

cb

MINOR TANK WATER MANAGEMENT IN THE DRY ZONE OF SRI LANKA

Occasional Publication No. 39



October 1987

**AGRARIAN RESEARCH AND TRAINING INSTITUTE,
114, Wijerama Mawatha, Colombo 7.**

SRI LANKA

2009/06

2010/4

MINOR TANK WATER MANAGEMENT
IN THE DRY ZONE OF SRI LANKA

SALEHA BEGUM

Occasional Publication No. 39

October 1987

Agrarian Research and Training Institute
114, Wijerama Mawatha, P O Box 1522
Colombo 7
Sri Lanka.

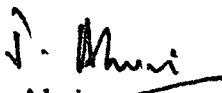
22939

22939

FOREWORD

The Agrarian Research and Training Institute commissioned Ms. Saleha Begum to study the operation of community organized small-scale tank irrigation systems in the Dry Zone in order to examine problems of maintenance and water management in such systems and to draw policy conclusions relevant to the development of new tank and canal management systems. The research was designed to provide material relevant to other studies within the Irrigation Water Management and Agrarian Relations Division of the ARTI and was funded under the Gal Oya Water Management Project sponsored by the USAID/Irrigation Department.

I thank Ms. Saleha Begum for carrying out this study. Dr. Jayantha Perera, Research Associate (formerly Head, Irrigation Water Management and Agrarian Relations Division), co-ordinated the study and edited the final version of the report for which I thank him. Our thanks are also due to USAID/ID for providing funds for this study.


J. Alwis
DIRECTOR

ACKNOWLEDGEMENTS

I owe special thanks to the Agrarian Research and Training Institute (ARTI) for offering me a position as a Visiting Student Researcher in order to undertake the research on which this report is based.

I am grateful to the United States Agency for International Development for funding the research and to the ARTI and the Irrigation Department for sponsoring my research application under their Gal Oya Sub-study Programme.

My biggest debt is to P. Panditha, Prema Jayantha and N.A. Ratnayake who worked with me during this study.

Numerous others have helped me during the course of my work and I am grateful to them all. Special thanks are owed to the farmers and village officials in our study locations and to the Assistant Commissioners of the Department of Agrarian Services and their staff in Anuradhapura, Puttalam, Trincomalee and Kurunegala districts who were always very willing to offer time and much needed advice despite their busy programmes; without the insights that they have provided in office discussions and on field trips this report would not have been possible.

I have learnt a great deal from discussions with Jaliya Madagama, Deputy Commissioner, Water Management Division, Department of Agrarian Services and A.J.P. Ponrajah until very recently Director of the Irrigation Department; their keen understanding of water management issues and their constant and friendly willingness to share their knowledge has been of enormous benefits to me, a

newcomer both to Sri Lanka and to water management. I am also very grateful to Dr.C.R. Panabokke (ex-Director Agriculture) for his help to me in two long sessions on my research.

I am very grateful to Mick Moore (IDS) for comments on an earlier draft of chapter three and to Martin Greeley (IDS) for help in editing the report.

I was able to complete this report before returning to Sussex only because of Ms. Carmen Channugam who worked under tremendous pressure with equally tremendous calm to produce this report on time. My very special thanks to her.

As always, none of the people or institutions mentioned above are in any way responsible for the contents of the report and any errors are my responsibility alone.

CONTENTS

<u>Chapter</u>	<u>Page</u>
Foreword	
Acknowledgement	
List of Tables	
List of figures	
Summary	
I Introduction	
Introduction	1
Organization of the Report	3
Agro-Climatic Zone	4
Type of Irrigation Schemes	5
Organization and Selection of Field Study Area	7
Survey Instruments, Data Collection and Data Processing	10
II Minor Tanks: Technical, Socio-Economic and Institutional Context	
Introduction	12
Minor Tank System	13
Minor Tanks: Their Current Status	14
Importance of Minor Tanks in National Paddy Production	15
Farming Systems under Minor Tanks	16
Chena Cultivation	17
Paddy Cultivation - land categories and agricultural practices in the command area	19
Minor Tanks: The Socio-Economic Context	22
Role of the Yaya Palaka	23
Kanna Meetings	24
Social Obligations for Maintenance of Irrigation Systems	25
The Economy of Minor Tank Village	29
Minor Tanks: Role of the State	34

<u>Chapter</u>	<u>Page</u>
III Minor Tank Water Management Programmes	
Introduction	50
Village Irrigation Rehabilitation Project....	52
The Department of Agrarian Services	
Water Management Programme	55
Components of the Water Management Programme	58
Organization of Water Management Programme..	60
The Water Management Package	
Dry Sowing of Paddy in the Maha Season....	63
Ploughing following the maha & yala harvest	72
Growing subsidiary (non-paddy) crops	
in the yala season	75
Development of Farmer Organizations	82
Promotion of the System under which only	
part of the command area is cultivated	
in periods of water shortage	89
Rotational Water Supply System	96
Allocation of Water from Tail to Head	97
Appendix to Chapter III	
Puttalam Rural Development Project.....	105
Anuradhapura Dry Zone Agricultural Project	109
National Freedom From Hunger Campaign	112
IV Minor Tank Water Management: Problems	
and Prospects	
Introduction	115
Problems with Physical Structures	116
Alternative Uses of Water Saved in the	
Maha season	119

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. Average Size of Operational Holdings by Land Type, and Sources of Cash Income In Ten Minor Tank Villages (1983).....	39-40
2. Percent Increase in the Size of Command Area in Twenty Minor Tank Villages	41-42
3. Five Years Data on the Proportion of the Command Area Cultivated in Twenty Minor Tank Village (Maha 1979-80 to 1983-84).....	43-46
4. Maha Rains: Monthly Distribution in Three Study Locations	47
5. The Importance of Drought as a Cause of Minor Tank Crop Failure (Maha 1980-81).....	48
6. Distribution of Tanks according to the Arrangement followed in Yala 1984	93

Chapter

Page

The Water Managment Programme	
Theory and Practice	125
Farmer Participation in the Programme	125
The Functioning of Agricultural Planning Teams (APTS)	130
Constraints on APTs	130
Current Activities of APTs	132
Effectiveness of APTs Activities	134
Specific Water Management Programmes for Individual Tanks	136
Future Prospects of Agricultural Planning Teams	136
V. Concluding Remarks	138
References	140

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1. Map of Sri Lanka	8
2. Water Allocation in Traditional Tank	28
3. Junction Block Type Sluice	55
4. Tower Type Sluice	56
5. Water Allocation in Water Management Tank.....	62
6. Average Weekly Income (Rs) From both Agriculture and Off-Farm Work	67

SUMMARY

The problems of managing water efficiently and equitably have become an urgent policy and research issue in recent years for Sri Lanka. This report attempts a preliminary assessment of the recent state initiatives on minor tank water management in the dry zone. It is based on one year's field work studying both traditional tank organisation and other tanks included in the water management programmes of the Village Irrigation Rehabilitation Project and an Integrated Rural Development Project which have been designed to raise the productivity of land under minor tanks.

The main theme throughout the discussion is that traditional methods of organising water management are rational and planned responses to the economic conditions of minor tank farming systems. Poor, risk-averse farmers behave in their own best interests in following water use practices that are apparently wasteful but in fact are their best strategy for ensuring a subsistence income. In these circumstances technical efficiency in water use does not correspond to economic efficiency from a farmer's perspective. Improvement in water availability and improved efficiency of water use (through better control structures and more formalised systems of water management) are partial interventions that are only likely to be successful when combined with other measures to reduce farmer risk-aversion; these measures (e.g. credit and seed availability, higher and more assured farm output prices) are necessary to allow the

farmer to use to best advantage the water which, as he is only too well aware, is scarce. Water management project documentation recognises this need as do project implementing agencies but the enormous and unavoidable implementation problems seriously limit the realisation of programme benefits. The rationality of current methods of water use ~~suggests~~ that the programme objectives are precisely what farmers methods would be- if they could afford them. For farmers to adopt them requires more than improved water management.

Chapter I

INTRODUCTION

Introduction

This report is concerned with water management practices in the minor irrigation tanks of Sri Lanka's dry zone. Land productivity under minor tanks is much lower than in major irrigation schemes and the government has identified improved water management as a principal means of raising productivity levels. The approach now being implemented is one of state intervention in traditional communal organisation of water allocation to enhance the efficiency of tank water distribution and use. The report provides an analysis of the rationale behind traditional water allocation methods, the proposals for improving these methods and an assessment of their potential impact.

Like many other developing countries in Asia, Sri Lanka experiences food shortage. One of the main targets of the government is to achieve 'self-sufficiency' in food and in recent years it has achieved a fair amount of success, at current levels of consumption. Sri Lanka has adopted two strategies to increase her food production; by extending agriculture to new areas, and by intensifying agriculture on land already being cultivated.

With substantial financial and technical assistance from donor agencies, massive investment is being made in Sri Lanka to develop large scale canal irrigation systems, to bring new land under cultivation and to improve the efficiency of the existing schemes. Whilst highly capital intensive long-gestation irrigation schemes have tremendous potential for boosting the country's economy, they also have

certain adverse effects in the short run, notably generation of inflationary tendencies and pressure on the balance of payments (World Bank, 1981). Moreover, these investments create economic disparities between regions as all parts of the country do not derive equal direct benefits from the investments made in highly capital-intensive irrigation schemes. One of the countervailing measures against economic disparity between regions that the Government of Sri Lanka (GOSL) has embarked on since 1981 is a number of short-term programmes of low capital-intensity for developing minor irrigation schemes (below 200 acres) in different parts of the country. Substantial government and aid donor money is being invested through these programmes to improve land productivity through minor tank rehabilitation followed by water management programmes. It has been argued (World Bank, 1981 p.1) that the greater dispersion of public investment through these initiatives will improve absorptive capacity and contribute to control of inflationary pressures.

The Village Irrigation Rehabilitation Project (VIRP) with a target of over a 1000 minor tanks is the largest programme. Others include the Anuradhapura Dry Zone Agriculture Project, the Tank Modernisation Programme of the Department of Agrarian Services (DAS), substantial components of Integrated Rural Development Projects (IRDP) and the National Freedom From Hunger Campaign (FFHC; this is a non-government programme).

The principal hypothesis underlying these minor tank water management programmes is that water can be saved during the maha season (October-March) and a second crop cultivated in the yala season (April - September). Dry sowing the first (paddy) crop, rotational water issues using newly formed farmer blocks, and crop diversification in the second season are the most important (though not the only) methods being

promoted to improve the efficiency of water use.

The main objective of this report is to provide a policy-oriented analysis of the design and implementation of these minor tank water management programmes. The prior physical rehabilitation of the tanks is treated as a separate activity, which does not depend for its cost-effectiveness on the subsequent water management programme. Farmer organisation of water use is often very efficient and the central interest of this project was to evaluate the extent to which planned intervention can help improve present practices.

Unfortunately, published information on management and organisation of minor tanks is conspicuously lacking and Leach (1961) is the only comprehensive study, on one tank village in the dry zone. Other studies, for example, Gunadasa et al (1980); Gunawardena (1981); Gunadasa et al (1981); Upasena (1982); and Herath et al (1984) deal only with particular aspects of minor tanks in the dry zone rather than generating information about the totality of the system. A more general objective of this study therefore is to try and elaborate, and make more precise, basic perceptions in this relatively under researched area.

Organisation of the Report

The rest of this introductory chapter deals, very briefly with: the agro-climatic zones of Sri Lanka; types of irrigation schemes; selection of field study areas; and description of survey instruments and methods of data collection and processing.

Chapter 2 discusses the technical, socio-economic and institutional context of minor tanks. The chapter provides a description of minor tanks, their farming systems, social

social organization in relation to water use, the economic condition of minor tank villages, and the role of the state in relation to minor tanks.

Chapter 3 has a number of sections which deal with two broad themes. The first is the design of minor tank water management programmes; this includes a description of the main (VIRP) minor tank water management programme implemented to date (and others in an appendix) and a listing of the main components of the programme. The second theme is the organization and operation of these programmes. Organization is summarily outlined and this leads onto a discussion of the principal operational issues (dry sowing, crop diversification etc).

Chapter 4 examines problems facing the current initiatives on minor tank water management and the prospects for these types of programmes. The chapter has three main sections that deal with: physical problems (bunds, sluices, spills); alternative use of water saved during maha; and the planned and actual implementation programme for minor tank water management.

The final chapter gives some concluding remarks.

Agro-Climatic Zones

Sri Lanka can be divided into two broad climatic zones; wet and dry, on the basis of annual rainfall which determines the primary characteristics of agricultural production. (Transitional areas between these two are sometimes referred to as the intermediate zone; the characteristics of the intermediate zone are discussed later on). The wet zone receives a fairly well distributed rainfall with an average of more than 1,900 mm annually.

This zone covers the southwest part of the Island and includes about 30 percent of the land area. There is not much potential for bringing new land under cultivation in the wet zone as almost all cultivable land is already under cultivation. A significant proportion of cultivable land is under plantation agriculture. In the wet zone, paddy is grown mainly under rainfed conditions and irrigation plays a limited role.

The dry zone covering most of the north, east and southeast parts of the Island receives an average rainfall of 900 to 1,900 mm annually. In contrast to the wet zone, rainfall in the dry zone is concentrated with a bimodal pattern. In a normal year, the dry zone gets heavy rain (accounting for about 70% of its annual rainfall) during the northeast monsoon late September to January and the main rice crop (maha) is grown from October to March by utilising this rain water with the help of supplementary irrigation. The second rains come during the southwest monsoon late March to late May but these rains are light and paddy grown during the minor (yala) season depends upon irrigation; this second crop is grown between April and September.

Apart from rainfall the dry zone differs from the wet zone in that:

- i) Shifting cultivation is extensively practised in the dry zone (chena) and is an important source of cash income for farmers;
- ii) A substantial amount of land is available in the dry zone that can be brought under cultivation through irrigation.

It has been recognised that in the dry zone it is not land but water which limits the extent of cultivation (Leach, 1961; Chambers, 1974; Harriss, 1977).

Types of Irrigation Schemes

Irrigation Schemes in Sri Lanka are divided into two broad categories, major and minor, according to the scale and type of organisation. According to the Irrigation Ordinance No. 32 of 1946, minor scheme are those that have been "constructed by the proprietors without government aid or with the aid of masonry works and sluices supplied free of charge by the government, and maintained by the proprietors". The officially used operational definition of minor irrigation schemes is those irrigation less than 200 acres of land.¹ These include village tanks, chiefly in the dry zone, and anicuts (river diversions), chiefly in the wet zone. This report is concerned only with dry zone minor tanks.

Currently in Sri Lanka, the Irrigation Department is responsible for the construction of headworks of all irrigation schemes (major and minor) and the Department of Agrarian Services is responsible for maintenance and repair of headworks of all minor irrigation schemes.

There are four basic differences that distinguish minor irrigation schemes from the major ones:

- i) Major schemes are connected with large central reservoirs and feeder canals whereas minor schemes are connected with small tanks or weirs associated with individual villages collecting water from their own catchment area.
- ii) Crops are more assured under major schemes, largely because of a more assured supply of water but also due to other improved facilities like more timely availability of credit and other inputs.

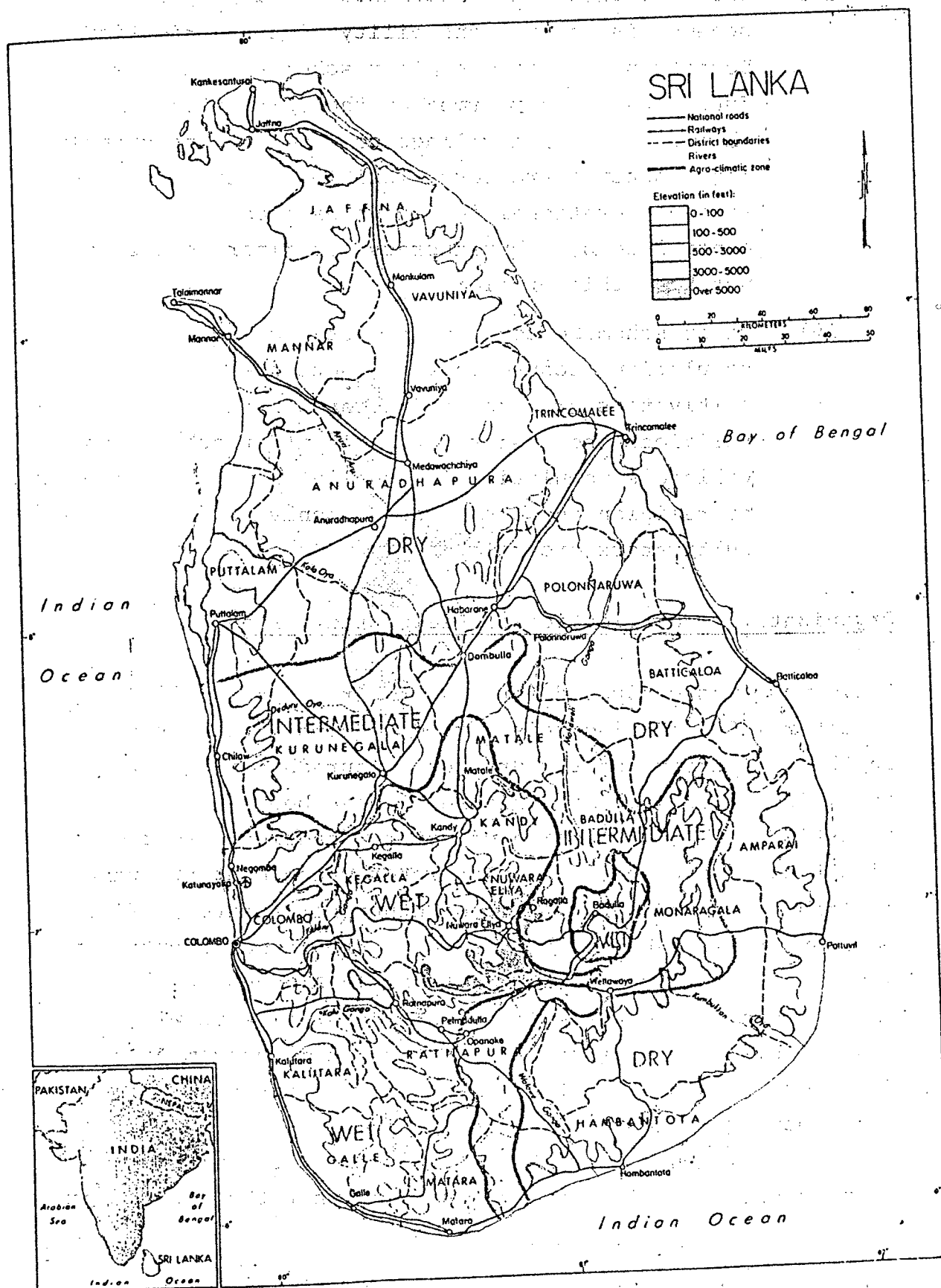
¹ Joint circular issued by the Ministries of Land and Land Development and Agricultural Development and Research, 4 October, 1979.

- iii) The operation and maintenance of all major schemes is the responsibility of the Irrigation Department whereas in minor schemes both these functions are performed by the cultivators themselves, as a village community; consequently, major schemes are less flexible in terms of day-to-day operational decisions as they are controlled by a bureaucracy but minor schemes do not have this problem.
- iv) Major schemes often have a 'heterogeneous' population because they are settlement schemes; cultivators are from different districts, religions and castes. In most minor schemes one village's population is usually 'homogeneous' both by religion and caste and commonly most cultivators are related.

Organization and Selection of Field Study Areas

Field work was conducted for a year, from January 1984 to December 1984. During this period, a sample of 20 tanks in three districts of the dry zone, Anuradhapura, Puttalam and Trincomalee (see Map, figure 1) have been used to investigate the functioning of water management programmes. Five tanks were under the VIRP water management programme in Trincomalee (Seruwawila and Muthur electorates), five were under the IRDP water management programme in Puttalam (Anamaduwa electorate) and ten tanks in Anuradhapura² (Madawachchiya and Horowpathana electorates) were without any rehabilitation or state-operated water management programme. These last ten tanks, without any new water management programme have been studied because it is essential to have a **through** knowledge of existing irrigation and farming practices in order to evaluate what the new programmes

2 These ten tanks will be referred to as traditional tanks in this report.



offer and their potential to improve upon current practices.

In addition to the 20 sample tanks three more tanks rehabilitated under IRDP in Kurunegala district in the intermediate zone have also been studied in order to have a broader understanding of the rehabilitation and water management programme and to examine differences in water management practices between the intermediate and the dry zone. Discussion in this report will be based mainly on the first 20 tanks and information from the later three tanks will be used to make references at appropriate places.

Anuradhapura district was selected to study traditional tanks because of three reasons:

- i. This district has a long history of minor tank culture.
- ii. This district has the largest number of minor tanks in the dry zone.
- iii. There was no state-operated water management programme operating in this district during the period of field work.

Tanks were selected in consultation with the local DAS officials and tanks selected were those that had least state intervention in terms of provision of headworks. The idea was to develop an understanding about how farmers manage their tanks with minimal assistance from the state.

Trincomalee and Puttalam districts selected for VIRP and IRDP water management tanks respectively were identified with the help of DAS headquarters personnel in Colombo and sample tanks were selected in consultation with local DAS staff. Those districts were selected where the water management programme was most advanced and within each district, the tanks which local DAS Offices thought were their best tanks were selected - for two reasons. The first reason is that with the

programmes being very new only the most advanced had sufficient experience upon which to base an evaluation. Second, by choosing those tanks which the DAS itself considered to have the best programmes, problems identified would almost certainly be of relevance to the rest of the programme.

Survey Instruments, Data Collection and Data Processing

Data was collected through structured interviews with farmers, vel vidhanes (village irrigation officers), and government staff. Three different surveys, i.e., Village Survey, Irrigation Survey, and Household Survey, were conducted. This work was supplemented by interviews with water management and agricultural researchers and with officials in government who are involved in water management programme planning and implementation.

A village survey was conducted for each tank village to gather information on a comprehensive set of socio-economic and agro-economic characteristics including general information on irrigation institutions and practices. This information was collected through interviews with local officials, village leaders and a cross-section of the village community.

An irrigation survey was conducted in all study villages through structured interviews with the vel vidanes. This included information on the history of the tanks; physical characteristics of the tank systems; institutional arrangements for operation and maintenance of the tank systems; role of kanna meetings (cultivation meetings); irrigation and farming practices and problems; mechanisms of conflict resolution; sanctions against those breaking rules decided in the kanna meeting; and socio-economic background of the vel vidane. In water management tanks,

information was also collected on changes introduced by the the new programme, vel vidanes participation in the programme, their views about the programme and their expectations from it.

A household survey was conducted in all households in 10 of the sample villages³ (5 traditional and 5 water management tank villages). Information collected included: household composition; land interests; tenancy arrangements; inputs use; sources of income; sources of credit; irrigation and agricultural problems; participation in the kanna meetings and in maintenance and repairs of the tank systems; and performance of the yaya palakas⁴. In water management tank villages, additional information was collected from farmers about water management, along similar lines to the yaya palakas interviews.

Three university graduates were employed as research assistants to collect data. All irrigation surveys were conducted by the principal investigator with the help of an interpreter (one of the research assistants). Research assistants lived in the study villages throughout the field work. The principal investigator was based at ARTI in Colombo and made one of two field trips every month spending about a week in each trip during the area selection and data collection phase of the research. The field data were processed in Colombo using computer facilities at the ARTI and manual tabulation by the research assistants and the principal investigator.

In subsequent chapters all unreferenced data presented are from the three surveys conducted by the project.

3 These ten villages will be referred to as the household survey villages in this report

4 This designation means actually "tract director" and is the term used for the farmer representatives (actually assistants to the cultivation officer) elected under provisions of the Agrarian Services Act of 1979. They are generally referred to in the vernacular as vel vidanes, the name for the traditional irrigation headmen, whose role is discussed in Leach (1961).

Chapter II

MINOR TANKS: TECHNICAL, SOCIO-ECONOMIC
AND INSTITUTIONAL CONTEXTIntroduction

Minor tanks are small reservoirs used for collecting run off water during the monsoon for irrigation and domestic water supply. They are created by constructing an earthen bund across a natural drainage basin. According to Oppen and Rao (1980b) tanks are developed in response to need for more intensive cultivation when traditional forms of extensive cultivation can no longer support the growing population.

Tank irrigation systems are not unique to Sri Lanka, they are found in other Asian countries, including, Burma, Thailand, Cambodia, and India (Meinzen-Dick, 1984 p.2). Within India tanks are used primarily to irrigated paddy and are found mainly in three southern states, Tamil Nadu, Karnataka and Andhrapradesh (Oppen and Rao, 1980a). According to Farmer (1954 p. 23), tank irrigation systems of Tamil Nadu have a similarity to those of Sri Lanka because of their close climatic resemblance in terms of seasonal variability and ineffectiveness of rainfall. There are about 3900 tanks in the Tamil Nadu state (Saktivadivel et al, 1982). These tanks fall into two categories: system and non-system tanks. System tanks receive supplementary water from nearby major rivers or reservoirs in addition to collecting water from their own catchment area; for non-system tanks the only source of water is runoff water from their own catchment area (Palanisami, 1982 p.14). Minor tanks in Sri Lanka fall into the latter category as their storage of water depends entirely on direct rainfall and runoff water from their own catchment area. According to Somasiri (1979 p. 34).

yield from this catchment area depends on: " the moisture condition for the soil profile in the catchment (area) and the intensity - duration relationships of the rainfall"

Minor Tank Systems

Minor tanks in Sri Lanka must be treated as single systems as most of these individual tanks meet irrigation water requirements of one village or one command area. Traditional minor tank systems consist of the following components;

- i. an earthen tank bund, (sometimes gravel is used to strengthen the bund);
- ii. sluice or sluices to let water out of the tank to the command area through the main and field channels. Usually Junction Block type and Towe type sluices are used with the former gradually being replaced by the latter as these are more efficient for controlling irrigation water issues;
- iii. a spillway to dispose of surplus water from the tank. A minor tank may have a concrete spill, a natural rock spill or no proper spillway at all;
- iv. main and field channels to deliver water to individual fields; and
- v. a drainage channel to dispose of excess water from the field during periods of heavy rain. However, a drainage channel is not a common feature of minor tanks in the dry zone. In many minor tanks in this area main channels are used as drainage channels as well.¹

1 This is achieved by cutting narrow deep trenches in the field that permits a reversal in the usual direction of water flows.

Minor Tanks: Their Current Status

There are about 30,000 minor tanks in Sri Lanka (Medagama, 1984; FFHC, 1979); most of them are in the dry zone and are of ancient origin (Leach, 1961; FFHC, 1979; Somasiri 1979; Gunadasa et al, 1980). According to Somasiri (1979 p. 33) it appears that spatial distribution as well as site and size of these tanks had been primarily dictated by social factors, perhaps human habitation and size of population rather than by such technical factors as hydrological relationships of the catchment. The irrigation capacity of minor tanks varies a great deal and is governed by the size relationships of the catchment, tank and command areas, as Somasiri has demonstrated by the tank hydrology.

It is very difficult to get any accurate estimate of the number of functioning minor tanks. Estimates provided by Leach (1961) and Gunadasa et al, (1980) are not of much help since they do not provide any numbers. According to the most reliable sources, the 'Wewas and Reservoirs Album' prepared by the FFHC (1979), about 52 percent of minor tanks are working currently with different degree of efficiency and the remaining 48 percent are abandoned. A similar estimate has been presented in Abeysinghe (1982b). Several causes have been put forward for abandonment of minor tanks. These include invasion, diseases (particularly malaria), decadence and failure to maintain the systems (Farmer, 1957; Murphy, 1957; Paranavitana, 1960). Not all abandoned tanks can be restored cost-effectively because of their physical environment (Abeysinghe, 1982b, p. 23). According to FFHC (1984; there about 7000 abandoned minor tanks that are amenable to restoration that could benefit about half a million people.

Importance of Minor Tanks in National Paddy Production

Using data from GOSL (1983a pp. 110-111 and 1983b pp. 97-98) it can be estimated that production of paddy on land irrigated by all minor schemes accounted for about 20 percent of total paddy production in 1980-81. This was from a 22.6 percent share in maha production (68% of the national total and a 15.3 percent share in yala production (32% of the national total). Dry zone minor schemes - almost exclusively tanks - accounted for nearly 45 percent of all harvested acreage under minor schemes in maha and for 10.1 percent of national maha production. In yala dry zone minor irrigation acreage was only 7.7 percent of total minor scheme harvested acreage and only 1.2 percent of national yala production. Overall, dry zone minor tanks accounted for 7.25 percent of paddy production in 1980-81. It should be noted that these figures for dry zone minor tanks exclude Kurunegala, an intermediate zone district sometimes included in dry zone statistics. If Kurunegala is included the share of dry zone minor tanks in paddy output increases to 14.9 percent for maha, 4.33 percent for yala and 11.55 percent for annual production.

Three comments on these figures are necessary. First in years of good rains the contribution of dry zone minor tanks to national paddy production in maha and, especially, in Yala (e.g. 1984) will be higher; figures for one year are fairly crude indicators.

Secondly, the figures cited are for paddy production from minor schemes, major schemes and rainfed areas and include an improbable estimate of 241,094 acres under rainfed paddy in the maha season in the dry zone, compared to 178,099 acres under minor tanks. As explained later it is very likely that the acreage effectively dependent on

minor tanks has been considerably underestimated. Ignoring the problem of definition for the moment, the sources cited above show that of the total officially identified irrigated acreage in maha, 40 percent is under minor schemes of which nearly 20 percent is in the dry zone,

Thus, from an irrigation perspective the dry zone minor tanks are an important component; indeed, the lower average yield figures on minor schemes (1.1 metric tons per acre) compared to major schemes (1.5 tons) are a major reason for renewed interest in improving irrigation efficiency, in part through water management, on minor irrigation schemes.

Thirdly, from a social or equity viewpoint, the lower yields and the smaller average holding sizes in dry zone minor tanks indicate that the percentage of rice-growing households who are dependent on paddy production from these minor tanks is much larger than is reflected by their percentage share in total production. This suggests that in social terms, the improvement of minor tanks is a more pressing need than major scheme improvement. A full development of this argument requires several qualifications or elaborations (employment patterns, relative importance of non-paddy income, annual variability of paddy income, etc.) but the basic message so far as development planning is concerned is clear; an equal contribution to efficiency objectives (food self-sufficiency) will be more valuable in social welfare terms if it resulted from (an equitably-distributed) improvement in minor tank productivity than if it resulted from (an equitably-distributed) improvement in major schemes.

Farming Systems Under Minor Tanks

Success of the new water management programmes will obviously depend on the extent to which they are based on a sound knowledge of the existing farming practices and

the rationale behind them. This section will provide a brief description of the current farming practices in minor tank villages but these will be discussed in more detail in the following chapters as they relate to the water management programme.

Farming systems in the dry zone minor tank villages are relatively homogeneous and have been portrayed in detail by a number of authors, Farmer (1954; 1957); Abeyratne (1956); Leach (1961); Somasiri (1978) and Abeysinghe (1982b). According to these sources a three-fold land use system is traditionally, practiced in these villages: gangoda or home gardening, chena or shifting cultivation and irrigated paddy cultivation with tank water. This system has evolved over generations on the basis of farmers' practical experience of how best to utilise the natural resources within the physical and financial constraints under which they operate.

The home garden is principally, though not exclusively, given to perennials and it is the other two components, chena and paddy land cultivation where the farmer exercises seasonal decisions; in most of the dry zone the fundamental criterion underlying his decisions is the minimisation of the risk of serious income shortage due to the unreliability of paddy land cultivation under conditions of uncertainty about rainfall. This theme is expanded later on, and the next few paragraphs provide an introduction to farming practices on chena and paddy land.

Chena Cultivation: Chena cultivation is mainly devoted to the production of cash crops. These are an insurance against a crop failure of the subsequent maha paddy crop. The seasonal pattern of chena earnings is also critical.

They occur principally at a time when local agricultural wage labour opportunities are minimal and this is immediately prior to outlays associated for the maha land preparation. In our 10 household survey villages, earning from selling chena crops, on the average constituted one-third of the total annual household cash income with a range from 8 percent of 59 percent (see Table 1)

Chena cultivation is undertaken by clearing forest areas near the village and shifting cultivation is traditionally, practised. Kurakkan (finger millets), cowpea, and ulundu (black gram) were the dominant chena crops in our study villages; and maize, sorghum and paddy were grown to a lesser extent. In most dry zone villages, chena crops can be grown only in the maha season; a second chena crop, usually gingelly (sesame), can be grown in the yala season only in a few areas and it involves high risk (Farmer, 1954 p. 27)

The size of chena area cultivated by a family depends entirely upon the number of adult family members available for work, and both men and women participate in it. The average extent of chena land cultivated was 2.4 acres in our study villages. All households in these villages grew chena crops except the few where the household consisted of only an old couple or a single old member.

Until recently there was no restriction on expanding chena cultivation by clearing new forest land, but currently this practice has been prohibited by the government in many parts of the dry zone. Also, this opportunity has become limited due to increased demand for chena land as a consequence of increase in population. Traditionally, chena land was cultivated for two years and then abandoned for 10-15 years. According to the villagers this chena cycle has gradually become shorter and shorter over the years due

to the reasons mentioned above, and in all our study villages the same chena lands have been cultivated continuously for the last 5-6 years. This is an inevitable process in all shifting cultivation cultures facing population pressure as described in Boserup (1965 p. 16). Thus, the traditional method of maintaining soil fertility by periodically shifting to newly cleared forest land, though still occurring, is very restricted. In an attempt at regulation the government does operate a system of issuing permits for cultivation for two years for which a fee is supposed to be paid.

Paddy cultivation - land categories and agricultural practices in the command area: Paddy is grown on land below the tank bund in the command area of the village tank. Traditionally, there were 10 - 20 acres of reserve land between the tank bund and the command area to supply soil for earth work on the tank bund. But currently due to increased demand for paddy land, this system of reserve land has either ~~disappeared~~ or become smaller in size in most villages. The average size of operational paddy land holding of dry zone farmers is 2.8 acres (GOSL, 1984 p. 62) but the average area under puranawela land (see below) in the ten household survey villages was only 1.9 acres². In minor tank villages, smallholders produce paddy mainly for home consumption. In two out of our 10 household survey villages, no paddy was sold, and in the remaining villages the contribution to total annual household cash income from selling paddy was only 11 percent, ranging from 1.5 to 34 percent.

There are two categories of land in the command area, puranawela, the old or the original land developed for

2 This is the asweddumized acreage in the 12 dry zone districts divided by the number of operating households. It does not refer to minor tank acreages only for which a breakdown is not available.

cultivation with the original construction of the village tank, and akkarawela, the newly developed land brought under cultivation over the years. There are four fundamental differences between these two categories of land:

- i) Puranawela land is privately owned by farmers and akkarawela land belongs to the state;
- ii) purahawela land enjoys a primary right to tank water and akkarawela land has only a secondary right;
- iii) when a bethma system (described below) is practised in periods of water scarcity, the amount of land allocated to a cultivator is determined in proportion to his land holding size only in the puranawela land; and
- iv) maintenance of puranawela land is a communal responsibility whereas that for the akkarawela land is left entirely to individual farmers. It must be emphasised here that although akkarawela lands are not legally owned by the farmers, cultivation rights to these lands are firmly established and recognised by the village community and the usual customs of inheritance, leasing-in and leasing-out are practised.

Akkarawela land, if sown, is invariably sown before puranawela land and under dry conditions; it usually requires only one of two issues of water from the tank. Puranawela land, if sown, is usually sown under irrigated conditions. Duration of paddy varieties sown for both categories of land depends upon timing and intensity of the maha rains. In almost all minor tank villages in the dry zone, paddy is grown only in the maha season and growing a second paddy crop in the yala season is extremely rare; this was evident from field work and is supported by Somasiri (1978 p. 28).

The literature, on dry zone minor tanks cited above, mentions a system of cultivation under which only a part of the command area is cultivated in times of water scarcity (usually the yala season) and land for cultivation is allocated to farmers in proportion to to the amount of land owned by them. This system is popularly known as the bethma system. This is an old system developed to share equitably a communally owned resource, tank water, in times of scarcity, and one which is believed to be almost universal. But according to the farmers interviewed by us, while it was possible to grow paddy under the bethma system 20-30 years back on a regular basis (in two out of five seasons), now bethma cultivation is possible only in years of unusually heavy rainfall like that of maha 1983-84. Our field experience suggests that currently the bethma system is hardly practised because the size of the command area under minor tanks has increased enormously (see Table 2) without any increase in the storage capacity of the tanks.

Paddy cultivation in minor tank villages is quite modernised. Land preparation and threshing are mechanised and two-and four-wheeled tractors are used for these operations. The vast majority of the farmers have adopted locally improved varieties of paddy. According to one report (GOSL, 1983c P.X.) 97 percent of all dry zone farmers used locally improved paddy varieties in maha 1982-83, and newly improved varieties were used by about 86 percent of them. Use of modern inputs, pesticides, weedicides and chemical fertilizers, is also prevalent. In maha 1982-83, 72 percent of all dry zone farmers used pesticide; weedicide was used by about 64 percent of them; and use of different chemical fertilizers was as follows: V-71 percent, N.P.K. - 30 percent, UREA - 93 percent and TDM-84 percent (GOSL, 1983c pp.XV XXI, XXV).

Minor Tanks: The Socio-Economic Context

The relative homogeneity of farming systems under dry zone minor tank villages also holds true for their socio-economic organisation. This section is concerned with social organisation as it relates to the farming systems of minor tanks and with main economic characteristics of these farming systems.

Of the three major social groups in Sri Lanka, Sinhalese minor tank villages have been most frequently studied and described. Out of 20 villages studied by us, 18 conform to the pattern described in earlier studies (Farmer, 1957; Leach, 1961) as single-caste villages. This is often claimed as a stabilising, or conflict minimising characteristic. Two of the other villages studied were Muslim and the third was a mix of Tamil land-lords (largely absentee) with sharecroppers from all three social groups. Sample selection criteria, which have been described in the previous chapter, were not designed to investigate any differential impact of socio-cultural variations upon social organisation. If the impact of such variations is important, and this study provides no evidence on this, then our conclusions must not be regarded as typical of non-Sinhalese minor tanks.

The most critical aspect of social organisation as it relates to the minor tanks concerns collective decisions by the community on the timing and distribution of tank water use and maintenance of the tank system; the forum for such decisions is the kanna meeting held prior to each cultivation season. These meetings are organised by the Yaya Palaka who is elected by the cultivators for a period of three years under the Agrarian Services Act of 1979. Role of the Yaya Palaka¹:

¹ See footnote 4 of Chapter 1.

Although the post of Yaya Palaka is an elected one, and formal elections do take place, in practice the post is most commonly hereditary. Only two out of the twenty-three Yaya Palakas interviewed by us who were elected in the last election came from a family different to that which had always held the position.

The Yaya Palaka is entrusted with several other responsibilities apart from organising the kanna meetings. These include operating sluices, ensuring fair distribution of water to all fields in the command area, guarding against wastage of water and stealing of water by the farmers, mobilising farmers to repair and maintain the tank system, conflict resolution on irrigation and other related issues, reporting to the local Agrarian Services Centre (ASC) of DAS about any major damage in the headworks of the tank which requires DAS assistance to be repaired and acting, as a liaison between the cultivation and the local ASC staff. In most of these activities, the Yaya Palaka is helped by elder members of the village and other influential villagers, e.g. school teachers, temple priest and government employees; effectively, decision-taking authority is not concentrated in the hands of only one person. For his work, the Yaya Palaka receives 1/4-1/2 bushel of paddy per acre of land irrigated in each season from the cultivators.

Yaya Palaka command a great respect from farmers for resolution of conflicts about irrigation-related issues. All cultivators interviewed in our 10 household survey villages reported that if they have any problem they go to the Yaya Palaka and they were happy with the Yaya Palaka's performance. Yaya Palakas state that they can solve most of the problems brought to them and refer only the very complicated ones to the Cultivation Officer (CO).

and Divisional Officer (DO) of the local ASC (only two such cases were reported).

It seems that the Yaya Palaka's authority to deal with problems may sometimes be undermined due to undesirable political interference. In one village the Yaya Palaka informed us that he was unable to enforce sanctions he imposed due to interference by the CO who was a local resident and who used his influence as a long-time supporter of a dominant political party to protect his friends and relatives. Consequently, the Yaya Palaka felt unwilling on the grounds of natural justice to impose sanctions against anybody else and suggested that he was unable to effectively impose sanctions anyway since his authority was undermined.

Kanna meetings: Kanna meetings are held either in the village temple, or village school, or in the Yaya Palaka's house and are usually presided over by the CO of the local ASC. The Kanna meeting is a mechanism through which cultivators can reach a general consensus on the following issues;

- i. fixing a date by which tank bund, main and field channels should be cleared and repaired;
- ii varieties of paddy to be grown;
- iii extent of command area to be irrigated (particularly in the yala season);
- iv preparing a cultivation calendar with specific dates by which particular operations must be completed;
- v preparing an irrigation schedule with tentative dates for first and last issue of irrigation water;
- vi tentative number of irrigation issues, duration of each issue and interval between issues;

- vii fixing dates for putting fences around the puranawela land and to put up watch huts;
- viii sanctions against stealing water, allowing cattle to damage crops in the field, and violation of any decision taken in the kanna meetings; and
- ix resolution of conflicts which remained unresolved from the previous season.

In some tank village (for example, Galegama), two kanna meetings are held in the same season; one regarding cultivation on akkarawela land prior to the onset of the maha rains and the other by early January to take a decision regarding cultivation on puranawela land. All decisions taken in the kanna meeting become by-laws which every cultivator is obliged to follow. A minimum attendance of one-third or one-fourth of the owner cultivators or occupiers of one-third or one-fourth of the total land cultivated is required to form a legal quorum for kanna meeting decisions to become by-laws (Agrarian Services Act, No. 58 of 1978 - the act itself (GOSL) 1979 p. 29 is badly worded specifying 'one third or twenty five per centum'). There is no sanction against not attending a kanna meeting but the absentee must abide by the decisions taken by others.

Social obligations for maintenance of irrigation systems:

As the minor tanks under discussion are communally owned, all members of the community have certain obligations towards maintenance of these irrigation systems. These include the tank bund, main and field channels and the

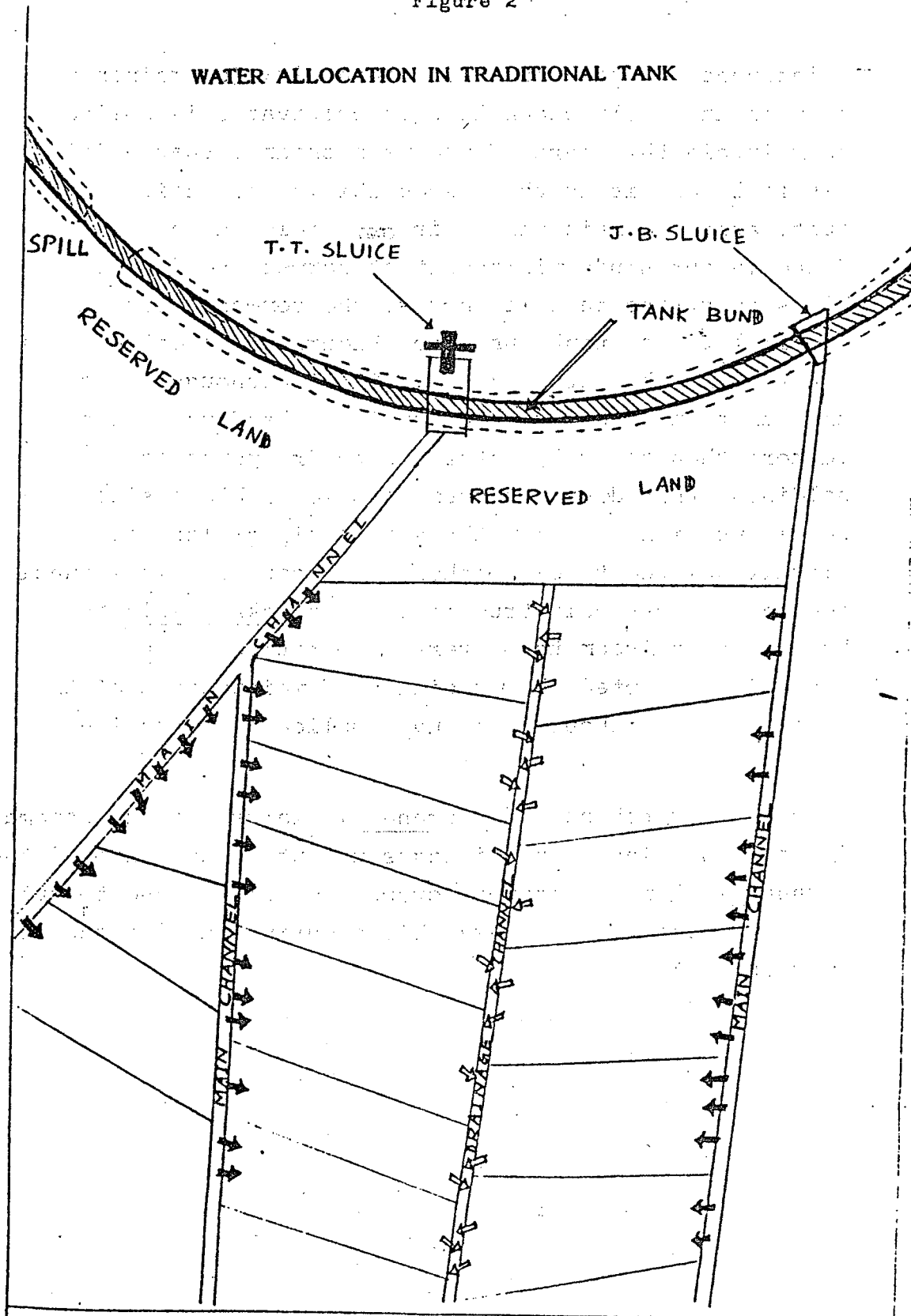
puranawela land. Although tank irrigation and other related issues are organised on a village to village basis, we observed that the principles followed by the villages are the same.

Maintenance of tank bund: The bund is cleaned of bushes and rat holes and other minor damage is repaired before the beginning of each cultivation season. All cultivators participate in this activity and the overall organisation and supervision is done by the yaya palaka. Literature on dry zone minor tank villages describes a system of tank bund maintenance whereby each cultivator's share in the work is determined in proportion to the size of land cultivated by him under the tank. Our field experience suggests that either this system has changed or is not followed rigidly any more. Currently, bund maintenance activity is carried out under two conditions, Shramadane (self-help) or the government's drought relief programme. Under Shramadana all cultivators and sometimes their family members take part in the activity and no individual cultivator is allotted a measured part of the bund as his share. The whole operation is performed in the spirit of a group activity and the same system is used for repairing village roads and other infrastructural amenities that all villagers use. Drought relief programmes are launched in minor tank villages from time to time because of the high incidence of crop failure. Drought relief programmes are food-for-work programmes in which tank bunds, village roads and culverts, and other public places like, schools, temples and clinics are repaired. As this is a government-sponsored programme, all works are supervised and food is distributed by the Grama Sevaka (village official responsible to the local Assistant Government Agent's office); the yaya palaka has a responsibility to organise tank bund work and to assist the Grama Sevaka.

Maintenance of main and field channels: For maintenance of main and field channels each cultivator is obliged to maintain that part of the main channel that adjoins his field and it is the responsibility of individual cultivators to maintain their own field channels. We found in our study villages that farmers hold their plots in strips that lie across the command area and parallel to the tank bund (see Figure 2), a pattern also reported by Abeyratne (1956 p. 200). Although it is true that in some cases one strip of land may belong to more than one cultivator due to fragmentation of holdings, this ~~does~~ not seem to pose problems since people who inherit from the same strip of land are closely related to each other. Of course this situation does not always hold true in cases of akkarawelaland but villagers seem to be very cooperative and have generally accepted the tradition of maintenance of the main channel without creating complicated situations.

Fences and watch huts on puranawela lands: It is customary in dry zone minor tank villages to put a fence around the puranawela land to protect crops from cattle and to put up watch huts to scare away birds during the day and elephants at night.

28
Figure 2



TOWER TYPE SLUICE



JUNCTION BLOCK SLUICE



INFLOW OF WATER



OUT FLOW OF WATER

Farmers are responsible for fencing the outer edges of their puranawela land. The top and bottom of the puranawela land is also fenced and this is entrusted by the community to two individuals who are remunerated by having cultivation rights on one acre of land each in every cultivation season. Lands are allocated to these two individuals at the top and bottom of the puranawela land (locally known as elapatha land), and their crops will be damaged first if they neglect their duty. This system is rotated among interested farmers so that they can all derive some extra profit by undertaking the responsibility.

Several watch huts are put up on puranawela land, (very roughly, about one watch hut per 3 to 5 acres of land). The cost is shared by a group of farmers whose land is guarded by a common watch hut. During the day time the job of scaring away birds is left to the children and night time guarding is done by farmers themselves. The number of nights spent in a watch hut by an individual farmer depends on the size of his share in the total land being guarded by that hut.

The economy of minor tank villages: The predominantly agricultural economy of dry zone minor tank villages is poorly endowed and a majority of the households maintain themselves at a subsistence level. The poor economy of the dry zone in general and minor tank villages in particular is due to a combination of problems -physical, social, economic and institutional.

Physical problems: The main problem of agriculture in the dry zone is its poor endowment with physical resources. None of the vital elements for enhancing agriculture, good soil characteristics, reliable ground water

resources and rainfall, are favourable in the dry zone. Soils in the dry zone, in general, do not have good water retention characteristics due to natural formation (for a detailed description see Farmer, 1954; 1957) Abeyratne, 1956); they are susceptible to erosion especially when chena cultivation is **practiced**, and are not intrinsically fertile due to low levels of nutrients and organic matter (Abeyratne, 1956). Ground water resources are very poor in the dry zone, except in the Jaffna peninsula, which means agriculture is almost entirely dependent on direct rainfall and surface water irrigation. The dry zone receives most of its annual rainfall in the maha season, and yala rains are quite ineffective. Maha rains are highly variable, causing total crop failure and greatly reduced yield in some years due to drought (see Table 3) and in other years damaging crops and irrigation works due to floods as happened in maha 1983-84. The problem of developing dry zone agriculture is aptly described in Farmer (1954 p. 23).

" the Dry Zone of Ceylon is thus a region with much spare land, but with a combination of most of the difficulties to be found in a tropical environment. Marked relief, a seasonal, variable and often ineffective rainfall, negligible underground and relatively small surface water resources, and soil difficulties should induce caution in the development of the region."

From the farmers' perspective it is the uncertainty about rainfall (both timing and intensity) that most adversely affects the amount and stability of their paddy production. This is supported by our data and information from other studies as presented in Table 3 and Table 5.

Table 3 clearly demonstrates that drought is the main cause affecting paddy production in dry zone minor tank villages. It is also evident from the table that rain-related problems are highly variable between dry zone districts; for example, a comparison between Trincomalee tanks and Puttalam and Anuradhapura tanks shows that the incidence of crop failure and reduced yields due to drought is more frequent under tanks in the latter two districts. Stable paddy production in minor tanks of Trincomalee is due to a more reliable rainfall pattern and more favourable catchment area/tank storage capacity/command area ratios.

In the absence of other data we have done a simple analysis on 20 years (1961-80) annual rainfall data for the three districts and the results are presented in Table 4.

Table 4 demonstrates that Trincomalee has a significantly higher mean annual rainfall than both Puttalam and Anuradhapura districts. What is more important for our purpose is that the table also shows that throughout the maha season Trincomalee has a significantly higher rainfall than Puttalam and Anuradhapura with the single exception of October.

However, as our data were based only on three dry zone districts we decided to do a statistical test on all 12 dry zone districts using data available from other studies (GOSL, 1983a) to examine what percentage of crop failure in maha season could be explained by drought alone. There was a slight problem in using the data because the data for crop failure were grouped under the general heading of minor schemes without further breakdown into tanks and anicuts but we believe that

this would not pose any problem for drawing conclusions about the dry zone since almost all the minor irrigation schemes in the dry zone are tanks. Certain other adjustments and assumptions have been made for the purpose of our analysis and these and the results are presented in Table 5.

This table suggests (see Col. 6) that in eight districts out of twelve drought causes 80 percent of crop failure under minor schemes and rainfed cultivation, in five cases it causes more than 90 percent and in four cases it causes more than 97 percent.

The only three districts³ where the cause of crop failure in minor schemes and rainfed cultivation is not principally due to droughts are the three eastern districts, Batticaloa, Amparai and Trincomalee. We have no evidence (except for Trincomalee as in Table 4) on how to decide which of several plausible reasons may be the explanation for the low incidence of drought-induced failure; however, these districts are responsible for only 12 percent of all paddy crop failures under dry zone minor schemes and rainfed cultivation.

Socio-economic problems: The problem of paddy production in dry zone minor tank villages is further aggravated by fragmentation of holdings, mainly due to inheritance and economic distress of farmers from repeated crop failures.

In our 10 household survey villages the average size of operated land in puranawela was very small (1.2 acres) and in almost all cases this was divided into more than one plot. This seems to be the result of the custom of inheriting land from different tracts of the puranawela

3 We have excluded Polonnaruwa because the total area on which the crop failed was very insignificant.

land. Average operational land holding size on akkarawela land was also not much larger (1.7 acres) and this was also divided into more than one plot. This is perhaps due to the fact that plots of land were brought under paddy cultivation by a particular family at different times and also due to inheritance.

These small holdings limit paddy production in two ways. They curtail access to scale economies associated with certain inputs, e.g. tractor use; and because the net returns are marginal in relation to household income needs, farmers provide their plots only minimal attention as they shift their economic priority to other areas, for example expanding acreage under chena cultivation or taking up wage employment (Gunasekera and Fernando, 1981; Gunasekera, 1982). Scarcity of water in combination with these factors results in very low paddy yield under minor tanks averaging 46 bushels per acre (World Bank, 1981) compared to about 68 bushels per acre in major schemes over the years 1975/76-1979/80.

Unstable paddy production under dry zone minor tanks coupled with substantial cash investment needs seems to have resulted in an increase in the percentage of paddy land cultivated under the share-cropping system, locally known as ande system. Leaving aside the cost of other inputs for the moment, in our study villages it costs Rs. 500-550 per acre to hire a tractor for land preparation which has to be paid in advance. For many farmers it is not easy to raise this capital and it becomes especially difficult in years following two or three seasons of no harvest or greatly reduced harvest. In such years the only alternative for many of the farmers is to lease out their land to tractor owners and this is popularly known as 'tractor ande'. Under this system the total harvest is shared equally by the tractor owner and the land

owner; the land is prepared and inputs are supplied by the tractor owner on the condition that half of all these expenses will be borne by the land owner and will be repaid in kind after the harvest. The above description is not intended to give the impression that land leased-out always goes to tractor owners; currently it seems to be the dominant share-cropping system in dry zone minor tank villages but some lands are leased-out to others (mostly local villagers) under similar terms and conditions.

The foregoing discussion illustrates the constraints under which farmers in dry zone minor tank villages operate. Some of these constraints could certainly be removed by offering institutional credit and timely supply of other inputs, especially, seed paddy. These kinds of institutional facilities are conspicuously lacking in most minor tank villages.

Minor Tanks: Role of the State

The traditional role of the state in regard to minor tanks was restricted; direct assistance was provided for tank construction but operation, maintenance and repairs were the responsibilities of local communities who developed a robust system of self-help and self-regulation. It has been reported (Roberts, 1980) that in the early days of British rule, various enactments interfered with the effectiveness of local community organization and it was not until the Paddy Lands ordinance of 1958 that a reversion to 'local customs' was introduced in an attempt to correct this. Whilst there were some minor modifications to this approach up to the time of independence from British rule, the state was directly involved only in support for construction. Otherwise it simply provided a legal framework to help strengthen the

traditional supervisor of minor tank operations, the yaya palaka, in enforcing water management decisions taken in the kanna meetings.

At the time of independence in 1948, farmer participation in water management was largely restricted to attending kanna meetings and carrying out the decisions taken in those meetings (Uphoff et al, 1982 p.7). Since independence, the Government of Sri Lanka has tried several institutional innovations to encourage farmer participation in all aspects of water management. These are well summarised in the World Bank document for the village Irrigation Rehabilitation Project (1981 p.4)

"With the passage of the paddy Lands Act in 1958, its subsequent amendment, and its replacement by the Agricultural Lands Act of 1973, the government attempted in various ways to replace the traditional system with elected committees under official sponsorship. During the 1960s, this system appears to have functioned fairly well, but further administrative changes weakened the effectiveness of the elected committees, with the result that the traditional system of control was undermined without being replaced by an effective alternative. Recognising this, the present government has abolished the system of elected committees, replacing it with one which in some ways returns to traditional practice."

Under the current practice, the yaya palaka is entrusted with the responsibility of taking day-to-day decisions regarding operation of tanks and he is assisted by a Cultivation Officer of the local Agrarian Service Centre of the DAS.

State intervention in minor tanks has not only been restricted to experimenting with local institutional innovations; it also involved shuttling the responsibility of maintaining minor irrigation schemes to different agencies at different times as summarised by Abeysinghe (1982a pp. 26-28) and presented below in chronological order.

1. Up to 1832 - Village irrigation works were maintained by village communities under a system of rajakariya (forced services for the King) which was abolished by the British in 1832.
2. 1832 - 1887 - From the abolition of rajakariya up to 1887 nobody was officially responsible for maintaining village irrigation works. This vacuum led to degradation of village irrigation works.
3. 1887 - 1900 - In 1887 Provincial Irrigation Boards were established and Government Agents were entrusted with the responsibility of executing all irrigation works (major and minor) in their own areas.
4. 1900 - 1932 - In the year of 1900 a separate Irrigation Department was created which was responsible for construction of all irrigation works (major and minor) and maintenance of all major irrigation schemes. Provincial Irrigation Boards were abolished with the creation of the Irrigation Department and the Government Agents remained responsible for maintenance of minor irrigation schemes in their areas with the help of communal labour.

5. 1932 - 1948 - A new irrigation policy was introduced in 1932 by the Minister of Agriculture and Lands. Under this policy, construction as well as improvements and maintenance of minor irrigation schemes were entrusted to the Irrigation Department.
6. 1948 - 1958 - In 1948, soon after independence, responsibility for maintaining minor irrigation schemes was taken over by the Ministry of Agriculture and Food because the Irrigation Department was heavily involved with the large-scale Gal Oya irrigation Project.
7. 1958 - 1972 - Department of Agrarian Services was established with the passage of the Paddy Lands Act of 1958 and it was entrusted with the responsibility for executing all minor irrigation schemes.
8. 1972 - 1985 - With the passage of the Agricultural Productivity Laws of 1970s, responsibility for executing all minor irrigation schemes was transferred back to the Irrigation Department.

Responsibility for maintaining all minor irrigation schemes was handed over again to the Department of Agrarian Services under the Agrarian Services Act No. 59 of 1979. It had been found that maintenance of minor irrigation schemes was being neglected due to the Irrigation Department's pre-occupation with major irrigation schemes. The same system is continuing up to date.

The principal concern of this report is with the current role of the state but it would be clearly inappropriate to attribute any shortcomings solely to the agencies now responsible, given the history of shifting responsibility which must have harmed the credibility of the state, in the eyes of farmers as an effective and benevolent mediator in their attempts to make productive use of limited natural endowments.

Table I

Average Sizes of Operational Holdings by Land Type and Sources of Cash Income
in Ten Minor Tank Villages (1983)

Village Name (electorate)	Av.size of puranawela operated (acres)	Av.size of akkarawela operated (acres)	Av.size of chena land cultivated (acres)	Av.annual cash household income (rupees)	% earned from selling paddy	% earned from selling chena	% earned as daily wage labour	% earned from profession 1	% earned from other sources
Halikubukgalewa (Madawachchiya)	0.83 n=14	2.86 n=19	5.50 n=20	5441 n=24	4.50 n= 4	28.00 n=15	18.07 n=11	45.00 n= 8	4.43 n= 1
Galegama (Madawachchiya)	0.79 n=20	1.69 n=22	2.56 n=31	3430 n=35	7.83 n=16	22.38 n=26	48.65 n= 2	20.99 n= 1	0.15 n= 1
Meegahadigiliya (Horowpathana)	0.94 n=19	0.97 n=12	2.09 n=28	3569 n=30	- -	33.81 n=26	30.89 n=15	10.83 n= 8	24.47 n=13
Nelugallekada (Horowpathana)	1.00 n=18	1.43 n=19	2.14 n=28	4556 n=30	3.47 n= 5	37.89 n=26	27.59 n=18	17.56 n= 2	13.49 n= 5
Nikawewa (Horowpathana)	0.86 n=17	2.98 n=21	2.83 n=39	6691 n=39	1.53 n= 3	59.26 n=38	35.96 n=27	- -	3.25 n= 8

Notes: a) Professional earnings include, hiring out tractors, government employees, village artisans and private business.

b) In all cases where earning from other sources was more than 5 percent, the sources were selling milk and cattle with the exception of Bakmeegama where it was from selling honey. In other cases the only source was selling fruit and vegetables.

(continued on next page)

Table I (continuation)

Average Sizes of Operational Holdings by Land Type and Sources of Cash Income
in Ten Minor Tank Villages (1983)

Village Name (electorate)	Av.size of puranawela operated (acres)	Av.size of akkarawela operated (acres)	Av.size of chena land cultivated (acres)	Av.annual cash household income (rupees)	% earned from selling paddy	% earned from selling chena	% earned as daily wage labour	% earned from profession	% earned from other sources
Mahadodanttawa (Anamaduwa)	1.94 n=24	2.27 n=18	1.81 n=35	5706 n=39	21.41 n=23	44.72 n=32	22.77 n=22	-	11.10 n=16
Perumakuttawa (Anamaduwa)	1.10 n=22	-	1.80 n=28	4489 n=29	2.30 n=1	50.68 n=25	31.15 n=19	15.52 n=6	0.35 n=2
Dharmapaliya (Anamaduwa)	0.61 n=18	-	1.52 n=24	5354 n=27	-	45.66 n=22	32.34 n=20	18.75 n=5	3.25 n=3
Bakmeegama (Seruwawella)	1.54 n=17	1.53 n=16	1.13 n=16	4732 n=27	11.62 n=9	7.30 n=6	71.14 n=26	-	9.94 n=27
Bellankadewella (Seruwawella)	3.66 n=26	3.25 n=12	1.00 n=26	5728 n=34	34.26 n=20	16.39 n=22	25.06 n=21	11.62 n=2	12.67 n=10

Source: Project field data from Anuradhapura, Puttalam and Trincomalee districts.

Table 2

Percent Increase in the Size of Command Area in Twenty Minor Tank Villages

(acres)

Tank Name	Size of the total command area	Size of the puranawela	Size of the akkarawela	% increase in size of the command area	Type of Tank
Meegaha digiliya	78	35	43	122.86	Traditional
Diganhamimillewa	126	75	51	68.00	"
Niluwewa	87	20	67	335.00	"
Nelugallekada	155	90	65	72.22	"
Nikawewa	170	50	120	240.00	"
Galegama	170	48	122	385.71	"
Heeralugama	153	60	93	155.00	"
Galebindunuwewa	160	45	115	255.55	"
Athakada	219	98	121	123.47	"
Halikubukgalewa	99	30	69	230.00	"

Notes: (a) The period over which these increases occurred was not well-defined but farmers stated that most of the increases were in the last two to three decades, subsequent to mechanisation of land preparation.

(b) The increase in the command area is equal to the area cultivated under akkarawela.

Table 2 (continuation)

Percent Increase in the Size of Command Area in Twenty Minor Tank Villages

(acres)

Tank Name	Size of the total command area	Size of the puranawela	Size of the akkarawela	% increase in size of the command area	Type of Tank
Perumakuttawa	50	50	-	-	Water Management (IRDP)
Unaleeya	130	130	-	-	"
Mahadodanattwa	120	55	65	118.18	"
Kohambagassewa	60	35	25	71.43	"
Dharmapaliya	40	18	22	122.22	"
Bakmeegama	47	18	29	161.11	Water Management (VIRP)
Bellankadewala	105	32	73	228.12	"
Pankulan	204	174	30	17.24	"
Naduvoothakalam	110	40	70	175.00	"
Mahamarkulam	70	20	50	250.00	"

Source: Project fieldwork in Anuradhapura, Puttalam and Trincomalee districts.

Table 3

Five Years Data on the Proportion of the Command Area Cultivated
in Twenty Minor Tank Villages (Maha 1979-80 to 1983-84)

(Area in acres)

Tank Name	Land type	Command area	1979 - 1980 sown - harv.	1980 - 1981 sown - harv.	1981 - 1982 sown - harv.	1982 - 1983 sown - harv.	1983 - 1984 sown - harv.	Type of tank and location
Meegahadi-giliya	puranawela	35	35 ^b	0 ^a	0	35 ^b	0 ^a	Traditional Horowpathana Anuradhapura
	akkarawela	43	0 ^a	0 ^a	0	0 ^a	16 ^c	
Diganhami-millewa	puranawela	75	0 ^a	0 ^a	0	24 ^b	12 ^c	"
	akkarawela	51	0 ^a	0 ^a	0	0 ^a	0	
Niluwewa	puranawela	20	0 ^a	0 ^a	0	20 ^b	20 ^c	"
	akkarawela	67	0 ^a	40 ^a	40	67 ^b	67 ^c	
Nelugalle-kada	puranawela	90	0 ^a	0 ^a	0	90 ^b	25 ^a	"
	akkarawela	65	0 ^a	0 ^a	65 ^b	0 ^a	61 ^d	
Nikawewa	puranawela	50	25 ^a	25 ^a	0 ^a	50 ^b	50 ^c	"
	akkarawela	120	35 ^a	70 ^a	70	70 ^a	70 ^c	

Notes: a = Either missed a cropping season totally or only part of the common area was cultivated due to uncertain rainfall both timing and intensity.
 b = Either total failure or reduced yield due to shortage of water.
 c = Either total failure or reduced yield due to too much rain.
 d = Either total failure or reduced yield due to insects.

Table 3 (continuation)
 Five Years Data on the Proportion of the Command Area Cultivated
 in Twenty Minor Tank Villages (Maha 1979-80 to 1983-84)

(Area in acres)

Tank Name	Land type	Command area	1979 - 1980 sown - harv.	1980 - 1981 sown - harv.	1981 - 1982 sown - harv.	1982 - 1983 sown - harv.	1983 - 1984 sown - harv.	Type of tank and location
Galegama	<u>puranawela</u>	48	0 ^a 0	0 ^a 0	0 ^a 0	0 ^a 0	48 48	Traditional Madawachchi, Anuradhapura
	<u>akkarawela</u>	122	35 ^a 35	6 ^a 4	10 ^a 6	20 ^a 12	122 122	
Heeralugama	<u>puranawela</u>	60	30 ^a 20 ^b	0 ^a 0	60 60	60 60 ^b	0 ^a 0	"
	<u>akkarawela</u>	93	35 ^a 10 ^b	10 ^a 3	9 ^a 9	72 ^a 40 ^b	55 ^a 35 ^c	
Galebindu-nuwewa	<u>puranawela</u>	45	30 ^a 0	0 ^a 0	0 ^a 0	0 ^a 0	15 ^a 8 ^c	"
	<u>akkarawela</u>	115	20 ^a 20 ^b	40 ^a 15 ^b	40 ^a 20 ^b	60 ^a 35 ^b	110 ^a 60 ^c	
Athakada	<u>puranawela</u>	98	48 ^a 48	0 ^a 0	48 ^a 0 ^b	48 ^a 48	0 ^a 0	"
	<u>akkarawela</u>	121	121 121	121 121	0 ^a 0	121 0 ^b	50 ^a 30 ^c	
Halikubuk-galewa	<u>puranawela</u>	30	0 ^a 0	17 ^a 17	0 ^a 0	17 ^a 0 ^b	0 ^a 0	"
	<u>akkarawela</u>	69	69 69 ^b	52 ^a 52 ^b	69 69 ^b	69 69 ^b	21 ^a 21	

Notes: a = Either missed a cropping season totally or only part of the command area was cultivated due to uncertain rainfall both timing and intensity.
 b = Either total failure or reduced yield due to shortage of water.
 c = Either total failure or reduced yield due to too much rain.

(continued on next page)

Table 3 (continuation)

Five Years Data on the Proportion of the Command Area Cultivated
in Twenty Minor Tank Villages (Maha 1979-80 to 1983-84)

(Area in acres)

Tank Name	Land type	Command Area	1979 - 1980 sown - harv.		1980 - 1981 sown - harv.		1981 - 1982 sown - harv.		1982 - 1983 sown - harv.		1983 - 1984 sown - harv.		Type of tank and location
Perumakuttewa	puranawela	50	0 ^a	0	0 ^a	0	15 ^a	0 ^b	5 ^a	5	0 ^a	0	Water management IRDP Puttalam
	akkarawela	-	-	-	-	-	-	-	-	-	-	-	
Unaleeya	puranawela	130	0 ^a	0	130	130	25 ^a	25	130	130	130	130	"
	akkarawela	-	-	-	-	-	-	-	-	-	-	-	
Mahadodanattewa	puranawela	55	55	55 ^b	0 ^a	0	0 ^a	0	33 ^a	33	0 ^a	0	"
	akkarawela	65	60 ^a	60 ^b	0 ^a	0	0 ^a	0	0 ^a	0	0 ^a	0	
Kohambagassewa	puranawela	35	35	35	35	35	35	35	35	35	32 ^a	32 ^c	"
	akkarawela	25	25	25 ^b	0 ^a	0	0 ^a	0	0 ^a	0	0 ^a	0	
Dharmapaliya	puranawela	18	18	18	15 ^a	0 ^b	0 ^a	0	0 ^a	0	5 ^a	5	"
	akkarawela	22	22	22	0 ^a	0	0 ^a	0	0 ^a	0	5 ^a	5	

Notes: a = Either missed a cropping season totally or only part of the command area was cultivated due to uncertain rainfall both timing and intensity.
b = Either total failure or reduced yield due to shortage of water.
c = Either total failure or reduced yield due to too much rain.

(continued on next page)

Table 3 (continuation)

Five Years Data on the Proportion of the Command Area Cultivated
in Twenty Minor Tank Villages (Maha 1979-80 to 1983-84)

(Area in acres)

Tank Name	Land type	Command area	1979 - 1980 sown - harv.		1980 - 1981 sown - harv.		1981 - 1982 sown - harv.		1982 - 1983 sown - harv.		1983 - 1984 sown - harv.		Type of tank and location
Bakmee- gama	<u>puranawela</u>	18	18	18 ^b	18	18	18	18	18	18	18	18 ^c	Water management, VIRP Trincomalee
	<u>akkarawela</u>	29	29	29 ^b	29	29	29	29	29	29	29	29 ^c	
Bellanka- dewela	<u>puranawela</u>	32	32	32	32	32	32	32	32	32	32	22 ^c	"
	<u>akkarawela</u>	73	0 ^a	0	0 ^a	0	0 ^a	0	73	73 ^b	58 ^a	48 ^c	
Pankulan	<u>puranawela</u>	174	174	174	174	174	174	174	174	174	174	174 ^c	"
	<u>akkarawela</u>	30	30	30	30	30	30	30	30	30	30	30 ^c	
Naduvoo- thukulam	<u>puranawela</u>	40	40	40 ^b	40	40 ^b	40	40	40	40	40	40	"
	<u>akkarawela</u>	70	70	70 ^b	70	70 ^b	70	70	70	70	70	70	
Mahamar- kulam	<u>puranawela</u>	20	20	20 ^b	20	20	20	20	20	20	20	20 ^c	"
	<u>akkarawela</u>	50	50	50 ^b	50	50	50	50	50	50	50	50 ^c	

Notes: a = Either missed a cropping season totally or only part of the command area was cultivated due to uncertain rainfall both timing and intensity.

b = Either total failure or reduced yield due to shortage of water.

c = Either total failure or reduced yield due to too much rain.

Source: Project field data from Anuradhapura, Puttalam and Trincomalee districts.

Table 4

Maha Rains: Monthly Distribution
in Three Study Locations

(inches)

Mean monthly rainfall and lower 75% Confidence Interval Limit (C.I.L)	Anuradhapura (Madawachchiya)	Puttalam (Anamaduwa)	Trincomalee (Seruwaweila)
Mean annual rainfall	50.67	50.74	69.88
Lower 75% C.I.L.	49.08	49.00	67.32
<u>September</u>			
Mean	3.27	2.69	6.08
C.I.L.	2.93	2.35	4.84
<u>October</u>			
Mean	8.86	10.85	9.49
C.I.L.	7.49	9.84	8.73
<u>November</u>			
Mean	9.60	9.46	14.52
C.I.L.	8.87	8.77	13.42
<u>December</u>			
Mean	8.93	5.51	17.10
C.I.L.	8.17	5.08	16.66
<u>January</u>			
Mean	2.53	1.64	5.00
C.I.L.	1.93	1.30	4.00

Note: As discussed in the text later on the 75% C.I.L. may be an optimistic assessment of farmers' perceptions of expected rainfall.

Source: Calculated from mean monthly rainfall data for 20 years (1961-80) from the Meteorological Rainfall Stations located closest to our field stations.

Table 5

The Importance of Drought as a Cause of Minor Tank Crop Failure
(Maha 1980-81)

(acres)

1	2	3	4	5	6	7
District Name	Total failure in minor schemes and under rain fed	Total failure in major and minor schemes and under rain fed	Total area failed under major schemes	Total area failed under minor schemes and rain fed due to drought (minimum)	% of total area failed under minor schemes and rain fed due to drought (minimum)	% of total area failed under minor schemes and rain fed due to drought (maximum)
Hambantota	356	333	-	333	93.75	93.75
Jaffna	12446	12762	353	12409	99.70	100.00
Mannar	4278	11550	7393	4157	97.17	100.00
Vavuniya	8255	9613	1396	8218	99.55	100.00
Mullativu	9514	13111	5582	7529	79.13	100.00
Batticaloa	2698	1279	1032	100	9.52	49.33
Amparai	314	99	173	-	00.00	31.50
Trincomalee	3369	1492	287	1254	35.78	44.28
Puttalam	3579	3554	487	3068	85.71	99.30
Anuradhapura	8563	9423	1642	7780	90.86	100.00
Polonnaruwa	10	7	2.47	5	50.00	75.00
Moneragala	664	561	17	543	81.78	84.40

Source: Calculated from Statistical Abstract (GOSL, 1983a) Table 72 page 110 and Table 84 page 122.

Notes to Table 5

Column two of the Table provides figures on the total area that failed in maha 1980-81 in minor schemes and in rainfed areas. We have added rainfed areas to minor scheme areas assuming that the data sources, based on asweddumized acreage, do not include highland paddy (which is genuinely rainfed) and that reported rainfed areas are sown under minor schemes on akkarawela land- this approach was adopted because there is no published data available on causes of crop failure by type of irrigation scheme.

Column three gives the total area of crop failure under both major and minor schemes and rainfed areas due to drought.

Column four gives the total area in which the crop failed under major schemes,

Column five gives the total area on minor schemes and rainfed areas that failed due to drought on the assumption that all failure in major schemes was due to drought.

Column six is column five as a percentage of column two.

Column seven is column three as a percentage (maximum = 100) of column two. Thus the percentage of area in minor schemes and rainfed areas that failed due to drought was between the values reported in columns six and seven.

Chapter III

MINOR TANK WATER MANAGEMENT PROGRAMMES

Introduction

The increasing size of government investments in water management programmes is a feature of almost all developing countries that have made substantial investments in irrigation. One major explanation of this trend is the realisation that the benefits from irrigation investments are often not maximised because of inefficient water use. A second factor is that, as the limited opportunities for surface water irrigation are utilized, increases in food production will become more dependent upon improving land productivity in areas where irrigation investments have already been made (Abernethy, 1984: pp. 1 - 8)

Though neither of these considerations are especially pertinent to dry zone minor tanks, these too have become a target for water management programmes. In part this is a natural, though not necessarily logical, development from water management programmes in major irrigation schemes; it is presumed that if investment in construction or rehabilitation of major schemes 'ought' to be accompanied by water management programmes, then the same imperative is valid for minor tank restoration or rehabilitation. Also, the traditional, apparently wasteful, water use practices in minor tanks during maha are taken, reasonably, as evidence of the need for improved water management. The main initiatives on minor tank water management have been in association with rehabilitation programmes but, as described below, they are also being developed for other tanks not in these programmes.

A distinction is often made (e.g., Levine, 1979; Uphoff et al, 1982) between hardware and software components of water management. By hardware is meant the improvements to downstream control structures and measuring devices that allow more efficient water use; also included are the basic technical maintenance requirements which in minor tanks involved bund, sluice spill and channel maintenance. Software concerns the organizational forms adopted to make most efficient use of the system and to ensure that the required maintenance tasks are carried out. In our discussion of water management programmes, the emphasis is upon the software component; it is of course the case, in any system, that there is an interdependence between the two components and an analysis of software is incomplete without considering the effects of changes in hardware. Nevertheless for minor tanks this software emphasis is justifiable because there is limited scope for flexibility in water management hardware, given that basic system designs are already fixed. Therefore our concern with hardware is restricted to issues related to farmer participation in design and location of hardware items and not with the technical characteristics of hardware... which we are not anyway competent to comment upon. As the discussion shows, the most fundamental issues relating to the efficiency of minor tank water management programmes are issues of software.

The following paragraphs outline the objectives and methods of the largest minor tank water management programme, the village Irrigation Rehabilitation Project, and this is followed by a paragraph on the DAS general water management programme. Details of some other projects with water management programmes are given in the appendix to this chapter. The next section then outlines the main elements of the Water Management Package being introduced by the

programme; this is followed by a short section on the organisation of water management programmes. The remaining part of the chapter analyses each main component of the package in relation to traditional farming systems and water management practices.

Village Irrigation Rehabilitation Project (VIRP)

This is the largest programme concerned with rehabilitation of minor village irrigation schemes and has financial support from the World Bank. It aims at rehabilitating 1200 minor irrigation schemes of which about 90 percent are minor tanks¹ and the rest are anicuts. It is expected that the rehabilitation work will minimise uncertainty related to the availability of irrigation water on 77,805 acres of land benefiting 20 - 25,000 farm families. The project area is spread over almost the whole of the dry and intermediate zones and a small part of the wet zone.

Objectives: The project has two main objectives: rehabilitation of deteriorated minor irrigation schemes to increase agricultural production and farm incomes and to ensure efficient utilisation of stored water once the rehabilitation work has been completed through introduction of a systematic water management programme. The project also aims to strengthen the capacity of the major government institutions involved with minor irrigation schemes, particularly the Department of Agrarian Services, by providing them with necessary training, staff, equipment and transport etc., to ensure proper maintenance of these schemes.

1 In this chapter, minor "schemes" refer to minor tanks.

Costs and benefits: The VIRP is a 5 year project (1981 - 85) and has a budget of US\$ 25.9 million US\$ 43.6 million including price contingencies (World Bank, 1981, p. 64). It is difficult to estimate precisely the share allotted to water management. There are five main budget heads; civil works; equipment; incremental staff costs; other incremental costs; and training, evaluation and technical assistance.

According to the project document, approximately 11 percent of civil works are for downstream works. The training, evaluation and technical assistance head and the incremental staff cost head (except regional office allocations) are principally for water management whereas the other incremental costs and equipment budget are mainly for headworks. Following this allotment, the share of water management in the budget (net of price contingencies) is US\$ 3.4 million, or about 13 percent. The project life has been estimated to be 25 years with the project reaching its full production levels in 1991. It is estimated that with full maturity of the project, cropping intensity in the project areas would increase from 83 to 116, leading to an increase in rice production of 37,800 tons p.a. and a 43% increase in per capita income.

Implementing agencies for rehabilitation work : The Irrigation Department is responsible for the civil works component of the project. Rehabilitation of minor tanks include improvement of tank bunds and spillways; replacement of all junction-block type sluices with tower-type sluices (see figures 3 and 4); improvement of main channels; alignment of main channels and field channels, provision of appropriate drainage systems, control structures, turnout structures and measuring devices. Improvement of field channels will be done by farmers under the guidance of the Department of Agrarian Services.

Operation and maintenance of the rehabilitated tanks:

Rehabilitated tanks will be operated and maintained by the farmers with support from the DAS. However, the Irrigation Department will be responsible for ensuring satisfactory functioning of the headworks and structures rehabilitated under the project for a period of 2 years.

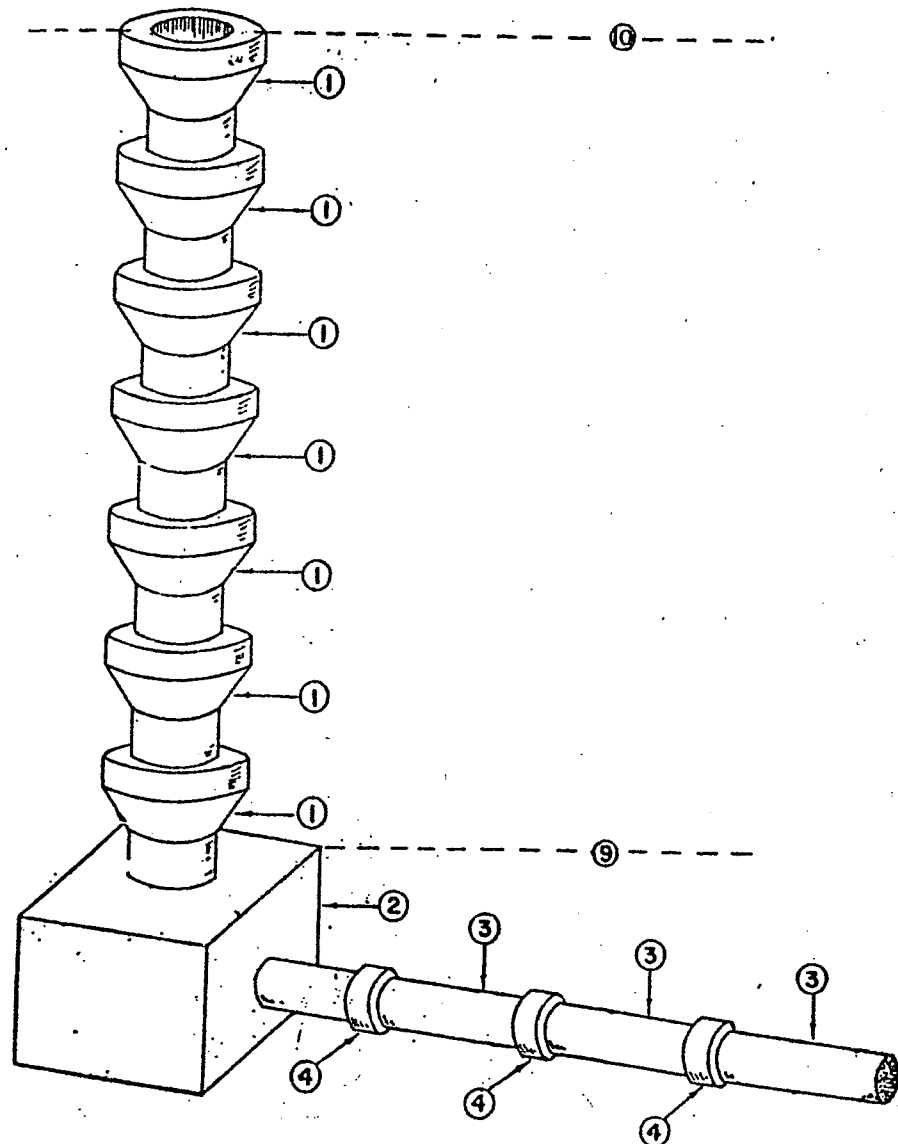
Implementing agency for the water management programme:

The Department of Agrarian Services is responsible for planning and implementation of the water management programme in the rehabilitated tanks to ensure optimum utilisation of the available water. Specific water management programmes will be prepared for individual tanks in consultation with the farmers and will be operated by the farmers under the guidance of the DAS staff. A new set of agricultural and irrigation practices is being introduced under the water management programme which will be discussed in detail later in this chapter.

Criteria for selecting minor tanks: According to the project document, in selecting minor tanks for rehabilitation, highest priority should be given to those schemes which would yield maximum returns with a relatively small investment. On the other hand, lowest priority should be given to those minor tanks which have been abandoned long ago and would require almost complete reconstruction. The following criteria are used for selecting minor tanks:

- i. the command area under a tank should not be less than 20 acres, except if a tank is one in a cascade and requires improvements to provide safety for the tanks downstream;

Figure 3



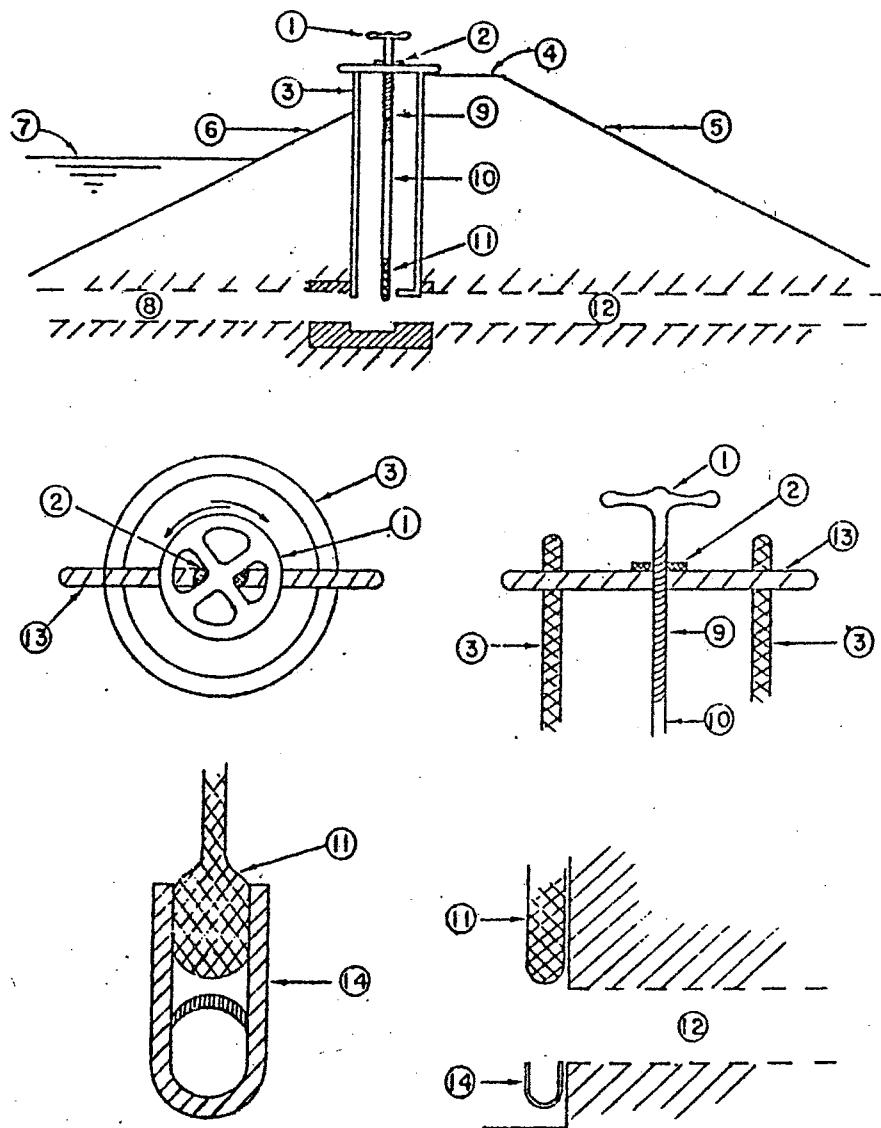
- 1. SLUICE VERTICALS PIPES
- 2. JUNCTION BLOCK
- 3. SLUICE OUTLET PIPES

- 4. OUTLET PIPE COLLARS
- 9. SILL LEVEL OF SLUICE
- 10. FULL SUPPLY LEVEL

Junction Block Type Sluice

Source: National Freedom From Hunger Campaign

Figure 4



1. SLUICE CONTROL WHEEL
2. NUT WELDED TO CROSS BAR
3. SLUICE TOWER CYLINDER
4. TOP OF BUND
5. DOWN STREAM SLOPE OF BUND
6. UPSTREAM SLOPE OF BUND
7. FULL SUPPLY LEVEL

8. SLUICE INLET PIPE
9. SCREW THREAD OF CONTROL SHAFT
10. CONTROL SHAFT
11. SLUICE DOOR
12. SLUICE OUTLET PIPE
13. CROSS BAR
14. (U) FRAME OF SLUICE DOOR

Tower Type Sluice

Source: National Freedom From Hunger Campaign

- ii. tanks in inhabited areas with easy access should be given priority;
- iii. the useful storage of the tank should not be less than 3 acre feet per acre, 2.5 acre feet per acre, and 1.5 acre feet per acre of command area in the dry, intermediate and wet zones respectively;
- iv. the useful tank storage should not exceed 70% of the yield potential computed from iso-yield curves of the Irrigation Department;
- v. the tank should benefit at least ten families;
- vi. the incremental area brought under direct maha irrigation should be at least ten times privately irrigated lands submerged or three times other cultivated lands submerged;
- vii. the soils of the catchment area, reservoir and the command area should be suitable for their respective purposes;
- viii. the cost for a project including all civil works and physical contingencies valued at mid-1980 prices, but excluding price contingencies, engineering and administration, should not exceed Rs. 5,000 per acre for the existing area plus Rs. 10,000 per acre for the incremental area.

The Department of Agrarian Services Water Management Programme

The DAS has undertaken a modernisation programme for 500 minor tanks with financial support from the World Bank. This is a two year programme (1983-85) and modernisation work mainly involves on-farm development work and minor repairs or improvements to the headworks.

The main objective of this programme is to introduce a systematic water management programme to the non-rehabilitated working minor tanks by providing them with appropriate downstream facilities - for example, improvement of main and field channels, provision of drainage systems and installation of control structures. The water management programme to be introduced to modernised tanks is identical to that of the minor tanks rehabilitated under VIRP and IRDP.

A small number of minor tanks are also modernised every year by the DAS with funding from its own departmental budget and from the decentralised budget. Tanks thus modernised are also brought under the new water management programme.

Components of the Water Management Programme

The description of VIRP, the DAS programme, and others in the appendix, provide a context for this section which lists the main components common to those water management programmes executed by the DAS.

The water management programme executed by the DAS has three components:

1. Civil Works:
 - i) improvement of field channels and provision of control structures for efficient delivery of water;
 - ii) installation of measuring devices to measure seepage and conveyance losses; and
 - iii) provision and upgrading of drainage facilities.

2. Improved Agricultural Practices:

- i. dry sowing of paddy in the maha season with early rains;
- ii. ploughing immediately after maha and yala harvests to facilitate early land preparation for the following season;
- iii growing subsidiary (non-paddy) crops in the yala season;
- iv promotion of short duration varieties of paddy in both maha and yala seasons.

3. System Management:

- i. establishment of farmers committees for the operation and maintenance of the schemes and for implementation of the water management programme;
- ii cultivating only part of the command area in periods of water shortage;
- iii rotational water supply system with fixed delivery schedule; areas
- iv allocation of water to tail/before giving it to the head²;
- v supplemental irrigation both in maha and yala; (World Bank, 1981, DAS, 1984a)

² Although there is no mention of this practice either in the World Bank or in DAS documents on the water management programme, we found during our field visits that Agricultural Planning Teams were trying to introduce this system.

Organisation of Water Management Programmes

The Water Management Division of the DAS is responsible for planning and implementing the above mentioned water management programme. This programme is introduced after DAS takes over rehabilitated tanks from the Irrigation Department on satisfactory completion of the construction work. At the field level, the water management programme is carried out by Agricultural Planning Teams (APTs). Each APT consists of a Technical Officer (TO), one Agricultural Instructor (AI) seconded to DAS by the Ministry of Agriculture, and the Divisional Officer (DO) of the local Agrarian Service Centre. The TO is mainly responsible for supervision of the operation and maintenance of the schemes; the AI is mainly responsible for introducing improved agricultural practices, and overall coordination of the APT's programmes at the field level is supervised by the DO. At the district level, the water management programme is coordinated by the Assistant Commissioner of DAS and Coordination at the national level is the responsibility of the Deputy Commissioner of the Water Management Division of DAS in Colombo.

Water management in minor tanks is a new subject in Sri Lanka and training programmes have been organised on it for APT members, other DAS personnel and staff from other government departments involved with this programme. These training programmes cover a wide range of disciplines in both social and natural sciences (DAS, 1984c). As effective implementation of the programme depends mainly on the cooperation of the yaya palakā and the farmers, training programmes have also been organised for them. There is a three-day training for the yaya palaka and a one-day training for the farmers, where they are introduced to the concept of water management, the importance of and benefits from improved irrigation and agricultural practices, and their roles in implementation of the water management programme and in the operation and maintenance of the schemes.

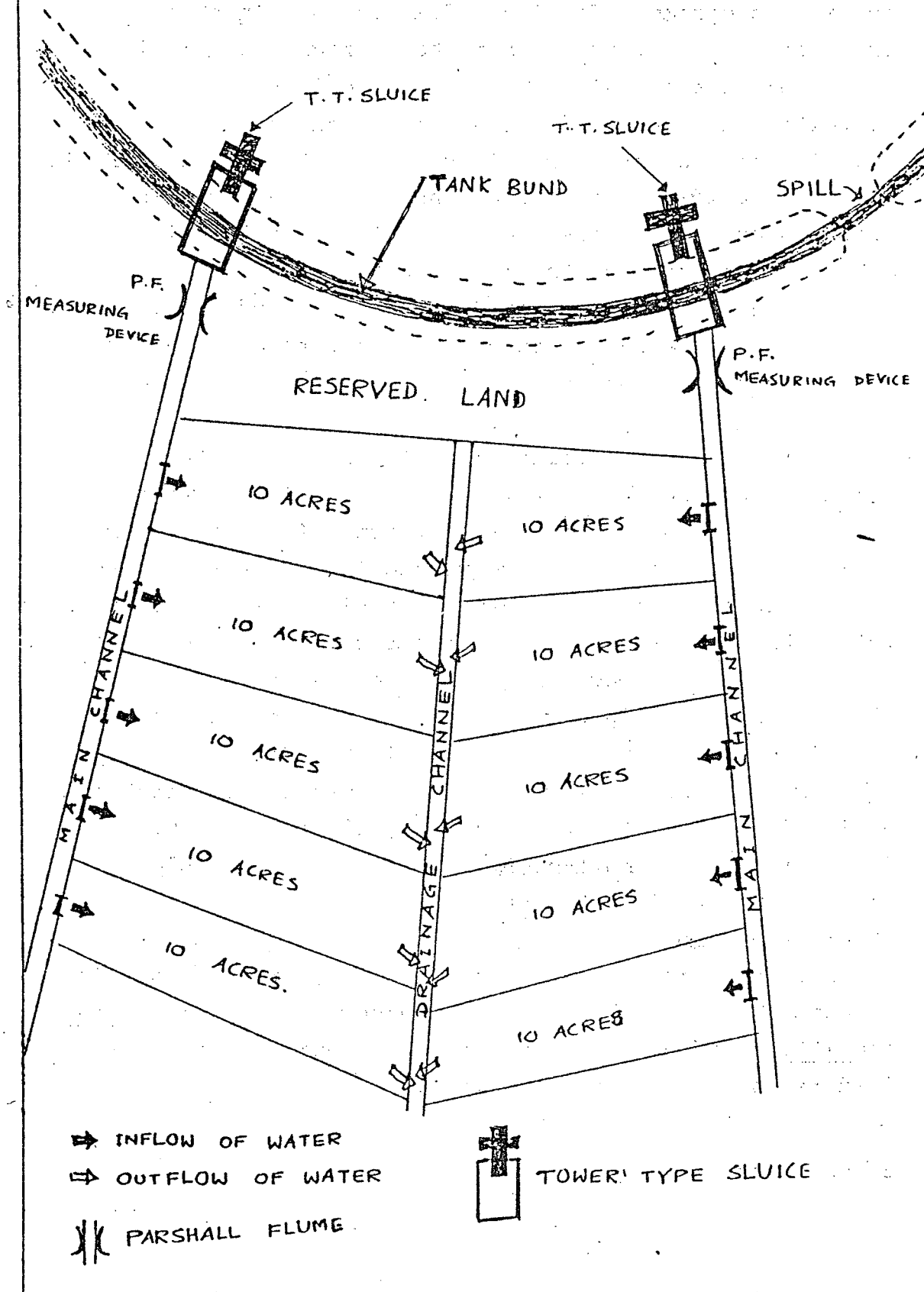
Each APT is responsible for the water management programme in 15-20 tanks and they are expected to develop specific programmes for individual tanks. In their training they are taught that these programmes should be developed on the basis of rainfall, soil type and hydrological data and a proper understanding of the existing agricultural practices; and that due consideration should be paid to production constraints and the risks under which cultivators operate. At the village level, APTs are supported by the local Cultivation Officer (CO) of DAS, the Tank Supervisor (TS) in charge of 10-15 tanks, also of DAS, the KVS of the extension services, and the yaya palaka of the tank.

To ensure efficient utilisation of tank water, the command area under each tank has been divided into a number of blocks. Each block consists of about 10 acres of land involving 6- 10 farmers receiving water from the same field channel. All farmers within a block are supplied water through a single farm turnout structure and pipe outlet.³ It is expected that this new system of water allocation will reduce seepage and conveyance losses. The pipe outlets are usually of 4 inches diameter and can discharge a maximum of 0.5 cusecs of water depending on the available head in the channel (DAS, 1984a pp. 9-10). Water is distributed on a rotational basis between the blocks and within a block distribution is from field to field. To ensure that each block receives its share of water and that water is not misused within a block, one group leader is selected from each block by the farmers. There is a tank committee for each tank with representation of the group leaders and headed by the yaya palaka. All local

3 See figure 5.

Figure 5

WATER ALLOCATION IN WATER MANAGEMENT TANK



government officials involved with water management programmes are members of the tank committee. Everything related to the water management programme should be discussed in meetings of the tank committee and must be approved by the farmers in kanna meetings (Medagama, 1982; 1984).

These components are discussed in the next section. Since the concern here is with the software components the civil works components have been excluded. Also, the promotion of short-duration varieties and the use of supplemental irrigation in maha and yala components have not been discussed since these practices are both widely adopted already.

The Water Management Package

Dry sowing of paddy in the maha season: Dry sowing of paddy in the maha season has been identified by the water management programme as the main contributor to its water saving strategy. The practice advocated is dry sowing of paddy with the onset of the maha rains instead of waiting for the tank to fill. The crop can thus mature with direct rainfall, requiring only limited supplementary irrigation from the tank. The water saved allows the cultivation of either another paddy or a non-paddy crop in the yala season.

Dry sowing is anyway a practice familiar to farmers in many parts of the dry zone (DAS, 1984a; Gunasekera and Fernando, 1981). The water management programme is essentially concerned with extending the practice in maha to a larger share of the cultivated area, thereby allowing an improvement in cropping intensity by extending the area cultivable in yala using stored tank water. The underlying factors determining land preparation practices are rainfall patterns, expectations about rainfall patterns, attitudes

towards risk, holding sizes, water rights and access to inputs. Whilst there is certainly scope for changes that will affect these determinants and thereby encourage dry sowing, it is by no means clear that water management inputs are the principal tool by which these changes can be achieved. Indeed, our field experience suggests that the emphasis on dry sowing is likely to have a very limited impact; where it is not already practiced there are rainfall and other factors which constrain its economic viability.

The Walagambahuwa "project" is frequently referred to as the model on which the principle of dry sowing has been elaborated. It has been described as introducing a new concept of technology to improve cropping intensities which are low in minor irrigation schemes "because of inefficient water management practices" (Upasena et al, 1980 p. 51). Timely cultivation (dry sowing) is "the crux of the new technology" (ibid p. 58). The study cited only uses data up to 1980 and the impressive yield and acreage improvements during this period were a consequence of well distributed rains (Somasiri, 1979 p. 36; personal communication, Dr. Fernando, Deputy Director Maha Illuppallama Agricultural Research Station) and substantial project inputs managed by project staff (personal communication, Ananda Jayasinghe, AO, Mahaweli H. Area and previously involved in the Walagambahuwa project). As described below these results have not been maintained; recent experience, as farmers there readily agree, does not support the adoption of dry sowing. This is not a criticism but a recognition that the Walagambahuwa project must be regarded in an action research frame work; the diversity of research at Walagambahuwa by many disciplines over several years, has substantively improved our understanding of the complexities of minor

tank operation. It has not really generated new technology but explored the technical feasibility of extending a traditional practice, dry sowing, to a wider acreage. The research need now is to identify the socio-economic constraints on what has been shown to be technically feasible.

If farmers dry sow paddy at the first maha rains, and then there is a prolonged gap between the first and second rains, the result is a total crop failure. This actually happened in the Walagambahuwa tank in maha 1981 - 82.⁴ Paddy was dry sown on the total command area with the first maha rains upon the advice of the project personnel but there was a total crop failure due to a long delay in the occurrence of the subsequent rains. Although it was a bad year (i.e. poor rain) for the whole of the dry zone, cultivators using the Walagambahuwa Tank believed that if they had not listened to project personnel and waited for the tank to fill (as they would normally do in a year of erratic rainfall), they could have grown at least some paddy on part of the command area using the tank water and avoided a total crop failure. In that season, cultivators wasted their effort, their money invested in land preparation and their seed. The success of project personnel in persuading farmers to dry sow was due in large part to the free provision by the project of tractors for dry land preparation. The project has now finished but according to the yaya palaka and

⁴ The latest paper on the Walagambahuwa cropping system project only uses data up to 1980 (Siripala, 1984) and this experience was related by the yaya palaka and the Agricultural Instructor. There was also no maha harvest in 1982-83.

the Agricultural Instructor of the Walagambahuwa Tank, it would now be impossible to persuade farmers to sow paddy under dry condition with the first maha rains due to the risks involved with it.

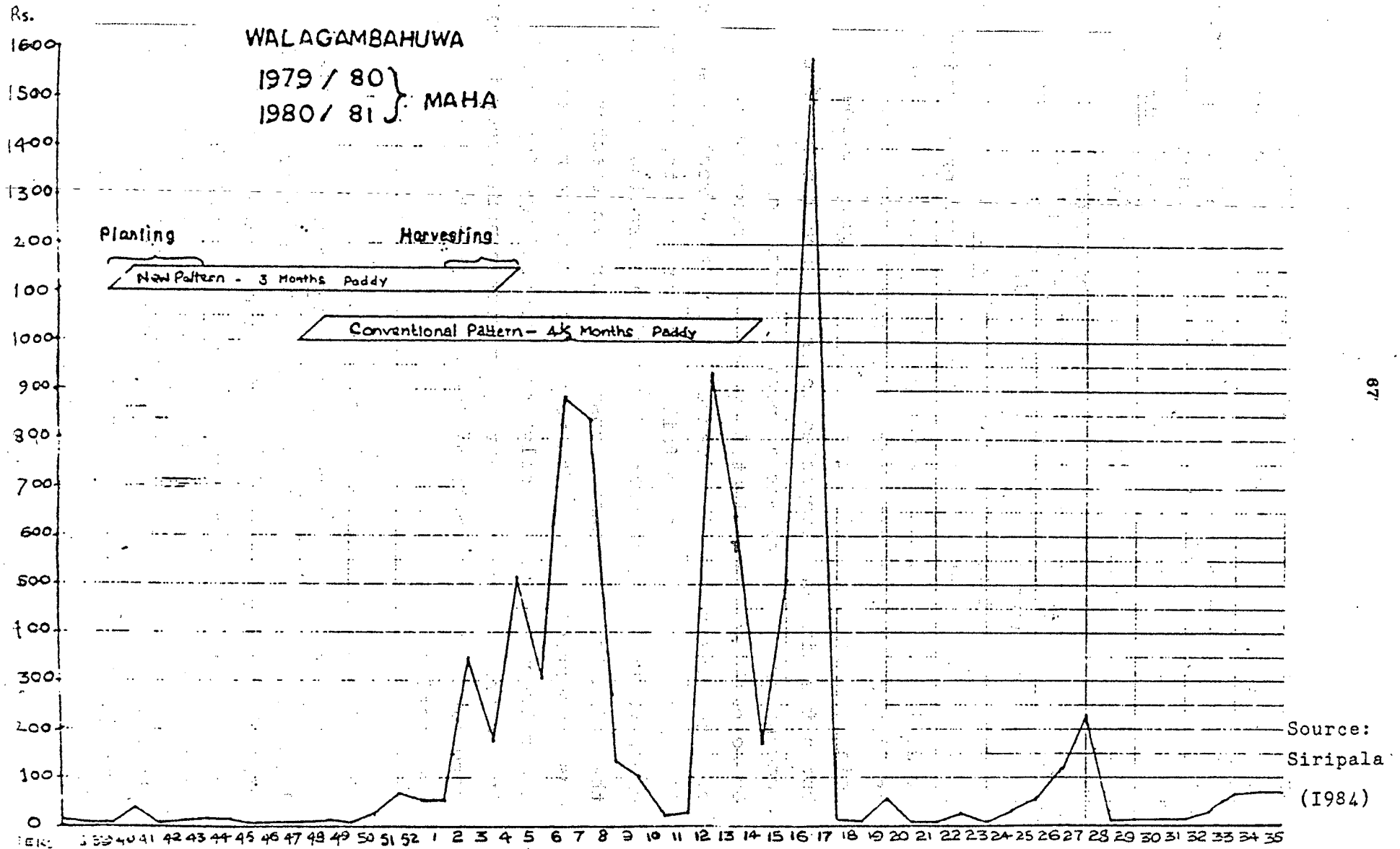
Other projects have had a similar experience. In the Tank Irrigation Modernization Project of five major schemes in the dry zone (initiated in 1978, an attempt has been made over several years to introduce dry sowing of paddy but so far it has not achieved any success. The possibility of wide-scale adoption of dry sowing in the project area in future also looks remote because the risk associated with its practice is so large compared to that of conventional sowing under mud conditions (Abeysekera, 1984).

Thus a careful reading of Walagambahuwa results would certainly not lead to the conclusion that the total command area should be dry sown with the first maha rains, yet this is the recommendation of the water management programme. This view is strongly reinforced by Walagambahuwa data on the seasonality of cash earning (see figure 6) which are at their annual low point precisely when cash to pay for tractors is needed (Siripala, 1984).

More generally, it has to be recognised that the traditional practice of dry sowing varies between areas of reliable (i.e., maha rain starts in time and once started follow a more or less predictable course) and unreliable rainfall patterns (i.e. maha rains often come late and are difficult to predict). In places where the rainfall pattern is reliable, both land preparation and dry sowing of paddy begin with the commencement of the maha rain which is generally at the end of September. Tanks studied under the water management programme of VIRP in Trincomalee districts belong to this category. In this area, in maha 1984-85 some farmers were observed to prepare their land even before the onset of the maha rains.

Figure 6

AVERAGE WEEKLY INCOME (RS.) FROM BOTH AGRICULTURE AND OFF FARM WORK



In areas where the rainfall pattern is erratic, land preparation and dry sowing usually occur from the middle of October to the first part of November with the occurrence of the second round of the maha rains. Of course, farmers do not remain idle with this time in years when maha rains come early and show promise of continuity, but farmers in many parts of the dry zone are not lucky enough to have such good years often. All the ten traditional tanks studied in Anuradhapura and the five IRDP tanks in Puttalam fall into this category. In maha 1984-85, in thirteen out of these fifteen tanks, no land preparation or sowing was done at all by the third week of October as farmers were waiting for the second spell of the maha rains; of the remaining two tanks, land preparation but not sowing was completed on only a small part of the command area. There was a special reason for this - those plots were cultivated by tractor owners; they prepared their land in advance because they would lose very little in case of a crop failure compared to the farmers who have to hire a tractor for land preparation. Moreover, at that time the opportunity cost of their own tractor use was, reportedly, low as there was no demand for hiring their tractors and the only cost incurred was for fuel. By preparing their land early, tractor owners generate more time for profitable hiring out during the land preparation season.

Thus in areas of unreliable rainfall, dry sowing of paddy at the beginning of the maha rains risks financial losses if later rains fail and crop fails. Farmers minimise the risk of a crop failure by delaying their sowing. This practice follows from farmers' experimentation with different sowing dates and their current practice is the one found to be optimal given their attitude towards income and risk (Farmer, 1954 p. 25; 1957 p. 45).

According to farmers in these areas, it is very difficult to tell anything about the season's rainfall pattern from a few showers in the beginning of the season- it is only around the end of October or beginning of November that the rainfall pattern becomes stabilised and farmers can be sure to some extent (they say they can) about the water situation. On careful examination of the rainfall, farmers grow dry-sown paddy only on that land for which there will be enough tank water for supplementary irrigation once rains stop in January, after supplying water to the land sown under irrigated conditions (this point will be taken up in detail later in this section). Even all these calculations do not always guarantee a successful harvest if the distribution of maha rains fails to conform to the expected pattern if rains stop earlier instead of continuing till January.

The above discussion shows that reliability of rainfall in a particular area is the main determinant of the period during which dry sowing of paddy is undertaken and the major constraint in the implementation of a programme to promote dry sowing of paddy with the first maha rains. The tanks under the water management programme, where farmers were observed to practice dry sowing of paddy with the beginning of the maha rains, had nothing to do with the programme in particular. Rather, it had been the traditional practice in those areas due to favourable rainfall conditions. On the other hand, dry sowing of paddy with the onset of the maha rains does not seem to have much prospect of being adopted in areas of unfavourable rainfall conditions because it involves too much risk.

Farmers have developed a strategy to overcome some of the risks associated with dry sowing of paddy with the beginning of the maha rains, on the basis of their experience. Under this strategy, paddy is dry sown on part of the command area (usually the akkarawela plots) if and when the maha rains appear reasonably stable and intense. According to Abeyratne (1962) this is usually around mid-October to early November which is consistent with our field evidence on the peak periods of dry sowing in areas of erratic rainfall. The remaining part (usually the puranawela land) is sown under irrigated condition if and when sufficient water is stored in the tank.

This was found to be a common practice in all the ten traditional tanks studied in the Anuradhapura and five water management tanks in Puttalam. This is different from the water management programme recommendation of dry sowing of paddy on the total command area but it is definitely regarded as a more viable strategy by the cultivators. Through adopting the combined methods of dry and irrigated sowing farmers are spreading risk. If dry sown paddy fails due to unreliable rainfall, there is still the possibility of some harvest from the irrigated fields; farmers will have some paddy to live on and seed for the next season.

Timing of the dry sowing of paddy in the maha season is also affected by whether the same farmer cultivates land under more than one tank. This influences farmers' decision about whether to do dry sowing or sowing under irrigated conditions in a particular maha season under a particular tank. The timing and method of sowing in one tank depends on what is being done under other tanks. Farmers mentioned that they practice a rotational system of dry sowing and irrigated sowing between the tanks.

This is similar to the risk aversion strategy of combining two methods of sowing under the same tank. Our field experience on this is also supported by Chambers (1974).

Farmers are often criticised for postponing their maha cultivation until their tank is full. This means total wastage of the benefits of direct maha rains, which, if utilised, can save a significant amount of tank water, which in turn can be used to bring more land under cultivation and thereby increase production. Although our study has not come across any tank where farmers wait until their tank is completely full, they do wait until sufficient water is stored in the tank and this is rational under situations of extremely uncertain rainfall pattern. Risk-averse farmers delay their cultivation because the only thing which is certain and which guarantees their crop is the amount of water stored in the tank.

Farmers cannot afford the luxury of obsession with the idea of water saving and increased national food production; the primary concern of their water management is to eliminate risks to farm income by securing some crop. There is a direct clash between the interests of the individual paddy cultivator and the national government's interest in achieving self-sufficiency in food through effective utilisation of water resources (ILO, 1970; Siy, 1982). Other researchers have drawn attention to this. A report on dry sowing of paddy under the Walagambahuwa Project (Sikurajapathy and Senaratne, 1978) pointed out that an overall recommendation for increasing paddy production under dry sown conditions may not be suited to farmers' best interests.

The main problem with the new agricultural practices recommended by water management programme is that although they are theoretically sound from a water-use efficiency viewpoint and more profitable on paper than traditional patterns, they conveniently sidestep the main issue. They assume that a farmer, under conditions of extreme risk, is a profit maximiser. In fact, as is well known (see e.g. Lipton, 1968), the farmers strategy is more likely to be one of minimising his maximum losses maximising his minimum profit) if things go badly and water is scarce. He is playing a game against nature in which he chooses the type and amounts of land that he invests his scarce labour, capital and management resources in after making informed guesses about how nature will play (this season's rains). Farmers with higher incomes and lower aversion to risk will be more willing to adopt the high-risk strategy of dry sowing the whole command area; in effect this suggests that adoption of this strategy is dependent upon other (income-enhancing or risk-reducing) interventions such as cheaper inputs, including credit, better product prices etc.

Ploughing following the maha and yala harvest:⁵ this exercise has been recommended to promote the practice of dry sowing of paddy with the onset of the maha rains.

5 Discussion will be limited to ploughing after the maha harvest only since a yala crop is not a regular even in most minor tank villages in the dry zone.

Ploughing under dry conditions generally requires a tractor and in many areas of the dry zone farmers suffer from the problem of inadequate access to tractors, for two reasons:

- i. every body wants to plough their land at the same time after the maha rains start and the number of tractors is limited; and
- ii. Some farmers do not have enough cash to hire a tractor. The suggestion of ploughing land immediately after the maha harvest is expected to solve both these problems because tractor availability should be greater than as there is no tractor demand for other agricultural activities and because farmers have cash in hand following sales of the recently harvested paddy.

There is a sound rationale behind this argument but there are some problems in its implementation. First, farmers have pointed out that the long gap between two maha seasons necessitates another ploughing immediately before sowing (Abeysekera, 1984). If this is generally true then farmers have every reason for not adopting the recommended practice, since the whole exercise is futile and merely increases the total cost of land preparation with tractor which is already high. In our study villages it costs Rs. 500 - 550 per acre; about the same amount has been reported in Abeysekera (1984) and in the costs of cultivation studies for irrigated paddy in Anuradhapura for maha 1982-83 (GOSL 1983c p. 65).

Second, it is more than six months between one maha harvest and the next maha cultivation. Poor economic conditions deprive many farmers from taking advantage of such long-term planning. Moreover, in areas of unreliable rainfall the idea of ploughing land before the maha rains may be viewed by farmers as foolish; they believe that how many acres of land and, therefore, which plots can be cultivated in a particular maha season can reasonably be determined only after the onset of the maha rains.

This aspect of farmers' behaviour may seem irrational to water management personnel who approximately predict the rainfall pattern using the lower boundary of the 75 percent probability levels of rainfall based on 20 Years or more of rainfall data. The accuracy of this prediction is not free from suspicion mainly because of the quality of data used (Panabokke and Walgama, 1974). But ignoring this problem, it is not clear that this measure will reasonably reflect farmer perceptions of probable rainfall patterns.

Rainfall distribution patterns are positively skewed, i.e., the mean will be higher than the median or mode. The modal value, the most frequently occurring rainfall, is the single best indicator of what rainfall may be in any one year. The lower boundary of the 75 percent probability level for the mean may or may not be greater than the mode, it depends on the degree of skewness. Farmers behaviour is influenced most by modal values/^{informed by} interpretations of early season rainfall patterns;⁷ they do not believe in abstract statistics; they believe in what they have

7 Whilst simple methods of correcting for skewness have been developed and applied to Sri Lankan data (Panabokke and Walgama, 1974): the probability level apparently now being used is the uncorrected 75 percent probability level based on the simple mean.

learned from their years of experience and act accordingly. Thus, independent of the problem of risk-aversion producing a different interpretation by farmers of a particular rainfall probability level, it also appears probable that the maximum likelihood figures used by APTs are different, and higher, than those that farmers have in mind however murkily calculated.

Third, it is misleading to assume that farmers are in a better financial situation after each maha harvest because in minor tanks it varies so much from year to year, largely due to variations in rainfall. This has been emphasised by Abeyratne (1975) and is supported by our data (Table 5). Our study has found that many farmers failed to grow a maha crop in a year of good rain when it was followed by a year of poor harvest as they did not have seed in their store nor did they have money to buy seed or hire a tractor.

These three points about farmers' behaviour are supported by the experience of the Tank Irrigation Modernization Project. Sufficient number of tractors have been introduced by the project to overcome the problem of inadequate access to tractors but even then farmers refrained from ploughing their land after the maha harvest because of the reasons already discussed (Abeysekera, 1984).

Growing subsidiary (non-paddy) crops in the yala season:

This aspect of the water management programme is aimed at diversification of crops by introducing the idea of growing non-paddy crops in the yala season. The purpose is to cultivate more land by using the same quantity of water since water requirements for non-paddy crops are significantly lower than for paddy crops. Farmer's preference for growing paddy in the yala season rather than growing

70

non-paddy crops is a well-established fact. Farmers' paddy preference is not purely economic; it is at least in part because rice is the dietary staple and other crops either cannot be used as a substitute for rice in consumption or are inferior substitutes- farmers prefer rice to other cereals. As a result, some farmers prefer to grow paddy on a small parcel of land rather than growing other crops on a bigger plot. This situation is not very likely to change in the near future without substantial change in dietary habits (this takes a long time). From an economic perspective, diversification requires that farmers must be sure about earning at least the equivalent amount of income from growing non-paddy crops as they can earn from growing paddy; there are at least five substantive limitations that are relevant here and which we discuss in turn: marketing, seeds credit, extension and soils.

Crop diversification programmes are not new in Sri Lanka (Sanmugam and Senanayake, 1982), several national policies and programmes have been introduced since the mid-sixties to promote cultivation of subsidiary crops although with a different objective in view, i.e. saving foreign exchange by curtailing import of these crops. There is a general consensus on the fact that the two main reasons behind farmers' reluctance to grow subsidiary crops are lack of assured markets and low prices; i.e., intensive irrigated cultivation of the suggested non-paddy crops requires large amounts of labour and the returns to labour are much lower than for paddy. To overcome this problem, floor price schemes have been introduced for coarse grains and pulses and several agencies have been entrusted with the responsibility of purchasing these crops. Despite all these efforts, so far, no significant changes have been observed in farmers' response to this programme (Farrington and Abeyratne 1982, part II, pp. 127; Sanmugam and Senanayake, 1982). According to Shanmugam and Senanayake (1982), poor implementation of

... policies and inefficient management of procurement and distribution systems were hindrances to the success of the programme. Purchasing agencies failed to perform their role effectively due to lack of capital and lack of supporting services, of which, inadequate storage facilities was the main one. Agencies had problems with disposal of the crops after they had been procured due to lack of demand in the market.

Cultivation of several crops, notably cowpea, millets, maize, black gram, green gram, soya beans, ground nut, onions and chillies has been suggested. To help relax marketing constraints on this crop diversification programme, the first step should be to determine the country's need for each of these crops. The second step is to expand the efforts already being made to explore export markets for those crops for which there is the potential of producing in excess of the country's requirement. Exploring both internal and external markets is essential because if government agencies cannot sell the crops procured by them then their operating capital is held up, which affects their subsequent operations. This is very likely to encourage these agencies to procure as little as possible. All these marketing problems clearly must be reviewed carefully and corrective measures should be taken for the crop diversification component of the water management programme to achieve success.

Second, this programme is vulnerable to seed problems. The decision about whether to grow paddy or a non-paddy crop under any tank in a particular yala season is actually taken after the maha harvest, depending on the amount of water left in the tank. However, in order to be able to supply seeds, the Department of Agriculture needs to know in advance for which crops and in which quantities seeds

are required. This is a vicious circle and since the ideal solution of taking crop decisions well in advance is infeasible under the current circumstances, there seem to be only two possible solutions.

- i. The Department of Agriculture should hold a buffer stock of seeds for both paddy and non-paddy crops so that it can supply whichever one is wanted. The problem here is the commitment of operating capital in the form of seed stocks which the department cannot afford due to the limited budget under the heading for seed (personal communication, S.H. Charles, Deputy Director, seed and farms). If the Government is determined to make the crop diversification programme a success, then it will be necessary to allocate more funds, at least initially, under the seed heading to give the department the required flexibility.
- ii Farmers should keep their own seed stock for both paddy and non-paddy crops. Agricultural extension workers are trying to persuade farmers to do this through selling sample stock. Own farm production of seed stock is of course the traditional practice. The problem with it lies in the economic capacity of farmers to hold stocks (to a lesser extent, their capacity to maintain quality and viability during storage) and their requirements for renewal to maintain purity. These issues cannot be dealt with here in the detail they deserve; there are a complex set of biological, economic and institutional aspects to seed policy which require special study (see Charles, 1982) and here we can only emphasise that the seed problem is a serious and fundamental constraints on the prospects for agricultural diversification.

Third, cultivation of non-paddy crops often has high credit requirements, because, apart from seeds and chemical inputs they involve considerable on-farm work for land preparation (furrows and ridges) and drainage systems. Therefore, no amount of extension work can make the programme a success unless farmers are provided with the necessary credit facilities. This is not to say that credit facilities are non-existent at present but that they are inadequate. IRDP has a credit component but VIRP has not included any such provision. Moreover, our field experience and data from other sources suggest that most farmers cannot utilise the limited credit facilities available mainly because many of them are defaulters and because of problems with the timelines of institutional credit.

Our household survey data from 10 villages showed that only 20 percent of total households (219) had taken loans for cultivation purposes and that not a single loan was from institutional sources. Defaulting was reported by most farmers as the reason for not getting institutional credit and long delay in receiving loans was mentioned by a small percentage of farmers. Herath et al. (1984) reported in a baseline survey of 6 VIRP tank villages that 56 percent of the total households (151) took loans for cultivation purposes and only about 17 percent of these came from institutional sources i.e., cooperatives and rural banks. The reasons for not taking loans from institutional sources were the same as those found by our study. The default problem has also been mentioned in the project document for Puttalam IRDP (World Bank, 1980 P.20). According to a statement of the Chairman of People's Bank, the rate of default from cultivation loans was as high as 78 percent in 1978 (Ceylon Daily News, 7 February 1985).

This problem of earlier non-repayment restricting farmer access to credit is a serious one not admitting of easy solution. The banks' reluctance to extend further services to defaulters is perfectly understandable, from their perspective.⁸ Successful credit schemes do require discipline in observing repayment schedules and failure to repay, whether due to a poor harvest or interfering politicians, is a threat to any institutional credit scheme. Since non-formal credit is usually more expensive, restrictions on formal credit are also a threat to farmer incomes. There are two problems - that concerning the position of past defaulters and that concerning the need to avoid defaulting becoming an established practice in new programmes. Legal controls are cumbersome and open to corruption and the solution to these problems must, to a very large extent, be found within the institutional framework in which new credit programmes are introduced.

A solution to the first problem will very probably depend upon high level decisions in Colombo to allow writing off the past loans. This will (or should) only be forthcoming if the banks can be convinced that future programmes will not suffer a similar fate (whilst the banks are under some political pressure to make farm loans available more readily, the high transaction costs they incur in part explains their reluctance even if there are no defaulters). A possible alternative solution to this first problem would be for new programmes to settle this defaulting farmers' debts but this is expensive for the programme and administratively complex.

8. It remains to be seen whether the recent (March 1985) government initiative on Regional Rural Development Banks will improve the situation.

The best chance of developing bank and farmers' relations lies in effective operation of new programmes through imposing strict credit discipline. This is costly, at least initially, and involves funding of additional supervisors (or paying the banks to provide them), simplification of loan procedures and, ideally, of repayment arrangements; an effective crop insurance is also necessary. It is not appropriate to dwell on these points here but if, as argued, effective credit is a necessary component of minor tank agricultural development, then it is also necessary that the credit problem be given a much higher priority than it has so far received.

Fourth, some of the crops suggested are completely new to many farmers and for other crops, although farmers may have experience of growing them under rainfed conditions, they lack experience in growing them under irrigated conditions. Therefore, in the beginning, the crop diversification programme will need intensive support of the agricultural extension service to select suitable crops for different soil types, to supply seeds, to determine input requirements of different crops, to determine water requirements of different crops and to develop irrigation schedules accordingly. Moreover, cultivation of non-paddy crops on irrigated paddy land may necessitate changes in irrigation layouts which may cause some social and other problems (Somasiri, 1978 p. 31).

Finally, some soils, for example, the heavy textured poorly drained types, may not be suitable for growing any other crop but paddy.

The foregoing discussion leads to the conclusion that efficient planning and coordination at every stage from production to final consumption of different crops is a pre-requisite for the success of the crop diversification programme. The issues, only summarised here,

are complex and it is possible, perhaps probable, that a well intended programme will fail to achieve its objectives due to lack of effective planning and coordination. Therefore, it is of utmost importance to build up a network of strong supporting services (extension, research, credit, storage, transportation and marketing) to ensure smooth operation of the programme. It will be unfair to blame farmers for not being responsive to the programme without first creating conditions which would offer them incentives to do otherwise.

Development of farmer organisations: There seems to be very little dispute about the significant role that farmers organisations can play in the operation and maintenance of irrigation schemes. There is an increasing concern in many countries, and Sri Lanka is no exception, in developing farmer organisations to help national agencies in the maintenance and operation of irrigation systems. This is particularly important for minor irrigation schemes because there are so many of them (in Sri Lanka there are 40,000 minor irrigation schemes) of which three-quarters are minor tanks and they are so widely scattered that proper maintenance of these schemes is almost impossible for any government without farmers' assistance. Although water management programmes may be developed by irrigation agencies their actual implementation lies with the farmers. It is with these views in mind that the water management programme for rehabilitated minor tanks in Sri Lanka has included the establishment of farmer organisations as described earlier as one of its strategies (DAS, 1984a p. 5).

Adoption of this strategy appears to imply that at present farmer organisations are non-existent in minor tank villages, which is far from being true. A considerable literature is available (Farmer, 1957; Leach, 1961; Abeysinghe,

1982; and Abeywickrema, 1984) which portrays the mechanisms through which cultivators under minor tanks reach a consensus in kanna meetings on issues related to cultivation and irrigation. These issues include: repairs and maintenance of the physical structure of tanks and main and field channels; allocation of individual cultivator's shares in the above mentioned works; mobilising cultivators to perform their share of work under the yaya palaka's leadership, and supervision and sanctions for not fulfilling obligations. We also observed in our study villages that farmers were very organised for maintenance of physical structures of their tanks and command area and for efficient utilisation of their tank water. In organising all these works the yaya palaka was always helped by elder cultivators and local schol masters. Some examples, from our field work experience, of the operation of indigenous farmers organisations are given in the following paragraphs. This is followed by a discussion of some specific needs for strengthening these organisations and a final section discusses two reasons why indigenous farmer organisation can be weak or non-existent.

During our one year of field work, we came across several cases where farmers were trying their best to maintain their tanks within their limited capacity, for example by repairing big holes in tank bunds by using sand bags and large pieces of stone. In maha 1983-84, in two tanks in Anuradhapura farmers cut tank bunds to let excess water out (there was a bad flood that year) to save the bunds from breaching; these bunds were cut by the side of the sluice so that water could flow through the main channels without causing much damage to the standing paddy crop in the field. Farmers took this decision because they believed that a breached bund would have caused more damage to the crop and because it is easier to repair a cut bund than a breached one. We have also noticed that yaya palaka and farmers block the mouth

of malfunctioning sluices with straw and mud to reduce the amount of water lost. In one village, the paddy crop in maha 1982-83 (a year of poor rain) was saved from being a total failure due to the timely action of the farmer organisation. In this case, during the latter part of the season, the tank water level became so low that water could not be released through the sluices but two more issues of water were necessary; to overcome this crisis farmers raised money and hired a diesel pumpset from a neighbouring village to pump water from the tank.

Existing farmer organisations are also very efficient in utilisation of tank water. We have already mentioned the distinction between purnawela and akkarawela land under minor tanks. Farmers have developed a system of water rights under which purnawela land has a primary right to tank water and akkarawela land has a secondary right. This indigenous principle of allocating primary and secondary rights to tank water between old and new land is followed by modern courts to settle water disputes. (For example, in Madras, one tank used to supply water to one village but subsequently rehabilitation of the tank increased the capacity of the tank to irrigate land in two more neighbouring villages. There was a dispute between three villages regarding who would get water first and how much. The case went to court and it was decided that the village that used to be originally irrigated by the tank would have first right to tank water and the other two villages would get water only after water needs of the first village have been met - this incident was related during a 1985 field visit to the Tank Modernization Project in Madras.)

In maha 1984-85 (as in several other years - see Table 3) in 5 traditional tanks studied by us in Anuradhapura, only akkarawela land was cultivated under dry-sown conditions and there was no cultivation on puranawela land because none of these tanks filled sufficiently during the maha rains and by December there was enough water in tanks only to provide supplementary irrigation water to the dry sown plots. Finally, the bethma system of cultivation of part of the command area in periods of water shortage is an excellent example of farmers' capacity to manage water.

These statements by no means suggest that there is no need for outside intervention in farmer organisation; rather we are suggesting that the focus should be shifted from attempts to establish new farmer organisations to strengthening the capacity of the existing farmer organisations by providing them with technical and financial support.

Technical support to build up local skills is essential for the maintenance of tanks. (One study of 165 districts in India showed that administrative support for operation, repairs and maintenance of tanks plays a significant role in efficient functioning of tanks (Oppen and Rao, 1980a)

Farmer organisations, with their present skills, are quite capable of maintaining tanks as long as maintenance work involves only human labour. But if maintenance requires some technical know-how, for example, repairing sluices and concrete spills, then even a very strong farmer organisation will fail to perform its task. This technical support should be supplemented by financial support to purchase the necessary raw materials.

There have been some discussions (DAS 1984a) about whether or not farmers should contribute financially for the maintenance of tanks in addition to their current contribution in the form of labour. Although no decision has been taken yet, experience from major schemes where attempts have been made to collect water rates from farmers to cover part of the operation and maintenance costs is not too encouraging. This policy has been implemented in the major schemes but due to lack of political support and farmers' dissatisfaction with the services of the irrigation agency, the results have been semi-encouraging. In minor tanks, the maintenance situation is expected to be much worse as there is no fixed annual allocation for maintenance on the basis of acreage irrigated whereas in major irrigation schemes there is now an annual allocation of Rs. 100 per acre for the operation and maintenance of the scheme (Abeywickrema, 1984 p. 121)

Farmer organisations should also be supported with technical assistance in order to explore the possibilities of improving some of the crude methods used by farmers to repair tanks. For example, we have mentioned that farmers try to repair big holes in tank bunds by using sand bags and large pieces of stone but these crude methods do not work when the damage is too serious; it could be worth experimenting to see whether gabion (interlined wire filled with rocks or other materials), used in the Philippines in construction of dams could be adopted in Sri Lanka for repairing holes in tank bunds. These types of experiment, if successful, would make a significant contribution to improved maintenance of tanks because the alternative technology would not be foreign to farmers but would rather be an improvement on the existing technology about which farmers are already knowledgeable.

In some villages farmer organisations are non-existent resulting in neglect of maintenance of tanks. These would appear to be direct evidence of the need for outside intervention to create farmer organisations. Whilst this argument is not totally refutable, it requires a deeper search to identify the causes behind the absence of farmer organisation; is it due to social factionalism or social indolence, or is it evidence of some more fundamental problem? We would argue that often the absence of farmer organisations is because of the limited importance of the tanks to the village economy. It would appear plausible to argue that the quality of tank maintenance will be better in villages which draw a significant portion of their earning by growing paddy under tanks, and that maintenance of tanks will tend to be neglected in villages where income from growing paddy under tanks forms only a small percentage of villagers' total income. Any attempt to establish farmer organisation for maintenance of tanks in the second category of villages would very probably be doomed to failure.

There is evidence on this point from programmes undertaken by the Freedom From Hunger Campaign. Under its "Small Reservoir Village Community Rehabilitation Programme" FFHC rehabilitated tanks in two of its project areas but it failed to bring farmers together to form the Reservoir Council and the Reservoir Maintenance Fund which were their institutional forms for ensuring proper operation and maintenance of the rehabilitated tanks. The reason behind this failure was that average irrigated paddy land holding sizes in these villages were very small (most parcels were less than a quarter of an acre) and income from paddy contributed very little to villagers' total earnings (FFHC, 1984, p. 4). The same argument has been put forward by Gunasekera (1982, p. 100) to explain maintenance problems of minor irrigation schemes.

Another similar factor affecting development of effective farmer organisations for maintenance of tanks and implementation of improved water management practices is regularity of paddy production under tanks. We have observed in our study villages that farmer organisations for maintenance of tank and command area structures was very poor and tank water use rules were less strictly followed in those tanks which did not spill regularly or spilt only once in 5-10 years. This evidence is also supported by Uphoff et al (1982, p. 12).

One point emerges clearly from the foregoing discussion: farmers are not likely to spend time in organising themselves to undertake some collective action unless they can derive substantial economic benefits from that activity. It is quite legitimate for irrigation agencies to be concerned about the maintenance of irrigation schemes but they would be wrong to expect farmers to maintain irrigation schemes regardless of their economic significance. If a poor farmer earns a very small proportion of his total income from irrigated paddy land, then he will be more attracted to work as a day labourer (as some of our Anuradhapura farmers did in neighbouring major irrigation schemes at the rate of about Rs. 30 a day) than to spend time in maintenance of his village tank. Therefore, it is misleading to expect farmers to organise themselves for maintenance of their tank and adoption of better water management practices under all conditions. It is equally wrong to assume that the opportunity cost to farmers of organising themselves to undertake the above mentioned activities is zero. (Weaver, 1985) .

Promotion of the system under which only part of the command area is cultivated in periods of water shortage:

This is an attempt to restore the traditional bethma system described earlier. The recommendation stems from the recognition among water management personnel (personal communication, district-level and headquarters' staff of DAS) that cultivation under the bethma system is no longer practiced in the yala season even when there is water in the tank to do so; and the reason behind this is believed to be the break-down of the traditional village community system due to various social, economic and political reasons. The water management programme proposes to stop wastage of water in the yala season due to non-cultivation by re-establishing the bethma system through farmers' committees organised for each tank.

This objective, expressed as an attempt to redress institutional malaise, gives one the impression that cultivation under the bethma system in the yala season used to be a regular event in the past and that this system can be reinstituted by forming farmers' committees to take up the role played by the traditional village community system of organisation. While disintegration of the village community system may explain disappearance of some social customs and rituals, it certainly cannot fully explain decline of a production system. In fact, just the reverse is true; it is changes in production systems that usually explain changes in community organisation. Any significant change in the system of production necessitates some fundamental change in the material conditions under which the production takes place. It has to be recognised that attempts to reinstitute traditional features of village economic organisation will fail if they do not take cognizance of the underlying

economic reasons for structural change in village communal forms. Simple reconstruction of institutions to replace the mythologised norms of village organisations as described in Leach (1961) is irrelevant to the social and economic conditions under which minor tank farmers currently operate.

Specifically, it is argued here that the bethma system has not disappeared due to simple breakdown of village organisation but it is due to an increase in the area irrigated by the tank which reduced water availability in yala (the bethma season) and consequently the feasibility of bethma type arrangements is reduced, as considered below. Elsewhere, in discussing akkarawela (p. 89), we have suggested that increases in the area irrigated from a given catchment area have resulted in new forms of organisations. This is markedly different from the idea that the traditional system breaking down. Further, water users have responded to changed demographic circumstances and in doing so have demonstrated the essential economic rationality of farmer organisations and the capacity of village institutions to respond flexibly to changing balances of water availability and water use.

It seems that the logical explanation behind the decline of the bethma system is the increase in the amount of land cultivated under minor tanks. In all except two of the twenty tanks studied, the size of total land irrigated by the tanks has increased enormously from the original size of the puranawela land (see table 2). There are two reasons for this: population pressure and mechanised cultivation. Population pressure: If we accept the rule of thumb offered in Leach (1961) that a full tank can effectively irrigate a command area which corresponds roughly to its

storage area⁹, then it is not too difficult to understand why the ~~bāhā~~ cultivation in the yala season has disappeared. For example, if the size of a tank is 75 acres, the ideal size of its command area should be very close to 75 acres; but if due to population pressure 50 more acres have been brought under cultivation under the same tank without increasing the tank's storage capacity, then the tank will hardly have enough water to irrigate the total land in the maha season with little possibility (given the rainfall distribution) of left over water for yala cultivation.

Mechanised cultivation: Another feature which helps to explain the extension of the area cultivated in the maha season is the introduction of mechanised cultivation over the last two to three decades. In all ten tanks studied in Anuradhapura district and in the five tanks in Trincomalee district, the total area sown was prepared using tractors in 1984. In the five tanks studied in Puttalam district, tractor use was not universal but very nearly so. The availability of tractors facilitated dry sowing in some soil types where non-mechanised dry land preparation is not anyway possible and thereby allowed an extension of the akkarawela land

9 See Somasiri (1979) for an excellent introduction to the hydrology of minor tanks based on a case study of Walagambahuwa. Leach's rule of thumb is crude and implicitly accepts that the depth of tanks is more or less uniform and makes implicit assumptions about rainfall, rate of evaporation, soil types, crop duration and water management.

In the study villages, farmers mentioned that about-20-30 years back, yala cultivation could be done in their areas once or twice in a period of 5 years. But the situation has definitely changed since then; in all the tanks studied, a yala crop was being grown (in 1984) for the first time after many years. The only exceptions were 2 tanks ~~where~~ some yala cultivation became possible in the previous year for the first time due to the rehabilitation work. However, yala cultivation in 1984 became possible (only paddy was grown) because although maha rain in 1983-84 came late, it was a very heavy rainy season. Many tanks in the dry zone spilled for the first time after 5-10 years and rains continued upto April/May. As a result, in some villages no tank irrigation was needed at all for the maha crop, in some villages only one or two issues of tank water were used, and in some villages no maha crop could be grown at all because rain came too late. All three situations meant that there was enough water in the tank to grow a yala crop. This provided us with an unusual opportunity to observe the different arrangements under which yala cultivation took place.

Four different arrangements were observed in the 20 tanks studied:

- i. the total command area was cultivated
- ii bethma system was followed;
- iii only purana land was cultivated and farmers grew crops on their own plots
- iv half of the command area was cultivated but only by those farmers who owned land in that part of the command area.

Table 6

Distribution of Tanks According to
the Arrangement followed in
Yala 1984.

Type of Arrangement	No. of Tanks	Type of Tank		
		<u>Traditional</u>	<u>VIRP</u>	<u>IRDP</u>
Total command area cultivated	6	-	1	5
Bethma system	2	-	2	-
Only purana land cultivated	11	10	1	-
Half of the command area cultivated	1	-	1	-
Total	20	10	5	5

This table apparently demonstrates a positive impact of the water management programme because it shows that the total command area was cultivated in 6 and the bethma system was practised in 2 out of the 10 tanks under the water management programme whereas in all the traditional tanks only purnawela land was cultivated. In fact, on this point, the table obscures more information than it reveals. The VIRP tank (pankulam) where the total command area was cultivated has fairly recently benefited from a major rehabilitation by the Irrigation Department; this tank's official irrigation capacity is 174 acres but it successfully irrigates 204 acres because it is not dependent for water on its own storage only but receives a significant amount of drainage water from a large neighbouring colony settlement tank (Morawewa). The yaya palaka of this tank has not received any training in water management and he claimed that nobody has ever discussed anything about water management with him.

In other words, the achievement of cultivating the total command area in yala is due to its superior water endowment, not water management inputs. The total command area was cultivated under the 5 IRDP tanks as well; in 3 of these there had been no maha cultivation due to delayed rains and in the remaining two there has been no increase in the size of the command area, perhaps due to non-availability of new land suitable for paddy cultivation in those areas (Puttalam district, Anamaduwa electorate). Moreover, all these tanks have been rehabilitated recently which has improved the condition of their headworks thereby minimising water loss due to defective structures; rehabilitation work has also increased storage capacity of these tanks.

In yala 1984, bethma was practised in two tanks. In one tank (Bellankadewella) bethma was done in the accepted manner on the left bank of the command area. This tank had undergone major rehabilitation in 1982 and it was the best tank out of the 20 tanks studied in terms of the condition of the headworks and development of the downstream works. The yaya palaka of this tank has not received any training on water management. (In fact, he is a colony Officer in the local A.G.A.'s office and he is respected by the villagers because of this official position.)

In the other VIRP tank (Mahamarkulam, the pilot schme in Trincomalee, there was inconsistency between the official information and what was actually being done. According to the local Agricultural Planning Team, 27½ acres of land were being cultivated under the bethma system but actually only 18½ acres were being cultivated and no bethma system was followed. Two rich farmers in the village paid off other farmers Rs. 500 to be able to cultivate the

other farmers share of land; cultivation was done only by these two farmers. There was no coercion behind this arrangement. The yaya palaka and the Cultivation Officer of this tank stated that farmers agreed to this arrangements because they did not have the financial capacity to meet the costs of cultivation. This was not unique to this tank alone: the same thing had happened in another VIRP tank in yala 1983, and Murry-Rust and Moore (1983) have reported the occurrence of similar arrangements in major schemes as well.

In all the traditional tanks and in one VIRP tank, only purana land was cultivated in yala 1984 and farmers cultivated their own plots. In one VIRP tank, half of the command area was cultivated and cultivation was done only by those farmers who owned land in that part of the command area. This method was adopted despite the advice of the local Agricultural Planning Team to practice the bethma system. According to the yaya palaka, villagers preferred this method because it simplifies the process of growing a crop only on part of the command area. It was decided that the other half of the command area would be cultivated in the next yala season and that farmers who were not growing a crop in yala 1984 would work as hired labourers for those farmers who were growing a crop.

The above discussion shows that if water is available, a yala crop will always be grown under some system regardless of whether a formal organisation of a farmers' committee exists or not. It appears that it is lack of water rather than absence of any formal organisation which inhibits cultivation of a yala crop in most years.

Rotational water supply system: The recommendation for a rotational water supply originates from the assumption that paddy is grown under continuous flooded conditions in the dry zone villages, leading to tremendous waste of tank water. According to one source (FAO/UNDP/SRL, 1980), due to this wasteful practice in some areas as much as 10-15 acre-feet of water are used while the actual requirement is 5-6 acre feet. According to another source (DAS, 1984a), the practice of growing paddy with standing water in the field throughout the maha season increases irrigation water requirements by 12-18 acre-inches per acre; and adoption of the same practice in yala season would necessitate an additional 12 acre-inches of irrigation water requirement per acre. These figures indicate an increase in the amount of irrigation water requirement in the maha season by 77 percent¹⁰ with a 3½ month variety and about 53 percent with a 4½-month variety of paddy; in the yala season (usually a 3½-month variety of already is grown, the increase is equivalent to over one-third of the total irrigation water requirement (calculated from DAS 1984b pp. 12-14). Therefore, a significant amount of tank water can be saved by replacing the system of continuous water supply with a rotational one.

Rotational supply of water was being practised in all 20 tanks studied except one (Bakmeegama). All the ten traditional tanks practised a rotational water supply suggesting that farmers do not need advice on methods to improve distribution and minimise wastage of this scarce resource. The one tank (Bakmeegama) that did not adopt the rotational supply system was under the VIRP in Trincomalee although the downstream work to facilitate its operation was completed. The sluice is kept open throughout the season and closed only when there is too much rain.

10 This example is based on a late sown crop in Anuradhapura.

Specific explanations are not easy to identify but it is worth noting that traditionally this village was dependent on income from collecting and selling honey - its members are popularly known as belonging to the Veddah community. Whilst this source now accounted for less than ten percent of their earnings (see note to Table I), the village did not have a deep tradition of paddy cultivation. The main income (71.14% of total earnings see Table I) was day labour work which was much more important in this village than in any other of the villages studied.

This tank has a very favourable capacity in relation to the area it irrigates and was the only tank among all the tanks studied where the reported size of the tank storage area was larger than that of its command area. The consequence is that limited expansion of paddy area under this tank allows them to use their tank water lavishly, supplying water continuously to the field throughout the season.

In all other tanks yaya palaka and farmers stated that they practice a rotational system of water supply because the amount of water stored in their tank would not allow them to do otherwise. It became quite clear from discussions with farmers that they would have preferred to have water continuously supplied to their field had there been abundant water to do so because continuous supply of water ensures better yield and controls weeds.

Allocation of water from tail to head: In Sri Lanka no research has been done on the problems of tail-end cultivators under minor tanks. This is perhaps because, given the paucity of research of any sort on minor

tanks, the problems of tail-enders in the small command areas of minor tanks were presumed to be of low priority. However, there has been much research on this topic in major irrigation schemes which have clearly documented the difficulties and disadvantages confronted by tail-end cultivators. Our field experience suggests that some of the problems identified are also faced by tail-end cultivators under minor tanks.

The main problem constantly faced by tail-end cultivators is insufficient supply of water to their plots due to cultivators at the head-end taking a disproportionately large share of the available water. This situation becomes worse in times of water scarcity, resulting in reduced yield or crop failure at the tail-end. The water management programme expects to overcome this problem by replacing the common practice of head-to-tail allocation of water with tail-to-head allocation. While the potential benefits of this practice may be very high both on equity and efficiency criteria, there are also serious constraints on its effective implementation.

Tail-to-head allocation of water requires two things:

1. suitable field channels and control structures to facilitate its operation; and
 - 11 changes in existing water management practices requiring farmers participation and cooperation for effective implementation of the new practices.
- Downstream work included under the rehabilitation

programme has been designed to take care of the first part.¹¹ Accomplishment of this part is not likely to face hostility from the farmers because of three reasons:

- i. the work, and benefit from it, is visible, i.e., improvement in distribution of water in all parts of the command area;
- ii farmers can earn some money during the construction phase by working as hired labourers; and
- iii there is no interference with cultivators established rights of cultivation or with when and how they receive water. Problems start at the implementation stage of the second part involving changes in the existing water management practices.

These things are much easier said than done especially because all farmers cannot be expected to respond in the same manner due to the differential impact of the new practices on them. Tail-to-head allocation of water, no doubt, will be considered as a blessing by tail-end farmers but it is very likely to antagonise the head-end farmers who may view it as intrusion on their established rights of cultivation, i.e., getting water first. In reviewing a number of case studies, Oxby and Bottrall (n.d.) reach a broadly similar conclusion that attempts to increase overall equity through transfers of water to downstream users "will

11 It is not necessarily the case that existing downstream works were inadequate for implementation of tail to head allocation but their improvement, by making control easier, makes any distribution system easier.

come into conflict with upstream farmers' adherence to the principle of prior rights" (ibid, p. 21). The rest of the section discusses the tail-to-head allocation under three headings: types of scarcity; prior physical access; and influential farmers.

Types of scarcity: Water is perhaps the scarce resource in the dry zone (Chambers, 1974; Harriss, 1977) and the quantity available is the critical determinant of whether one gets a crop and how much one gets. To understand attitudes towards tail-to-head water allocation, it is useful to categorise different types of scarcity faced in these tanks.

It is worth noting first that the equity and efficiency gains can arise only when water scarcity is resulting in tail-end crop losses; success in organising tail-to-head allocation is of little interest otherwise. And as Chambers (1980, p.37) has pointed out, priority to tail-enders can result in the reduction of efficiency of water use due to conveyance losses and loss of opportunity to reuse drainage water and to usefully raise the water table.

Following Uphoff et al. (1982), we use two categories, moderate scarcity and extreme scarcity; the probable success of any planned intervention ^{to} distribute water more equitably among cultivators will depend on the particular type of scarcity in question.

Water is moderately scarce when the amount of water stored in the tank is sufficient to meet genuine water needs (water required only for crop growth) of all cultivators with careful rationing and it does not demand personal sacrifice in the form of a reduced yield, assuming a standing crop in the field, by anybody in order for others to save their crop.

Water is extremely scarce when there is not sufficient water in the tank to meet genuine water requirements of all cultivators (assuming a standing crop in the field). This, can be created by two different situations. In one situation, the amount of water stored in the tank is such that all cultivators can be provided with that minimum amount of water necessary to avoid a total crop failure. The result is that every body gets some crop although at reduced levels of yield. In the second situation, the amount of water in the tank is so little that it can only ensure a reduced yield and only on part of the command area. In circumstances like this, water can be supplied to some plots to avoid their total loss of crop only by eliminating other plots. Usually, it is the tail-end plots that get eliminated because it is difficult to deliver water to these plots in times of severe water shortage as they are further away from the tank bund. This situation requires personal sacrifice (a lost crop) by some people so that others can benefit. Either situation can occur where the total rainfall for a season is less than expected and hence it becomes necessary to issue more water from the tank than estimated. They can also happen if the irrigation capacity of the tank water is overestimated.

Given the nature of scarcities, it will not be too misleading to expect that the tail-to-head allocation of water is likely to receive greater support and cooperation from cultivators in situations where water is moderately scarce than under the other situation. In times of extreme scarcity of water it would be very optimistic to expect the tail-to-head water allocation or any similar measure to work; everybody would be too anxious to save their crop and would try to get water to their field by adopting any means. From our field experience examples of 'any means' include cutting the main channel, blocking

others' field channels, cutting others' field bunds breaking control structures and even breaking the padlock on the sluice.

Prior Physical access: A second problem of the tail-to-head allocation of water is that water has to pass through the head-end to be delivered at the tail-end. If there is any uncertainty in the minds of the head-end cultivators about getting enough water for their land, they will not allow water to flow to the tail-end without taking water to their plots first. Yaya palaka and cultivation officers mentioned that farmers behave in this way, even when there is no real risk of losing their share of water. In theory, this practice can be checked by 'policing' especially if water is issued only during the day, but according to the yaya palaka and farmers, it is in practice difficult to guard for even 10-12 hours a day. Moreover, it is very likely that too much 'policing' may lead to confrontation with head-end cultivators and sometimes pose threats of physical violence (Moore, 1980).

Influential head-enders: Thirdly, the presence of one or two influential large farmers at the head-end (as in many cases there are) is enough to discourage the operation of the tail-to-head allocation of water or to make it non-functioning. They can change any planned schedule to suit their purpose, in this case getting water to their plots first and in sufficient quantity, because of their influence on the villagers and on the village level government officials. The basis of their strength is their wealth and political linkages (i.e. having friends or relatives who are MPs).

This was the case in one tank under VIRP in the Trincomalee district which in fact, happened to be the pilot scheme for the water management programme in that district. The yaya palaka and Cultivation Officer of that tank stated categorically that because of two influential rich farmers at the head-end it was unthinkable to allocate water to any other plots without giving water to their plots first. Even in times of water rationing due to scarcity, these two farmers take enough water to their plots directly from the tank by using their own pump sets. According to the yaya palaka and the Cultivation Officer, not much can be done about it because everybody in the village is dependent on these two farmers for credit in times of distress; nobody wants to go against them and it is also believed they can get the village-level government officials transferred if they do not cooperate.

This problem is not, of course, unique to this tank, it apparently happens quite frequently under both minor and major irrigation schemes. Political pressure from local MPs to deviate from the water allocation schedule decided at the kanna meetings and getting non-cooperative staff of the Irrigation Department transferred are not very uncommon in many of the major irrigation schemes (see for example, CH₂M Hill, 1979; Moore, 1980; Murray-Rust, 1983).

A variation on the influential head-enders theme is where the yaya palaka has his land in the head-end. If this is so and if he has any doubts about getting sufficient water to his field after allocating water to the tail-end first, he is very likely to be tempted to change the schedule.

Precisely this happened in one tank under IFDP in Kurunegala district in Yala 1983; tail-to-head allocation of water was being practised in this tank but the yaya palaka mentioned that there was crop failure on 5-6 acres of land at the tail-end due to non-availability of water at the end of the season. The reply to the obvious query on how that

could have happened when the tail-end was supposed to get water first was that as there was not enough water during the last two shifts of water issue to cover the total command area, he decided not to follow any schedule but just to open the sluice and let the cultivators help themselves.

Predictably this meant that by the time head-enders had finished helping themselves there was no water left for the extreme tail-end cultivators. The yaya palaka failed to give any satisfactory explanation of the basis on which he took his decision but his motive quickly became apparent when we found out, during our visit to the command area, that his land was located in the head-end part of the command area. One wonders whether the yaya palaka would have taken the same decision had his land been located at the tail-end.

It is difficult to draw generalisable conclusions i given the complexity of the considerations involved in determining the need for the likelihood of successfully implementing tail-to-head allocation. For tanks and seasons where moderate scarcity occurs, an enthusiastic and persuasive APT might well achieve implementation. Where extreme scarcity occurs or where there are influential head-enders, even the most subtle persuasion from APTs is likely to be ineffective. Most tanks in most seasons probably fall into the latter category.

Appendix to Chapter Three

This appendix details the minor tank programmes of the Puttalam Integrated Rural Development Project, the Anuradhapura Dry Zone Project, and the Freedom From Hunger Campaign's "Small Reservoir Village Community Rehabilitation Programme". In most respects, the first two have water management programmes corresponding to those analysed in the text. The FFHC programme is in several respects different in its objectives and approach and represents an illuminating alternative.

Puttalam Rural Development Project

This is an integrated rural development project and one of its objectives is to rehabilitate 10 major schemes and 200 minor tanks in Puttalam district to improve delivery of water on 18,900 acres of irrigated paddy land¹² with special focus on water management programme.

There are several integrated rural development projects in Sri Lanka funded by different donor agencies. The first such project was taken up in Kurunegala district in 1979 with financial support from the World Bank. Others have been implemented for Puttalam and Matale (World Bank), Matara (Sweden), Hambantota (Norway,) Nuwara Eliya (Netherlands) and Dadulla (IFAD). All these projects include rehabilitation of irrigation schemes (both major and minor as one of their major components).

12 The project document does not provide separate figures for areas to be covered by the major and minor schemes, Discussion here will be limited to minor tanks only.

Objectives: The main objective of the project is to improve productivity, incomes and standards of living of people in Puttalam district. To attain this objective the project has adopted an integrated approach to development consisting of five major components.

- i. Agricultural Sector: coconut development, agricultural credit, other agriculture supporting services, livestock, fisheries and forestry.
- ii Water resource sector: irrigation and water management, ground water exploration and exploitation, and rural water supply.
- iii Economic infrastructure: roads and rural electrification.
- iv Social infrastructure: health, education and vocational training.

Project Management

Costs and benefits : The project life has been estimated to be 25 years. The project will reach its full maturity in the 8th year after the completion of the proposed improvements. It has been estimated that the following benefits will be derived from the project after 8 years due to improvement in irrigation water deliveries and increased availability of other inputs brought in by the project: the yield of paddy will increase from 39 bushels per acre to 50 bushels per acre¹³ generating an incremental paddy production of about 14,000 MT which would increase paddy

13 The project document does not provide separate figures of benefits to be derived from the major and minor schemes.

production in Puttalam district by 65 percent; cropping intensity would increase from 122 percent to 157 percent and incomes of paddy-producing farmers under rehabilitated minor tanks would double.

Implementing agency for rehabilitation of minor tanks:

The Irrigation Department is responsible for planning, designing and constructing all minor tanks rehabilitated under the project. Rehabilitation of minor tanks includes: desilting of tanks; strengthening of tank bunds; repairs and improvements of sluices and spillways; installing measuring devices to measure discharges as well as to evaluate the seepage losses; and on-farm development works to facilitate the water management programme.

Operation and maintenance of the rehabilitated minor tanks:

The DAS, in cooperation with the beneficiary farmers, is responsible for operation and maintenance of all the rehabilitated minor tanks. However, the Irrigation Department is responsible for maintaining the rehabilitated tanks for 2 years following the rehabilitation.

Implementing agency for the water management programme:

The DAS is responsible for developing specific water management programmes for the individual rehabilitated tanks in consultation with the farmers. The water management programmes for minor tanks in the Puttalam project and in other integrated rural development projects are identical to that^{of} the V-R project, which is discussed in detail in the text.

Criteria for selecting minor tanks:

- i. The command area under each tank should not be less than 20 acres other than in exceptional cases dictated by technical requirements;
- ii The useful storage of the tank should not be less than 3 acre-feet per acre of command area in the dry zone and 2 acre-feet per acre in the intermediate zone;
- iii The tank should have a record of being filled at least three times during the last five years or hydrologic studies indicate comparable yield for damaged tanks;
- iv the tank should directly benefit at least ten families;
- v the incremental area brought under direct irrigation should be at least ten times the private irrigated land submerged, or five times other cultivated lands submerged; and
- vi the rehabilitation cost, including water management facilities, should not be more than Rs. 8,500 per acre of incremental irrigated area or Rs. 5,000 per acre for the total command area (World Bank, 1980 p. 75).

Anuradhapura Dry Zone Agricultural Project

This project aims at rehabilitating 600 minor tanks¹⁴ in Anuradhapura district in order to provide irrigation facilities on about 20,000 acres of new farming land along with a water management system and to stabilise about 65,000 acres of chena land with improved agricultural practices. About 23,000 families, all from poor (owning less than half to one acre of paddy land and mainly dependent on chena land) and landless classes will benefit directly from the project.¹⁵ As irrigated paddy land is scarce in relation to the population, each family will be allocated 1 acre of irrigated paddy land and 3 acres of rainfed land for growing subsidiary crops. Allotment of land will be supported by security of tenure which will give the cultivators access to institutional credit.

Objectives: This is a comprehensive rural development project and it has several objectives:

- i to establish a technically viable and economically attractive farming system by combining rainfed and irrigated farming which will be supported by a strong infrastructure and improved agricultural facilities and services;
- ii to supplement this farming system with small-holder livestock enterprises;
- iii to help protect available productive resources from further depletion because of shifting cultivation; and

14 Now only 290 tanks will be rehabilitated due to cost overruns : on the original estimate (APTI, n.d.)

15 Now only 12000 families will benefit due to the cut in number of tanks to be rehabilitated (ARTI, n.d.)

- iv to try to develop a model of farming systems which can be replicated in other dry zone areas with similar agro-ecological conditions.

Anuradhapura has been chosen as the project location for specific reasons; it represents the typical characteristics of dry zone farming where rainfed cultivation and chena cultivation predominate; chena cultivation is widespread, causing rapid depletion of natural resources through deforestation and soil erosion; there is a great potential for increased food production through development of land and water resources which at present are under-utilised; there is a large number of abandoned minor tanks in the district whose rehabilitation will increase agricultural productivity.

Costs and benefits: This is a 5-year project (1981-85) with financial support from the Asian Development Bank (ADB) and the International Fund for Agricultural Development (IFAD). The project has an estimated cost of US\$ 39.6 million or US\$ 29.6 million net of contingencies. Of ^{the} total budget, about 50 percent is allocated to minor tank rehabilitation works, and the amount allocated under the water management head is about 16 percent of that (and eight percent of the total). The project life has been estimated to be 30 years. The project will become fully developed by the tenth year and will generate the following benefits; overall cropping intensity should increase from 73 percent to 169 percent; average yield of paddy should increase from 0.8 tons per acre to 1.4 tons per acre which will mean an annual incremental paddy production of about 58,600 tons; income of farm families should double; and social disparity should be minimised as land will be allocated to poor and landless families.

Implementing agency for rehabilitation works:

The Irrigation Department is responsible for carrying out the rehabilitation works. These include increasing the storage capacity of tanks by removing silt; improvement of the catchment area; repairs and improvements of tank bunds, spillways and sluices and on-farm development works to facilitate distribution of water.

Operation and maintenance of the rehabilitated tanks: It is the responsibility of the COSL to provide necessary funds to the DAS to keep the rehabilitated tanks in good condition and operation and maintenance of these tanks will be managed by the farmers with assistance from the DAS staff.

Implementing agency for water management programme:

Planning and implementation of water management programme will be executed by the DAS.

This programme will include establishment of 40 pilot schemes on water management. The objectives are to conduct field research on efficient use of water; measure storage and conveyance losses of water; introduce rotational water supply to ensure equitable distribution of water to all farmers; design simple and suitable structure for on-farm development work; organise farmers associations to train and involve them in maintenance of the system and in water management; train the implementing staff for planning, construction and maintenance of the schemes. These pilot schemes will be selected from different parts of Anuradhapura district allowing representation of differences in size of the command area, topography and soil type.

Criteria for selecting tanks:

- i command area under each of the proposed tanks will not be less than 20 acres with a storage capacity of not less than 60 acre-feet;
- ii minor tanks will be located close to the settlement villages; and
- iii the investment cost per acre will not exceed Rs. 10,000 on an average, with exceptions allowed for technical considerations. The economic internal rate of return (EIRR) for each tank will be at least 15 percent (ADB, 1980 p. 56).

National Freedom From Hunger Campaign: (FFHC)

Since 1980 FFHC has been involved with restoration of abandoned small tanks (with a capacity to irrigate less than 50 acres of land) in the dry zone under its "Small Reservoir Village Community Rehabilitation Programme". Although the project is mainly concerned with restoration of abandoned tanks, it also does some rehabilitation work. Up to July 1984, 80 abandoned tanks have been restored and 31 tanks have been rehabilitated under this programme. FFHC is a voluntary agency. It receives financial support from the Deutsche Welthungerhilfe and the EEC and it operates under the auspices of the Ministry of Agricultural Development and Research.

Objectives: The objectives of the programme fall under three broad categories. The main objective is to improve living standards of poor rural communities by restoring their tanks. The second objective is to revive the ancient system where farmers were responsible for maintenance and repairs of their tanks by forming a Reservoir Council (RC) and a Reservoir Maintenance Fund (RMF) for each of the restored/rehabilitated tanks.

In villages with abandoned tanks, chena cultivation is practised, causing depletion of the natural resources. The third objective of the programme is to reduce chena cultivation by encouraging paddy cultivation through restoration of tanks. Under the restored tanks each family is allocated 2 acres of irrigated paddy land and 1.5 acres of highland for growing fruits and vegetables. A final more technical but very practical objective of FFHC is to develop simple sluices, with farmers' assistance, which can be easily constructed and maintained by the farmers themselves.

Implementing agency for restoration/rehabilitation of tanks:

All restoration and rehabilitation works are carried out by the FFHC itself. The project Technical Assistants (TAs) plan, design and implement all schemes. All the earth-work required is performed manually by farmers under the supervision of the TAs. Farmers contribute to the project by providing labour at a cheaper rate, they receive as wages 50 percent of what labourers get for earthwork from the Irrigation Department.

Operation and maintenance of the restored/rehabilitated tanks:

Farmers are solely responsible for operation and maintenance of their tanks. There is a Reservoir Council for each tank and all farmers (men and women) growing paddy under the tank are members of the RC. All decisions regarding operation of tanks, e.g., cultivation and tank water use lie with the RC which meets 2 to 3 times a month to discuss the relevant issues (FFHC 1983). To meet the cost of maintenance and repairs of the tanks a Reservoir Maintenance Fund has been introduced in all schemes. Each cultivator contributes 2 bushels of paddy per acre per cultivation season to the RMF. All maintenance and repair work is organised by the RC, (FFHC 1983).

Criteria for selecting tanks: Tanks are usually selected by the FFHC but it also includes tanks on request from farmers. In either case there are two conditions that must be fulfilled before any scheme is undertaken; farmers must agree to form a Reservoir Council to operate and maintain the scheme, and they must agree to create a Reservoir Maintenance Fund and to make regular contributions to it for the maintenance of the scheme.

Only very small tanks with an irrigation capacity of less than 50 acres are selected because these tanks are too small to receive attention from the government departments involved with tank rehabilitation. In selecting tanks, preference is given to tanks in very remote areas as these areas are very likely to remain untouched by most development programmes. Before undertaking any scheme careful consideration is given to the local capacity to operate and maintain the scheme with a little training.

Chapter IV

MINOR TANK WATER MANAGEMENT: PROBLEMS AND PROSPECTS

Introduction

It is frequently considered, as described by Coward (1980 p. 17), that problems of water management originate at the farm level because farmers are "unorganized or only poorly organized, and thus inefficient in the use of water, unpredictable in their behaviour, or simply 'uncooperative' with the irrigation agency." This belief is so deep rooted that as Wickham (1978) points out, questions are hardly ever raised about system efficiency, because it is easier to put the blame on the farmers who 'need' to be educated about water management.

Only during recent years has there been a gradual shift from this line of thought as it is recognised that farmers are not solely responsible for water management problems; other factors contributing to them include inefficient operation of systems due to poor physical structures and lack of control structures and poor maintenance of the schemes due to lack of adequate funds (CH₂M Hill, 1979). It has been argued (Murray-Rust, 1983; Murray-Rust and Cramer, 1979) that improved water management practices cannot be expected at the farm level from the farmers without ensuring efficient operation of the schemes.

Although these insights have been generated by studies on major irrigation schemes, our field experience suggests that some of these problems of water management are equally true for minor tanks. This chapter examines three aspects of the problems of implementing the water management programme in minor tanks. The first concerns

problems with the physical structures of minor tanks. The second concerns the validity of a fundamental assumption in the minor tank water management programmes - that efficiency of water use will be best enhanced through saving water in maha and using it for a yala crop. The third concerns the planned and the actual operating methods for programme implementation.

Problems with physical structures:

Out of the 20 tanks studied by this project, only one traditional and five rehabilitated tanks had no problems with headworks. The rest of the tanks had problems of leaking tank bunds (5 traditional and 1 rehabilitated); malfunctioning and defective sluices (6 traditional and 5 rehabilitated); and cracks in the concrete spill (3 traditional and 2 rehabilitated). All these problems in traditional tanks are existing for 3-5 years and in all cases the local Agrarian Service Centre of DAS has been informed but no action has been taken so far (up to February 1985) due to non-availability of adequate funds (personal communication, Asst. Commissioners and TAs of DAS). Another study on minor tanks has also reported defective physical structures of tanks as one of the main problems of water management (Gunadasa et al, 1980 p. 101)

Problems with tank bunds: Leakage through tank bunds could be either due to poor maintenance of bunds by the farmers or due to defects in the construction. The first reason is rarely relevant since tank bunds are cleared of bushes and rat and crab holes are repaired by the farmers before the beginning of each cultivation season. The second reason is more plausible and happens due to two main reasons.

- i. weak compaction when the work is done by farmers manually;
- ii improper compaction to save costs when it is done by contractors hired by the irrigation agencies.

Although contractors usually use road rollers for compaction they may not follow the necessary technical requirements - for example, removal of all vegetation from the bund before adding new earth or gravel and even compaction of all layers at an appropriate moisture content.

The first problem can be solved by supplying wooden rammers to farmer organisations; these are an improved method of manual compaction and have been used successfully in rehabilitation of some minor tanks under VIRP in Trincomalee (personal communication, TA local DAS office). The second problem can be dealt with by improving supervision either through the presence of staff from the relevant irrigation agency when the actual operation is performed, or in briefing the local farmer organisations about the detailed procedures involved and by entrusting them with the responsibility of supervising the contractor's work. This latter approach has been used successfully by the National Irrigation Administration in the Philippines (Alfonso, 1981; Korten, 1982). The important point is to make sure that the tank bund is constructed perfectly because if it is defective to start with, then no amount of subsequent maintenance work can make it function perfectly.

Once a major repair has been done on a tank bund it is the farmers' responsibility to maintain it. Even if there are subsequent problems with the bund due to defective construction it is very unlikely that more funds will be released by the DAS to repair the same tank for

two reasons. Firstly, DAS local staff will not be enthusiastic about requesting the head office to allocate funds for repairing a recently rehabilitated tank as it could reflect badly on their competence. Secondly, there are so many tanks that need to be repaired urgently but cannot be due to lack of capital. By way of example here, out of ten traditional tanks studied in Anuradhapura two breached due to heavy rains in maha 1983-84 and neither of these tanks have been repaired yet (up to February 1985) although the DAS launched a crash programme in 1984 particularly to repair those tanks that got damaged by the flood. Farmers under these two tanks have lost two maha crops and one yala crop so far.

Problems with sluices: Another problem with a majority of the tanks studied was malfunctioning and defective sluices: these were all Tower Type (TT - see Figure 4). For example, a common defect causing a sluices to leak is that the sluice gate does not seal tight shut because it is not greased; similarly, rusty screw threads on sluice control shafts prevent the sluice key operator from fully closing the sluice gate or, when open, from accurately regulating flow. Both these problems cause wastage of water. In most of the traditional tanks, TT sluices have been installed during the mid - 1950s to 1960s and according to the yaya palaka and the local people, there has not been much major maintenance in terms of replacing the worn-out or the damaged parts. Proper maintenance of TT sluices require regular greasing of the screw threads and painting of all other metal works. While these tasks should be performed by the yaya palaka, grease and paint are supposed to be supplied by the DAS and this service is very poor. However, there seems to be some more fundamental problem either with installation or maintenance of Tower Type sluice, because, of the ten rehabilitated tanks studied by the project, five had leading sluices although these were all

installed between 1981 and 1983; leaking since installation has been reported in all cases. Leakage of water through sluices in most of the rehabilitated tanks has also been reported by a major study on VIRP (DAS, 1984a p. 31).

Problems with concrete spills: A third problem observed was leaking of water through cracks in the spill in the case of the traditional tanks. In the case of the rehabilitated tanks, there was leakage of water from the point between the top of the old spill and the bottom of its extension.

These problems with physical structures must question the legitimacy of blaming farmers for wasting water, by using it excessively or practicing continuous supply of water, when the volume of water released cannot be controlled and the sluices cannot be closed due to technical problems. However, is it practical (or even possible) to convince farmers to save water in the maha season to grow a second crop in the yala season when a substantial amount of water saved leaks out through the holes and cracks in the tank bunds and the spills and through malfunctioning sluices.

Alternative Uses of Water Saved in the Maha Season

A fundamental objective in water management programme is the saving of water in the maha season for use in the following yala season. Chambers (1974) and Farrington and Abeysekera (1979) have drawn attention to the alternative uses and opportunity costs of water thus saved. Chambers (1974 pp. 31-33) has illustrated with numbers how extension of acreage in the maha season can be more efficient from both income distribution and production points of view than saving water for a yala crop.

A similar argument has been put forward by Weaver (1985) in a more general context. Two types of consideration are discussed here in relation to this issue- The extension of the maha acreage on encroached land and the size of net benefits through double-cropping given water losses in storage and the extra costs associated with dry sowing.

Encroachment during maha: While, in theory, it does not make any difference whether the production target is fulfilled through extensive or intensive cultivation, it seems, in practice, that there is a strong tendency to discourage irrigated cultivation on 'encroached' land and encourage intensive cultivation on authorised land. This is perhaps due to two reasons:

- i. legally recognized water users rather than actual water users are considered in planning water management; encroachment is ignored and it is encroachers who currently use maha surplus water;
- ii achievement of double-cropping brings credits to water management as a higher cropping intensity is always taken as a sign of agricultural development.

Unlike major irrigation schemes, the encroachers in minor tanks are usually the same farmers with land in puranawela. They chose now to cultivate akkarawela land rather than double cropping some of the puranawela land. Thus, unlike major irrigation schemes where there is a strong income distribution component to the water use pattern, in minor tanks, the issue is principally concerned with water use efficiency. There are exceptions, of course, in both cases. Some farmers in major irrigation schemes do extend their maha acreage using land outside the scheme

(personal communications, Mick Moore on the Kaudulla scheme and Oscar Zolezzi del Rio on the Gal Oya Left Bank scheme); and in minor tanks our field survey established that there are some cases of non-puranawela farmers cultivating on akkarawela land (for example, Pankulam tank in Trincomalee). Above all, this point draws attention to the importance of correctly defining system boundaries when trying to evaluate the production and income distribution consequences of water management interventions.

In our study, in almost all tanks the official size of the command area differed from the actual area being irrigated, and official figures invariably excluded the akkarawela land. DAS officials in Trincomalee (Asst. Commissioner; Regional Engineer and APT) were of the opinion that their failure to introduce double-cropping in tanks under the water management programme was due to illegal use of tank water in maha on akkarawela land. They felt the need for passing legislation which would ban supply of irrigation water to akkarawela land. This is a very sensitive issue and raises such critical questions as whether this step would be justified from productive and equity points of view and whether it would be feasible to implement it in the face of the obvious social and political constraints.

We were informed by the yaya palaka of Pankulam tank in Trincomalee that he was asked by the water management TA not to supply water to 30 acres of akkarawela land cultivated by encroachers (these people live in the village but do not own land under this tank). The yaya Palaka apparently ignored their instruction because he believed that the tank had capacity to effectively irrigate the total command area including 30 acres of akkarawela land and, in his opinion it would be unfair to cut off water to these plots since those poor people

need to feed their families as well. Moreover, these 30 acres of land are at the head-end of the command area adjacent to the main channels, therefore, if supply of water is stopped, there is nothing to stop the encroachers from taking water by cutting the main channels. In such cases the most sensible thing would appear to be legalisation of the encroached land and when we discussed this case with the Deputy Commissioner of the Water Management Division of DAS, Colombo we were told that he has advised the local office to take necessary action to legalise those encroached plots.

Such legalisation of akkarawela land under minor tanks will be a useful step in proper water management planning since tank water is used on these plots anyway and there does not seem to be much possibility of successfully cutting off water to these plots. Water management programmes will contribute more to social welfare if they concentrate upon village realities rather than legal niceties.

Net benefits from saving maha water: Planning a second crop in yala with water saved in maha depends not only on how much water can actually be saved by better water management practices but also what percentage of that water can be effectively conserved. Estimates of the amount of water that can be saved in maha by dry sowing vary from 15 to 30 percent of current maha water use (DAS, 1984a, Farrington and Abeysekera, 1979). Manual weeding or use of weedicide instead of using standing water to control weeds will also reduce maha water requirement but no estimate of the potential saving is available. All of this water cannot be utilised for yala cultivation because of evaporation percolation and seepage losses. No empirical data are currently available on this, except one water balance study conducted in Walacambahuwa tank over five cultivation

seasons during 1976-98. According to this study, on the average only 7 percent of water in storage was used for irrigation issues while 47 percent was lost due to evaporation, deep percolation and bund seepage (Somasiri, 1979 Table 2, p. 43). This report provided a figure for loss due to evaporation but it did not provide separate figures for losses caused by deep percolation and bund seepage. While no useful inference can be made from this data about the situation in all minor tanks in the dry zone, it can be safely assumed that losses due to defective physical structures of tank will be higher in most minor tanks because Walagambahuwa tank's physical structure was in very good condition when the water balance study was carried out.

The study included two yala seasons. In these seasons losses were higher, at 60 percent of total storage, presumably due to higher evaporation losses but irrigation issues were also higher at 14.5 percent of total storage. As a percentage of total outflow (losses plus irrigation issues), irrigation in these two seasons only accounted on average for 20 percent. The Yala season periods used by Somasiri were 20.3.77 to 24.9.79 and 1.3.78 to 25.6.78; an early yala would correspond approximately to the later year where irrigation issues as a percentage of total outflow were 24 percent. These figures¹ indicate that only one quarter of water saved during maha would actually be available for yala irrigation and the rest is loss. As the VIRP document recognised, "Such high losses severely restrict the irrigation potential of small, shallow tanks in yala." (World Bank, 1981 p. 9)

1 Moreover, Walagambahuwa has a storage area of 76 acres (280 acre feet) and a command area of only 32 acres which is a much more favourable ratio than most dry zone tanks (World Bank, 1981 p. 9) - the capacity to save maha water will be more restricted in those tanks where the ratio is less favourable.

In these circumstances it is obviously more sensible, where land is available, to increase the area under (a dry sown) maha crop receiving supplementary irrigation rather than to conserve water of which three quarters will be lost before it can be used. Where additional land is restricted and this ^{option} is not available the relevant question is whether the benefits farmers receive, by having a quarter of the water they save in maha effectively available for yala cultivation, are greater than the additional costs associated with maha water-saving practices. As the VIRP document states, "outlays tend to be lower if planting is delayed since farm power requirements and labour for weeding are both reduced if sufficient water is available (from prior rainfall or the tank) to flood the land." (World Bank, 1981 p. 13) . No precise information is available on the size of these additional costs associated with dry sowing. The average tractor hire rate in our field areas was Rs. 500-550 per acre and according to GOSL (1983c), weeding costs there were Rs. 113 per acre. The farmer has to calculate whether the increase in these costs due to dry sowing combined with the higher risks of wasted investment are more than compensated for by the possibility of an additional yala crop.

To the extent that programmes of rehabilitation and water management increase the effective availability per acre of water for irrigation in maha, the case for dry sowing is strengthened because the risks of dry-sown crop failure due to inadequate rains are reduced. However, unless such increase is shown to be substantial, it may not be, along, sufficient to persuade farmers to change to the more expensive and riskier dry-sown maha crop. The additional costs and the higher risk are definitely incurred, the yala crop is only a possibility if rains are adequate. Better access to credit, assured inputs, especially seed, and effective crop insurance are likely

to be more important influences on farmer behaviour than a moderate increase in per-acre water availability. Farmers will save water only when the benefits from doing so will be greater than the costs involved or, in Weaver's words (1985 p.3), "cultivators do not waste water that has value greater than the cost of saving it".

To summarise, it seems, from our field experience and from the available literature that often a better use of extra water available due to rehabilitation and improved water management practices is either to expand acreage in maha or to improve water supply to the existing irrigated area. A DAS study on VIRP has reached a similar conclusion, with reservations about the possibility of expanding acreage in most minor tanks (DAS, 1984a, p. 34). Somasiri (1979) has argued that the correct strategy for efficient utilisation of tank water is to use it in the maha season without reducing quantity at the expense of the crop rather than saving it for yala, since a substantial amount of water in the tank is lost during storage.

The Water Management Programme: Theory and Practice

Several differences were observed during our field study between official proposals and actual implementation of the programme. This section discusses these differences under two broad headings: farmer participation and the functioning of Agricultural Planning Teams (APTs).

Farmer participation in the programme: There is a common emphasis upon farmer participation in irrigation schemes in general and in water management in particular because it is evident that utilisation of farmer knowledge and their active participation in planning and designing of irrigation schemes improves the quality of their operation and

maintenance (Coward, 1980). Both the World Bank Project documents have heavily emphasised farmer participation in the water management programme. But while the nature of expected farmer participation in the operation and maintenance of the rehabilitated tanks has been clearly specified the nature of their participation in terms of planning and designing of on-farm development work and introduction of improved agricultural practices have been left vague. (World Bank, 1980 pp. 22-23, 76; 1981, pp. 32, 35).

The term 'farmer participation' has different meanings for different people. Within the context of water management, a commonly accepted meaning of the term seems to be utilisation of farmer knowledge about local problems and farmer skills in planning, design, rehabilitation, operation and maintenance of irrigation schemes (Coward 1980; Alfonso, 1981). Farmer participation in this sense was very limited in all ten tanks studied by us under the water management programme. The only form of active farmer participation was their work as hired labour for the contractors.²

Non-utilisation of farmer knowledge about the local conditions is very likely to affect adversely the subsequent operation of the rehabilitated schemes. Up to November 1984, down-stream work had been completed in seven tanks and in two of these, farmers complained that the on-farm development work has made water allocation more difficult. In one case, the main channel was deeper than the field level which made the control structures and pipe outlets ineffective; the main channel had to be blocked in places to increase the head in order to supply water to the fields. In the other case, an old concrete

2 Farmers in these areas were lucky to get this chance; in other areas contractors bring their own labourers (personal communication, T.O. DAS Kurunegala; Medagama, 1982).

anicut was removed by the authority responsible for the downstream work because they thought it would not be necessary any more after the main channel had been improved, but, in fact now farmers have to make a temporary anicut every season at the same place to supply water to part of the command area. In both cases farmers claimed that they warned the contractor about the consequences of these actions but their advice was not considered.

This has important policy implications because on-farm development work is supposed to make operation of the system easier not harder; moreover, non-involvement of farmers in on farm development work creates problems in subsequent maintenance of the system. We were shown an excellent example of this from our recent (January 1985) field trip to Madras to visit the Tank Modernization Programme.

We visited two tanks, Padianallur and Pillaipakkam, that have been recently modernised. In the first several meetings were held between farmers and the Public Works Department (PWD) to plan and design the on-farm development work. Along with other improvements, three distributary channels were lined to compare seepage losses with the non-lined ones. The contract was given to a local farmer and other cultivators worked as hired labourers. In discussions with the farmers, they expressed satisfaction with the work and subsequently no damage was done to downstream structures either to tap water illegally or for other purposes. In the other tank (Pillaipakkam) no meeting was held between the farmers and the PWD officials about the modernisation work. There was no farmer participation in planning and designing of the on-farm development work and work was done by an outside contractor. In fact more money was invested in this tank

because two of the main channels (out of seven) were also lined in addition to a number of distributory channels. In our meeting with the farmers, they complained about the quality of on-farm development work and mentioned that this work has made water allocation problems worse in parts of the command area. Lined distributory channels have been damaged by farmers either to get water to their fields or to drain excess water and some concrete slabs have also been stolen from the lined main channels. Farmers were claiming that the government should employ somebody to guard the structure from being damaged.

The farmers attitude was that they had no responsibility for the operation and maintenance of the modernised system since they were not consulted about it and they were not involved in the work; the government has done it; therefore, it is the government's responsibility to operate and maintain the system.

This contains an important lesson for minor tank rehabilitation programmes in Sri Lanka and measures should be taken to ensure increased farmer participation in these programmes since effective operation and maintenance of these schemes lie mainly in farmers hands.

One factor currently limiting farmer participation in the water management programme is that the proposed system of selecting group leaders from each block has not yet been fully implemented. The group leader system can be introduced only on completion of the downstream work and once the command area has been divided into separate blocks. In the ten tanks under water management studied by us, downstream work has been completed in seven and in five of these (as well as the other three tanks) either group leaders had not been selected at all or the

number of group leaders was fewer than the number of blocks. This lack of enthusiasm is perhaps due to the absence of any remuneration for the group leaders. In minor tanks, yaya palakas receive a remuneration of a quarter to a half a bushel of paddy from the cultivators per acre of land irrigated in each season. According to the yaya palaka and the farmers interviewed, the system of group leaders is not likely to function effectively unless some remuneration is offered for undertaking this responsibility. Attempts to introduce 'farmers representatives' to perform a similar function as the group leaders have failed in two major schemes mainly due to the same reason (Moore, 1980 p. 17).

A further constraint on farmer participation, especially in the early days of the programme, was delay in establishing APTs. According to the project documents (World Bank, 1980; 1981) two conditions must be fulfilled prior to the rehabilitation work: pre-construction meetings should be held between farmers and officials from the ID, DAS and Department of Agriculture to discuss the project, designs, cost estimates, operation of the programme, and farmer participation; and a preliminary water management programme should be prepared by APTs for tanks to be rehabilitated to ensure compatibility between physical structure improvements and subsequent operation of the programme.

Medagama (1982) states that in most schemes under VIRP pre-construction meetings were never held and the proposed inputs from the APTs in planning the physical structure of tanks could not be utilised initially due to non-existence of APTs at that time. APTs were established only in 1983 whereas rehabilitation work started in early 1981. About 200 tanks had already been rehabilitated by the time APTs were established. In all 5 VIRP tanks studied by us in Trincomalee, no pre-construction meetings were held because all these tanks

were rehabilitated in 1982. This situation must have changed now because proposed farmer meetings were held and preliminary water management programmes were prepared in all 5 IRDP tanks studied by us in Puttalam, perhaps, because, these tanks were rehabilitated in 1983. However, this discussion illustrates the problem of effectively coordinating different components of a project especially when fundamental components such as farmer participation are dependent upon creation of new establishment patterns (for the TOs in the APTs) within the public sector.

The functioning of agricultural planning teams (APTs)

Agricultural Planning Teams have so far (up to February 1985) been in existence for only two years. Moreover, the main job of APTs is to introduce improved irrigation and agricultural practices which requires a considerable amount of time (the rehabilitation work is easier to evaluate because benefits from it are easier to demonstrate since they are immediate and visible). Therefore, it would be inappropriate at this stage to attempt any evaluation of their achievements. This section discusses the functioning of the APTs under five heads: constraints on APTs; current activities of APTs; effectiveness of APT activities; specific water management programmes for individual tanks and future prospects for APTs.

Constraints on agricultural planning teams: Two main constraints under which APTs currently operate are lack of transport facilities and shortage of staff. Both these elements are of vital importance for effective functioning of the water management programmes.

Each APT is responsible for 15-20 tanks and they have to collect all the necessary information and prepare a water management programme for a particular tank within a maximum period of two weeks (Medagama, 1982). Proper understanding of existing irrigation and agricultural practices, and the constraints under which farmers cultivate is a pre-requisite for developing any useful water management programme and it requires spending a considerable amount of time in the village. The main problem is transport. Although the APT in Puttalam had a vehicle at its disposal, the APT in Trincomalee had to use either public transport or wait for a ride with their seniors or with officials from other government departments. In Trincomalee the tanks that we studied were about one to one-and-a-half hours' drive from the town in a private vehicle, and longer on a bus. Buses stop running earlier in rural areas and frequently do not go right to the village. Moreover, low levels of transport and daily allowances are a problem that the APTs share with most rural development workers. This suggests that only a limited number of field visits are likely to be made before preparing a water management programme.

The second common problem is the absence of an Agricultural Instructor from the APTs. The Trincomalee APT did not have this problem but in Puttalam there was no APT for quite some time because the previous AI had been promoted and his replacement had not come (personal communication, T.M. Piyasena, local T.O.). The T.O. was handling the water management programme in 20 tanks. The same problem was observed in Kurunegala; there were 5 APTs and in between them they had only one AI (personal Communication, K.A. Ariyaratne, local T.O.). This is a serious problem because it is mainly the AI's responsibility to plan cropping patterns and water and other input requirements

for the crops. Although the TOs get an orientation on agricultural issues in the training course on water management, this is an inadequate substitute for a thoroughly trained professional.

Two organisational points emerge from the foregoing discussion; the urgent need for providing APTs with adequate transport facilities and for improvement of coordination between the DAS and the Department of Agriculture to ensure constant availability of Agricultural Instructors. However, it must be emphasised that this latter problem of coordination seems almost inevitable whenever more than one agency is involved in a project, and this is not unique to this programme or to Sri Lanka alone. In a recent meeting in Madras (January 1985) on the Tank Modernization Project between Anna University staff, Public Works Department officials and International Irrigation Management Institute (IIMI) workshop participants, the problem of organising coordination between the different government departments involved in the project was mentioned as the worst one. Current activities of agricultural planning teams: Under the water management programme the APTs have to perform a variety of functions. These includes:

- i. Planning and designing of downstream work;
- ii advising farmers to select group leaders;
- iii preparing water management plans;
- iv attending kanna meetings to discuss water management plans with the farmers; and
- v organisation of demonstration plots.

The first three points have already been covered by discussions in previous sections. This section discusses: kanna meetings, and demonstration plots are discussed in

the following section.

The kanna meeting is the forum at which APTs and farmers prepare water management programmes including:

- i. fixing dates by which the tank bund, main channels and field channels should be cleaned and repaired;
- ii preparing a cultivation calendar which specifies dates by which particular operations must be completed;
- iii preparing an irrigation schedule which specifies first and last dates of issuing water from the tank, the number of issues to be made during the season, and the interval between the issues;
- iv) varieties of paddy to be grown;
- v) other subsidiary crops to be grown in the yala season, and
- vi) deciding how much of the command area should be irrigated in periods of water shortage.

In theory all these points must be discussed with and approved by the farmers in kanna meetings. To quote Medagama (1984 p.1) "Vital decisions pertaining to the water management programme would be decided by the farmers of the command area at the cultivation meeting (kanna Meeting)". In practice this does not seem to happen and , in fact, kanna meetings bear more resemblance to the common situation in major irrigation schemes as described in Murray-Rust and Moore (1983 pp. 30-31) where kanna meetings are used as a means for announcing decisions already made by government officials rather than as a mechanism to incorporate farmer inputs in the decision making process. The obvious consequence is poor farmer attendance in kanna meetings and lack of commitment of farmers to follow these decisions.

APTs complained that in kanna meetings it is difficult to get sufficient farmer attendance to meet the legal quorum because they are busy doing other things. We were informed by yaya palaka that often signatures are forged in the kanna meetings to show an official record that the required number of cultivators were present. We had an excellent opportunity of observing this in one kanna meeting (though it was not in one of our study tanks under the water management programme). The meeting was supposed to start at 9 a.m. at the yaya palaka's house and only 8 cultivators showed up but the minimum attendance required was 17. We waited for about one-and-a-half hours and nobody else came. At this point the yaya palaka and other farmers asked the Cultivation Officer (CO) whether they should go ahead with forging signatures but the CO did not agree³. Eventually the yaya palaka managed to get hold of 8 women (because no men were available), who were wives and daughters of cultivators to fulfill the legal quorum. It seemed from these women's behaviour that it was their first formal exposure to any such official meetings.

Effectiveness of agricultural Planning teams activities

APTs invariably complained that decisions taken (or announced) at the kanna meetings are not followed by the cultivators. They believe it is mainly because farmers are not cooperative and cannot comprehend the benefits

3 My investigator explained to me (as I did not speak adequate Sinhala) that the CO was disinclined to forge signatures because of my presence, not only an outsider but a foreigner as well.

of improved agricultural and water management practices. Lack of farmer cooperation has been mentioned as the common reason behind non-adherence to kannameeting decisions in 76 VIRP water management schemes (DAS, 1984a p. 28). The following example illustrates the kind of problem faced.

The Agricultural Instructor of Trincomalee APT mentioned that farmers in that area use much more seed than required to get optimum plant density on an acre of land because they believe more plants yield more paddy. To eliminate this wrong idea he organised cultivation on two plots of land in Mahamarkulam Tank (the water management programme's pilot project in the district) to demonstrate the benefits of using optimum plant density. According to the AI although the demonstration plots had a higher yield than other plots, farmers have not yet changed their old practice. In his opinion the reason was farmers' inability to comprehend benefits from this improved agricultural practice. While there may be some truth in this statement, it is not certainly the only reason behind farmer behaviour. In the demonstration plots, capital-intensive inputs like fertilizer, weedicide and pesticide were used in appropriate quantities at appropriate times and these capital outlays are beyond the means of most farmers. Therefore, it is quite plausible that farmers refrained from adopting the recommended method because they attributed higher yields of the demonstration plots to greater use of the different inputs rather than to lower plant density.

On the one hand we have APTs complaining about farmers for not being responsive to the water management programme and on the other hand, farmers in our study villages reported that they do not follow the water management package recommended by APTs because these are not realistic and for

the same reason they do not bother to attend kanna meetings. An important part of the explanation for the communication problem may be the lack of tank-specific water management programme as described in the next section.

Specific water management programmes for individual tanks:

Despite the rhetoric about preparing a specific water management programme for each individual tank, a strong tendency has been observed to apply the same 'package' to all tanks. It should be emphasised here that this is not a criticism of the dedication or capability of the agricultural planning teams but due to the constraints under which they operate. The implementation programme is being followed in principle in the sense that a specific plan for each tank is being developed,. But it is questionable to what extent the plan reflects a locally optimal solution rather than introduction of a 'package' solution. According to one DAS report on VIRP (DAS, 1984a) there were significant differences between areas in suitability of water management programme to local conditions. While in some areas the plans prepared by the APTs suited the local conditions in other areas they did not, although the plans were 'theoretically sound' (DAS, 1984a p. 11). This report has suggested that more detailed study of existing practices should be made before preparing water management plans. The same recommendation has been made in another DAS report on water management programme (DAS, 1983).

Future prospects of Agricultural Planning Teams:

We have described earlier that APTs operate under several constraints and it would be inappropriate to critically evaluate their current output. However, with full staffing and transport facilities and as APTs acquire more

experience, it should be possible for them to develop plans which are specific in design for each tank and based upon a collaborative effort of farmers and APTs.

These are the two major missing components now, and it will not be possible to provide one without the other.

It was encouraging to know that in maha 1984-85, a tank site workshop was organised by the APT in one VIRF tank to utilise farmer inputs in planning the water management programme and to examine whether this approach leads to increased farmer response to the programme.

(personal communication, Jaliya Medagama, Deputy Commissioner, Water Management Division, DAS). To a large extent, head office initiatives of this sort will be critical determinants, along with adequate staffing and transport, of the future success of the Agricultural Planning Teams.

Chapter V

CONCLUDING REMARKS

Study results suggest that the water management programme objectives are well identified but that the prospects for gains in crop output are highly variable and, on average, substantially less than programme documentation has indicated. The sources of this variability are many and complex, reflecting physical, economic, social and institutional differences between tanks. They result in different degrees of water scarcity between tanks and between years.

There are some widely acknowledged problems such as paddy variety preference, tail-end access and large farmer domination. Field results show that the following features are also particularly important in understanding farmer response to proposed changes in the use and distribution of their tank water:

- i. Farmer perception of risk often differ from programme perceptions; poor farmers cannot afford the higher risks associated with better water management even though profits may, on average, be higher.
- ii Limited degree of economic dependence on tank crops.
- iii Uncertainty about timeliness of inputs and markets for output required for crop diversification.
- iv Past expansion of cultivated area and consequent differential water use rights by land type (puranawela and akkarawela).

Three broad sets of issues need to be addressed to improve the prospects for effective state intervention:

- i. criteria and methods of selecting tanks for inclusion in the programme;
- ii greater flexibility in the content and implementation of programmes; and
- iii more explicit recognition that, with risk-averse farmers, water management programmes have to be developed within a comprehensive agricultural development plan that also deals with input supply, credit and security against risks.

The issue of risk-aversion deserves special emphasis. A recurrent theme in discussion of dry zone cropping patterns is risks due to uncertain rainfall. As the preceding discussion has suggested in several places, risk will be a critical determinant of the acceptability of water management programmes also. The strategy farmers are being advised to adopt is a profit-maximising strategy assuming that water availability will correspond to the 75 percent probability level. It is entirely possible, and experience suggests likely, that farmer decisions about the types and amount of land he cultivates, and about input use and crop mix will be at variance with this strategy. There are two possible reasons why. First, even if there were not other uncertainties (markets, prices etc) the farmer would adopt a strategy with lower maximum output if all goes well but with a higher minimum output (and income) if cultivation goes badly. For example, a farmer may prefer the minimum assured income from his chena land cultivation to the possibly greater income from dry sowing his maha paddy and later getting a yala crop. If risk aversion strategies are important elements in farmer decision-taking, then one could expect the new

package of practices to be more successful in areas where rainfall levels (and catchment area/storage/command area ratios) are more favourable. This is what appears to be happening.

It has been reported that the water management package has been well adopted in 62 tanks in Kurunegala district and is yielding encouraging results (personal communication, Dr. Fernando, Deputy Director, Agriculture, MI; Jaliya Medagama, Deputy Commissioner, Water Management Division, DAS; Assistant Commissioner, DAS, Kurunegala). This is not because farmers in this district are more enterprising than the dry zone farmers but because Kurunegala is in the intermediate Zone and has better rainfall. There are two more important reasons: soil in the intermediate zone has better water retention characteristics than that^{of} the dry zone (personal communication, Dr. C. Panabokke, ex-Director Agriculture, and almost all high land cultivation is stabilised with large areas under coconut, with the result that competition for labour or interdependence between highland cultivation and paddy farming is less marked than in the dry zone.

Secondly, even when farmer interpretation of the optimum practices for a 75 percent probability amount of rainfall corresponds to those developed for water management programmes, other constraints or other uncertainties may affect his behaviour. Uncertainty, for example, about seed availability or about family labour availability may suggest an alternative cropping pattern. On cash constraints, a classic example is provided from the Walagambahuwa tank in data analysed by Siripala (1984) of Maha Illuppallama. He shows that for the dates when dry land preparation using tractors on the puranawela land is recommended, farmers weekly cash incomes are at their annual low point (see figure 6).

(Tractor rental unlike payment for buffaloes, generally involves an 'in advance' or 'on the spot' cash payment). A few weeks later, when wet land preparation can take place, the first cash income from the maha chena crops has started and the cash constraint has been reduced.

Two broad types of conclusion emerge. First, while our technical knowledge of the interactions between rainfall probability levels, soil types and crop water requirements may have reached very high levels (for example, Panabokke and Walgama, 1974), understanding of the economic and social constraints that affect farmer decision taking may be inadequate. Risk-averse farmers have good reasons to avoid profit-maximising strategies. Second, and related, even if the different sources of scientists' and of farmers' knowledge do not result in different interpretation of expected rainfall the reason why farmers behave differently now may be due to constraints (credit, seed, etc) unrelated to water management. Successful water management programmes therefore require integration in a package that releases such constraints.

References

- Abernethy, C.L. "Methodology for Studies of Irrigation Water Management". In M.J. Blachie, ed., African Regional Symposium on Small Holder Irrigation. University of Zimbabwe, Harare, 1984. pp. 1-8.
- Abeyratne, E.L.F. "Dry Land Farming in Ceylon." Tropical Agriculturist, vol. CXII, 1956. pp. 191-229.
- _____. "Prospects for Agricultural Development in the Dry Zone." Annual Session of the Sri Lanka Association for the Advancement of Science, Section B-Agriculture and Forestry, Presidential Address. 1962.
- _____. "Some Aspects of Agricultural Development in Sri Lanka" Annual Session of the Sri Lanka Association for the Advancement of Science, Presidential Address. 1975.
- Abeysekera, W.P.T. A Preliminary Assessment of the Performance of a Major Irrigation Rehabilitation Programme: The Case of Tank Irrigation Modernization Project. Agrarian Research and Training Institute, Research Study No. 60. Colombo, 1984
- Abeysinghe, Ariya. "Minor Irrigation in the Agricultural Development of Sri Lanka" (Part I). Economic Review September, 1982a.
- _____. "Minor Irrigation in the Agricultural Development of Sri Lanka" (Part II). Economic Review October/November, 1982b.
- Abeywickrema, Nanda. "Irrigation and Water Management in Sri Lanka." PROGRESS, vol. 4 no. 1. 1984. pp1-18.
- Agrarian Research and Training Institute. "Anuradhapura Dry Zone Agricultural Project (ADZAP)." Research Proposal, n.d.

Alfonso, Felipe B. "Assisting Farmer Controlled Development of Communal Irrigation Systems." In Bureaucracy and the Poor: Closing the Gap. A. W. D. L., Singapore, 1981. pp-45-52.

Asian Development Bank. Appraisal of Anuradhapura Dry Zone Agriculture Project in Sri Lanka. Report No. SPI: AP - 20. 1980.

Boserup, Ester. The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure. George Allen & Unwin Ltd. London. 1965

Chambers, Robert. Water Management and Paddy Production in the Dry Zone of Sri Lanka. UCAPTI Working Paper, 1974.

_____. "Basic Concepts in the Organization of Irrigation." In E. Walter Coward, Jr. ed., Irrigation and Agricultural Development in Asia: Perspectives from the Social Sciences. Cornell University Press, Ithaca, New York, 1980. pp. 28-50.

Charles, S.H. "Proposals for a Seed Policy for Sri Lanka." Tropical Agriculturist, vol. 138 (1982). pp. 131-148.

CH₂M Hill. Proposed Water Management Programme for Major Irrigation Schemes in Sri Lanka. Prepared for U.S. Agency for International Development, 1979.

Coward, E. Walter, Jr. "Irrigation Development: Institutional and Organizational Issues." In E. Walter Coward, Jr. ed., Irrigation and Agriculture Development in Asia: Perspectives from the Social Sciences. Cornell University Press, Ithaca, New York, 1980. pp. 15-27.

Department of Agrarian Services. "Evaluation/Progress of Water Management Programme: Maha 1982-1983." Water Management Report. Water Management Division, Colombo, 1983.

_____. Village Irrigation Rehabilitation Project Water Management Programme. Water Management Division, Colombo, 1984a.

_____. "Irrigation Water Requirements and Water Management Practices." Water Management Report. Water Management Division, Colombo, 1984b.

- _____. "Water Management Training Manual: Training Programmes on Water Management." Water Management Division. Colombo, 1984c.

The Department of Agriculture. Proceedings of the National On-Farm Water Management Seminar: Welcoming Address Dr. Walter Fernando. FAO/UNDP - SRL/75/058, 1980.

Farmer, B.H. "Problems of Land Use in the Dry Zone Ceylon". The Geographical Journal, vol. CXX, Part I, (1954). pp. 21-33.

_____. Pioneer Peasant Colonization in Ceylon: A Study in Asian Agrarian Problems. Oxford University Press, London. 1957.

Farrington, J. and W.A.T. Abeysekera. Issues in Farm Power and Water Use in Sri Lanka. Agrarian Research and Training Institute, Occasional Publication 17. Colombo. 1979.

Farrington, John and Abeyratne Frederick Farm Power and Water Use in the Dry Zone (Part II). Agrarian Research and Training Institute, Research Study No. 52. Colombo, 1982.

Freedom From Hunger Campaign. Sri Lanka: Wewas and Reservoirs Album. Colombo. 1979.

_____. Rehabilitation of the Small Reservoir - Village Communities of Sri Lanka. The Associated Newspaper of Ceylon Ltd., Lake House, Colombo. 1983.

Sri Lanka Fights Rural Poverty. Frewin & Company Ltd. Colombo. 1984.

Government of Sri Lanka. Parliament of the Democratic Socialist Republic of Sri Lanka: Agrarian Services Act, No. 58 of 1979. Department of Government Printing, Sri Lanka. 1979.

Statistical Abstract of the Democratic Socialist Republic of Sri Lanka 1982. Department of Census and Statistics, Ministry of Plan Implementation. The Department of Government Printing, Sri Lanka. 1983a.

Socio - Economic Indicators of Sri Lanka. Department of Census and Statistics, Ministry of Plan Implementation. 1983B.

Cost of Cultivation of Agricultural Crops- Maha 1982/1983: Volume I - Paddy. Department of Agriculture, Division of Agricultural Economics and Projects. Peradeniya, Sri Lanka. 1983c.

Sri Lanka Census of Agriculture 1982: Small Holding Sector. Department of Census and Statistics, Ministry of Plan Implementation. 1984.

Gunadasa, J.M., P. Wickramasekera, H.M. Gamini Herath. Socio-Economic Survey of Minor Irrigation in the Dry Zone of Sri Lanka. University of Peradeniya, Sri Lanka, 1980.

Benefit-cost Evaluation of Village Tank Rehabilitation in Sri Lanka. University of Peradeniya, Sri Lanka. 1981.

Gunasekera, Wickremā and Sunimal Fernando. Water Management in the Village of Kelegama in Sri Lanka. Final Report. Marga Institute, Colombo. 1981.

Gunasekera, Wickrema. "The Role of Traditional Water Management in Modern Paddy Cultivation in Sri Lanka." MARGA Quarterly Journal. Vol 6. No. 3 (1982) PP. 69-123.

Gunawardena, A.M.T. Water Management under Small Village Tanks. Agrarian Research and Training Institute. Occasional Publication 25. Colombo. 1981.

Harriss, John. "Problems of Water Management in Hambantota District." In B. H. Farmer, ed., Green Revolution: Technology and Change in Rice Growing Areas of Tamil Nadu and Sri Lanka. The Macmillan Press Ltd. London, 1977. pp. 364-376.

Herath, H.M.G., C. Bogahawatte, C. sivayoganathan, S. Pinnaduwaage. "Socio-economic Data of Selected Village Irrigation Schemes in Sri Lanka: Village Irrigation Rehabilitation Project". Working Paper No. 1. Department of Agricultural Economics and Extension, Faculty of Agriculture, University of Peradeniya. Sri Lanka. 1984.

International Labour Organization. Matching Employment Opportunities and Expectations: A Programme of Action for Ceylon. Vol.I. Report, Geneva. 1971

Korten, Frances F. Building National Capacity to Develop Water Users' Associations: Experience from the Philippines. World Bank Staff Working Papers No. 528. 1982.

Leach, E.R. Ful Eliya, a Village in Ceylon: A study of Land Tenure and Kinship. Cambridge University Press, Cambridge, 1971.

Levine, Gilbert. "Hardware and Software: An Engineering Perspective on the Mix for Irrigation Management." Paper presented at the Workshop on Irrigation Research The International Rice Research Institute, Los Banos, The Philippines, 1979.

Lipton, Michael. "Game Against Nature: Theories of Peasant Decision-Making." (reference incomplete). 1968.

Medagama, Jaliya. "Some Observations on Farmer Involvement in the Village Irrigation Rehabilitation Project in Sri Lanka." Unpublished paper presented at the Workshop on Organization as a Strategic Resource in Irrigation Development. Asian Institute of Management, Manila, Philippines. 1982.

_____. "The Village Irrigation Rehabilitation Project." Presented at Agrarian Research and Training Institute's seminar on Water Management, 1984.

Meinzen-Dick, Ruth Suseela. Local Management of Tank Irrigation in South India: Organization and Operation.

Cornell University Studies in Irrigation. No. 3.
Cornell University, Ithaca, New York. 1984.

Moore, M.P.. Approaches to Improving Water Management on Large-Scale Irrigation Schemes in Sri Lanka. Agrarian Research & Training Institute. Occasional Publication 20. Colombo. 1980.

Murray-Rust, Hammond and Russ Cramer. "An Evaluation of Water Management and Water-User Organizations in Three Selected Irrigation Schemes of Sri Lanka (With Proposals for their Modification). USAID Project (383-0042), 1979.

Murray-Rust, Hammond. "Irrigation Water Management in Sri Lanka: An Evaluation of Technical and Policy Factors Affecting Operation of the Main Channel System." Unpublished Ph.D. dissertation, Cornell University, Ithaca, New York. 1983.

Murray-Rust, Hammond and Mick Moore. Formal and Informal Water Management Systems: Cultivation Meetings and Water Deliveries in Two Sri Lanka Irrigation Schemes. Cornell Studies in Irrigation, No. 2. Cornell University, Ithaca, New York. 1983

Murphy, R. "The Ruins of Ancient Ceylon." Journal of Asian Studies, Vol. 16 no. 2 (1957) pp. 181-200.

Oppen, M. von and K.V. Subba Rao. Tank Irrigation in Semi-Arid Tropical India, Part I: Historical Development and Spatial Distribution. ICRISAT. Progress Report No. 5. Economics Programme. India. 1980a.

Tank Irrigation in Semi-Arid Tropical India
ICRISAT. Progress Report NO. 9. Economics Programmes India, 1980b.

Oxby, Clare and Anthony Bottrall. "The Role of Farmers in Decision-Making on Irrigation Systems". Overseas Development Institute, London. n.d.

Palanisami, K. "Managing Tank Irrigation Systems: Basic Issues and Implications for improvement." In Proceedings of the International Workshop on Modernization of Tank Irrigation System: Problems and Issues. Centre for Water Resources, Anna University, Madras, 1982. pp. 149 - 158.

Panabokke, C.R. and A. Welgama. "The Application of Rainfall Confidence Limits to Crop Water Requirements in the Dry Zone Agriculture in Sri Lanka." National Science Council, Sri Lanka. Vol. 2 no. 2 (1974) pp. 95 - 113.

Paranavitana, S. "The Neglect of Irrigation Works in the Dry Zone and its Depopulation." In H.C. Ray, ed., History of Ceylon, Vol. I, Part II. University of Ceylon, Peradeniya. 1960. pp. 713 - 718.

Roberts, Michael. "Traditional Customs and Irrigation Development in Sri Lanka." In E. Walter Coward, Jr., ed., Irrigation and Agricultural Development in Asia Perspectives from the Social Sciences. Cornell University Press. Ithaca, New York. 1980. pp. 186-202

Saktivadivel, R., S. Savadamuthu, C.R. Shanmugham, P.K. Balakrishnam and C. Arputharaj. "A Pilot Study of Modernisation of Tank Irrigation in Tamil Nadu." In Proceedings of the International Workshop on Modernisation of Tank Irrigation System: Problems and Issues.

Centre for Water Resources, Anna University, Madras, 1982, pp. 1 - 20

Sanmugam, T. and S.M. P Senanayake. Prospects for Expansion in the Production of Coarse Grain & Grain Legumes. Agrarian Research and Training Institute. Research Study No. 51. Colombo 1982.

Sikurajapathy, Marvin and Tissa Senaratna. "Sri Lanka National Report". In Report of the Cropping Systems Working Group. 6th cropping Systems Working Group Meeting. The Department of Agriculture, Sri Lanka and the International Rice Research Institute. 1978. pp. 72-91

Siripala, Gamage Don. "Economic Analysis of Walagambahuwa." Unpublished paper presented at the National Cropping System Workshop, Peradeniya. 1984.

Siy, Robert Y. Jr. Community Resource Management: Lessons from the Zanjera University of the Philippines Press, 1982.

Somasiri, S. "Efficient Utilization of Physical Agricultural Resources in the Dry Zone of Sri Lanka." Tropical Agriculturist, vol. CXXXIV, (1978) pp. 17 - 31.

_____. "Village Tank as an Agricultural Resource in the Dry Zone of Sri Lanka." Tropical Agriculturist, vol. CXXXV, (1979) pp. 33-46.

Upasena, S.H., M. Sikurajapathy & T. Senaviratna. "A new Cropping System Strategy for the Poorly Irrigated Ricelands of the Dry Zone." Tropical Agriculturist, vol. 136 (1980) pp. 51-58

Upasena, S.H., "The Cropping Systems and Water Management Studies Carried Out at Walagambahuwa Minor Tank Settlement Scheme in the Dry Zone of Sri Lanka." In Piyasena Ganewatte, Douglas J. Merry and Shyamala Abeyratne, eds., Proceedings of Workshop on Water Management in Sri Lanka. Agrarian Research and Training Institute. Colombo. 1982. pp. 64-79.

Uphoff, Norman, M.L. Wickramasinghe and C.M. Wijayarathne. "'Optimum' Participation in Water Management: Issues and Evidence from Sri Lanka." Cornell University and Agrarian Research and Training Institute. 1982.

Weaver, Thomas F. "Problem Areas and Researchable Issues in Irrigation". Department of Resource Economics, University of Rhode Island, Kingston, 1985.

Wickham, Tom. Supplementary Report on Water Management, mimeo, United States Agency for International Development, Colombo. 1978.

The World Bank. Staff Appraisal Report Sri Lanka Second Rural Development Project. Report No. 2942 -CE. 1980

Staff Appraisal Report Sri Lanka: Village Irrigation Rehabilitation Project. Report No. 3363-CE 1981.

/ap