# Potential for Diversified Cropping in the Rice Lands of Sri Lanka



C. M. Wijayaratna
C.R. Panabokke
P.B. Aluwihare
S.H. Charles
R. Sakthivadivel



INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE

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Information and Communications Division
International Irrigation Management Institute
P.O. Box 2075
Colombo
Sri Lanka

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*Cover:* Soya plantation in a rice field, during the minor cultivation season (yala) in Huruluwewa.

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# Foreword

IN THE RECENT past, researchers have observed a stagnating or declining trend in productivity of major food grains grown under irrigation. For rice, the major crop under irrigation in most Asian countries, studies indicated that the technological yield frontier has stagnated and shows signs of long term decline. Moreover, incremental costs could exceed incremental benefits. In countries such as Sri Lanka, this condition could be further aggravated because the percentage of farmers engaged in rice cultivation on small landholdings is very high and they have limited opportunities in off-farm income sources. The opportunities for conventional alternatives such as "slash and burn" cultivation are fast disappearing.

In this context, the World Bank initiated a series of investigations related to the nonplantation crop sector, primarily to assess its performance as well as to evaluate the potential for future improvement. The Bank commissioned a study to the International Irrigation Management Institute (IIMI) primarily to identify and assess the nature of technical, institutional and financial aspects of constraints inhibiting reallocation of land from rice production to production of other field crops (OFCs), and to examine and assess the potential for expanding the cultivation of OFCs on rice lands. The study was based on data gathered over a decade (1982-92) in respect of extents cultivated as well as changes that have taken place on different categories of irrigated lands in the country.

The study compares and contrasts rice with OFCs with special emphasis on factors such as their suitability to different soils, water and other agro-climatological conditions, demand for labor, cash flow, profitability, and other economic aspects.

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# Executive Summary

THE MAIN OBJECTIVE of this study was to examine and assess the potential for expanding the cultivation of OFCs on rice lands, based on data available over a decade (1982-92) in respect of extents cultivated as well as changes that have taken place on different categories of irrigated lands in the country.

Past trends in the cultivation of OFCs on irrigated lands during the dry season show that a peak in extents cultivated was reached in 1986 followed by significant fluctuations in annual extents and a sharper fall between 1990 and 1992. There has been a steady increase in the total production of chili, green gram, big onion and red onion since 1982, with clearly discernible trends of regional specialization. The reasons for the pattern in past trends and fluctuations could be attributed to factors of climate, market prices, import policy, and less to pests and diseases. Despite the high annual and seasonal variations in production, the country has achieved a very high degree of self-sufficiency in respect of the major OFCs such as chili, onion, green gram, black gram and vegetables.

Recognizing the fact that the highest potential for diversified cropping is on the well-drained soils of the dry zone irrigation schemes, the relative potential for dry season diversified cropping in the four broad categories of irrigation systems has been outlined. This relative potential is based on the degree of stability and availability of irrigation supply between the wet and dry seasons. Building in flexibility to the design and operation of major and medium irrigation systems would further enhance the expansion of diversified cropping.

Economic factors, chiefly market prices and trade policies, have been identified as the more important determinants to the expansion of diversified cropping on rice lands. Past data analysis shows a declining trend in the profitability of all irrigated OFCs, and this is also related to the narrowing of the gap between demand and local production as well as to the increase in cost of production. Further analysis leads to the conclusion that if the "supply" from nonrice areas remain unchanged, then the area that should be allocated to satisfy local demand would be around 40,000 ha, which the country had almost achieved by 1992. All crops were analyzed as import substitutes and the results clearly show that rice and all the OFCs analyzed, except green gram, have a comparative advantage for local production.

More attention needs to be paid to searching for special crops for special markets and to an increase in agribusiness opportunities for value addition and export. There is a clearly felt need for continuing extension support but with new approaches that are different from those of the past. These include technical and organizational assistance for planning, storage, packing and grading, and linking small farmer organizations with the organized private sector.

The study highlights the great weaknesses of the database on diversified cropping, including basic information such as extents and crop yields. Establishment and maintenance of an accurate spatial database using a Geographic Information System (GIS) should therefore be given a high priority.

CHAPTER 1

# Introduction and Objectives

RECENT TRENDS IN the agricultural development strategies of many developing countries indicate a clear shift away from the traditional approach of expanding the supply of factors of production, such as land and water, toward improving the productivity of such factors. Increased scarcities of these inputs and poor performance in their utilization are the major factors that have contributed to this shift. Irrigation water, for example, has become an increasingly scarce input in agricultural production. In many parts of Asia, most of the 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 inefficiency 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 one of improvements in water management in irrigated agricultural systems.

Concurrently, a significant decline is observed in investments in irrigation—especially in new constructions—by the international donor community and recipient governments. Supply shortages in food grains and consequent price escalations influenced international donors and recipient governments in Asia to invest more in irrigation during the 1970s. A reverse trend was observed in the 1980s when, for instance, the supply of rice increased, prices declined worldwide and, consequently, investments in irrigation also declined. Crop diversification has since been assigned a prominent place among avenues available for improving the productivity of land and water.

It is believed that a great deal of development is necessary outside traditional monocrop farming not only to optimize the economic returns on scarce resources 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 in the long run to the production of both rice and the other food crops. However, the progress of diversified cropping is constrained by a number of technical, institutional (including financial and market-based), and sociocultural factors. These include compatibility of crop mix and land, water availability and water management, climatic factors, profitability, knowledge and skills available, ability and willingness of the farmers to participate, tenurial patterns, price levels and access to inputs, market factors, and price levels of outputs. Moreover, interactions of these factors may also influence the expansion of other field crops (OFCs) in the rice growing sector. In short, the issues related to crop diversification in this sector are multifaceted.

*The general objective of the study was to examine and assess the recent trends and current status of diversified cropping, and the constraints to and potential for alternative uses of rice lands in Sri Lanka.*

## 1.1 SPECIFIC OBJECTIVES

The specific objectives of the study were:

1. To examine the changes in cropping patterns in the rice lands of Sri Lanka over the past decade. The analysis was extended to quantify the changes in different water regimes such as major and minor irrigation systems.

2. To contrast the extent of crop diversification achievements with the expectations: For example, in certain irrigation systems, the area targeted for OFCs has been about 40 percent of the total area, but the reported achievement has been less than 10 percent.

3. To compare and contrast the cultivation of rice with that of other crops, with special emphasis on such factors as their suitability to different soils, water and other agro-climatological conditions, cash

flow, profitability, and other economic aspects. A comparison among selected nonrice crops was also attempted here. The validity of the analysis or the specific conditions under which these results can be obtained was analyzed; these conditions included price, availability of markets, water management, soil and other climatic conditions and input levels. The input profile, cost of production, the level and distribution of cash flow, productivity, and profitability were examined here. For example, the returns and profits on land, labor and water per unit time, and the opportunity costs (in terms of water and land productivity) of not converting various categories of rice land into OFCs in different seasons under different water regimes were examined.

4. *To examine and assess the potential for expanding the cultivation of OFCs in the rice lands.* The potential for expansion and the strategies to overcome constraints to expansion were assessed. Specific guidelines were developed on the basis of such assessments. The guidelines were sufficiently detailed to develop a comprehensive plan for the future. This analysis discusses, to a limited extent, the type and extent of rice lands available for diversification, suitability of other 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 was based on available data. The analysis of the potential for and the constraints to the cultivation of OFCs on rice lands were confined to technical, institutional (including financial and market-based) and socio-cultural factors. These included the following:

***Technical factors:*** Land suitability factors such as the drainage capacity of the soil and local topography; flexibility of the irrigation system, reliability and control of water supply; and agro-climatic constraints such as rainfall distribution, and technical aspects of groundwater utilization for cash cropping.

***Economic, socio-cultural, and institutional (including financial and market-based) factors:*** Product prices; price levels and access to inputs, credit, and agricultural extension services; profitability and earnings; seasonal labor availability patterns; tenurial and ownership patterns; user organizations and the relations between farmers, government agencies, and the private sector; level and regularity in cash flow; availability of markets; quality control standards; post-harvest technologies and facilities available; scope for value-added production; potential for small farmer companies aiming at commercialized diversified agriculture; thefts; capacity for group action; community induced constraints; farmer perceptions such as preference for rice and farmer attitudes.

The aim of the study was to provide a generalized response to the objectives stated earlier. The study attempts to answer such contentious issues as the potential for increasing OFC production while maintaining rice production at a high level. The study also discusses, to a limited extent, the potential for different crops in different water regimes and under different modes of diversification as, for example, crops for captive markets, diversification in the irrigated areas and during different seasons, the degree of specialization required, the opportunity costs of diversification under different conditions, cost effectiveness and associated risks, supportive as well as inhibiting policies and legislature, regulations, and subsidies.

## 1.3 RECENT TRENDS IN THE RICE PRODUCTION SECTOR

Rice cultivation plays a vital role in the Sri Lankan economy as rice is the staple food. Successive governments in Sri Lanka, as in many other countries of South and Southeast Asia, have followed a policy of achieving self-sufficiency in rice. During the last four decades, Sri Lanka has achieved substantial progress in rice production through heavy investment in irrigation, rice research, and institutional support. These achievements are best illustrated by the changes in the rate of progress toward self-sufficiency in rice during this period. Only forty percent (40%) of the national rice requirement was produced locally in 1948. By 1985, progress toward self-sufficiency in rice had reached a level of more than 90 percent (Aluwihare and Kikuchi 1990). In 1990, 735,000 hectares (ha) were cultivated with rice. This represented 41 percent of the total agricultural land area in use (Central Bank of Sri Lanka 1991). Aluwihare and Kikuchi (1990) estimate that rice cultivation has expanded at an annual rate of 2 percent during the period 1952-1985. They have identified the main contributing factors for this development as the introduction of seed-fertilizer technology (68%) and its expansion (32%) (Aluwihare and Kikuchi 1990).

A recent analysis of rice production trends in Sri Lanka (Wijayaratna and Hemakeerthi 1992) shows that the rice-growing area ("asweddumized" area)[1] has increased only marginally in recent years (1985-1990) (see figure 1). Since future prospects for expanding the rice-grown area are low, it is not possible to increase rice production through the expansion of the area cultivated to rice. This analysis also shows that the other two key determinants of rice production, yield (figure 2) and cropping intensity (figure 1), are also stagnating since 1985. It is very unlikely that a new high-yielding variety that could make a major impact on production would be developed 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 population will continue to be significant for at least a few more years. Rapid population growth coupled with rising "incomes" could increase the demand for rice. Diversification of rice lands should, therefore, be introduced without any detrimental effects on present rice production trends.

As stated earlier, the study will focus on diversified cropping in rice lands. The four factors quoted above, however, are interrelated; 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. It was introduced in coconut lands and in rice-based irrigation systems at the same time. However, the maximum rice area under irrigation, which has been diversified, has been only 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.

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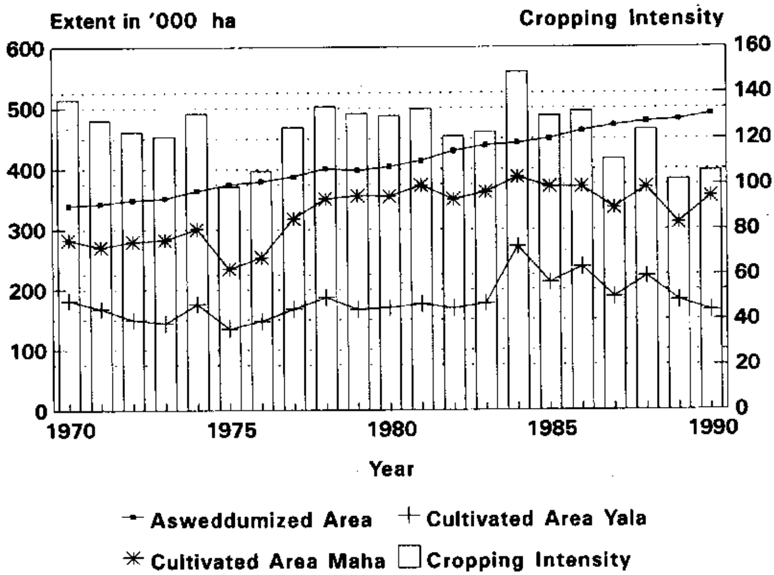
[1]New land brought under rice cultivation.

*Figure 1. Trends in cropping intensity and area cultivated to rice.*

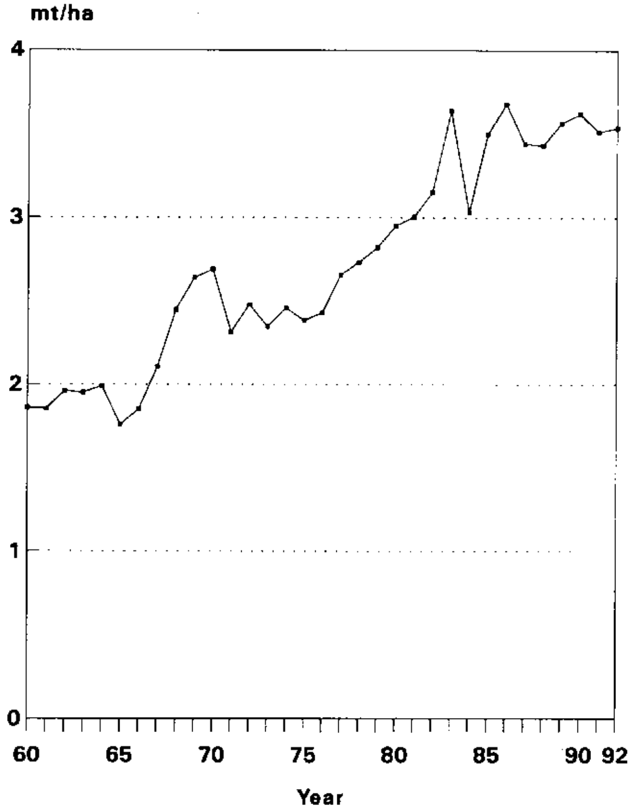



*Note:* Only major and minor categories are included.
*Source of primary data:* Department of Census and Statistics.

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

While an evolutionary and holistic approach has been adopted in this study on the potential for diversified cropping on the asweddumized rice 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 issues are connected with potential and past and present performance, and possible trajectories of future growth. An in-depth analysis has also been made on the profitability of different groups of nonrice crops, as well as other closely related issues of marketing, prices, national policies, etc.

*Figure 2. Trends in maha season rice yield.*




The report is organized in five chapters. After the introductory chapter, the "Recent Trends in Diversified Cropping in Rice Lands" are evaluated in chapter 2. This discussion focuses on the major crops classified under OFCs, and covers the period from 1982 to 1993. Chapter 3 is devoted to examining "Agro-Ecological Factors that Influence Diversified Cropping in Rice Lands"; and chapter 4 to the "Economic, Social and Institutional Factors Affecting Diversified Cropping." Finally, chapter 5 provides a summary of the study together with concluding remarks.

CHAPTER 2

# Recent Trends in Diversified Cropping in Rice Lands

## 2.1 INTRODUCTION

DIVERSIFIED CROPPING IN rice lands has primarily been centered around OFCs such as chili, red onion (shallots), big onion, green gram, cowpea, black gram, soya bean, groundnut and vegetables. Banana, sweet potato, maize, gingelly and gherkin have been cultivated on these lands to a lesser extent, and they are gaining importance in specific areas. More recently, attempts have been made to introduce newer crops, primarily for export. These include melon, baby corn, okra, and hybrid maize. Some interest is being shown in new oil seed crops such as sunflower. However, in examining the changes in cropping patterns during the past decade, the focus is on chili, onion, green gram, cowpea, black gram, soya bean, maize, groundnut, gingelly (sesame) and vegetables.

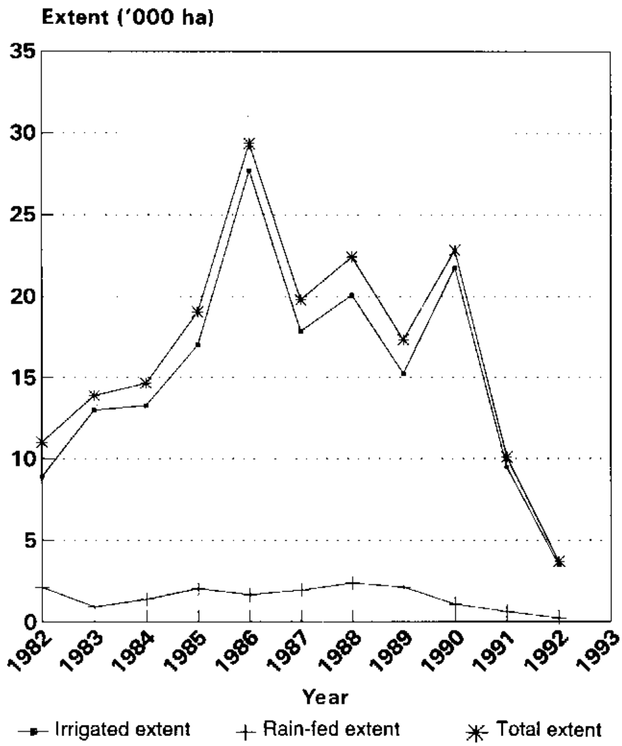
Unlike rice, for which a seasonal crop-cutting/estimation survey is conducted by the Department of Census and Statistics, the production and average yield figures for OFCs are only estimates based on field observations by agricultural extension staff. Although estimates of chili and onion yields are the closest to accuracy, the best available criterion for evaluating progress in cultivation of OFCs is the extent cultivated. This report is therefore based on crop extent.

Past trends in cultivation of OFCs in rice lands under irrigated and rain-fed conditions (as well as the aggregated nationwide extent) are summarized in table A.1 in the annex, and are illustrated in figure 3. The period covered is from 1982 to 1993.

## 2.2 ALL-ISLAND COVERAGE OF MAJOR OFCs OVER A TEN-YEAR PERIOD (1982-93)

Diversified cropping in rice lands must necessarily be viewed against the overall progress of OFC cultivation both in rice lands and highlands. The all-island coverage of the major OFCs over a ten-year period, 1982-1993, is presented in the annex figures A.1 to A.6. A few significant features in these trends are discussed below.

*Figure 3. Cultivation of other field crops (OFCs) in rice lands, yala season.*




*Source:* Department of Agriculture.

### *Chili*

The highest extent of chili cultivation was recorded both in 1986 and 1990. A declining trend followed thereafter (figure A.1). During the decade 1982-1992, a clear shift has taken place from rain-fed to irrigated chili in rice lands during the yala season, thereby increasing the yield per unit area. The yield levels of chili are now stagnant due mainly to serious disease conditions such as "narrow leaf" disease, thrips damage, and general dwarfing of the crop. The cost of chili cultivation is also on the increase because of the increased application of agrochemicals by the farmers. So far these disease and pest problems of chili cultivated in rice fields have been reported mainly during the yala season. No solutions have been forthcoming for these problems in spite of researchers having worked on them for over a decade. Chili production could be increased if these disease and pest problems are controlled. Given the high productivity of chili and its high net returns, the containment of these problems should not make it difficult to meet the country's total annual requirement of chili by increasing the total land area under chili cultivation to about 8,500 ha, a 21 percent increases over the present annual production.

### *Big Onion*

During the early 1970s, attempts were made to cultivate sufficient quantities of big onion to substitute imports from India, as the cultivation of this crop was becoming familiar to farmers during this period. After 1977, farmers were reluctant to grow big onion because of liberalized imports and low prices. However, since 1980, attempts were made to popularize big onion cultivation again as the prices became more attractive. Consequently, the extent under big onion increased appreciably from 1982 to 1988 (figure A.2 in the annex). The cultivation of big onion became localized to Dambulla, the Mahaweli System H area, and the Polonnaruwa and Anuradhapura districts due mainly 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 this increase was not the result of new technology till around 1988. New varieties, storage facilities and herbicides were introduced in 1988. The resulting boost to big onion cultivation was impressive. The total annual extent under big onion increased significantly—almost four-fold—from 1989 to 1991.

With the increase in extent, yield per unit area as well as profits also increased. This boost was followed by the stoppage of imports during the production period to ensure a reliable market and better prices. Producers were encouraged by agricultural extension staff to store their produce in local rustic stores so that they could sell it during the lean period, from November to early January. Technology to store big onion for a period of more than four months is not available locally. Efforts to cultivate big onion beyond the yala season have not been successful. Attempts are being made presently to produce shallots, popularly referred to as small onion or red onion, in different agro-ecological regions after the yala season. "Creollo" varieties in the upcountry have shown some promise but big onion has to compete with other traditional, highly profitable vegetable crops in these areas. At present, big onion produced during the yala season makes up 63 percent of the country's annual requirement. Expansion of big onion cultivation extensively during the yala season should not be embarked upon as it will affect the market and prices due to oversupply, unless technology can be obtained to enable longer periods of storage than presently available.

### *Green Gram*

In the Dry Zone, green gram has traditionally been a rain-fed crop during the maha season. Green gram cultivation during the yala season in the rice lands started expanding during the early 1980s (see table A.1 and figure A.4 of the annex). The highest cultivated extent reported for the yala season is 13,077 ha, in 1991, while for the maha season it is 33,448 ha during 1990/91 (figure A.4 in the annex). Traditionally, green gram has mostly been consumed as a boiled grain. It has also been used in the preparation of sweetmeats. However, during the late 1980s, the Cooperative Wholesale Establishment (CWE) and the private sector started marketing a "green gram dhal." With the increase in the import duty on red lentil, the market price of green gram dhal became very attractive to the processors as well as to the farmers. This resulted in an increase in the land area cultivated to green gram. The inclusion of green gram in the school midday meal from 1991 also strengthened the market. Gradually, the extent of land under green gram cultivation increased rapidly and became second only to maize (corn), which had 43,609 ha under cultivation in 1991.

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

During the early 1990s, a technology was developed to establish a green gram crop immediately after the harvest of the maha rice crop utilizing residual moisture with zero tillage, and short life cycle varieties were also introduced with very promising results. However, farmers were reluctant to go for such "sandwich cultivation" because of low prices. This sandwich cultivation technology offered a good opportunity to increase the productivity of rice fields without additional demands for irrigation water.

### *Soya Bean*

In the 1970s, soya was a new crop, and the extent grown rapidly reached a peak in 1983 (figure A.5 in the annex). Agronomically, it is profitable as a good rain-fed crop during the maha season and as an irrigated crop during the yala season. Its advantages are higher tolerance of drought conditions and excess moisture in comparison with other OFCs. The cost of harvesting soya is low as the soya bean crop can be harvested in one pick while other legumes need three to four picks. Unfortunately, the existing unreliable market has 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 (using "solvent extraction") has been dismantled. Soya production with or without processing for human consumption may not be profitable since the annual demand is low. No clear trend can be discerned in soya bean production and the marketing/price factors have caused sudden increases in prices as well as shortfalls. However, there are favorable signs for a better market in the future since several nongovernmental organizations (NGOs) have entered the soya food processing industry.

### *Cowpea*

The cultivation of cowpea peaked in 1983 (figure A.6 in the annex) and subsequently declined, mainly due to poor prices and marketing problems. In the past, cowpea dhal was popular, but green gram dhal with its more popular flavor was more marketable. There was a small boost in production during 1989-90 with the implementation of the school midday feeding program. Most of the lands under cowpea cultivation were switched to green gram during this period, and the latter showed a consistent increase in production whereas cowpea indicated a decreasing trend.

### *Yam (Sweet Potato)*

The intensive extension program to popularize yam cultivation during the 1970s resulted in the cultivation of sweet potato in rice fields. Presently, sweet potato cultivation is confined to the Godakawela area in the Ratnapura District, Mawanella and Rambukkana areas in the Kegalle District, and the Rajangane Major Irrigation Scheme in the Anuradhapura District. In some locations, farmers cultivate three crops during a year. In Ratnapura and Kegalle (in the Wet Zone), sweet potato is cultivated under minor irrigation and in rain-fed rice fields. The income and profit from sweet potato are much higher than those for rice. Sweet potato was preferred by farmers due to the higher profits gained, an assured local market, lower costs of cultivation, lower risks, higher utilization of family labor, and lower levels of hired labor. However, the extent cultivated has reached its peak due to saturation of the limited market. But sweet potato can still be cultivated in rice fields with well-drained soils during both wet and dry seasons.

### *Banana*

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

## 2.3 COMMON FACTORS CONTRIBUTING TO FLUCTUATIONS IN CULTIVATED EXTENT OF OFCs

### *Rainfall*

Rainfall has a direct impact on the extent of rain-fed crops cultivated during a given maha season. Early and well-distributed rainfall during the maha season results in an increase in the extent of land cultivated with rain-fed OFCs during the maha season, while heavy rainfall during maha reduces the cultivated area. Heavy rainfall during early yala tends to reduce the extent of OFCs under irrigation. On the other hand, heavy rainfall during maha and low rainfall during early yala tends to an increase in the cultivated area of irrigated OFCs.

### *Market Prices*

When the farm-gate price of any OFC drops below the price expected by the farmer during a given season, the extent of land cultivated with that crop falls during the following season. If the price is attractive, the extent of land under that crop increases during the following season.

The production of certain OFCs by farmers has no relevance to market prices. These crops are cultivated because they are ideally suited to existing ecological conditions. Farmers tend to give up producing nonfood crops when there are significant marketing problems. They, however, continue to cultivate edible crops that have a local market. When farmers experience two or more seasons of market breakdown, they move away from these crops and choose crops that enjoy a stable market. Thus, market forces determine the expansion or reduction in cropping extent.

The OFC market is very vulnerable to import policies, processing capabilities, and facilities. Any attempt to increase OFC cultivation under irrigation in the maha or yala season should be preceded by a careful review or study of the market 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 EXTENT OF OFCs GROWN FOR THE TEN-YEAR PERIOD, 1982 TO 1991

1. Districtwise information on areas cultivated with OFCs has been obtained by scrutinizing individual seasonal reports of the districts provided by the Extension and Communication Centre of the Department of Agriculture (DOA), Peradeniya. The reports after 1989 are incomplete, understandably an effect of the switch to provincial administration. However, the DOA is updating this information for both yala and maha seasons. These data include the extent under each of the major OFCs categorized under rain-fed (upland and rice land) and irrigated (upland and rice land) conditions. A detailed interpretation of these data both at district and national levels, is not attempted here.

Table 1 summarizes the changes that have occurred over the period under reference.

*Table 1. Changes in extent of OFCs grown, 1982-1991.*

| | Maha | | | Yala | | | |
|---|---|---|---|---|---|---|---|
| | Irrigated RL | Rain-fed UL | Irrigated UL | Rain-fed RL | Irrigated RL | Rain-fed UL | Irrigated UL |
| *Anuradhapura* | | | | | | | |
| Chili | - | Inc. | - | - | Inc. | - | Inc. |
| Green gram | - | Inc. | - | - | Sl/Inc. | Sl/Inc. | Inc. |
| Cowpea | - | Dec. | - | - | Inc. | Dec. | Inc. |
| Gingelly | - | - | - | - | - | Const. | - |
| Groundnut | - | (Const.) | - | - | - | - | - |
| Soya bean | - | R. dec. | - | - | Inc. | Dec. | Inc. |
| Black gram | - | Inc. | - | Inc. | Sl/dec. | Dec. | Dec. |
| *Kurunegala* | | | | | | | |
| Chili | Sl/Inc. | Dec. | Dec. | Inc. | Inc. | Inc. | Inc. |
| Green gram | - | Dec. | - | Inc. | Sl/Inc. | Dec. | - |
| Cowpea | - | Dec. | - | Inc. | Inc. | Dec. | - |
| Groundnut | - | Sl/dec. | - | Inc. | Sl/Inc. | Dec. | - |

*Note:* Const. = Constant; Sl/Inc. = Slight increase; RL = Rice lands; Dec. = Decrease; Sl/Dec = Slight decrease; UL = Upland; Inc. = Increase; R. Dec. = Rapid decrease.

A few points of significance that emerge from the annex data and table 1 data are:

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

* Extents cultivated with chili and green gram in the Anuradhapura District have increased in the maha season. All cultivated land is exclusively rain-fed during the maha season.

* Soya bean cultivation in the maha season declined sharply.

* The general factors responsible for these trends can be classified under several categories: climate, market and price factors,

availability of substitutes (mainly imported), and, to a lesser extent, factors such as diseases, pests, technologies and crop management.

2. The rain-fed uplands in the Dry and Intermediate Zones have provided the bulk of OFC requirements in the past. Lately, irrigated uplands under lift irrigation during yala, and well-drained rice lands under gravity irrigation contributed an ever-increasing supply of high-value crops such as chili and onion, providing a greater part of the country's requirements. A cursory glance at the extent of land cultivated with chili, green gram and cowpea in a few important districts, with water supplied from different sources during the maha and yala seasons (based on a 10-year average), is given in table 2. The bulk of the production in the Anuradhapura District is seen to come 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. In Polonnaruwa and the Kalawewa H Area, the bulk of the production comes from irrigated rice lands in the yala season. It is observed that crop diversification during the yala season on rice land has been a success under the major irrigation schemes.

## 2.5 REGIONAL SPECIALIZATION

It is evident from the ten-year annual trend (1982-1991) of total land area (rain-fed and irrigated combined) under major OFCs, that regional specialization in OFCs has been taking place. It is assumed that this represents the recent trend in production as well. Examining these trends, the district priorities can be listed as in table 3.

Favorable cultivation 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 lands. It is likely that these district ratings will change over time.

*Table 2. Extents grown (as percentages of the total) for a few important districts (based on an analysis of ten-year data).*

| | Maha | | | | Yala | | | |
|---|---|---|---|---|---|---|---|---|
| | Rain-fed RL | Irrig-ated RL | Rain-fed UL | Irrig-ated UL | Rain-fed RL | Irrig-ated RL | Rain-fed UL | Irrig-ated UL |
| *Anuradhapura District* | | | | | | | | |
| Chili | - | - | 75 | - | - | 18 | - | 7 |
| Green gram | - | - | 85 | - | - | 7 | 2 | 6 |
| Cowpea | - | - | 95 | - | - | 1 | 2 | 2 |
| *Kurunegala District* | | | | | | | | |
| Chili | 1 | 4 | 30 | 5 | 9 | 10 | 23 | 18 |
| Green gram | - | - | 63 | - | 3 | 1 | 29 | 4 |
| Cowpea | - | - | 65 | - | 2 | 2 | 29 | 2 |
| *Polonnaruwa District* | | | | | | | | |
| Chili | - | - | 11 | - | - | 88 | - | 1 |
| Green gram | - | - | 15 | - | - | 84 | - | 1 |
| Cowpea | - | - | 63 | - | - | 35 | - | 2 |
| *Kalawewa H area* | | | | | | | | |
| Chili | - | 3 | 1 | - | - | 96 | - | - |
| Green gram | - | 5 | 32 | - | - | 63 | - | - |
| Cowpea | - | 8 | 37 | - | - | 55 | - | - |

*Note:* RL = Rice lands; UL = Upland.

*Table 3. Regional specialization in OFCs.*

| Crop | Districts recording successful diversification | | | | |
|---|---|---|---|---|---|
| Chili | Kalawewa | Anuradhapura | Jaffna | Matale | Kurunegala |
| Red onion | Jaffna | Puttalam | Ratnapura | Batticaloa | Moneragala |
| Large onion | Kalawewa | Matale | Jaffna | Polonnaruwa | System B of |
| Green gram | Kurunegala | Moneragala | Hambantota | Puttalam | Mahaweli |
| Cowpea | Kurunegala | Puttalam | Anuradhapura | Moneragala | Ratnapura |
| Black gram | Vavuniya | Anuradhapura | Mullaitivu | Kurunegala | Hambantota |
| Soya bean | Anuradhapura | Matale | Kalawewa | | Puttalam |
| Groundnut | Moneragala | Puttalam | Mullaitivu | Ampara | Kurunegala |
| Gingerly | Anuradhapura | Kurunegala | Puttalam | Moneragala | Vavuniya |
| Maize | Anuradhapura | Ampara | Badulla | Moneragala | Matale |
| Potato | Nuwara Eliya | Badulla | Jaffna | | |
| Kurakkan | Anuradhapura | Matale | Moneragala | | |

## 2.6 TRENDS IN PRODUCTION LEVELS OF OFCs

Production levels of major OFCs are shown in table 4. Estimates of production of these crops, made by the DOA, are based on average yields and extents cultivated. The data show that there has been a steady increase in production of chili, 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, increased yield has also contributed toward the increase in production.

*Table 4. Production of OFCs, 1982 to 1991.*

| Crop | Production of major subsidiary crops in '000 MT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
| Chili | 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 |
| Big 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 (1991).

CHAPTER 3

# Agro-Ecological Factors that Influence Diversified Cropping in Rice Lands

## 3.1 INTRODUCTION

IT SHOULD BE recognized at the outset itself that both agro-ecological and socioeconomic-institutional considerations, together with their interactions, ultimately determine the potential for diversified cropping on rice lands as well as the pace of its acceptance. While this is especially so in the semihumid and humid tropical environments of South and Southeast Asia, it is quite different in the semiarid 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 semihumid and humid tropics, have been clearly brought out in two important International Rice Research Institute (IRRI) publications. These are (a) Proceedings of the International Symposium on Soils and Rice (IRRI 1978), and (b) Rice: Soil, Water, Land (IRRI 1979). The recognition of regional specificities of the different rice growing environments, therefore, assumes a special importance in respect of diversified cropping of rice lands.

It is now well recognized that, as far as the physical potential for diversification of rice lands in the humid and semihumid 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 lands or "paddy lands" vis-à-vis those of the rest of Asia is that more than 80 percent of these rice lands are located within *inland valleys* of varying form and size, rather than on alluvial plains and terraces and various types of floodplains that make up most of the rice growing landscapes of other Asian countries. This feature has special significance for crop diversification.

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 the countries in monsoonal Asia. This is clearly manifest in the humid Wet Zone of Sri Lanka, which is subject to both the southwest and northeast monsoons plus convectional and depressional rains of very high intensity. Such a rainfall regime, in combination with an inland hydromorphic valley environment, precludes opportunities available for diversification because of the absence of a well-defined and sufficiently long dry season. However, the opportunity for crop diversification in the semihumid, dry and intermediate zones of the country that 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.*

It is evident from the foregoing considerations that it is not possible to project a single "across-the-board" economic approach in addressing the issues on crop diversification on rice lands, 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 PRESENT

Irrigated agriculture in this country had traditionally 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 with rice since at least 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 cultivation. No further expansion has taken place since. The restoration of the abandoned major irrigation schemes of the Dry Zone commenced under state sponsorship in the early part of this century, and underwent further expansion from the 1930s until 1948 when Sri Lanka became an independent country. Almost the total increase in the extent of asweddumized rice lands in this country since independence is a result of both restoration of ancient irrigation schemes as well as construction of new schemes, both major and minor, in different parts of the Dry Zone.

The development of irrigation in Sri Lanka prior to the 1960s was mainly conceived in terms of advancing the country toward the goal of self-sufficiency in its rice requirements. The restoration of the abandoned networks of ancient irrigation schemes and the construction of new ones during this period were 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 extent of irrigated rice lands in the Dry Zone. Options of crops other than high water demanding rice had therefore to be properly planned and tested.

In the early sixties, agronomic research on the cultivation of nonrice crops on gravity-irrigated land in the Dry Zone helped firmly establish the feasibility of growing crops other than rice on the *well-drained* category of irrigated lands of irrigation schemes during the rainless yala season. Such alternative crops are referred to as other field crops or OFCs. 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 chili and onion, that practical and realistic incentives became available to farmers to undertake the commercial production of OFCs. These were mainly chili 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) season was used for irrigating a limited extent or portion of the command area for rice. 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 under 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 by the introduction of agro-wells close to and around the akkarawelas in the late 1980s. A relatively reliable, though limited supply, of groundwater during the period April to August, which could be drawn from open 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 chili, onion, and vegetables, which commanded a good market.

The highest extents of OFCs grown under the Mahaweli System H major irrigation schemes and minor tank systems with agro-wells are given in table 5. This is only for the Anuradhapura District and gives an approximate idea of the potential for OFC cultivation during the yala season in respect of one of the more important districts.

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

*Table 5. Highest extents of OFCs grown in the Anuradhapura District.*

| Irrigation systems | | Extent of OFCs (ha) | Season |
|---|---|---|---|
| 1. | Mahaweli System H (Kalawewa) | 12,090 | Yala 1986 |
| 2. | Major irrigation systems | 3,700 | Yala 1990 |
| 3. | Minor irrigation systems + agro-wells | 1,320 | Yala 1990 |
| | | 17,110 | |

An examination of the water regimes of the different irrigation systems, where dry season crop diversification has taken place over the last three decades, shows that it has been mainly confined to 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 the water supply during this limited dry season, 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.

Another area of concern is the poor performance of diversified cropping in some of the major irrigation schemes that have an assured supply of water for irrigation during the dry yala season. Examples include the major irrigation schemes in the Polonnaruwa District. Because of the reliable water supply in these systems during the dry yala season, they provide an ideal opportunity for the promotion of intensive, market-oriented nonrice crop products that should have a stable or assured market over the years.

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

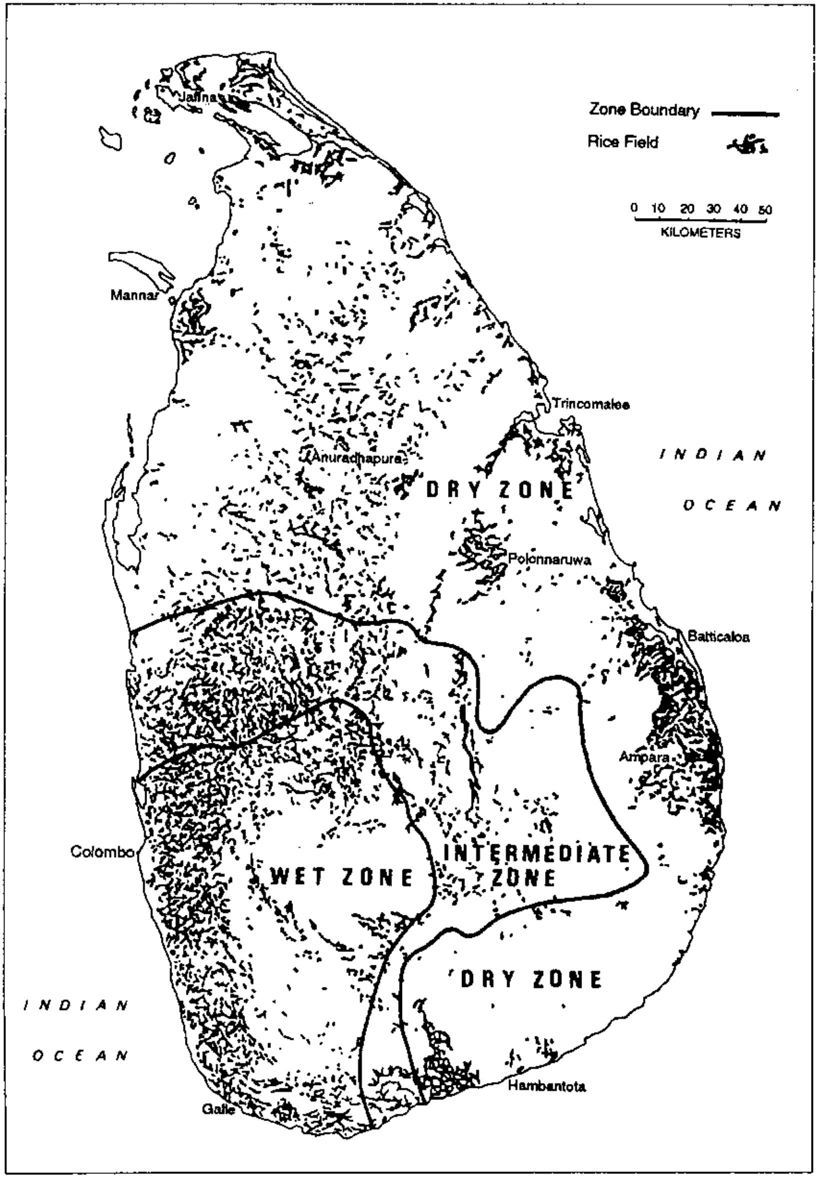
## 3.3 GENERAL CHARACTERISTICS OF RICE LANDS IN THE DIFFERENT AGRO-ECOLOGICAL REGIONS (AERs) AND THEIR SUITABILITY FOR CROP DIVERSIFICATION

The distribution pattern of rice lands in Sri Lanka is shown in figure 4, which also indicates the demarcation of the country into the Wet Zone, the Intermediate Zone, and the Dry Zone. The asweddumized rice lands of the wet zone are located in inland valleys of varying sizes and forms. The position of these rice lands in the landscape and their associated hydrology make cultivation of wet lowland rice 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 into nonagricultural uses such as human settlements and industrial establishments.

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

The rice lands of the low-country Intermediate Zone will be discussed along 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 also in 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 provided with

*Figure 4. Distribution of rice lands in Sri Lanka.*



conventional irrigation facilities. Only a single crop of rice is grown in these rain-fed lands during the wet maha season. They remain fallow during the rest of the year.

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 greatest potential for diversified cropping on rice lands exists in the well-drained soils that occur in these irrigated lands. It is therefore proposed to examine, in the next section, the relative potential for dry-season diversified cropping on these irrigated rice lands in the Dry and Intermediate Zones with different categories of irrigation schemes. At present, the following broad categories of irrigation schemes are recognized:

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

*Category II* Major irrigation schemes where the catchment or the source of supply is situated entirely within the Dry Zone. Such schemes, therefore, have an adequate supply of water for the maha season and a limited supply that can be used for only some of the rice lands during the yala season.

*Category III* Medium and minor irrigation schemes that have a moderately stable water supply that ensures at least a 75 percent cropping intensity in the maha season. Very little water is left for irrigation during yala.

*Category IV* 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 AND RECENT PERFORMANCE

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

Because of the high stability of the irrigation water supply during the dry season, the best opportunity for intensive dry-season diversified cropping exists within this category of irrigation scheme.

Table 6 shows some typical irrigation systems representative of this category, together with the extent of well-drained lands within each system, and the highest extent of land cultivated with OFCs during the past ten years.

*Table 6. Extent of well-drained soils and cultivation of OFCs in Category I irrigation schemes.*

| District | Name of system | Extent of well-drained lands (ha) | Highest extent of OFCs grown (ha) and season |
|---|---|---|---|
| 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. | 1,178 | 648 (yala 1990) |
| | Minneriya | 1,031 | 486 (yala 1989) |
| | Kaudulla | 655 | 203 (yala 1990) |
| | Giritale | 372 | 236 (yala 1988) |

*Note:* RB = Right Bank; P.S.S. = Parakrama Samudra Scheme.

Table 6 shows that System H of the Mahaweli had achieved almost its full potential on the well-drained soils during yala 1986. This exemplifies the degree of performance attainable when all essential support services, supplies, and marketing have been provided by the Mahaweli Economic Agency (MEA) management.

Approximately 75 percent of the land suitable for OFCs In the Uda Walawe Right Bank (RB) area had been cultivated with these crops during yala 1993. The greater part of such cultivated land was accounted for by banana and, to a lesser extent, by chili and onion. The management agency of this project planned to achieve OFC cultivation on the entire extent of 4,200 ha of well-drained soils by the end of 1995.

The extent of OFC cultivation in the major irrigation schemes of the Polonnaruwa District has been comparatively modest. This is not surprising because these irrigation systems have had a longer tradition of maha rice followed by yala rice since their inception in the early 1940s. The additional supply provided from the Mahaweli diversion for the yala season has only helped to stabilize yala rice production in preference to introducing OFC cultivation. Also, the proportion of well-drained soils within each system is significantly lower than that in the Mahaweli and Uda Walawe project areas as seen in Table 6.

Systems C and B of the Mahaweli are also areas with very stable and adequate water supply during both maha and yala seasons. Available data show a very slow progress in the 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. In system C, it has increased from 308 ha in yala 1987 to 836 ha in yala 1992. The reasons for this slow rate of the increase need further study.

The comparative advantage of the sustained and stable production of high-value crops is best afforded in lands within Category I, and efforts should be focused on this category of land. The need to do so has been demonstrated by results achieved so far in System H of the Mahaweli.

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

Some typical irrigation systems within this category, the extent of well-drained lands under each system, and the highest extent of OFC cultivation achieved in the past are shown in table 7.

*Table 7. Extent of well-drained soils and cultivation of OFCs in Category II irrigation schemes.*

| District | Name of system | Extent of well-drained lands (ha) | Highest extent of OFCs grown (ha) and season |
|---|---|---|---|
| 1. Anuradhapura | Rajangana | 1,590 | 1,146 (yala 1988) |
| | Padaviya | 1,560 | 502 (yala 1990) |
| | Huruluwewa | 1,050 | 972 (yala 1986) |
| | Mahavilachchiya | 450 | 320 (yala 1989) |
| | Devahuwa | 430 | 345 (yala 1989) |
| 2. Badulla | Nagadeepa<br>Sorabora<br>Mapakade | 1,700 | 1,238 (yala 1990) |
| 3. Mullaitivu | Muthiyankadu | 860 | 653 (yala 1986) |

Over the last two decades, there has been a significant increase in diversified cropping in rice lands in these systems during the yala season. However, extents cultivated in different years have been highly variable because of the high degree of variability of irrigation water supplied during the yala season in each of the years.

All these schemes within the Anuradhapura, Badulla and Mullaitivu Districts, except for Padaviya, have achieved at least a 70 percent cultivation of the total extent of well-drained soils with OFCs. The extent cultivated has depended on the amount of irrigation water available during a particular season. This indicates the potential for dry season crop diversification in this category of irrigation.

The Kirindi Oya Irrigation Project (KOIP) is a system with extreme water shortage. It is located in the semiarid region in southeastern Sri Lanka where diversified cropping on well-drained rice lands is possible even during the maha season. A total extent of 562 ha of OFCs was grown, under rain-fed conditions along with supplementary irrigation in maha 1992-93, in the new command area of the project. KOIP did not receive sufficient irrigation water for rice cultivation because of the restricted water supply from the main reservoir. In the yala of 1993, OFCs were cultivated on a total extent of 909 ha in the old command area of the project with a view to economizing on the severely restricted water supply experienced during that season.

One of the more difficult management problems encountered within this category is 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 water likely to be available during 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 geared mainly to the domestic market that can absorb these fluctuations, rather than to export-oriented crops, which require a more assured supply of irrigation water.

### *Category III: Medium Schemes with a Moderately Stable Water Supply for the Maha Season*

These systems fall within the Irrigation Department's broad classification of medium-sized irrigation schemes. Selective statistics given in table 8 for the Anuradhapura, Puttalam and Kurunegala Districts provide a general idea of the extent and size distribution of these systems.

*Table 8. Size range and command area of Category III irrigation schemes.*

| District | Main river basin | Number of irrigation schemes | Size range (ha) | Total command area (ha) |
|---|---|---|---|---|
| 1. Anuradhapura | Malwathu Oya | 35 | 80-350 | 5,182 |
| | Yan Oya | 20 | 80-250 | 2,432 |
| | Moderagam Aru | 7 | 80-150 | 834 |
| 2. Puttalam | Mi Oya | 7 | 100-350 | 1,447 |
| 3. Kurunegala | Mi Oya | 6 | 100-800 | 3,723 |
| | Deduru Oya | 10 | 80-150 | 1,163 |
| | | | | 14,781 |

These systems usually have an adequate supply of water for irrigation during the wet maha season, and an average maha season cropping intensity of more than 75 percent. Such systems in the Intermediate Zone of the Kurunegala District have a higher cropping intensity because of the higher rainfall there.

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

It is difficult to explain the very low state of progress achieved so far 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 high priority because of the distinct potential that exists for such diversification.

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

These systems fall within the category of minor tanks in the classification by the Irrigation Department and the Department of Agrarian Services. Almost all of these are situated within the minor tank cascade systems so typical of the Anuradhapura District.

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

It should also be noted that past attempts at intensification of rice production in these systems have not proved very successful. The present push toward use of both surface water and groundwater supplies for diversified cropping should therefore be strongly supported. The Agricultural Development Authority reports that a total extent of 488 ha of OFCs was cultivated in the Anuradhapura District during yala 1993 under the agro-well program. There is however an upper limit to the number of such agro-wells that should be permitted in the hard rock aquifer conditions that exist in the 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 OFC cultivation in rice lands. All of these studies have focused on OFC cultivation in the dry yala season.

According to these studies, in general, it has been found that OFC cultivation is possible in 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. Research conducted by IIMI in the Dewahuwa Irrigation Scheme and Mahaweli System H, during 1985 to 1988, observed that the unreliability and inequity of the water supply at the turnout level were 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 more vital than modification of the irrigation delivery system. The former would be a necessary condition for better OFC cultivation.

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

IIMI research has also found that, with management changes in the delivery of irrigation water (introduction of rotational water issues), OFCs could be successfully grown in existing irrigation schemes during the dry (yala) season. One of the major problems faced by farmers is irrigation at night. Unlike in rice, irrigation of OFCs at night is difficult because it needs much care compared to rice. The other major problem is the difficulty in water application due to different OFCs needing 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 the 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 evapotranspiration 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 the Kirindi Oya and Walawe, the following constraints were encountered:

1. 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 during the yala season in the upper reaches of well-drained soils, and rice in the lower reaches of poorly drained soils. The separate provision of parallel field channels for well-drained soils 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 as well. Under such conditions, field leveling needs to be perfect; otherwise, micro-depressions within the basin create water stagnation affecting OFC 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. It can be either 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 distributary 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 the agency and farmers. Changes in delivery schedules, if any, are to be communicated promptly, and the reliability of the 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 the 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 distributary and turnout levels.

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

8. OFCs of a wide range, 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 two to ten days, whereas the irrigation frequency is fixed at once in seven days, or once in ten 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 dugwells to supplement surface water when 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 five months. The physical infrastructure and management efforts combined together are not able to fully meet 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 beds, 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 conditions, essentially dictate whether a particular cropping pattern would be adopted in a particular location.

## 4.1 LOCAL DEMAND COMPARED WITH PRODUCTION

National demand for, or requirements of OFCs depend mainly on per capita consumption and population size. Per capita consumption of OFCs is largely determined by the price of the product and income levels. Therefore, the annual national requirements of OFCs have been computed mainly on the basis of these two factors. Wastage and seed requirements were also considered in calculating these requirements. Data on seed requirements and wastage of respective crops were obtained from the reports of the Department of Census and Statistics. Projected population data were also obtained from the same source.

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 9). According to the data, the consumption patterns for most OFCs, except for red onion and big onion, show a marginal increase with the rise of income. As shown in table 9, the rate of increase in the consumption of onion as income increases is higher than that for the other

*Table 9. Average quantities (in grams) consumed per capita per month by income groups, 1986/87.*

| | Income (rupees per month) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 801-1,000 | 1,001-1,500 | 1,501 - 2,000 | 2,001 - 3,000 | 3,001 - 5,000 | 5,001-10,000 | > 10,000 | Ave-rage |
| Chili (Dried) | 151.8 | 151.99 | 160.9 | 166.3 | 169.3 | 175.5 | 177.8 | 161.51 |
| Chili (Green) | 87.7 | 94.4 | 103.9 | 120.8 | 131.8 | 128.0 | 134.8 | 109.8 |
| Red onion (Shallots) | 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 |

*Note:* Income groups are in current rupees/month.

*Source:* Report on Consumer Finance and Socioeconomic Survey, 1986/87, published by the Central Bank of Sri Lanka in 1990.

*Table 10. Estimated national requirements of OFCs, in 000 metric tons.*

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|
| Population* (millions) | 17.90 | 18.11 | 18.31 | 18.51 | 18.70 | 18.90 | 19.09 |
| *Crop* | | | | | | | |
| Chili | 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 |

* Population projections are by the Department of Census and Statistics.

*Notes:* Requirement = (Per capita consumption X Population) + Wastage + Seed requirements

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

produce. These data roughly indicate that the demand for most other OFCs will increase marginally as income increases.

The estimated domestic requirements of selected crops are presented in table 10. In estimating local requirements, however, possible changes in per capita income in the future were not taken into account since the consumption of most of these crops, as indicated earlier, is low 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. The Department of Agriculture (DOA) estimates show much higher requirements for 1994 (table 11). The DOA estimates are based on local production and imports. In this estimation, annual carryover stocks have been ignored. Estimates of the onion requirement by the Diversified Agriculture Research Project (DARP) show a lower figure for onion requirements than the DOA estimates.

## National Requirements and Current Production Levels

It is necessary now to address the issue of national requirements of food items (OFCs) and production levels estimated, as planned for 1994, and the levels achieved. Table 12 presents a comparison of estimated requirements and estimated production. 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 productivity and profitability could be increased in existing areas of production to meet requirements, through better technology than through an increase in the extents cultivated.

It is likely that the produce of traditional upland irrigated crops such as chili and onion from Jaffna and Killinochchi will increase and reach the market as current civil disturbances ease. Projected population increases will undoubtedly mark an increase in requirements. From the above, it is clear that the search for newer crops with a comparative advantage is becoming vital. More attention needs to be paid to increases in agribusiness opportunities that help value-adding market search and promotion, quality control, and export.

*Table 11. National requirements of OFCs, as estimated by the Department of Agriculture (DOA) and the Diversified Agriculture Research Project (DARP), in 000 metric tons.*

| Crop | Estimated national requirements | | | | | |
|---|---|---|---|---|---|---|
| | Estimated by DOA[a] | | Estimated by DARP[b] | | | |
| | 1993 | 1994 | 1993 | 1994 | 1995 | 1996 |
| Chili | 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 an estimated demand equation.

*Table 12. Estimated requirement and planned production of major food items in 000 metric tons.*

| 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 chili | 50.0 | 48.4 | 52.0 | 59.3 |
| Red onion | 135.0 | 138.1 | 139.0 | 157.0 |
| Big onion | 60.0 | 37.7 | 64.0 | 48.8 |
| Groundnut | 12.0 | 21.6 | 12.5 | 13.5 |

*Source:* Division of Agricultural Economics and Planning, Department of Agriculture.

However, a more accurate picture of the gaps that exist between expectation and performance in crop diversification in rice lands cannot be predicated from the available data. Such information needs to be collected from individual project or program areas. Both on national and district bases, the most logical method of obtaining this information is to compare the seasonal and annual targets and performance of OFCs, documented in the annual agricultural implementation programs of the Ministry of Agriculture and the progress reports of the DOA. This can be done if needed.

## 4.2 MARKETS, PRICES, AND TRADE POLICY

In Sri Lankan markets, prices and trade policy act as key determinants of the level of adoption of OFCs. Both the profit margin and the 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 the 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 the consumer wants them. Unlike 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 readily perishable than rice and require special care in handling and storage. Marketing of these crops, therefore, often demands a chain of activities including assembling, transport, sorting, grading, storage, packing, initial processing, and taking the risk of holding the produce until an outlet is found. Some common problems associated with the marketing of OFCs include:

(a) ***High marketing costs:*** These are due to unjustifiable profits to local buyers or middlemen as a result of the weak bargaining power of farmers; 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 legislation; etc.

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

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

**Prices**

The price of an OFC reflects the market strength of that crop. It also determines the profitability of the crop. Unlike rice production, OFC production generally involves higher risks and greater uncertainty. Price uncertainty is usually more serious for OFCs than the risks associated with physical production. There could be many reasons for wide price fluctuations such as weak marketing structures and government policies. Minimizing price fluctuations is therefore more important for the promotion of crop diversification.

Farm-gate prices for selected OFCs in major OFC producing districts are shown in table 13. The data show that there is significant price variation both within and between districts. Despite the lack of clear information to explain such price variations between districts, it can be stated that it is related to the quantum of production in these districts. Prices are higher in low production volume areas where products are sold in a very localized market.

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

*Figure 5. Farm-gate prices of pulses (in 1993 prices).*

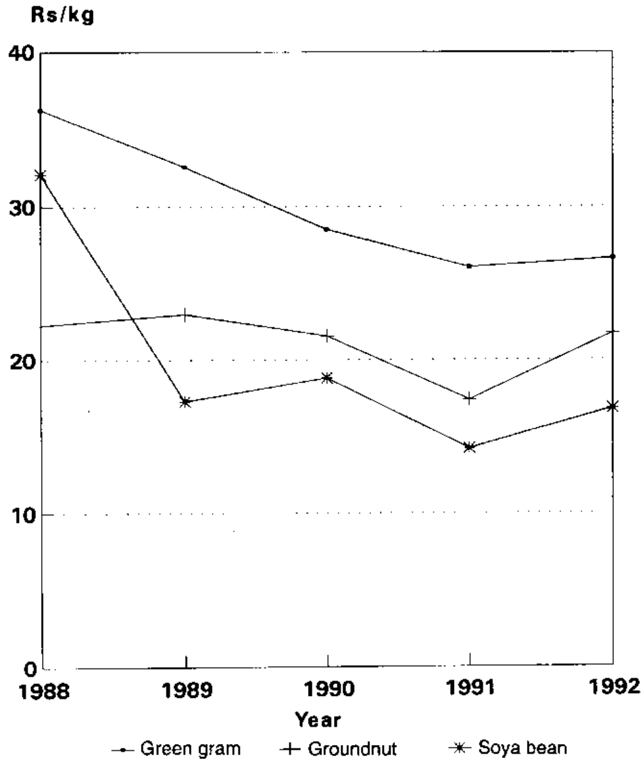


*Table 13. Farm-gate prices of selected OFCs, in Rs/kg.*

| | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|
| *Chili* | | | | | |
| 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 (shallot)* | | | | | |
| 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.

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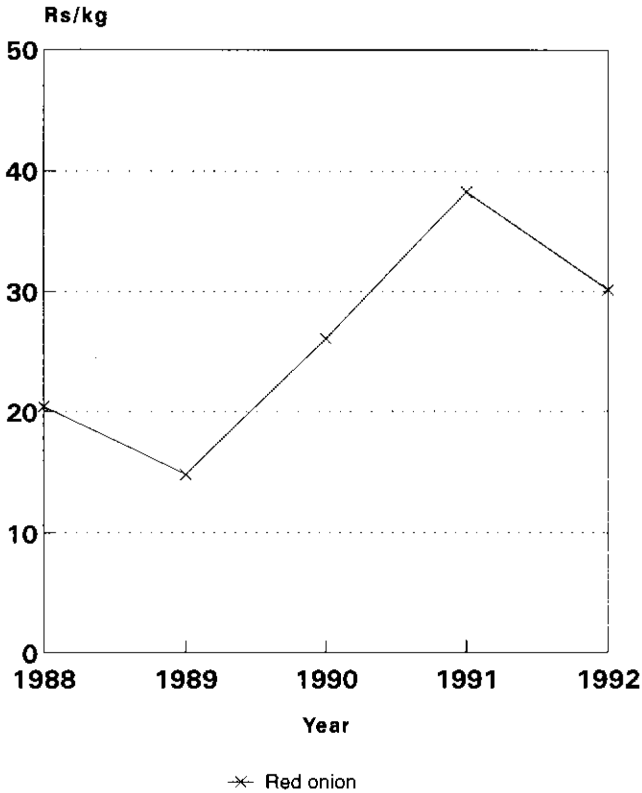
The farm-gate prices of chili show an increasing trend up to 1991, and a decline in 1992 (figure 6). The fluctuation of the annual average chili price corresponds to the total annual production. This implies that the price is determined by the annual chili production. In the recent past, the price of chili has remained in the range of Rs 80 to Rs 100 per kg.

*Figure 6. Farm-gate prices of chili (in 1993 prices).*

The farm-gate prices of red onion show a declining trend up to 1989 and increase and stabilize thereafter (figure 7). Since the annual production is very close to the annual requirement, the price cannot be expected to rise in the future. Several studies have shown a price decline during the harvesting period. This is however 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 generally about 20 percent. However, price drops for perishables such as big onion during the harvesting period are more significant compared to pulses and chili. Another reason is the low keeping quality of big onion compared to that of red onion.

*Figure 7. Farm-gate prices of red onion (in 1993 prices).*



Price analyses show a general trend of declining prices for most of the OFCs despite the wide variation within districts. This suggests that there is little prospect for expanding cultivation of these crops for local consumption.

### Trade Policy

Trade policy is an important factor associated with marketing at the macro level. For instance, it has been observed that the type and quantities of products that compete with local OFC produce that is cleared for importation, as well as the timing of the release of imports to the open market by state agencies/departments, have acted as impediments to local production. Adverse effects of foreign competition on local production need to be avoided at least during the infancy period of agricultural diversification. Sometimes the increase in supply after a ban on imports tends 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 an 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 pronounced in the case of most of the OFCs under consideration.

## 4.3 DEMAND FOR LABOR

"Underemployment" is a common feature in Sri Lanka. In the rural areas, especially where rice culture is dominant, a significant portion of the work force cannot find gainful employment on a regular basis. The demand for hired labor in such areas is confined to peak periods in the cropping season. On the other hand, despite population growth rates now being relatively low, the base population is high and the population growth in absolute terms therefore remains high. 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 nonagricultural sectors—notably in industries—is not adequate enough to absorb the numbers joining the labor force each year. Consequently, agriculture as 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 the demand for labor as a result of the adoption of different cropping patterns should be evaluated.

Tables 14 and 15 show that labor is the most significant input in crop diversification. OFCs can be classified on the basis of relative profitability into two categories: low-performance OFCs and high-performance OFCs (Kikuchi 1990).

The data in table 14 show that high-performance OFCs require much more labor than rice. Also, high-performance crops require very high labor inputs when compared to low-performance crops. Labor inputs for high-performance OFCs are almost five times as much as for rice, and around twice as much as for low-performance OFCs. Although high labor requirements create employment opportunities for rural people, they also create a scarcity of labor in the area and thereby increase wages for labor. Profitability too could decline as a result of this.

*Table 14. Labor requirement for OFCs and rice, in man-days/ha.*

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

*Source:* *Cost of cultivation of Agriculture Crops* (various issues), Department of Agriculture.

*Notes:* Percentages are given in parentheses. Averages are based on data from 1985 to 1992.

*Table 15. Average cash production costs for the 1986 yala season crops in Dewahuwa and Kalankuttiya in Rs/ha (1986 prices).*

| Cost item | Dewahuwa | | | Kalankuttiya | | |
|---|---|---|---|---|---|---|
| | Rice | Chili | Green gram | Soya bean | Rice | Chili |
| Fertilizer | 788 | 2,023 | 40 | 147 | 804 | 2,048 |
| Pesticides, herbicides | 181 | 2,580 | 1,053 | 381 | 420 | 2,196 |
| Seed, seedlings | 406 | 575 | 807 | 750 | 671 | 597 |
| Hired equipment | 1,323 | 1,406 | 1,278 | 1,702 | 1,930 | 1,517 |
| **Hired Labor** | **1,345** | **6,258** | **2,356** | **2,462** | **1,432** | **4,835** |
| Irrigation water* | 7 | 78 | 0 | 0 | 56 | 54 |
| Total cash cost | 4,050 | 12,920 | 5,534 | 5,442 | 5,313 | 11,247 |
| Gross returns | 7,814 | 26,265 | 12,848 | 16,863 | 10,436 | 25,383 |
| Net returns | 3,764 | 13,345 | 7,314 | 11,421 | 5,123 | 14,136 |

* Payments as irrigation fees.

*Source:* Panabokke 1989.

One advantage of the cultivation of OFCs rather than rice is that the farmers can depend on the use of more family labor. Sixty to eighty percent of the labor requirement for OFCs can be provided from family labor. The comparable value for rice cultivation is about 45 percent. Most OFCs, however, require a higher amount of hired labor than is required for rice. This is one of the major constraints for crop diversification in rice lands.

Seasonal peaks in labor demand are high for cultivation of mixed OFCs. Labor peaks of different crops coincide with one another. 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, where the 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 chili and onion, but it is substantial even for low-performance crops such as green gram.

*Figure 8. Cropping calendar for rice and nonrice crops in 1989 yala, Kirindi Oya.*

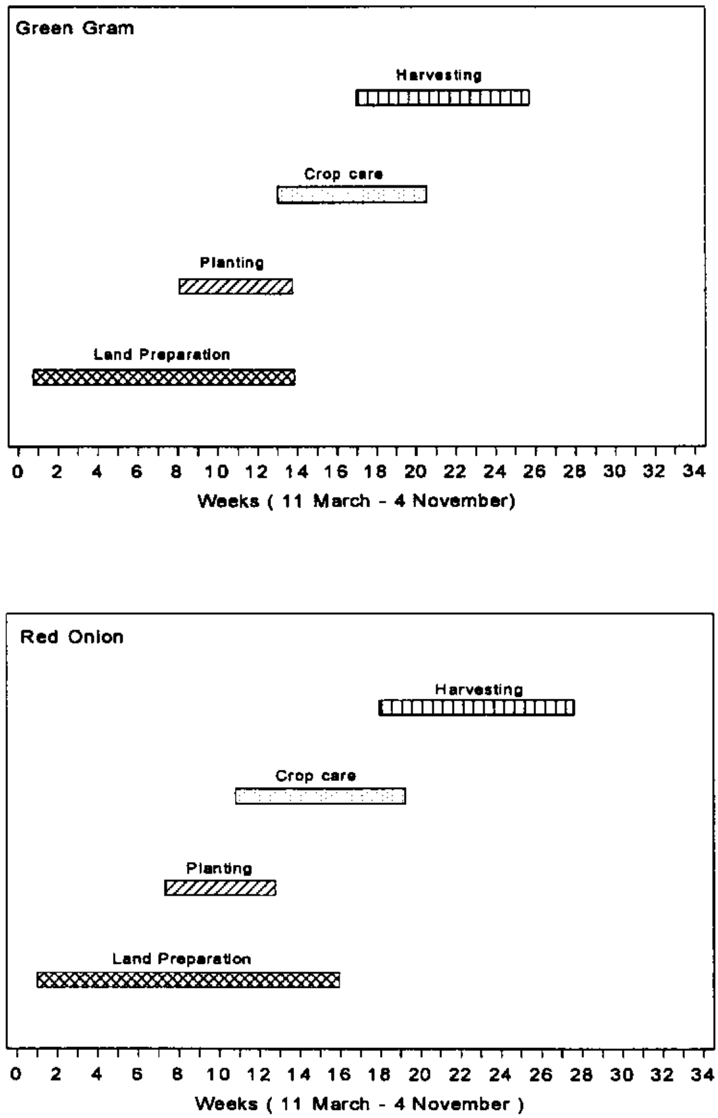
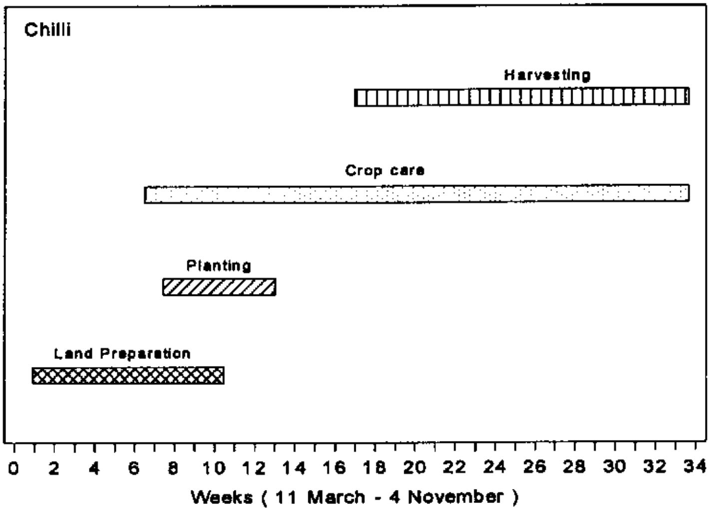


*Figure 8. (Continued).*



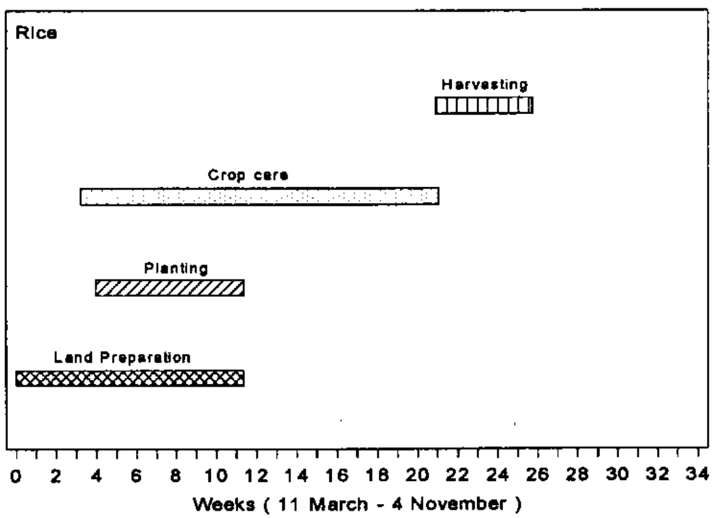
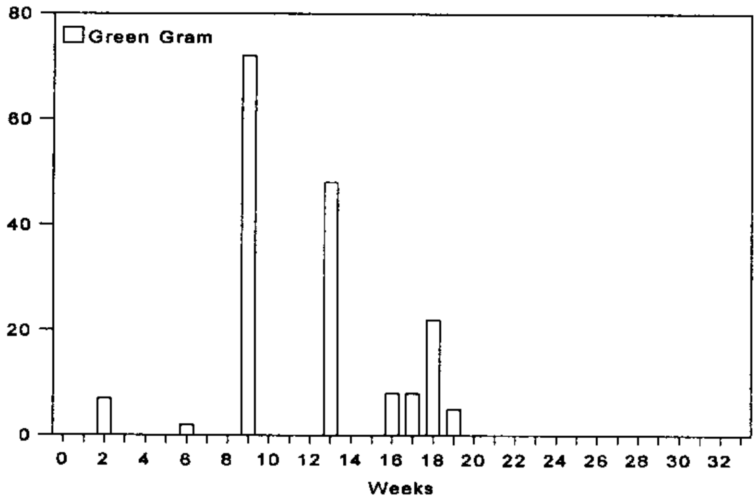



*Figure 9. Weekly labor requirements per hectare for rice and nonrice crops in 1989 yala, Kirindi Oya.*



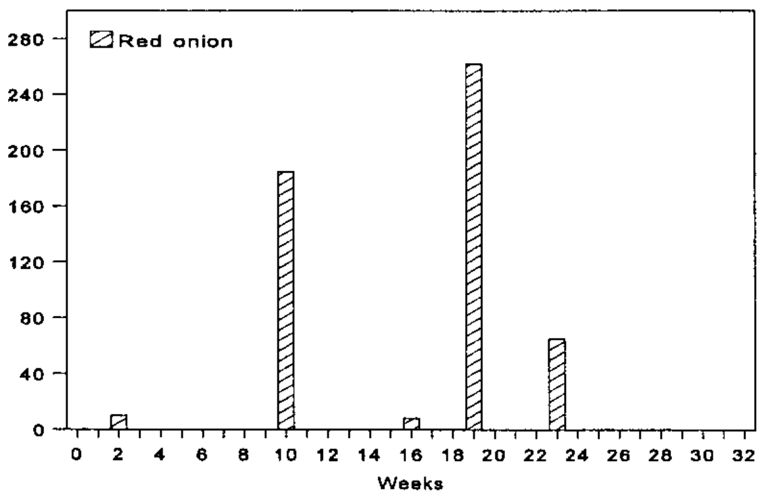
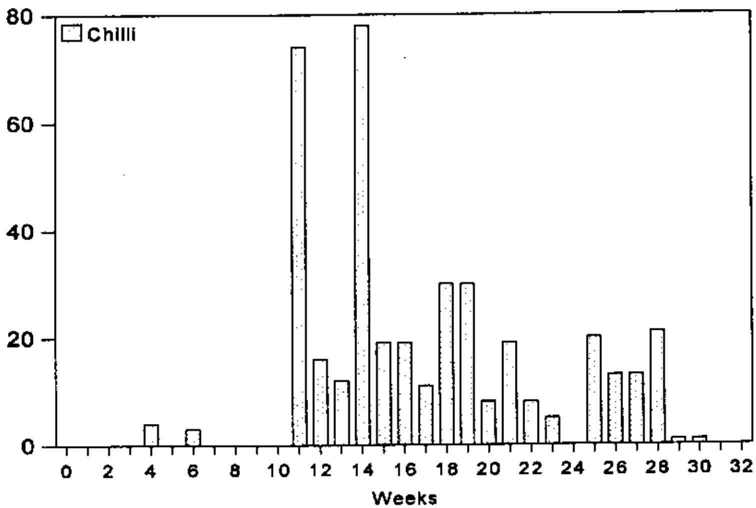
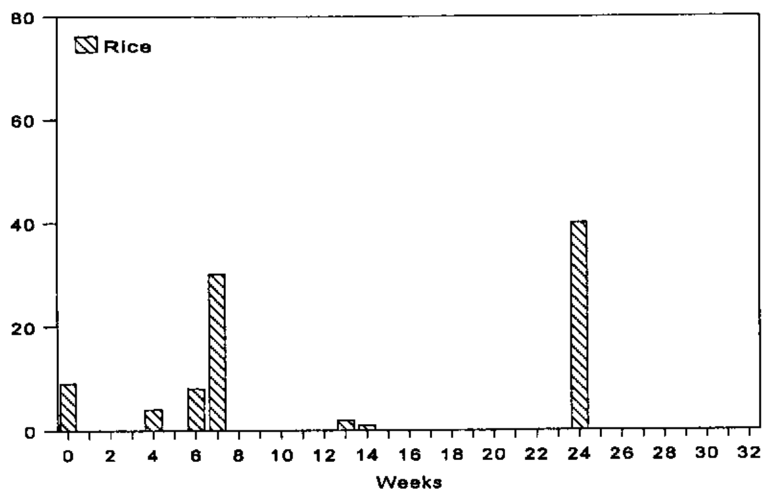



*Figure 9. (Continued).*



In addition to the labor required for cultivation activities, OFC cultivation mainly requires family labor for guarding the crops (mainly at night). Since the harvesting period for OFCs is long compared to that for rice, the labor for protecting the crops is required over a longer period. This compels farmers to guard their fields at night. This is another reason why many farmers are reluctant to grow OFCs in rice lands.

Mechanization of OFC cultivation is limited mainly to ploughing, unlike in rice cultivation. The other activities such as planting, weeding and harvesting are mostly carried out with manual labor. Labor requirements of the different activities in OFCs and rice cultivation are shown in table 16. The labor requirement for almost all activities in the cultivation of OFCs is higher than that for rice. The very high labor requirement for the land preparation activity for cultivating high-performance crops is a major problem faced by farmers. The type of land preparation for OFCs is also different from that for rice. Unlike in the case of rice cultivation, mechanization of these activities in the cultivation of OFCs is not possible. This suggests that labor could be one of the constraints if OFC cultivation expands in rice lands, particularly if the increase is in the cultivation of high-performance crops.

*Table 16. Labor use (man-days/ha) for OFCs and rice.*

| Activity | Chili | 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 |
| Harvest and post-harvest activities | 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 |

*Sources:* Data for OFCs are from Kirindi Oya, on-farm demonstration, 1989 yala season. Data for rice is from Kirindi Oya, 1987/88 maha season.

Although the demand for labor and the cost of labor are unusually high for OFCs like onion and chili, 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 through vertical expansion, etc., in areas related to activities such as processing, packing, and grading. Obviously crop diversification presents a much higher potential for secondary activities or linkage effects than in the case of rice cultivation.

IIMI research on labor and management inputs consumed by irrigation in Sri Lanka and the Philippines shows that nonrice crops demand more labor for irrigation even though the irrigation interval can be widened.

It may be concluded from the foregoing discussion that diversified cropping has greater potential than rice monoculture in the following labor-related aspects:

1. total labor absorption or employment generation
2. regularity in labor demand over time
3. employment in secondary activities (vertical expansion)
4. 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 capital intensive than rice. This is particularly true for high-performance crops.

Average cash requirements for OFCs and rice are shown in table 17. Among the OFCs, high-performance crops require more capital than rice. Capital requirements of high-performance crops are nearly twice as much as the capital needs of rice. This is mainly due to high input requirements such as fertilizer and chemicals and the high labor requirement of 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 cost of inputs required for rice. Data show that high-performance crops need twice as much capital as does rice. Since capital is a constraint for most farmers, high-performance crop cultivation should be limited to small extents of land.

*Table 17. Costs of production for OFCs and rice during the 1993 yala season (in 000 Rs/ha).*

| | High-performance crops | | Low-performance crops | | |
|---|---|---|---|---|---|
| | Chili | 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 |

*Notes:* Opportunity cost of family labor is valued by taking 0.7 of wage rate for hired labor.
Total 1 = Total cost excluding family labor.
Total 2 = Total cost including family labor.
Values in parentheses are percentages of Total 1.

Sources: For chili, big onion, soya bean and rice, data are from Cost of Cultivation of Agricultural Crops Yala 1993, published by the Department of Agriculture in 1994. For green gram, data are from Kirindi Oya on-farm demonstration in the 1989 yala season, published in the Final Report (Vol. II) of a study on Irrigation Management for Crop Diversification by the International Irrigation Management Institute in 1990.

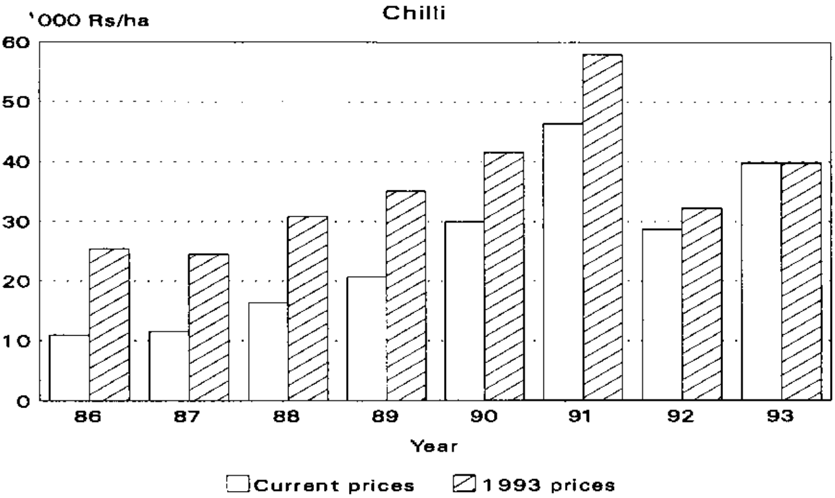
The capital requirements for low-performance crops are less than that for rice. Low-performance crops require fewer inputs compared to high-performance crops, and the prices of inputs for low-performance crops (such as seed and agro-chemicals) are less, compared to the inputs required for high-performance crops. Table 17 shows that in high-performance crops the major share of the capital is accounted for by fertilizer and agro-chemicals; it is around 43 percent for chili and 38 percent for big onion while it is about 35 percent for rice. Agro-chemicals and fertilizer for soya bean account for about 12.6 percent of the total cost.

Changes in capital costs of selected OFCs are shown in figures 10 and 11. These figures provide a clear indication that the real cost of cultivation of high-performance crops has shown an increasing trend from 1985 up to 1991, and declined thereafter while the real cost of cultivation of low-performance crops has shown a decreasing trend. The increasing trend of the cost of cultivation of high-performance crops could be due mainly to increases in prices of fertilizers after the removal of the fertilizer subsidy. Agro-chemical prices also increased after 1989 as a result of the depreciation of the local currency. These price increases have had a heavy impact on the cost of cultivation of high-performance crops since fertilizers and agro-chemicals account for nearly 40 percent of the total cost. Since agro-chemical and fertilizer application is low for the low-value crops, the cost of cultivation of these crops did not show an increasing trend as a result of the increase in the price of fertilizers and agro-chemicals. However, the real cost has declined over time. The declining trend in the cost of cultivation of low-performance crops indicates that real wages have not increased over time since labor costs account for the major share of the total cost of cultivation.

## 4.5 ECONOMIC PERFORMANCE OF OFCs

A number of different indicators are available for evaluating the economic performance of agricultural production. This report will use gross value added (returns on farm land, labor, and capital), farmers' net income, and returns on labor.

*Figure 10. Cost of cultivation of chili and big onion.*



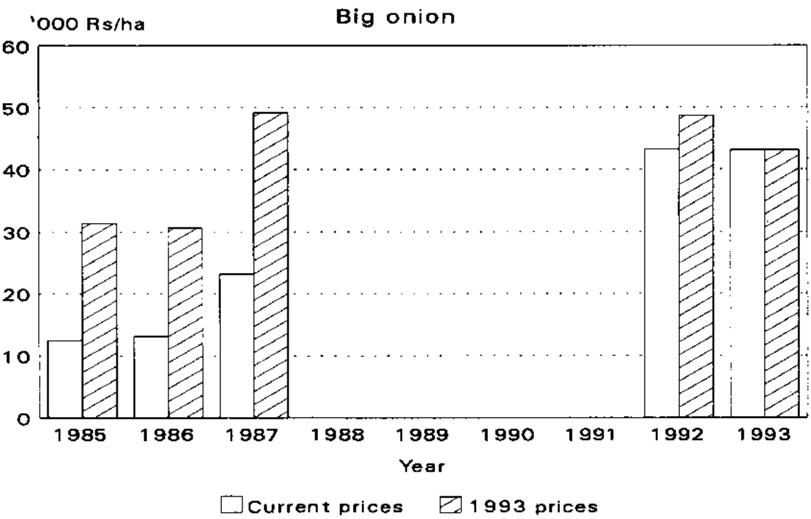
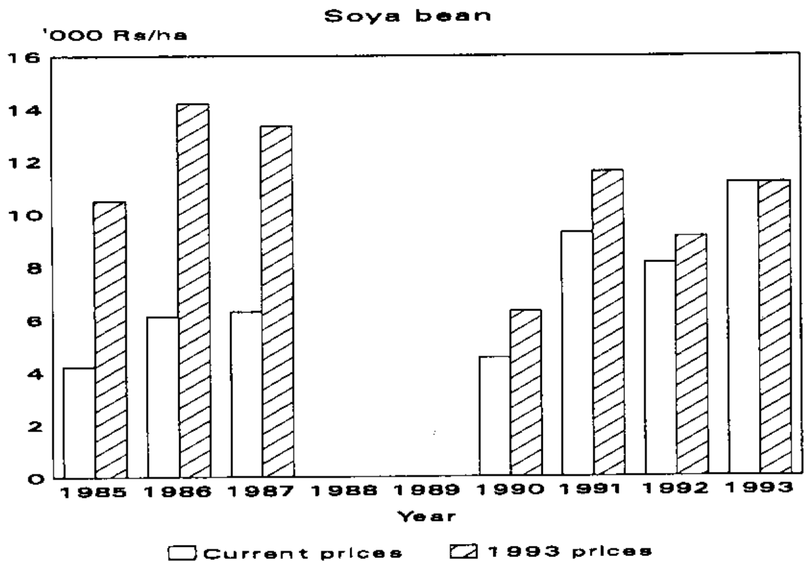



*Figure 11. Cost of cultivation of soya bean and green gram.*



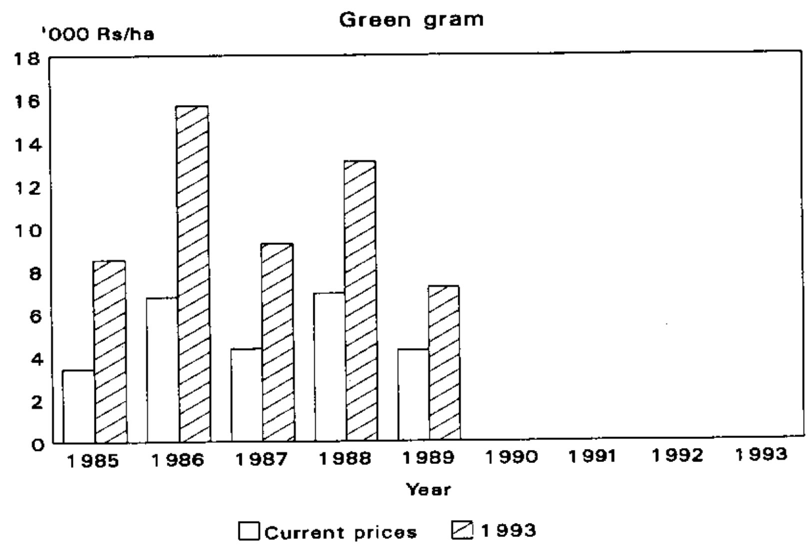



Table 18 provides a comparison of OFCs and rice in terms of selected financial indicators. This is mainly the profitability to the farmers. These calculations are based on data collected on the costs and returns in the 1993 yala season in various districts. Under present conditions, high-performance crops, with the exception of red onion, perform better than rice. Farmers can obtain more than twice as much income from chili as from rice. Farmers' income from big onion is nine times as much as the income from rice. Low-performance crops give incomes similar to that from rice. The prospects for high-performance crops (except for red onion) are good since the above yield levels and price levels are good and are not likely to increase significantly in the near future. The most remunerative crops (compared to rice) are chili and onion. However, these results cannot be generally applied since there are variations in yields, prices and costs between districts. The above data are for the districts where OFC cultivation is well established.

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

Trends of profitability of OFC cultivation with chili, onion, green gram, and soya bean from 1985 to 1993, are analyzed in figures 12, 13 and 14. The trend analysis shows that the profitability of all selected crops, except for big onion, shows a declining trend or stagnation. This implies that incentives for crop diversification are weakening. Although the real cost of cultivation of low-performance crops show a declining trend, profitability has not increased. This is mainly due to the decline in farm-gate prices and stagnating yields. Yields of green gram and soya bean depicted in figure 16 show a declining trend. However, soya bean yields show high fluctuation in comparison with green gram.

*Table 18. Farm-level profitability of 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 |
|---|---|---|---|---|---|---|---|
| *High-performance crops* | | | | | | | |
| Chili | 1.02 | 76.27 | 77.80 | 57.84 | 38.05 | 24.61 | 153.14 |
| Big onion | 12.86 | 13.67 | 175.80 | 149.41 | 132.68 | 121.27 | 434.33 |
| Red onion | 8.59 | 13.38 | 114.93 | 23.11 | 7.93 | 4.88 | 70.76 |
| *Low-performance crops* | | | | | | | |
| 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 |

*Notes:* Farmers' income 1 - Excluding opportunity cost of family labor
Farmers' income 2 - Including opportunity cost of family labor.

*Sources:* Data on chili, red onion, big onion, and soya bean are from Cost of Cultivation of Agricultural Crops Yala 1993, published by the Department of Agriculture in 1994. Data on green gram are from Kirindi Oya crop demonstrations during 1989 yala, published in the Final Report (Vol. II) on Irrigation Management and Crop Diversification by the International Irrigation Management Institute in 1990.

The profitability of chili has not changed since 1991 despite a decline in cost of cultivation since 1991 and stagnation of chili yield (figure 15). However, higher farm-gate prices received for chili during 1991 and 1992 compensated for the low yields. The average yield of chili is far below the potential yield (dry chili: 2,000 kg/ha). The profitability of red onion cultivation has declined drastically since 1987 (figure 13). This is mainly due to a decline in both yield and price. The price decline is obvious since production has reached the level of demand. The level of profitability of big onion has continued to remain high since 1985. The main reason for this is the increase in the yield over the past eight years (figure 15). At the initial stage of big onion cultivation, farmers lacked experience and there

*Figure 12. Costs and returns of chili cultivation (in 1993 constant prices).*

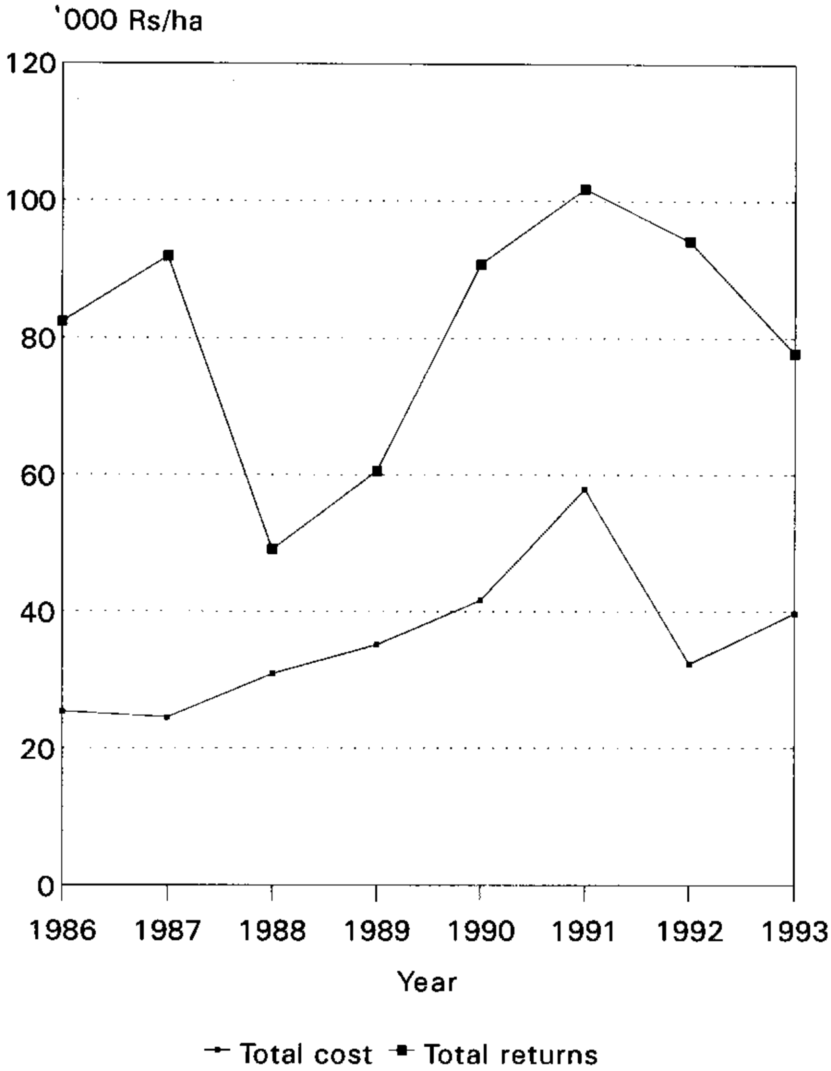
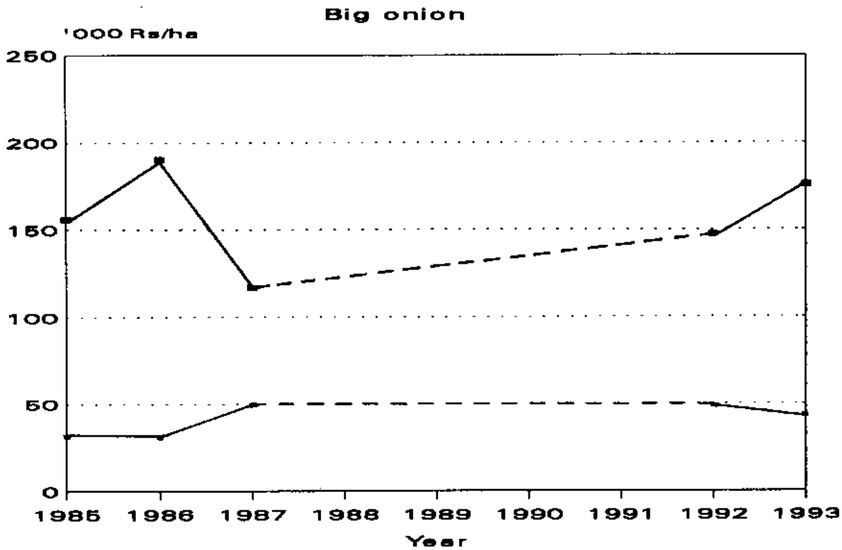


*Figure 13. Costs and returns of onion cultivation (in 1993 constant prices).*



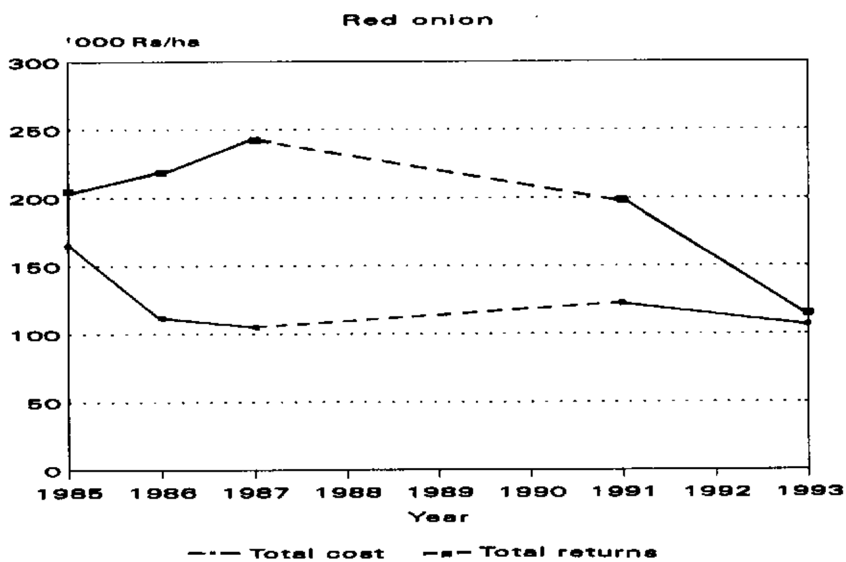



*Figure 14. Costs and returns of green gram and soya bean cultivation (in 1993 constant prices).*

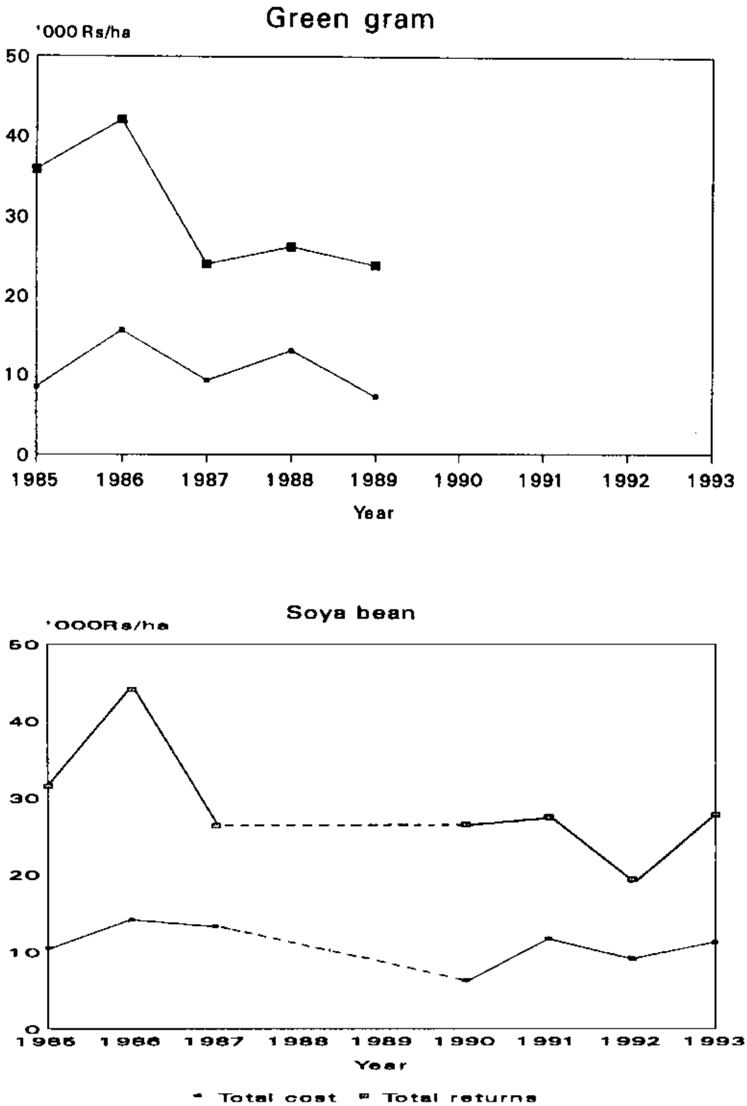


*Figure 15. Yield trends of chili and onion.*

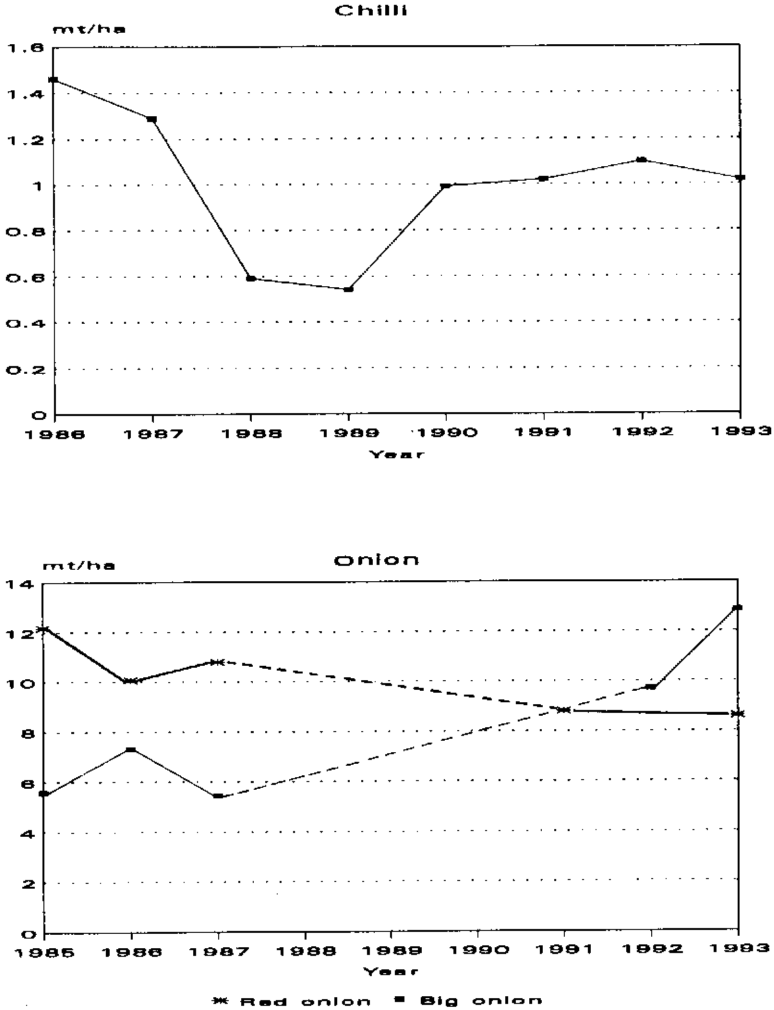
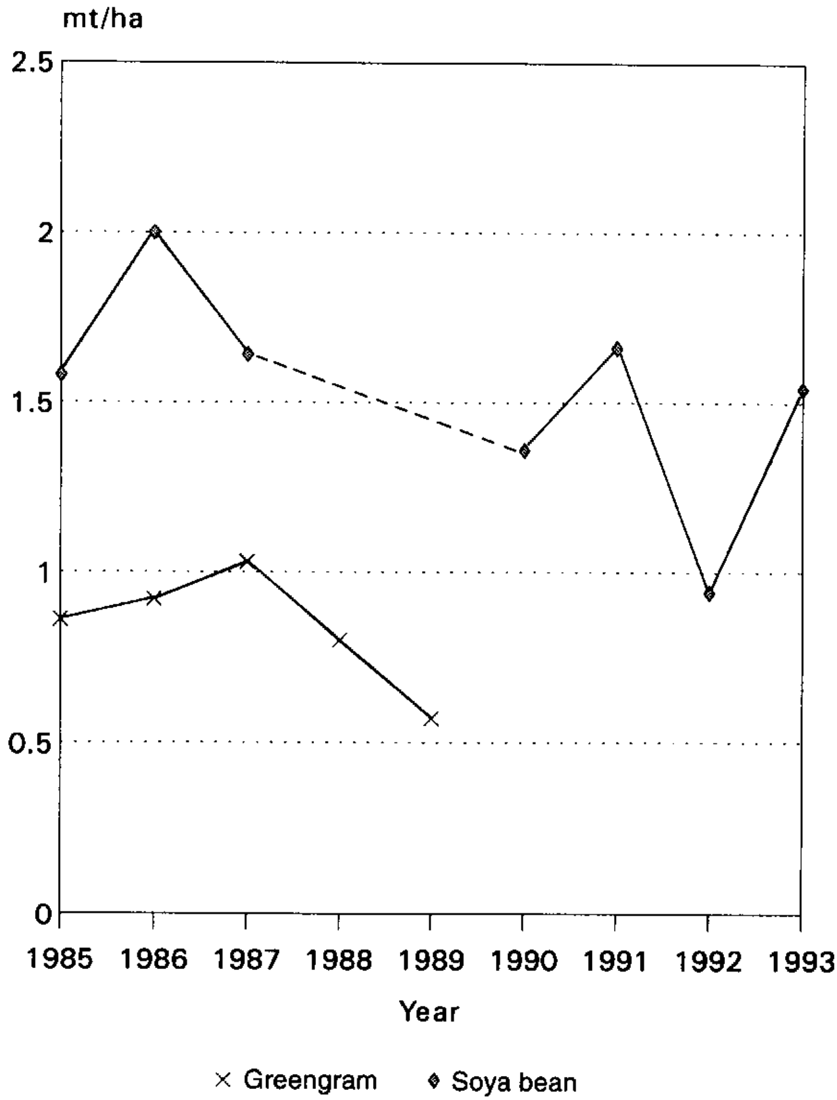


*Figure 16. Yield trends of green gram and soya bean.*



were problems in obtaining quality seeds. This situation improved once the farmers mastered the technology of big onion cultivation and the seed supply increased. As a result, yields increased from 5 mt per ha to around 10 mt per ha. However, there have been reports that farmers in Matale suffered losses in 1991 due to low prices prevailing even one month after harvesting. The low quality of local big onion and the lack of market information to the producer are the reasons given for such low prices. However, prices continue to show a declining trend. Prices could further decline if production exceeds demand. The main problem faced by big onion cultivators is market gluts during harvesting time.

It is important to store good quality onion bulbs that are gathered at the peak of the harvesting season to avoid a market glut. However, big onion, unlike red onion, cannot be stored for long periods. The price margin required to justify onion storage for two months is estimated to be Rs 13 per kg (Pattie and Wickramasinghe 1993). With adequate storage facilities, big onion production can supply the market demand for five months. Big onion can be stored for only three to four months unless expensive methods are adopted. Therefore, local production should be limited to the local requirement for six months.

## Economic Costs and Returns of Rice and OFCs

A comparison of costs and returns, in economic prices, of rice and OFC production is given in table 19.

It is interesting to note that the economic profitability of rice production under major irrigation schemes 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 for green gram. The break-even yield for green gram is 1.34 mt/ha, which is a most difficult target to achieve. The production, locally, of chili, big onion and soya is justifiable. However, the progress of diversification depends mainly on the financial profitability to the farmer, and input and market constraints to the cultivation of these crops.

*Table 19. Economic costs and returns of rice and OFC 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) |
|---|---|---|---|---|---|---|
| Chili | 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 = CIF price + port charges + economic transportation cost + economic handling cost + economic storage cost.
Economic prices are for the 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.

## Comparative Advantage of OFC Production in Sri Lanka

The domestic resource cost (DRC) is used as a tool to evaluate the comparative advantage of OFC production over rice production in Sri Lanka. DRC is defined as the ratio of domestic cost and border price of output minus foreign cost:

$$\text{DRC} = \frac{\text{Domestic cost in shadow prices per unit of output}}{\text{(Border price of output) - (Foreign cost per unit of border price)}}$$

The resource cost ratio (RCR) indicates the relative comparative advantage of an economic activity for a country. RCR is the ratio of DRC and the shadow exchange rate (SER). Thus, if,

(a) RCR $< 1$, it is a comparative advantage.
(b) RCR $= 1$, it is a neutral advantage.
(c) RCR $> 1$, it is a comparative disadvantage.

The costs of cultivation for OFCs and rice during the year 1993 were obtained from the Department of Agriculture. The conversion factors were developed on the basis of a study on DRC analysis of rice in 1993, conducted by the Agrarian Research and Training Institute, to convert the financial values of primary inputs for OFCs into economic values. Labor was valued under surplus labor conditions. A conversion factor of 0.722 was developed by the Bradford University, UK in 1991 to convert the financial value of labor into the economic value of labor. The ratio of domestic cost to foreign cost was obtained from a study conducted by the Agrarian Research and Training Institute for the rice producing sector. Domestic and foreign costs were separated by using this ratio. Irrigation and land costs were not taken into account because irrigation cost is a sunk cost for the diversification of existing irrigated rice lands. The land cost was ignored because land would be idling during the yala season if rice was cultivated, due to the limited availability of water.

Table 20 presents the efficiency indicators for the production of OFCs and rice under irrigated conditions during the yala season. All crops were analyzed as import substitutions. The results clearly show that rice and all OFCs analyzed, except green gram, have a comparative advantage. It is interesting to note that rice is more economical than OFCs, except soya bean. Among the OFCs, soya bean is the most economical crop with an RCR of 0.51. The major problem for green gram lies in its low yield.

Since the comparative advantage analysis is a dynamic concept, the above results should be considered as static indicators of economic efficiency of OFCs and rice for 1993. The comparative advantage is mainly determined by yield levels, resource endowments, and input-output ratios. Important factors that determine the yield include technology, agro-climatic factors, and farm-level management. The optimum interplay of these factors should therefore determine the sustainability of the comparative advantage in the long run.

*Table 20. Economic efficiency indicators for the production of OFCs and rice under irrigation, in rice lands of Sri Lanka.*

| Crop | Trade regime | Efficiency indicators | |
|---|---|---|---|
| | | DRC | RCR |
| *High-performance OFCs* | | | |
| Chili | Import substitution | 43.75 | 0.91 |
| Big onion | Import substitution | 33.08 | 0.69 |
| *Low-performance OFCs* | | | |
| Green gram | Import substitution | 62.27 | 1.30 |
| Soya bean | Import substitution | 24.43 | 0.51 |
| Rice | Import substitution | 27.43 | 0.57 |

*Notes:* The analysis is only for the Anuradhapura District, North Central Province.
The calculations are based on 1993 prices.
Irrigation cost and land rent are not taken into account.
Conversion rate of official exchange rate into shadow exchange rate = 1.
Average official exchange rate is Rs 48 = US$1.00.

The break-even yields for different crops at given border prices with the existing cost structure are given in table 21. The data show that there is a considerable gap between the actual and potential yields. Since the break-even yield is less than the potential yield, there is a possibility of increasing the actual yield beyond the break-even yield. However, this could affect the cost structure and hence economic efficiency. Therefore, yield improvements should be attempted without any major change in the cost structure. Factors beyond control that determine the break-even yield are the border prices of outputs and imported inputs. Changes in border prices of outputs and imported inputs may be brought about by changes in the supply of these items to the world market. These changes are difficult to predict. These results cannot therefore predict the efficiency of the crops in the long run.

*Table 21. Actual, potential, and break-even yields for different irrigated OFCs and rice at given border prices, Anuradhapura District, 1993 yala.*

| Crop | Border price (Rs/kg) | Yields (mt/ha) | | |
|---|---|---|---|---|
| | | Actual | Potential | Break-even |
| *High-performance crops* | | | | |
| Chili | 48.61 | 1.02 | 2.50 | 0.95 |
| Big onion | 11.15 | 5.58 | 25.00 | 4.25 |
| *Low-performance crops* | | | | |
| Green gram | 14.97 | 0.65 | 1.25 | 0.81 |
| Soya bean | 17.41 | 1.54 | 2.00 | 0.83 |
| Rice | 6.65 | 4.18 | 5.00 | 3.06 |

* Annual average CIF price.

*Source:* Sri Lanka Annual Customs Returns.

## 4.6 OTHER POTENTIAL CROPS

Vegetable is the other variety of nonrice crops that has the potential for cultivation in rice lands. However, cultivation of vegetables entails very high risks when compared with other nonrice crops. Price drop during the harvesting period is a major constraint to vegetable cultivation. Since good infrastructure facilities for the marketing of vegetables are not available in most irrigated areas, it could be difficult to promote the large-scale cultivation of vegetables in these areas. Table 22 shows the costs and returns for selected vegetables under irrigated conditions. The profitability of cultivating such vegetables seems to be very high. However, the cost of cultivation is also high. Another major constraint to vegetable cultivation in rice lands is drainage and soil factors. Initial land preparation costs will be very high because the conversion of land that has been prepared for rice cultivation during the maha season into land for vegetable cultivation during the yala season involves a good deal of work.

Banana is another cultivable crop that gives high profits to farmers. A significant extent of rice land in Uda Walawe has been 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 cultivation in Uda Walawe. A rough analysis of costs and returns of banana cultivation is presented in table 23. The cost of cultivation of banana is a little higher than that of low-performance crops, but less than that of chili. Unlike the other OFCs, a banana crop could last for about five years and give an income throughout this period. The initial cost is high for banana cultivation, which is about Rs 22,900/ha. The annual maintenance cost is around Rs 18,400/ha. The advantage in banana cultivation is that the annual cost of cultivation can be spread out evenly by staggered planting. The income from banana cultivation is high when compared with other high-performance OFCs.

*Table 22. Costs and returns of vegetable cultivation under irrigated conditions (in 000 Rs/ha).*

| | Bush bean[a] | Tomato[b] | Pole bean[b] |
|---|---|---|---|
| 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 |

[a] Matale District. b Badulla District.

*Note:* Costs and returns are based on 1993 prices.

*Table 23. Costs and returns of banana cultivation (in Rs/ha).*

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| Land preparation | 5,000 | 400 | 400 | 400 | 400 |
| Planting | 400 | - | - | - | - |
| Manual weeding | 4,800 | 4,800 | 4,800 | 4,800 | 4,800 |
| Fertilizer application | 400 | 1,600 | 1,600 | 1,600 | 1,600 |
| Earthing | 2,400 | 2,400 | 2,400 | 2,400 | 2,400 |
| Harvesting | 400 | 3,600 | 3,600 | 3,600 | 3,600 |
| Others | 1,600 | 1,600 | 1,600 | 1,600 | 1,600 |
| Inputs : | | | | | |
| Planting materials | 2,700 | | | | |
| Fertilizer | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 |
| Total cost | 20,500 | 16,000 | 16,000 | 16,000 | 16,000 |
| Yield (kg) | 2,000 | 12,000 | 14,000 | 13,000 | 10,000 |
| Price (Rs/kg) | 12 | 12 | 12 | 12 | 12 |
| Gross income (Rs) | 24,000 | 144,000 | 168,000 | 156,000 | 120,000 |
| Net income (Rs) | 3,500 | 128,000 | 152,000 | 143,000 | 110,000 |

*Note:* Costs and returns are based on 1993 prices.

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

The other promising nonrice crop variety besides banana that can be cultivated in rice lands comprises tuber crops. Data to evaluate the economic profitability of tuber crops are not available. However, DOA extension officers have reported that in places like Rajangana, farmers have obtained high returns from tuber crops such as sweet potato and *Kiri Ala* (a type of yam).

## 4.7 CREDIT

Credit and marketing are more often than not tied together. For instance, middle men 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 that 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 because of 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 more liberal approach with acceptable procedures and interest rates. The provision of *timely and need-based credit* must also be closely supervised. The following factors may also be considered along with others in lending, providing credit to these farmers:

* Provision of credit not only for short-term or seasonal production, but also for medium- and long-term investment needs associated with the handling and processing of farm produce such as sprayers, threshers, and processing equipment.

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

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

* Adequate supervision and follow-up, and the concurrent deployment of sufficiently trained staff to supervise and provide extension services.

## 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 since it 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. This knowledge will help greatly 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 pattern derives not only from the nature of the 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 efficient 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, vary from time to time for different reasons. Fluctuations in prices and weather, innovations and introduction of new technology, and changes in institutions and the economic structure, are among the factors that cause variations in farm incomes over time. The 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 of respective economies.* These aspects, which are related to supply and demand, may be considered in formulating an agenda for further research in crop diversification.

## 4.9 FARMER PERCEPTION AND ATTITUDES

Rice monoculture should not be regarded as "primitive." However, it is characterized by long-established routines in respect of all production activities. From the farmer's perception, the adoption of a new cropping pattern is therefore associated with risks and uncertainties that are as yet "unknown." Before adoption, a typical farmer whose aim is to avert risks would look for higher profit margins, long-term stability in income, etc. Risk is also associated with a variety of factors. *Profitability* is the primary factor. Others include crop failure, capital investment, *fluctuations in prices, lack of experience, stability of market, and marketing expertise.* As discussed elsewhere, the merits of diversified cropping in relation to some of these factors, such as the stability of income and markets, are yet to be found out. This explains the reluctance of farmers 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 are much higher in a *diversified cropping pattern* than in a *monocropping situation.* Different crops demand different cultivation practices and different inputs at different times. When a group of farmers uses a common source of input such as irrigation water, group action is necessary to maximize the benefits of such an input, especially if the supply is limited. Group action can benefit from economies of scale in respect of other inputs or outputs,

Many of the problems discussed in this report may not be difficult to overcome once the farmers are organized into groups. Transportation in marketing is a good example. Bulk handling could lower the cost of transportation and thereby reduce costs. Overdependence on local outlets can also be reduced by group action: Farmers can then look for more profitable outlets elsewhere. Moreover, collective bargaining is usually helpful in obtaining a fair price for farm produce. Likewise, many other activities in the purchase of inputs and in the marketing of outputs can be conveniently organized and effectively handled by farmer organizations.

## 4.11 INTERACTION AMONG PARTICIPANTS

It has been highlighted throughout this paper that the success of crop diversification in Sri Lanka, with its large number of small-scale farmers, would depend on a large number of factors that belong to different disciplines. Hence, interactions between different "participants" are essential to achieving 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. Close collaboration between these agencies is required to *promote crop diversification*, especially during the initial stages.

## 4.12 IMPACT ON LIVING STANDARDS

The impacts of diversified cropping on the living standards of people depend on a variety of factors. In addition to those actively engaged in diversified cropping, others may also benefit from crop diversification owing to linkage effects or vertical expansion as, for example, *employment generation through handling, processing, expansion of input and output markets, and through increased demand for agricultural labor. It may also be argued that the increased availability of a variety* *of food crops would improve the general living standards of the large number of consumers.*

Impact may also be assessed in terms of *efficiency in the production of nourishing foods per unit area of land (or water) during a unit of time.* One may consider protein and energy as the major factors in the diet of the people living in rural areas. The type of amino acid in protein is also a crucial factor. Methionine and lysine, for example, are important in tropical diets.

In general, *crop diversification provides foods of higher nutritive value.* For example, while a monoculture of rice may yield a higher amount of energy per unit of land, rotating it with legumes can provide more protein as well. Moreover, the qualities of proteins in *legumes* are generally superior to that of rice. Soya bean, for example, contains about 45 percent of protein with higher levels of methionine. The life span of most of the legumes commonly included in diversified cropping is much shorter than that of rice. It can, therefore, be claimed that *diversified cropping has a higher potential for improving living standards.* This statement is particularly relevant for areas where protein deficiency is pronounced, because a *rice-legume combination may be a more productive agricultural system.*

The factors affecting the volume of production and profitability have been discussed earlier in this paper. Profitability influences the capacity to spend on nonfood items as well. The overall impact of crop diversification on the living standards of people engaged in producing these crops would mainly depend on the distribution of the factors of production in respective areas. The composition of the labor force engaged in diversified cropping (owner-cultivators, tenants, agricultural laborers, etc.) is a decisive factor in the success of such efforts.

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

CHAPTER 5

# Summary and Conclusions

THIS CHAPTER PRESENTS a summary of the major findings of this study and attempts to draw some conclusions while focusing 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 significant increases in rice production and productivity in the past. The land area cultivated with rice and the national average rice yield reached their peak levels by the mid-1980s. The turning point appears to have been 1985. Since then, key determinants of total production such as yield level and area covered have not shown clear rates of growth, especially in irrigated areas. The cropping intensity, which had been stagnating over a long period, has also not shown any significant improvement. Moreover, the increase in the market price of rice during 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 more. Despite the low population growth rate, annual increases in population will remain high for some time more because the base population is high. Therefore, it is crucial to explore the possibility of 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 increasing the productivity of scarce factors of production, increasing cropping intensity, and checking increases in 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) against alternative rice-based cropping patterns *in areas where agro-ecological factors are conducive to such patterns.* In such cases, introducing "break crops" into a rice cropping system would help regenerate soil fertility, reduce weeds and pest buildups, and provide more diversified options to sustain total household incomes. Grain legume crops such as green gram, leguminous green manure crops, or vegetable crops may be particularly suitable rotation crops for a rice cropping system. Improving crop yields (both rice and nonrice) in such systems may be achieved through improved efficiency in input use. Improving irrigation management efficiency would be the key factor. Additionally, integrated plant nutrient management, integrated pest management, etc., should also be considered.

Hence, the future policy in this major staple food sector should be twofold: *Maintain a high degree of self-sufficiency in rice and encourage diversification in areas possessing comparative advantages for OFCs.* It is argued that this dual objective can be achieved through a proper mix of appropriate technology, organization, and resources.

For instance, the supply of water for crop production can be augmented through a judicious combination of surface water and groundwater and by optimizing the use of rain water through proper timing of planting operations. More profitable cropping patterns based on agro-ecological suitability can be established through organized group action by small farmers.

## 5.1 RECENT TRENDS IN THE CULTIVATION OF OFCs

Diversified cropping in rice lands has primarily been centered around OFCs such as chili, onion (red onion and big onion), green gram, cowpea, black gram, soya bean, groundnut and vegetables. To a lesser extent, banana, sweet potato, gingelly and gherkin have gained importance in specific areas. The rain-fed uplands in the Dry Zone and the Intermediate

Zone have provided the bulk of OFC requirements in the past. Almost all the maha-season (wet-season) OFC cultivation in the Dry Zone is rain-fed. Lately, upland areas under lift irrigation and well-drained rice land under gravity irrigation during the dry season have contributed to an increasing supply of OFCs.

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

* Although chili records the highest extents grown during 1976/77, the production over the years, in general, has shown an increasing trend up to 1986. It has remained stagnant since then. During the decade 1982-92, however, a clear shift from rain-fed to irrigated chili in rice fields is evident with irrigated chili reaching peak production in 1986. This, in turn, has resulted in increased crop yields and in higher total production. At present, however, the yields are being threatened by pests and diseases.

* In the case of big onion, the extents grown increased appreciably from 1981 to 1988. The increase thereafter was a very rapid—almost fourfold from 1989 to 1991.

* Green gram has shown a consistent increase whereas cowpea has shown a decreasing trend recently.

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

* Maize production has remained somewhat stagnant.

* Yam production, which increased through the 1970s, reached a peak in 1978 (due to policy interventions) but decreased to a lower plateau subsequently, is mainly cultivated under rain-fed conditions. Potato production has shown 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 attributed to a number of factors: climate, markets and prices, availability of substitutes—mainly imported—and, to a lesser extent, other factors like pests and diseases, and crop management. It can, however, be concluded that a substantial achievement is clearly evident in irrigated areas. While the Mahaweli H System has been able to achieve almost 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 irrigation systems and in small tank command areas in the Dry Zone. 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 with the introduction of dugwells.

The maximum irrigated area brought under OFCs (in rice lands) so far in one cultivation season has been around 40,000 ha. This has not exceeded 10 percent of the total area cultivated with rice in any given season. The study revealed that diversification in recent times has been mainly confined to major and minor tank systems that have a deficit or inadequate irrigation water 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 can 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: chili, onion (red onion and big onion), green gram, black gram, soya bean, groundnut and vegetables.* Irregularities in the supply of these products can be reduced to some extent by assisting farmers and farmer organizations in key producing areas to program their production, improving the database and forecasting supply-demand on a seasonal basis, proper timing and adjusting of competing imports based on local supplies, proper storage, improved post-harvesting technologies, and better organization, including transport.

## 5.2 AGRO-ECOLOGICAL FACTORS

In the context of diversified cropping, the lower level of flexibility of agro-ecological factors assumes special significance in semihumid and humid tropical environments of South and Southeast Asia, when compared with the semiarid tropics of India and West Asia. In the latter case, greater flexibility exists for a switch between rice and nonrice cropping 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.

The present status and potential of different categories of irrigated rice lands for diversified cropping, as revealed by this study analysis, could be summarized as follows:

***Category I: Major irrigation schemes with an adequate water supply during both seasons***

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

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

*Achievement (in the best season):*

* Mahaweli H and Walawe ---------> 75 to 80 percent of the potential of well-drained lands.

* Other systems---------> 40 to 50 percent of the potential well-drained lands.

Potential---------> 90 to 100 percent of well-drained lands in yala (dry) season.

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

***Category II: Major irrigation schemes with an adequate water supply for the maha (wet) season and an inadequate water supply for the yala (dry) season***

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

*Maha (Wet) Season:* All rice, depending on water availability.

*Yala (Dry) Season:* Only on well-drained areas.

*Achievement (in the best season)* ---------> Average, between 50 and 70 percent of well-drained lands.
Potential---------> 70 to 80 percent of well-drained lands during the yala (dry) season.

***Category III: Medium schemes with a moderately stable water supply for the maha (wet) season***

* Low stability, especially in the dry season water supply.

The record of OFC cultivation has been very low. About 20 to 25 percent of the command area of these schemes 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 (yala) season will not exceed 10 percent of the total command area. However, with improved organization and management and through improved support services, maha (wet) season OFC cultivation too may be attempted to a limited extent. Both in the maha and yala seasons, conjunctive use—combining dugwell supply and tank supply—may also be attempted. The maximum extent that could be brought under OFC cultivation during the yala season, however, may not exceed 25 percent of the total command area.

***Category IV: Minor irrigation schemes with an unstable water supply***

* Water supply is unstable even during the maha season.

* Cultivation of OFCs has been at very low levels.

Dimantha (1987) points to the possibility of growing OFCs in the 185,000 ha of the Dry Zone under minor irrigation schemes by availing of the short rainy period during April/May, and making 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 mentioned earlier (refer Category IV in section 3.4). Due to water scarcity, unsuitable soil conditions, and other reasons, it may not be possible to bring the entire 185,000 ha in Category IV under OFC cultivation during the dry season.

The close monitoring of dugwells is necessary to assess the "supply conditions," including quantities, spacing/density of wells, and costs. This may lead to a "regulated expansion" of OFC cultivation in such systems. This may be assigned high priority on an experimental basis in the initial phase. An increase in overall cropping intensity may 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. Table 6 in chapter 3 gives the greatest extent of nonrice crops grown in the major irrigation schemes in Category I in the Mahaweli (Kalawewa), Uda Walawe and the Polonnaruwa District as around 16,700 ha. In Category II of the Anuradhapura, Badulla and Mullaitivu Districts (table 7 in chapter 3) 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 there is no shortage of suitable land for dry season crop diversification under the various categories of irrigation systems. Water supply rather than extent of suitable land is therefore recognized as the major physical constraint for crop diversification.

## 5.3 IRRIGATION-RELATED FACTORS

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. This is found to be particularly true for major irrigation systems designed for rice cultivation. The provision of separate parallel field channels for "rice" and "OFC" soils would therefore facilitate better system operation, effectively intercepting the drainage flow and increasing on-farm water use efficiency. The density of drainage ditches in such systems also needs to be increased for efficient cultivation of OFCs.

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

However, as greater flexibility exists in the "supply" side of suitable lands, these difficulties in irrigation management may not seriously inhibit the expansion of diversified cropping in rice lands in the immediate future.

## 5.4 ECONOMIC FACTORS

Economic factors—especially markets, prices, and trade policies—can be identified as the most important determinants in the future expansion of diversified cropping in rice lands. Price analysis shows a general trend toward declining prices for most OFCs, despite high variation over time and space. According to trend analysis, the profitability of almost all major OFCs shows 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 nonexistent in the case of 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.

The estimated requirements and expected levels of production of major OFCs in 1994 (table 24) are given as an example.

*Table 24. Estimated requirements and expected levels of production of major OFCs in 1994.*

| | Requirement (000 mt) | Estimated production (000 mt) |
|---|---|---|
| Chili | 52.0 | 59.3 |
| Onion (red onion and big onion) | 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 |

This analysis leads to the conclusion that, if the "supply" from nonrice areas remains unchanged, the rice area that should be diversified in order to satisfy local demand would be around 40,000 ha. The country has reached this level during the recent past.

It is likely that the produce from areas such as Jaffna and Killinochchi will increase the supply once the current civil disturbances ease.

It should be noted, however, that even though the income effect of demand is not very significant, the local demand will increase because of population increases. Moreover, annual fluctuations in supply in the recent past have been significant. Despite the fact that the effects of the climate on such fluctuations are difficult to control, stable supply and price levels may be attempted through a combined effort of integrated land and water management, improved database and information systems, demand and 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, and transport.

In the recent past, the cultivation on a small scale in certain irrigated areas of certain new crops such as gherkin, cantaloupe and fine bean has been recorded. The sustainability of these ventures has yet to be evaluated. The cultivation of special crops for identified captive markets should be encouraged.

Farm-level profits should be the major consideration in any future effort in OFC cultivation. Because the country has approached a very high degree of self-sufficiency with regard to almost all the major OFCs, large-scale expansion of any 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 should therefore be focused on "special crops for special markets." It is clear that the search for new crops with comparative advantages is vital. More attention needs to be paid to increase agribusiness opportunities that help value addition, market research and promotion, quality control, and export.

The study included a preliminary analysis of the comparative advantage of OFCs and rice production by comparing the economic and financial costs and returns. It was revealed that the local production is advantageous for many crops (including rice). Green gram 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 the cost of water was not considered in this analysis.

## 5.5 ROLE OF FARMERS VIS-A-VIS THE GOVERNMENT

With 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 a dependency relationship 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 the 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 supply of different raw/processed commodities in time, 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.

There is an obvious need for continued government intervention in diversified agriculture, mainly in extension work, but with approaches different from those adopted in the past. Extension work should support farmers in intensifying and strengthening organizational activities. It is imperative here to encourage group action by farmers, for example, through farmer organizations, to ensure progressive expansion of the users' role in the management of resources and services. The main role of government and NGOs should be to "catalyze" or facilitate this process.

The government should also play a dominant role in sponsoring 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, semiprocessing at farm/village level, processing of value-added products/agro-based industry, transport, quality control, legal mechanisms, and environmental concerns. The government should also perform a regulatory role in the areas of quality control and environmental conservation.

*It is evident from this study that the database on diversified cropping—including basic information such as extents and crop yields—is weak.* Inconsistencies and errors are evident, and discrepancies exist between data from different sources (such as the Department of Agriculture and the Department of Census and Statistics). *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 proper balance between supply and demand; adjusting imports (quantity and timing); checking on quality and quantity; and providing information to the farming community and traders. It is proposed to develop such a database using a Geographic Information System (GIS).

# Literature Cited

Aluwihare, P.B. and M. Kikuchi. 1990. *Irrigation investment trends in Sri Lanka: New construction and beyond.* Colombo, Sri Lanka: International Irrigation Management Institute (IIMI).

Central Bank of Sri Lanka. 1991. Review of Economy. Colombo, Sri Lanka: Central Bank of Sri Lanka.

Dimantha, S. 1987. Irrigation management for crop diversification in Sri Lanka. In *Irrigation management for diversified cropping,* 135-150. Digana, Sri Lanka: International Irrigation Management Institute.

Jayawardena, J., A. Jayasinghe and P.W.C. Dayaratne. 1993. Promoting implementation of crop diversification in rice-based irrigation systems in Sri Lanka. In *Promoting crop diversification in rice-based irrigation systems,* ed. Senen Miranda and Amado R. Maglinao. 93-103. Colombo, Sri Lanka: International Irrigation Management Institute (IIMI).

Kikuchi, M. 1990. Research and policy issues in irrigation management for crop diversification: With special reference to Sri Lanka. A paper presented at the First Progress Review and Co-ordination Workshop of the Research Network on Irrigation Management for Rice-Based Farming Systems held at the National Irrigation Administration (NIA), Manila, 11-14 December 1990.

Panabokke, C.R. 1989. *Irrigation management for crop diversification in Sri Lanka: A synthesis of current research.* Colombo, Sri Lanka: International Irrigation Management Institute.

Pattie, S.P. and Y.M. Wickremasinghe. 1993. *Present status and future prospects of onion production in Sri Lanka.* Peradeniya, Sri Lanka: Department of Agriculture.

IRRI. 1979. *Rice: Soil, water, land.* Los Banos, the Philippines: International Rice Research Institute (IRRI).

IRRI. 1978. *Proceedings of the International Symposium on soil and rice.* Los Banos, the Philippines: International Rice Research Institute,

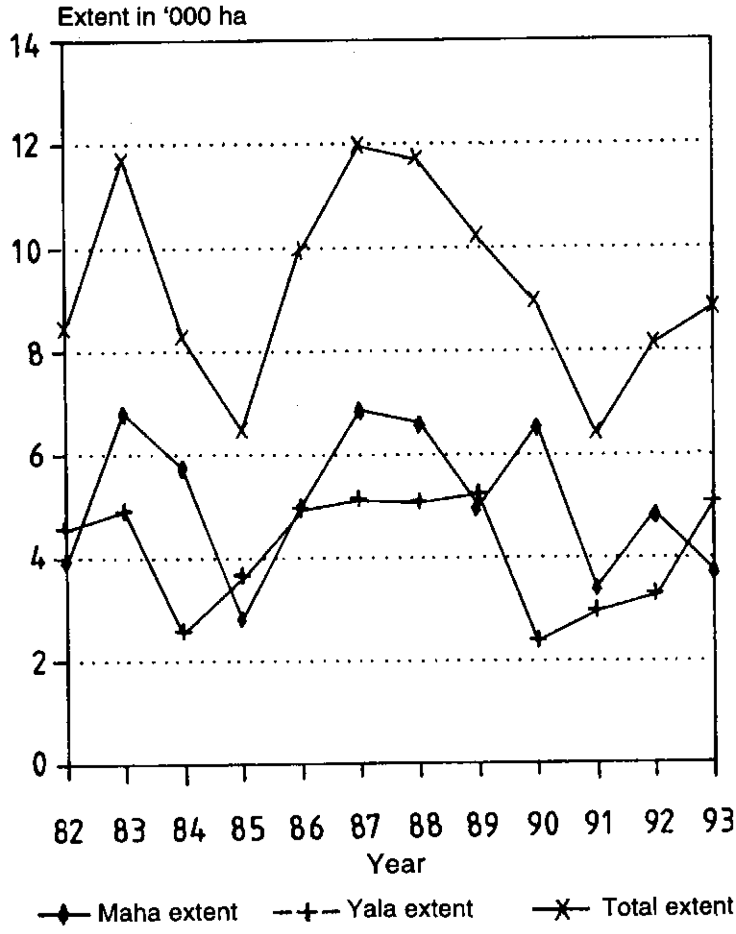
Wijayaratna, C.M. and K. Hemakeerthi. 1992. *Production and profitability of rice cultivation in Sri Lanka under different water regimes: A trend analysis.* Colombo, Sri Lanka: International Irrigation Management Institute.

Wijayaratna, C.M. 1994. Irrigated rice in Sri Lanka: Recent trends and future directions. Paper presented at the 6th Annual Congress of the Postgraduate Institute of Agriculture, 29-30 November 1994, at the University of Peradeniya, Sri Lanka.

Wijayaratna, C.M. and A. Widanapathirana. 1993. Significance of Sri Lankan agriculture in achieving newly industrialized (NIC) status: Myths and realities. Paper presented at the 1993 International Conference, 27-30 November 1993, at the International Institute of Strategic Management, Colombo, Sri Lanka.

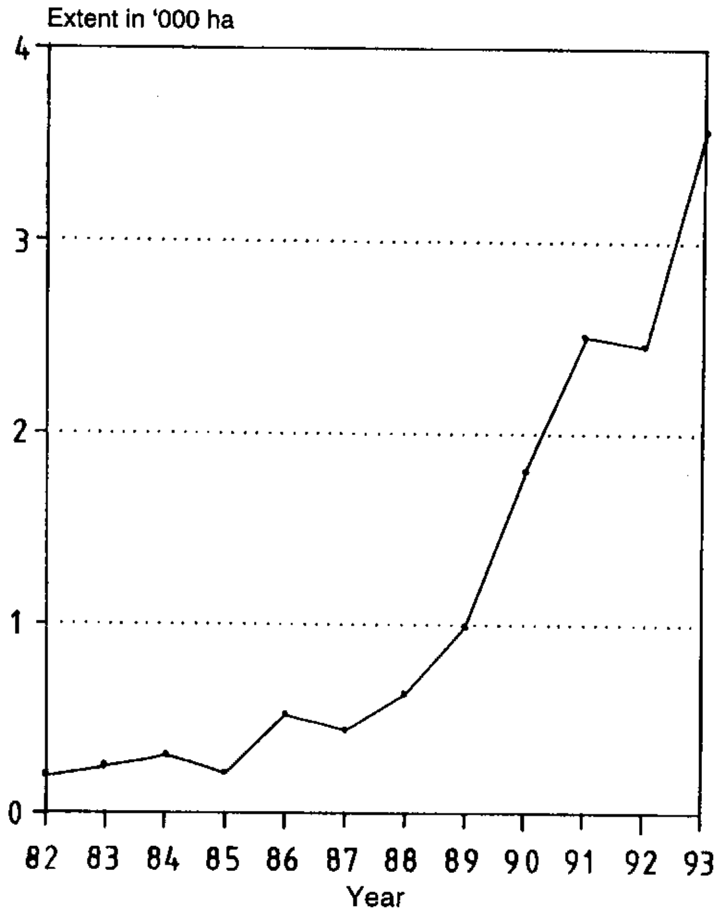
# Annex

*Figure A.1. Cultivation of chili: Total extent (irrigated and rainfed) during 1982-1993.*



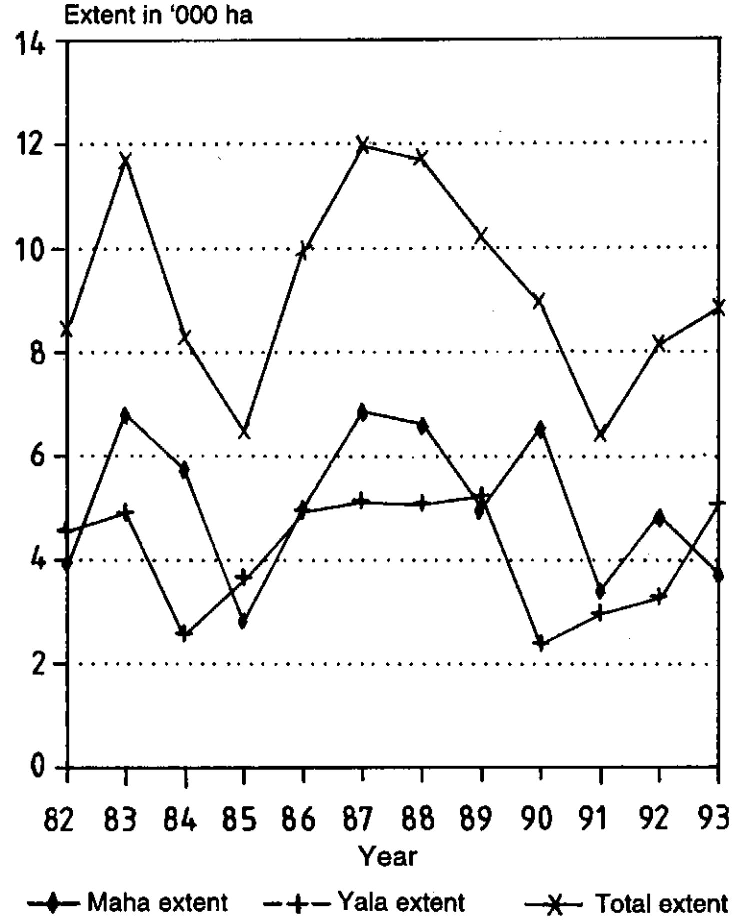

*Source:* Extension and Communication Centre, Department of Agriculture.

*Figure A.2. Cultivation big onion: Total extent (irrigated and rainfed) during 1982-1993.*



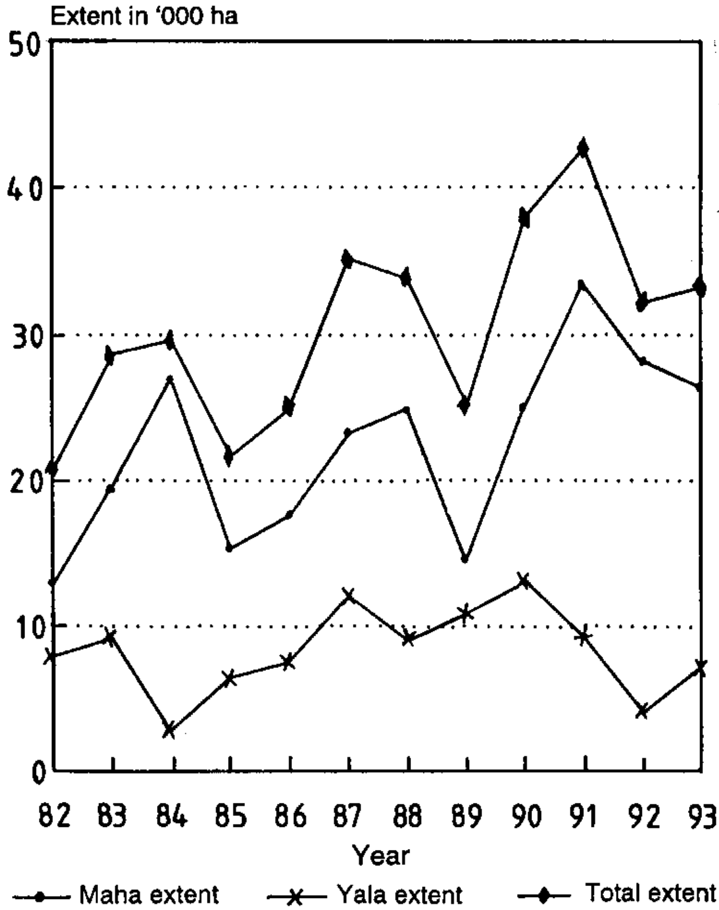

*Source:* Extension and Communication Centre, Department of Agriculture.

*Figure A.3. Cultivation of red onion: Total extent (irrigated and rainfed) during 1982-1993.*



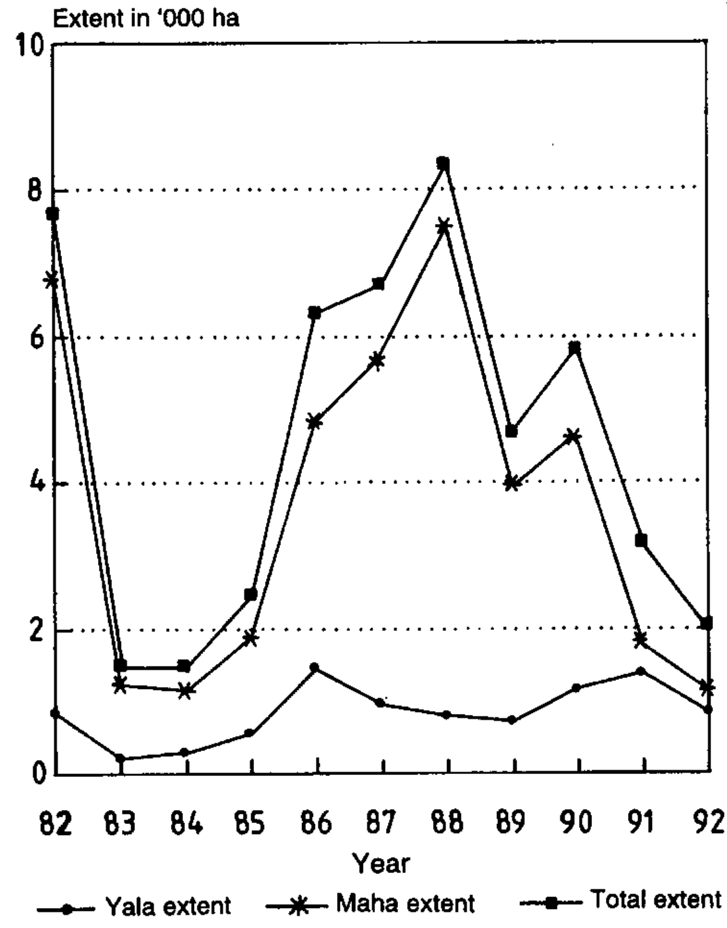

*Source:* Extension and Communication Centre, Department of Agriculture.

*Figure A.4. Cultivation of green gram: Total extent (irrigated and rainfed) during 1982-1993.*



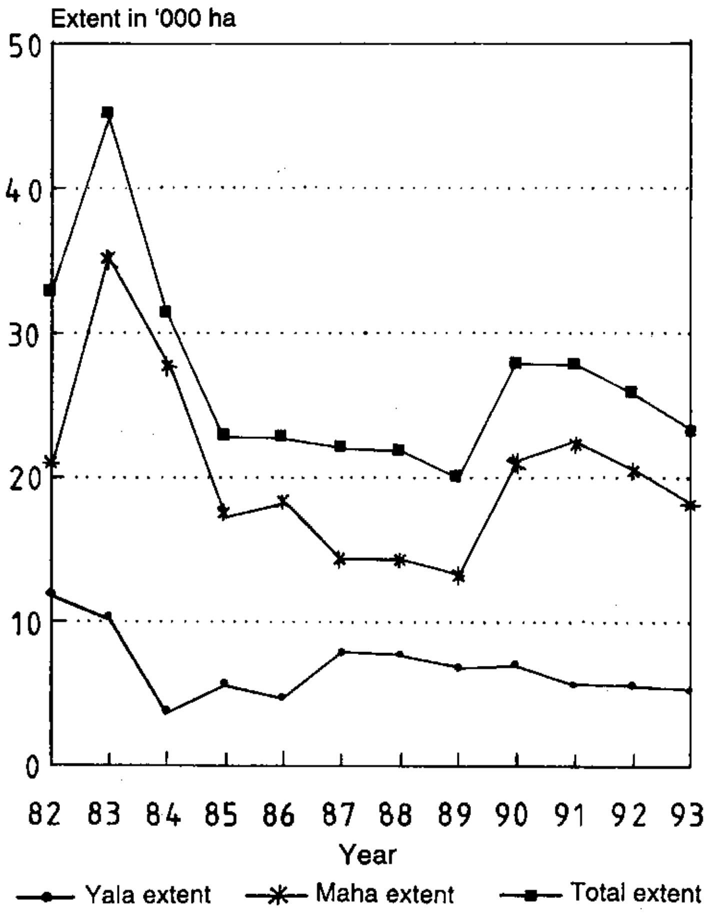

*Source:* Extension and Communication Centre, Department of Agriculture.

*Figure A.5. Cultivation of soya bean: Total extent (irrigated and rainfed) during 1982-1993.*




*Source:* Extension and Communication Centre, Department of Agriculture.

*Figure A.6. Cultivation of cowpea: Total extent (irrigated and rainfed) during 1982-1993.*




*Source:* Extension and Communication Centre, Department of Agriculture.

*Table A.1. Cultivation of other field crops in rice lands, yala season (in ha).*

| Year | Chili | Red onion | Big onion | Green gram | Cowpea | Black gram | Soya 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 | 2757 | 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.*