | 2,127 | 1,151 | 18 | 512 | 194 | 1,057 | 10,083 |
| 1992 | 915 | 229 | 80 | 401 | 283 | 10 | 166 | 50 | 1,563 | 3,697 |

Source: Technology transfer division, Department of Agriculture.

## Figure A1.1 Cultivation of chilli

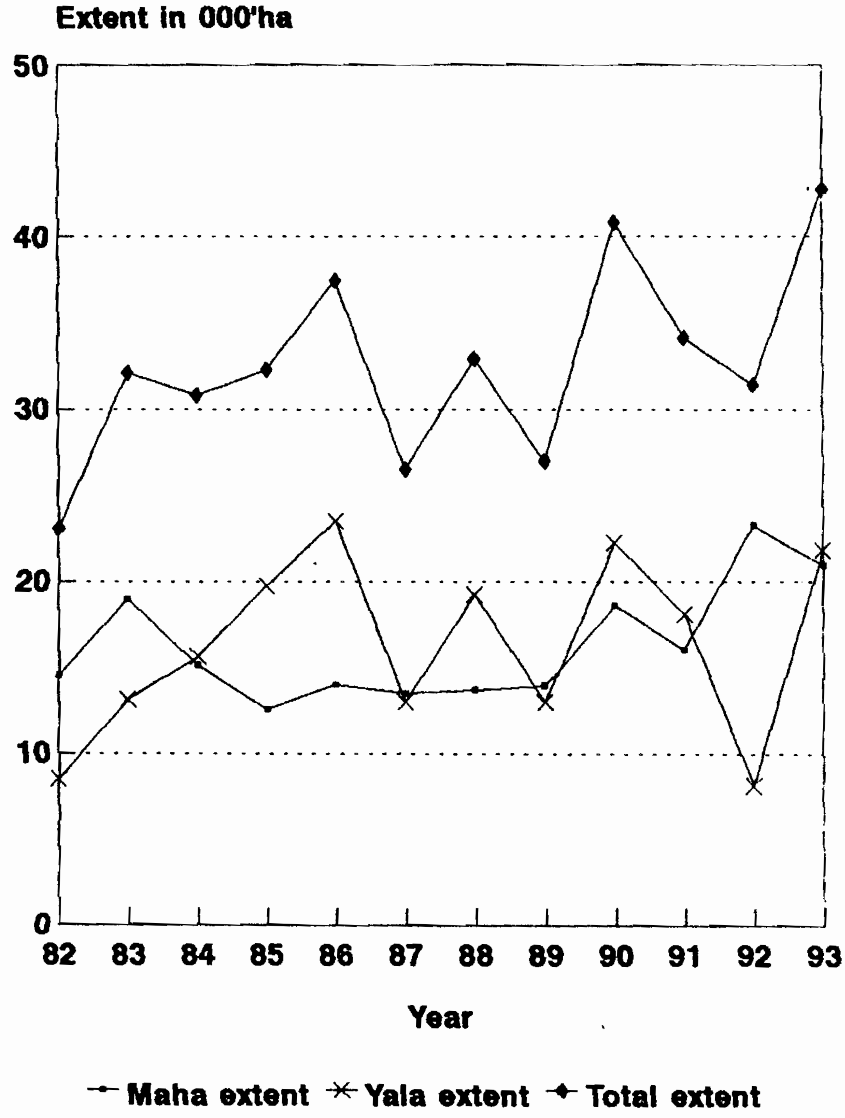
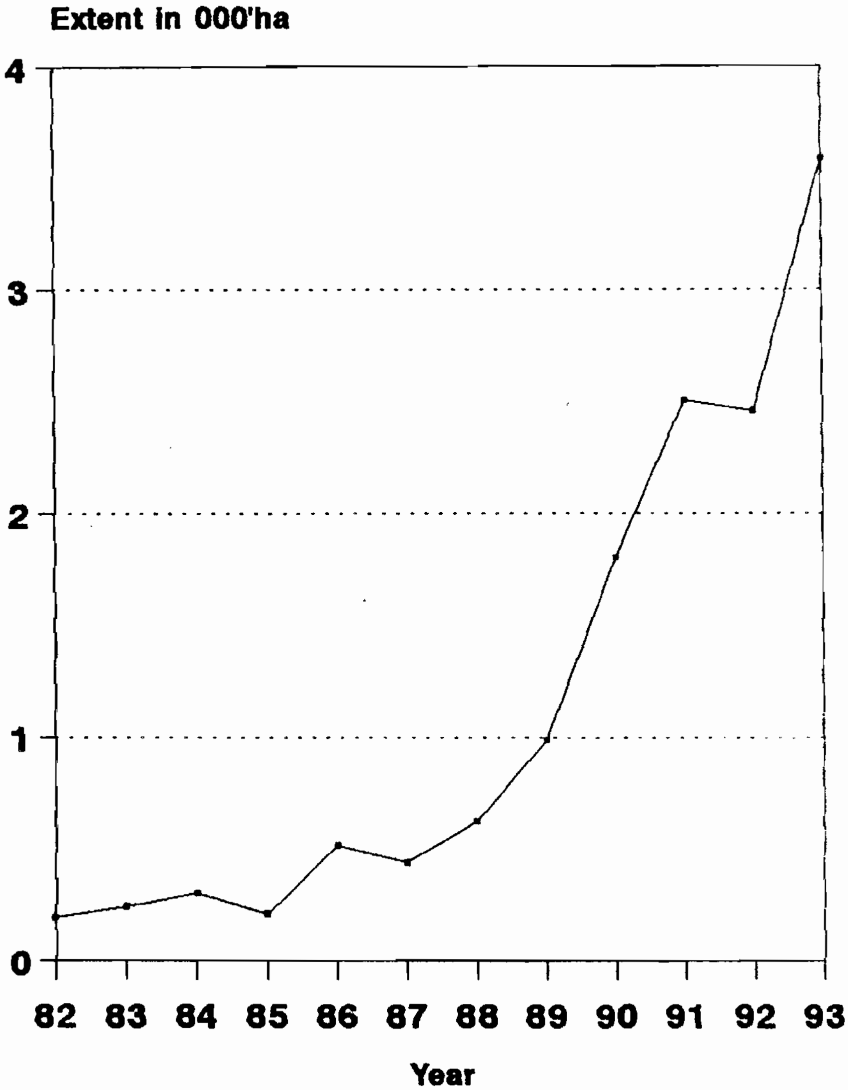
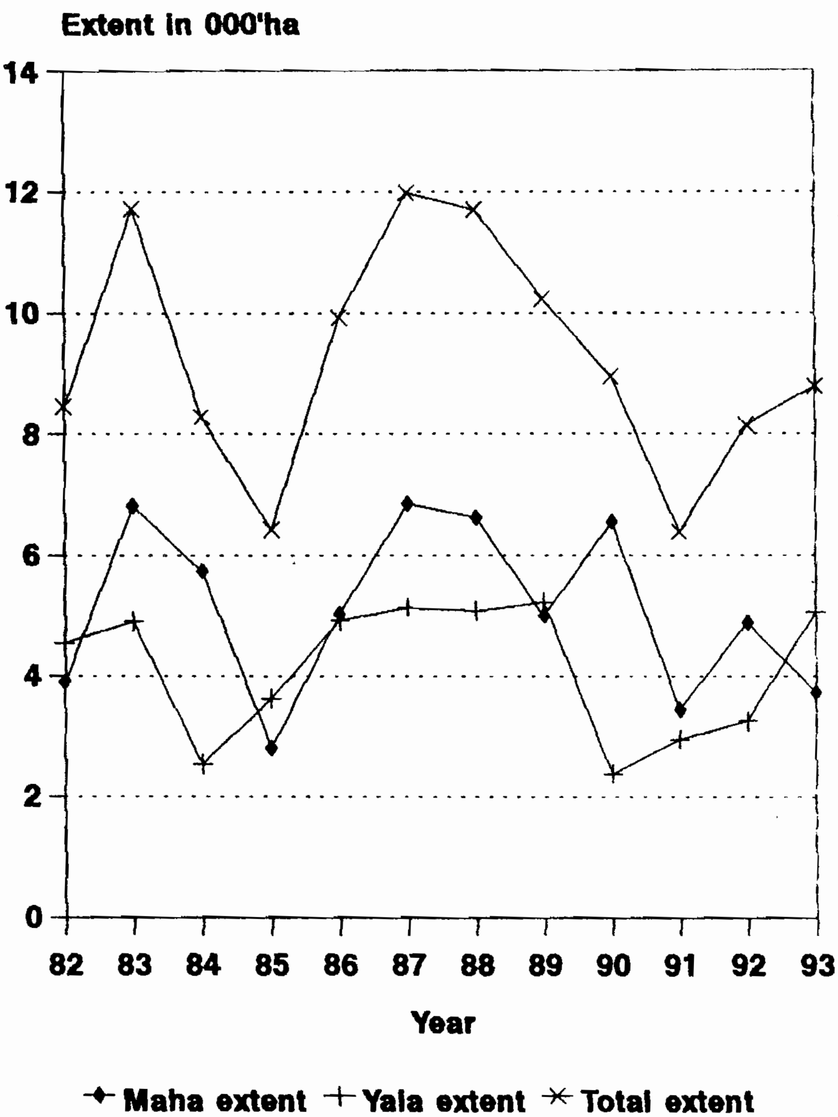


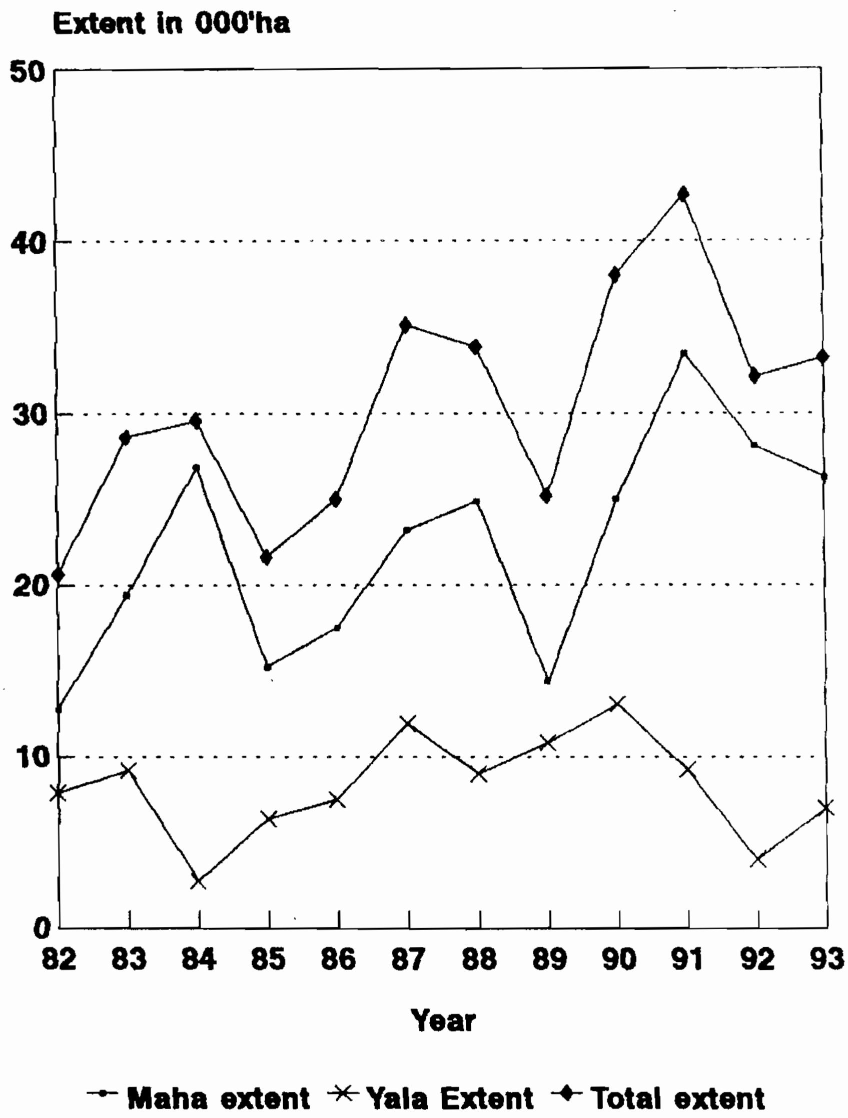
**Figure A1.2 Cultivation of big onion**



# Figure A1.3 Cultivation of red onion



## Figure A1.4. Cultivation of greengram



# Figure A1. 5. Cultivation of soya bean

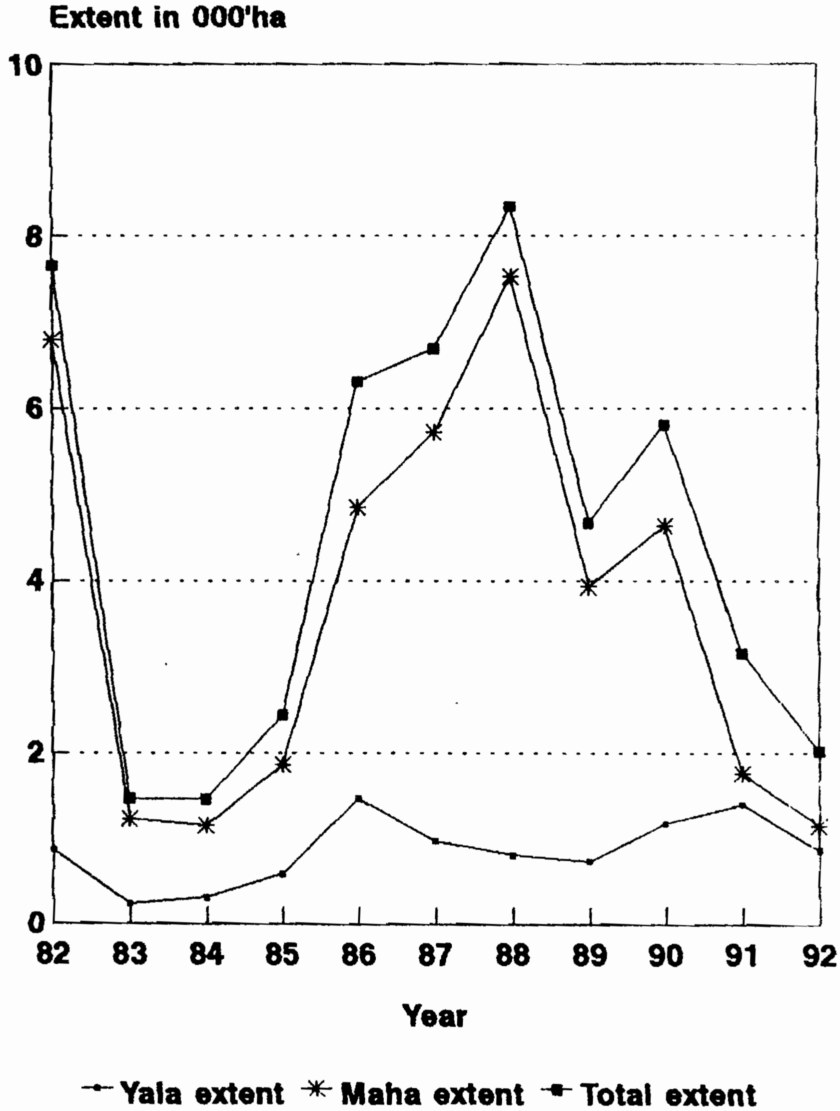


**Figure A1.6. Cultivation of Cowpea**

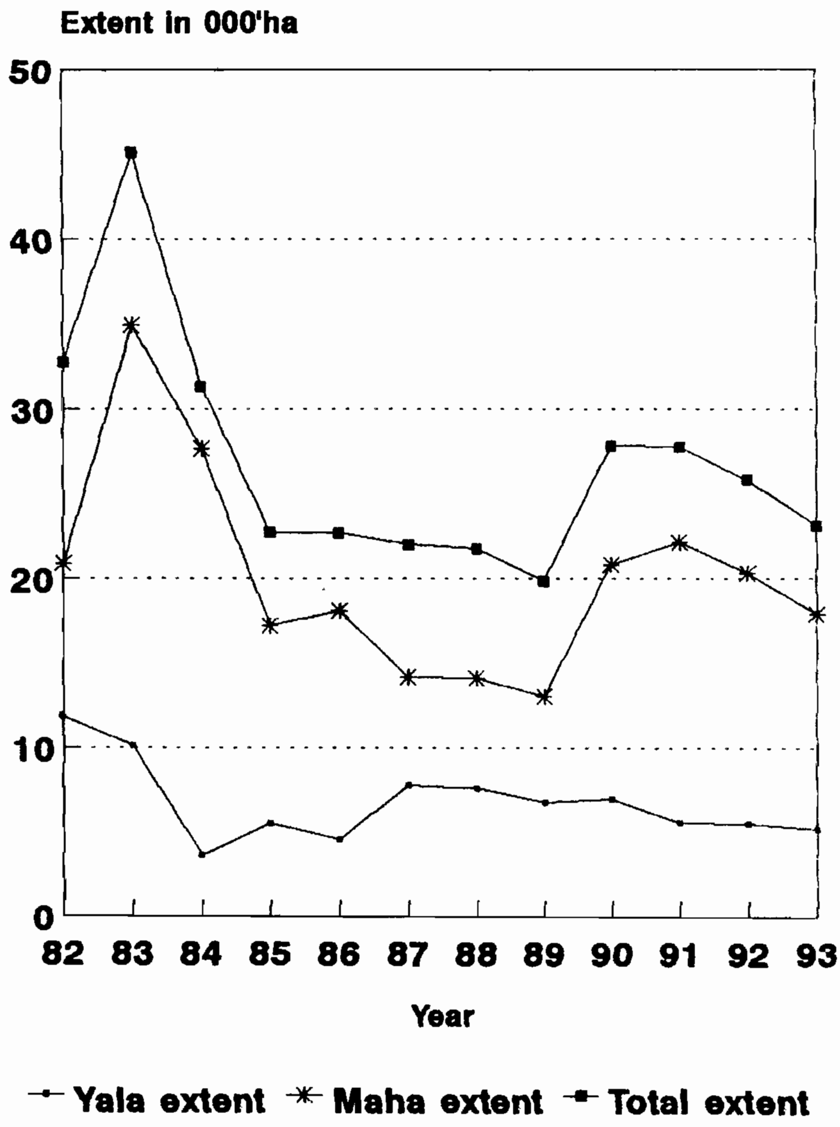


Figure A2.1. Cultivation of chilli on highlands in Anuradapura district, maha season, under rain-fed condition

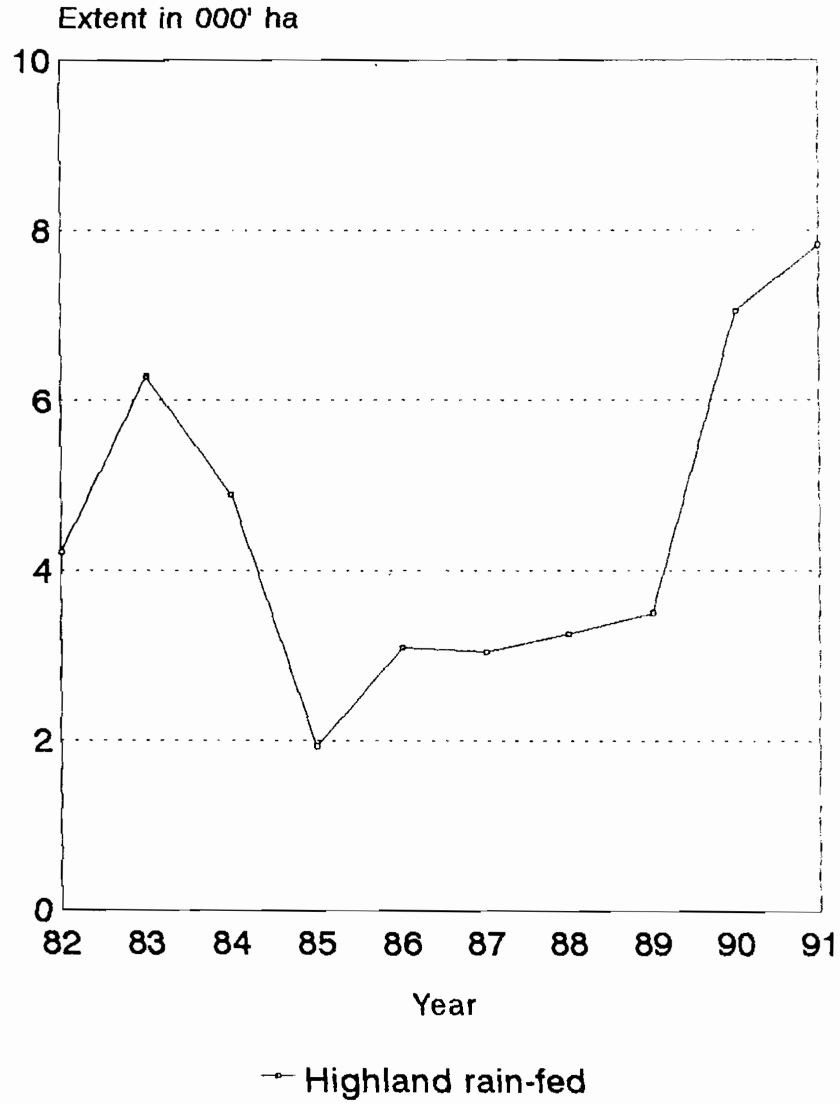


Figure A2.2. Cultivation of chilli in Anuradapura district,
yala season under irrigation

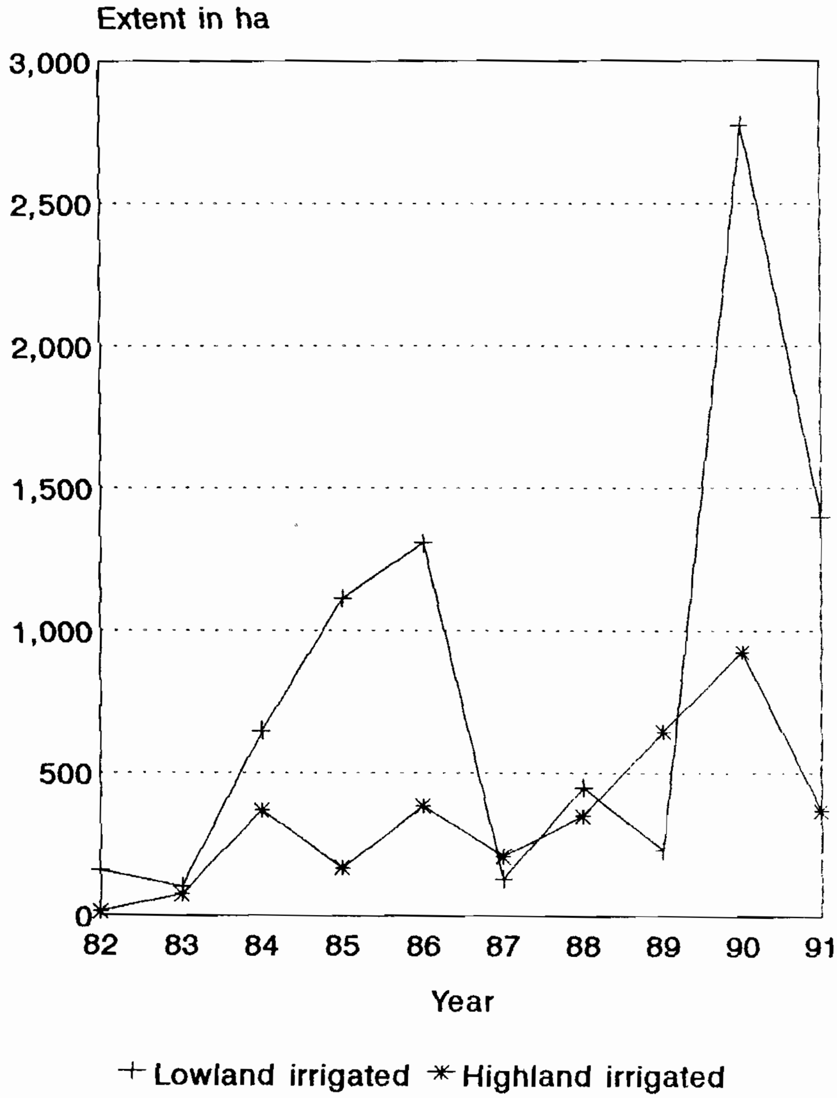


Figure A2.3. Cultivation of green gram in Anuradapura district,
yala season

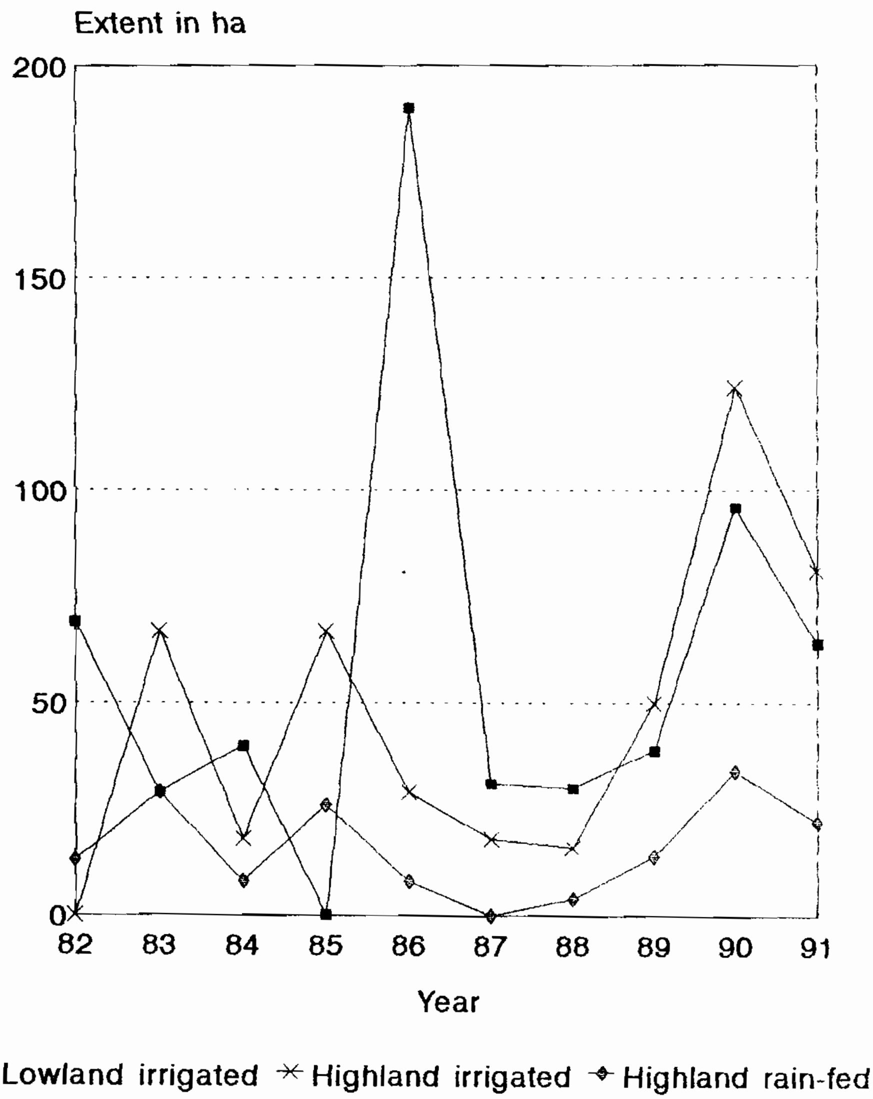


Figure A2.4. Cultivation of green gram in Anuradapura district,
maha season

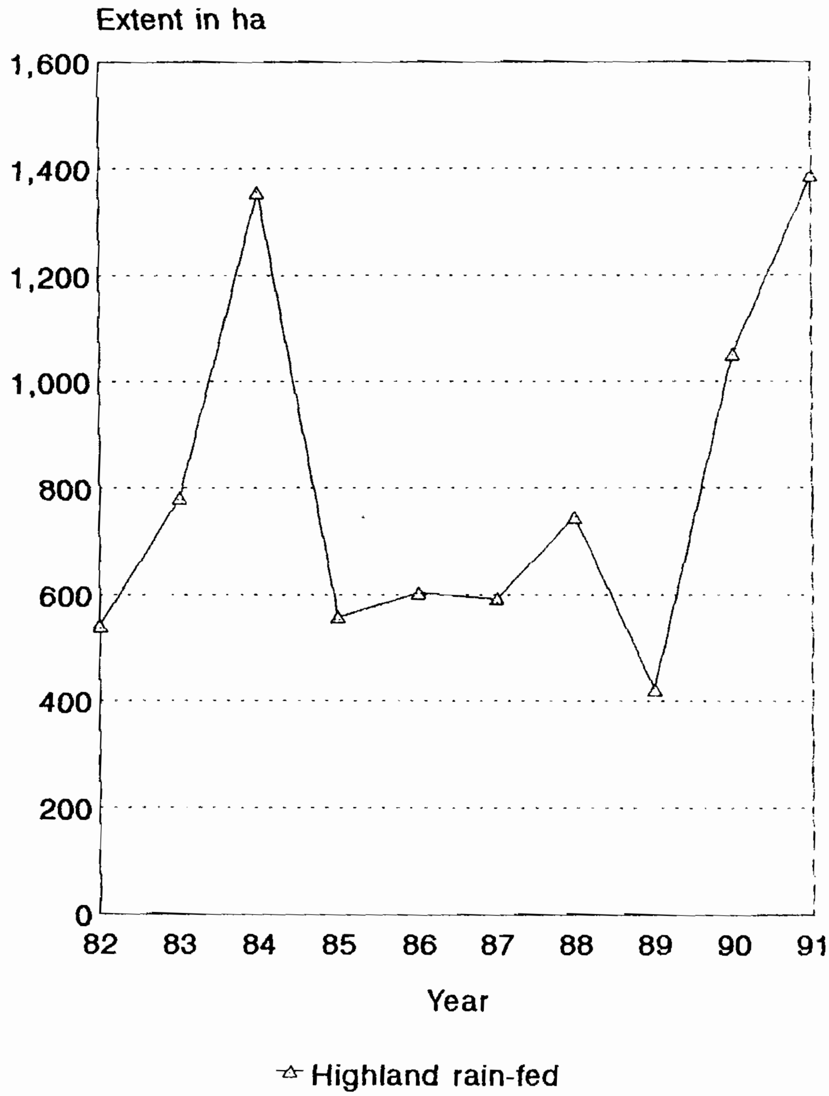


Figure A2.5. Cultivation of cowpea in Anuradapura district,
yala season

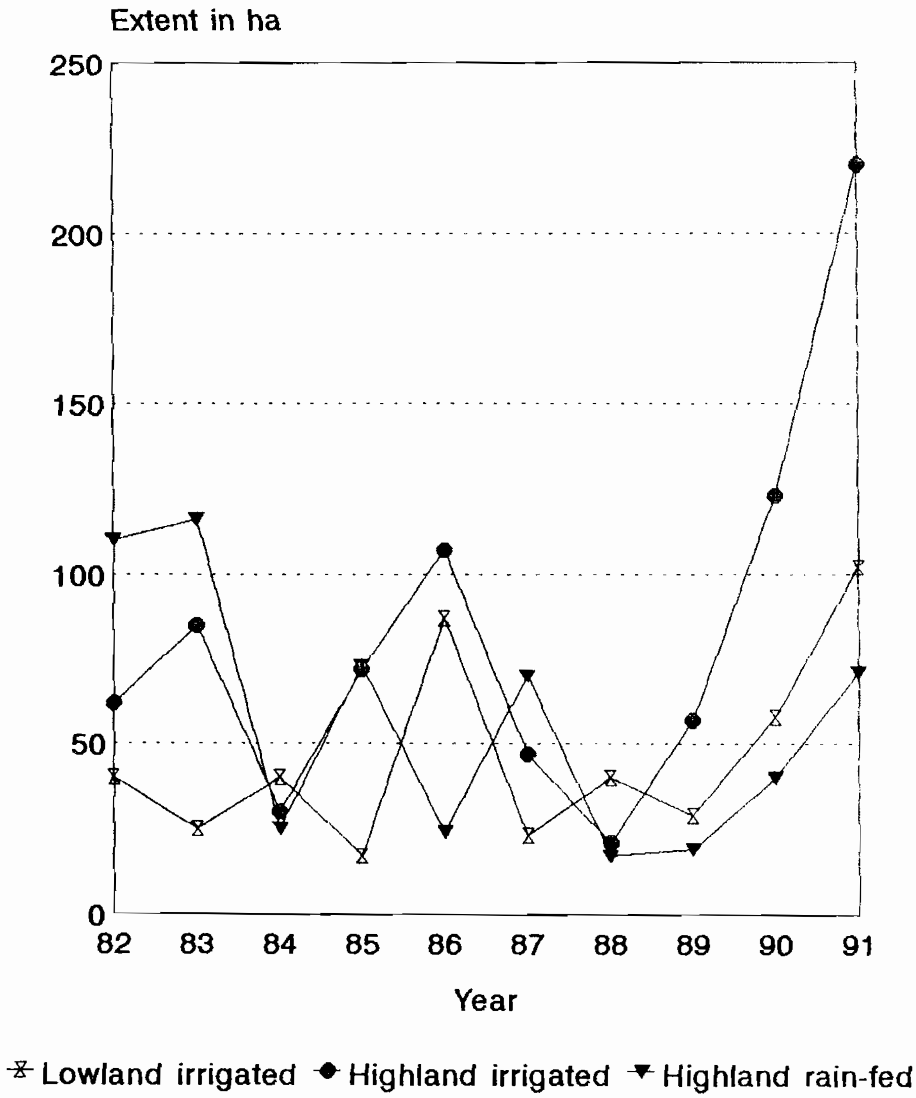


Figure A2.6. Cultivation of cowpea in Anuradapura district,
maha season

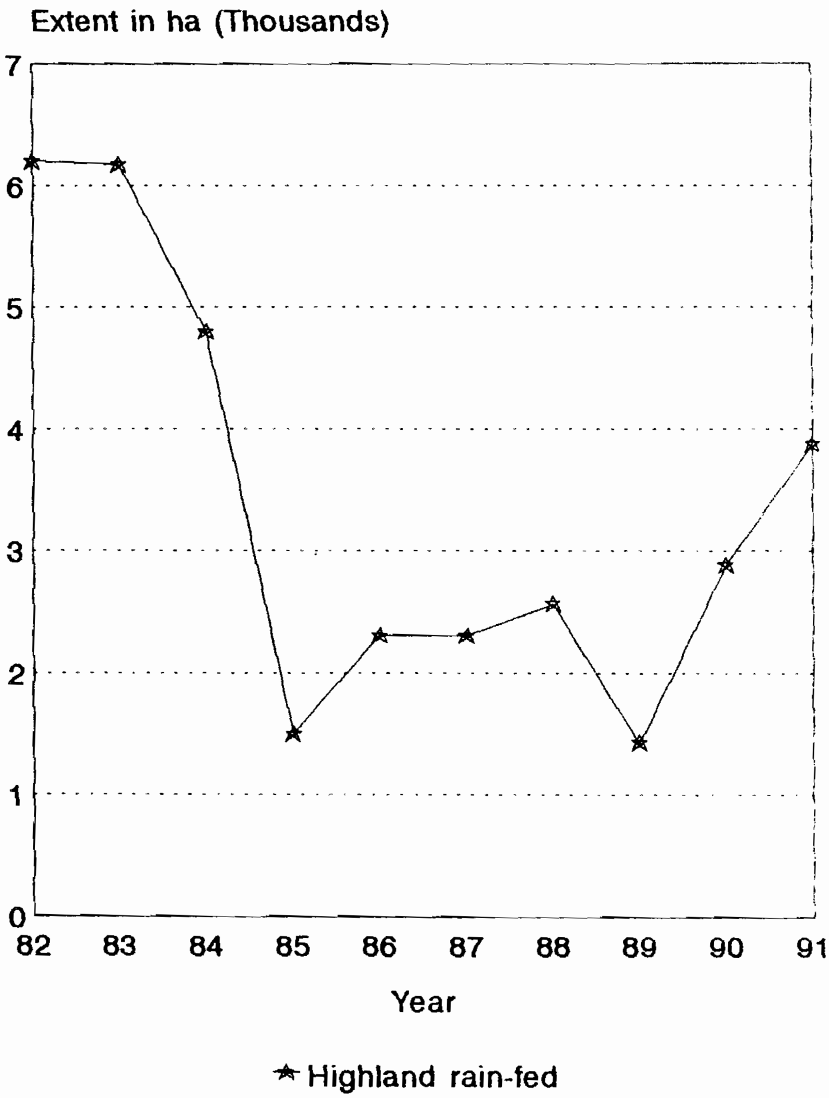


Figure A2.7. Cultivation of Soya bean in Anuradapura district, yala season

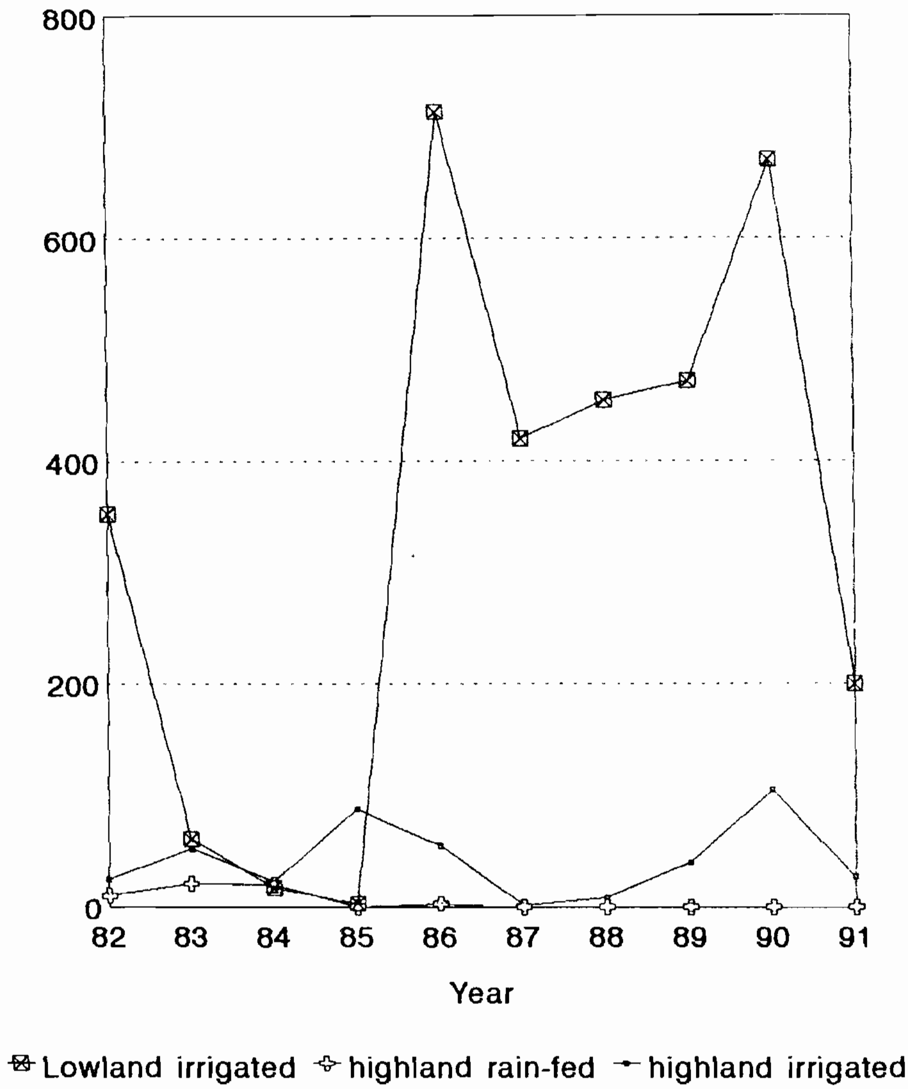


Figure A2.8. Cultivation of Soya bean in Anuradapura district,
maha season

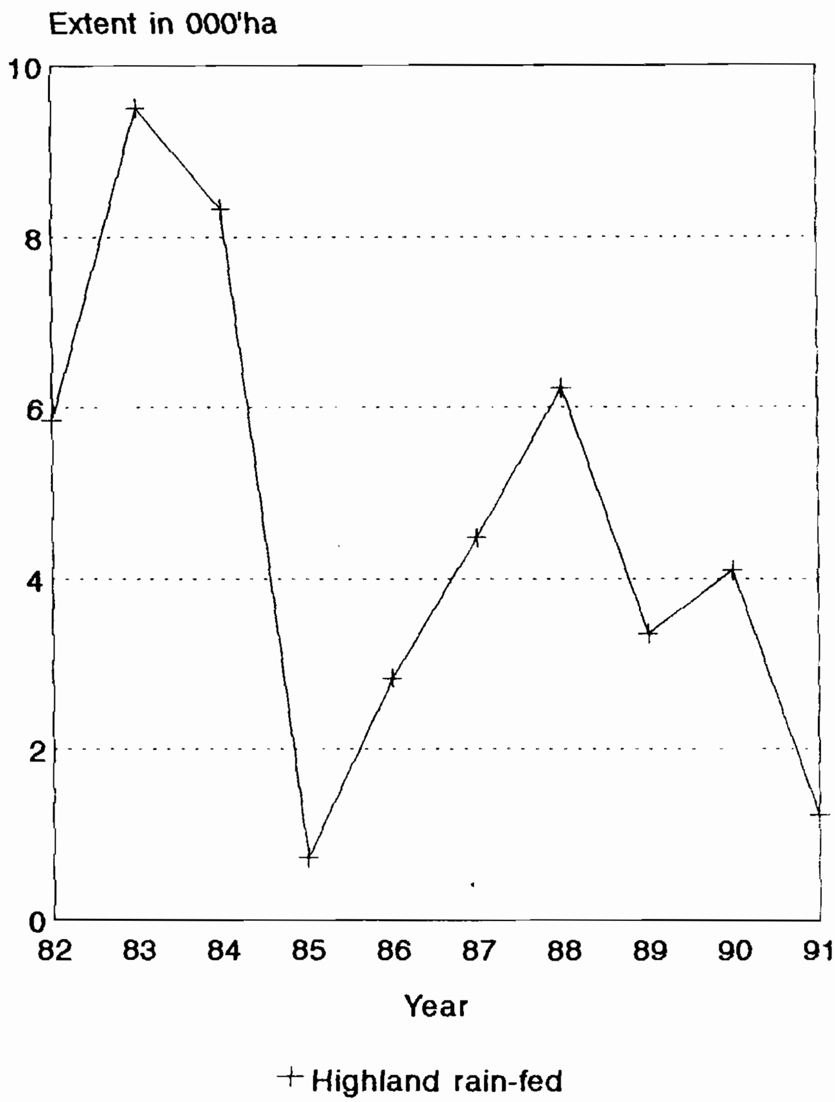


Figure A2.9. Cultivation of chilli in Kurunegala district
yala season

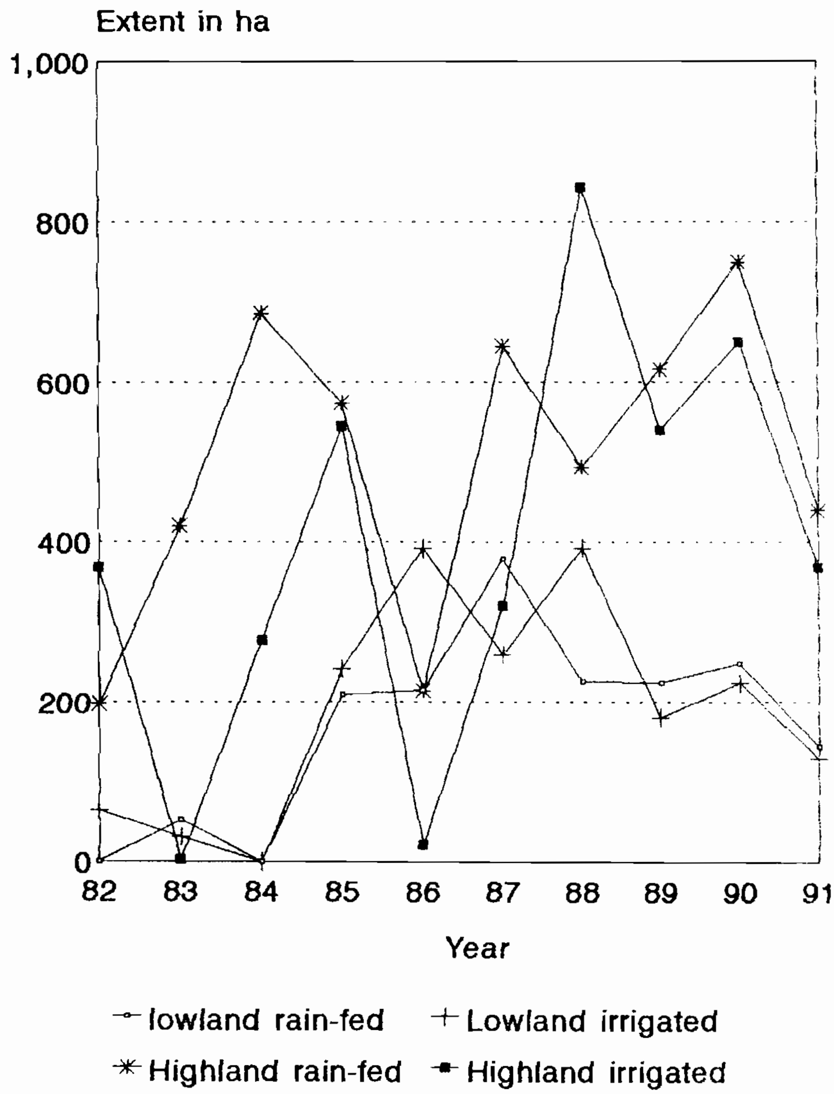


Figure A2.10. Cultivation of chilli in Kurunegala district
maha season

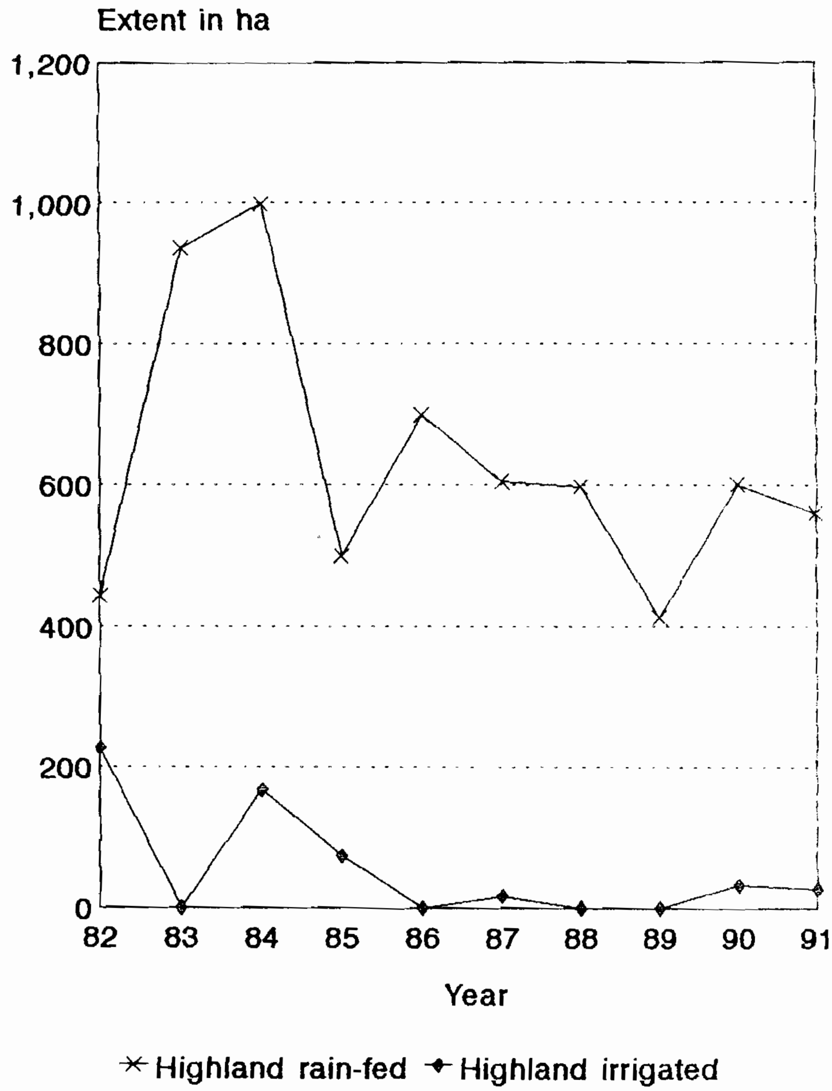


Figure A2.11. Cultivation of greengram in Kurunegala district
yala season

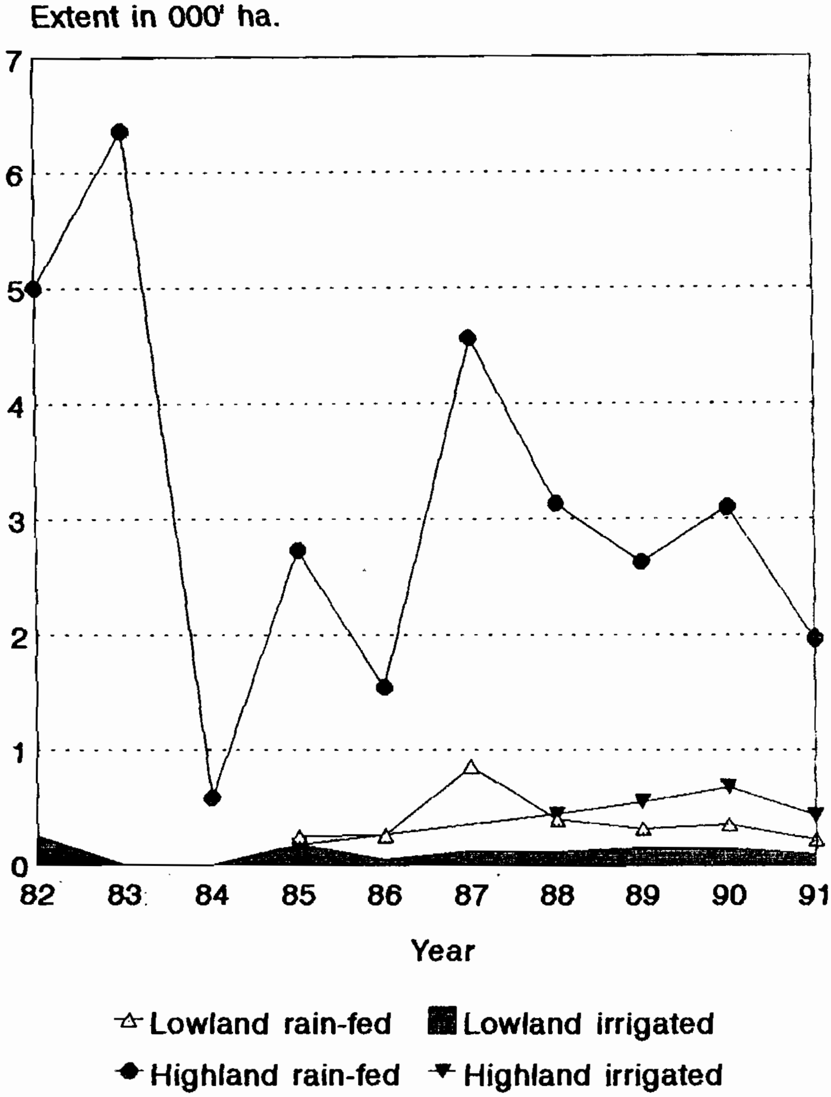


Figure A2.12. Cultivation of greengram in Kurunegala district
maha season

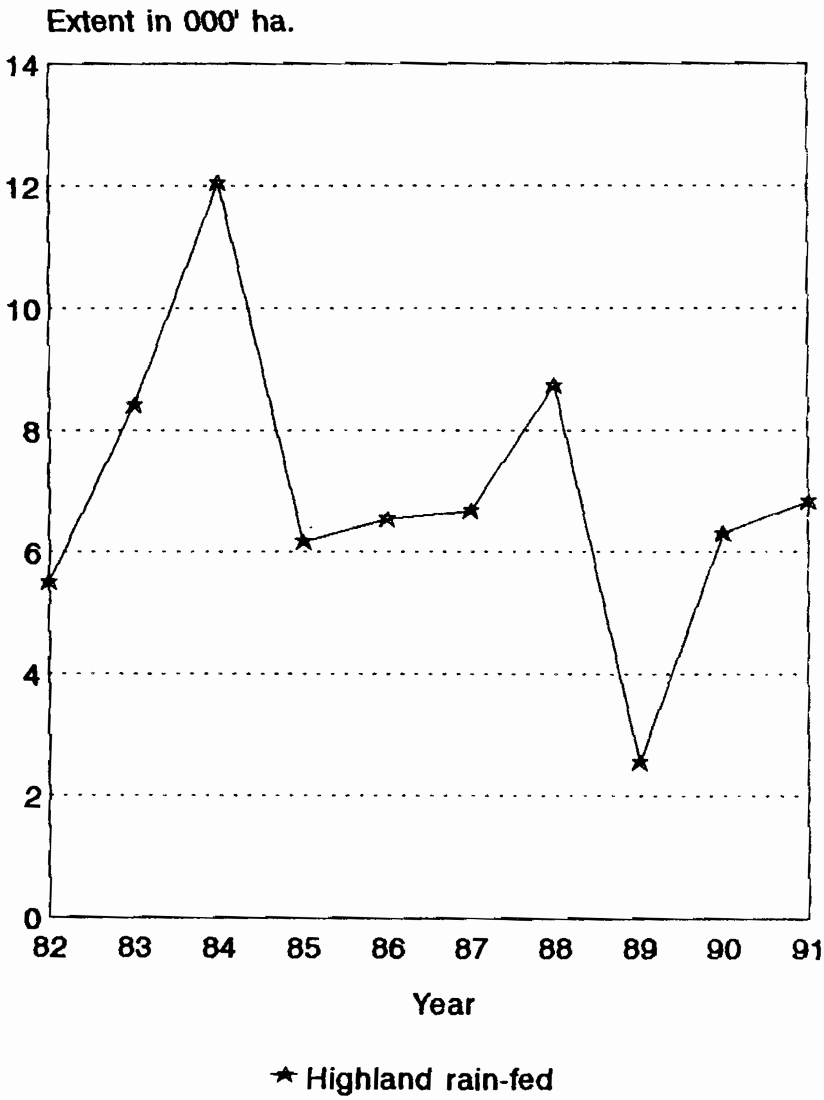
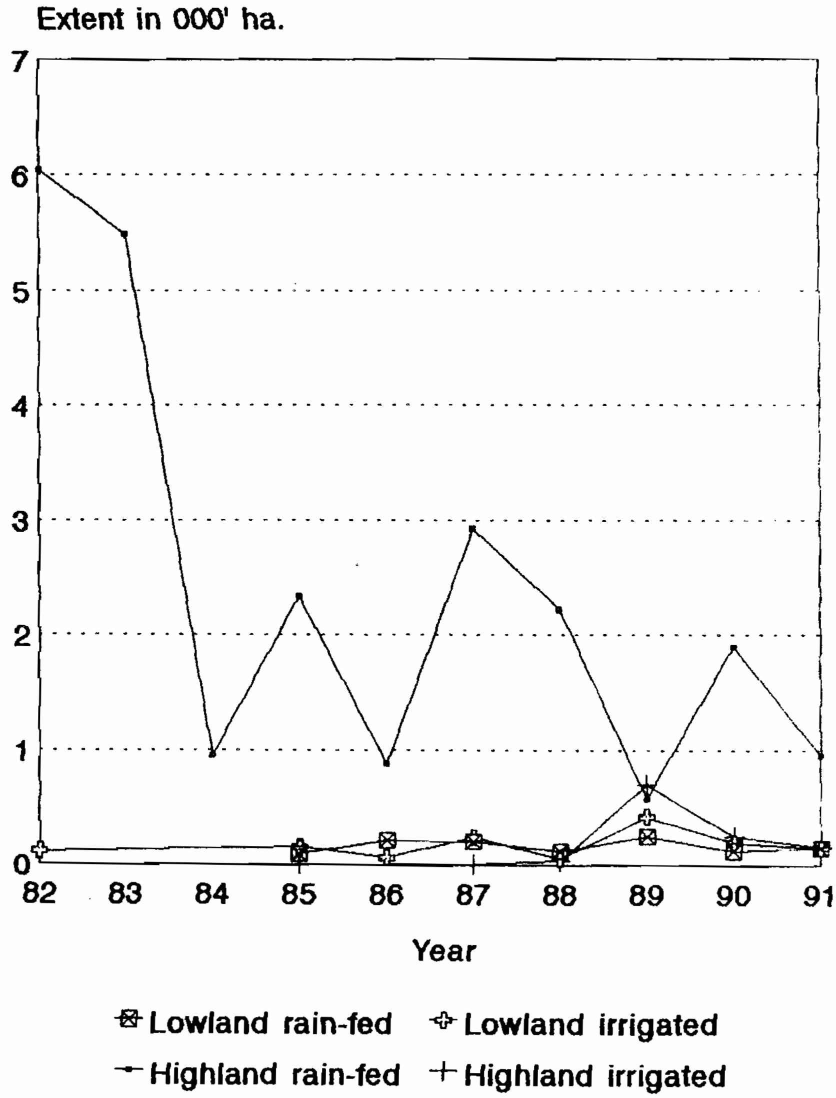


Figure A2.13. Cultivation of cowpea in Kurunegala district
yala season



## Figure A2.14. Cultivation of cowpea in Kurunegala district
maha season

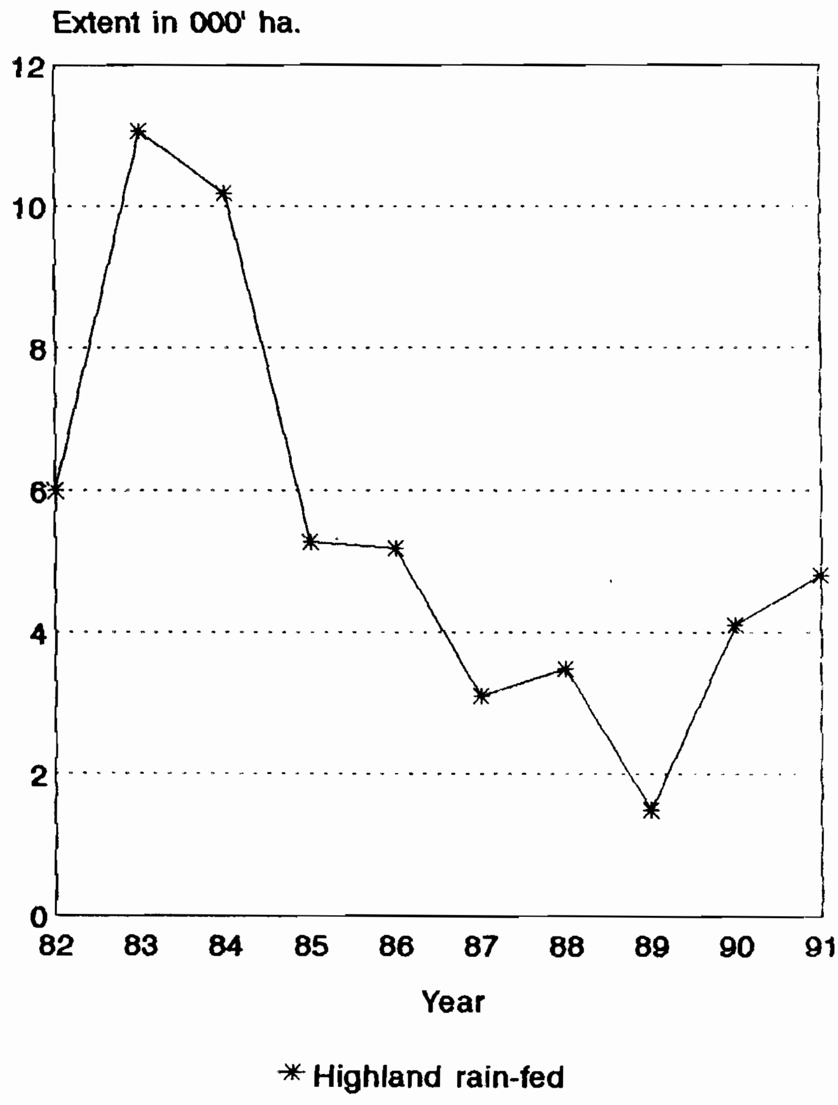


Figure A2.15 Cultivation of goundnut in Kurunegala district
yala season

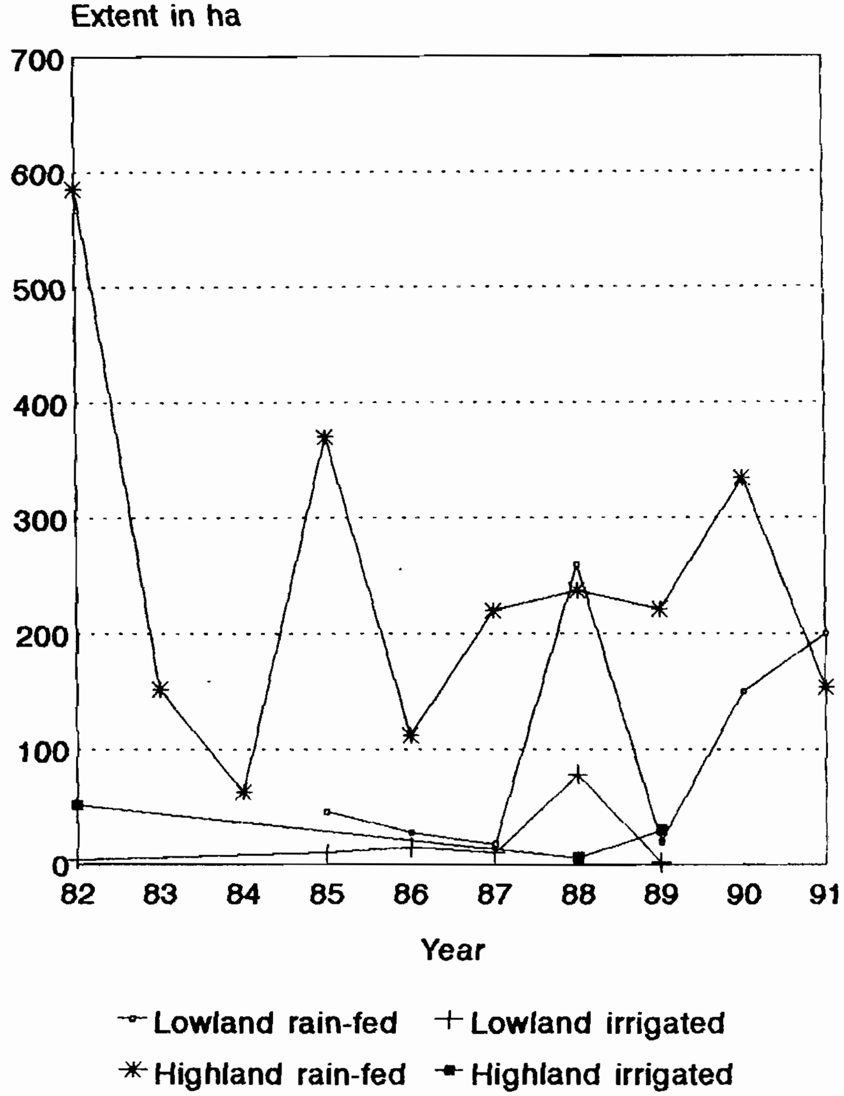


Figure A2.16 Cultivation of goundnut in Kurunegala district
maha season