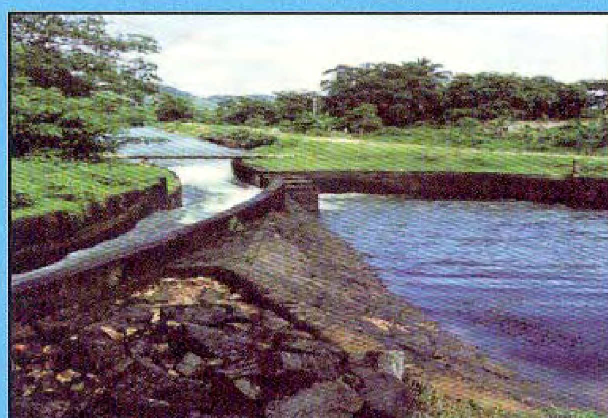
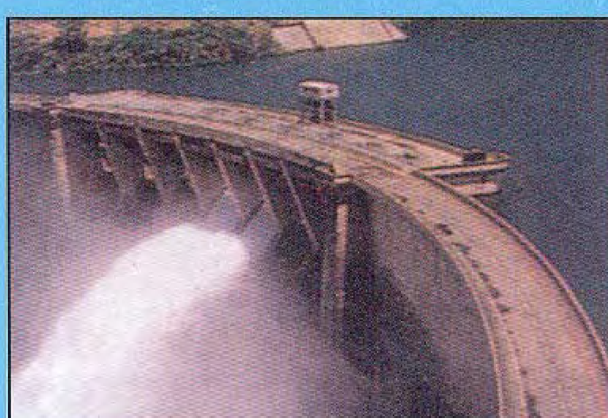
Irrigation and Agriculture in Sri Lanka





Edited by

Ric Shand

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Irrigation and Agriculture

in

Sri Lanka

by

Ric Shand

This study was first commissioned under the Public Sector Restructuring Project in Sri Lanka for the World Bank and the Ministry of Finance and Planning, Government of Sri Lanka, Colombo, 1

Contents

Foreword

Sri Lanka has always been predominantly an agricultural economy since ancient times and the history of irrigation facilities dates back to over two millennia. Small village tanks with single channel systems developed into an advanced irrigation technology such as the device called the valve pit (Biso Kotuwa) and a large number of irrigation systems helped make Sri Lanka in ancient times the “the Granary of the East”.

At the time of regaining independence the predominantly agricultural sector consisted of an export agricultural sector and a subsistence agricultural sector. Governments after independence attempted to develop the domestic agricultural sector through the development of agricultural infrastructure to improve irrigation facilities, apart from institutions for the delivery of credit, inputs and extension services. The major focus of agricultural policy was to achieve self-sufficiency in food, mainly rice and investments were made in the restoration and rehabilitation of existing irrigation schemes and the construction of new schemes. It was also to help in relieving the growing pressure of the population working on land in the existing dry zone areas.

About 75 per cent of the population still live in the rural sector and agriculture, particularly rice farming is, in Sri Lanka not merely a livelihood but is considered a way of life. In order to develop this sector it becomes necessary, as there is a seasonal variation in rainfall, to provide irrigation facilities to cultivate land in two seasons at least.

The Gal Oya Scheme was the first large multipurpose project to be undertaken followed since 1955 by a number of other irrigation schemes culminating in the largest ever multipurpose irrigation project undertaken by the State since independence in the Mahaweli Development Programme.

The present volume is timely and deals in depth with some important issues and problems associated with these irrigation schemes and agriculture. It has been written by a number of eminent specialists in their respective fields and ably correlated and edited by Ric Shand who has contributed considerably to the text himself. The study was originally completed in 1990 and has since been revised and updated to the year 2000. Of special interest is the examination of such issues as the costs and returns of irrigation schemes , the options for investment in irrigation, the adoption of new designs and technologies, the benefits and costs of rice based development with particular reference to productivity levels, and the prospects for diversification and development of commercial agriculture.

The arguments are supported by a wealth of statistical data and illustrated by some very interesting maps and diagrams. There is no doubt that the information and discussions provided in the book would be of interest and use to policy planners, administrators, experts in irrigation and agriculture as well as to the general public alike.

Gamani Corea
Chairman, IPS
August 2002

Acknowledgements

The editor and contributors wish to express their warm thanks to the Institute of Policy Studies and to its Executive Director, Dr. Saman Kelegama for their generous offer to publish an updated version of the 1990 study.

As team leader of the original study and as editor of this volume, I would like to express my deep appreciation for the contributions made by the highly talented specialist members of the team. Their team spirit and cooperation made the study an enjoyable experience at a difficult time for Sri Lanka. The team was ably and sympathetically coordinated by Mr. Merrick Perera.

We extend our warm thanks for the invaluable cooperation of the Cartography Unit in the Research School of Pacific and Asian Studies, Australian National University and in particular to Kay Dancey in the Unit who expertly and patiently prepared all the Maps, Diagrams and Figures. We also thank Christine Gomesz of the IPS who has guided this manuscript through the final stages of its preparation for publication.

Ric Shand
Editor
August 2002

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Special Terms, Acronyms and Abbreviations

ADB	Asian Development Bank
AC	Alternative crops
AMDP	Accelerated Mahaweli Development Programme
ANUGA	Biennial food fair held in Cologne, Federal Republic of Germany
BDS	Baffle Distribution System
BGs	Bathalagoda rice varieties
CEM	Country Economic Memorandum
CI	Cropping intensity
DRC	Domestic Resource Cost
EBCR	Economic benefit cost ratios
EDS	Enterprise development strategy
EIED	Employment Investment Enterprise Strategy
EIRR	Economic internal rate of return
EMS	Export marketing strategy
EPC	Effective Protection Coefficient
ERR	Economic rate of return
ESC	Effective Subsidy Coefficient
FCC	Field canals
GDP	Gross Domestic Product
GODB	Gal Oya Development Board
GOSL	Government of Sri Lanka
GPS	Guaranteed Price Scheme
IDA	International Development Agency
IPS	Institute of Policy Studies
ISMP	Irrigation Systems Management Project
LB	Left Bank
LDD	Land Development Department

LMCA	Lower Mahaweli Catchment Area
LHG	Low humic gley (soil)
MARD	Ministry of Agricultural Development and Research
MASL	Mahaweli Authority of Sri Lanka
MEA	Mahaweli Economic Agency
MECA	Mahaweli Engineering and Construction Agency
MIRP	Major Irrigation Rehabilitation Project
MOARD	Ministry of Agricultural Development and Research
NPC	Nominal Protection Coefficient
OECD	Organisation for Economic Cooperation and Development
OED	Operations Evaluation Department (World Bank)
OFC	Other food crops
O&M	Operations and Maintenance
PAR	Poverty Assessment Report
PCR	Project Completion Report
PIP	Public Investment Programme
PMU	Planning and Monitoring Unit
PPAR	Project Performance Audit Report
RB	Right Bank
RBE	Reddish brown earths
RVDB	River Valley Development Board
SEDZ	South East Dry Zone
SRD	SR Daines Report
TEC	Total estimated cost
TIMP	Tank Irrigation Rehabilitation Project
TOR	Terms of Reference
UKODM	United Kingdom Overseas Development Ministry

UMCA	Upper Mahaweli Catchment Area
UMPD	Upper Mahaweli Peripheral Development
USAID	Unites States Agency for International Development
VIRP	Village Irrigation Rehabilitation Project

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1. Introduction

Since Independence, investment in irrigation has received high priority in the Public Investment Programme (PIP) in Sri Lanka. The proportion of public investment allocated for irrigation varied from 9 per cent to 40 per cent in the 1950-87 period. Being traditionally a predominantly agricultural economy, it is not surprising that such large allocations were made for investment in irrigation. Irrigation is an input that helps not only in the expansion of area under agriculture, but can also facilitate technological change and therefore help to increase productivity. Also, agro-climatically, Sri Lanka has an unusually favourable environment for exploitation of rainfall and cultivable land through irrigation[1].

One major concern associated with past expenditures on irrigation in the PIP was that the high priority given to this sub-sector may have resulted in shortages of essential investment funds for other sub-sectors within agriculture. For example, the tree crop sector (tea, rubber and coconut), which accounts for a higher value added than the paddy sector in GDP, may have suffered. Relatedly, sectors other than agriculture in the economy may also have been adversely affected. Thus, essential developments in those areas may have been unduly postponed. It has been suggested that sectors such as industry and transport earn greater returns relative to irrigation and agriculture and therefore should be given preference in the allocation of scarce investment funds within the economy.

A 1988 study for the World Bank found that, in spite of substantial subsidies given for irrigation, fertilizer and credit, the overall effects of economy-wide policies discriminated against the rice sector, although to a lesser extent, relative to tree crops (Krueger *et al*. 1988). In this context, greater attention in allocation of Public Investment Funds to the agricultural sector relative to other sectors may have been justified. But, given that investments in irrigation were concentrated in particular areas, e.g. the Accelerated Mahaweli Development Programme (ADMP), the effect of the implicit tax on rice will have varied substantially within the rice sector. Thus, rice growers outside the AMDP are likely to have been at a greater disadvantage than those within the AMDP. This may have important socio-economic and even political implications.

The above issues relate to inter-sectoral allocations within the agricultural sector. Another important issue, which needs attention, is related to the allocation of public investment

[1] Sri Lanka has two monsoons, a rainfall distribution and drainage pattern that permit large proportions of rainfall to be harnessed for irrigation purposes.

within the irrigation sub-sector. In brief, the major issue relates to the overwhelming share of the PIP given to the Accelerated Mahaweli Development Programme (AMDP) in the post-1980 period. For example, by the end of 1988, a total of Rs. 46,546 million has been spent on the AMDP. Nearly 60 per cent of this was spent on major head works.[2]

What worried most critics was the impact of the acceleration. Fears were expressed in some quarters that spending such a large amount of the country's resources on the AMDP would pose a threat to the country's macroeconomic stability. Nevertheless, the AMDP went ahead because of the perceived necessity to secure the expected benefits of the programme, which were to reduce unemployment by creating short and long term employment opportunities; to increase agricultural production, particularly rice to achieve food self-sufficiency, and to alleviate power shortages. The World Bank (1987) agreed to the AMDP for the above reasons despite the lack of knowledge and studies. There were also political considerations. The decision to accelerate the Mahaweli Programme involved a trade-off. Political and economic benefits were to compensate for the economic and political costs of the economic and reform measures of the 1978 government, e.g., devaluation and reducing subsidies. Also, many donors were prepared to fund large capital projects.

Whether the potential economic benefits of such a programme justify the enormous capital costs needs to be established. The AMDP is already near its end, and the major issue is not whether it was justified, rather it is whether similar programmes should continue to form the basis of national irrigation policy.

This study was originally completed in 1990. It has since been revisited and updated to Year 2000, so this particular question can be tested against the Public Investment Programme through the 1990s.

In the chapters that follow, a brief historical background on irrigation in Sri Lanka is given in Chapter 2. Chapter 3 tracks investment in irrigation from 1950 to Year 2000, with

[2] This was not a new phenomenon. The Short Term Implementation Program of the Department of National Planning (1962 p.119) drew attention to the fact that irrigation and land development continued to absorb a greater part of investment in the agricultural sector and stated that:

> "despite this considerable investment, the output of this sector has not been such as to make any significant impact on our food problem. It is time, therefore, to critically examine returns in relation to investment made and to adopt a more realistic approach to development. This is all the more necessary at a time of scarce capital and foreign exchange resources. Continued investment in a traditional field quite unrelated to output can only be undertaken at the cost of funds to other more productive activities."

particular emphasis on the period from 1979 to 2000 in the PIP. In consideration of investment in irrigation, a key factor to be considered is the comparison of costs and returns of the alternatives. Chapter 4 reviews costs and returns of past irrigation schemes for which adequate data could be obtained, ranging from the largest river basin development schemes such as the Accelerated Mahaweli Development Programme (AMDP) to the smallest minor irrigation projects.

Chapter 5 examines options for investment in irrigation, including new projects within and outside the AMDP, rehabilitation and modernisation of existing projects, minor projects and ground water-based irrigation systems. It considers the need for adoption of new design concepts and new technologies in major irrigation schemes, and makes recommendations amongst these options.

Chapter 6 comprises two parts. The first reviews O&M requirements and the past record of fee collection in Sri Lanka under traditional systems of rice based irrigated agriculture. The second is concerned with O&M under modernised irrigation systems and more diversified irrigated agriculture.

The history of irrigated agriculture in Sri Lanka has essentially been one of rice based development with particular priority to self-sufficiency in rice. Chapter 7 examines the benefits and costs of rice based development and self-sufficiency with special reference to productivity levels in 1980 and prospective levels with planned expansion in irrigated area during the 1990s. It reviews past strategies for irrigation, land settlement and rice production in terms of direct and indirect intervention by government. It analyses the issue of self-sufficiency in cereals on both the supply and demand sides. It examines the social benefit/costs to rice growers in real financial terms. Finally, it examines private benefits/costs to rice growers in real financial terms.

Chapter 8 examines the prospects for diversification and the development of commercial agriculture. These are considered in an environment in which paddy cultivation is not adequately remunerative on the typical smallholder area, and where traditional irrigation technology for rice may not suit prospective crops with diversification.

Chapter 9 updates the original study from 1990 to 2000. It examines agricultural performance and its major determinants in the 1990s and reviews significant development policy shifts in the 1980s and 1990s, concentrating particularly on those that have influenced outcomes in the agricultural and irrigation sectors. It ends with a brief consideration of prospects.

2. Historical Background

2.1 Early Development

The origin of the irrigation civilisation of Sri Lanka in time cannot be identified with any precision (Brohier 1934). One school of thought argues it commenced in the 5th Century BC or even before. Harder evidence places it BC, but more recent, and that it continued up to the 13th century, developing from independent small tanks to more elaborate irrigation networks and culminated in transbasin diversions to augment major tanks. Examples are the Kalawewa-Yoda-Ela system, the Angamedilla-Parakrama Samudra System and the Elahera-Minneriya-Kantalai System. Very often, these transbasin diversion-based major tanks in turn fed a series of small and medium tanks. The final delivery of water for agriculture took place from these small and medium sized tanks. The command areas of these irrigation systems were limited to the poorly drained soils, which are suitable only for lowland rice cultivation.

This gradual transition of the "hydraulic civilisation" from the original small and medium sized tanks into major transbasin diversions from small tanks was undertaken to increase the reliability of irrigation water by tapping the rivers originating in the Wet Zone rather than by simply depending on the erratic rainfall pattern of the Dry Zone. This can be viewed as the ultimate point in the technological advancement of the ancient "hydraulic civilisation". The absence of irrigated upland agriculture practiced on a sustained basis over this period is a noteworthy feature.

While it is not the purpose of this study to dwell on the achievements of the ancient hydraulic civilisation, there are some questions and comments which are relevant to present and future irrigation investments. First, the engineering question remains as to how it was built. Second, by all accounts, it was sustainable, which contrasts sharply with the requirements for rehabilitation of present systems after only a short span of time from construction. Was the old operations and maintenance (O&M) system more efficient? Third, given all its merits, it was a low cropping intensity system. What is now needed in Sri Lanka is a sustainable high-cropping intensity system.

2.2 Recent Irrigation Strategies

The recent development of irrigation in Sri Lanka began in the mid-eighteenth century and continued until about the time of Independence with the restoration of certain major irrigation works.

Under Colonial Rule, investment in irrigation development started in a small way primarily due to personal interests of Governors in the restoration of large reservoirs that lay abandoned in the Dry Zone jungles. With the abolition of *Rajakariya* by the British in the latter part of the 19th century, a number of village reservoirs were restored with government assistance. Restoration of major irrigation works started in the 1920s and became an integral part of government's activity in the 1930s. This trend continued till Independence in 1948 during which time Minneriya, Parakrama Samudra and Elahera reservoirs were restored. In 1970, the government embarked on its most ambitious programme, the Mahaweli Ganga Development Programme (Map 2.1), to harness the waters of the Mahaweli Ganga (river) for irrigation and power. Since the early phase of development did not match the needs of employment generation, food production and electric power, the government decided to accelerate its implementation in 1977.

The early restorations were mostly limited to the reservoirs, while the distribution systems were left more or less unchanged. Such restoration of major schemes in the 1900s was coupled with the creation of new settlements and was done on the basis of two main canals (left and right bank) and a system of distributory canals, which irrigated the entire area below their command. Thus, both well-drained and poorly drained lands were irrigated.

The momentum was stepped up after Independence through a six year programme (1947/48-1952/53) to complete settlement activities under the restored reservoirs (Arumugam, 1969). The Gal Oya Scheme, the first river basin development, was started during 1948. Work on the Uda Walawe Scheme was started during the latter part of the 1960s and continued through the 1970s. The next phase of irrigation development commenced with large multi-purpose projects such as Gal Oya, Uda Walawe and finally the Accelerated Mahaweli Development Project.

Map 2.1: The Mahaweli Development Project and Special Areas

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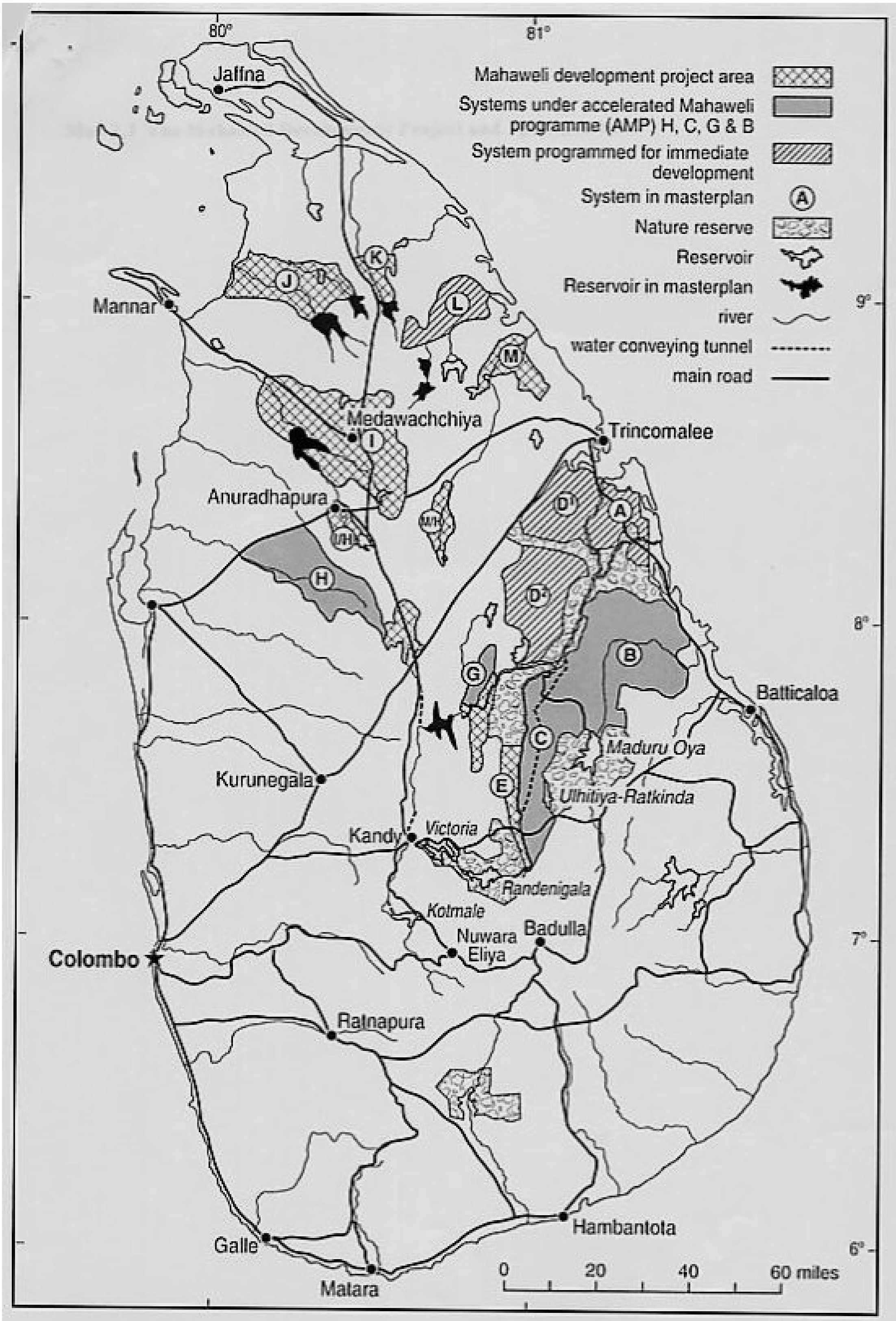


While this investment in new irrigation facilities has been taking place, culminating in the Accelerated Mahaweli Development Project from the late 1970s, the operation and maintenance of existing schemes has become a problem. A breakdown of the ancient and traditional institutions for the operation and maintenance of the restored and newly developed irrigation systems, together with the inability of the state to allocate sufficient public funds for their operation and maintenance, has resulted in a rapid deterioration of these schemes. In recent years, the rehabilitation and the modernisation of these deteriorated schemes has become an important component of the national irrigation strategy. Several other approaches have been tried on an experimental basis, including an attempt to irrigate upland areas with lift irrigation. Another was the use of ground water resources by means of tube wells and lift irrigation in some areas of the country.

2.3 Irrigation Water Distribution Strategies

In the traditional systems, only poorly drained soils (Low Humic Clays) were incorporated within the distributive systems, and individual irrigation and drainage outlets to farmers were not provided. These systems could only be operated as community ventures and not as independent operations of individual farmers. Water distribution and drainage took place from farm to farm down the slope. If the community decided on the dates and patterns of irrigation, individuals in the community had no option but to adhere to the common plan. The next stage of development in design was the provision of individual irrigation and drainage outlets. This system was based on a continuous supply of irrigation water and therefore did not require community participation for the operation. However, the tailenders of canals were always at a disadvantage since the headenders could obtain a more or less unlimited supply of water. Given that the paddy plant does not suffer from over-irrigation and that the maintenance of standing water in the fields reduces weed problems, the headenders were not concerned about the extent of their water consumption.

The most recent design in distributory irrigation systems was adopted in the 1970s under the Mahaweli Project. Here a tertiary distribution system based on field channels of uniform capacity serving a more or less similar number of farmers was utilised to practice a rotational system of irrigation. This system was expected to alleviate the tailender problem of the earlier model, but depended on total cooperation of the farmers in each field channel area for efficiency and equity in the distribution of water. This, however, has not eliminated the problems of the tailenders. Another innovation tried out on an experimental basis was a piped distribution system. This was designed to enable individual farmers to obtain water as and when required. The two most recent irrigation methods tried out in Sri Lanka are first, a hydraulic canal water control system to provide constant water levels as required, and second, an on-farm and on-demand system of drip or trickle irrigation to increase the efficiency of water use further.

2.4 Definitions and Issues for the Irrigation Sub-sector

Before discussing the key issues which have emerged in the debate about future investment in irrigation in Sri Lanka, it is important to have a clear understanding of what irrigation actually is. Despite the obvious importance of definition, it is seldom seriously discussed.

Wyatt (1966) observed that irrigation is a term that is subject to inaccurate and loose usage. Indeed, there are a number of possible definitions. Most broadly, it has been described as "the action of supplying or fact of being supplied with moisture" or more specifically," the action of supplying land with water by means of channels or streams" (Shorter Oxford English Dictionary 1959, p. 1047).

These definitions are non-technical and make no reference to the control of water so supplied. Wyatt on the other hand incorporates control in a scientific definition of irrigation:

"the controlled application of pre-determined quantities of water to the soil, in such a manner that the optimum quantity required by the plant, at the time of irrigation, is made available to it, with the minimum of losses".

He emphasises the need for (a) absolute control of water at all stages of distribution, and (b) a method of distribution and application that will ensure the minimum of waste. Significantly, he adds "The haphazard application of unmeasured water to a crop is not irrigation in the accepted scientific sense".

Too little attention has been paid to the question of control in the past and this scientific definition is highly relevant to this study in Sri Lanka and to the issues addressed in it. It is well known, that the island can be classified into the Wet (rainfall 2500 to 5000 mm) and Dry (rainfall less than 2000 mm) seasons. It benefits from two monsoons and has two crop seasons (Maha and Yala). The Dry Zone, which extends around the hills from the North West to the South East, requires irrigation for its agriculture and most of Sri Lanka's irrigation works are found in this Zone (see Map 2.1).

Impounded water sources are from sub-surface and surface storage, and irrigation is either by lift or gravity flow. Most of the lift irrigation works are in the hands of private operators. Gravity irrigation schemes are in the state sector. The latter predominate and are synonymous with irrigated settlement schemes. Gravity irrigation schemes can be classified according to (a) the size of the command areas, (b) quantum of investment, and (c) the type of management institution. Classifications have changed from time to time.

The Irrigation Ordinance of 1946 classified any scheme built without government aid and maintained by the proprietors as a Minor or Village work. Thus, other schemes were classified as Major, the operation and maintenance of which have been the responsibility of the Irrigation Department. The Agrarian Services Act No.58 of 1979 now defines any irrigation work with a command area of less than 200 acres as Minor and is managed by farmers under the supervision of local governments. The remaining category is Major, within which schemes are constructed and managed by the Irrigation Department. But recently, this category has been further sub-divided (Abeywickrema 1985) on the basis of institutions responsible for management. These are:

1. Medium - with command areas roughly within the range of 200 to 1000 acres, which are managed by the Irrigation Department;
2. Major - with a command area of more than 1000 acres, also managed by the Irrigation Department; and
3. River Basin Development - with a command area of more than 1,000 acres. These are constructed and managed by special institutions.

This classification helps to differentiate the Mahaweli and Uda Walawe Scheme from other Major schemes, as set out in Table 2.1.

Since 1970, investments in irrigation works other than Mahaweli have been referred to as "other irrigation", as construction of Mahaweli works commenced in this year. Therefore, it is proposed to study investment in irrigation as Pre-Mahaweli and Post-Mahaweli in this study. The Post-Mahaweli period can be further divided into the non-Accelerated and Accelerated phases. The Accelerated phase of Mahaweli investments the Accelerated Mahaweli Development Programme or AMDP started in 1977 (Map 2.2). During this phase large investments were also made in the power sector through the construction of multipurpose dams. In this study, investment is apportioned between these two main uses viz. irrigation and power.

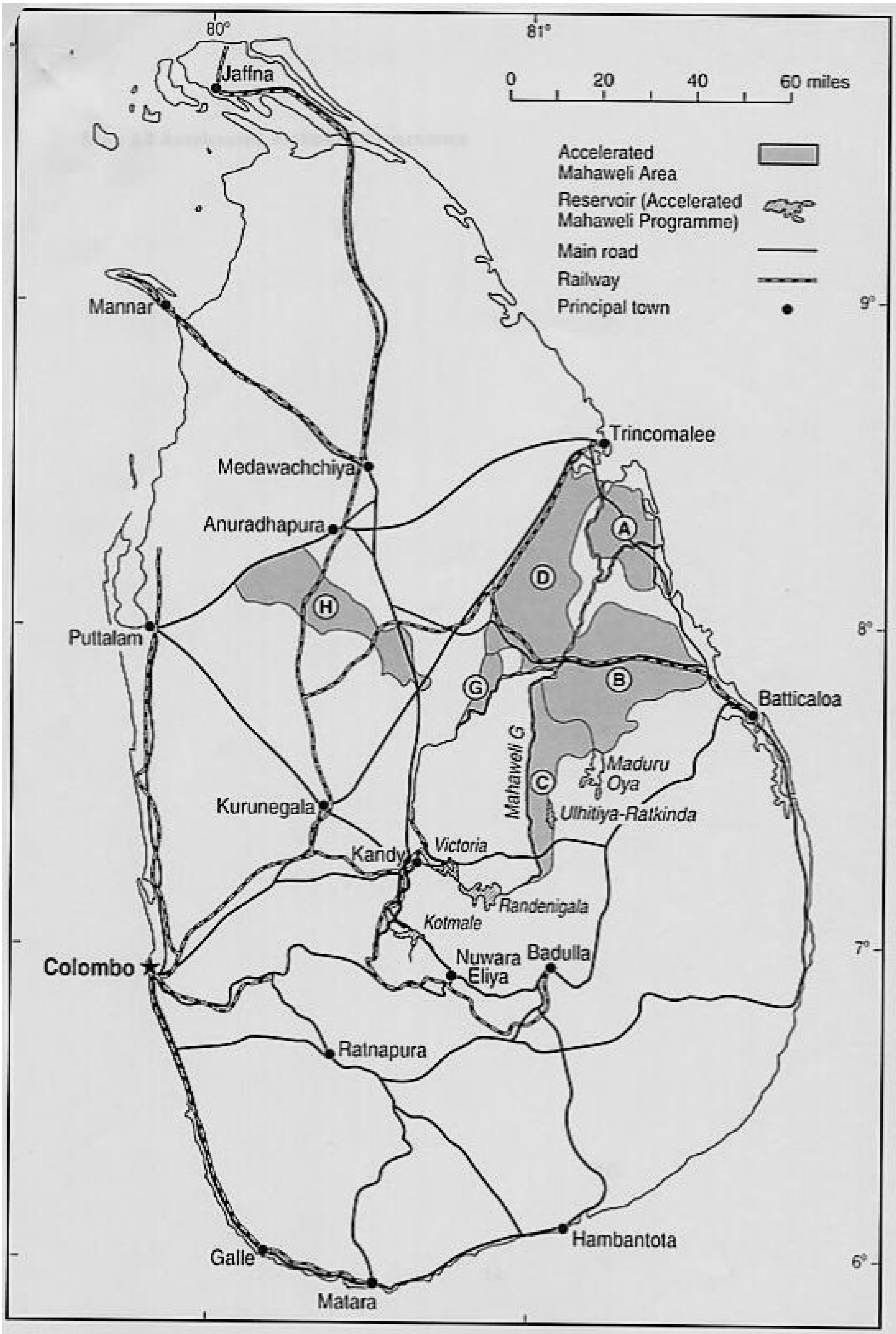
In the Mahaweli Scheme, a large and contiguous command area falling within a major hydraulic basin is referred to as an Irrigation System or simply as a System. Head works include multipurpose dams for energy and irrigation and diversion weirs to feed the adjoining basins.

The gravity irrigation schemes, except for a few new ones, were designed mainly for rice cultivation to provide supplemental irrigation in the Maha season and a limited Yala cultivation using the remaining storage in the reservoir. Therefore, by modern standards they are not efficient in the control of irrigation.

Table 2.1: Classification of Irrigation Works by Type, Size and Features

Type	Size	Features
Minor Village irrigation works	Up to 200 Acres	Irrigated from a single canal and served from field with no FCC.
		Managed by local governments, maintained by farmers.
		Predominantly *praveni* or private land.
		Designed for one season (Maha) cultivation.
		Crop invariably rice for subsistence.
Medium	200-500/1000 – Acres	A complete distribution system with FCC.
		Managed and maintained by the Irrigation Department.
		A mix of private and LDD land.
		Designed for a Maha and part Yala cultivation crop, mainly for rice.
	500/100Acres – to about 25,000 Acres	A complete distribution system with branch distributary and field channels.
		Predominantly LDD plus a limited extent of private land.
		Fairly uniform holdings designed for Maha and substantial Yala crops.
		Rice plus other crops.
		Non-farm activities important.
Major	River basin schemes	Similar to above but most management decisions and allocations are decided from a central point.

Map 2.2: Accelerated Mahaweli Area



3. Irrigation in Public Sector Investment Programmes, 1950 to 2000

3.1 Overview

Investment in the irrigation sub-sector increased from about Rs. 3 million annually in the 1940s to an average of about Rs. 50 million per annum in the 1950s and 1960s (Abeywickrema, 1984). Since 1970, investments increased unprecedentedly due to the Mahaweli Programme as shown under River Basin Development in Table 3.1. From 1980 to 1987, this category absorbed an average of 87 per cent of total irrigation investment. The most important category of irrigation investment in the 1960s, Major irrigation, continued to expand during the 1970s but its relative significance was reduced during the 1980s owing to the massive increase in investment in the Accelerated Mahaweli Development Programme (AMDP**)** (Map 3.1).

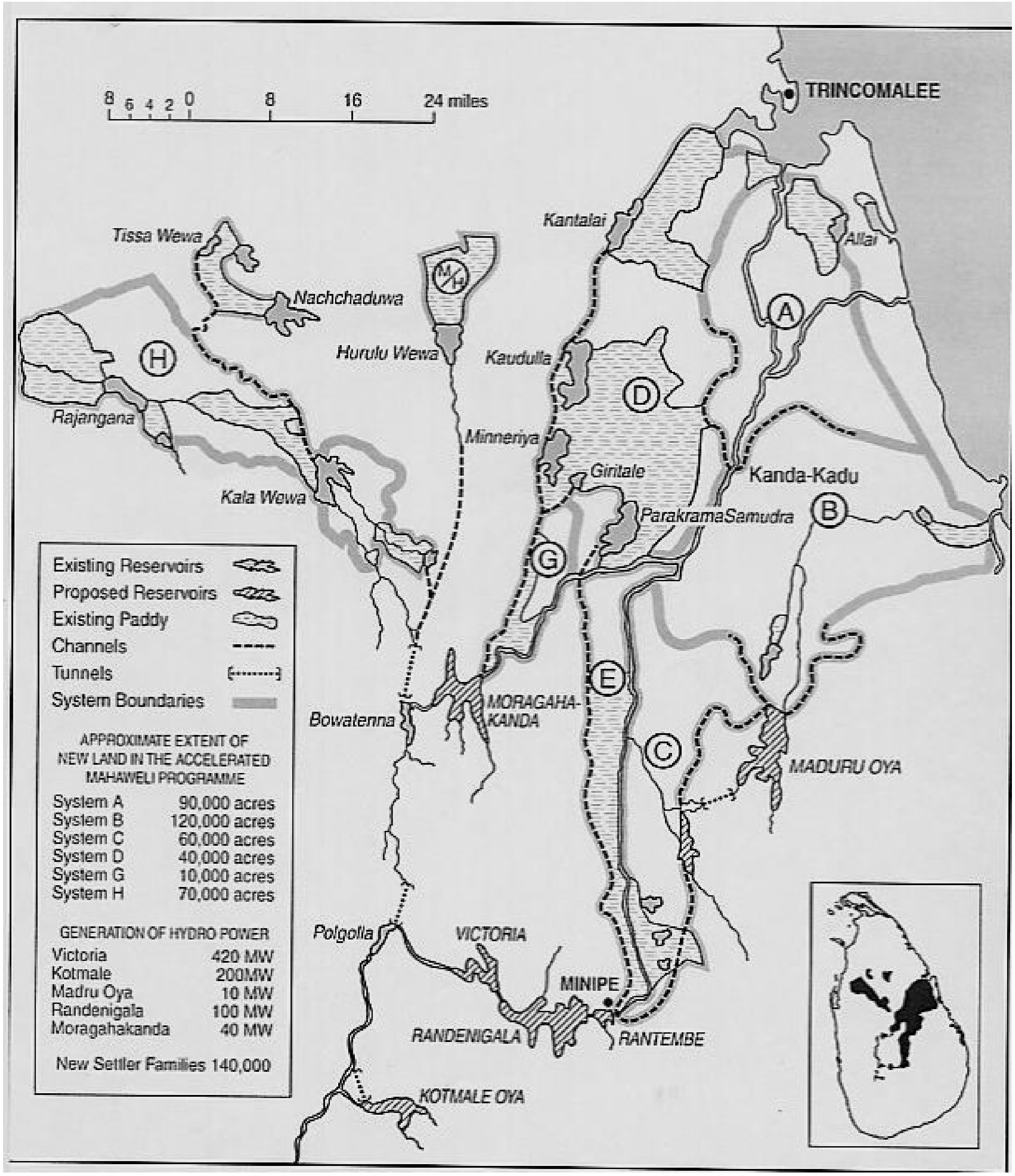
Investment in Minor (Village) works has remained more or less static and has continued to be the smallest category. It was only 3 per cent of total investment during the whole 1950-1987 period.

Investment in irrigation declined rapidly in the 1990s with the completion of the Mahaweli programme and most of the Major irrigation works. Expenditures have focused on O&M, rehabilitation and water management.

3.2 Irrigation in Public Investment Programmes

Sectoral allocation of resources in the Public Investment Programme (PIP) has varied over time in accordance with measures taken by government to deal with prevailing economic and political conditions and also with total resource availability. The PIP, a rolling plan, is flexible and reflects changes in government policies and priorities from year to year. The PIP is divided according to economic sectors viz., Agriculture, Industries, Social Overheads, Economic Overheads and Human Settlements. It lists projects by sectors under three categories: on going, annuals and new projects. Those that do not fit into any sector are grouped under a heading "Miscellaneous". Resource requirements are indicated by the implementing agencies for a period of five years from the current year. The aggregate of requirements of all agencies gives total resource requirements.

Map 3.1: Accelerated Mahaweli Development Programme



Total resource availability is estimated from resource flows that are dependent on international trade effects on primary commodities, the vagaries of weather on agriculture and upon international assistance. Thus, these have a direct control over the size of the PIP. Domestic savings are inadequate to finance the investment programme and recurrent expenditure of the government, so foreign assistance is always needed.

Irrigation investment as a proportion of total PIP has fluctuated widely since Independence (Table 3.2). In the Pre-Mahaweli period it was as high as 31 per cent in the 1950s, falling to 9 per cent in the 1960s. In the Mahaweli period it rose again to 15-17 per cent in the 1970s, peaked at 40 per cent at the height of the Accelerated Mahaweli Development Programme (AMDP) construction period in the early 1980s. It dropped to 13 per cent by 1990, and thence to 2-3 per cent from the mid-1990s.

An examination of projections of investment from 1979 to 2000 shows a clear shift of emphasis between sectors (Table 3.3). The Agricultural sector, which includes the AMDP, dominated the PIP during the 1980s. This was reversed in the 1990s during which it progressively gave way to the Economic Overheads sector.

The government elected in 1977 faced problems of high unemployment, acute food shortages, a shortfall in electric power and a dearth of housing. In order to alleviate the situation it decided to implement three lead projects: (a) the Accelerated Mahaweli Development Programme, (b) Investment Promotion Zones, and (c) an Urban Renewal and Housing Development Programme.

Public investment averaged 7.7 per cent of GDP during 1970-77, but rose to 16.6 per cent during 1978-84. The average annual growth rate of the PIP also increased, from 2.9 per cent during the former period to 6.0 per cent during the latter period. However, it was accompanied with high inflation. These large investments were made possible through the support of international donors. The adoption of liberal economic policies was the chief attraction for large amounts of foreign aid.

The AMDP received more foreign aid than the other two lead projects, so allocations in the first half of the decade were heavy in the agriculture sector, facilitated by this international support (Table 3.3).

Allocations declined as the head works programme in the ADMP approached completion in 1985 and because of the low absorptive capacity of downstream works that dominated the AMDP from 1985 onwards through the 1990s. Other reasons include high inflation rates and the balance of payments, which deteriorated after the commodity boom in the early 1980s. It was found necessary to effect more reforms which included privatisation, greater financial discipline and manageable budget deficits to bring stability to the economy and to contain inflation.

Table 3.1 Investment in Irrigation 1950-1987 (Rs million)

Period	Years	River Basin Devpt	Major Irrigation	Village Irrigation	Total	Total PIP
Pre-Mahaweli	1950-54	85	172	16	273	888
	1955-59	35	134	11	180	1226
	1960-64	15	154	6	175	2012
	1965-69	20	245	23	289	3191
Mahaweli	1970-74	538	150	72	760	5104
	1975-79	2687	642	77	3406	20240
	1980-84	27050	2639	499	30188	76094
	1985-87	16758	2749	562	20069	80236

Source: Abeywickrema, N. 1984, Annual Reports of the Central Bank and General Treasury.

Table 3.2: Investments in Irrigation as Percentages of PIP *

Period	Years	River Basin Devpt per cent	Major Irrigation %	Village Irrigation %	Total Irrigation %
Pre-Mahaweli	1950-54	10	19	2	31
	1955-59	3	11	1	15
	1960-64	1	8	0	9
	1965-69	1	8	1	9
Mahaweli	1970-74	11	3	1	15
	1975-79	13	3	0	17
	1980-84	36	3	1	40
	1985-87	21	3	1	25

* Columns in Table 3.2 correspond with the respective columns in Table 3.1.
Source: Public Investment Programmes, Ministry of Finance and Planning, Colombo.

The government redefined its priorities in February 1984 and decided to:

(i) provide adequately for O&M allocations as a first priority.

(ii) exclude activities that could easily and efficiently be undertaken by the private sector.

(iii) embark on:

- quick-yielding, production oriented projects which would reduce the balance of payments problem.
- essential infrastructure needs in power, irrigation, transport and communications.
- urgent needs in health, education housing and nutritional standards of the people.

The completion of the Agriculture Food and Nutrition Strategy Study later in the same year identified areas of the agriculture sector that were starved of investment, such as the plantation sub-sector, for which the Medium Term Investment Programme was implemented.

However, the declining trend was not reversed. From the latter part of 1987, civil strife began to spread all over the country. As a result, revenue collection fell from an average of 21 per cent of GDP to 18.8 per cent in 1988. Export earnings declined further and private transfers from migrant Sri Lankan workers leveled off. To add to these difficulties, in 1989 the new government launched its lead programme on poverty alleviation, employment generation, nutrition and other social welfare measures to fulfil its election promises.

The PIP for 1989-93 (Table 3.3) was formulated to take these constraints and changes into account. In its 1989 Policy Framework Paper, the government agreed with the IMF and World Bank to bring stability and to contain inflation. The main reforms to be effected during 1989-93 included:

a) reduction of the PIP from 11 per cent to 9 per cent of GDP.

b) reduction of the overall deficit from 12.5 per cent to 8 per cent of GDP.

c) reduction of domestic borrowing from 6.4 per cent to 3.8 per cent of GDP. However, to accommodate the government's new lead programme, subsidies and current transfers would increase during 1990-1991 but should level off thereafter.

The Transport Sector Master Plan and the ongoing Power sector study were other areas that would compete for additional investments. Thus, a further shift of emphasis away from agriculture was envisaged.

Although areas starved of investment were identified in the National Agriculture Food and Nutrition Strategy Study, the absorptive capacity of the agencies within the agriculture sector did not improve to the point where they became real competitors for irrigation. Total Public Investment at the end of the 1980s was around Rs.30 billion. It was not expected to grow at more than 2 per cent per year in the 1990s, with the adoption of the new Policy Framework by the Government in consultation with donors. However, this control was not exercised in practice. Total public investment rose from around Rs.38 billion in 1991 to Rs.61 billion in 1996, with expectations of Rs. 114 billion in 2001.

Table 3.3: Sectoral Allocations in Public Investment Programmes from 1979-83 to 1996-2000 (percentages)

Period	79-83	83-87	87-91	92-96	96-2000
Capital Budget	100	100	100	100	100
	(n.a.)	(33)	(37)	(40)	(40)
Agriculture	43	45	22	17	10
Of which	(n.a.)	(45)	(53)	(47)	(41)
Mahaweli	23	27	12	8	3
Irrigation	(n.a.)	(53)	(52)	(31)	(29)
Non-Mahaweli	2	4	3	2	2
Irrigation.	(n.a.)	(43)	(60)	(56)	(52)
Industries	10	2	-	2	3
	(n.a.)	(8)	(6)	(7)	(66)
Human Settlements	10	11	9	18	14
	(n.a.)	(17)	(50)	(42)	(49)
Economic	30	26	41	51	40
Overheads	(n.a.)	(37)	(43)	(55)	(64)
Social Overheads	7	9	9	13	13
	(n.a.)	(15)	(22)	(23)	(17)
Miscellaneous	-	7	7	6	21
	(n.a.)	(0)	(7)	(-)	(4)

Note: Numbers in brackets are percentages of foreign assistance.
Source: Public Investment Programmes, Ministry of Finance and Planning, Colombo.

3.3 Breakdown of Expenditures on Pre Mahaweli and Mahaweli Schemes

3.3.1 Pre-Mahaweli schemes

Gal Oya scheme

The Gal Oya Scheme was the first multipurpose scheme, providing for both irrigation and power, that was constructed on the island. It was also the first project in which foreign contractors were engaged. The construction and operation were the responsibilities of a special institution called the Gal Oya Development Board (GODB), which was also entrusted with settlement activities. Preliminary work started with Independence in 1948 and it was completed in 1952. The Gal Oya reservoir, known as Senanayake Samudra with a designed command area of 120,000 acres is fed by a network of reservoirs and distributary canals which are in turn fed by two main canals.

The Left Bank canal was designed to irrigate an area of 80,000 acres while the Right Bank canal was to serve the balance of 40,000 acres. But the area finally realised under irrigation was only 65,000 acres. Under the management of the GODB and the River Valleys Development Board (RVDB), the project was referred to as a River Basin Development Scheme, but after it was handed over to the Irrigation Department, it was treated as a Major Scheme. The reservoir was completed at a cost of Rs. 75 million in 1949.

Uda Walawe

The second river basin development scheme, Uda Walawe, was initiated in 1963 to provide irrigation for about 71,000 acres and hydro-power capacity of 5 MW. About 10,000 acres of the total area constituted existing irrigated rice lands. About 25,000 acres of the land was situated under the Right Bank Canal and the balance of 46,000 acres was under the Left Bank canal. The cost to completion was estimated at Rs. 135 million. Dam and electrical power plants were completed during 1967 at a cost of Rs. 71.6 million. Owing to balance of payments problems, the government sought assistance from the Asian Development Bank (ADB) to complete irrigation and settlement activities. A programme to develop about 33,200 acres on the Right Bank (RB) at a cost of Rs.157 million was accepted by the ADB for funding. The project completion report by the ADB in 1979 found that about 10 per cent of the physical works were still incomplete and water distribution was inefficient and inequitable. It also criticized design flaws, poor construction and the neglect of O&M. ADB funded the Left Bank Sevenagala Sugar Development project in 1982. It also funded the project to rehabilitate the Right Bank in 1985.

Under the management of the GODB and the River Valleys Development Board (RVDB) the project was referred to as a River Basin Development Scheme, but after it was handed over to the Irrigation Department, it too was treated as a Major Scheme. The reservoir was completed at a cost of Rs.75 million in 1949.

Mahaweli Programme

Past expenditure allocations to the Mahaweli Programme in the PIP are examined here under three headings:

a) original capital expenditure requirements
b) annual allocations
c) actual expenditures

a) Original Capital Expenditure Requirements

The estimated cost of the original UNDP/FAO Master Plan, which proposed to construct fifteen reservoirs and to irrigate 900,000 acres over a period of 30 years, was Rs. 5.583 billion with a foreign exchange component of 38 per cent. This included provision for irrigation, drainage, flood protection, land development and settlement, and power generation. Additional activities resulting directly from the scheme such as power transmission, marketing and processing, agricultural products, and revenue earning government activities were estimated to add a further Rs. 1.2 billion giving a grand total of some Rs. 6.7 billion.

These estimates were revised in 1977 to take account of price and exchange rate changes. A cost revision undertaken prior to the devaluation on 16 November 1978 estimated the total cost of the programme to be Rs. 15 billion. In 1978, however, when the Accelerated Mahaweli Development Programme (AMDP) was drawn up, a somewhat more modest estimate of Rs. 11 billion (at 1978 prices) was prepared covering four major reservoirs, three power generators and downstream development of Systems A, B, C and D. Later, when work on most of the major head works had been completed, two more projects that were in the original Master Plan, namely Moragahakanda and Uma Oya reservoirs, were added to the AMDP. Thus, from time to time project components were either added to or subtracted from the Mahaweli Programme which, quite apart from the cost escalation due to price and exchange rate changes, caused changes in cost estimates and capital expenditure requirements.

b) Allocations to the Mahaweli

The Mahaweli Development Programme was financed by loans and grants received from a number of countries and international agencies and by the Sri Lankan government as the local counterpart. The money received for the programme was usually allocated through the Public Investment Programme (PIP) which reviewed the performance of ongoing programmes and activities and the rate of utilisation of funds in each project before further funds were released to the Mahaweli Authority. Additionally, the PIP acted as the guide for prospective foreign participants who wished to consider providing assistance to one or more projects within or outside the Programme. The PIP depicted the government's current priority areas for investments in the short to medium term. Thus, the question as to how much expenditure was allocated to the Mahaweli each year depended on the government's priorities at that time and to some extent on other constraints imposed by international financial institutions.

The government has consistently emphasised the importance of agriculture and irrigation in its Public Investment Programme to varying degrees, but the role of the Mahaweli as an irrigation and hydropower project was dominant from 1970 until the 1990s. In particular, large sums of capital were allocated to the AMDP through the PIP in successive years. During the construction period of the major head work projects, for example, the PIP allocated as much as 40 per cent of its total capital expenditure to the Mahaweli Programme (Table 3.4). These allocations slowed down in the latter part of the 1980s with the completion of major head works projects[3], but were then sustained by expenditures on the Upper Mahaweli Catchment Area (UMCA) and on downstream investment in irrigation system development. They declined further as ongoing downstream investment was completed[4]. The latter investment was finished by 2000. Without new investment, expenditures will comprise only annual outlays on O&M and rehabilitation[5], and allocations to the Mahaweli remain at around 2-3 per cent of the PIP (Table 3.4).

In 1980 it was thought that, whilst providing for the completion of major irrigation projects started in 1978-79, emphasis should also be given to medium sized and minor irrigation projects. This would redress a possible imbalance that might be caused by the heavy investments in the AMDP and other large irrigation projects. Emphasis was also placed on water management with the main objective of increasing cropping intensity and crop

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[3] Victoria reservoir was completed in April 1985, Kotmale in August 1985 and Randenigala in 1988.

[4] In 1997, the total command area under irrigation was 128,250 hectares, of which 112,578 hectares were under paddy and 15,700 hectares were under other field crops.

[5] Rehabilitation commenced in 1993, 15 years after the start of the programme in 1978.

production. Finally, a need was seen to strike a reasonable balance between long gestation projects and quick yielding, high return and export oriented projects in commodity producing sectors when making capital expenditure allocations.

Table 3.4 Mahaweli Allocations in the Public Investment Programme 1980-2000 (Rs. billion)

Year	Allocation in PIP	% PIP
1980	2.0	17
1981	3.8	31
1982	7.2	40
1983	6.8	38
1984	6.0	35
1985	5.5	24
1986	3.5	14
1987	3.7	13
1988	5.1	17
1989	4.3	13
1990	4.3	13
1991	3.2	7
1992	2.7	6
1993	2.7	6
1994	7.5	14
1995	2.8	5
1996	2.1	3
1997	1.8	3
1998	1.3	2
1999	1.9	3
2000	2.0	3

Sources: Public Investment Programmes 1980-84 to 1996-2000. Ministry of Finance and Planning, Colombo.

An adverse budgetary situation in 1980 required the government to review the PIP in November 1980 and March 1981 owing to the heavy expenditures made by a number of government institutions, including the Mahaweli Development Board. The government then decided to impose ceilings to contain expenditures within limits consistent with the volume of financial and real resources estimated to be available for investment. As a result, it became possible to increase expenditure on the AMDP and minor irrigation. However, no new projects were contemplated for implementation in the short run. New projects could be admitted to the PIP only if they met strict economic criteria. Expensive capital and import intensive projects and those with heavy building commitments and energy content were to be de-emphasized. Also, owing to financial constraints, it became necessary to re-phase part of the downstream development and to recover O&M costs from settlers in the newly irrigated areas.

In the PIP for 1986-90, emphasis continued to shift in favour of irrigation projects other than the Mahaweli, i.e., major irrigation schemes, maintenance and rehabilitation and water management of existing schemes. In 1987, the PIP concentrated on the encouragement of private investment in developed areas to raise incomes of settlers, create employment, and promote agro-processing industries. Infrastructure and rehabilitation continued to receive attention.

The PIP for 1988-1992 assigned a still lower importance to the Mahaweli as work on major ongoing projects neared completion. Also, from early 1989 there was some change in investment emphasis after the introduction of new welfare policies that altered the pattern of investment. Capital expenditure for the Ministry of Lands, Irrigation and Mahaweli Development decreased by 28 per cent from 1988 from 1989. The voted expenditure for the Mahaweli Authority of Sri Lanka (MASL) decreased by 41 per cent; and the share of MASL in the total voted expenditure for the Ministry decreased from 75 per cent to 62 per cent.

By 1991, forward irrigation policy showed two features: an orientation towards rehabilitation, management and improved O&M, and the adoption of participatory management of irrigation systems through farmers' organisations, reducing the role of government. By then, the Mahaweli had spent Rs. 52 billion, major construction work had been completed (five reservoirs and main canals and hydro power systems), satisfactory progress was being made with settlements (Systems G, H and L) and more attention was being given to the protection of the Mahaweli catchment area.

In the 1990s, the Mahaweli entered a mature phase with 14 per cent of country's total cultivated area and 20 per cent of total paddy. It was, however, still in an early stage of crop diversification and commercialised agriculture. Most of the command area was under paddy and only about 10,000-15,000 hectares were under other food crops, mainly chillie, maize and onions.

Policy initiatives for this new phase introduced in 1990-91 included farmers' organisations for O&M; a review of land and water policies, leasing of larger areas for commercial farming and industrial parks for processing industries. Future projects were under study such as rehabilitation of canals in Systems H and C.

c) Actual Expenditure on the AMDP

By December 1995, over Rs.66 billion at current prices (Rs.125 billion at 1994 prices and exchange rates) had been spent, and the targets for new irrigable area and for settlement of families had almost been met. The MASL was now burdened by heavy overheads which policy was directed to reduce. MASL was studied as a River Basin Authority to oversee system needs and environment and to broaden economic opportunities there.

From 1979 to 1990, a total of Rs.57.1 billion was spent on the AMDP (Table 3.5). By Year 2000, total expenditure had reached Rs.76.2 billion. Some 41 per cent of total capital expenditures had been spent on major head works. The expenditure on the Victoria project was Rs. 9.8 billion or 31 per cent of expenditures on all head works and 15 per cent of total capital expenditure. Expenditure on the Kotmale project was Rs. 9.8 billion or 32 per cent of all head works, and 15 per cent of total expenditure on the AMDP. Randenigala and Maduru Oya utilised 28 per cent and 13 per cent respectively of total capital expenditure on head works.

The 1988 estimate of costs to be incurred to 2000 in peripheral works within the UMCA gave a total of Rs.2.1 billion. Of this, 57 per cent was for land acquisition for settlement, 5 per cent was allocated to buildings and roads, the development of townships accounted for 1 per cent, 3 per cent were for settler services. Another 26 per cent of expected costs were for the environment (agriculture, forestry, fisheries etc).

Donors played a significant part in assisting projects in the Upper Mahaweli, providing around 28 per cent of the project finance. The main projects were the:

- GTZ Upper Mahaweli Watershed Management Project funded by the Federal Republic of Germany,
- Victoria Land Use and Conservation Project for mapping of the Victoria catchment area (ODA), and
- Upper Mahaweli Forestry Project for pine plantations, a pilot forestry extension programme, and a research programme in plantation forestry (also ODA).

Table 3.5. Ongoing and New Investments and Annual Expenditures in the Mahaweli, 1979 to 2000 (Rs. Million)

Item	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Headworks												
Victoria	77	945	1,128	1,405	1,825	1,635	668	531	1,050	223	140	90
Kotmale	259	909	1,016	1,353	2,170	1,880	761	383	688	208	83	51
Maduru Oya	68	371	827	937	436	1	1	-	-	-	-	-
Randenigala	23	36	45	534	935	847	1,542	1,061	628	244	23	18
REV	-	-	-	-	-	-	-	91	115	207	-	-
UMCD	-	-	-	-	-	-	-	-	-	-	146	66
EIED											108	143
Downstream												
Stage I	451	7	9	16	7	24	-	-	-	-		
Stage II	536	371	344	323	264	457	66	29	71	29	8	2
System B (LB)	11	100	86	317	592	1,079	1,451	1,175	539	561	630	695
System B (RB)					195	175	22	20	-	3	361	494
System C	50	90	315	296	500	668	719	819	1,027	1,055	1,004	633
Minipe TBC	36	160	205	251	299	216	22	5	12	-	-	-
System I											54	-
System G			1	7	18	67	104	99	82	56	-	-
System L										81	45	57
Uda Walawe			13	29	40	82	60	118	113	157	282	226
Access Roads				1	21	40	83	90	63	117	108	38
New Investment											-	-
Annual												
DA & Dairy Dev.												
O&M							205	305	313	372	328	348
Rehabilitation												
Other	25	28	2	-	8	-	-	-	-	-	-	-
Total	1,536	3,017	3,991	5,469	7,272	7,179	5,704	4,726	4,701	3,313	3,320	2,861
Per cent foreign Assistance											59	49

Item	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total	% of Capital
Headworks												
Victoria	52	19	15	1	1	2	1	1	1	1	9,811	15
Kotmale	28	10	13	10	1	1	18	-	-	-	9,842	15
Maduru Oya	-	-	-	-	-	-	-	-	-	-	2,641	4
Randenigala	27	70	50	10	50	30	1	1	-	-	6,175	9
REV	-	-	-	-	-	-	-	-	-	-	413	1
UMCD	186	219	91	150	70	116	20	-	-	-	1,064	2
EIED	168	176	184	180	155	35	5	-	-	-	1,154	1
Downstream												
Stage I	-	-	-	-	-	-	-	-	-	-	514	1
Stage II	7	4	7	2	-	24	-	-	-	-	2,554	4
System B (LB)	724	582	520	470	733	481	230	225	220	-	11,421	17
System B (RB)	-	-	-	-	-	-	-	-	-	-	1,270	2
System C	1,194	699	579	150	180	207	60	-	-	-	10,245	15
Minipe TBC	-	-	-	-	-	-	-	-	-	-	1,206	2
System G	34	9	-	-	-	-	-	-	-	-	531	-
System I	-	-	-	-	-	100	70	50	35	25	280	-
System L	75	72	150	200	200	-	-	-	-	-	880	1
Uda Walawe	199	274	208	390	469	217	520	550	750	850	5,547	8
Access Roads	77	53	15	19	40	3	2	-	-	-	669	1
New Investment	5	5	10	10	-	20	62	186	150	240	688	1
Annual												
DA & Dairy Dev.	91	29	20	28	10	17	1	-	-	-	196	
O&M	310	287	295	390	400	338	325	300	250	250	5,016	
Rehabilitation	-	269	519	539	421	518	463	460	382	305	3,876	
Other	-	-	-	-	-	-	-	-	-	-	63	1
Total	3,179	2,712	2,676	2,604	2,764	2,139	1,798	1,875	1,852	1,697	76,214	100
% Foreign assistance	50	43	26	28	34	19	22	33	40	35	15	

Sources: Mahaweli Authority of Sri Lanka; Ministry of Finance and Planning; and Central Bank of Sri Lanka.

The major expenditure items in downstream development work were System B (LB), System C (Rs. 10,234 million) Stage II, and Uda Walawe. The fact that 41 per cent of total expenditure was spent was on head works and 54 per cent on downstream development signifies the relative and absolute importance attached to the construction of major infrastructure requirements and efforts to meet the increasing demand for irrigation water. The focus of expenditures in the 1990s was almost entirely on downstream development, and in policy, on how it was sustained.

Fears were expressed from time to time that spending such a large amount of the country's resources on the AMDP would pose a threat to the country's macro-economic stability. What worried most critics was that the "Acceleration" component of the funding would become the major problem. Foreign sources came to the rescue by financing about 60 per cent of this cost (i.e., Rs. 30 billion), while the balance of 40 per cent or Rs. 20 billion had to be financed locally through the budget. At that time the government had embarked on a number of other large scale projects such as the Million Houses Programme, building of the New Parliamentary Complex, Integrated Rural Development Projects (IRDPs), Free Trade Zones (FTZs) and the Road Development Project. Hence the allocation of such large sums to the AMDP became burdensome on the budget. This was reflected in the trimming of costs of some components. For example, the height of the Kotmale Dam was reduced, the construction of infrastructure facilities in System B was slowed down and the implementation of Moragahakanda and the Uma Oya projects were postponed. These components were thought to be the least detrimental to the objectives of the AMDP.

3.4 Other Irrigation

A breakdown of allocations to Other Irrigation according to their constituent projects (Table 3. 6) includes ongoing projects and annual expenditures. Some 80 per cent of the allocations for Other Irrigation from 1978 to 2000 were capital expenditures, of which 78 per cent were ongoing and 2 per cent were new after 1987. Within capital expenditures, priority was given to projects receiving no concessional foreign assistance. Maintenance (O&M) and rehabilitation absorbed most of annual expenditures (15 per cent), but attracted little or no foreign aid. Other annuals received about 7 per cent.

The number of Major irrigation projects undertaken showed a considerable increase in expenditures over the pre-1970 period. Among Ongoing works, the largest were the:

- Kirindi Oya Irrigation and Settlement Project (KOISP) Phases I & II to irrigate new and existing land (17 per cent of total expenditures),
- Minipe Nagadeepa Project with tubewells, shallow wells, roads and a bridge (13 per cent),

Table 3.6. Investment in Non-Mahaweli Irrigation Schemes, 1986 -2000 (Rs. millions)

Item	To 1986	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total
Village Tank Rehabilitation	659	151	152	77	73	116	40	-	-	-	-	-	-	-	-	-	1,268
Kirindi Oya I	1,524	196	118	104	52	14	116	62	3	-	-	-	-	-	-	-	2,189
Kirindi Oya II	-	34	40	70	85	112	62	101	119	60	-	-	-	-	-	-	745
MIRP	-	-	-	-	176	162	110	72	33	-	-	-	-	-	-	-	553
ISMP	-	-	-	-	150	180	208	113	114	105	83	55	44	-	-	-	1,052
Minipe Nagadeepa Rehabilitation	-	-	-	-	125	19	12	136	63	190	99	558	361	400	245	-	2,208
Moneragala	-	-	-	-	50	119	-	-	-	-	-	-	-	-	-	-	169
Nilwala Ganga Flood Prtctn.	839	254	538	416	50	45	15	6	5	-	-	-	-	-	-	-	2,168
12 NWP schemes	-	-	-	-	-	14	41	56	22	23	45	83	44	7	-	-	335
NIRP	-	-	-	-	-	-	-	51	140	157	265	535	512	-	-	-	1,660
NWP Water Res. Project					-	-	-	-	90	23	50	83	44	162	147	-	599
Kalu Ganga study					-	13	-	-	-	-	-	-	-	-	-	-	13
Other Ongoing					-	-	-	27	50	43	28	54	54	58	31	34	379
ANNUALS																	
Rehab. and Maintenance					130	140	81	107	148	170	179	208	215	220	222	225	2,045
Improvements to major works					15	15	10	9	11	12	14	16	18	20	20	20	180
Strengthening of H/Works					15	13	9	9	14	18	18	22	20	16	18	20	192
Investigations					6	7	7	32	33	27	20	31	22	15	15	15	230
Flood Damage Repairs					10	14	9	10	18	11	18	22	22	20	20	20	194
Strengthening of ID and IMD					14	14	9	3	-	-	-	-	-	-	-	-	40
Other					11	9	8	8	8	8	65	77	77	66	68	70	475
NEW							1	-	-	-	26	93	49	57	55	11	292
TOTAL	3,022	635	848	667	962	1,006	738	802	871	859	910	1,837	1,482	1,047	841	415	16,942

Sources: Mahaweli Authority of Sri Lanka; Ministry of Finance and Planning; and Central Bank of Sri Lanka.

- Nilwala Ganga Flood Protection Project (13 per cent),
- National Irrigation and Rehabilitation Project (NIRP) (10 per cent), and
- Village Irrigation and Rehabilitation Project (VIRP) (7 per cent).

Other smaller projects included the

- Major Irrigation and Rehabilitation Project (MIRP),
- Irrigation System Management Project (ISMP) to develop the institutional capacity of the Ministry of Lands, Irrigation and Mahaweli to operate and maintain major irrigation systems,
- North West Water Resources Development Project, and
- Restoration of 12 schemes in North West Province in Kurunegala and Puttalam districts.

By 1994, it was judged that “practically all economically viable irrigation schemes have been constructed” (PIP 1992-96, p47). With construction and rehabilitation of most of the Major schemes completed or nearing completion, budgetary allocations to Other Irrigation decreased in the agriculture sector. The emphasis has shifted to institutional re-orientation, rehabilitation of existing systems to optimize efficiency in water utilisation (farmers’ organisations for O&M) and an increasing emphasis on achieving diversified high income agriculture based on consolidation of systems and improved drainage, salt water exclusion and ground water development. Broad priorities are given to sustainability, watershed management and comprehensive river basin development.

3.5 A Review of some Completed Major and Medium Irrigation and Rehabilitation Schemes

3.5.1 Major Schemes

The Inginimitya project

This reservoir project was completed in 1988 at a cost of Rs. 360 million, funded by the Japanese government. The reservoir impounds the waters of Mi Oya with a three-mile long dam to irrigate about 4700 acres of new lands and 1900 acres of existing paddy (Table 3.7). Around 2000 farm families were settled in the head works lands. The reservoir was completed in 1985 and the settlement of families in 1988.

The project was approved in 1978 but construction did not start until 1981. The final estimate of costs of completion is more than double the original estimate. The "extra long" dam is reflected in the head works component in the final estimates, though this is not obvious in the original. To our knowledge, no evaluation of this project has been carried out to date.

Rice was cultivated in the Yala season of 1985 on 3000 acres and was followed by a full Maha crop. This indicated a cropping intensity of about 145 per cent. Details of yields are not readily available. The pro-rata costs are:

Cost per acre (new)	-	Rs. 76,595
Cost per acre (all)	-	Rs. 54,545
Cost per Settler Family	-	Rs. 180,000
Cropping intensity (per cent)	-	145

Kirindi Oya Project

The implementation of this irrigation and settlement project started in 1978. A three-mile long dam was constructed to impound the waters of Kirindi Oya to benefit 32,970 acres of which 21,697 acres were new and the balance of 11,273 acres were existing irrigated lands. A target of 8,600 farm families was set. During the first phase of the project, construction

Table 3.7: Breakdown of Expenditures on the Inginimitiya Project (Rs. Million)

Categories of Expenditure	Appraisal (1977)	Final (1988)
Civil Works	64.6	239.5
Access facilities	0.5	1.8
Head works	31.2	145.2
Irrigation facilities	27.6	70.4
Settlement facilities	5.3	22.1
Machinery	35.6	-
Overheads	11.0	32.5
Land acquisition	1.0	3.2
Engineering & Administration	10.0	29.4
Consultants	-	8.4
Base Cost	111.2	280.5
Contingencies		
Physical	5.9	30.4
Price	27.8	49.1
Total cost	145.0	360.0

Source: Irrigation Department.

of the dam and irrigation facilities to serve 10,797 acres of new and 11,273 acres of existing irrigated lands were to be completed to settle 4200 farm families. The remaining new area of 10,970 acres was to be developed during the second phase. The first phase was estimated to cost Rs.1.6 billion, and the second phase costing was Rs.0.9 billion. Phase I was completed in 1992 for a total cost of Rs.2.2 billion, a substantial cost overrun. Phase II was completed in 1993 and cost Rs.0.7 billion, which was below the final estimate.

Table 3.8 Estimated Costs of Kirindi Oya Project (Rs. million)

Categories of expenditure	Phase I	Phase II
Dam	614	-
Irrigation Facilities	164	245
Roads etc	-	50
Settlement	84	258
Agriculture Extension	11	17
Livestock Development	-	45
Social Forestry	-	3
Consultancy	35	9
Engineering & Admn.	66	47
Evaluation	6	4
Physical Contingencies	78	59
Price Contingencies	539	203
Total	1597	940

Source: Irrigation Department.

The dam work was completed in 1986. Up to the end of 1987, irrigation facilities were supplied for about 10,715 acres of new land and 8,913 acres of existing lands. A mid-project evaluation was carried out (Gamage, Wanigaratne, Wijetunge and Tudawe, 1988) but at that stage, with only two seasons of production after the dam was completed, the report could offer only limited insights.

3.5.2 Medium Irrigation Schemes

The Mahadiulwewa Project

This scheme involved the restoration of an abandoned reservoir to irrigate 1200 acres of new lands and 160 acres of existing paddy land. About 480 farm families were settled on the new land, each receiving 2.5 acres of irrigated land. The total estimated cost in 1978 was Rs. 16 million but it was completed at a cost of Rs. 34 million in 1982. The EEC funded the project.

The reservoir supports two seasons of cultivation. It was found that water availability was in excess of requirements of the command area so some of the excess water was diverted to an adjacent basin. This indicates that the cropping intensity may be over 175 per cent. The cost per settler family in this scheme was Rs. 70, 833 while the cost per acre of irrigation was Rs. 28, 333 or Rs. 25,000 when existing land was also taken into account.

Among the Major and Medium schemes, Mahadiulwewa was cost effective while in the cases of Inginimitya and Kirindi Oya, extra long dams had to be constructed which involved heavy costs (Table 3.9).

Table 3.9: Some Performance Indicators of Major and Medium Schemes

Indicators	Unit	Mahadiulwewa	Inginimitya	Kirindi Oya
Cost per family	Rs	127,287	180,000	42,571
Cost per acre (new)	Rs	50,914	76,595	166,712
Cost per acre (all)	Rs	44,925	54,545	81,558
Cropping intensity	%	175	145	n.a.

Source: Irrigation Department.

3.5.3 Rehabilitation Schemes

Minor (Village) Schemes

The quantum of expenditure involved in the construction or rehabilitation of a Minor irrigation scheme is very small compared with that of a Major scheme. Statistics of investment and its benefits are rarely kept in a systematic manner. Also, it is difficult to find a reliable source of statistics for the purposes of comparing investments and the resulting benefits of individual minor schemes with those of other schemes. However, through the selection of the on-going IDA-funded Village Irrigation Rehabilitation Project (VIRP), this difficulty is partially overcome. This project provided for the collection of such information necessary to evaluate the project and comparisons are presented in a later chapter.

The VIRP provided for the rehabilitation of about 1200 village reservoirs by the Irrigation Department, benefiting about 78,000 acres of land, and modernising another 500 reservoirs (by the Department of Agrarian Services), benefiting about 30,000 acres (Table 3.10). Completion of the project was originally expected in five years with an estimated cost of about Rs. 784 million in 1981, but actual expenditure on the completion of this project in 1991 was Rs. 1,168 million.

It was expected that the average cost per acre of rehabilitation would be Rs.8, 400, and for modernisation, it would be Rs.1, 100. However, these costs were exceeded owing to delays in selection of reservoirs and other implementation difficulties.

Major Schemes

The O&M of Major schemes are the responsibility of the state. Neglect of maintenance in the past has resulted in the deterioration of the systems. This was partly due to insufficient allocation of funds for maintenance and partly to the greater attention being paid to new construction works during the period. The Irrigation Department, which is responsible for both maintenance and construction works, favoured the latter.

Table 3.10 Breakdown of Expenditures on the Village Irrigation Rehabilitation Project

Categories of expenditure	**Cost estimate 1981**			**Work done up to December 1986 Cost in 1988**		
	Qty*	Rate Rs.	Amount Rs. mn.	Qty*	Rate Rs.	Amount Rs. mn.
Civil Works						
Survey and Investigation	1440	7500	10.8	1100	9181	10.1
Rehabilitation by ID	1200	545250	654.3	592	694087	410.9
Rehabilitation by DAS	500	66000	33.0	228	93421	21.3
Equipment & Vehicles						
Procured by ID			38.7			38.9
Procured by DAS			7.5			
Consultancy & Training						
Coordination & Admin ID			10.4			5.6
Administration DAS			11.7			6.9
Consultancy			9.0			8.8
Training			5.3			5.6
Contingencies			3.6			0.0
Total			784.3			508.1

Qty* = No of reservoirs.
Source: Irrigation Department.

3.6 The Tank Irrigation Modernisation Project (TIMP)

In 1976, the TIMP was launched to rehabilitate five major schemes in the North Central Dry Zone that were operating well below designed capacity. This project provided for the rehabilitation of the physical system and machinery for O&M. A water management component was also included. It was expected to benefit about 10,600 farm families on 31,500 acres of irrigated land and the International Development Agency (IDA) and United Kingdom Development Ministry (UKODM) funded it (Table 3.11).

Studies have pointed out that there has been a heavy bias towards engineering solutions (e.g., Abeyasekera 1986). Physical improvements should be coupled with appropriate cultural practices and strengthening of farmer organisations to ensure success. It is also necessary to consult the farmers in the initial stages of the project. Failure to observe this has resulted in many control structures and channels left damaged after a short period of their completion. These points are taken up in later chapters.

Table 3.11: Estimated Actual Costs of the Tank Irrigation Modernisation Project (Rs. millions)

Tank	Area Acres	Civil Works	Equip-ment	Tech Asst.	Total	Pro-rata Cost (Rs./ac)	CI (%)	Yield (bush. /ac)	ERR (%)
Mahakandarawa									
Mahawilachchiya	26100	22.25	5.61	1.82	29.68	11415	169	80	11
Pavathulam	4400	24.21	9.51	2.91	36.63	8325	165	80	21
Padaviya	12500	65.76	27.03	6.75	99.54	7963	118	80	14
Vavyunikulam	6000	31.17	12.98	3.24	47.39	7898	147	80	16
Total	31500	198.14	68.1	18.91	285.15	9052	146	80	15

Source: Tank Irrigation Modernisation Project, Credit 666-CE Completion Report, August 26,1985, World Bank.

3.7 Gal Oya Left Bank Water Management Project

The Gal Oya Scheme was started in 1948 and completed in the early 1950s. It has a command area of 120,000 acres, of which its Left Bank Canal serves 65,000 acres. The system had deteriorated considerably and about one third of the Yala area was not receiving water when it was chosen for rehabilitation in 1979. The original total estimated cost of rehabilitation was Rs. 295 million in 1979, but this had increased to Rs. 524 million when it was terminated in 1985. Civil strife in some parts of the project area prevented its completion.

The original total estimated cost placed a heavy emphasis on machinery and equipment. This bias was later changed and the socio-economic research component was given more emphasis. The strengthening of farmer organisations was considered to be the key factor in achieving success. Specially trained Institutional Officers were deployed before the commencement of physical rehabilitation of secondary and tertiary systems to organise farmers and get their views and suggestions on proposed rehabilitation. The activities, listed below in Table 3.12, in Gal Oya included support of rehabilitation, water management and training of irrigation staff throughout the country. Some before and after performance indicators are given in Table 3.13.

Table 3.12: The Gal Oya Left Bank Management Project

Categories of Expenditure	Appraisal (Rs. million)	Revised (Rs. million)
Rehabilitation	91	198
Machinery & Equipment	65	73
Master Planning and On-farm Research	3	1
Central support	42	96
Training	16	18
Socio-economic Research	9	39
Contingencies & Inflation	58	64
Sub-Total	284	490
Improvements to GITI	12	16
Investigations of follow on project	0	13
Water Management	0	3
Water Management Research Centre	0	2
Total	295	524

Source: Irrigation Department.

Table 3.13: Other Performance Indicators of the Gal Oya Left Bank Management Project

Description	Unit	Before Project (1979)	After Project (1985)
Irrigated Area	acres	42,000	53,000
Cropping Intensity	%	119-129	>165
Cost of Production	Rs/acre	2232-2460	2573-3802
Production	bushels	3,057,360	7,039,853
Pro-rata cost	Rs/ac	--	9,000-11,000

Source: Irrigation Department.

The achievements, according to the International Science and Technology Institute (ISTI) (1985) evaluation, were:

i) Rehabilitation of a scheme in very bad repair in a cost-effective manner and to an operational state.

ii) Ability to form farmer organisations.

iii) Some beneficial changes in the agronomic practices, viz.,

- timeliness of land preparation;
- shortening of time between land preparation and sowing;
- enhanced fertiliser application;
- improved pest control.

The Irrigation Systems Management Project (ISMP) was a follow up of the above project and drew heavily on the Gal Oya experience. The Major Irrigation Rehabilitation Project (MIRP), completed in 1993, is another with similar characteristics. The Nagadeepa and Minipe Rehabilitation Project was also similar but had additional components in the nature of a rural development project. The Moneragala Agricultural Resources Development Project, completed in 1990, was another rehabilitation project, designed to carry out similar activities but in a medium sized irrigation context.

3.8 Lift Irrigation

The Impact Evaluation Report on the Sri Lanka Lift Irrigation project (World Bank 1985) stated that the project was an overall failure. The project envisaged the provision of lift irrigation and agricultural development to 13,500 acres above the command areas of four existing major irrigation schemes. Beneficiaries were to be both landless labourers in the schemes and educated but unemployed youths (7,400 acres were allocated to the latter). It provided for the construction of irrigation canals, control structures and installation of pumps and housing for settlers at a cost Rs. 19.6 million. At completion in 1976 the cost had escalated to Rs. 35 million. Conceived as a crash programme, it was prepared without adequate information on beneficiaries, conditions and institutions involved.

The Impact Evaluation Study observed that farmer organisations can play an important role in the functioning of lift irrigation schemes if they are made responsible for operations and replacement of pumps and engines as well. This Scheme is further analysed in a later chapter.

3.9 Concluding Remarks

Investment in irrigation after Independence assumed a greater role in the Public Investment Programme than before, though this was highly variable between 1950 and 2000. It was as high as 31 per cent in the early stages, fell to a low of 9 per cent in the 1960s. It rose in the 1970s again, culminating in a high point of 40 per cent in the first half of the 1980s, and thereafter fell again to only 5 per cent in 1996-2000.

The diversity of types of irrigation schemes needs to be stressed. There was a wide range in size of schemes. Those which were in favour early were Major Schemes, whilst the advent of the Mahaweli Programme and its Accelerated Project changed the emphasis to large scale river basin development schemes. The smallest, the Minor or Village works received relatively little attention until the 1980s but even then were dwarfed by the other two categories in that period and at no stage were more than 3 per cent of total irrigation investment (and 2 per cent of total PIP). One other important point arising from the preceding discussion is that, there are currently three fairly distinct directions for future irrigation investments.

i) Investment in the Mahaweli Programme. This was necessarily biased in its initial years towards the construction phase, particularly in head works. The benefits of settlement schemes downstream are not yet fully exploited.

ii) Investment in rehabilitation of existing schemes where there is much scope in both major and minor schemes. However, the economics of such investments need to be explored and is in later chapters. In this respect the balance between rehabilitation in infrastructure and management that will encourage farmer participation and production efficiency is a significant issue.

iii) Modernisation of irrigation systems and diversification of cropping patterns. This study expands beyond consideration of completing on-going new investments and rehabilitation of old schemes. Despite the difficult economic circumstances, Sri Lanka needs to consider the economics of modernisation of irrigation systems and diversification of cropping patterns.

This review of past irrigation investments and their importance in past PIPs is a necessary first step in generating perspectives for future investments, but there are other options also to be considered. These will be examined and where possible compared, in terms of a variety of performance indicators in later chapters.

4. Benefits and Costs of Past Irrigation Investment

4.1 Introduction

In the consideration of future investment in irrigation, one of the key factors to be considered is the comparison of costs and benefits of the alternatives. It is, of course, very difficult to predict the outcome of future irrigation investment schemes, but past experience can assist. This chapter reviews costs and benefits of those schemes in Sri Lanka for which data are available.

The government of Sri Lanka formulated an irrigation investment strategy in the early 1980s (Ministry of Lands and Land Development 1984). Whilst this was flexible in terms of choice of schemes, it did indicate the preferred direction of priorities.

”Construction of any new major schemes should be taken up again only after a period of review and research, including environmental impact assessment. A strategy of future expansion of irrigable area based on construction and rehabilitation of small and medium scale tanks is far preferable, especially when one takes the nation's financial limitations into consideration".

At that time, such a shift in allocation of diminished financial resources in this direction was more easily said than done, for the GOSL had already made substantial commitments, particularly in the AMDP. There was nevertheless more flexibility from 1990-91 onwards than there was earlier, so the setting of priorities was a highly pertinent exercise, since even forward commitments to on-going schemes can be altered in timing and size, and availability of financial resources can improve.

The general direction of allocation projections in 1984 showed a lower priority for irrigation as a whole after 1985 and a greater shift in emphasis to projects outside the Mahaweli Programme, both of which were welcomed by the World Bank (1986).

The alternatives were summarised by the World Bank (1986) in terms of a number of indicators of costs and benefits for the Mahaweli and Rehabilitation schemes as follows (Table 4.1):

Table 4.1: Indicators of Costs and Benefits for Mahaweli and Rehabilitation Schemes

Indicator	Mahaweli	Rehabilitation
% Economic Rate of Return (ERR)	12-21 (7-18)	16-23 (13-29)
Investment Cost per hectare (US$)	3800 - 6200	530 - 1930
Net Investment Benefit per hectare (US$)	930 - 1134	150 - 630
Investment Cost per (US$)	4000 - 6200	720 - 2340
Net Incremental Benefit per family (US$)	970 – 1340	200 - 760

Notes:

1. ERRs in parentheses include sunk costs of major head works, and for rehabilitation projects, denote the range of returns from individual tanks.
2. Total investments included in the economic analysis in the appraisal reports are in constant 1984 prices. They explicitly exclude costs of settlement and social services, which are assured to generate their own benefits, but include all irrigation infrastructure and on-farm production costs.

Source: The World Bank (1986) Sri Lanka. Institutional and Policy Issues for Agricultural Development. Washington DC.

These data suggest that Mahaweli projects generally cost more per hectare because of the new development costs of clearing and irrigation infrastructure, but generate higher benefits and create more employment than rehabilitation projects. Thus, while the latter are likely to earn higher economic rates of return, Mahaweli projects will produce higher net economic benefits (net present values) per hectare.

Given the need for reductions in investment allocations for irrigation beyond 1985, the World Bank (1986) gave the following ranking of priorities in irrigation for the medium term:

"(a) Increased provision of funds for investigating and preparing rehabilitation projects and for strengthening the institutions involved with a view to accelerating the investments in this area by about 1988

(b) Selectivity in rehabilitation investments, and the study of an entire catchment area as a whole

(c) Increased funding for investments aimed at improving water management

(d) Adequate fund allocations for system operation and maintenance

(e) Concentration of most Mahaweli resources on completing Systems B and C incorporating the lessons learned from System H.

(f) Implementation of detailed studies and designs for Mahaweli Systems A and D so as to allow initiation of construction when funds and organisational capacity permit.

(g) Shelving of irrigation development plans for the Southeast and Northwest Dry Zones".

We are concerned here with examining the validity of the conclusions drawn from the above comparison of the Mahaweli and Rehabilitation projects. These calculations and the underlying assumptions are therefore examined in the light of the range of studies now available on Sri Lanka's past and on-going irrigation projects.

The World Bank (1984) gave a more detailed set of parameters of six irrigation projects which they have supported (Table 4.2). The six comprise the Mahaweli Ganga II, III and IV, the Tank Irrigation Modernisation Project (TIMP), the Village Irrigation Rehabilitation Project (VIRP) and the Major Irrigation Rehabilitation Project (MIRP).

The parameters used in Table 4.2 are drawn from the Appraisal Reports of the six projects. The validity of the conclusions drawn in these Reports depends upon the extent to which actual costs and benefits matched these appraisal projections. Also, there is a question as to whether these six were representative within Sri Lanka. This chapter examines and compares these projects to weigh up, to the extent possible, the relative merits of large new schemes and smaller rehabilitation projects.

4.2 River Basin Development Projects

The Mahaweli Ganga Project II

Performances can only be judged by comprehensive and careful *ex post* evaluations and not by appraisal indicators, as the latter are all too frequently based on assumptions that are wide of the mark. Furthermore, much importance is placed on the assessment of assumptions made in *ex post* evaluations.

The World Bank undertook an *ex post* assessment of the performance of Mahaweli Project II of the AMDP, which was completed in 1985, in their Project Completion Report 1987 (World Bank 1987). This was based on a draft prepared by PMU/MASL in 1984 and other MASL data. The PMU draft did not contain a benefit cost analysis of Project II either in financial or economic terms. The Bank did make such an analysis based on the benefits and costs of H4 and H5 areas of System H only[6]. The PCR reported an internal rate of return of –1 per cent as against an appraisal ERR of 21 per cent. Unfortunately, some of the critical

[6] These comprise irrigation development of the Right Bank area of System H together with the provision of some facilities for the Left Bank area.

assumptions, viz., those on which the economic price of rice was based and the base year for the cost calculations, were not made explicit. Also the PCR II assumed the cropping pattern of System H would not change.

The price assumption was most important as the ERR was particularly sensitive to change in shadow prices. Indeed, a Project Performance Audit report of the Bank for Project II in May 1988 based on the PCR II found that the Bank's negative rate of return was largely due to the depressed price forecast. The use of appraisal shadow prices (1976) gave an ERR of 16 per cent on completion. This assumption is, however, too arbitrary.

The Project Monitoring Unit of the Mahaweli Authority undertook its own appraisal of the returns from Project II in 1988. Its assumptions differed substantially from those of the World Bank with respect to the shadow price of rice and yield with and without Project II of paddy and chillie, at the commencement and during the life of Project II. The resulting ERR was a more attractive 10 per cent. The Bank eventually accepted the differences in assumptions and there is no apparent reason to question the revised ERR of 10 per cent. Indeed it could well be higher.

For the Mahaweli Authority, crop diversification is a policy priority, in line with government policy. In its conclusions, this study considered this priority and a range of investments and pre-investment studies on the basis of prospects for the production of high value export crops both within and outside Mahaweli. System H is one of the promising locations for these alternative crops where an ERR of 10 per cent could be conservative if diversification can be achieved.

The same argument can be applied to the prospective ERR of System B, Right Bank. The World Bank completed an *ex ante* reappraisal of System B (RB) in 1986 and calculated a low ERR of 3 per cent. The underlying assumptions are not known but would require careful scrutiny, particularly in the light of possible diversification and irrigation modernisation in this area.

Table 4.2: Cost and Benefit Parameters for Six World Bank-Supported Projects

Project	Area Develo-ped (ha.)	Steady Stream of Production Costs US$mns	Stream of O&M Costs US$mns	Economic Appraisal	Net Benefits US$mns	Net Benefits US$ mns	Invest-ment US$mn of 1984	Costs US$mn of 1986	Net Benefits Per ha. US$	Invest-ment Costs/ha US$	Benefit/ Costs Inv./Cost Ratio	Economic Rate of Return/s	Families benefited '000	Increment Paddy Pdn.. ('000)
Mahaweli-Ganga II (1976)	14,700	14.6	4.7	0.5	9.4	13.6	38.5	55.1	925	3,789	24.4	21.2 (14.4)	14	51.5
Mahaweli Ganga III (1980)	24,100	55.5	20.1	1.2	34.2	32.3	125.3	118.4	1,340	4,913	27.2	18.0	24	185.8
Mahaweli Ganga IV (1984)	14,000	22.8	8.8	0.2	13.8	14.3	83.8	86.7	1,021	6,193	16.5	12.0 (7.0)	14	104.0
TIMP (1976)	12,750	8.6	2.7	0.4	5.5	8.0	17.0	24.6	627	1,929	32.5	23.0 (20-29)	11	25.5
VIRP (1980)	31,500	11.4	4.6	0.4	6.4	6.0	24.0	22.7	190	721	26.4	20.0	25	37.8
MIRP (1984)	46,264	13.9	6.6	0.3	7.0	7.0	24.7	24.7	151	534	28.3	16.0 (13-20)	34	73.8

Data in brackets are: - for Mahaweli projects, ERRs with sunk costs of head works, etc. included in the computation;
- for Irrigation rehabilitation projects, the range of ERRs for individual tanks included in the respective projects.
Source: IRBD Staff Appraisal Reports, Washington DC.

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4.3 Major Irrigation Schemes

The Uda Walawe Project

Development and settlement of the Walawe River Valley was initially included in the National Council's Ten-Year Plan in 1959.

The Uda Walawe Project was started in 1969 in the Walawe River Basin in the Southern Dry Zone with Asian Development Bank's assistance as its first integrated rural development undertaking in Sri Lanka. The project area was envisaged as 30,000 net irrigable acres, comprising the Right Bank service area of the Uda Walawe Reservoir. Project work included:

i) Improvement of the existing irrigation system and land use.
ii) Construction of new irrigation facilities, land development and settlement.
iii) Development of settlement infrastructure.
iv) Establishment of an agricultural experiment and extension centre.

The executive agency was the River Valley Development Board (RVDB).

The prime objective was to develop and irrigate the 30,00 acres for double cropping, enhance yields, accommodate about 3440 new settlers, and to improve agricultural productivity and living standards for about 3,100 earlier settlers. Farm production was expected to increase to more than Rs. 70 million under full development.

The Project was scheduled for completion in three years, i.e., in 1972. At Appraisal, two assumptions were made. Under Assumption A, total construction costs of the Walawe dam after 1964 and investment after 1970 were taken into account. Under Assumption B, only the latter was included. Assumption A was thought to be the most relevant since investment from 1970 only continued the older project from 1964.

The ERRs at appraisal and on completion were as follows:

Assumption	Appraisal	Completion
A	12 per cent	10 per cent
B	16 per cent	11 per cent

The ERRs on completion, as assessed in 1979, were 2 per cent and 5 per cent lower than at appraisal. There were a number of reasons for the reductions. First, implementation was much delayed. Disbursement ended only in 1977, and in 1979, the Project was only 90 per cent complete. Second, two tracts were eliminated from the Project. Third, due to the absence of adequate design and construction supervision, the quality of irrigation works was not satisfactory which resulted in severe scouring and/or siltation at many canal structure locations. Fourth, additional costs were incurred to rehabilitate Project works. Fifth, paddy yields were lower than expected in the early years. Finally, only a small area under village tanks, which were to receive water from the Walawe system, actually received it, and even then only from 1978.

The Uda Walawe Reservoir was expected ultimately to serve about 81,000 net acres (33,000 on the RB and 48,000 on the LB). However, water use in the Project area far exceeded original expectations. In 1979, the entire supply from the reservoir and local tanks was delivered to an average of about 21,000 acres on the RB and 10,900 acres on the LB. Only lack of development of the LB allowed this excessive use.

This use arose from a change in the cropping pattern envisaged, which was to devote 55 per cent of the irrigable area, on below-command land at higher elevations with well drained soils, to subsidiary crops (maize and groundnuts in Maha and cotton, chillie and red onions in Yala seasons). Instead, double cropping of paddy prevailed. Of the 16,522 acres of irrigable land newly developed under the Project, all but 300-400 acres, either in Maha or Yala seasons in all years to 1979, were used to grow paddy. The small areas of non paddy crops were planted with chillie, vegetables, green gram, cowpea, maize and gingelly in Maha season, and with cotton and green gram in Yala season.

Thus in Maha, proportions of the total cultivated area were 88 per cent paddy, 3 per cent chillie, 4 per cent vegetables and 5 per cent other crops. In Yala, the pattern was 93:1:1:5 respectively.

Cropping intensities fell well below the expectations of 2.0. In one section of tracts it reached 1.67 in 1978/9 or 89 per cent of projections. In the other larger section, it only reached 0.94 or 47 per cent of projections. Thus, both in terms of diversification and cropping intensity the Project fell well short of expectations.

4.4 Rehabilitation Projects

Rehabilitation projects are divided into two major groups according to size: Major and Minor (village). This analysis follows rehabilitation schemes since Independence in historical sequence. The Tank Irrigation Modernisation Project (the TIMP) concerned with major tanks was identified in 1973 and for which credit agreement was effectively given in 1977 with expected completion in 1980. The Village Irrigation Rehabilitation Project (VIRP) was appraised in 1981 and was planned for implementation from 1981 to 1983. The Major Irrigation Rehabilitation Project (MIRP) was appraised in 1984 after a 1983 feasibility study, using the approach of and lessons from the TIMP in its design.

4.4.1 The Tank Irrigation Modernisation Project

Projections

The TIMP was designed for five tanks in the North of Sri Lanka's Dry Zone where reservoirs were planned to supplement Maha rainfall and utilise any remaining rainfall for limited Yala cultivation. It was believed that increases in production could be achieved by scheme modernisation, improved water management and by the introduction of improved cropping practices utilising existing water supplies.

The water balances were highly variable in the five tanks before the project, ranging from poor to very favourable. Past inflow analyses had indicated that water was available to increase yields and cropping intensities if irrigation practices and tank operations were improved. With better use of rainfall and tank water, average cropping intensity was expected to increase from 103 per cent to 156 per cent. For this, a firm irrigation calendar was established and strict rotational irrigation was to be enforced based on crop water requirements. Paddy was to remain dominant but with significant diversification into crops such as maize, sorghum and pulses. With better extension services, yields were expected to rise considerably. A substantial incremental increase in rice production was also expected. There would be savings in foreign exchange and some 10,500 farm families were to benefit directly. Net farm incomes were expected to double, raising them to the national average.

The economic rate of return of the project was estimated to be 23 per cent. Sensitivity analysis gave a 13 per cent return at worst (with 25 per cent cost increase, 25 per cent lower benefits and a 2-year delay in reaching full development). Viability of each tank was 'proven' with estimated rates of return varying from 20 to 29 per cent.

Most importantly, the principal agronomic changes were to follow the practices of the Walagambahuwa model (IBRD 1976). These practices were:

1. Use of intermittent irrigation for paddy as needed by the crop (not tried in this zone to that time but demonstrated at Maha Illupalama and elsewhere).
2. Use of weedicides and hand weeding to counter the expected increase in weeds caused by intermittent irrigation.
3. Land preparation by tractors on a significant portion while dry, or following first monsoon rains, to reduce the traditional use of tank water for this purpose.
4. To establish firm irrigation schedules to improve the efficiency of water use.
5. To grow other crops on paddy lands in Yala, and in some areas, in Maha season.

Early and dry cultivation with tractors using shorter duration varieties of paddy and savings of tank water to increase cropping intensity in Yala season were the cornerstone of the Walagambahuwa model (see with and without estimates in Table 4.3). Critically, farmers needed the rainfall (and the assurance of its availability) in time for the early sown crop.

Performance

The completion report for the Project (IBRD 1985) estimated the EIRR at 15 per cent (as against 23 per cent at appraisal) with a range from 8 to 21 per cent. These assumed that "full development targets set at appraisal will be reached in all schemes except Mahakandarawa". These included projected yields and cropping intensities. The lower projections of the EIRR were explained by:

(1) Cost increase of 67 per cent over appraisal due to inflation, rupee devaluation and delayed implementation.
(2) Extended implementation - three years longer than expected.
(3) Lower rice prices.
(4) Poorer outlook for the Mahakandarawa Scheme. It is useful to note the various estimates of cropping intensities and paddy yields (Table 4.3).

Table 4.3: Appraisal and Project Completion Projections of Cropping Intensities and Paddy Yields for the TIMP				
	Appraisal Estimates		Project Completion Estimates	
Scheme	**Without project**	**With project**	**Without project**	**With project**
A. Cropping intensities (per cent)				
1	94	168	90	110
2	90	169	125	169
3	124	165	130	165
4	92	118	92	118
5	109	147	110	147
Total	**108**	**156**	**114**	**146**
B. Paddy yields (60 bushels/ac)				
1	52	73	60	80
2	47	73	60	80
3	57	73	60	80
4	50	74	60	80
5	51	74	60	80
Total	**54**	**73**	**60**	**80**

Source: Project Completion Report (PCR) (IBRD 1985) p.30.

The PCR projections could only be based upon data from one or two crop years after the completion of the project (and some years prior to this). These did not provide an adequate guide, as the first year experienced severe water shortage and the second experienced extremely heavy rainfall (as admitted in the PCR on p25). Also, rainfall incidence in earlier years showed a wide range and thus implies much uncertainty as to monsoon behaviour in this region. Paddy yields in the two years were not far below the full development estimate but so were average yields for the entire districts of each of the scheme.

The PCR reported generally adequate resources in terms of availability of draft power. It did report a lack of credit, but more importantly, an unwillingness of farmers to invest in early cultivation (ibid p.24). Further:

> "The recent drought years have not helped in building up farmer confidence that irrigation water would be available for their early sown crops or, in some

> areas, for any crops. Difficulty of ensuring against failure of early sown crops and expectations (based on experience) that additional water issues could be obtained for later sown crops, further reduced farmers' willingness to assume the risk of early cultivation".

Further corroborative evidence of the limited applicability of the Walagambahuwa concept has since appeared, particularly in studies by Abeysekera on the usefulness of the TIMP, as the concept was adopted as a model for the Major Irrigation Rehabilitation Project (MIRP). Abeysekera carefully scrutinised the performance of the Walagambahuwa Model within the TIMP by means of a base line field study in 1978-80 and a later study of the situation after completion in three of the tank areas in May 1983. The latter study's findings suggested that a majority of farmers felt that the irrigation network had improved after the modernisation though problems still remained. The detailed schedules for rotational distribution of water were not functioning below field channel owing to a lack of cooperation among farmers and because they were not convinced of the benefits.

Preparation of paddy lands prior to rains was not favourably received by farmers despite the potential for saving tank water for Yala season. Reasons given for non-adoption were erratic rainfall (which is supported by rainfall records for Maha season), difficulties in weed control (in the absence of suitable pre-emergent weedicides) and non-availability of suitable rice varieties for dry sowing. Where *chena* cultivation was practiced, there was also a conflict between its cultivation and dry sowing, with preference for the *chena*. Mud sowing and a "full tank mentality" prevailed.

Despite extension efforts, there was little diversification into other crops in Yala season, despite the savings in water. Farmers preferred to grow paddy. Other reasons given were soil problems associated with drainage (on LHG and poorly drained RBEs), inadequate water supply, marketing problems, lack of familiarity with these other crops and heavy credit requirements.

Thus, neither the Bank's assessment nor Abyesekara's field studies suggested that the target projections for paddy yields, cropping intensity and total production, and for diversification into other crops, were likely to be achieved. Seasonal data for more recent years would be helpful and allow firm conclusions to be drawn. However, on the basis of available evidence we cannot accept the Bank's optimism expressed in the PCR and therefore would expect an EIRR below the projected 15 per cent.

This project has been considered at some length for two reasons. It was the first systematic attempt to rehabilitate older irrigation schemes taking water management into account. Previous schemes were confined to engineering work to put the tanks back into good working order. Second, the TIMP was accepted as the model for the later Village Irrigation Rehabilitation Project (VIRP), the Major Irrigation Rehabilitation Project (MIRP) and the Kurunegala Integrated Rural Development Programme (KIRDP).

4.4.2 Village Irrigation Rehabilitation Project (VIRP)

Projections

The VIRP was concerned with the scattered irrigable areas commanded by small village tanks and anicuts. The project area covers the whole of the dry and intermediate zones and parts of the neighbouring Wet Zone and excludes only the two Dry Zone districts of Anuradhapura and Polonnaruwa (Water Board 1981).

The objectives were centred on increasing agricultural production and farmer incomes by rehabilitating about 1200 village irrigation schemes with improvements and repairs to tank infrastructure and irrigation distribution systems, and modernising working schemes to facilitate the introduction of systematic water management programmes. Conditions of tanks varied widely from abandoned schemes to operational tanks that required rehabilitation to maintain or increase production.

The total command area was estimated at about 31,500 hectares and the work was scheduled for 1981-85. Higher yields and cropping intensities were expected along with 7,100 rainfed hectares to be brought under irrigation. Cropping intensities were low in the Dry Zone at around 70 per cent in Maha (irrigated and rainfed) and 5 per cent in Yala. With the project, these were expected to rise to 85 per cent irrigated in Maha and 20 per cent in Yala. The corresponding figures in the intermediate zone were 90 per cent and 25 per cent (without the project) rising to 95 per cent and 50 per cent (with the project). Some diversification was expected into chillie, and cowpea on lighter soils provided the water management programme succeeded. Yields of paddy were expected to rise from 2.25 to 2.8 tons per hectare in Maha and from 2.2 to 2.8 tons per hectare in Yala. Families who would benefit would number around 20-25,000 and farm incomes would rise by an average of 43 per cent. A project life of 25 years was assumed. One year's rehabilitation (1981) would give first benefit in 1982 and full production benefits in 1999. The ERR of the base case was projected at 19.8 per cent and was tested for sensitivity as follows (Table 4.4).

Table 4.4: Sensitivity Tests on the Projected EIRR of the VIRP

Variables	%Change	% EIRR
Base case	-	19.8
Economic price of paddy	+20	24.8
Economic price of paddy	-20	14.0
Paddy yields with project	+20	30.6
No increase in dry zone Yala cropping	-	14.4
No diversification into upland cropping	-	17.8
Total command area	-20	16.1
Agricultural value added without project	+20	12.4
All farm costs	+20	12.4
Delay in benefits by two years	-	14.8

Source: Staff Appraisal Report (World Bank 1981).

The set of farming practices, which were expected to be adopted in order to obtain the projected increases in paddy yields and cropping intensity, together with the desired degree of diversification in Yala season, were again those of the Walagambahuwa concept. An FAO/IBRD Appraisal Mission (FAO 1980) carefully reviewed the experience gained in the field from the Walagambahuwa village tank area from 1976-77 to 1979-80. It was with some reservations:

"As the new concept is based on a very tenuous factor, sufficient rainfall, to initiate the paddy rice crop and fill the small village tank, it is important for the proponents of this concept and the farmers that it does not fail due to a period of drought" (ibid Annex 4, p7).

The Mission noted the concept was not new to Sri Lanka but that at Walagambahuwa they had been more successful. With a list of requirements to facilitate its success, the Mission then decided to support and expand the Walagambahuwa concept as a project component.

Performance

The most important performance analysis of the VIRP came from a series of socio-economic studies undertaken by the Department of Agricultural Economics and Extension, University of Peradeniya, and by the Agricultural Research and Training Institute (ARTI). The former (the UP studies) commenced in 1981 as part of project preparation and were completed in 1989 with the publication of the final report (Herath 1989) that examined in depth the changes that have occurred as result of rehabilitation for the period 1981-88. This last covered six districts and had to abandon studies of schemes from the Northern and Eastern Provinces owing to the prevailing civil disturbances there.

Economic benefit/cost ratios were computed for 36 tanks. This is an admittedly limited number in relation to the VIRP as a whole (about 1 per cent of all small tanks in the Dry Zone and around 3 per cent of those in the project). It regrettably had to exclude those selected in the five districts within the Northern and Eastern Provinces. Nevertheless, the analysis of the 36 provided valuable and much needed insights into performances.

The farming system in the tank areas typically comprised upland and lowland components. Only the lowland areas were affected by the Project. In all districts and tanks, Maha paddy was the dominant crop before and after rehabilitation. In a few cases the proportions of farmers growing Maha paddy increased. Subsidiary crops were virtually absent in this season both before and after rehabilitation except in one district (Badulla) where there was a slight shift towards them.

In Yala season, inadequacy of water was a feature before rehabilitation. In the four districts of Badulla, Moneragala, Galle and Ratnapura, the proportions of tanks left fallow were 33 per cent, 63 per cent, 33 per cent and 18 per cent respectively. In this season paddy was also the predominant crop in the tanks where cultivation occurred. Few reported other crops, again with the exception of Badulla, where potatoes and vegetables were widely grown.

After rehabilitation, no significant changes in cropping pattern were reported, i.e., there was no major shift towards subsidiary crops. In Yala season, the results were mixed. Overall there was some reduction in tank numbers left fallow. One or two definite increases in cropping intensity were reported and some others in which there were marginal increases and decreases, but the broad conclusion was that changes in Yala cultivation were not very satisfactory and land use intensity was still low after rehabilitation.

There was an absence of mechanisation in preparatory tillage and timing of preparatory tillage coincided with the rains. It was advanced in only two tanks but even these later reverted to traditional timing. There was considerable uncertainty in farmers' minds over storage and assured water supplies even after rehabilitation. Newly improved varieties (Bgs) were generally grown before rehabilitation but their adoption did increase after the project. Maha paddy yields increased in 60 per cent of lands in Badulla, 72 per cent in Moneragala and average Yala yields increased in both. Maha yields increased in 64 per cent of tanks in Ratnapura, and finally, increases in average yields occurred in Matara and Galle in both seasons. Costs of production of paddy had risen markedly over the period (mainly in hired labor). Overall, this caused an absolute decline in profitability of paddy despite rehabilitation.

The economic analysis was made difficult by constraints on data collection of cost and benefits and some data could not be obtained at all, so sophisticated analysis using shadow prices could not be applied. Use was made of conventional benefit/cost techniques and focused only on economic returns to the society as a whole. Forty-four schemes were evaluated. In eight (19 per cent), total rice production was lower due to rehabilitation, which of course meant negative incremental net benefits. A distribution of benefit/cost ratios by district (Table 4.5) shows the eight negative cases and another four with less than one, which are positive but are also unprofitable. Fourteen are between 1 and 5 while eight are above 10, thus illustrating the large variation.

The cases with very high Economic Benefit Cost Ratios (EBCRs) are those in which there was no Yala cultivation prior to rehabilitation, and where the addition of this crop occurred. While caution is necessary in generalising from this analysis, it is suggestive of some important conclusions. First, translation of the EBCRs into ERRs would not give a high average economic return from the VIRP. Second, the cases where a second crop can be added in Yala will give high returns even if the crop is paddy. Third, the VIRP does not appear to be generally capable of achieving a second crop in Yala and reasons for this need to be identified. Fourth, there is no evidence in this study of any significant adoption of the Walagambahuwa model by small tank farmers. This suggests the model is generally inappropriate under village tank conditions and that any positive net benefits in terms of economic returns from the project were mainly obtained from the structural, storage and distributional components of the Project.

In another study of the VIRP, Somasiri (1987) commented that the "limited studies at Walagambahuwa conducted by the Department of Agriculture provided the rationale for water management under the village irrigation tanks". While stating that the data were inadequate for far reaching conclusions, he made several useful observations based on hydrological data. First, he emphasised the wide variability, intensity and spatial distribution of Maha rainfall in the Dry Zone. Second, within the Dry Zone, the northeast was favoured in terms of amounts and regularity, receiving a greater inflow for a longer period. Thus, it may be that the Walagambahuwa model is effective in such areas but even this suggestion needs further study of rainfall records to determine the likelihood of success. The author commented that in this north east region and in the intermediate zone, advancing Yala planting time substantially would enable the Yala area to expand using tank water effectively and would possibly permit diversification.

Table 4.5: Distribution of the Benefit Cost Ratios within the VIRP

District	Negative	Less than 1	1-5	5-10	Greater than 10	Total
Badulla	3	3	6	2	1	15
Moneragala	2	1	4	3	1	11
Ratnapura	3	-	1	3	4	11
Matara	0	-	1	1	1	03
Galle	0	-	2	-	1	03

Source: Herath et al. 1989.

Somasiri's water balance data confirmed "that it would be more advantageous to have an adequately well managed Maha rice crop than to conserve the water in the tank at the expense of the Maha crop". It would be of little value to conserve the water for a second crop (Yala crop) without providing adequate irrigation for the Maha crop.

Finally, a study by Begum (1987) pointed out that the success of the Walagambahuwa project itself was the result of well distributed rains up to 1980. These results were not subsequently sustained and recent experience does not support the adoption of dry sowing. On the other hand, in locations where rainfall is reliable, e.g., in Trincomalee district, farmers do prepare their land before the onset of the Maha rains.

4.4.3 The Major Irrigation Rehabilitation Project (MIRP)

Projections

The MIRP envisaged the rehabilitation of seven major tank systems commencing in 1986 with a completion target for rehabilitation in 1990. Total area to be rehabilitated was 46,240 hectares or 26 per cent of the total land under major irrigation tanks in Sri Lanka. The production potential of each of these schemes was seen as high at appraisal (World Bank 1984, p.32) given "adequate and timely supply of water, adoption of improved water management and other supporting agriculture services". Expected gains in paddy and soyabean production from the project were to come from improvements in cropping practices and from higher cropping intensity and yields. The economic rate of return of the project was estimated at 16 per cent at appraisal. A breakdown by schemes of ERRs and NPVs is given in (Table 4.6).

Table 4.6: Projected Economic Returns from the Major Irrigation Rehabilitation Project (MIRP)

System	ERR%	NPVs (US$M)
Kantalai	18.0	1.1
Morawewa	20.0	0.5
Iranamadu	18.0	2.6
Giant Tank	13.0	0.9
Rajangana	18.4	1.8
Nachchaduwa	13.4	0.7
Huruluwewa	19.0	0.8
Total	16.0	8.4

Source: Staff Appraisal (World Bank 1984).

The project's economic viability was said to be sensitive to shocks arising from major cost increases or reductions in benefits, which were "both unlikely". For incremental benefits to drop by 13 per cent, either the projected yields or the cropping intensity would have to fall significantly. Leaving aside the question of a cost escalation, the issue of a fall in benefits needs consideration. The Bank's Appraisal Report notes considerable differences in water supply situations between the tanks. Also, intensity of cropping and crop yields and cropping practices were directly related to the availability of water, though interbasin water transfers have helped to increase inflows.

The criterion for adopting a cropping pattern based on hydrological studies was the finding from rainfall records that a shortage of water would occur in only 4 of 30 years. This criterion was admitted as being somewhat arbitrary but was considered as reasonable as "an attempt to rationalise the planning for tank fed irrigation in Sri Lanka" (World Bank 1984, p 21). On the basis of these studies cropping intensities (CIs) were projected to be 150 per cent, 150 per cent, 150 per cent, 188 per cent, 143 per cent, 95 per cent and 150 per cent for the seven tanks after rehabilitation. The increases, mostly to be achieved in Yala season, were 15 per cent, 20 per cent, 13 per cent, 7 per cent, 25 per cent and 20 per cent respectively.

The changes in cropping practices recommended for the MIRP were to be those of the Walagambahuwa model. However, the only tank scheme in which dry land cultivation and dry zoning are currently practiced in Maha season is in Iranamadu which is located in the northeast and, as has been pointed out above, is one area which has reliable Maha rains.

The crucial question is whether farmers could be persuaded to adopt these new practices. The prospects were not particularly favourable given past experience in the TIMP, on the basis of which the MIRP was planned. The problem lay in the choice of the criterion for assessing the potential cropping intensities. For farmers, the question to be taken into account was not only the likelihood of failure of Maha rains, but was also the reliability of onset and follow-up rains. Late rains do not necessarily mean a failure of the monsoon but they can cause a failure of the crop, which farmers cannot afford.

The adoption of the Walagambahuwa model for the MIRP was therefore likely again to pose problems in areas unlike Iranamadu and the projected economic returns and farm incomes were probably too high, since a large proportion of farmers would reject the recommended cropping practices.

The Kurunegala Integrated Rural Development Project (KIRDP)

District Integrated Rural Development Projects are one of the major strategic approaches of the GOSL to strengthen the pace of rural development. Kurunegala was the first district in which an IRDP was introduced in 1979, and it was completed in 1986. It was thus a blueprint approach for later IRDPs and was important for that reason alone. The strategy followed in Kurunegala was to upgrade the small holder farming systems prevalent in paddy and coconut production with better techniques and increased input use through project intervention and to raise production.

One component of this KIRDP is of particular interest to this study: the rehabilitation of irrigation tanks. The Appraisal Report (World Bank 1979) highlighted two main problems in irrigation schemes in the Kurunegala District:

a) inefficient use of rainfall water and a wasteful use of stored water, and
b) inequitable water distribution within the irrigation schemes.

The former was said to be due to the priority given to *chena* cultivation over paddy, the consequent delay in paddy cultivation and dependence on tank water in Maha season which finally led to a low cropping intensity in Yala season. In this project, once the physical rehabilitation work was done, it was intended to introduce a system of controlled water use to prevent crop losses and raise cropping intensities. Tank rehabilitation/improved water management was financially, the largest component in the KIRDP and furthermore was to be the basis of other components of the project on which higher productivity, employment and other living standards would depend. The expenditure for this component was 34 per cent of the total (Malagoda 1986).

For improved water management, the Project adopted the now familiar Walagambahuwa model.

Experience with this model in the KIRDP (Malagoda 1986) was that “only a few farmers practiced it in the project area”. Two major reasons were given for its rejection:

a) Irregular nature of rainfall, which often caused crop failures.
b) Heavy weed growth.

Also, dry land preparation required tractors for ploughing and limited access to tractors and cash costs discouraged tractor use. No positive acceptance of dry sowing was observed in the study area.

A later evaluation study (Asoka et al. 1988), in reviewing component-wise target achievement of the KIRDP, reported first, that the envisaged water management programme could not be implemented until very late in the project life (from around 1982 onwards). Second, it reported that agronomists at Maha Illupalama “no longer advocated dry sowing as a means of saving water under village tanks". Instead, the Department of Agrarian Services had introduced their own systematic water management programme including cropping calendars with specific dates for operations, rotational water issues, or issues according to need. Thus, the KIRP appears to have been the first rehabilitation project that dropped the Walagambahuwa concept. Accordingly, appraisal projections of ERRs do not need to be reconsidered because of this factor. Rather, their achievement will depend upon the success of the water management programme that replaced the concept.

The Gal Oya Left Bank Rehabilitation System

This project was otherwise named the Water Management Project in Sri Lanka. It was designed to develop a replicable institutional capacity to manage large irrigation schemes more efficiently and effectively with active farmer participation, an objective which a final evaluation report believes was substantially achieved (Institute of Science and Technology, 1985). This project involved the rehabilitation of the Left Bank of the Gal Oya Irrigation System that was originally completed in 1955 with a capacity to irrigate 42,000 acres. By 1980, it was estimated that only 30,000 acres could be adequately irrigated[7].

The Evaluation Report (ISTI, 1985) concluded that the Project had been a success by any reasonable standard. Rehabilitation of the system had been achieved, 370 farmer organisations had been formed and were functional. The irrigated area had increased by some 11,000 acres, and with changes in agronomic practices, yields and cropping intensity had been increased. These achievements had produced an EIRR of 47.4 per cent, despite ethnic disturbances to the Project. Such a result in terms of achievement of objectives and such a high economic rate of return deserves consideration in the light of future investment priorities.

The capital costs were larger than expected but were spread over 10 years rather than the first 2-3 years. The benefits, according to this report came sooner than expected and boosted the discounted benefit stream. Cropping intensity rose from 129 per cent to 197 per cent by 1985 but was expected to average 175 per cent in the future (years 10 to 20). Yields increased from an estimated 65 to 79 bushels per acre in 1985. This performance resulted in this high estimation of the economic rate of return as against 23.3 per cent projected in the Project Paper and 34.7 per cent projected in the Project Paper amendment. A few important agronomic changes contributed to this:

- timeliness of land preparation.

[7] Tilakaratne (1989) summarizes the history and accumulated weaknesses.

- reduction of time between land preparation and sowing.
- enhanced use of fertilisers.
- improved weed and pest control.

There was a modest achievement in diversification by 1985, with chillie (393 acres) and green gram (605 acres). The Department of Agriculture (DOA) anticipated no significant expansion until marketing and pricing policies were improved.

A more recent assessment of this project differed somewhat in its conclusions, based on data collected by the ARTI, in its baseline studies, monitoring programme and final impact assessment (Tilakaratne 1989).

First, the project was characterised as physical rehabilitation and modernisation for greater efficiency. Modernisation included better water control with gates, regulators etc. and better water measurement capacity with measuring devices, structures and techniques. It was agreed that this programme had been largely achieved. Also, there was effective cooperation of farmers through farmer organisations. It became possible to reduce water duties as a consequence of these improvements and there was narrowing of disparities in water availability. In the initial years to 1985 there was an unusually favourable water supply owing to heavy rains. This was not expected to continue so a lower CI of 165 per cent was assumed. Also, this analysis could suggest no clear yield trend for 1980-85, but projected average yields for the project were a little lower in early years and little higher on maturity. A shadow price for labour of 50 per cent of the market wage rate was assumed. Finally, there was greater emphasis on capital costs in the earlier years.

In the upshot, the estimated ERR was only 17 per cent. This was of course very much lower than the 47.4 per cent referred to above. However, it should be noted that the estimations of the ERR by the evaluation team have varied greatly as follows:

IRR Project Paper	High	32.0 per cent
	Low	13.0 per cent
	Base Case	23.3 per cent
IRR Project Paper Amendment	High	44.2 per cent
	Low	23.7 per cent
	Base Case	34.7 per cent
Final Evaluation		47.4 per cent

A precise explanation of why base case evaluations shifted from 23.3 per cent to 47.4 per cent over the project period is not available. However, reasons were suggested as to why the ISTI estimates were so high. First, an unrealistic exchange rate was used (US$1 = Rs.15.50). Second, O&M changes were underestimated (Rs. 125 per acre as against Rs. 200 per acre). Third, there was an exaggeration of the area that benefited.

4.5 Lift Irrigation Scheme (LIS)

Projections

One of the most interesting but least successful of the post-Independence irrigation projects in Sri Lanka was the Lift Irrigation Scheme (LIS). This scheme has considerable significance for this study, which is concerned to assess the potential of lift irrigation for upland crops in Sri Lanka. The project originally envisaged provision of lift irrigation and agricultural development for 13,500 acres comprising 6,100 acres of uplands in existing settlement schemes of formerly landless labourers and 7,400 acres for settlement of unemployed educated single youths.

The objective was to construct irrigation channels and provide pumps, pump houses and water delivery structures to irrigate about 6500 acres of uplands in low areas in the Dry Zone. These were at Vavunikulam (500 acres) in the north, Rajangana (3700 acres) in the north-west, at Polonnaruwa (850 acres) in the east and Nagadeepa (1200 acres) in the central area. It was designed to increase the production of upland high value cash crops, particularly chillie and onions, for the domestic market, which were then mainly imported. It was, therefore, also an early attempt to diversify agricultural production under irrigation. At appraisal (IBRD 1968), cropping intensity for areas irrigated was projected at 133 per cent and the ERR was projected to reach 16 per cent.

Performance

The basic concept of providing irrigation for upland crops was sound. However, it was demonstrated that most of the conditions which would make such a project viable were not met during or after implementation and the LIS was considered to be a failure, achieving an ERR of only 1.3 per cent. The project was judged as non-sustainable (IBRD 1985).

In the early stages, one of the schemes was replaced by a more recently established colonisation scheme (Nagadeepa). There it was agreed to grow tree crops, especially papaya, banana and citrus under irrigation. Settlers arrived with the belief that they would grow two crops of rice per year, but that was not possible owing to inadequate water and high soil percolation rates, and many farmers had to seek supplementary employment in the dry season. This particular part of the scheme was completed near the end of the project and provided water for only 18 per cent of the potential command area. Subsequently farmers were offered canal water for upland areas, which they refused because they had already planted fruit trees that they did not wish to irrigate. They preferred traditional upland crops in the absence of any familiarity with intensive chillie cultivation and did not wish to divert water to these lower value crops. In 1981, all pumps were removed and this component of the scheme was written off as a failure.

The northern scheme of Vavunikulam did develop as envisaged in the Appraisal Report. This is a Tamil area where intensive vegetable cultivation was traditional and local lift irrigation was not uncommon. Most of the 500 acres were planted with chillie, and from 1981, onions were increasingly grown. There was, however, a decline in LIS utilisation either temporarily or permanently for reasons that were not clearly determined, though the farmers were concerned about input costs including fuel, market prices and demand.

The Rajangana RB and LB scheme was a partial success, as the cultivation of chillie gradually became more popular. But water supplies were limited in early years especially on the RB. Greater and faster commercial chillie production was achieved on the LB.

The Youth Scheme in Polonnaruwa was partially and intermittently successful. Early, when the farmers were provided with food supplements and other incentives, they used the system. When full costs were imposed they ceased to use the pumps. They later returned when credit for fuel was made available by the Bank of Ceylon and they produced chillie with efficient pump use.

Overall, completion of civil works fell five years behind schedule and there was a substantial cost overrun (79 per cent) owing to higher prices, delays and construction changes. By 1978, only half of the target acreage of 6,500 acres were under irrigation and of this fewer than 1,500 acres were under chillie and onions. Excluding the Nagadeepa project, cropping intensity was only 28 per cent, against a planned 133 per cent. There was inadequate extension, a serious lack of institutional coordination between Irrigation and Agriculture Departments and a considerable reduction in producer prices of chillie and onions.

Farmers' decisions were also affected by the uncertain or very limited supply of water owing to shortages at source, pump breakdowns, scheduling problems, poor farmer cooperation, wasteful use or combinations of these factors, and by a serious under estimation of the amount of water needed for chillie and onions. No scheme was immune from this problem, but worst of all, the severity of shortage occurred in the early stages. Also, these crops are capital and labour intensive and costs are too high for subsistence cultivators unless supported financially. This problem is intensified with uncertain water supplies. Finally, there was a cost/price squeeze with a rise in costs of production and a drop in chillie prices during the period concerned. The two crops do give good returns but prices of both fell. Thus, the LIS failed through a multiplicity of faults in both planning and implementation stages.

The LIS was the largest lift irrigation scheme undertaken to date but it is by no means the only one. A 1982 survey of lift irrigated agriculture lists these others. Although the total area then of some 15,000 acres was small by comparison with the 1.4 million acres cultivated in Maha and Yala seasons, it did contribute to highland (or subsidiary) crop production (chillie, onions, cowpeas, green gram etc.) and furthermore there is much scope for area expansion. If properly organised with modern irrigation techniques, this could be a way of at least satisfying the expanding domestic demand for this particular group of food crops. The use of lift irrigation for upland tree crops should also be explored.

5. Options For Investment In Irrigation

A major theme of this study is that a part of future investment in irrigation needs to be used for the improvement of water management practices, as national economic benefits associated with improved water management would be substantial. Technological discussions within this chapter will enable this theme to be spelled out in later chapters.

This chapter examines options for investment in irrigation, ranging from new projects within and outside the Accelerated Mahaweli Development Programme (AMDP) and the Mahaweli project master plan, rehabilitation and modernisation of existing projects, minor projects and ground water based irrigation systems. It considers the need for adoption of new design concepts and new technologies in major irrigation schemes, and makes recommendations amongst these options.

5.1 New Projects

5.1.1 Within the AMDP

Areas Potentially Cultivable

A computer simulation study was carried out in 1985 within the Mahaweli Water Resources Management Project, financed by the Canadian International Development Agency (CIDA) (ACRES 1985). The study revealed that, assuming current water duties in systems under the AMDP, there was sufficient water in the Mahaweli and allied basins to support an annual cropping intensity (CI) of 2.0 (i.e., full Maha and Yala crops) in all irrigation areas, with the exception of System H (Diagram 5.1).

In System H, even an overall improvement of 10 per cent in irrigation efficiency, with a shift to a diversified Yala cropping pattern would be unlikely to result in a reliable annual cropping intensity of 2.0. The main constraints to achieving intensity objectives in System H were a lack of diversion capacity at the Bowatenna tunnel, a lack of adequate storage capacity within System H itself and the excessive use of water under the gravity flow system. It was found that only 65 per cent of the total area of System H could be cultivated during Yala with an acceptable reliability of existing water duties. The study showed that the economic impact of achieving a Yala cropping intensity of only 65 per cent is very significant. A reduction from an annual CI of 2.0 to 1.65 results in an 18 per cent decrease in average family income.

Supportable Irrigation Areas

The Acres study showed that substantial benefits could be realised by reducing irrigation water duties in the Mahaweli Scheme with improved water management practices. It was shown that:

- by achieving an increase in overall system efficiency of 10 per cent, reliable annual cropping intensity could be increased from 1.65 to 1.80 in System H and this would increase agricultural benefits in Yala from System H alone by an estimated Rs.47 million per annum,
- allowing more water to be routed down a higher generating head with efficient water use in existing areas would generate more power and greater benefits,
- higher efficiencies would reduce the number of years of water deficits in System D1 and C.

New Systems Development

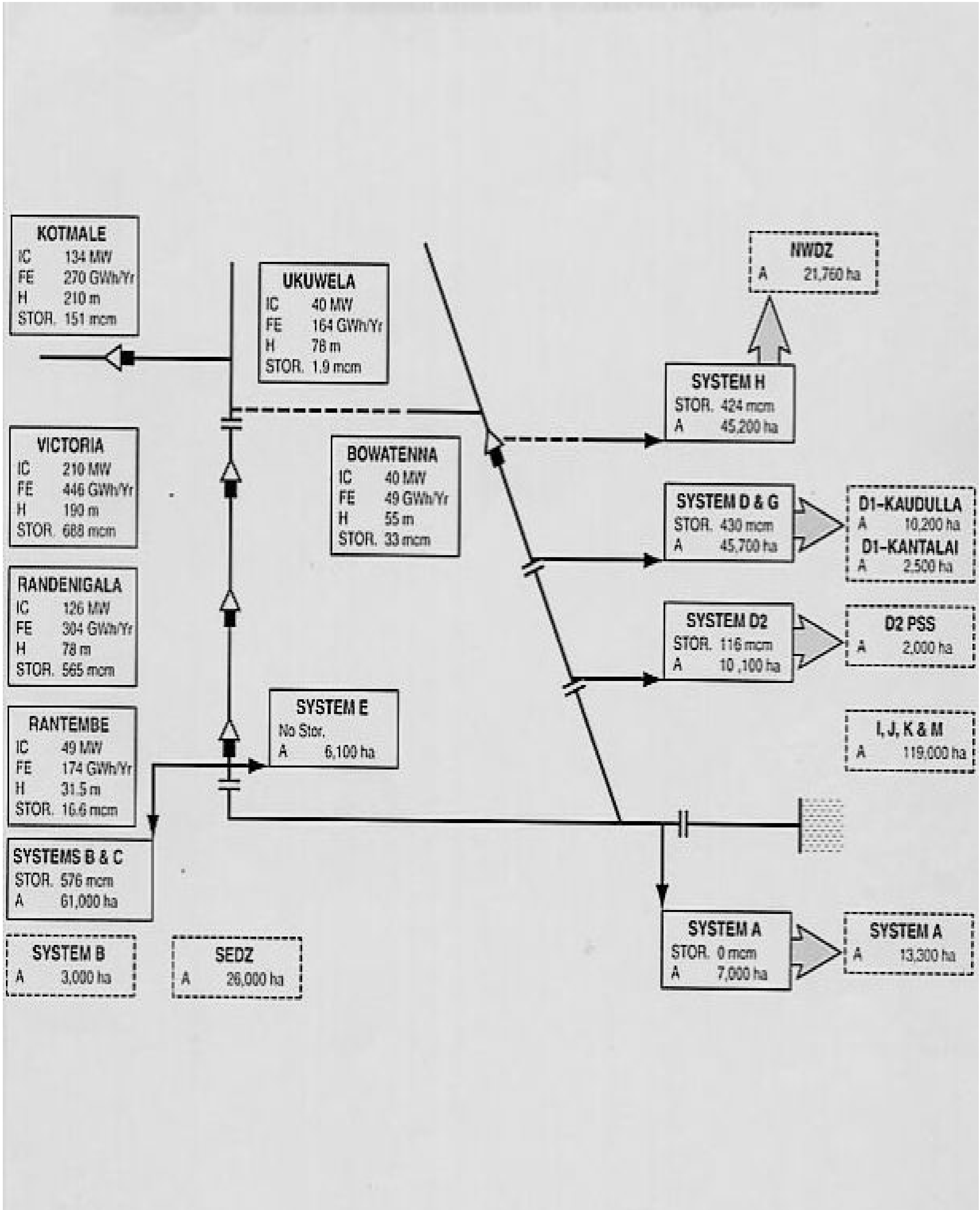
It was planned to develop areas identified as Systems A, B, C, D, G and H under the AMDP (Figure 3.1). Chapter 3 described the development of various Systems to Year 2000. The only Systems that have not been developed are Systems A and D. These are discussed below.

a) **System A**

System A is the furthest downstream system in the Mahaweli Basin. It is bounded to the west by System D and to the south by System B. A part of System A has now been reserved for a wild life sanctuary. The net command area of System A, according to the NEDECO study (1984) was 36,200 hectares but subsequent studies have estimated the net command area at only 20,300 hectares, including the 7,000 hectares of the existing Allai scheme.

The ACRES study (1985) indicated that System A could be supplied without shortage for the period of 32 years considered for simulation for the cultivation of the full potential area of 20,300 hectares. Soils were found to be suitable for wetland rice cultivation. The areas identified as suitable for upland crops were less than 1500 hectares, which ruled out crop diversification in System A. As this area is in the actual delta of the Mahaweli, floods might become a problem during Maha season and further studies of the drainage system would be required. The head works of System A consist of a barrage on the Mahaweli at Kandakadu. Figure 3.1 indicates the location of the barrage and the proposed main canal.

Diagram 5.1: Present and Additional Areas Under the Mahaweli Irrigation System



A feasibility report, prepared by Joint Venture Randenigala for System A, indicated an economic rate of return of 14.2 per cent per annum. Sensitivity tests on changes in costs, benefits and timing gave EIRRs in the range of 12-16 per cent, which showed that the project was economically viable. This report recommended the project area should be limited to Mahaweli Right Bank lands and should exclude Left Bank lands except for 3000 ha in the Verugal area below the existing spill structures. It also recommended rice monoculture.

According to the JVR study, the financial investment, including monetary contingencies over a period of six years would be Rs.6.6 billion for all components of the project. Based on 1981 prices, it was estimated that public works would cost Rs.5.5 billion and the foreign exchange element would be 66 per cent.

b) System D

System D has been sub-divided into Systems D1 and D2. The Parakrama Samudra Scheme constitutes System D2. The other schemes namely, Minneriya, Kaudulla and Kantalai Tanks fall under System D1. Apart from run-off from its own catchment area, System D1 draws water from the Aban Ganga at Elahera. An anicut at Elahera diverts water through the existing Elahera-Minneriya Yoda Ela. The Kantalai Tank is supplied from Minneriya Tank through the existing Minneriya-Kantalai Yoda Ela, while Kaudulla Tank receives overspill from Minneriya Tank through Aggalawan Oya. Parakrama Samudra receives additional supply from the Aban Ganga at Angamedilla anicut.

An additional area of 10,000 hectares has been identified for possible development in the Kaudulla Scheme in System D1. This would bring the total irrigable area to be served in this scheme to 14,600 hectares. However, the ACRES study found that the expansion of the Kaudulla Scheme would be subject to the following constraints on water availability.

- limited diversion capacity at Polgolla.
- limited main system storage at Kotmale.
- limited diversion capacity from Minneriya owing to the high sill level of the Minneriya-Kantalai Yoda Ela sluice.
- limited storage in the Kaudulla Tank.
- priority given to meeting water requirements at Kantalai tank.

These factors limit the additional land area that could be developed in the Kaudulla Scheme. This study indicated that an increase in area of only 2,500 hectares could be supported with adequate reliability, which is far less than the area available. Expansion beyond this limit would require the development of additional main system storage, possibly at Moragahakanda. A second alternative could be to construct a dam and diversion on the Kalu Ganga, which would supply additional water at the Elahera diversion. Under this arrangement, however, Kalu Ganga flows would be unavailable for diversion at Angamedilla. These expansion options were not investigated by the ACRES study.

The following potential system expansions were recommended within the limits imposed by water availability:

System A: An additional area of 13,300 hectares identified for possible development would bring the total irrigable area to be served to 20,300 hectares.

System B: An additional area of 3,000 hectares, identified for possible development in Zone 4B would bring the total irrigable area to be served to 41,300 hectares.

System D: An additional area of 10,000 hectares, identified for possible development in the Kaudulla Scheme of System D1, would bring the total irrigable area to be served to 14,600 hectares.

Moragahakanda Project

In the Moragahakanda Project, it was proposed to build a rock fill dam to form a reservoir across the Aban Ganga, which is the main tributary of the Mahaweli River. This reservoir would supplement the irrigation needs of 62,200 hectares of existing and new lands in Systems D and C. It would also facilitate the operation of a powerhouse.

The ACRES study found that the expansion of the Kaudulla Scheme in System D1 would have to be limited to 2,500 ha in the absence of additional main system storage. It would be possible to develop a full potential area of 10,100 ha in System D1 if this reservoir was constructed. According to revised estimates this project would cost US$310 million.

5.1.2 Outside the Accelerated Mahaweli Program

There were a number of new proposals made in the Master Plan that were excluded from the AMDP.

The South East Dry Zone Diversion

In addition to the systems expansion discussed in the previous section, the ACRES study (1985) found that a substantial volume of water could be diverted at Minipe by new conveyance works without adversely affecting the water supply to existing irrigation projects.

It was therefore proposed to divert this uncommitted water to the South East Dry Zone (SEDZ) which is located south of the Maduru Oya reservoir. The SEDZ comprises the Gallodai Aru Maha Oya, Rambukkan Oya, Magalwattawan Aru, Navakiri Aru and Andella Oya. Of the 225,290 hectares of gross area available in the basins, 82,890 hectares were located in the command areas of the proposed irrigation systems. The total irrigable area of 40,000 hectares were divided into two sub-systems:

- SE1, which consists of the Gallodai Aru basin, with a net irrigable area of 15,500 hectares, including the existing Rukam Scheme, and
- SE2, which consists of the Maha Oya, Rambukkan Oya and Magalawatawan Aru basins, with a net irrigable area of 24,500 hectares, including the existing Unichchai Scheme.

Other proposals were made that require the construction of costly diversion works, storage reservoirs and tunnels, with complementary investment in irrigation infrastructure. Feasibility studies are required to ascertain the economic viability of these proposals.

5.2 Other River Basin Development Proposals

5.2.1 In the Mahaweli Master Plan

In the original UNDP/FAO study there was a proposal to divert Mahaweli waters to the North Central Province beyond Anuradhapura, to Systems designated as I, J, K, L and M with a total potential irrigable area of approximately 190,000 hectares (Table 5.1).

The supply of water to these systems would require the construction of approximately 215 km of canals and several pumping stations.

The Transbasin Diversion Study completed in 1981 concluded that the development of these Systems would not be economically justified.

Table 5.1: Total Areas under Other Proposed River Basin Development System Proposals within the North Central Province

System (ha)	Gross Area (ha)	Command Area Area (ha)	Irrigable
I	144,550	79,250	49,350
J	82,430	54,420	34,200
K	31,110	15,060	9,800
L	96,370	70,520	42,650
M	160,100	94,900	54,150
Total	514,560	314,150	190,150

Source: UNDP/FAO study.

5.2.2 Outside the Mahaweli Project Master Plan

a) Kalu Ganga Diversion

A feasibility report on multipurpose development of the Nilwala Ganga, Gin Gange and Kalu Ganga basins showed that the transbasin diversion of Kalu Ganga waters to the South Eastern Dry Zone (SEDZ) will increase the internal rate of return (IRR) in relation to the within-basin development concept.

The Master Plan study for the Electricity Supply of Sri Lanka (1989) also considered the diversion of Kalu Ganga waters to the SEDZ. This proposal included construction of five major reservoirs across the Kuda Oya, Manik Ganga, Kubukkan Oya and Weli Oya.

b) Nalanda Diversion

In this proposal, the waters of the Nalanda reservoir in Matale district could be diverted through a tunnel and a powerhouse to Kurunegala District. The water would be diverted to Kimbulwana Oya and to a new reservoir on Kimbulawana Oya approximately 6.5 km upstream of the existing Kimbulawana tank. This would allow an increase in, and improvement of, the reliability of water supply to existing major tanks, as well as an expansion of the irrigable areas in the central Kurunegala district.

The main project components would be:

- an earth-fill dam on the Kimbulawana Oya, creating the "Ragedara" reservoir,

- a diversion weir approximately l km upstream of the existing Diyatura anicut on Kimbulwana Oya, for diverting flows into the northern and southern transfer canals,
- a northern transfer canal from the Ragedara reservoir to the existing Hakwatuna Oya reservoir,
- a southern transfer canal from the Ragedara reservoir to the existing Batalagoda tank, and
- secondary and tertiary works to serve the areas under command.

The scheme would allow intensification of existing irrigated agriculture on approximately 9,100 net hectares and development of a new irrigation scheme on about 3,200 net hectares.

The overall cost excluding Ragedara Dam was estimated at US$11.2 million with a present value of US$14.3 million assuming a four-year construction period. The net present benefits from this project were estimated at US$43.4 million and the present worth of the project at US$7.4 million.

In Maha season, 77 per cent of cropped area in this region is under paddy, with the rest under vegetables, green gram and cowpea, plantain and maize. In Yala, about 50 per cent are under paddy, 20 per cent under vegetables and other subsidiary crops. Some 60 per cent of the project area may comprise LHG soils though some of the lowlands may be alluvial. The rest are RBEs.

The proposed cropping pattern would have all land under paddy in Maha season. In Yala, 50 per cent would be under paddy and the rest under brinjal, green gram, cowpea, red onion, chillie and capsicum. Cropping intensity was put at 1.85. The net present benefit with the project using a 10 per cent discount rate is US$43.4 million. The overall cost excluding the dam has a present value of US$11.2 million over a four-year construction period. The power component of the project is promising and one of the best small-power schemes in the country. The addition of irrigation and flood control benefits makes it one of the most attractive water resources development projects in the country. For the central Kurunegala district, it is the only project that could secure a surface water supply for 12,000 hectares of often drought stricken irrigation areas. Finally, this project rates very highly amongst hydro projects according to system merits as assessed by the Master Plan.

c) Uma Oya Project

The head works of the existing Uma-Ela scheme lie downstream of the proposed UMA0063 hydropower project. A 16 km long winding channel, which almost reaches Welimada area, supplies water to 405 hectares of paddy cultivation in steep terrain. The potential new irrigable area is located uphill of the existing irrigated area.

The proposed irrigation development would include:

- improvement of water supplies to the existing Uma-Ela irrigation scheme.
- development of 492 hectares of new lands to the north of the existing scheme.

The overall cost of capital works for irrigation is estimated at only US$3.6m, with a Present Value of US$4.3m assuming a three-year construction period.

Net present benefits from the project are estimated at a high US$12.2 million, and the Present Worth of the project is US$6.9 million. These figures reflect the high potential value of the use in this area of well-drained soils for crops such as potatoes, cabbage and tomatoes (typical of the Nuwara Eliya district). Cropping intensity is assumed at 1.85 with vegetables (and paddy) in both seasons.

The other interesting feature is the recommendation of a pipe-based tertiary distribution to farms because of the terrain. This could provide an opportunity for introducing on-farm, on-demand micro-irrigation as well.

Water released from the powerhouse would be adequate for irrigation so that the two objectives of power generation and irrigation are complementary. However, this project is listed at only 16th (of 25) in ratings out of all hydro projects according to system merits in the Master Plan.

d) Loggal Oya Project

The potentially irrigable areas in this Project are located on the left and right bank of the Loggal Oya, downstream from the proposed BADU013 powerhouse site.

Left Bank irrigation development would include the following components:

- improvement of irrigation water supply to the existing 800 hectare Komarikagama project, immediately downstream of the powerhouse.
- expansion of the irrigated area downstream of the Komarikagama project. The total new net irrigable area would be 2,413 hectares. The proposed cropping pattern would be (long and short-term) paddy only in Maha season. In Yala season, almost half the area would be under paddy and the rest under brinjal, tomato, beans, chillie, capsicum, cowpea and green gram, i.e., subsidiary crops typical of the Badulla district.

The canals, structures and on-farm development costs were valued at US$12.9 million with operation and maintenance requirements of US$2.5 million, giving a total Present Value of costs of US$15.4 million. The Present Value of Benefits was estimated at US$23 million and Present Value of Project Worth was an estimated US$7.3 million at an assumed discount rate of 10 per cent, making the project potentially attractive from an economic viewpoint.

5.3 Rehabilitation and Modernisation of Existing Projects

During the early post-Independence period, several irrigation schemes were restored and a number of new projects, including major projects such as the Gal Oya Scheme and the Uda Walawe Scheme, were completed. More recently, the Mahaweli Ganga Project for the development of nearly 250,000 hectares of new land became the focus. Within this, nearly 50,000 hectares were developed during the last ten years.

At present there are approximately 520,000 hectares of irrigated land in Sri Lanka. Nearly 34 per cent of this, about 175,000 hectares, come under minor irrigation schemes. These are managed by the Department of Agrarian Services. The Irrigation Department is responsible for the operation and maintenance of nearly 300,000 hectares including all irrigation schemes with a command area of more than 80 hectares. The Mahaweli Authority of Sri Lanka manages another 45,000 hectares under the Mahaweli Project. Overall, about 80 per cent of the total irrigated area of 300,000 hectares in Sri Lanka comes under major projects each of which has a command area of more than 1,000 hectares. Total irrigated area under major irrigation projects was about 203,000 hectares in 1975, but by 1985 it had increased to 277,000 ha.

5.3.1 Project Life of a Scheme

The first rehabilitation of major projects commenced in 1976 to benefit five tanks serving a total of 12,600 hectares. In 1979, a rehabilitation project for Gal Oya commenced at an estimated cost of 490 million rupees. This project was originally started in 1948 and construction of an irrigation network continued through the 1950's until about 1965. It can therefore be said that rehabilitation was necessitated after an operational life of 20-25 years. The Uda Walawe Project was initiated in 1959 and development work continued up to 1979, although it was scheduled for completion in 1972. A project was initiated in 1987 for the rehabilitation of this project and work started in 1988 after 15 years of operation. It is therefore safe to assume that Sri Lankan irrigation projects need rehabilitation after 20 years of operation owing to poor on-going maintenance of the systems, which in turn is a consequence of a lack of public funds allocated for this purpose.

5.3.2 Annual Requirements of Funds for Rehabilitation Works

With a total of nearly 300,000 hectares of irrigated land, it would be necessary to rehabilitate 15,000 ha annually to keep all major irrigation schemes in operational condition on the assumption of a 20-year project life span. The total project cost of the Gal Oya rehabilitation project was Rs.503 million for a command area of 24,300 ha. The average rehabilitation cost was Rs.20,700 per ha in 1985 prices. For the Uda Walawe Project the estimated cost was US$13.7 million for the benefit of 12,000 hectares, so the average cost of rehabilitation was nearly Rs.38,000 per hectare in 1985 prices. The rehabilitation cost of the MIRP project was Rs.26,000 per hectare in 1984.

Therefore, the average cost of rehabilitation can be taken to be around Rs.30,000 per hectare. Hence, the total annual requirement of funds for rehabilitation works to maintain all major irrigation schemes would be about Rs.450 million.

5.4 Recent Rehabilitation and Modernisation Projects

The first rehabilitation project, the Tank Irrigation Modernisation Project (TIMP) commenced in 1976. This was t o benefit five tanks covering a total of 12,600 hectares. The second project, the Irrigation Rehabilitation and Water Management Project commenced in 1979, was to serve 24,300 hectares on the left bank system of the Gal Oya Irrigation Scheme. The Major Irrigation Rehabilitation Project (MIRP) was commenced in 1984 to serve seven major tanks covering an area of 46,240 hectares. The Irrigation System Management

Program (ISMP) commenced in 1987 to serve 51,000 hectares. The Village Irrigation Rehabilitation Project (VIRP) was started in 1981 to serve 31,500 hectares under minor irrigation schemes. A VIRP Stage II serves 125 medium size tanks. In all, nearly 50 per cent of Sri Lanka's irrigable area under major irrigation schemes has been subject to rehabilitation and modernisation or improvement during 1970 to 1980.

The rehabilitation of the irrigation infrastructure usually means a restoration of the physical system to its original design specifications that were based on the objectives, agricultural practices, and water management practices at that time. But during the operational period (usually more than 20 years) some of the project objectives might have changed along with agricultural and water management practices. Therefore, the original specification may not be appropriate for the changed conditions of the project.

Rehabilitation should provide an opportunity to reap the benefits from changes in technology that have occurred since the inception of the project. Hence, modernisation of the physical system may become necessary in order to improve upon the original design specification. As restoration, rehabilitation, improvement and modernisation are frequently used in relation to irrigation projects, the following definitions are given:

Restoration - restoring non-functional or abandoned irrigation projects to the existing and original level of design specifications,

Rehabilitation - restoring the physical system to its original design specifications from the present functional level of the system,

Improvements - Improvement of the physical systems of irrigation projects to current design specifications,

Modernisation - Adoption of new technologies designed to maintain water level and/or discharge in main and distributary canals or automation of canal systems using the advanced concepts of canal and pipe line operation as discussed later in this chapter.

5.5 Need for Management Process Improvement

Until recently, irrigation rehabilitation was considered primarily to be a technical exercise to improve the physical condition of irrigation systems necessitated by:

- ageing of systems.
- changes in demand pattern.
- increased costs of operation and maintenance.
- excessive operational losses.
- mismatches between demand and delivery.
- outdated system objectives and purposes.

However, recent studies have shown that physical rehabilitation of irrigation systems alone is not sufficient to increase yields significantly and efforts to improve management are also required. Hence, all recent rehabilitation projects have allocated a part of project budgets to improve water management practices. Indeed, the main objective of the Gal Oya rehabilitation project was to develop better water management practices. Studies of the first rehabilitation project (TIMP) identified a need to look beyond purely engineering solutions into the following areas:

- focussing on building farmer organisations.
- providing more adaptable agricultural technologies.
- incorporating farmer's knowledge and experience in designing rehabilitation projects.

The TIMP contributed significantly to an improved understanding of the requirements of rehabilitation projects in Sri Lanka. Many lessons learned have been incorporated into planning and implementation of subsequent rehabilitation projects like MIRP and the Gal Oya water management project. For example, more emphasis is now placed on software solutions to improve the reliability and equality of water distribution in all parts of the system. The need was recognised to organise water sharing programs and to work closely with the engineers involved in the redesign and reconstruction of the canal network.

The Irrigation Systems Management Project (ISMP) was designed to continue testing and improving the approach used for organising farmers of Gal Oya. In addition, the project has attempted to develop strong farmer organisations and to develop a performance and financial monitoring capacity.

5.5.1 Need for Selection of Appropriate Methods

There is typically considerable variation in water availability at the head, middle and tail areas of an irrigation canal of a project. It is a common belief that the improvement of an irrigation system alone will not ensure reliability and equality of water distribution. Hence, strong farmer organisations are necessary to ensure such equitable distribution occurs. However, there are other factors that need consideration.

Irrigation managers tend to believe that most problems in canal operations, such as inequity and unreliability, enter the system at the secondary and tertiary levels, and the main canals operate according to their design under steady flow conditions. After improvements to the irrigation system, it is intended to ensure:

- Reliability, by improving:
  - water control capacity with control gates and cross canal regulators.
  - water measurement capability by installation of measuring devices, structures and techniques.
- Equity of water distribution, through the introduction of strict rotational delivery schedules with the cooperation of farmer organisations.

It is however, very difficult to maintain main canals under steady flow conditions. Variations of flow occur owing to such factors as rainfall, opening and closure of off-takes, and water demand variations. As all control gates and most regulators need manual adjustment, frequent resetting of the gates becomes necessary to maintain canal water levels or discharge through off-takes to ensure strict rotational schedules. This requires a large number of trained and dedicated operational staff, a good communications system and transportation facilities. In turn this will increase operational and maintenance costs of the project.

Effective farmer organisations lead to improved co-operation among farmers, and to improved co-operation and communication between farmers and agency officials. Water distribution at secondary and tertiary levels can then be handed over to farmers along with canal maintenance. These improvements can lead to improved performance on a sustained basis. The farmer organisation program of the Gal Oya water management project has been fairly successful, but the experiences in other irrigation systems, such as Mahaweli "H" area and Minipe were not encouraging. There are a number of other social issues that have very important impacts on the effectiveness of farmer organisations.

As there is no guarantee that farmer organisations will be sustainable in the long run in all irrigation projects, other options must be sought that will not require dependence solely on the organisations, e.g., through:

- reliability and equity of water distribution.
- penalties (or disincentives) for over-consumption of water.
- flexibility in delivery to maximise on-farm yield (for crop diversification).

It is therefore recommended that at least a part of any rehabilitation project area, preferably the head end areas, should be modernised by the adoption of advanced concepts of canal and pipeline operation. These can have a decisive influence on the success of a project (see below) or to allocate a portion of rehabilitation funding for a research program to identify appropriate technology for irrigation system modernisation.

5.6 Other Issues Under Rehabilitation

The primary objective of any rehabilitation project is to improve and sustain the performance of an irrigation system by appropriately upgrading the physical structures and infrastructure (hardware) and the associated organisational structures and the management processes (software). The following software solutions will also help to increase the efficiency of irrigation water use:

- irrigation system management,
- computer modeling of canal operation and irrigation scheduling,
- on-farm development works to improve application efficiency,
- development of water user associations for equitable distribution of water,
- training of farmers with modern agricultural and water management practices,
- co-ordination between agencies,
- elimination of negative factors responsible for rejection of agricultural innovations (uncertain water supply, limited land base and landlessness, mortgaging and leasing of lands, indebtedness),
- systematic maintenance of irrigation infrastructure, and
- introduction of water charges.

The above issues will be discussed in this study. Chapter 6 will assess operation and maintenance requirements of irrigation systems (O&M) within the context of improved water management and farmer participation that will encourage cost recovery.

5.7 Minor Irrigation Projects

The land area provided with irrigation facilities in Sri Lanka is about 520,000 hectares of which nearly 175,000 hectares are under minor irrigation schemes. The Agrarian Service Act No.58 of 1979 defines a minor irrigation scheme as an irrigation work serving up to 80 hectares (or 200 acres) of agricultural land. The Ministry of Lands and Land Development estimates that there are over 25,000 minor schemes in the country. A survey carried out by the Department of Agrarian Services shows that there are 9,294 village tanks and 9,796 weirs (anicuts) in working order with varying degrees of efficiency and cropping intensity. These minor irrigation schemes play a vital role in Sri Lanka's economy. It has been estimated that village irrigation accounts for 34 per cent of the 175,000 hectares under irrigated paddy cultivation.

During the 1980s, the restoration of abandoned village irrigation works and rehabilitation of working irrigation schemes became an important component of rural development in Sri Lanka.

5.8 Ancient Irrigation Schemes

The remains of extensive and elaborate tank irrigation systems in the Dry Zone of Sri Lanka are ample evidence of an ancient and advanced hydraulic civilisation. It is said that the first irrigation tank was built early in the fifth century BC, with a 24 foot high and mile long bund. The development of a hydraulic civilisation continued up to 13th century. At that time, there were a number of major tanks in the Dry Zone, viz., Kalawewa, Minneriya, Parakrama Samudra, Wahalkada, Padaviya and Giant's tank and a few transbasin diversions. The size and extent of the cultural monuments of this period suggest a self-sustaining agro-surplus economy built on the more fertile soils of the Dry Zone. The absence of irrigated upland agriculture practiced on a sustained basis on the island over a span of nearly 1,000 years should be noted. This ancient civilisation was centred on and sustained by irrigated lowland rice cultivation. In addition, during the rainy season, coarse grains, gram, legumes and oil and fibre crops were grown under shifting or *chena* cultivation.

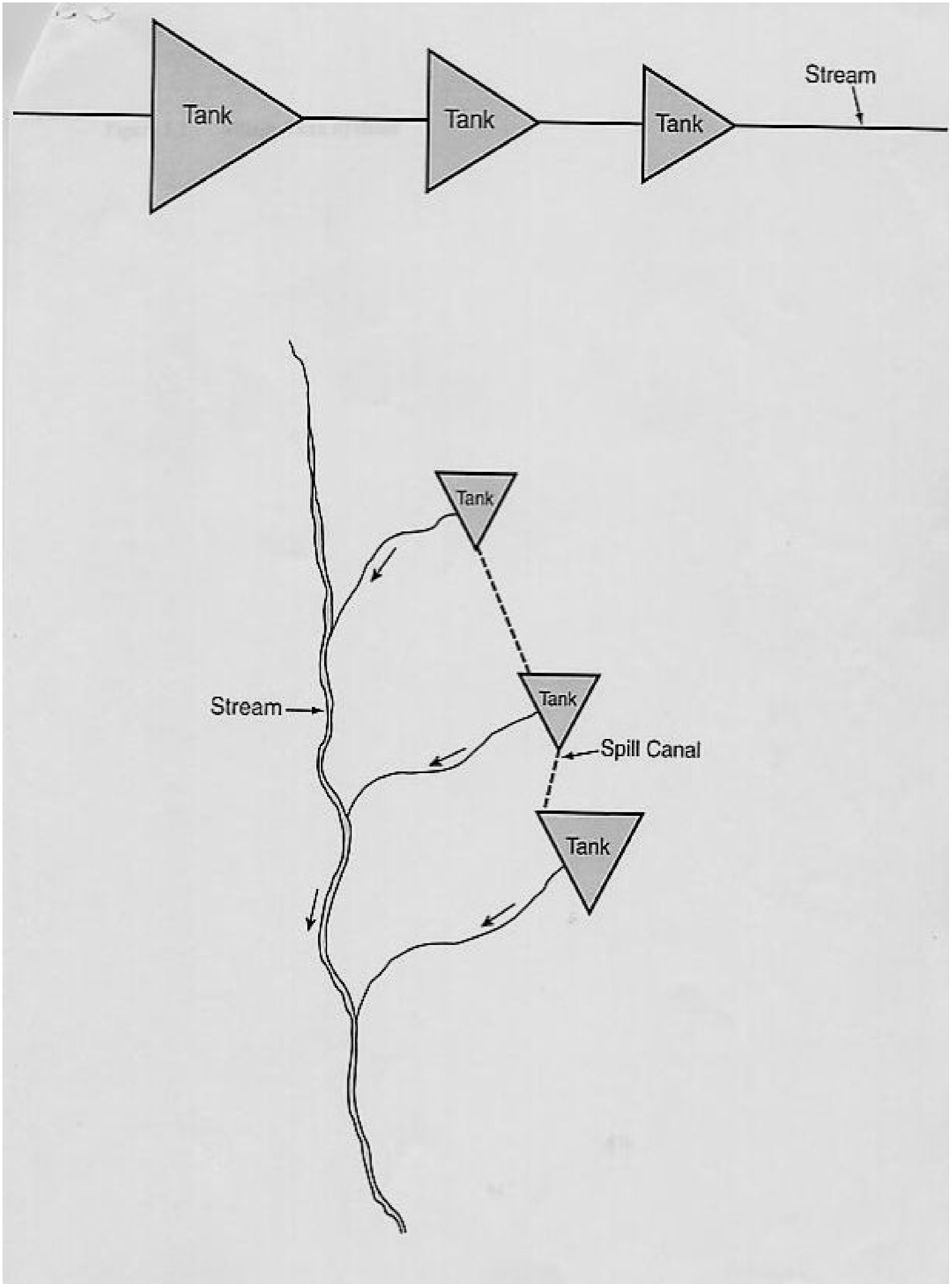
As the average annual rainfall of the Dry Zone is about 1,500 mm (e.g., Anuradhapura has 56 inches), of which over 70 per cent falls during the northeast monsoon season (October-March), it follows that the irrigation system that evolved in the Dry Zone maximised the use of rainfall.

Most village tanks are shallow and have a widespread area of water compared with the area irrigated and are replenished by local minor streams that are not perennial. As the capacity of the tanks is small, water cannot be stored for the next cultivation season, so cultivation under these tanks is usually limited to the Maha season. According to traditional cultivation practices, when the storage in the tank is insufficient to cultivate the full command area, only a part is cultivated at the head-end of the canal, but every farmer gets a piece of land to cultivate in proportion to his land holding.

Careful observation of village tanks shows that most are connected in series or by parallel links. Excess water from one tank can be sent to an adjoining tank with this arrangement as shown in Figure 5.1 During a cultivation season, drainage water from the cultivated area under a tank is stored in the tank below. This arrangement facilitates the re-use of drainage water. During the rainy season, when a tank in the upper reach is full, excess water (or spill water) is sent to lower tanks. A number of tanks connected in parallel are shown in Figure 5.1. With this arrangement, when a tank is filled, excess inflow to the tank could be sent to an adjoining tank through a canal. This can be considered as a small-scale transbasin diversion, as excess water of one stream is diverted to the adjacent stream. By combining these two systems a very effective small tank system is formed, where a high percentage of rainfall is stored for cultivation and return flows from the cultivation areas are used a number of times.

Even small tanks in major irrigation schemes functioned in a similar way so as to increase the re-use of water. Therefore, it is suggested in planning the rehabilitation and/or modernisation of village tanks these tanks and their links should be considered as systems instead of individual tanks. This will be further discussed below.

Figure 5.1: Village Tank Systems



5.8.1 Walagambahuwa Model and Its Application

The Walagambahuwa Village tank settlement is a typical example of tank based agriculture in the Dry Zone. Its development was undertaken jointly by the Department of Agriculture and IDRC Canada under a research program started in 1977. The objective was to develop a new cropping system for small farmers. It was found that, by using dry tillage, dry seeding, short duration varieties and a greater dependence upon Maha season rainfall, a rice crop could be brought to maturity with minimum dependence on the tank, and sufficient water could be saved for a second non-rice crop during the Yala season. In the early years this was considered as a success story. Project results are given in Tables 5.2 and 5.3.

Subsequently, several irrigation projects (e.g., VIRP and TIMP) were designed and implemented on the basis of the 'Walagambahuwa Model' as discussed in Chapter 4. The economic findings of Table 5.2 showed that, with the Walagambahuwa approach, rehabilitation of village and medium sized reservoirs would be economically attractive. However, subsequent studies have revealed that farmers in Walagambahuwa returned to traditional practices after a few years, mainly because Maha rains did not come in time as expected. In their study, Panabokke and Balasuriya (1988) stated:

"At Walagambahuwa, a typical northern Dry Zone (DL1) tank village, owing to water scarcity, a successful rice crop was obtained only once in four or five years. In this village the Department of Agriculture (DOA) undertook a cropping systems research program from 1976-81, with the objectives of increasing water use efficiency and land use intensity. Upasena (1986), reporting on these findings, stated that with dry tillage and dry seeding prior to the main Maha rains (i.e., in September or early October, rather than the customary sowing in November to December**).** With a short term duration rice variety (3 month), sufficient water could be saved in the tank for raising a second low water consumption non-rice crop such as a pulse in Yala season. However, extending these findings to other areas through the Tank Irrigation Modernisation Project (TIMP) did not prove popular among farmers (Ministry of Lands 1983, Abeysekera 1985, 1986). The main reasons were high cost of dry tillage using tractors, heavy weed infestation, high cost of weed control, and uneven plant stands due to erratic early seasonal rains. In summary, the high cost and risks were unacceptable to small farmers" (p 44).

Abeysekera (1986) concluded that agricultural innovations including dry sowing, which advance the sowing time using short season varieties and saving water from Maha to enable a

Yala crop, do not produce higher returns than those which follow the conventional practice of planting a long season variety of paddy in late Maha (also see Abeysekera 1988).

Murray-Rust and P. S. Rao (1987) stated that farmers prefer to ensure one good wet season rice crop, and use irrigation water for land preparation and long term (4.0-4.5 month) rice varieties.

Table 5.2: Reported Differences brought about by the New Technology at Walagambahuwa

Traditional (Agricultural Practices)	New Technology
1. Rice crop once in 5 or 6 years	1. Rice crop every year
2. No secondary crop	2. (i) Second rice crop every average year (ii) Second pulse crop every poor year
3. Rice production per acre per year – 20-25 bu (1,020-1,287 kgs/ha)	3. Rice production per acre per year – 70-80 bu (3,605-4,124 kgs/ha)
4. Risks involved high, no or very little investment in terms of cash inputs	4. Risks involved minimum, potential for investment in the rice crop

Source: Cropping Systems Project – Walagambahuwa, Department of Agriculture, Peradeniya, March 1988.

Table 5.3: Cropping Patterns Followed by Farmers

Year	Cropping Pattern	Annual Precipitation
Before 1976	Traditional pattern rice-fallow	-
1976/77	Rice-Pulse	817 mm
1977/78	Rice-Rice-Vegetable	1,036 mm
1978/79	Rice-Rice	925 mm
1979/80	Rice-Rice	742 mm

Source: Cropping Systems Project – Walagambahuwa, Department of Agriculture, Peradeniya, March 1988.

Using traditional agricultural practices, rice cultivation usually starts in mid or late December, about one month before Maha rains stop. When farmers start cultivation late in Maha, the amount of tank storage is known and they can decide on the areas that can be cultivated given the storage volume in the tank.

In review, the available evidence suggests that traditional practices are the most economical in the long run in risky rainfall environments. It is suggested here that future VIRP projects should only base project appraisals on this model if it can be shown that rainfall is reliable, and risks in using the new practices are low.

Additionally, scientists have consistently found a high positive correlation between the amount of solar radiation received by the rice plant during last 45 days before harvest and grain yield (Figure 5.2). Solar radiation is quite low during the Maha season, mostly because of the cloud cover during this period. The lowest value for solar radiation occurs during December while the highest values occur in February and March. Therefore late cultivation can gain the advantage of high solar radiation which is lacking with early cultivation and short-term varieties.

5.9 VIRPs and Their Performance

There are nearly 20,000 village (minor) irrigation schemes in the country. Assuming a project life of 25 years for a scheme, nearly 800 schemes must be rehabilitated annually to keep the minor irrigation schemes in good operational condition.

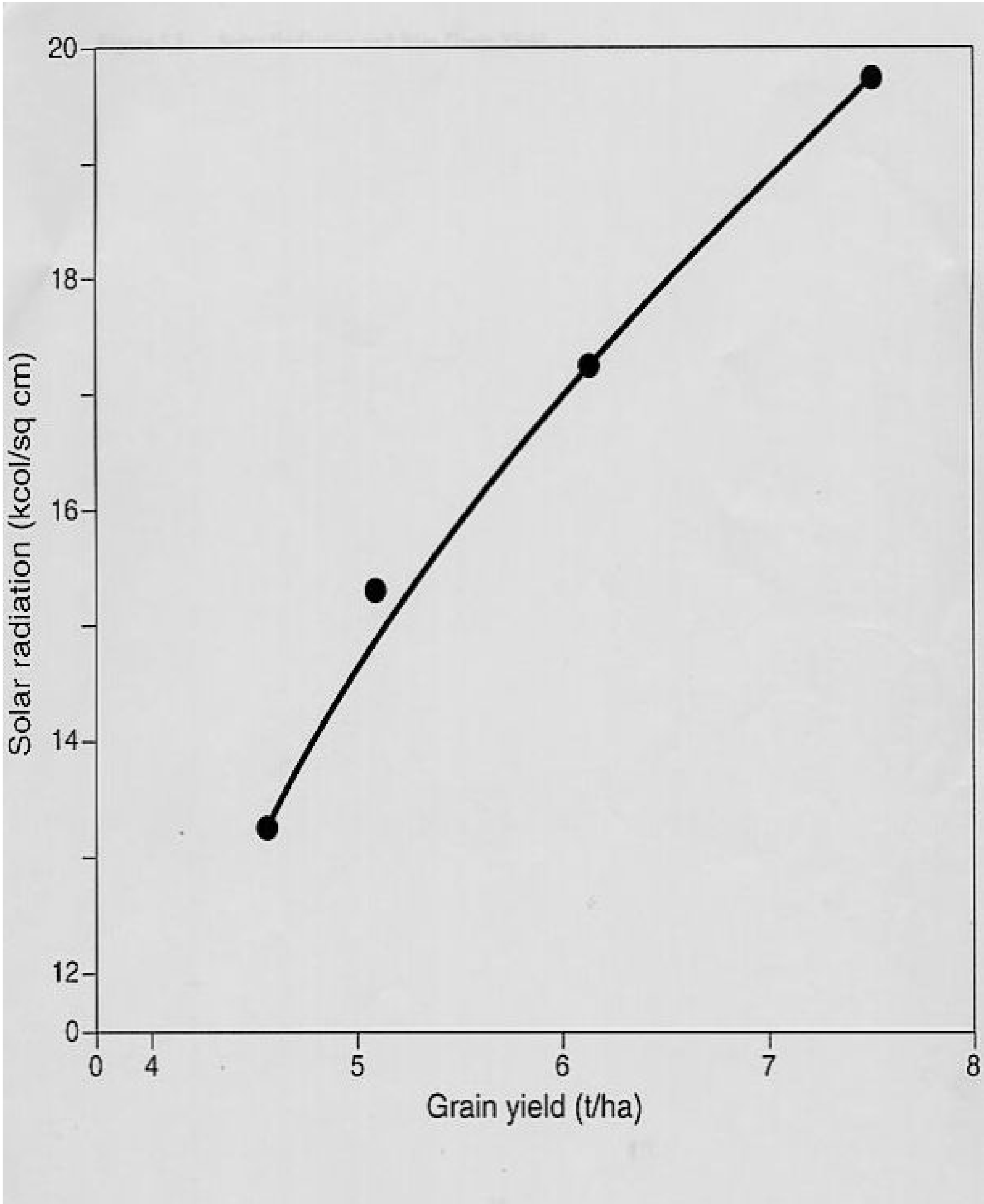
The Government of Sri Lanka gives the rehabilitation of minor irrigation schemes a high priority for agricultural development as the area under these projects accounts for 34 per cent of the total area under irrigation. The Government channels funds through District Development Councils, in addition to the rehabilitation projects undertaken by the Irrigation Department.

In 1981, the World Bank promoted a Village Irrigation Rehabilitation Program (VIRP) to benefit 1,200 village works covering 31,500 ha at a cost of Rs.180 million targeted for completion in 1985. The project was extended to 1992 owing to interruptions of work by civil strife. Herath et. al. (1989) reported highly variable benefit/cost ratios of rehabilitating most tanks and some were negative. They also indicated that most of the tanks rehabilitated did not conform to the selection criteria laid down for such tanks.

One of the factors found to be relevant was average farm size. Herath et. al. concluded "lowland farms under command area were found to be very small in size. In many cases they were less than 0.5 acres. Therefore it is evident that these lowland farms cannot give substantial support to family income even under best conditions and they tend to find other lands outside the command area".

Under these circumstances it is clear that family income cannot be increased substantially through the VIRP. A new development model, which considers highland cultivation under rainfed conditions along with lowland cultivation of paddy, should be considered. As

Figure 5.2: Solar Radiation and Rice Grain Yield



pointed out earlier, it would be necessary to rehabilitate minor irrigation schemes at a rate of 800 per year to avoid deterioration of the total system through reduction of total cultivable land. At present rates this would require an investment of Rs.240 million annually. To maximise returns from this investment, including social benefits, a new approach along the line of the Weli Oya model, which considers all tanks in the system and traditional cultivation practices, should be developed. A research program is recommended along this line to develop one or more suitable location specific models.

Muthukandiya and Weli Oya Models

The Dry Zone has an undulating landscape with a ridge and a valley pattern. The northern dry zone has relatively low ridges and broad flat valleys, while the southern dry zone shows few broad valleys. The soils in the dry zone are differentiated into categories. The convex upper slopes have well drained reddish brown earths (Figure 5.3). The middle slopes have imperfectly drained reddish brown earths (RBEs) and concave bottomlands are composed of poorly drained low humic gley soils (LHGs) and varying areas of alluvial soils together with saline/alkaline soils.

The Muthukandiya and Weli Oya models have been tried out to overcome the limitations of the traditional dry zone farming approaches, i.e., minor tank and *chena* models, and to stabilise shifting or *chena* cultivation under rainfed conditions. They try to match cropping patterns with dry zone landscapes and also to maximise storage of rainfall in storage reservoirs and as ground water.

The Muthukandiya Model

In this scheme a farmer is given 2.5 hectares of land and a pond about 15 ft deep is constructed on his holding (Figure 5.4). The land is developed in such a way that all storm water after rainfall is channeled to the pond. Soil conservation bunds are also formed to prevent soil erosion and to increase the infiltration rate. By this method, ground water recharge is maximised during the rainy season. Water from the pond (ground water) is used during the dry season.

Figure 5.3: Profile of a Typical Dry Zone Landscape

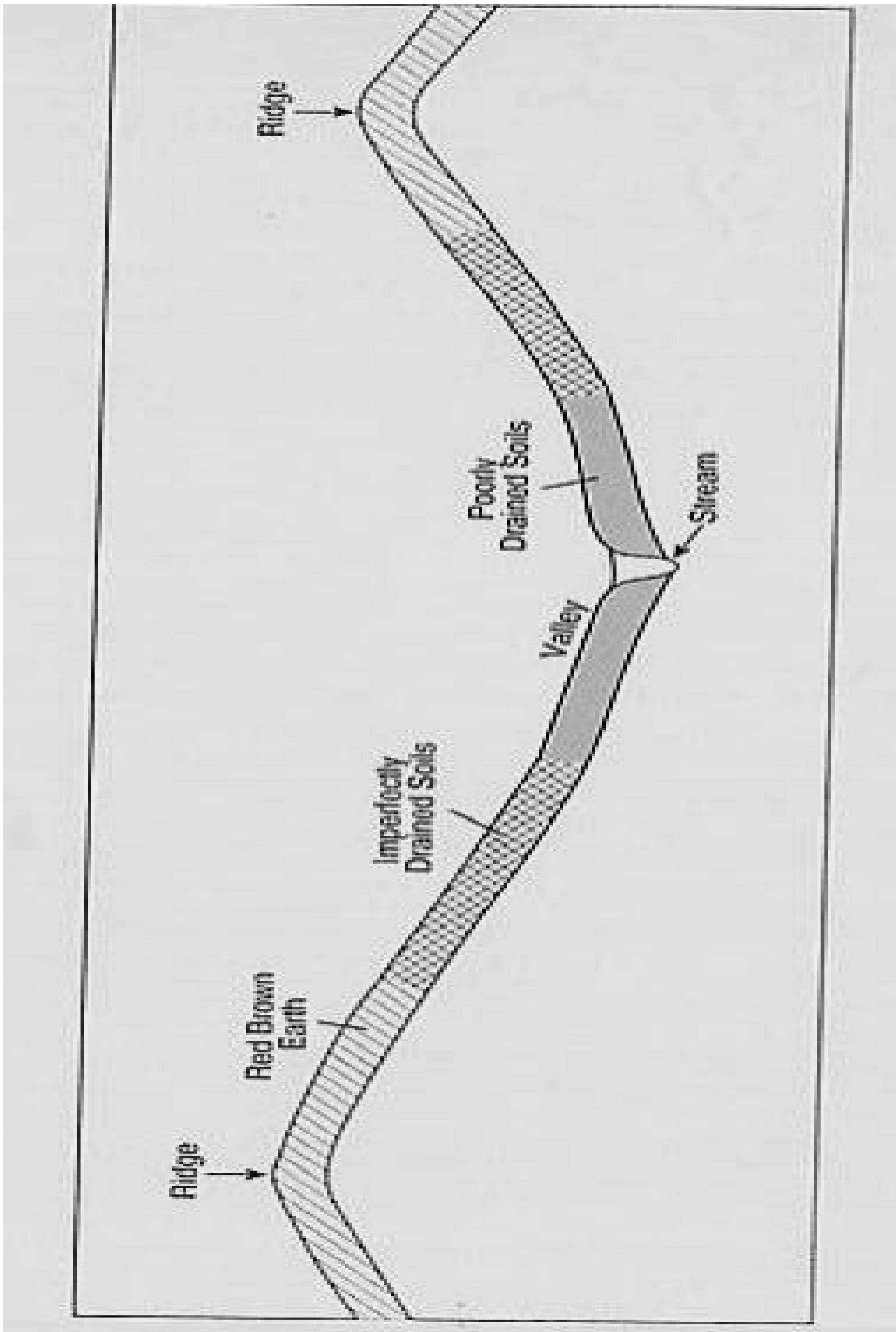
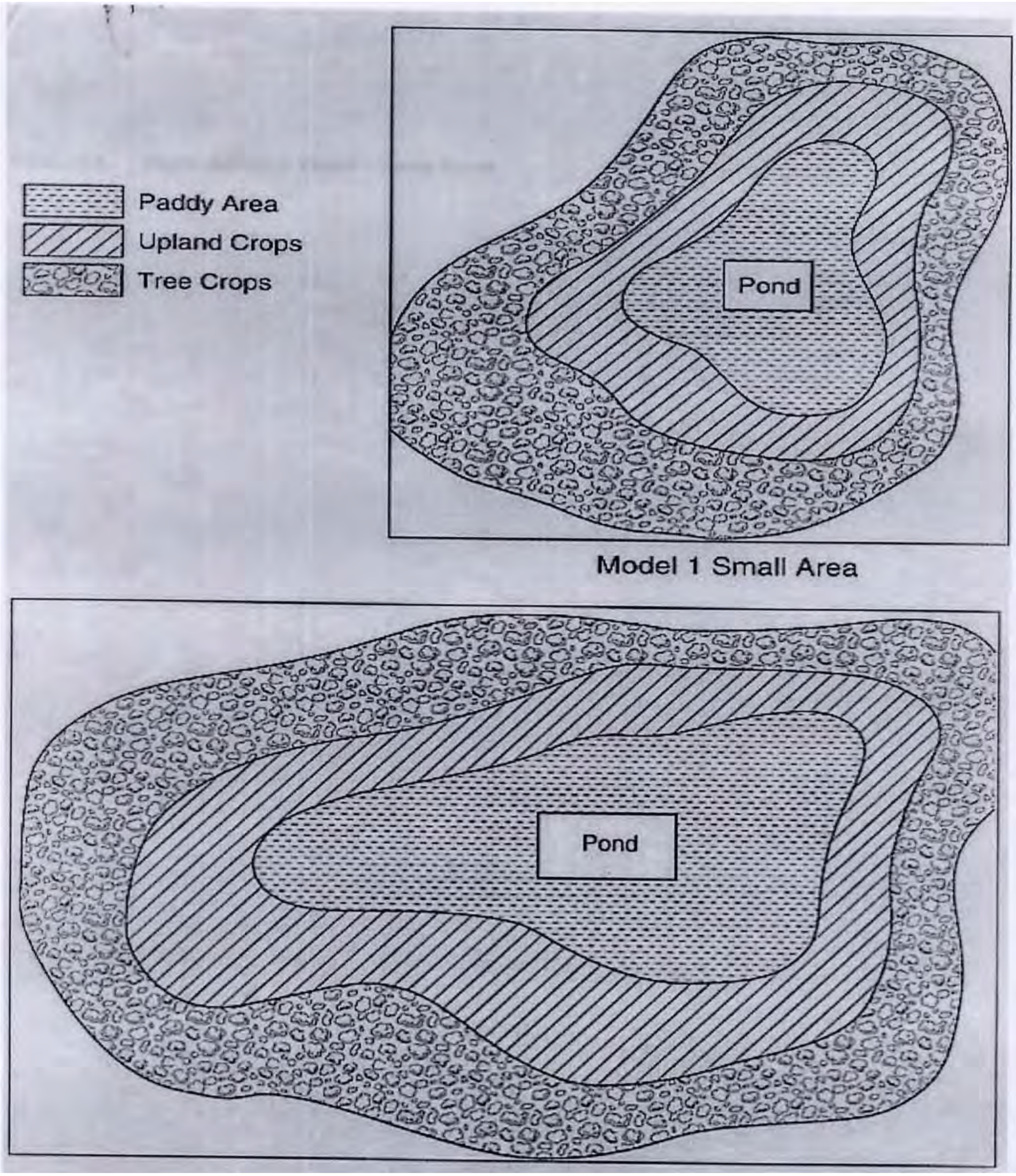
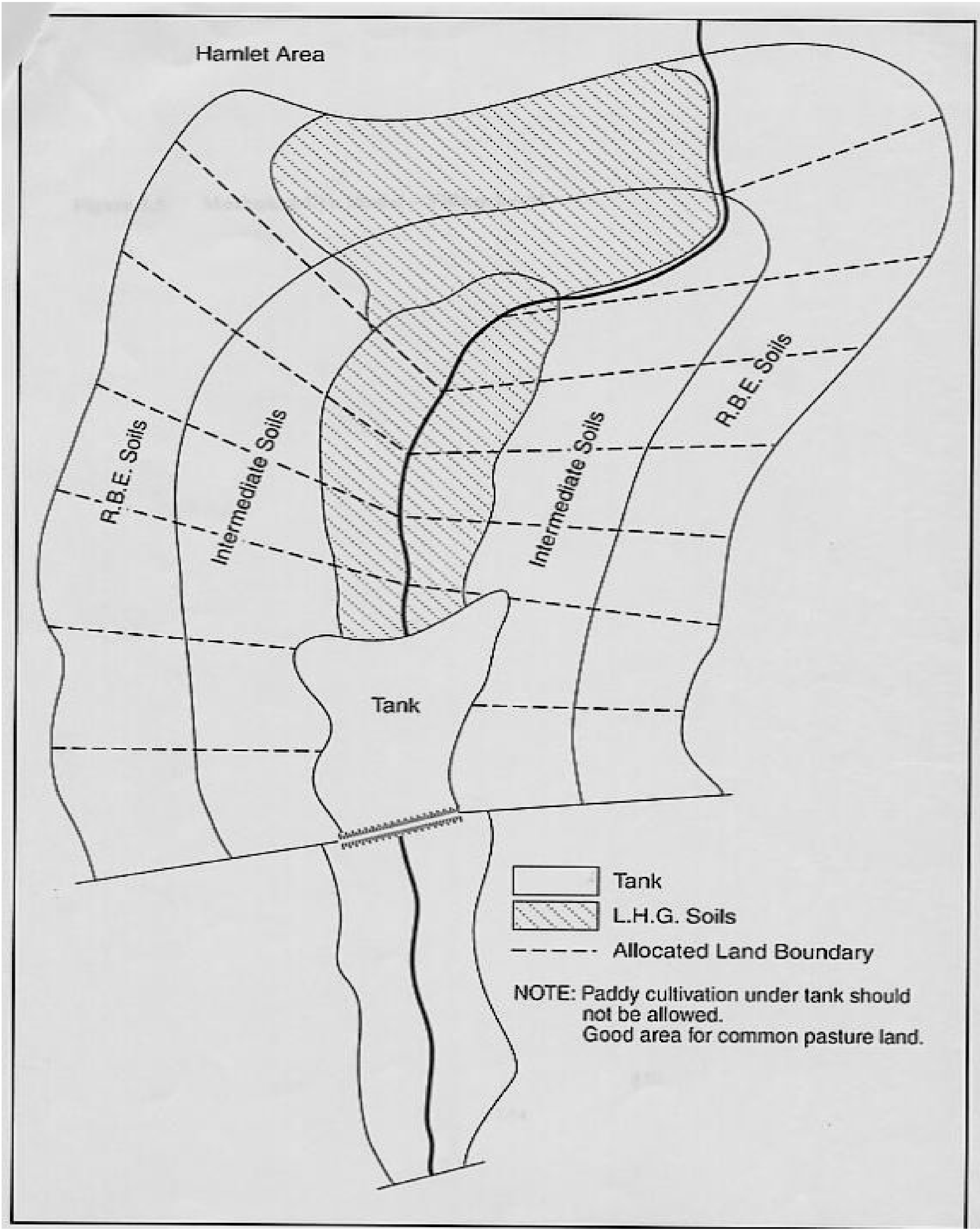


Figure 5.4: Muthukandiya Model – Farm Level



Model 2 Large Area

Figure 5.5: Muthukandiya Model – Village Level



With a little modification, such a village tank can be developed into a similar system (see Figure 5.5) for village tanks that can be used to maintain a high ground water table as well as to store surface runoff during rains. Usually LHG soils are available close to the stream (Figure 5.5). Adjoining them would be moderately drained LHGs and then RBE soils. When a bund is constructed across the stream, a reservoir is formed which would save rainfall runoff. If a block of land is selected so as to contain LHG, moderately drained LHG and RBE soils, crops could be selected to match the soil types, e.g., paddy for LHG soils, annual crops such as chillie, and pulses, or vegetables such as citrus, mango or cashew which can withstand prolonged dry periods for RBE soils. The tank would ensure a high water table in the area and the down stream area could be used as common pasture. This model, called the Muthukandiya model (Figure 5.5), would give year around income, as different crops could be cultivated to match soil types. Moreover, it would encourage efficient water use, as cultivation under the tank is not allowed. Land could be divided as shown in Figure 5.5, so that each farmer would have access to water in the tank. The cropping patterns for both systems should be developed to suit the typical dry zone landscape (see Figure 5.3).

Weli Oya model

Figure 5.6 shows a typical example of the Weli Oya model. This is similar to the Muthukandiya model described above except that paddy cultivation is allowed under the tank with the stored water in the tank. Here also each farmer is allotted soils suitable for cultivation of paddy, upland crops and perennial crops. This facilitates a suitable cultivation pattern even during a dry year. This model can be improved by combining two tanks, as shown in Figure 5.7. Two tanks will ensure a high water table between them. A farmer can have a well on his land to get water for cultivation of upland crops and the upper tank should ensure a high water table. Farmers can then cultivate non-rice crops using ground water. Paddy cultivation can be allowed under the lower tanks during Maha season.

Advantages of the Weli Oya model include:

- each farmer would have suitable land for rice cultivation, and home garden crops and each family gets about 2.5 hectares which is sufficient to generate a good income,
- it matches with traditional *chena* cultivation,

- soil conservation methods can be practiced which will also increase infiltration to ground water, and
- the farmer is gainfully employed all year round instead of only in the Maha cultivation season. As current VIRP projects using the Walagambahuwa model do not generate sufficient income, variations and combinations of this model may give better results and they will also improve cost recovery.

Studying the literature on VIRP projects the following shortcomings were identified.

- average farm size under the command area is typically very small, so family income will not vary or increase significantly through rehabilitation,
- cultivation development outside command areas was not considered under this project,
- identified tanks were considered as individual units and not as a part of a unified tank system,
- it was assumed that farmers would adopt agricultural innovations originating in the Walagambahuwa Project,
- based on the above assumption, the ratio of tank storage to command area was kept low, and
- farmers were not consulted in the process of identifying necessary improvements.

Suggestions to improve VIRP project benefits include:

- consider an identified tank as a unit of a small tank system and its contribution in storing rainfall as a part of the tank system,
- explore the possibility of allocating lands adjacent to the command area for cultivation of other crops as in the Weli Oya Model,
- maintain a high storage to command area ratio (say 5 cu ft/acre) to avoid water shortage at the end of the season,
- assume that farmers will not change traditional cultivation practices as the latter have been proven to give greater benefits, unless rainfall reliability is demonstrated,
- increase farmer participation in the planning phase, and
- develop farmer organisations to improve irrigation water management.

Figure 5.6: Weli Oya Model

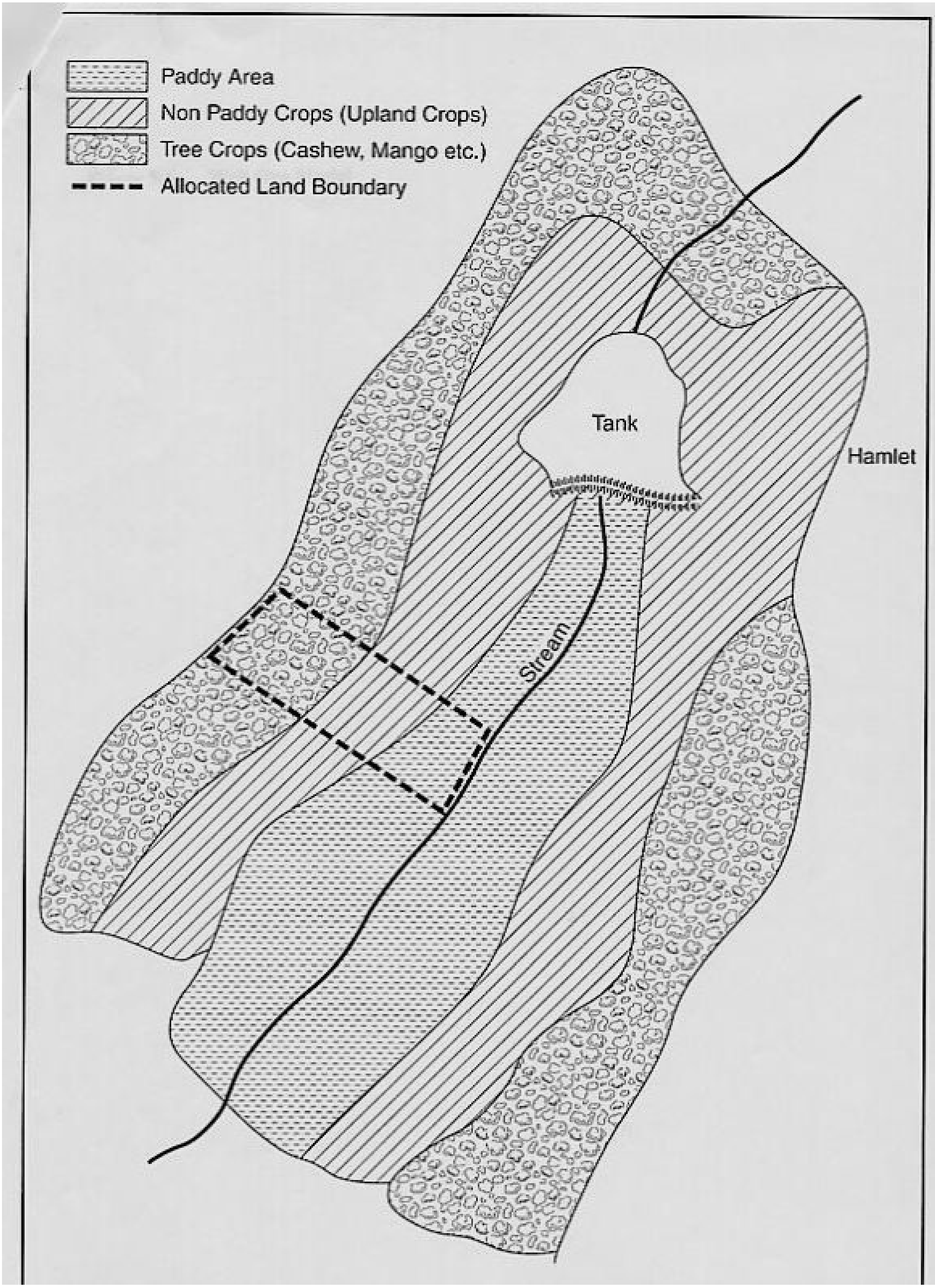
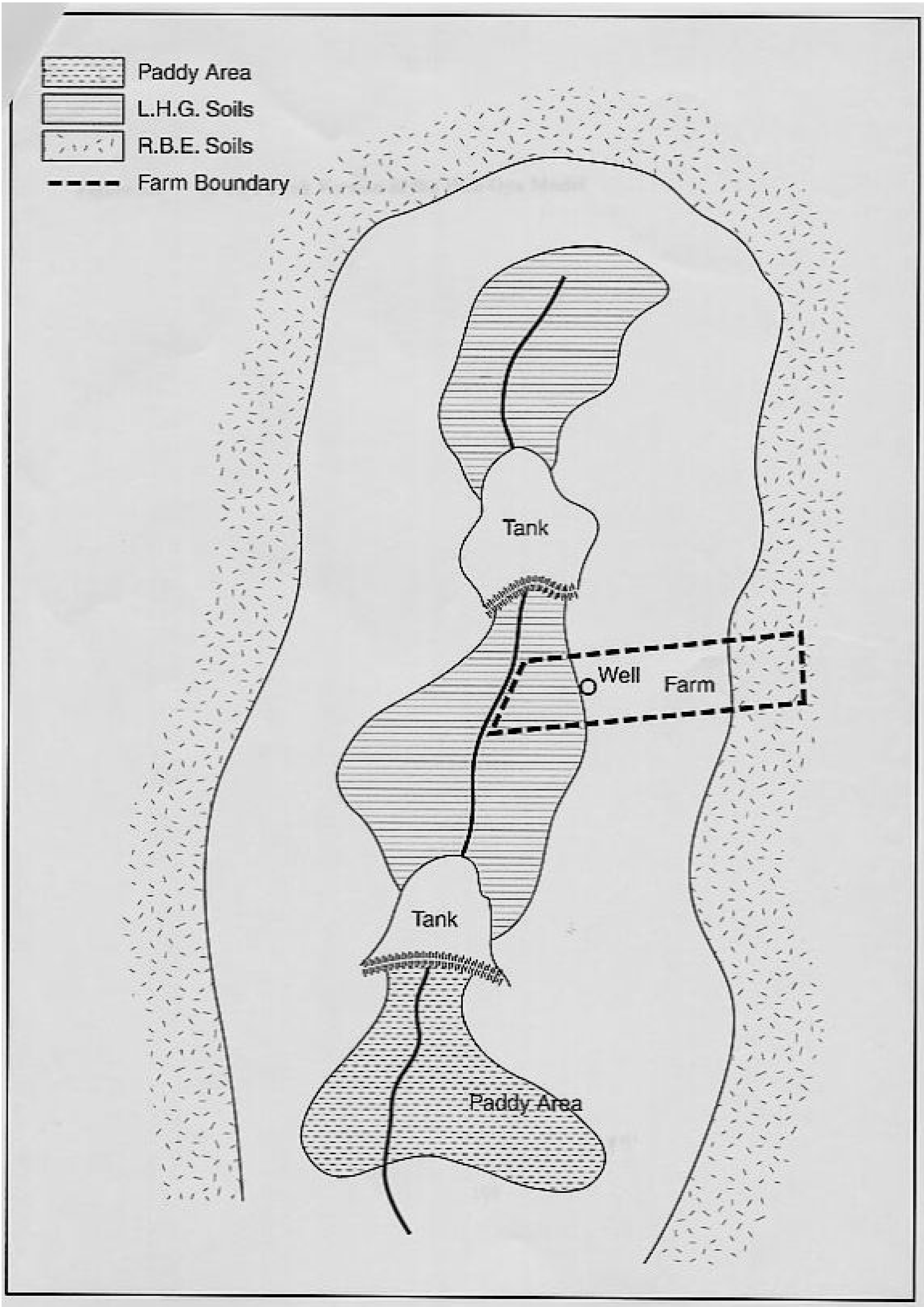


Figure 5.7: A Two Tank Version of the Weli Oya Model



5.10 Ground Water Based Irrigation Systems

5.10.1 Incidence of Ground Water

In general, ground water resources in Sri Lanka are widespread owing to the abundant annual rainfall throughout the island. However, the quantity and the quality of ground water and its development for irrigation depend mainly on the thickness, extent and localities of aquifers and their hydrological characteristics.

In many cases of practical interest, ground water occurs in a water bearing layer of relatively high permeability (e.g., a layer of sand) confined between two layers of very low permeability e.g., clay layers (see Figure 5.8). The soil layer transmitting water is called a confined aquifer when its pores are filled with water and when it is bounded on its two sides by completely impermeable layers. When one or both of the layers above or below the soil layer are not completely impermeable, but their permeability is very low compared with permeability of the layer itself, this layer is then said to be a semi-confined aquifer, for example, the Vanathavillu aquifer north of Puttalam.

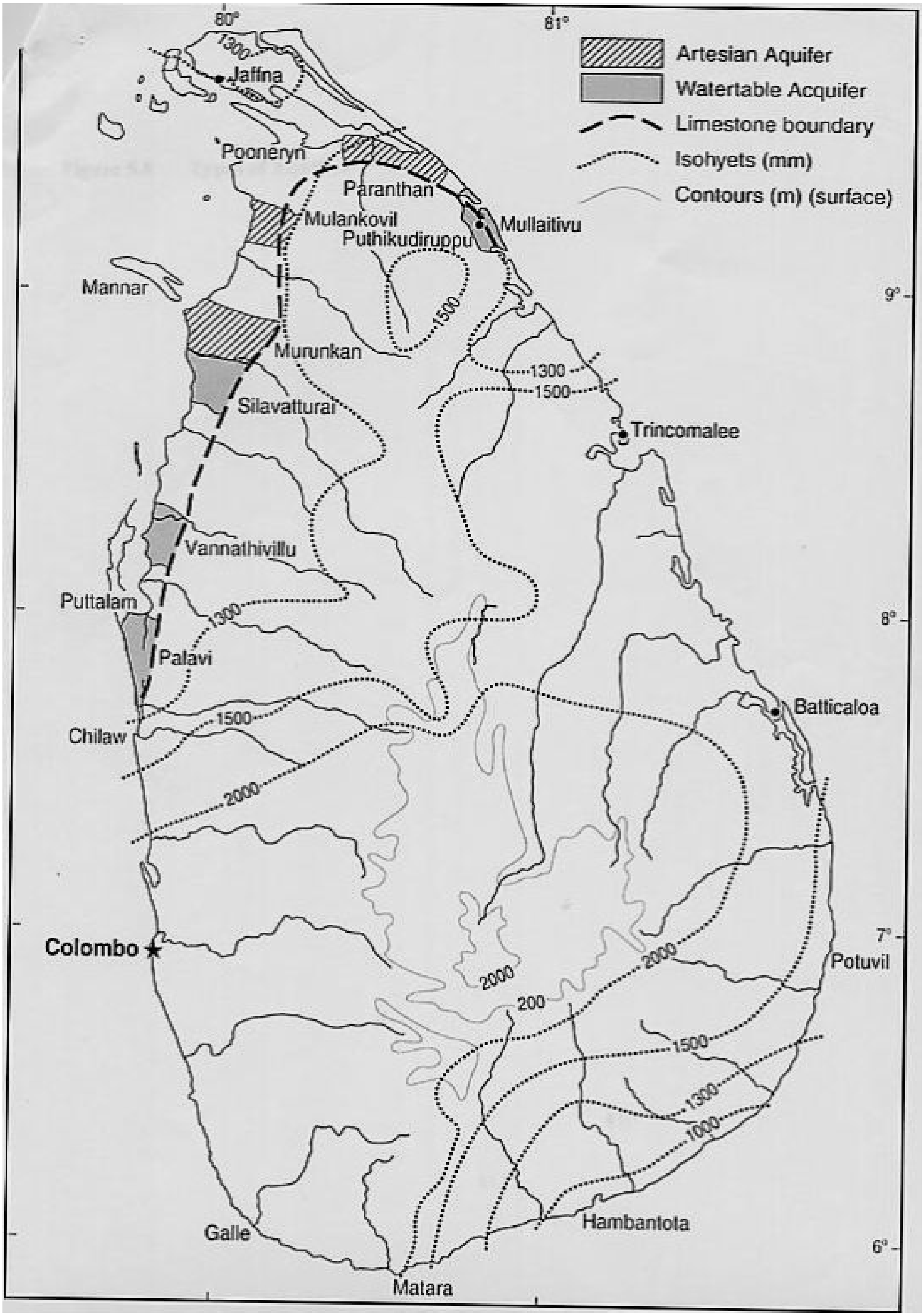
When a cross section of a soil profile is considered (Figure 5.8) there is a level (ground water table line) below which all pore space is filled with water and the soil is saturated with water. This water-bearing layer usually rests on an impervious layer and this type of aquifer is called unconfined.

It can be said that all shallow wells in Sri Lanka tap unconfined aquifers. When water collected in a location is bounded by an impervious layer 'X' it is called a perched aquifer. Deep wells constructed in metamorphic rocks usually draw water from this type of aquifer.

5.10.2 Geology in Relation to Ground Water

Crystalline rocks cover nearly 90 per cent of the land area of the island, irregularly covered by an overburden of decomposed rocks and alluvial deposits, which seldom exceed 15 metres. Underlying the water bearing soil cover of generally mixed gravel, sands, silts and clays, the basement rock strata of this area show deep irregularly weathered zones with open joints, fissuring etc., often poorly interconnected. Thus deep ground water encountered in this part of the island has insufficient yield potential for successful development of large-scale agriculture. The other type of sub-surface in the Dry Zone is shallow ground water. The availability of such reserves has not been adequately studied and thus the prospects for

Figure 5.8: Types of Aquifers



tapping this water for irrigation in the Dry Zone are uncertain. In his survey of available evidence, Madduma Bandara (1974, 1977) suggests the strong probability of a high water table below tanks which "provides a good starting point to explore the possibility of using (shallow) sub-surface water for irrigation in the Dry Zone". Large scale use would require (1) an adequate supply, (2) suitable lifting techniques (3) a lift irrigation program to suit the existing socio-economic organisation (4) substantial economic returns, and (5) no serious unwelcome ecological or other consequences with extraction. In the Wet Zone, as a result of evenly distributed rainfall, the overburden soil often retains sufficient water throughout the year for domestic consumption and small-scale agriculture.

The remaining 10 per cent of the island consist of deep sedimentary formations in the north and northwestern coastal belt (Figure 5.9), where the Miocene limestone formations provide major karst aquifers. Development of ground water resources for agriculture in this area is possible.

Areas identified for development include:

Vanathavillu Basin

The area underlain by the Vanathavillu limestone aquifer measures nearly 55 sq km (Figure 5.10). It has been estimated that approximately 24.6 million cubic metres of water flow through the aquifer. An area of nearly 1620 hectares along the eastern boundary directly recharges this aquifer with 6.2 million cubic metres. It is possible to increase this recharge rate by the development of a belt along the eastern boundary of the aquifer using the water of Kala Oya from which the flow has increased considerably as a result of return flows from irrigation areas of System H.

This needs further investigation, but it is possible to increase the recharge rate so that more land than planned could be brought under cultivation.

The development of this area should receive high priority for the following reasons:

- development costs per hectare are low compared to a new irrigation scheme,
- there is a lower rainfall during the Maha season than in other dry zone areas. Therefore, year round cultivation of upland crops is possible since crop damage due to heavy rains is negligible,

Figure 5.9: Areas Under Ground Water Investigations

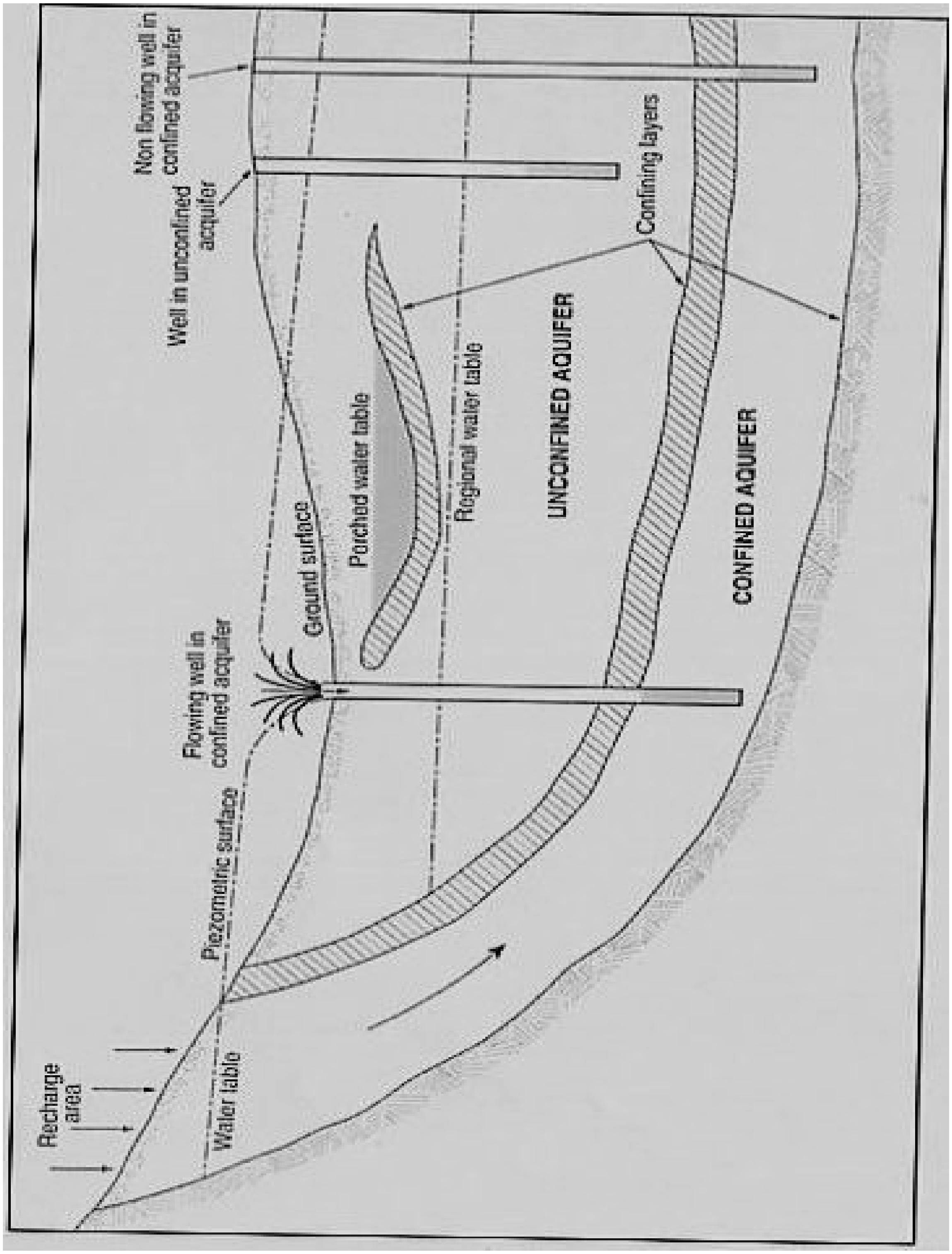
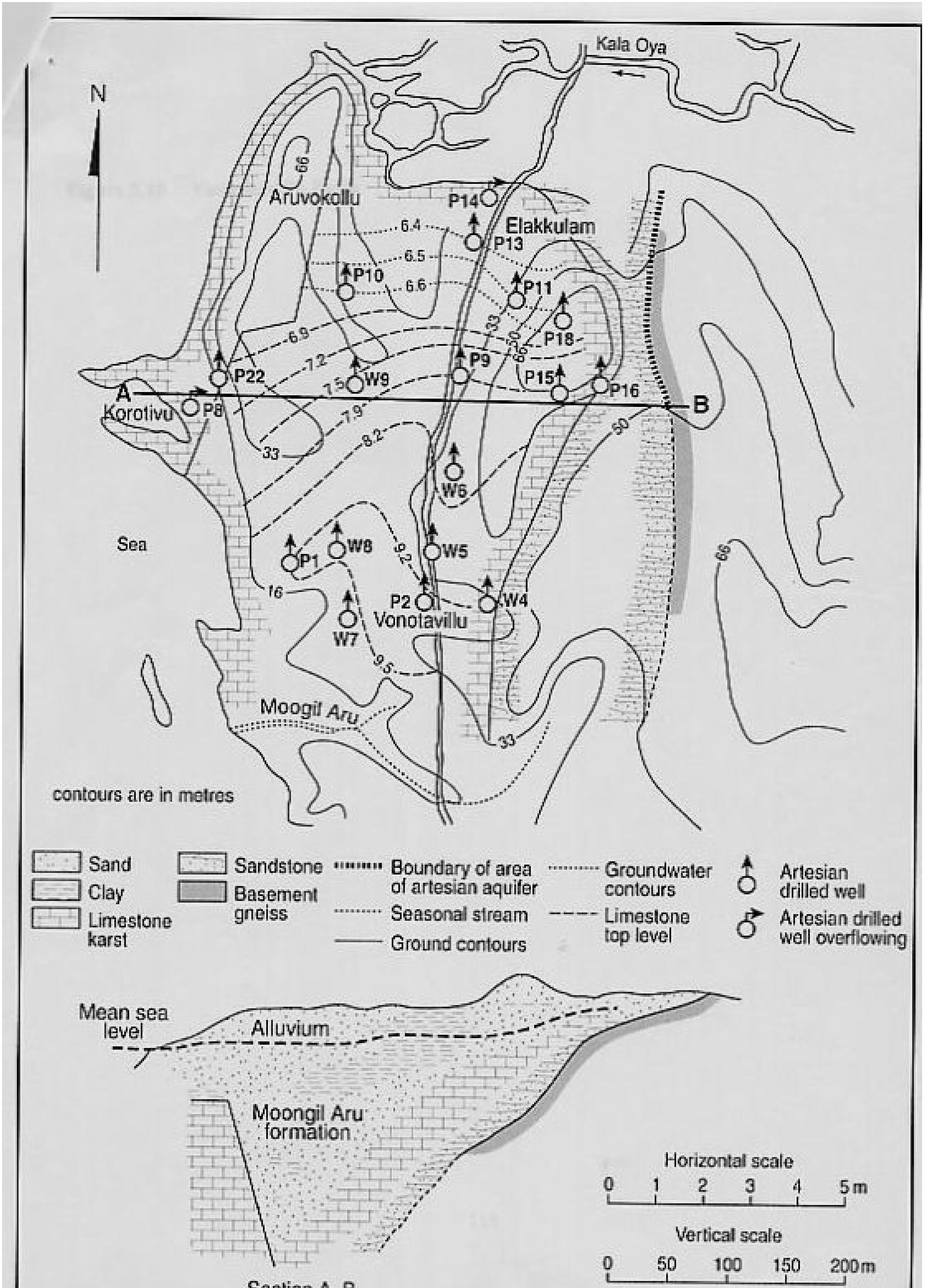


Figure 5.10: Vanathavillu Basin



- people of this area are used to growing alternative (to paddy) crops such as chillie, onions and potatoes, and they will not grow rice under irrigation. Hence net returns to them and to the economy would be high,
- the high permeability of the soils is good for cultivation of horticultural crops such as onions. Also, day and night temperature differences are favourable for potatoes,
- this is a comparatively undeveloped area with almost flat lands, and
- there are other advantages associated with ground water development in this area.

Murunkan-Silavaturai Basin

This basin near Mannar (Figure 5.11) covers an area of 310 sq km. It is a water table aquifer from which free water is available in the region of 5 to 10 metres depth. The quality of the water is also very high. The total recharge of the basin is expected to be around 120 million cubic metres (80,000 acre feet) by direct precipitation and runoff from basement areas. Pump tests have indicated safe yields of around 14.1 per second, so this area should also be given high priority.

Puttalam-Palavi Area

This area covers approximately 80 sq km. There are a few flowing wells near the edge of Puttalam lagoon at Palavi and within Puttalam town. As this aquifer is in a pressurised condition, pumping costs are much lower than in other basins. As the potential development area is large, a feasibility study is needed and recommended to formulate a development plan. This also should be given high priority since it has the advantages mentioned under Vanathavillu basin.

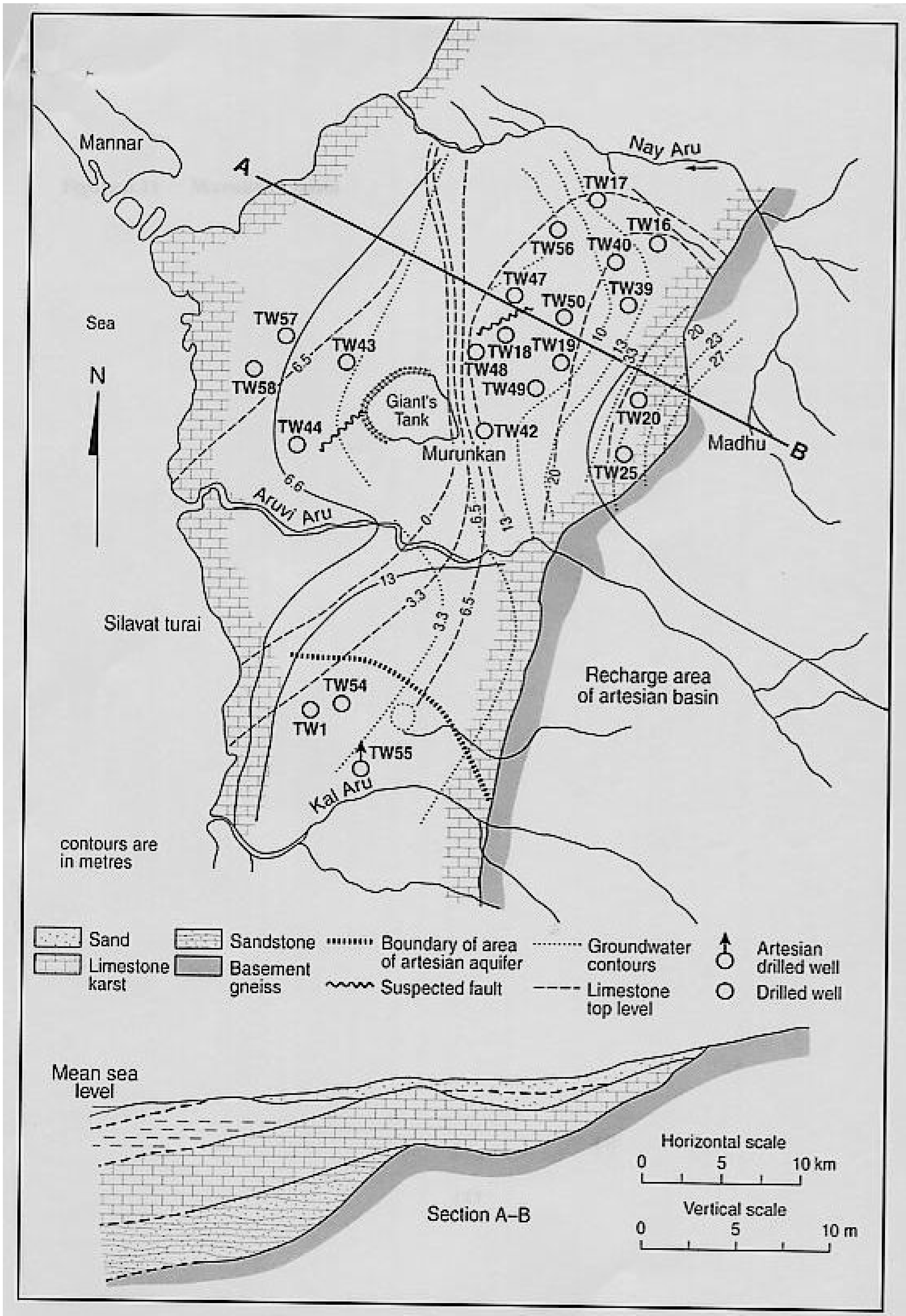
5.10.3 Other Areas Planned for Development

Potential ground water basins, namely Mulankavilu, Paranthan and Puthukudiyiruppu within the Mannar-Mullativu limestone belt have been identified. These areas should be further investigated in a feasibility study program to assess their optimum development potentials.

Jaffna Peninsula

The whole Jaffna Peninsula and its islands are composed of Miocene karst limestone and the sandstones assume depths in all of around 243.8 metres. Recharge of these aquifers is

Figure 5.11: Murunkan Basin



from direct rainfall. As this area is already developed to a maximum, it may not be possible to develop additional areas there.

5.10.4 Conjunctive Use of Ground Water

Conjunctive use of ground water in areas served by surface canals is possible as a supplement to canal irrigation or for water table control with irrigation as a secondary benefit (e.g., for crops like sugar cane).

In irrigated areas, recharge from canal irrigation will ensure availability of ground water. For example, losses from the canal system are around 30 per cent. The application efficiency for upland crops would be around 40 per cent. Percolation losses from paddy fields are nearly 30 per cent of their daily requirements. Therefore, average gross efficiency of a project area would be around 40 to 45 per cent. The major part of these losses will appear as ground water and drainage flows. These losses can be re-used for irrigation, either by pumping from shallow wells or from drainage canals.

The total amount of reusable water is roughly 40 per cent of the losses or 25 per cent of the irrigation issues as soil cover is shallow and the bedrock is impermeable. But there are two practical problems:

- if the water requirement from ground water is distributed equally among all farmers, then each farmer will require a shallow well and pump to meet his needs (say 25 per cent of his total requirements),
- if the use of ground water is limited to certain areas it would be unpopular with farmers due to pumping costs and their costs would have to be absorbed by the Government. Hence development of large wells would be necessary. But this is not possible, as the rate of recharge is low since the wells are shallow and have low permeability. Pumping from drainage canals is one possible way of overcoming the above problems.

The use of ground water is possible in existing irrigation areas in the following situations:

- to solve tail end problems in field canals,
- to solve water shortages (usually limited to 2-3 weeks at the end of the cultivation period),
- when it is necessary to lower the ground water table for cultivation of alternative (non-rice) crops (e.g. sugar cane),
- pumping from drainage streams to irrigate large areas (say 20-100 hectares), and
- to serve highland areas.

The expansion of the Mahaweli canal system has changed the groundwater picture in the N.W. Province and the Dry Zone. However, these changes are, with few exceptions, restricted to the project (irrigation) areas and the development of groundwater use would be limited to the cases given above.

Future projects can be designed to increase overall efficiency by using ground water conjunctively with irrigation water when benefits from the additional areas cultivated offset the pumping costs involved. Canal systems can even be designed to maintain a ground water table at a suitable level so that farmers can pump water according to their requirements. As pumping costs are involved, farmers will not pump more water than they require. They may even choose to use high efficiency irrigation methods like micro (drip) irrigation to reduce pumping costs. Such systems are highly efficient and are discussed later in this study.

5.10.5 Other Alternatives

Lift irrigation from canals can utilize a belt of land along main canals or transbasin canals could be developed if it is planned at the start of the project. Rajangana lift irrigation project funded by the World Bank (IBRD, 1985) has been considered as a failure. In existing projects, this type of development can be reconsidered when present water duties are lowered through improved water management practices that would economise on water. There would then be additional water available in the system to develop new lands through lift irrigation.

Sub-surface reservoirs: The Dry Zone of the island has a large number of shallow tanks. The water losses through infiltration into the ground may be in order of about 5-10 per cent of the total storage. As rice is also cultivated under flood irrigation, seepage losses from paddy fields are about 20 per cent of the water requirements. During the monsoon rains, a part of surface runoff also infiltrates into the ground. Therefore the extent of ground water flow in the Dry Zone needs further study to ascertain its development potential. As subsurface reservoirs have distinct advantages a study along these lines would be worthwhile to identify potential areas suitable for subsurface reservoirs outside major irrigation projects.

5.11 Need for Adoption of New Design Concepts and Technologies in Major Irrigation Schemes

5.11.1 New Design Concepts

Before 1970, irrigation systems were designed for rice cultivation, which is primarily an aquatic crop that grows well under saturated conditions or with 3-5 cm of standing water. Hence, irrigation systems were designed to supply continuous irrigation water throughout the growing period. These systems did not have sufficient control structures or measuring devices to issue water according to the need of the crop nor of the soils. When shortages were experienced, a rotation among distributary canals was practiced.

When designs for Mahaweli areas were undertaken, it was assumed that upland crops would be cultivated on well-drained soils during Yala season. It was also decided to limit the size of a turnout area to 20 hectares in view of the proposed water distribution between farms. This method looks attractive on paper, but efficient distribution of water within turnout areas needs total cooperation from the farmers in the turnout, otherwise head end farmers get more than their fair share. It therefore became necessary to establish farmer organisations at turnout level for proper distribution of water. Such efforts have been made to organise farmer groups at turnout level (maximum 20 farmers) for the last 10 years without much success. An effective turnout, where water is distributed in the way envisaged at the planning stage, does not exist. Now it is proposed to organise farmers at distributary canal level (80-200 farmers), as turnout level organisations cannot function without the support of head end farmers of secondary canals.

Farmer organisations are now the most important factor for the smooth functioning of present irrigation systems. Equitable distribution of irrigation water and the maintenance of field canals will never be achieved without properly organised farmer groups. Farmers at the tail end of field canals never know whether or when they will get their due share, and therefore consider this system as very unreliable. If farmer organisations cannot be developed within the next five years, it will be necessary for irrigation system planners to consider irrigation systems, which can operate and function without farmer organisations.

5.11.2 Crop Diversification and High Reliability and Flexibility in the Irrigation System

Improvements in rice growing technologies and the development of new lands for irrigation during the last two decades have resulted in near self-sufficiency in rice production in Sri Lanka. Therefore, policies have shifted towards maximising the economic utilisation of land and water resources and income of farmers, particularly by growing non-rice crops in irrigated areas. It is therefore necessary to investigate the potential for improving the manageability and performance of irrigation systems to meet the specific demands of more diversified cropping in the dry season. In 1985, the Asian Development Bank requested the International Irrigation Management Institute (IIMI) to undertake a study to develop a practical technology for irrigation to achieve crop diversification. According to the project co-leaders, "A major factor constraining the farmers' ability to diversify their cropping pattern is the unreliability of supply at the farm level" (Panabokke and Balasuriya 1988).

Future projects should therefore be planned to achieve high reliability and to minimise those factors affecting reliability. Otherwise, farmers will not be motivated to grow non-rice crops, which are a high risk venture where cash and labour inputs can be three or four times those of rice. It is also necessary to have a flexible system, as crop water requirements and the response to water stress by different crops vary with the growth stage of the crop and climatic factors. Therefore, future irrigation systems should give farmers the flexibility to decide upon the time of irrigation, the quantity of water to use and the duration of irrigation. Such irrigation systems, which give the farmer full flexibility, are called "on-demand" systems. Examples of this are low pressure pipe systems, free level canal systems equipped with automatic downstream water level control gates, and lift pumps (or tube wells).

There are a number of constraints to diversification in existing irrigation projects, which have been designed for the irrigation of rice. These can be avoided either by making the system "on demand" or having farmer organisations share water within the command area of the field canals/distributary canals.

5.11.3 Automation of Canal Systems

Upland crops have very specific water requirements for optimal production, and both excesses and deficits in water delivery will affect yields. As a number of different crops are cultivated in a large irrigation project on different types of soils, irrigation water is required at

3variable intervals, mostly during the daytime. Farmers may also use different modes of on-farm water application methods. Surface methods, such as drip or sprinkler irrigation require different flow rates at different locations. Moreover, the farmer may want to cultivate according to his own crop calendar to benefit from high market demand or to avoid gluts. Thus, the farmer requires flexibility in water distribution in terms of frequency, rate and duration. The frequency of irrigation needs to be scheduled flexibly to prevent crop stress and to avoid interference with other activities like spraying for weed control.

The rate of water delivery determines the uniformity of distribution and efficient use of labour. Similarly, the duration or length of time that water is applied to a field needs to be adjusted to avoid over or under irrigation. The ideal mode of water delivery to match the above requirements is an "on-demand" system. The canal system, therefore, should be designed to function as an automated irrigation system.

5.11.4 Methods for Automation of Canal Systems

Free level canals can be automated by installation of hydraulically controlled gates, so that the canal system will behave in a fashion similar to one with a pressurised water piping system.

Control technologies (technologies designed to maintain water level and/or discharge in open canals as per given target) have been extensively used for surface irrigation in Mediterranean countries with success, in Morocco in particular. The modern development of control technologies implemented in this region started about 40 years ago. But in Asia, application of these modern technologies is rare. If modernisation of irrigation systems is carried out on an "on-demand" level for cultivation of upland crops, this technology can be used, as there are distinct advantages over centrally controlled irrigation systems. The cost of this type of system can be minimised by using upstream control gates from the main reservoir to feed balancing reservoirs, and downstream water level control gates to distribute and control waters from balancing reservoirs to the end of canals.

This hydraulic regulation offers a high degree of automation but without dependence on an external source of energy. Furthermore, it requires minimal staff training. But care must be taken in introducing these systems to Sri Lankan farmers. With the proposed irrigation systems, the farmer is given freedom to take as much water as he needs at any time, and also to select the crops he will cultivate. It is said that Sri Lankan farmers are inclined to grow rice when there is a liberal water supply in the dry season, even though alternative crops return greater net profits. Therefore, without volumetric billing, an "on-demand" system would be a failure, as farmers would most probably cultivate rice even on light soils.

Another aspect to which attention should be paid is the tampering of irrigation systems by farmers to avoid volumetric billing. With volumetric billing, a price can be placed on irrigation water to encourage farmers to adopt efficient on-farm systems like drip, sprinkler or furrows with precise land levelling, to increase application efficiency and reduce costs of irrigation. It will also motivate farmers to grow crops that give high returns or increase cropping intensity to maximise returns.

5.12 Future Project Development Scenarios with Alternative (non-rice) Crops

Most non-rice crops cannot be successfully grown when the water table is high. Rice is still considered the best crop in both wet and dry seasons under heavy soil conditions (LHG soils), although recently other crops for those soils have shown promise, where drainage is adequate as will be discussed later. Therefore, cultivation of non-rice crops should be promoted only on well drained soils (or light soils) during the dry season. As heavy rains during the Maha season are concentrated only in October, November and December, there is a nine-month dry period in which two crops can be easily raised. The rainy period can be considered as a fallow period for non-rice crops.

It is therefore suggested that development of land in future irrigation projects should be limited to areas with well-drained soils in the first stage. The balance of areas with heavy soils can be sold to the farmers after a few years, either to cultivate rice or to grow pasture. The analysis of a project in which only non-rice crops are grown during a nine-month dry period would definitely give higher ERRs and cost/benefit ratios than one in which rice is cultivated during the wet season and non-rice crops on light soils during the Yala season.

When land is reserved for future development in the project area it gives the following additional advantages:

- progressive farmers with excess cash reserves can purchase land closer to their existing land, and need not go elsewhere to invest their money profitably,
- the development cost of land would be borne by farmers,
- there will be land for the second generation, and

- farmers may even develop heavy soils with adequate drainage for cultivation of non-rice crops.

In this case, storage reservoirs, main and branch canals will have to be designed to take account of the total requirement in the project area.

First, consider a simple "on-demand" system that pumps from ground water (e.g., a shallow well or tubewell). As pumping costs are involved, a farmer will not wish to pump more water than is required and will also seek methods of reducing pumping costs through efficient water application. Then new irrigation systems like drip irrigation can be introduced showing their advantages including lower pumping costs. Most systems that involve pumping costs at farm level are likely to be efficient systems as they are alternatives to volumetric billing systems. If pumping costs are comparatively low, then costs can be recovered by efficient introduction of a different tariff system.

When the present operation and maintenance costs of pumping are considered, the cultivation of rice will not give adequate returns for pumped water. Therefore, such systems should be limited only to areas with light soils.

Considering the facts discussed above, future projects should have the following features:

- first stage development is limited to areas with light soils (well-drained soils). Areas with heavy soils are reserved for future development and farmers will have the option to buy these lands,
- water levels in main and branch canals are controlled by hydraulically operated gates, and
- secondary canals are designed to maintain a constant level, and field canals are replaced by low pressure pipe systems with meters to measure volumetric discharges or water is pumped to farms from the secondary canals (or shallow dug wells on the farm), or
- a constant discharge module is fixed at each turnout and farmers are well organised at turnout level for distribution of water within the turnout for the secondary canal command area,
- precise land levelling is required to increase the efficiency of surface application methods, or drip/sprinkler irrigation methods are used,
- rice is not cultivated even during Maha season (or high rainfall period may be followed), and
- each area specialises in one type of crop.

5.13 Upgrading of Existing Projects

The objectives of upgrading a project's design and operation would be the same as those for new projects, but implementation of actual physical improvements would be more difficult. Built-in constraints and limitations in existing projects have to be identified, evaluated and removed on a project-by-project basis. For some projects, significant improvements may not be technically or economically feasible e.g., older long canal systems. It also may not be practical or economical to replace the existing major control structures (equipped with large conventional radial or sluice gates) by automatic hydromechanical equipment. A great variety of modern concepts and associated technologies are available for canal design to improve water management in irrigation systems, but no one concept or technology is appropriate for all types of irrigation projects. It is therefore recommended to take maximum advantage of hydraulic regulation in the design process.

5.14 Major Recommendations

Major recommendations arising from this examination of options for investment in irrigation include:

1. Among major schemes within Mahaweli, decide whether or not to proceed with the Moragahakanda, and the SouthEast Dry Zone Diversion.
2. Outside Mahaweli, decide on major schemes including the Diversion of the Kalu Ganga to the SouthEast Dry Zone and the Diversion of the Nalanda to Kurunegala.
3. Give a high priority to planned rehabilitation and modernisation of all major tanks. This would involve 15,000 hectares annually at a cost of Rs. 30,000/hectare and would need an allocation of Rs.450 million annually.
4. Give a high priority to planned rehabilitation and modernisation of all minor tanks. This would involve 800 annually, and at Rs. 30,000 per hectare, would require an annual allocation of Rs.240 million.
5. Give high priority to the development of location-specific sustainable models of water conservation and storage in tanks to maximise efficiency of use for irrigation, e.g., Weli Oya and Muthukandiya models. This would also require study of crop production systems appropriate for each model.
6. Give high priority to the development of groundwater based irrigation schemes. Suggested locations are the Vanathavillu Basin (with investigation), Murunkan-Silavatirai Basin, the Puttalam-Palavi area (needs a development plan) and a feasibility study for the Mulankavilu, Paranthan, Puthukudiyiruppu areas.

7. Invest in the conjunctive use of groundwater in the Mahaweli settlement areas, both below and above canal command areas. This would entail a study of sub-surface groundwater reserves there (and elsewhere in the Dry Zone outside major irrigation project areas).

8. Give priority to research in on-demand delivery systems both to the farm (hydraulic control systems) and on-farm (micro-irrigation systems) for existing schemes, and in the design of new schemes and rehabilitation plans, in conjunction with research in a program of crop diversification (discussed in Chapter 7). It will also greatly assist in the problem of cost recovery.

9. Give first priority to the development of well-drained soils in recently completed irrigation schemes, as irrigation of these high value crops will earn high financial and economic returns.

6. Operation and Maintenance Requirements of Irrigation Systems

6.1 Introduction

Until 1984, the entire responsibility for financing and implementing the operation and maintenance programme of major irrigation schemes up to the distributary channel level lay with the state and the Department of Irrigation. The O&M of field channels were the responsibility of the farmers. Over the years it was found that the financial burden on the state for O&M expanded and the required funds could not be generated in full within the government budget.

In 1984, the government introduced an O&M fee to all major irrigation schemes. The average cost of operating and maintaining an acre of irrigated land within major irrigation schemes was estimated to be Rs. 200 per acre. However, government policy was to begin recovery of O&M cost at the rate of 50 per cent, which would eventually be increased to cover the full amount. Accordingly, the fee payable by farmers was set at Rs. 100 per acre in 1984. Actual collections subsequently began to diminish at a rapid rate so the original proposal to increase the O&M fee annually was not implemented.

This chapter comprises two parts. The first reviews O&M requirements and the past record of fee collection in Sri Lanka under traditional systems of rice based irrigated agriculture. The second is concerned with O&M under modernised irrigation systems and more diversified irrigated agriculture. The review of the past is based upon the findings of a 1989 consultancy (TAMS, 1988) which undertook of field survey of 1000 respondents in twenty major irrigation schemes in Sri Lanka, and upon a review of literature on this topic.

6.2 O&M in the Past

The major socio-economic issues relevant to the problem of O&M fee collection are discussed under the following themes in this section.

- the need to collect O&M fees,
- the ability of water users to pay fees,
- their willingness to pay,
- actual payment of fees, and
- how, when and how much to collect.

6.3 The Need to Collect O&M Fees

The need to collect O&M fees arises from the inability of the state to generate and allocate sufficient funds to operate and maintain major irrigation schemes at an optimum level. Allocations received for O&M of major irrigation schemes were only 51 per cent of requirements from 1984 to 1988 decade (Resource Development 1978-1987, Ministry of Lands and Lands Development). The total amount of funds required for O&M in this period, was Rs. 735 millions. In 1988, the allocation received was the lowest amount and was only 39.7 per cent of the estimated requirement (Rs. 182 million).

The direct consequence of the failure to allocate sufficient funds for O&M over the long run has been a rapid deterioration of irrigation infrastructure. This has resulted in reduced water control and has created disparities in relation to adequacy, reliability and equity in the supply of water within major irrigation schemes. As noted earlier in this study, about 15,000 hectares need rehabilitation annually if present levels of productivity are to be maintained. This would require approximately Rs. 450 million at present prices. Obviously, a more effective maintenance regime would reduce the annual cost incurred on rehabilitation, at least in the medium and long term if not in the short run. Thus, in this way it may be possible to reduce the total expenditure incurred on O&M plus rehabilitation.

A strong economic argument in favour of pricing services or commodities is the need to ensure optimum resource allocation in production. Thus, volumetric pricing of irrigation water, if feasible, can ensure that wastage of water is minimised. In other words, if farmers have to pay for the amount of irrigation water consumed, they will be motivated to use only that quantity, which will equate the marginal productivity of water with its price. However, irrigation water within gravity fed irrigated projects serving a large number of small farmers exhibits many characteristics of a public good and therefore, volumetric pricing is not feasible. Hence, O&M fees are based on the area of land cultivated irrespective of the volume of water consumed. In economic efficiency terms, area based O&M fees have the exact opposite effect on water users, i.e., they are inclined to use as much water as possible for the given fee in the absence of physical, administrative, legal or social restrictions to prevent them.

In recent years many researchers have suggested that in most developing countries macro-economic policies have consistently been biased against the agricultural sector. Krueger *et al*. (1988) found that, in spite of substantial subsidies given for irrigation, fertiliser and credit, the overall effects of economy-wide policies in Sri Lanka have discriminated against the rice sector, although to a lesser extent than against tree crops. To the extent such discrimination prevails, the socio-economic justification for the collection of any fee is weakened. However, such inter-sectoral biases are dictated by political realities and have to be accepted as given in the short term. Therefore, suitable mechanisms have to be evolved within the irrigation sector for the generation of the required funds.

6.4 The Ability of Water Users to Pay Fees

The ability of water users to pay a fee or any other levy related to irrigation has been a major determinant in the decision as to how, when and how much to collect. Legislation or administrative measures that force beneficiaries to pay/contribute an amount in excess of the capacity of a majority can afford invite large scale defaulting. When large numbers default, the enforcement of the law or administrative measures becomes impossible. After all, the objective of constructing, maintaining and operating irrigation schemes is to allow the maximum possible number of farmers to receive water and not to reduce the number of beneficiaries. A historical review of irrigation legislation in Sri Lanka has shown that, even in colonial times the state was sensitive to the ability of farmers to pay in enforcing irrigation levies (Teams, 1989).

The ability of farmers to pay fees is determined by their surplus, which is defined as follows:

Farm family economic surplus = Total farm family income - Cost of living

Total farm family income is defined as the difference between gross farm income and the cost of purchased inputs. Where off-farm sources of income are available, total farm family income is the sum of the above and off-farm income. Total farm income is determined by a wide range of factors that vary from scheme to scheme and also within schemes from one location to another. Some of these factors are the area cultivated, cropping intensity, cropping pattern, crop yields, and costs of production. Crop yield in turn is determined by soil type, access to irrigation water, cultivation practices, agro-ecology of the area, etc. Secondary information sources suggest that holding size and area cultivated, crop yields, cropping intensities and profits have varied greatly between schemes (Tables 6.1 & 6.2) as well as within schemes (Ekanayake 1987). Accordingly, it is clear that ability to pay varies and therefore even a nominal fee may adversely affect the subsistence level of a sizeable proportion of the farming community.

Table 6.1: Holding Size and Cropping Intensity in Major Schemes						
Project Name	**District**	**Year of Alienation**	**Holding (LL Ac.)**	**Size (HL Ac.)**	**Paddy area (acres)**	**CI in 1985/86**
Nachchaduwa	Anuradhapura	1925	3.25	0.4	6,263	
Minneriya	Polonnaruwa	1933	2.6	1.7	10,028	200
Minipe Stage I	Kandy	1937	5.0	3.0	2,435	
Parakrama Samudra	Polonnaruwa	1942	4.6	3.0	15,916	200
Huruluwewa	Anuradhapura	1952	3.8	1.2	8,685	100
Kantalai	Trincomalee	1953	3.0	2.0	7,463	183
Gal Oya	Ampara	1956			32,643	
Giritale	Polonnaruwa	1956	5.5	3.2	3,756	200
Padaviya	Anuradhapura	1956	5.0	2.0	13,000	
Mahakand-arawa	Anuradhapura	1961	2.7	1.6	5.036	
Rajangana LB	Kurunegala	1965	2.0	1.1	5,510	200
Kaudulla	Polonnaruwa	1966	3.0	1.4	10,454	121
Minipe	Matale	1968			5,294	
Stages III & IV						
Nagadeepa Mahawewa	Badulla	1968	1.9	1.0	4,028	
Muruthawela Stage I	Hambantota	1969			2,458	
Muthukandiya	Monaragala	1980	3.4		2,043	
Kirindi Oya	Hambantota	1982	1.8	0.5	3,825	
Ridiyagama	Hambantota	N.A.			6,770	
Batalagoda	Kurunegala	N.A.			6,624	
Nuwarawewa	Anuradhapura	N.A.			6,624	
Kimbulawana Oya	Kurunegala		2.0	1.0	2,400	166

Notes: LL = lowland; HL= highland; and CI= cropping intensity.
Source: - UNDP – SRL/84/037.
- Annual Plan 1987, Ministry of Lands and Development.
- Land Commissioner's Department.

Table 6.2: Profitability of Irrigated Paddy (per acre)

District	Maha 1985/86	Yala 1985
Anuradhapura	2389.8 (939.8)	1832.8 (969.9)
Polonnaruwa	2695.2 (2010.9)	2386.4 (1603.1)
Kandy	2824.2 (888.0)	2380.7 (834.2)
Trincomalee	n.a.	n.a.
Ampara	1132.2 (526.3)	1687.3 (886.9)
Matale	3183.0 (2073.0)	1224.1 (886.9)
Badulla	3637.9 (1625.7)	1224.1 (191.6)
Hambantota	1275.5 (578.0)	2153.0 (1516.0)
Monaragala	1864.1 (557.8)	2537.9 (1006.6)
Kurunegala	3749.4 (2656.5)	4410.8 (3354.5)
Kalawewa	3490.4 (2523.80)	2729.9 (1829.8)
Udawalawe	1606.9 (1008.5)	1552.1 (819.6)

Note: Figures in brackets include the imputed cost of family labour.
Source: Cost of cultivation of Agricultural Crops, Department of Agriculture, Peradeniya.

The analysis of actual payment of O&M fees in the 1984-87 period by farmers classed according to their output showed an increasing trend of fee payment from low output to higher output classes. This trend has sharpened over the years, owing to the rapidly escalating costs of production of rice relative to its price.

6.5 Farmer Willingness to Pay Fees

The field survey explored the attitudes of farmers towards the payment of O&M fees. Some 94 per cent of sample farmers expressed willingness to pay O&M fees if the supply of water is adequate. At first glance this appears to be at variance with their economic circumstances, i.e., their ability to pay as discussed above. But their ability to pay at present is determined by their incomes, which in turn are influenced to a great extent by the adequacy of irrigation water and the reliability of supply. The reliability of water supply has implications for risk aversion of farmers and therefore, influences yields and profits. Farmers responses to the question of whether they were willing to pay O&M fees may have been based on the potential yields and profits under an improved O&M scenario.

6.6 Actual Payment of Fees

Our review of the history of irrigation levies in Sri Lanka shows that farmers have been willing to contribute and have contributed towards meeting the various costs of irrigation, financially or otherwise. In recent times, with the bureaucratization of the management of irrigation systems, willingness to pay and actual incidence of payments appear to have declined.

Although 94 per cent of farmers were willing to pay an O&M fee if the water supply was good, only 40 per cent paid in 1984. In 1987 this had declined to 10 per cent and today it is effectively zero. This situation suggests first, that the collection mechanism is faulty and second, that farmers are not satisfied that they get a service which deserves payment of a fee.

It was mentioned earlier that irrigation water is a commodity with certain "public good" characteristics and therefore, enforcement of fee collection is difficult. Although there is evidence of a decline in profits from rice cultivation, the rate of decline is certainly not as steep as the drop in the payment of O&M fees. It is clear that the major cause of this decline was not the profit rate alone. Where the enforcement mechanism for fee collection is weak, it is good economic sense for a farmer not to pay for a service that could be obtained free. In the gravity operated, surface irrigation setting for small farmers, the prevention of access to water on grounds of default is virtually impossible unless cultivators are evicted. The political will for such drastic action is not present at this time, and probably never existed in the recent past.

The survey on which this section draws showed that farmers had sufficient reasons to feel that water problems did not justify payment of fees at present (Table 6.3 to 6.6).

Thus, it is easy to understand why the rate of O&M fee payment declined when one combines the fact that the enforcement mechanism was not effective with the dissatisfaction that farmers had about the water service which discouraged voluntary payment.

Table 6.3: Incidence of Paddy Parcels with Water Problems by Size of Parcel, Maha Season 1986/87 (per cent)

Paddy Parcel Size (acre)	Parcels with Water problems	Parcels without Water Problems
Less than 0.5	49	51
0.5 - < 2.0	27	73
2.0 - < 3.0	37	63
3.0 - < 5.0	21	79
5.0 & above	28	72
All parcels	31	69

Source: TAMS (1988).

Table 6.4 Incidence of Paddy with Water Problems, Yala 1987 or Most Recently Cultivated Yala (per cent)

Paddy Parcel Size (acre)	Parcels with Water Problems	Parcels without Water Problems
Less than 0.5	74	26
0.5 - < 2.0	61	39
2.0 - < 3.0	57	43
3.0 - < 5.0	43	57
5.0 & above	47	53
All	55	45

Source: TAMS (1988).

Table 6.5: Percentage Distribution of Paddy Parcels with Water Problems by Type, (Maha 1986/87)

Duration	Inequity	Inadequacy	Out-of-schedule
Land preparation	8	81	11
Sowing	6	89	5
After sowing	5	81	14
All	6	83	11

Source: TAMS (1988).

Table 6.6. Percentage Distribution of Paddy Parcels with Water Problems by Type, (most recent Yala)

Duration	Inequity	Inadequacy	Out-of-schedule
Land preparation	7	88	5
Sowing	6	87	7
After sowing	3	72	25
All	4	78	18

Source: TAMS (1988).

6.7 When, How and How Much to Collect

Irrigation schemes of Sri Lanka are very different from domestic water supply schemes. In the latter, each consumer enters into a contract with the supplier and is billed on a volumetric basis. In advanced economies/societies the consumer can even sue the supplier for any lapses on his part. The technical design is such that all individuals get more or less the same service. Sri Lankan irrigation schemes are not like this. The amount of water received is not controlled fully by design, the actions of other users are an influence, and water supply to individual farm lots is not on demand. Furthermore, the supplier cannot be held responsible for any lapses in the availability of irrigation water to an individual.

The overwhelming evidence is that irrigation water is best managed when it is treated as a social good and managed through social action. Hence the notion of a "user support system" arises. Since all societies have "black sheep", legal measures are necessary to control them. But the emphasis should be on user support systems leading eventually to "user owned systems". Our analysis suggests that where farmers can decide or help to decide O&M priorities and to determine the relevant fee, they are more likely to be responsible partners within the O&M system, and pay O&M fees. In effect, such a situation could lead to significant reductions in O&M costs in financial terms. For example, farmers themselves can carry out most labour intensive maintenance activities during the off season. This is again good economic resource management since the opportunity cost of labour during the off season is near zero. Similarly, there are operational activities that can be taken over by farmer representatives on a voluntary basis thereby reducing the cost in financial terms.

6.8 Recent Changes in Government Policies

Early in 1989 the GOSL adopted the following proposals made jointly by the Ministers of Agriculture and Lands for participatory management in irrigation schemes:

- the need for participatory management be accepted as a policy by government with the objective of improving overall management and performance.
- the management principle of the village tanks be adopted in larger systems in the turnout areas, field canals and the distributary canals respectively.
- village level institutions be developed to provide for active farmer participation and involvement.
- farmers be encouraged to manage the O&M of distributary systems by contributing their labour and other resources. It is expected that such a development would enable the exemption of farmers from payment of O&M fees.
- Government funds continue to be made available to maintain and manage the Main System, namely the head works and main canals. It is estimated that this would amount to approximately 50 per cent of the total cost of maintenance.
- a legal framework be provided to recognise the rights and obligations of farmer organisations through amendments to the Irrigation Ordinance and to the Agrarian Services Act, as required.
- legislation be enacted to transfer, over a period of time, the ownership of the irrigation network below the D-canal level to farmer organisations when they are found to be ready to take on that responsibility.

6.9 O&M Options Under a Modernised Irrigation System

When an irrigation system is modernised to increase its flexibility by installation of hydraulically controlled structures, dependence on manual adjustments is considerably reduced. This has been confirmed by the findings of the Impact Study of the Rajangana Pilot project implemented under MIRP (1989). The Impact Study gave only the results obtained during 1987/88 Maha season, but it can be safely assumed that the operation costs will fall even further when the irrigation staff and farmers become accustomed to the system.

The study found that the Avio and the Baffle Distribution are very convenient and easy to operate because of the simplicity of the operational mechanisms compared with the functioning of the standard weir regulators. The relative convenience of operation of the various structures was assessed, by comparing the frequency of operating the structures in the Pilot and Control areas. It was observed that the Avio gate needs only 6 adjustments compared to the 30 adjustments required for the conventional turnout structure.

The report estimated the operational cost per turnout in the Pilot area at Rs. 284 against Rs. 483 for the Control area. It was concluded that modernisation reduced the operational cost to 59 per cent of that of the Control area. Overall, the case for modernised systems is very strong on the ground of savings in operation costs.

7. Benefits and Costs of Rice Based Agricultural Development

This chapter examines Benefits/Costs of predominantly rice based agricultural development with special reference to self-sufficiency in rice on the basis of productivity levels in 1980 and prospective levels with planned expansion in irrigable area.

The chapter comprises four sections:

- A review of past strategies for irrigation, land settlement and rice production in terms of direct government intervention and indirect intervention in the form of subsidies etc.
- An analysis of the self sufficiency issue in cereals, both on the supply side, with expansion of area cultivated, changes in cropping intensity, yields, technological changes, and on the demand side, with population increase, changes in per capita income, tastes and preferences, and prices. Projections are made for years 1995 and 2000 based on Sirisena (1988).
- Social benefit/costs of rice production, including strategic interests, income distribution effects, nutritional status, financial and budgetary implications, and linkage effects with other sectors of the economy.
- Private benefit/costs to rice growers in real financial terms. This component takes account of the fact that private benefit/costs diverge from social benefit/costs owing to various distortions in the economy and that farmer decision making is based on the former.

7.1 Past Strategies for Irrigation Land Settlement and Rice Production, Government Intervention

Irrigation water is almost exclusively used for rice cultivation with a few notable exceptions, e.g., Jaffna Peninsula, Puttalam area and Mahaweli System H. Further, most major irrigation schemes have significant settlement components.

Agricultural development in Sri Lanka has been overwhelmingly influenced by concern for supporting the rice production sector. "Successive governments in Sri Lanka, particularly after gaining independence in 1948, have implemented a number of policies and programs for the rice sector to increase production, to reduce reliance on imports and to maintain the nutritional intake of the population.

These policies and programs have included:

On the production side:

- irrigation schemes and land resettlement projects,
- research and extension programs,
- provision of subsidised credit and fertiliser,
- crop insurance, and
- implementation of a guaranteed price scheme.

and on the consumer side:

- provision of rice to consumers at subsidised prices under rationing, and
- food stamp schemes."(Gunawardena and Quilkey 1988).

Achievements in terms of the construction of new projects and rehabilitation of existing projects have been presented in previous chapters. In spite of these achievements, national irrigation policy has been subject to constant criticism from various quarters. The Agriculture Plan of the Ministry of Agriculture and Food of 1958 for example stated that. "It has been shown that the costs of current policies for development of irrigation and colonisation are extremely high. The annual production in the average Dry Zone colony represents only about 16 per cent of the total capital outlay as contrasted with over 100 per cent in the Punjab. Moreover, as these schemes are extended and marginal lands are brought in, costs will progressively increase. Colonisation has also led to the emergence of new and serious problems including the establishment of communities without social cohesion; the phenomenon of landlessness in colonisation schemes which results in an unprecedented number of squatters; the piecemeal restoration of irrigation schemes with probably permanent damage to the water resources of certain catchments; the indiscriminate clearing of forests and dangers of siltation of the existing reservoirs and channels. The continuation of present policies will endanger not only the agriculture of Ceylon but will also seriously undermine all efforts to develop the country on economic lines." (pp 5-6).

The Short Term Implementation Program of the Department of National Planning in 1962 drew attention to the fact that irrigation and land development continued to absorb a greater part of investment in the agricultural sector. It stated that, “despite this considerable investment, the output of this sector has not been such as to make any significant impact on our food problem. It is time, therefore, to critically examine returns in relation to investment made and to adopt a more realistic approach to development. This is all the more necessary at a time of scarce capital and foreign exchange resources. Continued investment in a traditional field quite unrelated to output can only be undertaken at the cost of funds to other more productive activities" (p 119).

The evaluation committee appointed for the Gal Oya Project (Government of Sri Lanka 1970) raised a major criticism of the larger multipurpose irrigation schemes:

"Our detailed findings have revealed some striking features to which close attention must be paid by policy makers in the future. The first is the poor benefit/cost ratio of the colonisation element of the Gal Oya Project. The existing expenditures on the infrastructure and the low productivity of the individual colonists have been clearly shown in our evaluation. This finding makes it necessary that policy makers take a long, hard look at the advisability of diverting resources to what is essentially a social welfare function in an economy where the greatest need is to maximise production" (p 140).

The most recent of such criticisms was the Country Economic Memorandum of the World Bank submitted to the Sri Lanka Aid Group Meeting in 1988 (World Bank 1988). The report recommends that the share of irrigation/resettlement in future PIPs be reduced substantially and that future investment should concentrate on high return projects in rehabilitation and on the upgrading of existing irrigation schemes. Finally, it was suggested that a major reorientation of the existing programs, and particularly reconsideration of plans to complete the fifth dam under the AMDP (Moragahakanda), might be needed.

The pros and cons of large scale irrigation/resettlement programs such as the Mahaweli have been examined in Chapter 4 above. It was argued there that judgement of the performance of such projects should be based on the evidence of *ex post* evaluations and also that the validity of their conclusions depended on the validity of assumptions used. In particular, it was found that with correct assumptions, Mahaweli Project II would give a respectable rate of return of 10 per cent, and perhaps more if plans for crop diversification came to fruition.

7.1.1 Rice Production Policies

Other major components of national rice policy are the guaranteed price scheme, rice marketing policies, institutional credit, the fertiliser subsidy and the research and extension programs.

7.1.2 Guaranteed Price Scheme

The objectives of the guaranteed price scheme (GPS) were to assure producers of fair prices and a ready market for their produce, to stimulate the production of food crops consumed in the country, and to replace food imports by locally produced food with self sufficiency as the long term goal. The GPS was used solely as a mechanism for supplying the rice rationing scheme, particularly during 1970-77. Since 1978, the major objective of this scheme has been to provide a minimum price insurance to farmers.

Over much of the period from 1952 to 1977, the GPS was above the import price at the official foreign exchange rate (Figure 7.1). Between 1973 and 1985 the GPS was substantially below the border price, and from 1972 to 1983, the average producer price was also less than the border price. From 1983 to 1988, the producer price was higher than the border price.

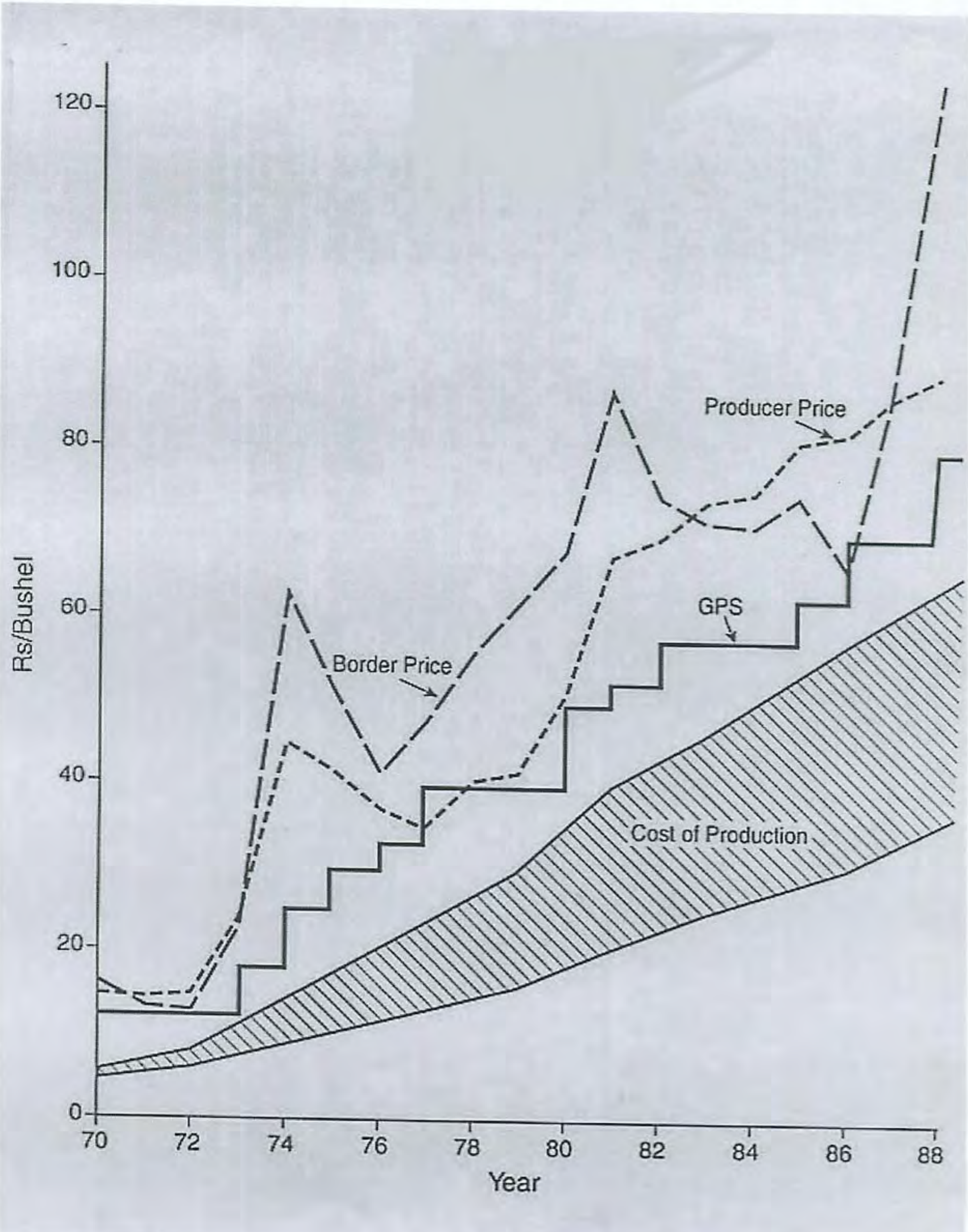
7.1.3 Effects of Rice Pricing and Marketing Policies

Rice pricing and marketing policies can be expected to have significant effects on farmers and consumers. Taxpayers are affected to the extent that these policies involve a transfer of funds from the national treasury to producers and consumers. The resulting net gains or losses to society depend on the net effects on the producers, consumers and taxpayers.

Gunewardena and Quilkey (1989) studied the welfare effects of rice marketing policies in Sri Lanka within a comparatively static partial equilibrium framework. This enabled measurement of the welfare effects separately for the concessional (subsidised) market, open market and the "arbitrage market". The arbitrage market refers to the selling of subsidised rice in the open market by some consumers thereby resulting in a reduction in the economic loss due to price distortions in the open market.

The outcomes of policy interventions were compared with a hypothetical situation where Sri Lanka would be a net importer of rice under conditions of free (international) trade in rice at world prices. The analysis showed that rice pricing and marketing policies in Sri Lanka have favoured consumers and had an unfavourable effect on the welfare of farmers since 1952. The unfavourable effect has been greater for small farmers than for large farmers. However, because all farmers received benefits in their capacity as consumers in the concessional market, it may well be that the eventual welfare losses of farmers were reduced.

Figure 7.1: Trends in Paddy Prices and Cost of Production



In addition, it was found that the maintenance of domestic rice prices below the world market price resulted in substantial losses of production to the economy over time. The overall conclusions of this study, therefore, were consistent with the hypothesis advanced by a number of economists, that agricultural pricing and marketing policies in less developed countries favour consumers at the expense of farmers.

7.1.4 Fertiliser Subsidy

The fertiliser subsidy represents one of the most important direct measures of state intervention in the rice sector in Sri Lanka. This scheme, introduced in 1950, continued virtually uninterrupted until 1990 when it was removed. Initially, the rate of subsidy was one-third of the cost of fertiliser. The subsidy rate was raised to 50 per cent of the cost for members of cooperatives. From 1963, all paddy farmers who paid cash for fertiliser became eligible for the 50 per cent subsidy. From 1968, it was extended to farmers who bought on credit as well. The subsidy rate remained around 50 per cent of the cost until 1977. In that year, following the unification of the exchange rate, the subsidy was increased to 75 per cent so that the domestic fertiliser price remained unchanged. The World Bank (1986) found that the financial subsidy for fertiliser ranged from a high of 55 per cent for urea to a low of 20 per cent for rock phosphate, while the economic subsidy ranged from a high of 47.4 per cent for TSP to a low of 19.7 per cent for rock phosphate.

A World Bank comparative analysis showed that the US dollar equivalent of the urea price to Sri Lankan farmers was lower only in Burma and Indonesia in the whole of Asia, and that the economic subsidy was substantially higher in Sri Lanka than in India, Pakistan and Bangladesh. Further, only Indonesian farmers enjoyed a significantly better paddy to fertiliser price ratio.

Since 1983, the administration of the fertiliser subsidy has been the responsibility of the National Fertiliser Secretariat. According to the Director of the Secretariat: "The intention of the government in providing fertiliser subsidies is to encourage the use of fertiliser in adequate quantities in agriculture and to educate the people of its importance for efficient cultivation. The government proposes to progressively reduce these subsidies with the gradual realisation of this objective and to curtail its burden on the finance of the state" (Kuruppu, 1984, p 3).

From 1983, the government imposed a ceiling of Rs.1 billion in nominal terms as the total budgetary cost of the fertiliser subsidy. As a result, the government's objective of gradually phasing out the subsidy may be achieved, owing to inflation and the increase in the total quantity of fertiliser used.

7.1.5 Subsidised Credit

Agricultural credit is another important policy measure with potentially high benefits for small farmer based agriculture. Adequate and timely availability of credit is considered essential if maximum benefits are to be realised from new high yielding rice technology. The history of Sri Lanka's formal agricultural credit schemes for the rice sector extends back to the late 1940s. Originally, agricultural credit schemes were implemented through the Department of Agrarian Services with government funds. In 1967, this operation was re-assigned to the People's Bank. Subsequently, the Bank of Ceylon and other commercial banks started to participate in the program.

In spite of its long history, the proportion of total rural credit supply accounted for by formal sources remains small. In 1986, for example, only Rs. 450 million were directed to private holders under Central Bank re-financing schemes while the total amount available for the entire agricultural sector was Rs. 5,152 million. Only 42,000 farmers were given formal agricultural credit out of a total number of farming families in the island of around 3,000,000. Thus, it is clear that the formal rural credit program in Sri Lanka has failed up to the 1990s. A high rate of default by farmers has often been cited as the major cause of such poor performance. However, a number of recent reviews of the rural credit sector suggest that the causal factors lie in a number of inadequacies within the organisation and operation of the formal credit system and not with the borrowers (Ministry of Finance and Planning 1984, FAO/ADB 1988, Fernando and Nanayakkara 1984, Fernando 1987).

Formal sector rural credit schemes in Sri Lanka have been conceived, designed and launched by the state. Banks are then called upon to participate in subsidised credit programs with re-finance facilities provided by the Central Bank. It is clear that commercial banks do not consider rural credit as an important area of their operations mainly because of the small margins allowed to them. As a result, formal rural credit in Sri Lanka is characterised by a low volume of lending, high rates of default, a large subsidy element, and above all, the reluctance of the rural banks to engage in this market beyond a minimum level.

There appears to an emerging consensus by 1990 that the subsidy element in the rural credit programs should be gradually phased out, positive real interest rates should come into operation, and in general give sufficient incentives for the commercial banks to engage actively in this market.

7.1.6 Effects of Economy-wide Policies

Moore (1987) argued that government policy in Sri Lanka has supported farm level prices of rice below world prices through the maintenance of an over-valued rate of exchange. Krueger et al. (1988) studied the impact of sector specific (direct) and economy-wide (indirect) policies on agricultural incentives for eighteen developing countries. The direct effect was measured by the proportional difference between the producer price and the border price (with adjustments for distribution, storage, transport, and other marketing costs). The indirect effect was measured by identifying its two components:

(a) The impact of the unsustainable portion of the current account deficit and of industrial protection policies on the real exchange rate and thus on the price of agricultural commodities relative to those of non-agricultural tradables.

(b) The impact of industrial protection policies on the relative prices of agricultural commodities to those of non-agricultural tradable goods.

It was found in almost all cases studied, that the direct effect is equivalent to a tax on exportable goods, and that indirect effects also tax agriculture and dominate the direct effect. Specifically, it was found that the direct effects on rice in Sri Lanka amounted to a subsidy of 18 per cent in 1975-79 period and to 11 per cent in the 1980-84 period. These levels seem to be realistic given that there are substantial subsidies for capital, fertiliser and irrigation water. However, the negative impact of the indirect effect was sufficiently large in both time periods to produce significant overall negative protection for rice. The indirect effects were -35 per cent and -31 per cent in the two periods, resulting in an overall effect of -17 per cent and - 20 per cent respectively. In other words, although sector specific policies have subsidised rice cultivation, the positive effect from such subsidies have been more than offset by the broader economy wide policies that have adversely affected agriculture.

7.1.7 Agricultural Policies of Developed Countries

The importance of such negative protection of rice on the impact of irrigation within the economy is obvious. A more disturbing implication is that agriculture in general is possibly subject to such discrimination within the normal policy framework of developing countries. If this is the case in Sri Lanka, then crop diversification, which aims to optimise scarce land and water resources of Sri Lanka, can encounter problems. Industrialised countries are known to use a variety of controls such as price support systems, generous crop finance programs and import controls against agricultural imports as a result of the powerful lobby of the domestic rural and rurally-related industrial interests. The effects on domestic efficiency of such distortions have a relatively small impact in these countries since the agricultural sector is very small relative to the industrial and services sectors. The impact of these controls on the predominantly agricultural DCs, which need overseas markets for their farm produce is of great significance (Asian Development Bank 1988). In Japan, for example, rice imports are largely prohibited and domestic rice growers are heavily subsidised. In USA, sugar imports are controlled extensively by quotas and domestic sugar prices are supported by crop financing schemes. In the European Economic Community, sugar, rice, fruits, vegetables and derivative vegetable oils are controlled by the Common Agricultural Policy (CAP) which applies variable levies to raise import prices to levels comparable to domestic prices of farm products in the community.

Recent country studies on foreign trade barriers and export growth in Asia (Asian Development Bank 1988) reflect the concerns of exporters from Asian DCs that agricultural policies in advanced industrial countries have contributed significantly to depressed international markets for such agricultural commodities as sugar and rice. The most important offenders appear to be the USA and EEC. The provision of direct subsidies in the form of highly concessionary crop loans, to encourage US rice exports under the US Farm Security Act of 1985 is viewed as further depressing the already low international rice prices. This hurts the efficient rice exporters in Asia such as Thailand and Pakistan. The EEC similarly has depressed world sugar prices by "dumping" excess stocks of sugar accumulated through official purchases to support domestic sugar prices. Such practices are not confined to the EEC or to sugar alone.

7.1.8 Income Distribution

If the prevailing domestic macro economic environment continues unchanged, together with that of international markets, the present trend of declining real profits from rice may persist, and therefore, rural income distribution can deteriorate. Settlers in the AMDP, for example, will experience lower rice incomes and increased poverty with unchanging yields. Solutions to this lie in any one or more of the following:

- technological change,
- greater economic efficiency on farm,
- crop diversification, and
- changes in the mode of production.

A hypothetical case is worked out below using System H data.

7.2 Supply and Demand for Rice and Other Cereals

7.2.1 Supply of Rice

With the national self sufficiency target in sight, a number of independent analyses of national rice production have been made (Ministry of Finance of Planning 1984, Abeyratne 1986, Department of Census and Statistics 1987). The last date for which the Ministry of Finance and Planning (1984) has made a projection was 1991. Abeyratne (l986) gave a projection to the year 2001. The study by the Department of Census and Statistics (l987) provided an estimate for 1991 but with their estimation equation it is possible to project production for the remaining years, up to 2001.

The three estimates are given in Table 7.1. The basis of the estimates in the last two studies was trend line analyses. The former used a straight line (linear) trend approach, while the latter fitted a parabolic function to the historical trend of aggregate rice production in all categories of areas. The latter approach is justified purely on the higher R^2 obtained rather than on any economic justification. As the table shows, this attempt to maximise the R^2 has yielded a projection that is excessively optimistic. It is obvious that if the true trend in rice production was parabolic then there will soon be a time when an infinite amount of the grains could be produced on a given land area.

Table 7.1: A Comparison of Estimates of Rice Production (paddy million bushels)				
Source	**Year of Study**	**1991**	**1996**	**2001**
Census	1987	152.1	183.57	217.58
		(1.96)	(2.36)	(2.80)
NPD	1984	142		
		(lower bound)		
		(1.83)		
USAID	1986	139.2	157.7	172.5
		(1.79)	(2,03)	(2.22)

Source: Ministry of Finance and Planning, 1984.

The approach of the Ministry of Finance and Planning (1984) was far more realistic. Its estimate was based on targeted expansion in the land area cultivated and alternative assumptions of expected yields. The performance of the rice sector up to 1987 with this estimate showed that even the low estimate (given in Table 7.2) was not achieved. Obviously, the underlining yield targets were not attained, and it is also known that area expansion under state sponsored schemes, which is the major means of new land development for rice cultivation in Sri Lanka, did not occur at the rate expected in the 1983/84 period.

Given that area expansion and average yield trends differ among major and minor schemes and in rainfed areas, our own analysis disaggregated the three categories. Since area expansion under major schemes (which account for 55 per cent of national rice production) is entirely dependent on government programs, it was considered prudent to base the area expansion estimates for this category on currently available data up from on-going and projected programs (Public Investment Programme 1988-1992). Future area expansion for the other two categories (minor schemes, and rainfed areas) was based on a linear trend line analysis.

A base case for future expected average yields was obtained for major, minor and rainfed areas by means of linear trend analysis separately, using historical data from the year 1974. Disaggregated data for each category were not available prior to this date. Visual observation of plotted aggregate national average yields since the 1950's show that an upward shift occurred in the early 1970's (Table 7.4). This is to be expected since the Green Revolution in Sri Lanka took place in the period extending from the late 1960s to the early 1970s. In fact, this explains the better statistical fit obtained by the Department of Census of Statistics with their parabolic functional form. In our view it is wrong to consider the post

70s as a continuation of the pre-1979 trend as the underlying production technologies and production functions were very different.

Theoretically, the expected average yield over time for a given technology can be expected to take the form of a sigmoid curve. Immediately after introduction, a technology will normally increase average yields very slowly, but yield will soon start rising, first at an increasing rate and then at a decreasing rate until a yield plateau is reached at the maximum potential of that particular technology.

Currently available varieties of rice can yield around 200 tonnes per hectare. How this potential will be achieved, if at all, will depend on many factors, such as producer

Table 7.2: Projected Paddy Yields (bushels per acre)

Year	Minor Irrigation		Major Irrigation		Rainfed	
	Maha	Yala	Maha	Yala	Maha	Yala
1986	70.7	58.4	80.8	73.9	53.9	47.4
1991	75.4	68.7	88.7	88.3	62.4	57.6
1992	77.4	70.4	90.6	90.5	63.9	59.2
1993	79.4	72.1	92.4	92.8	65.3	60.7
1994	81.4	73.8	84.2	95.0	66.8	62.2
1995	83.4	75.4	96.0	97.3	68.2	63.8
1996	85.4	77.1	97.8	99.5	69.7	65.3
1997	87.3	78.8	99.6	101.7	71.1	66.8
1998	89.3	80.4	101.4	103.9	72.5	68.4
1999	91.3	82.1	103.2	106.2	74.0	69.9
2000	93.3	83.8	105.0	108.4	75.4	71.4
2001	95.3	85.4	106.9	110.7	76.9	73.0
2006	105.3	93.8	115.9	121.8	84.1	80.6
2011	115.2	102.1	125.0	133.0	91.3	88.3
2016	125.1	110.5	134.0	144.2	98.5	96.0
2021	135.1	118.9	143.1	155.3	105.7	103.6
2026	145.0	127.2	152.1	166.5	112.9	111.3
2031	154.9	135.6	161.2	177.7	120.2	119.0
2036	164.9	143.9	170.3	188.9	127.4	126.6
2041	174.8	152.3	179.3	200.0	134.6	134.3
2046	184.8	160.6	188.4	211.2	141.8	142.0
2051	194.7	169.0	197.4	222.4	149.0	149.6
2056	204.6	177.3	206.5	233.5	156.2	157.3

Source: Department of Census and Statistics, Ministry of Plan Implementation. Progress in Paddy Cultivation and Production in Sri Lanka: Forecasts for the Future. New Monograph Series No.1, Colombo.

incentives, markets, institutional influences etc., and in the absence of reliable estimates of changes in these factors in the future, the only choice is that resorted to in this study. As shown in Table 7.2, the potential average yield of 200 tonnes per hectare will only be achieved in the year 2041 in major irrigation schemes with paddy grown in both Maha and in Yala seasons. Obviously, this is a very conservative estimate that will be relaxed in the later versions of this study.

Table 7.3: Average Paddy Yields in System H (in bushels per acre)

Reference Period	Maha	Yala
1976/77	76.5	63.6
1977/78	75.6	42.6
1978/79	82.2	Na
1979/80	77.7	54.0
1980/81	95.6	52.4
1981/82	72.0	52.0
1982/83	104.1	80.9
1983/84	84.0	56.4
1984/85	85.0	62.0
1985/86	92.9	58.8
1986/87	99.6	54.5

Sources: Ekanayake 1982, Crop cutting surveys of the Department of Census and Statistics.

As shown in Table 7.3, the average paddy yield in Mahaweli System 'H' has been over 90 bushels per acre on the average for the 1982/83 to 1986/87 period in the Maha season.

National production of rice after conversion from paddy and with allowances for seed, wastage, etc, under two basic assumptions are given in Table 7.4 (see the last two columns). The first estimate considers only the area expansion planned up to 1992. The second includes the RB area of System 'B' and the planned Moragahakanda Project.

7.2.2 Demand for Rice

The average per capita consumption of rice in Sri Lanka is about 98 kgs per year (Ministry of Finance and Planning 1984, Abeyratne 1986). The standardised per capita consumption of rice in the major rice consumer countries, as calculated by FAO, is given in Table 7.5. Although the per capita consumption in Sri Lanka is over-estimated by about 40 per cent in this table (presumably because of differences in definition), the relative differences in quantities of rice consumed per capita are of use. Malaysia and Philippines are very similar to

Sri Lanka in this respect while Burma, Thailand, Bangladesh and Indonesia consume 32 per cent to over 100 per cent of the Sri Lankan level. Japanese consumption is about 22 per cent less than that of Sri Lanka.

The above data illustrate that rice consumption is probably determined by a complex of factors (historical, economic etc.) and that attempts to estimate future trends in rice consumption in any country can be hazardous. Our approach, therefore, is to derive two estimates of per capita rice consumption as follows, and then estimate the national demand for rice using population projections (Korale 1988).

(a) Historical average per capita annual rice consumption (98 kgs), and
(b) Nutritional requirement of cereal consumption as recommended by the Medical Research Institute (145 kgs).

These two are used as minimum and maximum figures/estimates in the analysis. Actual consumption at any given time will depend on per capita incomes, prices of rice and other grains, and changing tastes and preferences.

Given that wheat cannot be profitably produced in significant quantities in Sri Lanka, and that wheat prices are determined in an imperfect international market primarily based on political considerations, gradual substitution of wheat for rice is probably a prudent course of action for Sri Lanka. Related issues will be discussed at length in the following sections.

7.2.3 Prospects for Meeting Domestic Demand from Local Production

The demand and supply position for rice in Sri Lanka (Table 7.4) shows that, if rice consumption continues at the historical average of 98 kgs/capita, Sri Lanka will be self-sufficient by 1991. But at that point, overall self-sufficiency in terms of cereals will be 71 per cent. Demand estimates are given for 98 kgs/capita, 107 kgs/capita, 112 kgs/capita and 145 kgs/capita in the table. The first and the last were described earlier. The second and third are the medium and optimistic estimates used in the Ministry of Finance and Planning Study (1984). These are useful in illustrating how self-sufficiency may be achieved at alternative levels of consumption.

Table 7.4: Projections of Population, Demand and Supply of Rice, 1991 to 2016							
Projected Demand	**Population (million)**	**At 98 kgs/cap.**	**At 107 kgs/cap.**	**At 112 kgs/cap.**	**At 145 kgs/cap.**	**Supply (a)**	**Supply (b)**
Year	17.9	1.75	1.91	1.99	2.59	1.84	1.84
1991	19.0	1.86	2.03	2.12	2.75	2.09	2.03
1996	20.1	1.96	2.14	2.24	2.90	2.31	2.20
2001	21.0	2.60	2.25	2.35	3.05	2.48	2.37
2006	21.0	2.15	2.35	2.35	3.19	2.64	2.53
2011	22.9	2.24	2.45	2.56	3.32	2.79	2.69
2016							

Notes: (a) Assumes area expansion planned to 1992, RB of System B and Moragahakanda.
(b) Assumes only area expansion planned to 1992.
Source: Ministry of Finance and Planning Study, 1984.

The most striking finding here is that, even by the year 2016, Sri Lanka will be only 84 per cent self-sufficient if area expansion halts with System B-RB and Moragahakanda at current yield trends (Table 7.6).

Given the substantial scope for increased technical efficiency in rice production in major irrigation schemes, i.e., the potential for increasing output at the present levels of inputs applied, the possibility of accelerating the achievement of self-sufficiency in food grains was subjected to the following sensitivity analysis. The average yield in the major irrigation schemes was progressively increased at the rate of 5 per cent per annum with the following two scenarios.

(a) Taking only the expansion area up to 1992.
(b) Including System B-RB and Moragahakanda as well.

Minor irrigation schemes and rainfed areas were not subjected to this treatment since it is evident that the current high risks of these forms of cultivation for small farmers prevent the adoption of cultural practices which increase crop yields. The failure of the "Walagambahuwa Model" discussed earlier in this study illustrates this problem.

Table 7.5: Total Rice Production at Varying Levels of Yield Increase per annum with Area Expansion as Planned in 1992

Year	% Increase in average yields of Major scheme									
1991	5%	10%	15%	20%	25%	30%	35%	40%	455	50%
1996	1.86	1.91	1.97	2.03	2.09	2.15	2.22	2.29	2.36	2.44
2001	2.08	2.14	2.20	2.26	2.33	2.40	2.48	2.56	2.64	2.73
2006	2.30	2.36	2.43	2.50	2.58	2.65	2.74	2.82	2.91	3.01
2011	2.51	2.59	2.66	2.74	2.82	2.91	3.00	3.09	3.19	3.29
2016	2.73	2.81	2.89	2.97	3.06	3.16	3.25	3.36	3.46	3.58
2021	2.95	3.03	3.12	3.21	3.31	3.41	3.51	3.62	3.74	3.86
2026	3.39	3.48	3.58	3.69	3.80	3.91	4.03	4.16	4.29	4.43
2031	3.61	3.71	3.81	3.92	4.04	4.16	4.29	4.42	4.56	4.71
2036	3.83	3.93	4.04	4.16	4.28	4.41	4.55	4.69	4.84	5.00
2041	4.04	4.16	4.27	4.40	4.53	4.66	4.81	4.96	5.11	5.28
2046	4.26	4.38	4.50	4.63	4.77	4.91	5.07	5.22	5.39	5.56
2051	4.48	4.61	4.74	4.87	5.02	5.17	5.32	5.49	5.66	5.85
2056	4.30	4.43	4.57	4.71	4.86	5.02	5.18	5.36	5.5.4	5.73

Source: Ministry of Finance and Planning Study, 1984.

Table 7.6: Total Rice Production at Varying Levels of Yield Increase per annum with Area Expansion Planned in 1992, Including System B (RB) and Moragahakanda

Year	% Increase in Average Yields of Major Scheme									
1991	5%	10%	15%	20%	25%	30%	35%	40%	455	50%
1996	1.97	2.03	2.10	2.16	2.23	2.31	2.38	2.46	2.55	2.64
2001	2.19	2.26	2.33	2.40	2.48	2.56	2.64	2.73	2.82	2.92
2006	2.41	2.48	2.56	2.64	2.72	2.81	2.90	3.00	3.10	3.20
2011	2.84	2.93	3.02	3.11	3.21	3.31	3.42	3.53	3.65	3.77
2016	3.06	3.15	3.25	3.35	3.45	3.56	3.68	3.80	3.92	4.05
2021	3.28	3.38	3.48	4.59	3.70	3.81	3.94	4.06	4.20	4.34
2026	3.50	3.60	3.71	3.82	3.94.	4.07	4.20	4.33	4.47	4.62
2031	3.72	3.83	3.94	4.06	4.19	4.32	4.45	4.60	4.75	4.91
2036	3.94	4.05	4.17	4.30	4.43	4.57	4.71	4.86	5.02	5.19
2041	4.15	4.28	4.40	4.53	4.67	4.82	4.97	5.13	5.30	.5.47
2046	4.37	4.50	4.63	4.77	4.92	5.07	5.23	5.40	5.57	5.76
2051	4.59	4.72	4.86	5.01	5.16	5.32	5.49	5.66	5.85	6.04
2056	4.41	4.55	4.69	4.85	5.01	5.17	5.35	5.53	5.72	5.92

Source: Ministry of Finance and Planning Study, 1984.

An alternative is to move in the direction of another "quantum leap" in technological change, i.e., towards another "green revolution". This may be achieved in bio-technical areas or in modern forms of irrigation or in combinations of the two. Options in this area are discussed at length later in this study.

7.3 Social Benefit/Costs of Rice Production

7.3.1 Strategic Interests

Most studies of future world food supply conclude that the world as a whole has the resources and the technological capacity to produce food at least at the same rate at which the demand will grow (Mahangas 1985). However, the mechanism to distribute food among consumer nations, the world market, is highly artificial as shown below, and developing countries might feel justified in avoiding it as much as possible. It is of course possible to prove on theoretical grounds that, where markets are competitive, trade oriented self reliance may often be superior to domestic self-sufficiency in food in terms of maximising economic welfare.

A country considering food self-reliance through trade needs security of access to export markets to obtain the necessary exchange as well as to the food markets. It has to cope with the general protectionist tendencies existing in the richer countries described in an earlier section and thus its vulnerability to potential *ad hoc* restrictions. For instance, Mahangas (1985) suggests that any country which imports food from the USA should not have any trade with Cuba. In general, these restrictions imply that access to markets is determined not only by economic factors but also, and may be predominantly, by political factors.

The actual price paid for food imports in monetary as well as non-monetary terms depends on the relative bargaining powers of the buyers and sellers. For obvious reasons, USA has extracted a much higher price from Bangladesh, for example, than from the USSR.

"The price at which trade takes place becomes, as often as not, a function of three domestic decisions: the willingness to subsidise exports in surplus periods and to restrict exports in shortage years; the willingness of other countries with more flexible trade policies to enter the market to remove surpluses; and the extent to which governments and private firms choose to hold reserves. Rather than a smoothly functioning “competitive world market, one has a strange market structure composed of the complex of these policy decisions" (Josling quoted in Mahangas 1985).

World rice price forecasts of the World Bank predict a declining trend in real prices for rice as well as for other food grains in the medium and long term. In contrast, the Global 2000 Report to the US President predicts increasing real prices of energy by the year 2000, and accordingly, an increase in the real prices of food grains (Barney, 1980).

The World Bank forecasts are based on the unrealistic assumption that there are no major "shocks" in the system as occurred, for example, with the 1987 drought in Asia. Other shocks which may increase world rice prices include: disease and pest attacks, a large increase in fertiliser prices, changes in USA or EEC agriculture policies, domestic instability in either importing or exporting countries, or increased demand in Asia or in other regions such as the Middle East, Africa or Latin America.

Monke and Pearson (1987) noted that, while the possibility of any one of these events happening is small, their joint probability of occurring is high. The impact of the Asian drought in the 1980s demonstrates how volatile world rice prices are to shocks: a 4 per cent decline in world production in 1987 raised the rice price by nearly 30 per cent in the same year.

The unreliability of World Bank commodity price forecasts for rice has been noted by well known economists and even by certain departments of the World Bank itself. Given that the appraisal of agricultural projects routinely depend on commodity price projections of the World Bank in determining shadow prices, and the sensitivity of such projects to price variations, a careful investigation of this problem is required.

Siamwalla (1987) noted that the January and August 1986 World Bank forecasts of rice prices for the year 1990 differed by 43 per cent in real 1984 prices and 68 per cent in current prices. Mahaweli System H was one major project that was adversely affected by the unreliability of price forecasts of the World Bank. The ex-post evaluation of this major project (the pilot scheme of the Mahaweli Program) found that, although the project was successful and achieved the project targets, the economic rate of return was a disappointing -1 per cent.

The comments of the Operations Evaluation Department (OED) of the World Bank on this project and the ex-post evaluation were that "attaining major objectives such as land development, settlement, and crop production ….the project ERR has been recalculated at -1 per cent mainly due to much lower actual and forecast prices for rice than price forecasts at the time of appraisal (p xii),…. the cropped area at the time of project completion was only 14 per cent below appraisal, but paddy production of 67,473 tons compared with 59,554 tons estimated at appraisal was more than 135 per cent higher…."

In analysing the reasons for this variation of prices, which made System H uneconomic in spite of the attainment of project targets, the OED found that such "large differences between rice price projections and actual market developments were not a particular negative case but that price projections for other commodities [by the World Bank] were equally flawed". However, the OED was satisfied that improvements to the Bank's price forecasting methodology since 1982 by the introduction of 22 global models have resulted in greater accuracy (p 34).

The substantial variations noted above in the Bank's 1986 forecasts do not justify the optimism of the OED. Siamwalla (1987) notes the difficulties involved in making projections in an uncertain world, prescribes the adoption of a policy rule in pricing rather than a fixed policy and suggests that one starts with a possible list of contingencies and then identifies a course of action for each contingency. The relevant contingencies identified are (a) global weather conditions, (b) the level of stocks existing in the market, (c) policy decisions of major countries, and (d) commodity price forecasts of the World Bank. The last is important since investments in agriculture, particularly in relation to irrigation, are affected by the price projections. As discussed earlier, the investment for System H may not have been undertaken if the drop in real prices in the '80s could have been predicted.

While the recent price increase may have been triggered by weather factors, the dynamic effects of low world prices on future production growth, which are typically ignored in price forecasts, is creating a condition for food shortages and for high rice prices in the future. For example, Hayami (1978, 1988) has shown that low and projected low rice prices make irrigation investment unattractive and reduce public support for rice research. Alternatively, when rice prices are high, so is investment. The impact of these reductions will be felt in the medium to longer term, which fuels roller coaster effects.

Changes in price policies have more immediate impacts. For example, reductions in the fertiliser subsidy are predicted to have a major impact in Indonesia's rice production as nearly half of the growth in rice output in the past decade has been attributed to this policy instrument (Timmer 1985).

Rice markets are said to be dominated, not by fundamental demand and supply factors, but by policy decisions taken in many countries (Siamwalla 1987). Macro economic events and policy distortions rather than supply and demand factors have been the more important factors affecting the secular trends in world prices (Mitchell 1987). Among agro-economic variables, rapid growth of income of oil exporting countries and of newly industrialised countries, overvaluation of the dollar that increases the price of grain to non-US importers and exporters, and the sharp price increases of fertiliser due to the oil price shocks in 1973 and 1979, were the most important factors behind the unprecedentedly high world prices in the 1970s.

Policy induced distortions in developed countries also directly and indirectly reduce world rice prices. The US Food Security Act of 1985, the Export Credit Guarantee Programs and the PL 480 Programs reduced US export prices by 30 to 35 per cent which in turn boosted US export shipments. The growing protection of rice markets in Japan, Taiwan and Korea has curtailed world import demand. High protection of wheat and other grains in developed countries has led to dumping of surpluses that eventually depress world rice prices because of the increasingly strong linkage among the grain markets (Mitchell 1987). By contributing to the general collapse of agricultural commodity markets, agricultural protectionism has exacerbated foreign exchange constraints and thus weakened import demand of many developing countries.

While a low world price of rice is beneficial to consumers and importers, economic welfare and farm incentives of exporting countries and of rice farmers in importing countries are reduced. Declining rice prices as a result of technical change, on the other hand, can benefit consumers without necessarily hurting the producers. However, it is unjust that low income countries must bear the burden of adjustment to the market distortions which are due to developed country polices of agricultural protectionism. An OECD report monitoring progress in agricultural markets (1988) noted that there is "a continuing structural over-supply in major agricultural commodities produced by developed countries, to the detriment of developing countries in Asia and elsewhere" (Far Eastern Economic Review, 2 June 1988). This report showed that agricultural subsidies are on the increase in spite of repeated calls for their reduction. For the 24 countries of OECD, the average subsidy to agriculture - or price support equivalent (PSE) as the OECD terms it - rose from around 30 per cent in 1979-81 to 47 per cent by 1986. The best performer was Australia where the PSE increased only from 9 per cent to 15 per cent. The worst was Japan, where it had increased from 57 per cent to 75 per cent.

The foregoing discussion illustrates why small developing countries would prefer food self-sufficiency to trade-oriented self-reliance. The fundamental reality is that the world rice and grain markets are not competitive or guided by demand and supply forces. Hence, trade based on comparative advantage cannot be expected to maximise welfare.

This has profound implications for the methodology of project appraisal as well. The border prices observed in such a distorted market cannot be expected to yield valid economic opportunity costs.

7.4 Income Distribution Effects

7.4.1 Nutrition

The Food Balance Sheet 1985, under the heading "Comparison of Nutrient Availability with International Standard", states that Sri Lanka is far ahead of most of the developing countries with a per capita availability of 2,500 calories per day (Table 7.7), which is also the level required in the Ministry of Plan Implementation (MPI) recommendations (Ministry of Agricultural Development and Research 1987). Moreover 95 per cent of this has been produced by vegetable sources such as rice, wheat, flour, sugar, coconuts and coconut oil. Per capita availability of proteins, which is around 55 grams per day, also fully satisfies the physiological requirements as recommended by the MPI.

The available evidence discussed above indicates that food supplies have been sufficient on average to meet nutritional requirements in Sri Lanka. However, the itemised food balance sheet indicates an overwhelming dependence on imported food items.

Table 7.7: Supply of Nutrients and the Sources					
Commodity Group	**Per Capita Availability**				
	Kg/Year	**Grams/ Day**	**Calories/ Day**	**Protein Grams/ Day**	**Fat Grams/ Day**
Cereals	146.65	401.77	1400.75	30.12	2.24
Roots, tubers & starchy food	34.79	95.3	137.81	0.83	0.19
Sugar	18.49	50.65	200.51	0.02	-
Pulses & Nuts	37.71	103.20	449.12	7.58	38.19
Vegetables	63.16	173.03	95.06	4.57	0.38
Fruits	8.16	22.37	17.28	0.20	0.02
Meat	1.57	4.12	5.16	1.02	0.12
Eggs	2.21	6.05	10.46	0.81	0.81
Fish	9.82	23.90	43.18	6.94	1.54
Milk	19.11	52.36	61.52	2.83	3.72
Oils & Fats	3.93	10.77	96.54	0.01	10.74
Total			2,517.48	55.02	57.95

Source: Food Balance Sheet 1985 – Department of Census and Statistics of the Ministry of Plan Implementation, Sri Lanka.

Table 7.8 shows the extent of the contribution made by locally produced food commodities and the state of under-nutriment if imports were curtailed. In the case of cereals, 75 per cent of the total supply comes from rice and 23 per cent from wheat flour imported under PL 480. Only 2 per cent come from other cereals. Given the problems associated with a trade-based strategy of self reliance discussed earlier, there is a strong case for self-sufficiency of at least the staple food. At present there is a shortfall of 32.98 gms on the daily requirement of cereals. Any problems in relation to Sri Lankan export markets and/or access to food supply sources in the world market can have serious implications for average domestic nutrition levels.

With regard to pulses, present local products provide only 36 per cent of the total requirement. For nuts and seeds, available data are insufficient to make a quantitative analysis, but even so, shortfalls are evident. These are other potential areas for expansion of production under irrigation.

Table 7.8: Availability, Requirement and the Per Capita Per Day Shortfall of Locally Produced Food Items

Food Items	Availability per capita per day (gms)	Recommended levels per capita per day (gms)	Shortfall
1. Cereals			
Rice	288.96		
Maize	4.24		
Kurakkan	2.02		
Wheat flour (PL480)	69.80		
Total	365.02	398	-32.98
2. Pulses			
Green gram	2.29		
Cow-pea	5.20		
Black gram	1.53		
Soya-beans	1.20		
Total	10.22	21	-10.78
3. Yams and tubers			
Potatoes	14.77		
Manioc	85.65		
Sweet potatoes	13.94		
Other yams	5.73		
Total	120.22	114	+6.09
4. Nuts & seeds			
Gingelly	2.25		
Ground-nuts	2.19		
Coconut, margarine butter to contribution.	4.44	85	-
5. Condiments			
Chillie	5.31		
Onion	11.34		

Source: Ministry of Agricultural Development and Research, 1987.

8. Diversification and Development of Commercial Agriculture

8.1 The Development of Diversified Cropping in Sri Lanka

8.1.1 Historical Background

The most compelling justification for diversified production on irrigable lands is that paddy cultivation is not adequately remunerative on the typical area cultivated by smallholders. As its water use is also inordinately high with the traditional system of gravity flow irrigation, any restriction of the area committed to the crop will release irrigation water in quantities capable of developing much larger areas of alternative crops (ACs) and thus of enhancing returns to investment in irrigation projects. For this of course, modern technologies for irrigation of such crops may be necessary and the economies of the combination of such technologies and these non-paddy crops must be shown to be attractive.

The importance of diversifying agricultural production is expressed in virtually all documents relating to agricultural policy and planning, investment in the irrigation sector and improvement of the economic conditions of the rural sector, not only for Sri Lanka but elsewhere in Asia.

In Sri Lanka, early peasant settlement schemes in the Dry Zone were based on a traditional pattern of land use where the poorly drained soils on the valley bottoms were used exclusively for rice and the better drained upland soils for rainfed arable crops.

Certain areas of ill-drained soils of the Low Humic Gley (LHG) type are continuously committed to paddy all year round. Rice has remained the most remunerative crop for such marshy soils and other options are severely limited with traditional irrigation technology. Where RBE soils are ill-drained, they are commonly used for paddy in the Maha Season and for other crops in Yala. The well drained sections can be used for irrigated crops in both seasons and currently represent the major short-term opportunity for diversification. Above command areas are committed to rainfed cropping in Maha or to perennials, though an economical system of lift irrigation would open up further options and change existing cropping patterns.

The early concept of irrigated agriculture in the Dry Zone was to supply water for rice cultivation. Irrigation of other field crops in the command area of an irrigation system was prohibited by the Irrigation Ordinance. From the mid-1960s however, the scope for crops was widened. All field crops were included and diversified cropping in irrigable lands became "the more acceptable pattern of land use" (Somasiri 1981). However, it was found that, quite apart from the issue of suitability of the gravity flow system for such crops, farmers lacked experience with crops other than rice under irrigation.

Nearly thirty years ago, plans for settlement in the Uda Walawe were made on the expectation of diversification on irrigable allotments. The Uda Walawe Project was notable for being the first project after Independence in which crop diversification was planned on a major proportion of irrigated land (Table 8.1).

Table 8.1: Area Planned by Crops, Uda Walawe Project

Crop	Area (acres)	% of Land
Paddy	22,000	34
Cotton	16,000	25
Sugar Cane	16,000	25
Subsidiary crops	8,000	13
Citrus	2,000	3
Total	64,000	100

Source: Hunting & Co., Uda-Walawe Project, 1981 in Pinnaduwage (1982).

The results fell well short of targets with respect to the irrigable uplands while the paddy area, though it expanded during the 1970s, fluctuated and also fell short of the target (Table 8.2). Areas planted to subsidiary crops in rainfed conditions expanded much more than those under irrigation.

Reasons given for the lack of success in diversification included an absence of adaptive research to ensure suitability of crops to local conditions, low profitability compared with paddy and a poor system of input distribution, as a result of which extension workers could not operate effectively for diversification. The crops introduced (maize/groundnuts in Maha and cotton/chillie/red onions in Yala) were new to the farmers and thus called for management practices and extension assistance that were quite different than for paddy. By 1979, aside from a small area of chillie and vegetables, farmers chose to double crop paddy.

Season	Year	Paddy	Irrigated Subsidiary Food Crops	Cotton	Rainfed Subsidiary Food Crops
Maha	1969/70	7627	-	-	-
Yala	1970	4876	-	7	-
Maha	1970/71	8771	-	2	-
Yala	1971	8502	62	6	205
Maha	1971/72	9357	19	-	1354
Yala	1972	8533	55	47	86
Maha	1997/73	11148	52	-	1505
Yala	1974	15427	376	679	366
Maha	1975/76	17344	1282	-	7833
Yala	1976	15353	610	847	1417
Maha	1976/77	16111	913	557	8052
Yala	1977	8031	534	278	1574
Maha	1977/78	17175	598	267	7764
Yala	1978	16880	249	168	244
Maha	1978/79	17351	581	-	8813
Yala	1979	14680	395	-	1211

Table 8.2: Area Cultivated in Uda Walawe Project by Crops, Year and Season 1969/70 to 1979 (acres)

Source: River Valley Development Board (RVDB) Reports, in Pinnaduwage (1982).

With the development of irrigation in the Dry Zone from the late 1960s, all soils in the catenary sequence were included. Thus, the relatively well drained upland RBEs were irrigated as well as the poorly drained LHGs, traditionally cultivated with rice. It was then that diversified cropping was introduced. However, owing to the paucity of data on performance of crops other than rice, a number of pilot farms were established to test performance on the range of soils types in Maha and Yala seasons commencing in 1972. These were further developed in Mahaweli System H in 1976 and in catchment C at Maha Illupallama. Crops chosen were the following:

(1)	chillie	(7)	green gram
(2)	onion	(8)	ground nut
(3)	maize	(9)	cowpea
(4)	sorghum	(10)	red-dhal
(5)	paddy	(11)	cotton
(6)	soyabean	(12)	sweet potatoes

Rice proved to be the best performer on LHG soils in both Maha and Yala seasons. All the other crops performed better on the well drained soils and yields were generally higher in Yala than in Maha season. Two types of irrigation were tried, gravity flow and sprinkler. There were pros and cons to sprinkler irrigation but the most decisive factor found against it was the recurrent on-farm costs of sprinkler irrigation. The 18 farmers who cultivated these crops over two seasons in each of four years obtained their highest profits from non-paddy crops on RBEs in Yala season. It was considered that these results were sufficient to provide a basis for recommendations for other food crops (OFCs) and their location and timing. Somasiri (1981) concluded that in Mahaweli "irrigated agriculture will not be confined to irrigated rice but diversified cropping would be the normal pattern of land use. The experiences of both pilot projects indicate that a farming family seeks an insurance against extreme want. Consequently, paddy had to be one of the crops in the rotation. It was the main crop in both pilot projects in the Maha rainy season, and was followed by high value crops such as chillie, onion and vegetables in the Yala season.

8.2 Current Support for Diversification

Crop diversification is an explicit objective in the National Agriculture, Food and Nutrition Strategy (1984), and this was to be promoted in all agro-ecological zones. In particular, other field crops (OFCs) were to be encouraged on well drained rice lands "to obviate prodigality of water use and in certain areas sugar cane cultivation must be substituted for rice"(ibid p. 22). Diversification was envisaged as a major task over the next decade. Increased emphasis on it would require:

(a) Institutional re-orientation of research, seed production and support service systems.

(b) Redirection of resource allocation to selected crops.

(c) A marketing programme to ensure the commercial viability of the non-rice crops.

(d) Greater attention to policy review and assessment of other field crops to ensure that producer incentives are maintained.

The OFCs embraced coarse grains, legumes, spices, oil seed crops, roots and tubers. In particular, priority was given to maize, kurakkan, grams, sesame, groundnut, soyabean, chillie and onions, of which only some were grown under irrigated conditions. The crops were grown mainly for the domestic market and for home consumption, and profits in the domestic market were quite low. Constraints on development were seen to include:

- weak government support services.
- generally low yields.
- a thin research base.
- weak marketing institutions.

Under developed storage and processing facilities within the Accelerated Mahaweli Development Project, approximately 150,000 acres of upland and intermediate level areas were available for crop diversification of which 75,000 could be cultivated with OFCs and the rest with sugarcane or cotton. There was no specific consideration given in the NAFNS to growing OFCs on irrigated lands outside the Mahaweli in the Dry Zone, i.e., in major, medium or minor irrigation schemes.

The rationale for irrigated crop diversification has been well argued by Miranda and Panabokke (1987) for tropical Asian countries including Sri Lanka. They particularly cite the approach of self-sufficiency in rice and a complementary push for self-sufficiency in selected non-rice crops, especially those with potential for import substitution. They expressed concern over the problems of growing such non-rice crops in irrigation systems that were designed for irrigated rice and for the need "to find appropriate management practices that will make possible the efficient and productive use of irrigation for crops other than rice". In analysing some of the constraints to non-rice cropping from irrigation water supplies, greater economic risks, larger cash and labour inputs, uncertainty of market prices and the demand for an increased managerial input were cited.

In a 1986 review of institutional and policy issues in Sri Lanka's agriculture, the World Bank (1986) saw an increasing need to augment the national diet with additional supplies of foodstuffs other than paddy and imported wheat. A wide variety of such crops were already being grown but usually under relatively low intensity and low yield production systems. The Bank argued for diversification, not because of the likely but possibly temporary achievement of rice self-sufficiency, but rather because it would allow considerable improvements in the efficiency of both real and financial resource use in the agricultural sector. Many of the non-paddy food crops were seen as having "potential for significant productivity improvements and/or acreage expansion, into either rainfed or irrigated areas in the Dry and Intermediate Zones". The Bank particularly favoured diversification into crops for the expected growth in the domestic market. It saw a role for some export crops (e.g., pepper) but advised a cautious approach in view of the "difficulties and uncertainties involved in producing for uncertain export markets".

The Ministry of Agricultural Development and Research produced an Agricultural Diversification Plan in the late ‘80s (MOADR, 1987) in which a case for crop diversification with OFCs as the base was "a distinct possibility in Sri Lanka". Again, this Plan was primarily concerned with the domestic market for a range of these crops, and concluded that "for many of these crops the domestic market may prove insufficient to absorb the entire production that will come off an organised diversification programme". Production efficiency was therefore, essential in order to keep export options open. A study for the Mahaweli Authority in 1985 (Agroskills 1985) saw the principal agricultural and industrial thrusts of the Authority's Enterprise Development Strategy (EDS) as being aimed at:

(1) "diversifying agriculture in settlers' farms to raise settlers income levels.

(2) bringing in agriculturalists from higher income brackets to introduce basic processing facilities for primary produce and to provide feed stock for agro-industries.

(3) encouraging the setting up of agro-industries designed to draw feed stock from nucleus estates, small holder farmers and Mahaweli settlers".

These crops should be readily marketable either locally or abroad. This EDS was based on the availability of a large area of well drained irrigable soils capable or growing a wide variety of crops. Finally, it should be noted that in 1989, the government approved submissions for new strategies in agricultural development that would move away from mono cropping towards diversified and commercial cropping systems, stressing "higher productivity per land area"(Ministry of Agriculture, Food and Cooperatives 1989).

8.2.1 Technical Inputs Required

Compilation of basic information required for a substantial commitment to diversification in Sri Lanka has proceeded along three broad lines:

(a) surveys for assessing land suitability and water availability,

(b) identification of potential candidate crops, and

(c) agronomic studies of promising crops.

Much work on soil surveys and land capability classifications has been done over the years by several agencies including the Land Use Division of the Irrigation Department. A generalised agro-ecological map for the island was prepared in 1976 that provides broad information on crops for different regions of the country. Information in greater detail has been presented in studies commissioned for major irrigation schemes and in the districts falling within the purview of the various Crop Research Institutes in assessing intercropping opportunities on tea and rubber lands. Information relevant to areas outside the major irrigation schemes has appeared in the FAO study on uneconomic tea lands and in feasibility reports for the UNDP-supported Integrated Rural Development Projects. While these are indispensable as aids to policy planning, they are unfortunately of limited use to actual land users. Since settlement activities in the major irrigation schemes (including the AMDP) continue to alienate irrigable land in small parcels, and taking account of the variations in land use characteristics over relatively short distances, there was no alternative to detailed and essentially "case by case" assessments of potential land use. The requirements could change if irrigable lands were granted to entrepreneurs in much larger areas than hitherto, particularly if they could act as nuclei for surrounding small holders.

8.2.2 Area Potential for Diversification

Some 483,000 hectares were estimated to be irrigable under major and minor irrigation schemes. A minor area of about 6000 to 8000 hectares of this total area has been under sugar cane as a permanent irrigated crop. Another 20,000 hectares were cultivated under diversified short-term crops during the 1986 Yala season. It was estimated that the balance of some 72,000 hectares of well drained land was available under gravity command in the major irrigation schemes and on which farmers could be persuaded to grow upland crops at least in the dry season (Dimantha, 1987). The major problem was that excess moisture in the wet season and unseasonal rains in the dry (Yala) season hampered upland crop cultivation. Selection of short duration varieties and sowing dates became critical.

It was also estimated that there were 185,000 hectares under minor irrigation schemes, where there was insufficient water for rice in the dry season, which could be considered for upland crops. However, much of this area was imperfectly to poorly drained and would require measures to improve surface and sub-surface drainage and avoidance of cropping during the very wet months.

In the context of the present study, which considers investment only in the irrigation sector, emphasis is necessarily placed on the Dry Zone to where the efforts of all major and most minor irrigation schemes have been directed. Diversification of Dry Zone production was thus a central objective. Abeyratne (1967), identified the following features:

(i) Population pressures compel settlements in smallholdings that, however, cannot be economically viable, unless they are entirely irrigated.

(ii) Although a wide variety of food crops are possible, there is no way of producing them effectively without irrigation.

(iii) Due to the soil and drainage characteristics of the Dry Zone even over small distances, a system of diversified farming is essential.

(iv) To maximise returns from land and water, it is essential to grow one type of crop in all suitable land, irrespective of ownership.

8.2.3 Criteria for Diversification

In achieving the objective of developing irrigated farms Abeyratne (1967) envisaged a three fold increase of cultivated area by disciplined water use. He identified farm management, irrigation and mechanisation as three factors to be brought together if any headway was to be made in Dry Zone agriculture. The extreme importance of maximum economy in the use of irrigation water and in the adoption of technologies capable of efficient on-farm water management was emphasised by the assessment that "the total extent of agriculturally good soil in the Dry Zone is far in excess of the total area which could be economically served by conventional irrigation, even after complete exploitation of all the water resources that could be made available from all proposed major storage and diversion schemes" (Panabokke 1967).

The following criteria were identified as important for a successful cropping pattern or for diversification (NEDECO 1984).

Biological feasibility: Crops should be suited to the environment, flexible enough to accommodate drought conditions and should constitute good land use.

Technical feasibility: Technical aspects should be within the capability of the farmer. He should be able to understand and accept new methods or techniques or to improve old ones.

Economic feasibility: Costs of cropping should fall within available resources and yield a reasonable and reliable level of profit. Cropping should be capable of accommodating changes in market demand.

8.2.4 Choice of Crops for Diversification

Historically, there have been two major approaches to the choice of crops for diversification. The first focussed principally on the objectives of attaining domestic self-sufficiency in the more important food items. The quantities were determined by the requirements for balanced nutrition. The second focussed on identification of crops with export potential. Both approaches are discussed below.

8.3 Traditional Crop Strategy

8.3.1 Domestic Market Prospects

Dimantha (1987) estimated the quantities and areas required for some traditional Dry Zone crops (Table 8.3).

The required area of 222,000 hectares of irrigated uplands on the basis of a single crop per year, is not available under the major irrigation schemes. The estimate is 70-80,000 hectares. However, the overall area of all food crops, which is indicative of the total area (irrigated and rainfed) available, conforms reasonably well to the figure of 222,000 hectares required. Clearly this includes rainfed cultivation and single season activities in Yala on paddy lands.

In terms of commercial opportunities offered by prospects for import substitution, flour, milk, cotton and sugar are potentially attractive.

Major factors that determine the extent to which farmers will diversify are the relative financial returns from each crop, labour needs and availability, input costs, cash income flows, level of required technology, storage and markets, accessibility to suitable soils and control over water.

Table 8.4 presents costs and returns for paddy (in Polonnaruwa) and estimates compiled from a number of sources for several other food crops that are commonly cultivated in irrigable uplands.

Table 8.3: Quantities, Yield and Area Required for Some Traditional Dry Zone Crops in 1987

Crop	Qty Required ('000 mt)	Rainfed Yield (Kg/ha)	Irrigated Yield (Kg/ha)	Rainfed area Required ('000 ha.)	Irrigated area Required ('000 ha.)
Cowpea	75	700	1,500	107	50
Green gram	38	600	1,000	62	38
Black gram	27	800	1,500	32	17
Ground nut	30	800	1,500	36	19
Soya bean	9	1,500	2,000	6	5
Chillie	32	400	1,000	77	32
Onions	112	7,000	10,000	16	11
Sugar	300	4,000	6,000	75	50
Total	623	15,800	24,500	411	222

Source: Dimantha, 1987, p.140.

Table 8.4: Costs and Returns for Paddy and Some Other Crops Under Irrigation at Polonnaruwa (Rs. per acre)

Crop	Labour Cost	Other Costs	Total Cost	Yield	Unit Price	Gross Returns	Net Returns
Paddy	730	3,115	3,845	70 bu.	72.0	5,100	1,255
Sesame	2,360	3,759	6,119	1,000 kg	10.25	10,250	4,131
Green gram	4,800	5,411	10,211	1,700 kg	13.5	22,950	12,379
Ground nut	4,600	5,391	9,991	2,000 kg	10.0	20,000	10,009
Soya	3,840	2,870	7,710	2,200 kg	7.5	16,500	8,790
Melon	13,920	4,840	18,760	20,000 kg	3.0	60,000	42,240
Gherkins	28,200	11,000	39,200	8,000 kg	9.0	72,000	32,800
Chillie	20,600	10,561	31,161	1,800 kg	60.0	108,000	76,839
Onions (large)	25,280	15,724	41,004	20,000 kg	13.5	270,000	228,996

Sources: Polonnaruwa District (Agricultural Economics Unit, Department of Agriculture). Other figures were compiled from various sources by Marketing Division, EIED of MASL.

Of particular interest are melons (identified as a potential export crop in an SRD market study discussed below), gherkins (which have acquired considerable popularity by 1980), chillie (very popular in System H) and onions (gaining in popularity). It should be cautioned that these costs and returns are only indicative and can vary sharply with location.

Table 8.5 presents an analysis from crops grown in 1982 Yala at Kalawewa in System H of the Mahaweli.

Financial returns from the crops exert a considerable influence on farmers' choice, and Table 8.4 shows the apparent influence of other related factors, principally prices and markets in Yala season 1982. Chillie predominated in relative popularity amongst OFC's in System H during the 1977-84 period (Table 8.6).

Where conditions for cultivation are appropriate, the opportunity for import substitution is a clear factor in determining the choice of crops. Requirements based on assessed nutritional needs of the population represent the safe upper requirements (Table 8.7). A more immediate opportunity, subject to appropriate purchase and marketing arrangements, is the quantum of imports of commodities that can be produced in the Dry Zone under irrigation.

Table 8.5: Yield and Returns from Crops Grown at Kalawewa, System H Yala Season

Item	Unit	Paddy	Irrigated Chillie	Irrigated Soyabean	Irrigated Cowpea	Irrigated Red Onion	Irrigated Tomato	Irrigated Seed Cotton
Av. Yield	Kg/ha	3,200	1,411	1,444	806	8,675	12,566	1,949
Av. Price	Rs/kg	3.06	19.71	9.34	7.74	5.00	2.75	8.24
Gross Return	Rs/ha	9,799	27,874	13,484	6,255	43,373	34,557	16,060
Net Return (incl. family labour)	Rs/ha	3,561	12,990	4,486	(-)1,155	17,306	15,765	6,203
Net Return (excl. family labour)	Rs/ha	5,825	19,812	8,266	5,045	23,584	21,929	10,798
Net Return (/unit of capital)	Rs	1.46	2.46	1.59	4.18	1.19	1.74	2.05
Net Return (/manday)	Rs	27.43	28.64	17.87	4.48	41.22	38.72	24.89

Source: NEDECO (1984) Detailed Proposals on Alternative Cropping Patterns, Mahaweli Authority of Sri Lanka, Colombo, Annex 1.

By its nature, the Food Balance Sheet does not represent the maximum absorption capacity of the market. Rather, it suggests the lower limit. The comprehensive study of agricultural diversification, completed by the Ministry of Agricultural Development and Research in

1987, was originally to include fruits and vegetables and the crop cluster known as OFCs. For various reasons, the diversification action plan was narrowed down only to OFCs. In diversifying from rice, these crops were seen to be the logical alternatives under irrigation in the pursuit of maximum returns on investment. The OFCs considered were coarse grains (maize), oilseeds (soyabean, groundnuts and sesame), pulses (green and black gram and cowpea), and condiments (chillie and onions).

Table 8.6: Areas of Crop Grown in System H in Yala Season, 1977 to 1984 (hectares)

Year	Chillie	Soyabeans	Cowpea	Green Gram	Red Onion	Bombay Onion	Vegetables	Other
1977	11	4	12	6	3	-	3	36
1978	13	1	35	1	4	-	12	4
1979	9	2	20	13	2	-	49	-
1980	478	40	383	76	31	-	82	19
1981	1,050	170	380	71	29	-	135	15
1982	1,504	457	112	48	20	-	66	100
1983	2,479	394	283	51	18	31	198	-
1984	8,790	800	1,000	300	100	85	16	50

Source: Project Manager's Office, Galnewa.

Table 8.7: Crop Requirements Based on Nutritional Needs in 1986 ('000 tonnes)

Commodity	Total Supply	Production	Imports
Maize	70.62	40.62	30.0
Onions	104.16	56.84	47.32
Soyabean	4.56	3.80	0.76
Cowpea and Dhall	65.9	23.9	42.0
Sugar	358.59	35.06	323.53
Rice	2911.67	25.88	323.67

Notes: a. To this may be added 514,250 metric tons of wheat flour, 24,090 metric tonnes of dried fish and 25,630 tonnes of milk powder.
Source: Food Balance Sheet 1986 - Department of Census and Statistics.

Some 72,000 hectares of irrigable land high in potential for diversification with OFCs were identified in Systems H, B, and C of the Mahaweli Project, Kirindi Oya and Uda Walawe Schemes in this study. Future demand for OFCs could not be estimated with any degree of econometric precision. Two approaches were used, one based on nutritional needs and the other on per capita income growth. The former was naturally the higher. Future production was estimated on a straight line trend basis, assuming technology remained unchanged.

The analysis suggested that production of pulses, soyabean and maize was most likely to encounter domestic demand constraints. There could be a big gap between supply and demand for onions, which would favour producers. Production of black gram, groundnut and gingelly exceeds nutritional needs, which has led to some exports.

Demand estimates, based on income elasticities of demand, suggested that production levels were even closer to potential demand. Only potatoes and onions showed a wide enough gap to encourage rapid production increases. For the rest, additional supplies would have to find export markets. Sri Lanka's potential for exports was assessed for the OFCs with particular reference to Thailand. Average costs of production were compiled on a district basis over the 1978 to 1986 period for comparison, and these were found to vary widely. Overall, gingelly and black gram were competitive, groundnuts to a lesser degree while green gram and maize were not competitive. Certain districts were competitive in these other food crops but others were not, so there was no consistency by location. Over recent years, exports of OFCs have declined owing to such factors as instability in local production, poor quality and unfavourable local prices. This study concluded "diversification (with OFCs) cannot be based entirely on the domestic market as there are indications that the domestic market could be easily saturated".

8.3.2 Export Market Prospects

“Sri Lanka has the potential to break into the export market but the difficulty has been to produce efficiently and competitively" (MARD, 1987, p.20). Sri Lanka would need to lower costs and raise quality with these crops (OFCs) in order to compete internationally. The other crucial question linked with export potential is whether the private profitability of the OFCs is sufficiently attractive to encourage higher production levels. Table 8.8 casts much doubt on this. Comparison of returns per unit of family labour for these crops shows that long and short duration rice varieties were two of the three most remunerative crops. Chillie gave the second highest return. There was then a substantial fall in returns per unit of family labour, ranging from black gram down to the lowest for cowpea. Big and red onions (along with chillie) gave high returns to management and land, but notably, both onion crops were highly labour intensive, which reduced returns to family labour. There was also a major contrast between total variable costs per hectare between rice and chillie and the two onions. Red onions were outstanding in gross returns per hectare, total variable cash costs per hectare, net benefits to management and labour requirements. Attractive as some of these OFCs may be in certain respects, marketing prospects must play a dominant part in the promotion or otherwise of each, as discussed above.

Organisationally, the MARD study recognised the limited administrative, manpower and budgetary resources available and recommended a diversification plan for a number of large contiguous blocks of land where a programme could be carried out economically. Thus, it was not to be a nation-wide programme but one which selected some 11 blocks of land ranging from 5,000 to 54,000 hectares, of which five were in existing irrigation schemes in the Dry Zone. The study of alternative cropping patterns for the Mahaweli Authority in System H, the pilot scheme for the rest of the Project referred to above (NEDECO 1984), was amongst the first to focus on diversification under irrigation. It considered a range of upland crops for the Yala or dry season to be grown on irrigated, well drained reddish brown earths (RBEs). These included the familiar OFCs: chillie, soyabeans, cowpea, green and black grams, red and big onions and vegetables.

The first approach to a diversification strategy for irrigable land is to identify crops that most gainfully exploit the available resources of land, water and labour. Such a study was undertaken in respect of Systems B, C, G and H (AMDP) of the Mahaweli.

The strategy proposed was that well-drained soils not yet allocated to settlers should be reserved for non-rice cropping. Where contiguous lands were available, they were proposed for development in the form of nuclear estates. Such estates would attract the participation of agriculturalists from higher income brackets who would be capable of introducing basic rocessing facilities and providing feedstock for agro-industries. The agro-industries that would thus develop would be designed to draw feedstock from the nuclear estates, small holder farmers and settlers. The resulting diversification in settlers' farms would raise their income levels. The availability of areas of well drained and imperfectly drained land with gravity command in the AMDP are given in Table 8.9.

Crop and Duration (months)	Gross Benefits	Total Variable Cash Cost	Return to Farm Labour, Land, Management and Capital	Total Variable Cash Cost and Opportunity	Net benefit to Labour and Land
Rice 3-3.5 mn.	11,370	5,968	5,672	7,621	4,109 (9)
Rice 4-4.5 mn.	14,417	6,257	8,160	8,108	6,309 (7)
Chillie	47,005	9,787	37,218	18,287	27,718 (3)
B'Onion	55,425	11,225	44,200	26,320	29,105 (2)
R'Onion	91,505	54,762	36,743	62.027	29,478 (1)
Soya bean	12,087	4,675	7,412	7,595	4,492 (8)
Cowpea	9,230	2,322	6,908	7,980	1,250 (11)
Green Gram	14,137	1,987	12,150	6,165	7,972 (4)
Black Gram	12,732	2,362	10,370	5,867	6,865 (6)

Table 8.8: Economic Performance of Crops in Yala Season in Well Irrigated Areas (Rs/hectare)

Note: Figures in brackets are rankings.

Table 8.8. continued

Crop and Duration (months)	Return per Unit of Family Labour	Net Return per Unit of Capital	Return per Unit of Cash Cost	Total Labour Requirement (md/ha.)
Rice 3-3.5 mn.	105 (3)	1.53	1.96 (12)	90
Rice 4-4.5 mn.	129 (1)	1.78	2.30 (11)	105
Chillie	124 (2)	2.43	4.80 (4)	436
B'Onion	86 (6)	2.11	4.94 (3)	662
R'Onion	71 (8)	1.47	1.67 (13)	669
Soya bean	57 (9)	1.59	2.58 (9)	209
Cowpea	34 (12)	1.15	3.97 (5)	220
Green Gram	83 (7)	2.29	7.11 (1)	188
Black Gram	98 (4)	2.17	5.39 (2)	141

Table 8.9: Areas of Gravity Command Within the AMDP by Type of Drainage			
System	**Well Drained Irrigable**	**Imperfectly/Poorly Drained, Irrigable**	**% Well Drained**
B	4,790	39,425	11
C	3,276	18,696	15
G	996	1,993	33
H	9,675	14,500	50
Total	18,737	74,614	25

Source: Agroskills Ltd., 1985.

8.3.3 New Crops

In Systems G and H, settlers occupy almost all arable lands (about 27,000 hectares). Unallocated irrigable land in Systems B and C amounts to around 7,300 hectares while a further 19,000 hectares of poorer soils are available for crops that are not exacting in their soil requirements.

Once the assessments of land availability indicated that sizeable areas were available, selection of crops was based on four main criteria.

a) agro-climatic suitability.

b) amenability to crop rotation patterns and versatility to be grown profitably on different sizes of units - small holdings, commercial farms and settler lands.

c) consistency with planned irrigation development and labour availability.

d) ready marketability - domestic or export - or as the feed stock for agro-industries to be set up.

A first list of 27 crops was prepared, using criteria (a)-(c) above. This necessarily was not exhaustive and relied heavily on already available evidence of local performance and familiarity with the crops. It excluded crops with potential if they were unproven in the locality. The report acknowledges this deficiency. The next phase of crop selection took account of the marketability criterion (d) within the terms of domestic and potential export demand.

Next, the crops were placed in categories according to priority, with the following specifications:-

Category 1 Crops with potential for immediate results on account of their agronomic suitability and marketability: mango, pawpaw, tomato, capsicum, sesame, blackgram, cashew, soyabean, greengram, chillie, onions and pasture.

Category 2 Crops that appear to have potential but whose agronomic suitability and/ or marketability would need further investigation for which government support would be warranted: pineapple, ginger, turmeric, coconut, maize and groundnut.

Category 3 Crops which appear to be agronomically suitable but whose economic feasibility and marketability should be further investigated by prospective investors: banana, passionfruit, okra, gherkin, cucurbits, cassava and specialty rice.

The above crops were further assigned to the different systems on the basis of expected suitability and their irrigation requirements, and end uses were defined. Subsequent to the preparation of this study, progress in certain crops - notably gherkins, passionfruit, groundnut, melons and pineapple - seemed to establish their agronomic suitability and may warrant revisions of this position.

8.3.4 Candidate Crop List

The soils of the Dry Zone fall largely into four great soil groups - the Reddish Brown Earths (RBEs), Non-calcic brown soils, red-yellow latosols and Low Humic Gley soils (LHGs). The last named are generally distributed throughout the lowlands in the lower topographic sites. Small deposits of alluvial soils occur along valleys and flood plains of major streams and rivers (Panabokke, 1967). The RBE soils are the most important quantitatively and agriculturally. With the exception of the LHGs and some of the alluvial soils that are ill-drained and thus are more suitable for paddy than for diversified cropping, by far the greater part of the Dry Zone is eminently suitable for diversified irrigated agriculture. This is all the more so because well drained LHGs are now known to be able to be used for crops other than paddy. Since most crops other than paddy favour moist to dry soil conditions, the essence of their successful management is the avoidance of over-wet conditions in the Maha (wet) Season and assurance of regular supplies of irrigation water in the dry periods of the Yala season.

It has been argued in a number of studies that, if proper irrigation technology, land formation and selection of appropriate cultivars are practiced, the range of soils in the irrigated zones provides very satisfactory conditions for a diversity of crops. In addition to traditional crops grown, a lengthy list of candidate crops, held out to have agronomic promise and expected to perform well under irrigated conditions, have been put forward (Table 8.10).

Table 8.10:Crops Identified as having Potential for Mahaweli areas

Crop List		
1. Traditional Crops		
Manioc	Maize	Cowpea
Sweet Potato	Sorghum	Groundnut
Yams	Finger Millet	Soyabean
Red Onions	Foxtail Millet	Green Gram
Big Onions	Sesame	Black Gram
Chillie	Vegetables	Dhall
2. Agroskills	**Recommendations**	
Castor	Maize	Mango
Groundnut	Chillie	Passion Fruit
Sesame	Onions	Papaya
Soyabean	Manioc	Pineapple
Black Gram	Grass/Legume Pastures	Tomato (industrial)
Green Gram	Banana	Cashew
Gherkin	Citrus	Coconut
Vegetables		
3. Daines (SRD Study)	**Recommendations**	**(on market demand)**
Grapes	Strawberries	Speciality bananas
Asparagus	Pineapple	
4. STA Group	**Recommendations**	
Sweet bamboo	Ginger	
Baby Corn	Asparagus	
Other Prospects		
Oilseeds	**Fibre**	**Condiments & Spices**
Castor	Hemp	Ginger
Sunflower	Kenaf	Coriander
Sesame	Flax	Turmeric
Jojoba	Kapok	Mustard
Niger	Pepper	Garlic
Beverages	**Essential Oils, Drugs**	**Feed & Fodder**
Coffee	Catharanthus roseus	Sorghum
Cocoa	Gloriosa superba	Maize
Lemon Grass	Pastures	Pelletised Grass
Citronella	Vetiver	Leaf Protein
Industrial	**Fruit & Orchard**	**Water Bodies**
Bamboo	Mango	Ornamental Fish
Cane	Avocado	Freshwater Prawns
Rubber	Sour Sop	Edible Fish
Coconut	Woodapple	*Fish Meal
	Chicle (sapota)	
	Beli Fruit	

Sources: S.R. Daines (1988), Agroskills (1983), STA Group.

There is little experience in irrigated culture of perennial and semi-perennial crops. However, demonstrations in the 1990s (e.g., Galnewa Farm of System H) have provided useful evidence of effectiveness of micro-irrigation systems in delivering water directly to the root zones of trees.

8.4 The Export Market Strategy

8.4.1 Perishable Products

The second approach taken towards diversification in irrigated agricultural areas is one that can be termed the Export Marketing Strategy (EMS). This was favoured by the EIED of the Mahaweli Authority in the late 1980s and early 1990s. A private consulting firm identified commodities with an export potential. This was undertaken in two stages: the first identified perishable products, the second identified processed or semi-processed commodities for export markets. This discussion is confined to the first category.

The export potential for a product was seen as based on a long run competitive and comparative advantage: long run because risks and costs are high, so that Sri Lankan products must be assessed as having an underlying advantage, preferably over most, if not all, competitors. The SRD study suggested Sri Lanka had three major long run competitive advantages over many existing or potential competitors:

Seasonal flexibility: enabling many crops to be grown all year round owing to favourable temperatures, rainfall incidence and irrigation water availability (provided the water can be used efficiently). The long dry season in the Mahaweli and South East Dry Zone minimises pest and disease problems.

Low labour costs: labour costs are substantially lower than those in other developing countries of Asia, Central and Southern America. This advantage of course becomes more marked for crops where labour inputs are high. Labour intensity was a criterion in choice of products.

Geographical position and Transport costs: the SRD group considered Sri Lanka to be very advantageously located, mid way between the two largest importing regions for fresh fruits and vegetables, Western Europe and the Pacific Rim, centred on Japan. The study suggested a valuable opportunity for geographical diversification between these two market regions. In practice, while it is true that most other existing or potential competitors are restricted to only one of these regions, Sri Lanka is located relatively distantly from each of these market regions (Nippon Koei, 1988). For example, tropical African countries are closer to Western Europe, Central America to the USA, and Thailand, Malaysia and Taiwan are closer to Japan. The major exception is the Gulf market, where Sri Lanka has only India, Pakistan and Kenya as its competitors.

A lack of transport advantage may not be critical if it is outweighed by the first two advantages of seasonal flexibility and low labour costs. Finally, it should be noted that at present, Sri Lanka is not well served by air or sea freight services. Air Lanka is a small airline with limited flights and routes, and other major airlines utilise Singapore (and Bangkok to a lesser extent) to take advantage of the high frequency/high volume traffic flow. It may be necessary for Sri Lanka to link up with this international network through Singapore under special freight agreements, or improve its range of direct flights. Sri Lanka's future in sea freight remains unresolved at this point of time, though it does have a favourable location. Singapore would offer the greatest competition.

There is one aspect in which geographic isolation could act as a disadvantage. The Mahaweli and the South East Dry Zone (SEDZ) are located at considerable distances from the one international airport near Colombo. For producers, road and rail links are reasonably well developed, if somewhat slow-moving, but there are difficulties in communications and living conditions, and there is a lack of the sophisticated services necessarily associated with exports by air-freight in particular. These factors place the Mahaweli and the SEDZ at a management disadvantage (SRD, 1988: p.3).

The SRD study first decided to select the major markets most favourable to Sri Lanka. Choice was based upon accessibility (tariff, sanitary restrictions and barriers based on quality standards and sophistication) and market size. On these criteria, accessibility ratings ranged from Gulf markets (easiest), Singapore/Hong Kong (easy), Europe and Australia (average) and Japan (difficult).

In terms of market size, the most dominant market was Western Europe. Excluding internal supplies, the non-EEC imports to Europe of fresh fruit and vegetables were roughly double those in the USA and treble those in Japan. Gulf markets were small but easy to enter and are of particular significance for crops such as bananas. The

Singapore/Hong Kong/Australia ("South East Asia") area was also easy and gives a margin for quality. Collectively, they are about twice the size of Gulf markets. SRD's final country ranking in terms of relative importance was:

1. West Germany
2. United Kingdom
3. Japan
4. Gulf and Middle East
5. Hong Kong
6. Singapore

A selection of products then followed, for which seven criteria were used including market demand (imports and consumption), transport shelf life (days), labour content and technology requirements. The weightings given to each were arbitrary, so that the 'final priority score' might be arguable. First, products were preferred with large market demands and second, where large proportions were met by imports. Transport shelf life was evaluated in terms of perishability and feasibility of reaching markets in 10-15 days of sea travel. Labour content was important partly because it is an indicator of comparative advantage for Sri Lanka and partly because productive employment generation is an important objective. The final three were technological difficulty, availability of existing produce and the time frame for impacts on the Mahaweli.

Sixty products were given preliminary listings in Mahaweli/SRD lists, of which 18 were left after application of the above criteria, viz.,

1. Bananas
2. Tomatoes
3. Carnations
4. Peppers/Chillie
5. Shrimp
6. Mushrooms
7. Grapes
8. Pineapples
9. Mango
10. Gherkin/Cucumbers
11. Cashews
12. Orchids
13. Strawberries
14. Asparagus
15. Ginger
16. Melons
17. Papaya
18. Garlic

As the SRD report notes importantly (p.6) "The strength of a seasonally flexible production climate such as Sri Lanka has, is that the current size of imports is a vast underestimate of total import 'demand' for most products". This is because supply is seasonal while household consumption demand is often fairly even throughout the year.

A demand model constructed for 17 selected products for Sri Lankan local consumption (with income and population growth assumptions to year 2000) showed that only chillie and papayas would require sizeable extra output and then only around 10,000 additional hectares for each. Garlic was a third and special product since most is imported. None of these three "survived" as a high priority export product. Hence, it was concluded that the local market had very limited absorptive capacity for products with high export potential. Thus, the possible local absorption of export oriented crops was not recommended. This, therefore, quite clearly differentiated the domestic-oriented from the export-oriented crops.

The 18 selected products were tested in a field survey by the SRD team in 13 countries to obtain a final priority list of 14 products associated with markets. This was done by adding two criteria to the seven described above: market interest and competitive position of Sri Lankan products. The final ranking for export market priorities was as follows:

1.	Grapes	2.	Strawberries
3.	Asparagus	4.	Pineapple
5.	Bananas	6.	Mango
7.	Melon	8.	Shrimp
9.	Mushroom	10.	Orchids
11.	Pepper	12.	Cashew
13.	Gherkin	14.	Tomato

The SRD study separated these 14 into four categories:

a) **Springboard** - large markets and favourable competitive positions with a potential to become whole industries in the Mahaweli leading the way in infrastructural development technology transfer for other industries to follow. In order, five such products were identified: table grapes, strawberries, asparagus, pineapple and bananas, with grapes well out in front involving few technological, management or infrastructural difficulties. Strawberries involved difficult training infrastructural and management requirements. Pineapples and bananas would give most problems.

b) **General Major Markets –** viz., mangoes, melons and shrimps that have large markets in more than one area. Mangoes should, on SRD criteria, be the first and maybe only focus in exotic tropical fruit market as the most important single market, but Sri Lanka faces stiff competition.

c) **Single Major Markets** - two in all and both in Japan: viz. dried Shitake mushrooms and potted orchids. Both are large enough markets for exploitation.

d) **Target Markets** - these are small and locationally specific, e.g., gherkins in Australia and more recently in Europe. This and others crops can be important for a few enterprises with a limited total area under production.

The top market in terms of priority rankings was West Germany (fruits, vegetables, flowers). Twelve products/markets were in the highest 'springboard' category and half were in West Germany. Japan and the UK were seen as ranking next for Sri Lankan produce with the former having the larger long term potential with higher income and population, but adjusted downwards for difficulty of market entry owing to rigid sanitary regulations, and of communications.

Another report, focusing only on the UK fruit and vegetable market (M&IA, 1988), suggested that prospects for exotic fruits and vegetables were favourable, both during the on and off seasons, particularly for fruit. This has been partly due to increased airfreighting to the UK adding to the variety available, but also to retailers in presenting new lines, especially through the supermarket chains. Among the fruits were avocado, mango and (perhaps) papaya. Smaller volume fruits including lychees and passionfruit were mentioned. On a cautious note, the study concluded that opportunities for Sri Lankan produce would centre on high value categories, which justified transportation costs. It also concluded that few such products could be sent by sea owing to perishability, so airfreight would be crucial. The main opportunities for Sri Lanka would lie in these higher value, smaller volume categories e.g., exotic or speciality fruits and vegetables and the out-of-season non-exotics e.g., strawberries. The main concern was whether Sri Lanka could land produce in the UK at a competitive price, given the distance involved. It voiced some doubts as follows:

"For many lines it is evident that however good the quality and presentation and however efficient were production, marketing and distribution, Sri Lanka would be unable to land produce in the UK at a price which was on a par with prevailing levels. This is largely a matter of transportation costs, Sri Lanka's distance from the market imposing a major barrier. In addition, production in major supplying countries is by large scale highly efficient operations, and it must be questioned whether Sri Lanka is suited to such agricultural organisation" (M&IA, 1988, p.i).

The SRD report finally listed the top five products for export from Sri Lanka.

1. **Grapes**

   Their analysis showed an almost six month off-season market window, from mid-December to the end of May. It noted that, up till then, off-season supplies have come from temperate climate countries in the Southern Hemisphere. Tropical quality, table grape production on a commercial scale is very recent, e.g., from Maharashtra, India. Northern Europe is the best market and SRD recommended this as the top priority crop for the Mahaweli. This crop has a lengthy storage life.

2. **Strawberries**

   The best market window in major markets is from December to May and especially in December and January. The crop has a short shelf life. It should be noted that expertise in this crop exists in Nuwara Eliya from production through to market and much could be learnt from this.

3. **Asparagus**

   The European market window is from July to December/January. Again this is a typically temperate climate crop and tropical production on an export scale is very recent and will grow in Thailand and Sri Lanka. Fresh asparagus markets are largest in West Germany, followed by France, Japan and other European countries. Production is already under way in the Mahaweli, but yields, profitability and market connections need further study.

4. **Pineapple**

   Major competitors are from Latin America, tropical Africa and Southeast Asia (Thailand, Malaysia and the Philippines). There has been a shift from processed to fresh fruit in the market and it is becoming a major all year round fresh fruit staple. Successful experimental trials have been undertaken in the Mahaweli (System H).

5. **Bananas**

SRD claimed that the most important market for Sri Lankan bananas in Europe was in the speciality varieties, as the world market is dominated by the Cavendish variety. Those with promise of high price and profitability and a market niche may be Ambul and Kolikuttu, both native to Sri Lanka. The country is in a highly favourable position to sell to Middle East markets from Iran to Libya. Historical ties between colonies with multinational involvement dominate the large markets in Europe for Cavendish bananas. Again, trials are in process in System H with these two local varieties under irrigation. Systems B may be suitable for this crop in the Mahaweli.

The two broad approaches presented above represent opposite ends of the spectrum in terms of developing a strategy for diversification for Sri Lanka. The first commences at the production end, with familiar crops but with a limited vision of the potentialities of modernising agriculture through crop diversification and on-demand irrigation. The market strategy has the vision, in terms of an export crop strategy for diversification, but is weak at the production end. Both approaches envisage diversification as being based upon the irrigation technology currently available and do not consider modernisation. Perhaps this last is too much to expect, yet in other countries dependent upon export-oriented crop diversification, irrigation technology is a central concern. It is still a marginal consideration in Sri Lanka, immersed as it has been in a rice based farming system and a traditional gravity flow irrigation system. It is well recognised in Sri Lanka that this system is not suited to the demands and needs of non-rice crops but to date neither crop diversification nor the techniques of modernising irrigation water delivery systems and their integration have become part of the thinking of policy makers.

This study recognises the continuing role of rice in the agricultural sector, as set out in the previous chapter, and thus of the continuity of the traditional irrigation systems and methods of water delivery. But in seeking to diversify production in the long term and on a large scale, it also canvasses the options among irrigation technologies both to and on-farm, for these determine productivity, investment levels and returns on investments. Above all, the choice must be made amongst options that are adapted or are adaptable to the small holder who is to be the basic production unit.

8.5 Field Production Data

One major weakness in the various recommendations of the export market strategy has been the paucity of field production data on export-oriented crops selected by the SRD study for their market potential. It is not that the crops in question are unknown in Sri Lanka. Indeed of the eighteen priority crops, virtually all are produced on some scale, however small. The problem is that very few are grown on an organised industry basis as sole or even as interplanted crops. They may or may not be irrigated, but if they are, the system used is 'low irrigation technology". Many are grown in house lots in a haphazard cropping mixture. With such organisation, statistics on inputs, yields, costs, and returns are of course not available. Data are almost non-existent on production under `high irrigation technology', which is necessary to break the monsoon cycle.

The SRD study was conscious of both the production and the intermediate stages leading to actual sales in export markets. They emphasised the wide variety of skills required in this pioneering area of diversification, and identified three key areas in which experience was required.

a) Experience in production of perishables.
b) Experience in post harvest handling and transport of perishables.
c) Experience in marketing of perishables.

But the SRD survey study team interacted mostly with private sector firms and not with small holders. The preferred strategy was to find firms with production experience and those that were capable of and interested in developing the necessary technological skills of production and to use these as the starting base for each industry. Each would be allocated a substantial area of suitable land, e.g., up to 50 acres, on a long-term lease. It was envisaged that these firms would have a demonstration effect on surrounding smallholders who would acquire the technology to grow the crop on a small scale. Technology and support would thus flow from the central firm outwards in what is termed the 'outgrower' system. This had already commenced independently with gherkins within and outside the Mahaweli. Among private sector firms, 40 to 50 had some production experience with perishables and a number had experience in four of the top seven products in priority, pineapple, bananas, mangoes and melons, in order of frequency.

Experience was much less common in post-harvest handling and transport and perishables (8 of 100 businessmen), so skills in cooling, selection, packaging and refrigerated transport were seriously lacking, and this area was named as the single most important enterprise capability constraint. This is hardly surprising, as marketing organisation is weak in Sri Lanka. First, only a small volume of perishables is exported e.g., to the Maldives. Second, marketing is dominated by small farmers with limited quantities of surplus produce for sale, ‘assemblers’ who aggregate this produce, and 'collectors' who generally trade with wholesalers located in the main consumption centres (Nippon Koei, 1988). The practices of sorting, grading and drying of crops for storage are rare, as are cold store facilities, which are needed between production areas and ports of exit. The transport infrastructure is quite well developed (though not specifically for exports) but marketing facilities are poor. The third area is export market experience. Farmers are not well informed about prices, varieties or quality standards required for export. Only a few private sector firms have had direct experience with these markets, particularly in Japan or Western Europe.

Thus there are gaps in knowledge of requirements in post harvest technology, handling and transport of perishables and of course in export market information. These gaps can be filled from experience available in other countries that can be transferred to Sri Lanka, with modifications as may be needed. In relation to market demand, there are a number of ways information can be obtained to assess market potential for new Sri Lankan exports. One, however, with particular merit is ANUGA, the biennial food fair that has been held in Cologne in the Federal Republic of Germany since the 1950s. It is the world's biggest food fair and attracts buyers and sellers from all countries.

An area of greater concern is the nucleus firm/outgrower strategy of developing these industries. While an attractive approach, there are inherent weaknesses in relying solely upon it.

l. It is questionable whether enough private sector firms will be prepared to invest in each of the priority industries identified for development.

2. There is no assurance that they will be successful and thus subsequently have the desired demonstration effect upon outgrowers.

3. These `nucleus' firms appear to be expected to impart the necessary technology to outgrowers through active extension activities. It is open to doubt whether all or many would wish this involvement and/or would have the resources and expertise to participate in this way.

4. Even if they were willing, there would be a time lag involved. The nucleus firms would themselves have to achieve successful results on their own farms before they

could confidently offer technical advice to farmers. While large firms could afford to absorb initial losses, small holders could not.

This strategy of production organisation deserves support in cases where nucleus firms are likely to be successful and wish to assist the development of an outgrower system. However, it has restricted appeal from the viewpoints of whole industry organisation and of a time frame for the development of broad (smallholder) based export industries. Since MASL does not have the resources for much research and extension itself and already depends heavily upon the Department of Agriculture, it seems appropriate that the Department should play a role, if not the major role, in smallholder development of these crops. This would involve a change in emphasis for the Department that hitherto has been primarily concerned with rice. However, it could be achieved through an expansion of the existing Horticulture Division, which in fact has been recently engaged in the importation of a large number of varieties of a wide range of existing and exotic horticultural crops for introduction and commercial development in Sri Lanka. Other Divisions should also be strongly involved, particularly Research, Extension and Agricultural Economic and Projects. This could remove much of the uncertainty of dependence of the smallholder on the lead activities of the private sector and accelerate the contribution of the smallholder. The private sector may well benefit more through expanded activity in the post-harvest to marketing phases, where its strengths are more proven.

8.5.1 Processed Export Crops

Discussion to this point has focussed solely upon perishable export crops, as this has been the focus of interest for diversification. Another direction in the diversification process is into processed export crops. This area has been little explored as yet in terms of potential in international markets, but is a logical next step, i.e., into post-harvest technology research. It can be argued that the initial focus of the export strategy might be more strongly focussed on processed commodities as they pose fewer problems in technology between field and market, e.g., gherkins.

8.5.2 Import Substitution Products

The potential for expanded production of some commodities for the domestic market should not be ignored where a potential exists. This has already been discussed in relation to OFCs, where there is a limited potential except for chillie and perhaps onions. The other commodity areas with potential under irrigation conditions are sericulture and livestock products and within this latter category, milk production. At present, milk products are a major and costly import item.

8.5.3 Dairy Development[8]

Dairy development was originally begun as a Draught Animal Programme by MEA in the Mahaweli to enable substitution of draught animal power for expensive tractors. This was expanded to include a Dairy component in 1983 as a result of the desire of farmers to add one or two animal production units to their agricultural incomes. This latter programme comprised:

- Breeding better quality dual purpose animals.
- An active extension service.
- A positive nutrition programme.
- An animal health and disease control programme.
- An efficient milk collection system.
- Milk processing to give added value to the farmer .

By 1990, all indigenous animals will have been upgraded in Systems H and C using imported bulls. The extension service has encouraged the formation of producer associations (self- managed). Producers were paid fortnightly in Mahaweli areas. However, by then only 10-15% of settlers is associated with income generating dairy production. This was due primarily to the shortage of suitable improved stock to expand the number of units.

In addition to these efforts, one large company in the private sector commenced dairy development in 1983 through the encouragement of fresh milk collection from outgrowers. Factories were set up in Anuradhapura, Kurunegala, Puttalam and Kandy. Total collections have increased from 5.7 million litres in 1983 to 13.06 million litres in 1987. While this was only a small proportion of total consumption of milk products, it is a profitable and expansionary type of diversification for small holders, and deserves encouragement.

8.5.4 Other Livestock

Small holder participation in poultry, goat, pigs and duck programmes has started in the Mahaweli but these programmes are currently given lower priority than dairy development.

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[8] This section benefited from advice of Mr C.de Saram, Secretary General, MASL who initiated and developed the Mahaweli Livestock Programmes.

9. Developments in Irrigation and Agriculture in the 1990s

This final chapter focuses on developments in irrigation and agriculture in the 1990s. It examines agricultural performance and its major determinants in the 1990s highlighting significant shifts in policy in the agricultural and irrigation sectors.

9.1 Agricultural Performance

During the 1980s, there was widespread concern that agricultural sector growth rates in developing countries were much slower than those in the industrial and service sectors, and that agricultural performance was retarding the overall pace of economic development. Also, since population growth rates remained high and the transfer of labour out of agriculture was slow, poverty was increasingly becoming concentrated in the rural sector. This deteriorating situation led to a reassessment of development strategies from the mid-1980s.

Table 9.1 Growth Rates and Structure of Real Output, 1986 to 1997 (constant prices)

1. Growth	**1978-89a**	**1990-97a**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Agriculture	2.5	2.2	0.8	-2.4	5.0	3.8	3.3	-5.1	3.0
Manufacturing	5.4	8.7	6.8	8.8	10.5	9.1	9.2	6.5	9.3
Services	5.5	5.6	5.9	5.7	6.4	5.3	5.0	5.5	6.6
GDP	4.7	5.4	4.6	4.3	6.9	5.6	5.5	3.8	6.4
2. Structure	1980	1990	1991	1992	1993	1994	1995	1996	1997
Agriculture	22.2	19.9	19.2	18.0	17.6	17.3	17.0	15.5	15.0
Manufacturing	13.7	17.4	17.7	18.5	19.1	19.7	20.4	21.0	21.5
Services	58.5	56.4	57.1	57.8	57.5	57.4	57.1	58.1	58.2
GDP*	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes: a. Annual average compound growth rate.
* Includes Mining and Quarrying.
Sources: Ministry of Policy Planning and Implementation (1991) and Institute of Policy Studies (1998).

Sri Lanka was one such case of weak agricultural performance (Table 9.1). The average growth rate of agricultural output during 1978-89 was 2.5 per cent per annum as against 5.4 per cent for manufacturing and 5.5 per cent for services, which substantially dampened the growth rate of GDP to an average of 4.7 per cent. In the subsequent period of 1990-97, average agricultural growth was slower at 2.2 per cent per annum, as against 8.7 per cent for manufacturing and 5.6 per cent for services and 5.4 per cent for GDP. Over the period 1980 to 1997, the share of agriculture in GDP fell from 22.2 per cent to 15.0 per cent, but in 1995, some 65 per cent of total population, and 40 per cent of the total workforce were still rural based (World Bank 1995).

9.2.2 Determinants of Agricultural Performance

Key factors that influenced agricultural performance in the 1990s were irrigation policy and the priority given to irrigation in the Public Investment Program (PIP), macroeconomic policy and agricultural policy, which are considered below:

9.2.1. Irrigation Policy and Practice

Irrigation has been traditionally a cornerstone of agricultural development policy. It has underpinned the policies of self-sufficiency in basic foods, enhancement of the nutritional status of the people, and the alleviation of poverty. It has been a prominent, at times dominant, component of the Public Investment Programme (PIP) as shown in this study. Large scale irrigation schemes have been the leading edge of this policy, culminating in the Accelerated Mahaweli Development Programme (AMDP).

At its height, the agricultural sector, including irrigation, dominated the PIP during the 1980s. In 1981-85, agriculture's share was 45 per cent (Chapter 3, Table 3.3). Total irrigation investment was 43 per cent of total PIP and thus dominated agricultural investment. Of this, 38 per cent was on the Mahaweli (AMDP) and only 5 per cent on non-Mahaweli.

In the 1980s, concerns grew over the dominance of irrigation and the AMDP. Possible adverse impacts on Sri Lanka's economy were canvassed by critics including:

- inflationary pressures arising from the high and sustained levels of investment in irrigation.
- postponement of essential developments in other sectors.
- the crowding out, by emphasis on large scale new irrigation schemes, of other options within the irrigation sub-sector, such as rehabilitation schemes. Only 4 per cent of the cropped area was in new large irrigation schemes, while 41 per cent was in rehabilitated schemes, 24 per cent in minor schemes and 31 per cent in rainfed areas.

- The unaffordably high opportunity cost of pursuing food security through physical self-sufficiency in basic foods in terms of sector growth foregone. The World Bank (1995) estimated that on 1993 output with no cost recovery, the total annual cost of the subsidy was US$250 million for paddy and other import-competing crops. This amounted to about 3 per cent of GDP and favoured farmers in major irrigation systems. The Bank calculated that the subsidy on recently constructed schemes was five times that in major rehabilitation schemes and seven times that in minor rehabilitated schemes.

In 1984, the National Food and Nutrition Strategy (NAFNS) called for a new perspective on irrigation development (NAFNS 1984), in the form of redirection of investments towards rehabilitation and new efforts in water management. It continued to espouse self-sufficiency in basic foods, but it also advocated enhancement of incomes and creation of new employment opportunities in the rural sector, improved nutritional status of the people and expansion of export capacity to improve the balance of payments.

The World Bank (1987) highlighted serious challenges with respect to cost recovery, water management and the rehabilitation of irrigation infrastructure. It emphasised that financial viability required full cost recovery (capital and O&M) from the farmers and that an economically efficient system required water to be priced by the market through supply and demand interaction. The Bank urged irrigation policy reform through the treatment of irrigation water as a private good with:

- basic legal and institutional structures to facilitate market forces, and
- enforceable water property rights for individual farmers and water markets.

The Bank criticised the high cost of irrigation in its Country Economic Memorandum submitted to the Sri Lankan Aid Group Meeting in 1988 (World Bank 1988). The report recommended that the share of irrigation/resettlement in future PIPs be reduced substantially, and future investments should concentrate on high return projects in rehabilitation and on the upgrading of existing irrigation schemes. It also recommended a major reorientation of the existing programs, and particularly reconsideration of plans to complete the fifth dam under the AMDP (Moragahakanda).

The cost of irrigation development, particularly of new large scale schemes, has been high because successive Sri Lankan governments have regarded irrigation water as a public good and have invested without recourse to cost recovery. In 1983, a nation-wide program of water charges was introduced but with little success. Cost recovery conditionality was tried but collections ceased in the face of political opposition and enforcement problems. To date, the Bank's efforts to introduce a cost recover program into irrigated areas has achieved a degree of success only in the Mahaweli.

Greater priority was urged for rehabilitation schemes from the mid-1980s based partly on attractive projected rates of return. While the need for rehabilitation of existing major and minor schemes was clear, our *ex post* analysis of past schemes (Chapter 5) showed that returns fell well short of expectations. The optimism was based on the prospects of a new technology and cropping pattern – the "Walagambahuwa" model – included in successive rehabilitation schemes. In practice this technology proved too risky for farmers who preferred to continue with traditional practices. Nevertheless, the rehabilitation program of major and minor schemes continued to be implemented in successive projects.

In practice, the 1990s witnessed a major shift in public investment away from agriculture and irrigation in the PIP, as described in Chapter 3 (Table 3.3). The agricultural sector's share fell from a peak of 54 per cent in 1981-85 to 22 per cent in 1987-91 and again to 10 per cent in 1996-2000.

Total irrigation investment was 43 per cent of total PIP in 1981-85 and thus dominated agricultural investment. By 1987-91, it was down to 15 per cent, with Mahaweli still dominant (12 per cent) and non-Mahaweli only 3 per cent. By 1996-2000, total irrigation was 5 per cent with Mahaweli 3 per cent and non-Mahaweli 2 per cent.

In the early 1990s, it was judged that practically all economically viable new irrigation schemes had been constructed (Ministry of Finance and Planning 1992). With construction and rehabilitation of most of the major schemes completed or nearing completion, budgetary allocations to Other Irrigation also decreased. The emphasis shifted to institutional re-orientation and rehabilitation of existing systems to optimize efficiency of water utilisation (i.e., farmers' organisations for O&M). There was also an increasing emphasis on diversifying into high income agriculture based on consolidation of systems and improved drainage, salt water exclusion and ground water development. Broad priorities were given to sustainability, watershed management and comprehensive river basin development.

The emphasis in the PIP shifted to economic and social overheads. In 1981-85, total investment in overheads were 27 per cent of PIP (23 per cent economic and 4 per cent social). By 1996-2000, total overheads received 53 per cent of total PIP (40 per cent economic and 13 per cent social).

9.2 Macroeconomic Policy

Under the policy regime pursued until 1977, the agricultural sector suffered from discrimination in favour of manufacturing with:

- high effective rates of protection through high import tariffs and trade restrictions on final products
- lower but substantial import tariffs on intermediate products,
- an overvalued exchange rate
- export taxes on tree crops

In the 1980s and 1990s, the Sri Lankan government pursued a course of economic reform through liberalisation, market-orientation and globalisation, which progressively reversed previous inward-looking policies of stringent exchange and trade controls and import substitution, and state intervention in all areas of economic activity (Athukorala 1997). The agenda for reform and liberalisation including reduction of levels and adjustment of relative levels of protection between sectors, particularly of bias towards manufacturing at the expense of agriculture. Trade liberalisation programs underway since 1977 included rebate schemes for manufactured exports to provide access to imported inputs at duty free prices, but these had limited effect on agriculture due to the relatively low use of imported inputs.

After 1988, the pace of trade liberalisation was slow and poorly designed (Athukorala 1997). Where some tariffs were reduced, benefits were moderated by changes in other taxes or administrative procedures. Instead of liberalising trade, the main focus was in trying to offset biases in the protection system against exports through a host of special incentives for exporters. In the face of a strong bias against agriculture, pressures also developed for further interventions aimed at protecting or subsidising some segments of agriculture rather than phasing out high protection for import substituting manufactures.

Agricultural price and trade policies were left virtually undisturbed. The most important intervention domestically was the Guaranteed Price Scheme (GPS) for paddy, which set the domestic producer price above the border price. This was introduced in 1948 and still applies. However in recent years, a restrictive import price has had a greater impact.

Government intervention in paddy marketing was greatly reduced with only a small proportion of paddy output purchased.

A study of protection undertaken by the World Bank (1995) quantified the types and levels of protection given in 1993 to agriculture, to sub-sectors within agriculture and the relative levels between agriculture and manufacturing. As bias against agriculture has been considered to be a factor retarding agricultural performance, the major findings are presented below:

(a) Agriculture

- There was positive protection for the main import-competing crops (paddy, chillie,onion and potato), as measured on output. Nominal Protection Coefficients (NPCs)[9], were in excess of 1. The NPC for rice was 1.3 in 1993. In 1985-93, NPCs averaged 1.3 for chillie, 2.0 for big onions and 1.6 for potato. Using production weights, the average NPC for import competing crops was 1.33, which was close to rice.
- The Effective Protection Coefficient (EPC)[10], which measured protection provided to rice on traded inputs and output, was small after 1990. In 1993, it was between 1.34 and 1.38 for rice, depending on the water regime (Table 9.2). Average EPCs for rice and import competing crops were 1.36 and 1.70 in 1993. Both were close to their respective NPC estimates in that year, showing that output price policy dominated price-based production incentives for farmers.
- The EPC for export crops in 1990-93 averaged 1.02, implying a virtually neutral regime. Nonplantation export crops were mainly fruits, vegetables, foliage plants, medicinal herbs, etc., which showed active growth up to the early 1990s. Other minor crops, such as cinnamon and raw tobacco also showed growth.
- The overall EPC was 1.35 for the nonplantation crop sector in 1993. It was 1.00 for plantation agriculture, which reflected the removal of export taxes on plantation products. The EPC was 1.24 for agriculture as a whole.

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[9] Positive protection is indicated by ratios exceeding 1.
[10] Effective Protection Coefficients (EPCs) measure net incentive for a crop showing the combined net protection or disprotection received by output and by traded inputs (fertilisers, agrochemicals, machinery) used in its production.

- Effective Subsidy Coefficients (ESCs)[11] are important in Sri Lanka because of the importance of irrigation, research and extension in crop agriculture, for which cost recovery has been zero. For irrigation, the subsidy is 100 per cent of the annual cost repayment, finance and O&M charges. In large scale irrigation systems, the construction cost subsidy was 96 per cent of the economic value added per hectare for paddy. With no cost recovery, the subsidy to major new irrigation systems was as high as US$1,000 per hectare per annum. The O&M subsidy was 3.5 per cent of the economic value added for paddy. For rehabilitation investment, the subsidy totaled 27 per cent for major and 21 per cent for minor schemes respectively.

This comprehensive measure (ESC) showed that agriculture benefited far more than was apparent from the EPCs. The ESC was 2.30 for paddy produced on a recently constructed large scale irrigation scheme, as against its EPC of 1.34. Other import competing and export crops produced under similar conditions experienced similar additional protection. For average paddy production nation-wide (Table 9.2), the increase was 20 per cent (1.36 to 1.56), while for the plantation sector overall, there was a 10 per cent increase (1.35 to 1.45). Thus the most substantial increases came from irrigated agriculture and particularly from new large scale schemes.

- In contrast, the plantation sector had an ESC of 1.03 in 1993 and so was highly disprotected compared with irrigated agriculture.
- Domestic Resource Cost (DRC) analysis showed Sri Lanka had no comparative advantage in production of rice or other field crops under irrigation or rainfed, i.e. domestic production was more costly than imports.
- In review, far from suffering an anti-agricultural bias, paddy farmers have received support of around 5 per cent of GDP to produce a low value and uncompetitive crop. Furthermore the concentration of irrigation expenditure on construction of large scale irrigation systems resulted in a large subsidy being captured by only around 3 per cent of all farmers. Within the nonplantation crop sector, the protection afforded paddy and other import competing crops has been much higher than for export crops. This bias has been a clear impediment to diversification and export orientation within the agricultural sector, and has encouraged it to retain its traditional inward orientation.

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[11] Effective Subsidy Coefficients (ESCs) include subsidies on nontraded as well as traded inputs and outputs.

Table 9.2 Sri Lanka Trade Policy Protection – Agricultural Crops Relative to Manufacturing Industry

Crop	EPC 1990	EPC 1993	ESC 1993
Rice – rainfed	1.47	1.34	1.34
Rice – in a new major irrigation scheme	1.39	1.34	2.30
Rice – in a rehabilitated major irrigated scheme	1.23	1.36	1.63
Rice – in a rehabilitated minor irrigated scheme	1.31	1.38	1.60
Rice – average	1.33	1.36	1.56
Import-Competing Vegetables – rainfed	Na	1.68	1.68
Import-Competing Vegetables – in a new major irrigation scheme	Na	1.68	2.26
Import-Competing Vegetables – in a rehabilitated major irrigation scheme	Na	1.70	1.82
Import-Competing Vegetables – in a rehabilitated minor irrigation scheme	Na	1.72	1.80
Import-Competing Vegetables – average	1.28	1.70	1.79
Export Crops (Vegetables) – rainfed	Na	1.00	1.00
Export Crops (Vegetables) – in a new major irrigation system	Na	1.05	1.25
Export Crops (Vegetables) – in a rehabiliatated major irrigation system	Na	1.03	1.10
Export Crops (Vegetables) – in a rehabiliatated minor irrigation system	Na	1.01	1.05
Export Crops (Vegetables) – average	1.00	1.02	1.06
Nonplantation Crop Sector Average	Na	1.35	1.45
Plantation (Tree) Crops	1.00	1.00	1.03
Agriculture Average	Na	1.24	1.32
Import Substituting Manufacturing	Na	1.70	1.70
Export Manufacturing	Na	1.00	1.00
Manufacturing Average	1.80	1.30	1.30

Sources: Nonplantation Sector 1990: - Edirisinghe N., F. Abeyratne, W.G. Somarathne, P. Wickramarachi, and P.I. Tudawe (1991), "Efficiency and Policy Incentives in Rice Production in Sri Lanka",Colombo: ARTI/IFPRI. Nonplantation Sector 1993: Para 3.8 and Working Paper #2. Average using: Within crops area wts. Rainfed 0.31, New 0.04, Major Ir 0.41, Min Ir. 0.24. Between crops VA wts Rice 0.30, Imp. Comp. 0.33, and Exp. Comp. 0.37. Plantation: Adjusts public sector EPC (1.0) for financial subsidies and labour taxes and weights with smallholder plantation EPC (1.0).

Table 9.2 (continued)

Crop	**Crop Protection (ESC) relative to:**		
	Import Substg. Manufact-uring	**Export Manufact-uring**	**Manufact-uring Average**
Rice – rainfed	0.79	1.40	1.03
Rice – in a new major irrigation scheme	1.35	2.30	1.77
Rice – in a rehabilitated major irrigated scheme	0.96	1.61	1.25
Rice – in a rehabilitated minor irrigated scheme	0.94	1.60	1.23
Rice – average	0.92	1.59	1.20
Import-Competing Vegetables – rainfed	0.99	1.35	1.29
Import-Competing Vegetables – in a new major irrigation scheme	1.33	1.57	1.74
Import-Competing Vegetables – in a rehabilitated major irrigation scheme	1.07	1.41	1.40
Import-Competing Vegetables – in a rehabilitated minor irrigation scheme	1.06	1.39	1.39
Import-Competing Vegetables – average	1.05	1.39	1.38
Export Crops (Vegetables) – rainfed	0.59	1.00	0.77
Export Crops (Vegetables) – in a new major irrigation system	0.74	1.16	0.96
Export Crops (Vegetables) – in a rehabiliatated major irrigation system	0.65	1.04	0.85
Export Crops (Vegetables) – in a rehabiliatated minor irrigation system	0.62	1.03	0.81
Export Crops (Vegetables) – average	0.62	1.03	0.82
Nonplantation Crop Sector Average	0.85	1.28	1.12
Plantation (Tree) Crops	0.61	1.03	0.79
Agriculture Average	0.78	1.20	1.02
Import Substituting Manufacturing	-	1.70	1.31
Export Manufacturing	0.59	-	0.77
Manufacturing Average	0.77	1.21	-

Sources (continued) Agricultural Average: Weighted average, using 1993 value added shares as weights. Nonplantation 0.68, Plantation 0.32. Import manufacturing: - Edwards C. (1993) Protectionism and Trade Policy in Manufacturing and Agriculture: Sri Lanka Institute of Policy Studies. Estimation process gives upward bias, but used in the absence of any meaningful basis to adjust for this. Export manufacturing: - assumes no export subsidies and refund of import taxes on inputs. Manufacturing Average: - weighted average of industrial production, 60 per cent exports and 40 per cent import substitutes.

(b) Agriculture versus Manufacturing

Within the two components of manufacturing, the World Bank (1995) study showed:

- export manufacturing enjoyed no protection or disprotection with an ESC of 1.00 in 1993 (Table 9.2).
- import substituting manufacturing recorded an ESC of 1.70 in 1993. This suggests a higher level of protection for this type of manufacturing than for average non-plantation agriculture (1.45) and for average agriculture (1.32). However, the measure for import substituting manufacturing was derived from the tariff schedule rather than from comparison of actual prices. Tariff collection was subject to widespread *ad hoc* exemptions, reducing the effective rate below the actual rate. In 1992-93, import tariffs were restructured into three bands between a maximum of 35 per cent and a minimum of 15 per cent, which further reduced industry protection. Finally, to obtain an overall protection rate for industry, the weightage of 60 per cent for manufactured exports (EPC = 1.00) reduced protection even further and gave an average EPC and ESC for manufacturing of only 1.30, a little below the ESC of 1.32 for agriculture.
- The average EPC or protection for import substituting manufacturing of 1.70 was clearly greater than that for agriculture in 1993 of 1.24. Like plantation tree crops in agriculture, the EPC for export manufacturing was near unity and close to policy-neutrality. The EPC for average manufacturing (1.30) was slightly higher than the 1.24 for average agriculture in 1993. This comparison shows that, overall, there was little difference in the levels of protection between the two sectors.
- The substantial differences came from within agriculture where the extent of protection was higher for non-plantation agriculture. It was:
  - much higher for irrigated non-plantation crop agriculture,
  - increased with the size of the irrigation system, and
  - was inversely related to the age of the system (Table 9.2).

The degree of protection of the various crops relative to manufacturing industry (Table 9.2) with crops differentiated by types of irrigation system shows:

Within the nonplantation sector

- Average nonplantation crop protection (ESC of 1.45) was higher than for manufacturing (EPC/ESC of 1.30) and received much more protection than export manufacturing (EPC/ESC of 1.00).
- Relative to export manufacturing, only rainfed export crops received the same disprotection as manufacturing exports.
- Irrigated crops were given far more protection relative to manufacturing than rainfed crops, e.g., paddy grown in Mahaweli received 230 per cent more protection than manufacturing exports such as garments.
- Paddy grown in rainfed areas received only 40 per cent more protection.
- Export vegetables averaged only 3 per cent more protection, while export vegetables grown in rainfed areas received the same zero protection as manufactured exports.

Within the nonplantation sector:

- relatively favourable treatment was given to paddy and other import-competing crops relative to export crops, i.e., on average 47 per cent more protection for rice and 117 per cent for rice in the Mahaweli, and 69 per cent for other import-competing crops.
- this showed a strong inward-looking or anti-export bias in agricultural trade policy, which discouraged diversification.

Sri Lanka has recently acceded to trade reform measures under the Uruguay Round Agreement on Agriculture (URAA), which means that agriculture is now covered by mainstream GATT rules for agricultural trading (Athukorala and Kelegama 1998). In 1996, Sri Lanka still retained import restrictions on a few commodities, but under pressure has since complied. It bound all tariffs on agricultural goods at a uniform 50 per cent and has removed quantitative restrictions (QRs) on all but wheat and flour. It has also begun to dismantle import licensing and reduce tariffs on agricultural imports. There has been a consensus on the desirability of going further with trade liberalisation and trade reform has been accepted as beneficial for growth and poverty alleviation.

9.2.3 Agricultural Policy: Paddy Farming and Diversification

The 1995 World Bank study also estimated the comparative advantage of producing the main import-competing crops in Sri Lanka, using the Domestic Resource Cost (DRC)[12]. For paddy, the DRC ratio varied from 2.16 in new large scale irrigation systems to 1.53 in rainfed production. It was generally higher in regions with high yields, implying a negative relation between yield and DRC, owing to higher irrigation investment and O&M costs. But estimates exceeded unity for all regions, averaging 1.73 for Maha season 1993. Thus for its most important crop, Sri Lanka possessed no comparative advantage.

Amongst other food crops, the DRC ratio for chillie also exceeded unity, varying from 1.68 rainfed in Anuradhapura to 2.17 irrigated in Jaffna, and implied losses for this crop. Also, since assumptions about cropping intensity and the construction period for irrigation schemes were overly-optimistic, these DRC estimates were biased downwards, indicating the situation was likely to be worse.

Clearly there has been a very high cost attached to self-sufficiency in food crops, especially rice. The World Bank study estimated that the total annual transfer from taxpayers to paddy producers, mostly in irrigation infrastructure, based on 1993 output, was about US$240 million for paddy and $8 million for chillie, giving a total of $250 million or around 3 per cent of GDP.

Nonplantation agriculture has been stagnant and incomes low in the 1990s. Paddy output has shown no trend or yield gains since 1990. Paddy prices and real net incomes have fallen, making subsistence difficult for farmers. Diversification of nonplantation crop agriculture has been disappointing. Trials were conducted on horticultural crops with an export emphasis after 1989 (Institute of Policy Studies 1997), combined with contract farming as a way of involving smallholders. There was some progress, particularly with gherkins, which supplied 80 per cent of vegetable exports in 1993 and 1994, but this expansion was short-lived and collapsed in 1995 and 1996 from low yields and high cost of production. Also, contract farming failed to realise its promise. Most recently, the liberalisation of food crop imports has lowered prices for crops such as chillie and potato and production has declined (Institute of Policy Studies 1998).

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[12] The DRC ratio shows the cost of domestic resources used to produce a unit of foreign exchange, or the value (cost) of the resources used to produce a unit of the product. Comparative advantage increases below 1, while losses increase above 1.

Views diverge as to the seriousness of the agrarian situation in Sri Lanka's rural sector. The World Bank (1995) calculated that the incidence of absolute poverty declined between 1985 and 1993, with the proportion of rural households below the poverty line falling from 32 per cent in 1985/86 to 24 per cent in 1990/91. This improvement was attributed to an increase in real average per capita consumption (5 per cent) and to a better income distribution (the Gini coefficient down from 0.30 to 0.28 in 1995).

The World Bank (1996) believed farm input and output markets were not constraints and placed the blame for stagnation on the rural markets for labour and land.

The Bank argued that off-farm employment earns more than any crops other than paddy. As paddy required little labour, farmers maximise earnings from off-farm employment. The Bank saw off-farm labour market as the key to farmers' behaviour and to its recommendations.

The Land Reform Law of 1970 and 1975 Amendment nationalised large estates and regulated the size of paddy farms, alienating excesses for redistribution to smallholders as tenants in perpetuity. The ceiling on private owner operated paddy land was 25 acres, and 5 acres for tenant farming and in public sector irrigation schemes. Rapid population growth since World War II, slow growth of employment in other sectors and the limits of cultivable land being reached have meant that population pressure on existing agricultural land has become intense and farm size has been dwindling. Increasing cropping intensity, which has been low and falling, has not counterbalanced this. A three-year CI average for paddy in 1988/89 to 1990/91 was only 109 per cent .

At present there is no formal market for land. Government land is only leased and there are no sales or sub-leases. Normal adjustment in farm size is blocked by dominance of Government land ownership and the ineffective land market. The Bank accordingly recommended:

- a generalised policy of private ownership of agricultural land
- programs in settlement areas to transfer ownership to listed tenants
- programs to enhance the efficiency and transparency of the land market, and
- elimination of restrictions on land use.

The World Bank's broad recommendations for the agriculture sector (1995 and 1996) were:

- diversification from paddy into higher value crops, livestock, forestry and fisheries. For this, the following improvements were needed:
  - a well functioning land market
  - further privatisation of the tree crop sector
  - removal of constraints of existing agricultural trade policies and state intervention in marketing.
  - continuing public support in research and extension
  - infrastructure up-grading and human resource development
  - institutional reforms in the Mahaweli.
- With poverty reduction as a concomitant of better agricultural policies, growth was to be achieved with:
  - creation of an effective land market (collateralizing land, enabling mobility of labour without loss of asset base and increased holding size to encourage commercial farming for higher incomes)
  - lower state intervention in trade and pricing policies with public sector support to be made cost-effective. Inefficient paddy was protected by tariffs and subsidies on non-traded goods, which do not help the poor.

Dunham and Edwards (1997) took issue with the World Bank's analysis and conclusions and argued that an agrarian crisis had been growing in rural areas since the mid-1980s from population pressure on finite land resources engendered by:

- an acute land shortage,
- small and diminishing farm size, and
- low out-migration, with rural population still comprising 72 per cent of the total in 1990/91.

The authors then argued that real incomes in the peasant sector were stagnant or declining from the mid-1980s owing to stagnant or declining real income from paddy. This decline could be attributed to:

- a decline in the real price of paddy, stagnation in average paddy yields and a decline in the hired labour for paddy.
- limited success achieved in crop diversification into higher value crops. Statistics showed a decline in sown area of paddy by 11 per cent , which

suggested that some diversification had occurred in the second half of 1980s. Value added from "other agriculture" rose steeply 1985 to 1991 but this was not confirmed by sectoral and area studies, which suggested on-farm diversification was uneven, occurred mainly in Yala season, and was generally slow growing. Few farmers with significant assets experimented this way. Homestead production did not appear to have expanded. There was some increase in area of some subsidiary crops (onions, potatoes and green gram) but not for others (Bombay onions and chillie). Thus crop diversification did not appear to have been a major new source of income for the rural poor.

- Progress was also restricted in extensive development to new land. There was settlement in Mahaweli but the rate declined to 1993, at the time when the World Bank claimed that poverty had declined. There was no evidence that many escaped from poverty.

➢ the rate of job creation in the rural non-farm sector was extremely slow. There was little information on rural non-farm incomes though it was thought to be low productivity, mostly in services and unlikely to be the answer to poverty. Less was known about trends over time and real wage rates in rural non-farm employment. The World Bank argued that there was significant movement out of agriculture between 1985 and 1990 – either out of rural areas or into rural industrialisation. But migration out of rural areas was low and was difficult to judge the impact of industrialisation. Survey data did not show that industrial employment had risen, and at that time it was mostly in Greater Colombo. Also, with real farm incomes in decline, it was unlikely that any substantial increase in rural employment was created. A 200 Garment Factory scheme was started in rural areas but not until after 1990, so rural non-farm employment grew very slowly, at least until after 1990.

Dunham and Edwards argued three objective factors were signaling a deepening agrarian crisis in the Sri Lankan countryside:

➢ prices had moved against paddy and average yields had stagnated with falling returns per family labour day and in the absence of an increase in the demand for casual labour
➢ on-farm diversification out of paddy into other crops had been very limited, generating little employment and little extensive development
➢ rural non-farm employment had grown very slowly, at least after 1990.

Given the already high incidence of poverty, these amounted to an agrarian crisis – production and social. This conclusion flatly contradicted the World Bank's argument (1995) that rural poverty had been declining since the mid-1980s in the following ways:

World Bank	Dunham and Edwards
sufficient out-migration to reduce poverty	no evidence for this and some counter-evidence
income transfers into the rural areas	not enough to make a difference
the agrarian crisis is a myth	a review of paddy incomes showed declining earnings regardless of the deflator or methodology
Poverty Assessment Report calculations indicated lower poverty incidence	the PAR calculations were wrong. There are no concrete grounds for doubting their own conclusions though there were areas of uncertainty. The Bank's argument was rooted in two surveys' evidence which were both in unusual years so their analysis was skewed.

Dunham and Edwards concluded that agricultural growth had been far too slow to affect poverty levels. With 80 per cent of the poor in agriculture and a relatively slow rate of absorption into non-agricultural activities, what happened in agriculture was of major social and economic importance.

The authors criticised the Bank for failing to account for Sri Lanka's special characteristics in agriculture:

- Farm size argument was crop specific; small scale farmers can diversify,
- Sri Lanka's farm sector is increasingly dependent on transfers from outside to enable them to survive. It is a remittance and transfer economy, which has ramifications for agricultural policies. Since they depend massively on funds from outside, they may not feel inclined to sell up their land, and concessionary input credit may not have the desired effect.
- There was no evidence that transfers had been fed productively into agriculture. If land ownership became concentrated and transfers fell, social differentiation may be exacerbated with worrying implications for stability. Local conditions must be taken into account.

In 1995, after forming a new government, President Chandrika Kumaratunga issued a new policy statement for agriculture. The Government's programme of action to achieve broad sectoral goals would include the following new reform initiatives:

- remove hidden discrimination against agriculture from inequitable macroeconomic and trade policies of the past.
- all types of agricultural market monopolies will be eliminated and greater competition fostered.
- Domestic agricultural prices will be brought into line with international prices over time.
- The agricultural research system will be reorganised to make it more responsive to markets. Producers and other private sector agencies will be given a greater voice in research planning bodies. A program of market research will be developed to provide more information on prices and market trends. These measures will enhance productivity.
- A more appropriate division of labour between public and private sectors will be achieved in the management of the nation's irrigation facilities. It is a matter of concern that many farmers in the Mahaweli settlements earn less than Rs. 1,500 per month, so that these huge investments have sustained poverty instead of prosperity. In particular commercial activities can be handed over to the private sector, and downstream operation and maintenance activities to relevant public agencies and farmer organisations.
- Improvements in agricultural productivity and incomes, together with the creation of non-farm jobs, are the only viable solutions to rural poverty.
- A well coordinated plan to develop the conjunctive use of surface, ground and run-off water will be implemented with due regard for environmental considerations.

The 1990s have witnessed a sharp reduction in the role of irrigation in agricultural development policy, particularly in new investment with the completion of the AMDP. This has relieved pressures on the Public Investment Programme. The decade has seen further liberalisation and globalisation in macroeconomic policy, which has removed intersectoral bias against agriculture. Also, new policy guidelines have been set for agriculture. But to date, there has been no significant improvement in agricultural growth performance. This appears to be partly due to lack of progress with diversification into higher value crops, particularly for export, which remains a challenge. This is coupled with the absence of relief from resource pressures through accelerated out-migration of rural labour or from improved rural labour market opportunities.

Annex 1

1. Public Sector Restructuring Project: Irrigation Sub-Sector Study Terms of Reference

The tasks to be undertaken by the research team will consist of but not be limited to the following:

A) Review past expenditure allocations to irrigation and area related projects in the Public Sector Investment Program.

B) Examine the overall allocation for irrigation including irrigation related multi-purpose area development projects versus other claims on the capital budget.

C) Assess options for investment in irrigation, e.g., new irrigation related multi-purpose area development, expanded program for tank rehabilitation and improvement, supplementary irrigation facilities of a combination of these strategies etc.

D) Make policy recommendations for the overall investment pattern and investment options in irrigation and related multi-purpose area development and also make proposals on sector related programs and projects.

2. Assessment of Benefits/Costs of Future Mahaweli Related Investment Costs

A) Assess investment requirements for on-going programs such as Mahaweli System `B' Left Bank and System `C' and new projects.

B) Review completion of the Mahaweli System `B' Right Bank works with possible re-designing of components of the project emphasising activities (such as crop diversification, newer irrigation technologies, agro-industrial development etc.) giving a higher rate of return.

C) Review Upper Mahaweli Peripheral Development work (UMPD).

D) Assess operation and maintenance requirements of irrigation systems within the context of improved water management and farmer participation that will encourage cost recovery.

E) Review all proposed/potential area development program for irrigation agriculture within Sri Lanka, e.g., Moragahakanda Project. Assess economic costs, benefits, financial implications and systems water balance effects of such project.

Benefits

A) Examine Benefits/Costs of predominantly rice based agricultural development with special reference to self sufficiency in rice on the basis of present and potential levels of productivity and planned expansion in irrigable area inclusive of the Mahaweli and Moragahakanda projects.

B) Assess the impact of returns of past and intended investments resulting from a) changing strategies for production patterns, adoption of more efficient technologies for water use, water provision and crop productivity, b) improving the incentive management structure, c) crop diversification.

C) Assess the relative merits of Benefits A) and B) above for strengthening employment investment and enterprise development activities and commercial agriculture.

3. **Structure of Costs/Benefits**

Review the structure of costs/benefits of irrigation development to allow a proper comparison of investment in various modes of water resources development.

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