SOME ISSUES CONFRONTING THE REHABILITATION OF MAJOR IRRIGATION SCHEMES IN THE DRY ZONE

A.S. Ranatunge
J. Farrington
W.A.T. Abeysekera

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

SOME ISSUES CONFRONTING THE REHABILITATION OF MAJOR IRRIGATION SCHEMES

- A report arising from pre-investment surveys of conditions at the Tank Irrigation Modernization Project ("Five Tanks") -

A.S.R
J.F
W.A.T.A

Research Study No: 44 **February, 1981**

Agrarian Research &.Training Institute
P.O.Box - 1522
Colombo
SriLanka

FOREWORD

At the request of the Overseas Development Administration (UK) and the World Bank, the ARTI undertook a series of baseline studies at each of the five tanks under the Tank Irrigation Modernisation Project. These studies commenced in 1976-77 and have now all been completed and reports published. They will be followed in due course by a similar set of monitoring studies designed to assess the impact of the modernisation programme.

The publication of the baseline studies aroused considerable interest within the TIMP, among donor agencies and among local institutions. The studies presented a rigorously assembled set of data on a range of issues relevant to tank modernisation which has found interest beyond the immediate requirements of the TIMP.

Towards the end of the baseline studies it was felt, however, that there was a need for the researchers to distance themselves from the details of data collection and to take a broader perspective. Many issues had emerged during the course of investigations which could not be adequately dealt with in the routine of data collection. Similarly, some issues which appeared to be of strong relevance in the later studies were thought to merit at least some attempt at retrospective assessment in those tanks for which the study reports had already been published.

This final volume in the TIMP baseline study series, then, represents an attempt to take a broader view of agrarian and water management problems at the five tanks. It represents in some sense a deeper and more up-to-date "appraisal" of the rehabilitation project. Comments inevitably emerge on the adequacy of the initial appraisal, and some necessary changes in the implementat ion of the rehabilitation programme are indicated. It is hoped that this discussion of the broader issues in tank rehabilitation will serve as useful material for tank modernisation in other parts of the country.

This volume was written by two Research and Training Officers who have been associated with the TIMP baseline studies throughout, A S Ranatunga and W A T Abeysekera and by J Farrington, Colombo Plan Adviser in Farm Production Economics. My thanks are due to them for their attempt.

T B Subasinghe
Director
AGRARIAN RESEARCH & TRAINING INSTITUTE..

ACKNOWLEDGEMENTS

This report draws on data provided by the Staff of the Departments of Agriculture and Irrigation, and on information collected during the baseline studies and the farm power study by our field investigators. We wish to acknowledge with gratitude their cooperation and efforts.

The substance of the report, however, is qualitative rather than quantitative. Ideas were conceived and arguments constructed in discussion with staff and advisers of the Tank Irrigation Modernisation Project. These were modified in the light of comments received from Research and Training Officers and Advisers of the Agrarian Research and Training Institute. Helpful comments were also received from former colleagues at the Universities of Reading and Sussex. The contribution of all of these is warmly acknowledged.

We are grateful to the Director, Agrarian Research and Training Institute, for encouragement and stimulus in the preparation of this volume.

Mrs. M.A.Ebert transformed a pock-marked draft into a neat final proof, which was ably checked by Miss. J.L.Carr.

We acknowledge a debt of gratitude to all of these.

A. S. Ranatunga
J. Farrington
W.A.T.Abeysekera

Colombo, January 1981

CONTENTS

GLOSSARY

AI	Agriculture Instructor
KVS	Field-level Extension Worker
CO	Cultivation Officer
IE	Irrigation Engineer
BOP	Blocking-out Plan
LMC	Lower Main Channel
UMC	Upper Main Channel
TIMP	Tank Irrigation Modernisation Project ("5 Tanks").
Liyadde	The smallest bunded unit within an irrigated field
Yaya	An irrigated tract of land, comprising several farms
Yala	The lesser (South-West) monsoon: October - April
Maha	The (North-East) monsoon : May - September
Bethma	from the Sinhala "bethima"(= to share or divide). A system of (usually Yala) cultivation in which allottees at the lower ends of irrigation tracts are given part of the plots allocated to farmers at the upper ends for a single season's cultivation (usually a half or third share) to reduce conveyance losses when insufficient water is available to irrigate the full command area.
Mudalali	A small businessman having strong economic and social interaction with farmers through the supply of farm inputs and consumer goods, and the purchase of crops.

SUMMARY

In this report we attempt to draw together some of the main agrarian themes emerging from a baseline study of the Tank Irrigation Modernisation Project. The issues are highlighted both for their direct implications for the realisation of benefits from the TIMP investment, and for their broader significance in Dry Zone agricultural development. In particular, we draw attention to certain inadequacies in the TIMP appraisal, indicating the implications that current shortcomings might have for the progress of the project and suggesting alternative courses of action which might reduce the potential loss of benefits from the project. The issues we discuss are thus of prime importance to the future monitoring of the TIMP.

The anticipated benefits from the TIMP are heavily dependent on an increase in cropping intensity, to be achieved both by earlier planting of the maha crop with better use of rainfall, and the widespread cultivation of subsidiary crops during yala. The prospects for achievement of both of these objectives, and the organisational effort they require, are discussed in depth.

We conclude that the issues surrounding early tilling and sowing were not identified with adequate clarity or depth in the TIMP appraisal. One consequence of this ambiguity was the misdirection of investments entirely into tractors, when animal draught, given a programme of research and development into implements suitable for semi-dry cultivation and seeding, would have been available in adequate numbers for timely cultivation at the majority of the 5 tanks. The example of Padaviya is cited, at which data from a current ARTI/Reading University study show that tractors are seriously underutilised, and we conclude that the returns anticipated from this investment will not be fully forthcoming.

We discuss a number of supporting measures in a programme of early cultivation which did not emerge from the TIMP appraisal. TIMP staff at Anuradhapura have, however, come to appreciate the significance of these, and they form an essential part of the current thrust towards early planting at Mahakandarawa and elsewhere. Measures introduced in this programme need to be kept under close observation since they are fundamental to the success of early cultivation.

The relevant components of this programme include :

- the rationalisation of scheme staff functions, so that formerly narrow job demarcations give way to a collaborative effort to meet farmers and act on their problems
- concerted action from those in political authority to stress that tank water will not be issued outside the agreed seasonal limits
- the provision of adequate and timely credit for land preparation, and organisation of farmers into groups to facilitate farm power hiring

Urgent consideration of other measures which could support a programme of early planting and water economy, but have not yet been implemented, is necessary. These include :

- stronger incentives for senior scheme staff to stay at one location for several years, to gain local knowledge by meeting farmers and to put such knowledge to good use.
- parallel programmes of rigorous supervision of such staff, and their training in improved water management and in the agricultural consequences of water-related decisions.
- provision of training and materials to permit a detailed and timely reporting of water availability (including rainfall) within the command area, upon which more efficient water management decisions ultimately depend.
- arrangements to ensure that crop insurance schemes cover a partly-related paddy crop and that adequate compensation can quickly be obtained in the event of crop failure.

The crop diversification component of the TIMP was inadequately identified in the appraisal. Little progress has so far been made in this direction, and no cross-reference to earlier unsuccessful attempts at diversification elsewhere seems to have been made. This is a difficult undertaking which will require a more timely availability of inputs, stronger advisory service, and better organisation of marketing than is commonly observed in the Dry Zone. Above all, farmers will have to become more commercial in their outlook before they will prefer the higher returns, but also higher labour and capital requirements, of non-paddy crops to the relative security of paddy. This, like any other attempt to change aspirations and attitudes, is a long-term process which will require much patient and consistent farm-level advisory work. It will depend for its success on detailed knowledge of soil and water conditions, and therefore, since these may vary substantially even within farms, on close involvement of the farmer himself in cropping decisions.

We suggest that chena cultivation is likely to decline in relative and absolute importance if paddy production systems can be improved and stabilized. The potential clash in labour requirements between the two systems in the early part of the season will thus be reduced.

Highland allotments continue to be largely neglected, and the absence of a development programme for them in the TIMP appraisal implies the neglect of a potentially productive resource. Our analysis suggests that lift irrigation of intensive annual crops, whilst a highly productive use of water is likely to be unprofitable where the installation of a completely new system is concerned. We suggest the promotion of tree crops, with particular attention to the cultivation of papaw (for papain, as currently practised in parts of Padaviya) and mango as candidates for consideration. For the medium term, the cultivation of fodder crops on highland allotments may be a necessary complement to the intensification of animal husbandry. Animal draught is currently managed under low-intensity systems and, with escalating fuel prices, both this and other types of animal husbandry (eg. milk production) might benefit from closer attention in the future.

We analyse the tail end problem in terms of both uncultivated acreages and low yields. From an example at Padaviya we suggest that encroachments in the upper reaches of the command area will lead to higher-than-anticipated water consumption there, with reduced availability at the tail ends. Annual cropping intensities prior to rehabilitation are under 100% at three of the five tanks, and tail end yields are 25% - 50% below those at the top ends. This provides strong evidence of the scope for improvement in agricultural performance, particularly at the tail ends. Current monitoring within the TIMP, however, is not geared to adequate analysis of the project's impact on intra-scheme imbalances and needs to be re-designed.

INTRODUCTION

1.1. Study Objectives

This paper attempts to draw together the individual findings arising from detailed field investigations for the benchmark survey of five major irrigation schemes. This is thought to be worthwhile for two broad reasons: first, the individual baseline reports for the 5 tanks under the Tank Irrigation Modernisation Project were prepared over a time span of some 3 years; only towards the end of this period did the researchers become familiar with the diverse conditions at all 5 Tanks, and the broader perspective arising from this familiarity now presents an ideal opportunity to re-assess the TIMP proposals vis a vis the condition at individual tanks. This report will thus attempt to assess the prospects for achievement of the TIMP agricultural objectives, and to suggest where amendments might be necessary. A particular effort is made to suggest important criteria by which the agricultural progress of the TIMP should be monitored. Second, the rehabilitation of major irrigation works in the Dry Zone is an important component of agricultural development policy, and the lessons arising from the planning and implementation of the TIMP are likely to be of broad and lasting interest.

1.2 Irrigation Settlements in Sri Lanka

The main thrust in development of the Dry Zone during the post-independence era has been through a strategy of expanding the cultivable acreage by opening up new lands under irrigated settlements. This strategy sought to expand domestic food production primarily through improved land utilization in the dry zone, which covers two thirds of the land area in this country. In fact, between 1946 and 1972, paddy acreage increased from 913,000 acres to 1,448,000 acres and much of this is accounted for by the major irrigation schemes. Of the million acres of paddy under irrigation in 1977, the major irrigation schemes, amounting to 118 in number, cover around 400,000 acres in extent.

However in most irrigation schemes, except in those well served with irrigation facilities such as Polonnaruwa district, double cropping is limited and cultivation is only undertaken in the Maha season. Increased cropping intensity, whilst a major concern of development strategy in the past, has achieved only limited success to date. Until recently, the management of settlement schemes had been geared primarily to accommodating a single paddy crop during the year. This results in a long fallow period during the dry season with adverse implications for settlers' living standards.

From a national viewpoint the performance of many such irrigation works has been distinctly sub-optimal. For instance, in some the capital investment made per settler family is estimated at Rs.60,000. Despite sustained efforts over two decades, to develop these settlement schemes, the results achieved are far from impressive. Low farm incomes, poor nutritional levels and subsistence-oriented production methods continue to be a dominant feature of the system. In many cases, often very little or no difference is seen in the living levels of the settler and the adjoining, traditional (purana) village community.

1.3 The Tank Irrigation Modernization Project

Since this presentation is based on research findings related to the Tank Irrigation Modernization Project, it is pertinent to mention briefly some of the salient features of the project. The TIMP was initrated some four years ago following the mixed success of previous efforts to re-vitalise major irrigation schemes. The project aims to improve the living levels of about 10,000 settler families as direct beneficiaries. The Project area covers 31,500 acres of irrigable land located under five major irrigation schemes; Mahawilachchiya, Mahakandarawa, Pavatkulam, Vavunikulam and Padaviya in the north central dry zone of the Island.

Table 1 Demographic and land settlement data for the TIMP

Project Area	Area under paddy (acres)	Total number of households
1) Mahawilachchiya	2,600	889
2) Mahakandarawa	6,000	2199
3) Vavunikulam	6,000	2143
4) Pavatkulam	4,400	1062
5) Padaviya	12,500	4226

The project basically aims at achieving improvements in agricultural production through an intensification of irrigable land use. Assured supply of irrigation water being a critical production input hindering the development of the farming sector, greater efficiency of water use is given a pivotal role in the overall strategy. The approaches directly relating to rational water use in the TIMP can be summarised as :

- Firstly, the early preparation of paddy lands prior to the onset of maha rains and the introduction of dry sowing of paddy. Under the existing conditions land preparation commences only after the initial heavy rains are received. This practice has long been recognised as a method involving a considerable waste of rainfall. In addition, the conventional method of paddy land preparation under mudland conditions requires a large amount of water which is often derived from the stored water in the tank. At some locations as much as one-third of the total seasonal tank water issue is made for land preparation alone. The assumption is that this water could be saved for use for a second crop during yala season.
- Secondly, rigid enforcement of better water management practices through controlled water supplies. As opposed to the present practice of continuous issue of irrigation water throughout the growing season, rotational issues are contemplated, involving at least some night-time issue of water. The importance of having an efficient conveyance system for effective control of water issues is well recognized in this project. Thus a major share of the investment programme is allocated for improvement of the channel system. The range of improvements proposed in the conveyance system includes construction of newer channels whenever needed, lining of channels, provision of gates, control structures and other locking devices.
- Thirdly, a shortage of draught power was also identified as a potentially important production constraint. In fact the project appraisal document postulated this problem almost exclusively as a mechanised power constraint, and proposed a substantial increase in tractor stocks. Assistance in increasing the animal draught stock was not considered.
- Fourthly, as a further means of economizing water use on the

irrigable lowlands, radical changes in cropping patterns during yala were also envisaged. These involved the introduction of non-paddy crops with low water requirement onto lowlands during the dry season. Paddy is associated with water duties as high as 10 acre/feet/acre. Crops such as pulses can be raised on as little as 2 acre/feet/acre.

The implementation of strategies such as these is expected to bring about substantial increases in production through increases in cropping intensity.

As a result of the innovations contemplated, the development project anticipates significant changes in the economy of the areas concerned.

They are:

- Increases in physical area cultivated. As already discussed, this is to be achieved through the removal of production constraints such as irrigation water shortages and problems associated with draught power supplies.

- Enhanced crop yields through stronger extension efforts and timely supply of production inputs. The extension component envisages more intensive coverage by field officers such as the Agricultural Instructors (A.I.) and field level Extension Workers (K.V.S.). The introduction of a team of Subject Matter Specialists represents a departure from the conventional system of Staffing Extension Units.

  This is being done in the hope that this approach would result in greater exposure of farmers to modern technical know-how, which would in turn lead to productivity increases. The communication process between the farmer and the extension worker is expected to be considerably strengthened through greater mobility of extension staff, since the officers are to be provided with transport facilities under the project investments.

- The third major element envisaged in the project for improving the farm economy is to offer better prices to growers for their produce. Improvement of access roads has received a major emphasis in the project investments. This would no doubt facilitate the marketing of produce.

2. MAJOR ISSUES IN TANK REHABILITATION PROGRAMMES

2.1 Agrarian Problems at the Five Tanks : a new perspective

In this section we attempt to identify major agrarian problems, causes and potential solutions on the basis of our experience in collecting information for the baseline studies.This exercise inevitably leads to questions of how adequately the World Bank Appraisal (Report 951a - CE of 1976) identified the constraints to agricultural production. It also leads us to suggest how the initial rehabilitation programme might eventually have to be modified. Even if, in certain cases, the implementation schedule is so far advanced as to prevent such modification, the recommendations we make are likely to be of strong relevance to other rehabilitation programmes for the future.

2.2. Data Base

This paper is heavily dependent on the information gathered during the course of bench mark studies undertaken in the five irrigation schemes referred to earlier. Extensive field studies in the form of farm record keeping as well as questionnaire surveys were conducted in the five settlement schemes during the period 1976-1979. In addition, the close association the authors have with the project areas in general and the numerous discussions they have had with various categories of officers linked with the project during the past three years provided valuable insights into conditions at each of the tanks. This background provided an ideal opportunity for a review of the major problem issues confronting the proposed development project. One of the authors is also joint coordinator of a large-scale study of Farm Power and Water Use in Dry Zone, and part of the argument presented here is drawn from that study's preliminary results (Farrington et al, 1980).

Some of the problems raised here are no doubt manifestations of problems often inherent in many other settlement systems in the Dry Zone. Many are deep-rooted and might be traced back to the evolution of the farming systems in this area. Seeking solutions to such problems is likely to be more difficult than seems at a superficial glance. Hence the need for detailed analysis of issues and problems which this report attempts to meet.

In the remainder of this report, we draw together the evidence relating both to current experience and to the broad validity of the TIMP appraisal under the two main themes of the modernization programme, namely the timeliness of lowland cultivation and the production of non paddy crops in lowland in yala. In this process, a number of issues relating to the farm power situation, irrigation water management, potential prospects for changing cropping patterns in lowland allottments in yala, the role of chena, neglect of highland allottments and some deficiencies observed in the project implementation are highlighted.

2.3 Early Planting and Farm Power

Dry sowing, in place of current mudland preparation and sowing, was regarded as an important potential means of advancing the timing of cultivation and reducing the extent of staggered sowing among farmers. Indeed, if anything, it is this practice which forms the basic agricultural rationale of the TIMP, and which contributed to the perceived need for additional investment in farm power. However, the analysis of this problem was ambiguous in the appraisal document, and there is good reason to believe that it has led to errors in farm power investments. Anticipated use-levels of, and returns to, such investments may not be achieved during project life.

The appraisal document refers to the need to prepare land by mechanical power "a significant portion of it while dry or following the first monsoon rains" (A.3 p.4). Furthermore, it claims that "About 65% of the farmers in the tank areas use four wheel tractors for land preparation ...... Two-wheel tractors and water buffalo are sometimes used as substitute sources of draft power; however, that requires using scarce irrigation water for pre-softening the soils" (p.8). Quite apart from the overestimate of the significance of 4-wheel tractors, on which we expand below, these statements generate a commitment to 4-wheel tractor power which is far from adequately substantiated.

Let us re-examine the "need" for four-wheel tractors, not merely as an academic or hypothetical exercise, but as an attempt to understand how biases can be introduced into a planning process, which will both result in low returns to planned investments and, more generally, may act as precedents for further ill-conceived planning exercises at other locations.

A central ambiguity lies in the proposal to plough "before or on" the first rains. If the soil is to be tilled in a completely dry condition, there can be no doubt that only four-wheel tractors are physically capable of adequate performance. If, however, some pre-wetting by rainfall occurs, (or, a possibility not recognised in the appraisal, if ploughing is done on residual moisture at the end of the previous season) then two-wheel tractors or animal draught are physically capable of tilling, and their acceptance or rejection becomes a matter of economics, not of absolute physical/technical limits. Certainly, and contrary to the appraisal's conclusion, two-wheel tractors or animal draught do not "require" irrigation water to pre-soften the soil.

The lack of clarity in the appraisal document produced a recommendation that farm power investment should be directed exclusively towards mechanical power, with the provision of 150 four-wheel tractors and (somewhat oddly, in view of the comments on their high consumption of irrigation water for pre-softening) 450 two-wheel tractors. Animal power was not to receive any support, in spite of the fact that (leaving aside any potential for use in first ploughing) its use in second ploughing and subsequent operations was very extensive at the fiveTanks[1], and its continued use in this role would not have negative implications for the timing or synchronisation of cultivation.

Whether four-wheel tractors are physically necessary depends heavily on the possibility of introducing completely dry tillage. Let us reconsider the possibilities of alternative systems of tillage at the five tanks and their power requirements :

(i) Completely dry tillage: To the best of our knowledge, this system is not currently practised at the small farmer level anywhere in Sri Lanka. Nor are we aware of experimental work which has demonstrated either its feasibility or its superiority over alternative systems. Whilst its timing advantage may permit more economic utilisation of water, penalties over semi-wet tillage in high fuel consumption, the requirement for more expensive and sophisticated implements, and high depreciation of both tractor and implement might be anticipated. Certainly it would require a very substantial revision of small farmers' attitudes and priorities, demanding replacement of other economic (e.g.preparation of chena lands, grazing of paddy stubble) or non-economic activities (pilgrimages, visiting

---

1. The ARTI/Reading University Farm Power study found that in maha 1979 80 at Padaviya, 63% of sample farmers used buffalo for at least part of the land preparation sequentce. 53% used four-wheel and 16% used two-whee tractors for atleast part of the land preparation. (Farrington et al.1980)

friends and relatives) normally undertaken in the off-season by a clear and coordinated effort in land preparation. We would suggest that this is the most unpromising of the alternative land preparation strategies, and would require much more engineering, agronomic and socio-economic research before any clear commitment of investment in farm power could be given to it.

(ii) Tillage on residual moisture: Again, this is a possibility which seems to have received little attention either at farm level or in research. It would carry the same potential timing and water-saving advantages as completely dry tilling. Yet it would not be exclusively reliant on four-wheel tractors or sophisticated implements, and would be likely to incur lower power source and implement operating costs. Again, it would involve a shift in farmer attitudes away from the view that the immediate post-harvest period should be reserved for festivities, consumer goods spending sprees, and visiting friends and relatives. Such a change in attitudes is unlikely to be rapidly forthcoming, and it is perhaps ironic that the system appears to offer most potential in the maha/yala turn-round, which currently coincides with the period of most extensive annual festivities at the Sinhala/Tamil New Year. An earlier-planted maha crop would, however, bring forward the potential turn-round period to February, well ahead of the April New Year.

In spite of the greater demands that it would place on administrative flexibility (e.g.in the timely provision of seasonal credit), we would suggest that tilling on residual moisture deserves more attention than it has been given in the past. It is particularly relevant after either a maha or yala paddy crop, where residual moisture levels are likely to be high. Staff currently employed at the TIMP recognise this, in spite of its omission from the appraisal report, and deserve support in their efforts. One of the most attractive features of tilling on residual moisture is that it reduces the presure that would be imposed on resources with attempts to plough on the first rains. For instance, where large areas of yala cultivation are undertaken, a residual moisture tilling need be followed perhaps only by a single light tilling at the start of the maha rains, and both could be undertaken by any of the currently - utilised power sources, without the need for exclusive reliance on four-wheel tractors.

(iii) Tilling on the first rains : It is for the maha season that this strategy has strongest appeal : the long dry spell from June to September generally marks a "closed season" and the start of the maha season acts as a bench-mark for the remainder of the agricultural calendar. A late start in maha inevitably delays the start of a yala crop or, if tank water consumption during maha has been too prolonged, may prevent a yala crop altogether. It is on this strategy that the TIMP efforts have so far concentrated. Progress up to 1980 has, however, been slow. At some schemes (e.g. Vavunikulam) it has long been practised in those bottom-end tracts where irrigation water for mudland tillage is not expected to arrive. In others, a more extensive but fluctuating area has been tilled on the rains (at Pavatkulam, 39% of a sample of farmers in 1978-79, but only 29% in 1979-80).

A more intensive effort in maha 1980-81, involving meetings with farmers and power owners, greater coordination among scheme staff, and a revised credit scheme for land preparation, has resulted in 100% tilling and planting on the rains at Mahakandarawa before the end of October, with high adoption on at least one of the other five tanks. Although precise data are not available, the bulk of first and subsequent tillings (at Mahakanadarawa, at least) were done by four-wheel tractor. TIMP staff have suggested that this pattern is not essential to the system: it appears to have been adopted largely on grounds of convenience.

(iv) Mudland Tillage : Since it is only under exceptional circumstances that enough residual water will be available in the tank to permit early mudland tillage, this system appears to offer the disadvantages of delayed maha cultivation with the prospects of reduced areas in yala. In maha the grounds for cultivation on the rains, with minimum use of tank water, are compelling, even where the canal-linking of tanks (as in Polonnaruwa, and as more widely envisaged for Mahaweli) permits abundant supplies of irrigation water early in the season. But in yala, there remain prospects for mud-tillage which seem worth exploring. Several possibilities can be suggested, some involving the yala cultivation of non-paddy crops, where mudland tillage does not come to consideration. But where paddy is to be grown in yala, and adequate water exists in the tank with no possibility of transferring it to other tanks where its marginal productivity might be higher, the opportunity cost of that water is low. Its optimum use may therefore lie in a mudland tillage with transplanting and heavy inputs of fertiliser and agro-chemicals to take advantage of the secure water supply, i.e. in the pursuit of a high-input high-output strategy.

(v) Other Systems: Much experimental work is being carried out in Sri Lanka on zero tillage, a technology which has already gained popularity in rainfed cultivation in parts of Africa. The fact that the technique, with its associated seeding and fertiliser application methods, has not yet been proven for irrigated paddy cultivation in Sri Lanka prevents its detailed consideration here. However, it has strong intuitive appeal, and if current field trials prove successful, it may result in radical departures from conventional tillage practices in the future.

Other cultivation techniques still in the experimental stage, such as "continuous cropping" at the International Rice Research Institute, may eventually be relevant to certain conditions in Sri Lanka, but, again, the fact that they are still unproven here precludes worthwhile discussion in the present context.

Whilst more precise definition of the available tillage/cropping options and their various economic potentials in the diversity of hydrological, soil and water-transfer conditions that exist in the dry zone must await more comprehensive investigation, it does not appear premature to assert that strategies being currently pursued at the five tanks are broadly appropriate in technical and economic terms. An early planted maha paddy crop, following a low input/low output strategy, may be adversely effected by moisture stress in the early stages, and by weed problems (cf. farmers' concern expressed in the baseline survey, summarised in Appendix 1), but any small yield reduction can be borne, since it will have been a relatively inexpensive crop to grow, both to the farmer and, more important, to the national economy, in view of its low consumption of stored water. This can then be followed by high-input yala, with tilling on a combination of residual moisture, rainfall and tank water, to grow either paddy or subsidiary crops, depending on overall water availability. Strategies for other locations with more abundant water throughout the year (e.g.at Uda Walawe, or in the Polonnaruwa complex) may be very different.

What is significant for the present discussion is that there are no technical grounds under this current TIMP strategy for giving priority to one power type over another. The criteria for power selection are economic and more likely to be constrained by organisational capacities (especially in the case of animal draught) than by absolute technical considerations.

There were thus no grounds for the exclusive concentration of TIMP investment into tractor power (and, within this, for the heavy inputs of four-wheel tractors), to the complete exclusion of animal draught. We submit that more adequate investigations and clearer thinking at the appraisal stage would have made this abundantly clear. The future monitoring of the TIMP is therefore likely to reveal tractor use-levels below anticipated levels (for current data for Padaviya, see Appendix 2). With buffalo populations remaining high (over 600 adults per 1000 acres of paddy at Padaviya - see Appendix 2), there will be far more power at the five tanks than is necessary even for rapid tilling on the first rains for many years to come. This saturation of the farm power market, along with private purchases of both tractors and essential spares under the post 1977 trade liberalisation, is reflected in the sale of only 67% of the four-wheel tractors and 30% of the two-wheel tractors envisaged under the TIMP investment.

If late planting continues for the future, despite the efforts of TIMP staff, the reasons must be sought in factors other than the stock of farm power. In Appendix 3 we discuss some of the potentially disadvantageous effects of heavy reliance on four-wheel tractors which should be monitored closely in future evaluation.

We now broaden our discussion of early planting to embrace the organisational support necessary to introduce and sustain a programme of early planting. We maintain that the problem has hitherto been specified in narrowly agronomic or technical terms, with insufficient recognition of the necessary organisational and management context.

2.4 Early planting - the necessary organisational framework

Perhaps the most commonly perceived reason for late planting under current mudland tillage is a shortage of draught power. However, a detailed study has already taken issue with this notion (Farrington et al 1980), and for the TIMP we have already seen that power supplies are now more than adequate. In the search for strategies essential to the long-term continuation of early tilling advantage may be gained from discussing the broader context of continued late tilling in many areas.

In the analysis of why water is used so lavishly in a long and staggered mudland tillage system, perhaps a single main theme emerges, within several distinct contexts. We suggest that this main theme is one of confidence. If farmers do not have confidence that irrigation water will be available to make good any gaps in rainfall during land preparation, they will be reluctant to adopt either a mudland or a more precarious rainfed tillage system. Both the decomposition of weeds and the preparation of the seedbed are largely dependent on a reliable source of water. Improvements to the physical irrigation infrastructure under the TIMP will improve accuracy in the timing and placement of water issues, but we suggest that the main problem is organisational: with a weak water administration authority, farmers are confident that a regular supply of water will be forthcoming only when it has actually started to flow through the channels. Once they have planted their rainfed upland crops, what is the incentive for the individual farmer to rush into rainfed preparation of lowlands? The individual farmer has hitherto been faced with twin disincentives to early ploughing: he knows that (in spite of what water issue deadlines might have stipulated) water will flow at the end of the season until the crops of even the very slowest farmer have matured; he also knows that the potential advantage of extra water availability for a yala crop resulting from early maha tillage will thus have been lost.

Similar questions of confidence and motivation must be posed at higher management levels: even after heavy rain in catchment areas, a major tank will be slow in filling, and the Irrigation Engineer has no incentive to take even the slightest risk of crop failure by issuing water before he is confident of having enough to see the season through. Thus at Padaviya, the tank level started to rise from the 'low' 6'4½" in the early part of October, 1979. By the end of the month it stood at almost 9'0", and by the end of November at 17'5", but the first recorded water issue was on 14th of December when the tank had reached spill capacity of 22'7". To delay for so long until the tank is completely full must represent the ultimate risk aversion strategy on the part of the Irrigation Engineer. In terms of agricultural production, such an approach was an extremely counter-productive tank water issues were delayed and there was no corresponding effort to encourage rainfed tillage. One clear consequence was the lack of time and water for a yala crop in 1980.

It is not easy to make confident recommendations that might permit the late mudland planting syndrome to be broken. Certainly, the problem is chiefly an institutional/organisational one and is less amenable to solution by injections of capital

There is thus a potential vicious circle: farmers will only risk planting on the rains if they are confident that water will be supplied to see the crop through, and that the added benefit of water for a yala crop will be realised; Irrigation Department Staff have nothing to gain by risking an early start to water issues if they subsequently have to lose face by discontinuing water supplies when the tank threatens to run dry. So long as some farmers drag their heels and plant late, there is the danger that end-of-season issues will be continued to accommodate them, with the loss of potential yala water.

The components of a management strategy for early planting thus emerge:

(i) A network of persuasive forces which will impress upon farmers that it is not only in the national economic interest, but ultimately also in their own, to plant early and improve the prospects of a yala irrigation. Such a network would be dense enough in the field to single out any recalcitrant farmers, identify the causes of their delay and where possible, overcome them. A concerted effort along these lines has been made for the maha 1980-81 at Mahakandarawa. It has involved extensive dismantling of the boundary between the conventional spheres of interest of scheme staff. The staff from several Departments (Agriculture Department Extension Workers and Agriculture Instructors; Irrigation Department Technical Assistants; Colonisation Officers, Cultivation Officers) have been pooled into a single entity. From this have been drawn 5 teams, each chaired by a Colonisation Officer as the Government Agent's representative and each being allocated a specific tract or group of tracts. Within this area, each team member takes responsibility for a sub-area. Teams have the responsibility of explaining all the ramifications of the early planting programme to the farmers within the tract, and each team member liaises with Vel Vidanes (Irrigation Headmen) within his sub-area in a two-way information flow. All team members, regardless of their specific functions, are responsible for promoting the early planting programme. Additionally, interaction among the team members is anticipated to increase the effectiveness of their specific spheres of duty.

Information from team members is passed to farmers either directly, or through Vel Vidanes (selected by Tract Committees of farmers). The Farmer Groups previously proposed for the TIMP have become widely defunct.

(ii) Concerted action from those in political authority to publish final dates of water issues from the tank for each season and to indicate that no pressure from farmers to continue beyond that date will be entertained. Again, at Mahakandarawa, (and, for maha 1980-81, throughout dry zone major irrigation) this has been secured in the form of a jointly-signed circulation from the Secretaries of the Ministry of Agriculture Development and Research and from the Ministry of Lands and Land Development.

(iii) An assurance to farmers that a partly rainfed crop will be covered under present crop insurance arrangements, (which normally only cover fully irrigated paddy) and that speedy and effective procedures exist for settling claims.

(iv) Adequate training of senior Irrigation Department staff in water-conservation practices (such as impounding rain-water within the canal system before water issues start) and the generating of a stronger awareness among them of the agricultural consequences of their water-issue decisions. This can be brought about only slowly, and depends heavily on the personalities of those involved. With a strong Project Leadership and Advisers' Team at TIMP headquarters some progress seem likely. Without this "umbrella", progress in this area is likely to be much slower.

(v) Provision of adequate and timely credit to permit payment for farm power services. There is some uncertainity over the need for seasonal credit in the medium or long term in relatively prosperous settlements. Certainly, though, credit will be an essential step in achieving an initial synchronisation of land preparation. Unfortunately, seasonal credit has also been plagued by a high incidence of repayment default, with the result that the majority of farmers are no longer eligible for seasonal credit in many locations. At Mahakandarawa this has been overcome, initially at least, by the issue of a reduced credit to defaulters. Arrangements have also been made to prevent the misuse of credit funds by making payments directly to farm power owners. Whether a high level of repayment can be achieved which is replicable across other locations remains to be seen.

(vi) Efficient group organisation of farmers. Attempts at the TIMP in maha 1980-81 to arrange hiring of the same power unit among several contiguous paddy allotments is thought to have increased power use-efficiency, since time is no longer lost in searching for hire-work or in travelling long distances between farms. The group of farms thus established normally occupies a single irrigation turnout. Apart from increased efficiency in power use, its functions are also intended to embrace more equitable water allocation within the group and improved performance in credit use and repayment through "group guarantees". The groups are also seen as a useful entity in a two-way flow of communications.If they succeed in their present objectives it is possible to conceive of various additional functions, such as the purchase and distribution of fertilizer and the marketing of both paddy and subsidiary crops which would contribute to production efficiency in the medium term.

Two common themes emerge from this discussion of early tilling strategies: on the one hand, they indicate the complexity of issues underlying the continued practice of mudland tillage, which have to be resolved for successful introduction of early planting. Yet the organisational efforts necessary to overcome them were largely neglected in the TIMP appraisal, so that anticipated project benefits will be delayed.

On the other hand, they indicate the massive organisational effort on the part of TIMP staff and advisers which has been necessary for the achievements at Mahakandarawa in maha 1980-81. Whilst these are a tribute to the energy with which objectives have been defined and pursued, it remains uncertain whether this level of effort can be:

- attained at other locations without the co-ordinating influence of an organisation such as the TIMP,
- sustained within the TIMP with inevitable changes in Sri Lanka staff and the reduction in expatriate advisory services.

The supporting strategies that we have listed above are essential to a continued adoption of early planting. They are placed on record here for two reasons: first so that it will be understood in future monitoring and evaluation why the benefits attributable to dry tilling have been slow to materialise, and secondly so that the progress of these and any other organisational innovations can be kept under close observation. It seems unlikely that early planting will continue beyond the short term if these supporting efforts are not sustained.

2.5 The Timeliness of Cultivation - some conclusions

The arguments in this sector are complex, often necessarily reaching beyond the immediate scope of land preparation systems, and to some extent, are necessarily tentative.

We believe, however, that sufficient justification is at hand from empirical observations and from a priori argument the following set of conclusions:

i) The TIMP appraisal report, whilst commendable in its emphasis upon introducing greater efficiency into the use of private and public resources at land preparation, was ambiguous in its advocacy of dry tillage and erroneous in the contingent proposals to inject substantial additional tractor resources into the five tanks. In both cases, the costs and benefits of alternative systems (including for instance, animal draught with improved implements suitable for rainfed tillage and sowing) were not sufficiently explored.

ii) We believe that the root of the problem in late and staggered land preparation is psychological and organisational. Both farmers and administrators have, perhaps through a combination of previous mishaps and as a result of inadequate incentives to do otherwise, fallen into a strongly risk-averse strategy of late water issues, delayed start of land preparation until water issues are made and inadequate time and water for a second crop. Whilst risk aversion of this kind is rational within the perceived sets of objectives and constraints of both farmers and administrators it remains a low-productivity strategy. Escape from this security orientation is possible only by administrative reforms adequate to make full use of the water management potential that a rehabilitated irrigation system offers, and to restore farmers' confidence in the working of the system.

In this connection, there is no substitute for an energetic and highly motivated scheme staff, who are prepared to gain intimate knowledge of the system, to meet farmers out in the field, to gain their confidence by dealing promptly with the problems they raise and to encourage them to till and plant on the rains. At the most basic level, such staff must be prepared to stay for long enough in one scheme to put such knowledge and confidence to good use. Unfortunately, such highly-motivated staff are at present very thin on the ground, and increasing disparities between current salaries and potential overseas earnings are likely to make their recruitment and retention increasingly difficult. Adequate recognition through appropriate salaries of the strategic national significance of those who manage irrigation systems of several thousands of acres is long overdue. In the meantime, a combination of more rigorous supervision of (particularly) Irrigation Department Staff, and long-term training in the agricultural consequences of water management decisions,is essential. At the TIMP, formal training and supervisory programmes do not appear to exist. Whilst these requirements may be met in the short term (e.g. through the expariate advisers), the fact remains that the TIMP should recognise the importance of - under a broad heading - "improved management" in making full use of the rehabilitated infrastructure. This would best be done by designing and implementing long-term programmes of training and supervision of scheme staff. Injections of capital are only peripherally relevant to the solution of problems such as these.

iii) The pre-conditions for successful implementation of rainfed tillage were not fully identified in the TIMP appraisal. Current efforts to achieve extensive rainfed tillage for the 1980-81 maha at the TIMP deserve detailed evaluation against the set of preconditions identified in this report.This listing in itself is by no means exhaustive, nor can it be applied uniformly across the diverse major tank conditions in the dry zone. What our arguments have suggested is that the TIMP appraisal report was too narrowly concerned with the physical parameters in land preparation such as tractors (which, incidentally, are the most easily remedied by foreign investment) Organisational issues, whilst much more difficult to resolve, are strongly relevant to early land preparation, and yet were almost completely disregarded in the appraisal. In particular, the bias of TIMP farm power investment towards tractors, contrary to the assumptions of the appraisal, was not a sufficient condition for early tilling. We would go so far as to suggest that it was not even a necessary condition. The implications of misplaced heavy investment in tractors are twofold: first, the benefits anticipated from this investment are not likely to be achieved. Second, certain negative repercussions of a broader kind, primarily relating to the access/ownership distribution of land, might be anticipated. These are elaborated upon in Appendix 3.

We have already stressed the need for a vigorous and systematic programme of training and supervision to enhance management ability. A further requirement to which inadequate attention was given in the TIMP appraisal is that of improved information flow to facilitate accurate and detailed decisions. It would be impractical to enumerate here the full range of data that might be collected, but two basic parameters call for urgent attention : one is the timing and distribution of rainfall within a command area at critical periods; the other is adequacy of channel or field-to-field water flows over the scheme. Efficient regulation of water in main and distributary channels can only be achieved if adequate information on local water availability is forthcoming. A functional surveillance system will, in turn, depend on the adequate allocation and enforcement of staff reporting schedules (and of covering duties). Its efficiency may be enhanced by a network of motorised transport and radio communications.

3. THE CULTIVATION OF NON-PADDY CROPS

3.1 Background

The TIMP appraisal proposes the irrigated cultivation of some 8,500 acres of pulses and cereals, principally on well-drained lowlands in yala. This is proposed as a major factor in increasing cropping intensities. In this, it follows early efforts (e.g. at Elahera and Uda Walawe) to persuade farmers to cultivate upland cropping in paddy fields during yala. The Uda Walawe experiment already documented (by e.g. Farrington, 1979) is not a success story.Cultivation of irrigated cotton, for instance, which started in 1973, was scheduled to reach 9,710 acres by 1977, but only 820 acres were planted in that year and acreages have subsequently declined. At Elahera, in spite of the pressure under the Special Projects Programme,initiated in 1967-68, to cultivate non-paddy crops under irrigation in yala, by 1970-71 less than 8% of the yala cropped area of 827 acres was under non-paddy crops (Jogaratnam, 1971). The cultivation of non-paddy crops under the same Programme at nine further major irrigation schemes was similarly negligible. It is somewhat surprising that the Appraisal Report contains no reference to these early failures.

Since the irrigated production of subsidiary crops on paddy fields forms an important component of the TIMP strategy to make more productive use of water, it is worth devoting some attention to the issue to predict likely sources of failure, to attempt to suggest how they might be remedied, and to press for a downward revision of performance expectations in subsequent evaluation, largely because of initial under-estimations of the size and scope of the problem. This leads into a general discussion of land use within the TIMP.

3.2 Irrigated Production of subsidiary crops

The following context and potential problems can be identified:

(i) The traditional form of production of non-paddy field crops in the Sinhala-speaking parts of the dry zone is under rainfed slash-and-burn (chena) conditions, involving minimal use of production inputs and requiring a shifting form of cultivation as soil fertility declines and weeds become unmanageable. Intensive irrigated production of non-paddy crops is altogether a new concept to farmers in the five tank areas except in Vavunikulam.

The first problem with which the farmers are faced in proposals of this kind is therefore one of unfamiliarity. Farmers have to be first convinced of the economic benefits of field crop production in lowlands under irrigation. Secondly, the necessary skills and knowledge about new practices have to be imparted. Farmer responses collected in the Mahawilachchiya baseline study show a lack of farmer interest in this regard. Some preliminary extension work in the form of demonstration plots had been carried out there with much perseverance and State assistance in 1978-79. However, in the following year hardly any farmers had introduced irrigated upland crops in the lowlands.

(ii) The prospects for subsidiary crop production, particularly in the last decades have been, impaired by inconsisent and disjointed policies. Since Sri Lanka is not self-sufficient in the majority of subsidiary crops, the price, quality and volume of imported crops has a strong bearing on local producer incentive. The inter-relationship between local and international markets has not consistently been taken into account in the design of import policies. In fact, it would be erroneous even to suggest that an import policy has been designed and consistently applied; subsidiary crops have been imported in an ad hoc fashion to meet anticipated shortages. Narrow division of departmental responsibilities within the Administration have contributed to the confusion. Whilst recent efforts appear to have been made to come to grips with the problem, it remains to be seen whether these will be successful.

iii) Paddy, as the sole significant irrigated crop, is in many ways a poor starting point for subsequent irrigated cultivation of other crops: it can withstand inundation, whereas most other crops demand a much more precisely-regulated water regime both in water supply and in drainage; paddy plant densities, through tillering, are to a large extent self-regulating, whereas more precise spacing is essential with other crops; water can to some degree be used as a weed-suppressant with paddy, whereas other crops require manual or chemical weeding, in addition to higher labour inputs for a range of other operations.

(iv) The strong local demand for paddy for domestic consumption, the ready availability of marketing outlets, both public and private, for this commodity together with lower labour and cash inputs compared with most other field crops, act as a strong motivating force for most dry zone farmers to choose paddy for lowlands whenever even limited water becomes available for cultivation purposes. In contrast, in the case of most other field crops, the local demand is much less strong and proper marketing outlets at farm level are largely lacking. Consequently, disposal of perishable produce poses severe risk. Up to now in the five tank areas, even the State sponsored production programmes have failed to grasp the full implications of problems associated with marketing of farm produce other than paddy. For example, in the case of large scale demonstration plots established with other field crops in paddy fields in yala, such problems have arisen but have not been tackled. For these reasons it is doubtful whether extension messages will elicit the desired response from farmers.

(v) The evidence gleaned from a wide cross-section of farm surveys suggests that the Sinhala small farmer has strong preferences for crops with clearly-defined labour requirements which are low overall. (Fieldson, forthcoming). Even at low level of farm labour input, a preference for spending time on social interaction may begin to outweigh any perceived need for its allocation to economic activity.

Again, the high potential return to land which irrigated subsidiary crops offer may be of little attraction to the farmer unless the returns to labour are also high. Farrington's (1979) analysis of one subsidiary crop (cotton) suggests that returns to labour are critically important to the small farmer. The fact that cotton, even under optimistic yield assumptions, could not compete with paddy in return to labour contributed strongly to its failure.

The list could probably be expanded, but enough has already been said to suggest that, whilst irrigated subsidiary crop production is an attractive strategy in terms of returns to publicly-owned resources (land and water) it is not so attractive to the farmer, and will require a high degree of organisation of services, a well informed and diligent extension effort, and favourable pricing of inputs and output to establish even a foothold among the bulk of Sri Lankan farmers. If, as the evidence suggests, they place a high shadow price on the value of their own labour and prefer crops with low overall labour requirements, then even these measures might prove inadequate.

The TIMP appraisal contained only fragmentary reference to issues such as these, and it seems unlikely that the measures conceived in the appraisal will be adequate to promote irrigated cultivation of 8,500 acres of subsidiary crops on paddy fields even if farmers can be assumed to have the necessary interest and motivation.

Indications from the baseline studies are that farmers lack both enthusiasm and previous experience in other field crop production in paddy fields. The achievement of even moderate success in the cultivation of other field crops will require a massive effort in persuasion and coordination. Strict water control will certainly have to be used as an instrument of persuasion in the early stages. Of particular relevance to the TIMP is the need to organise pre-season water decisions on a footing more appropriate to the requirements of subsidiary crops. In particular, decisions on water allocation need to be taken much earlier than at present if input supplies for subsidiary crops are to be organised before the season starts. Whether the high returns to land and water attributable to cultivation of subsidiary crops can generate autonomous interest among farmers in the longer term remains to be seen.

3.3 Chena Cultivation

There are numerous important interactions between slash and burn cultivation and other components of the farming system, viz. paddy farming and the settled cultivation of (rainfed or irrigated) upland crops. In particular, these various activities may compete for the same farm inputs (especially labour) under existing or proposed farming system. Here it is possible only to sketch out the main characteristics of chena at the 5 Tanks and to suggest how it might interact with such proposed innovati‹ion in paddy farming as early tilling. Of the five settlement schemes included in the tank modernization project, Mahawilachchiya and Mahakandarawa are unique in that chena cultivation plays a dominant role in settler income. In particular at Mahawilachchiya 90% of the settlers had engaged in chena farming in the maha season. Chenas cultivated here conform to the traditional long cycle chenas seen in the North Central Dry Zone. At Mahakandarawa only a third of farmers had engaged in some form of chena cultivation. Here, black gram is almost the sole crop grown and the land is essentially used in very short cycle chenas - almost constituting settled cultivation. In Padaviya the incidence of chena was considerably lower - only in 6% of the sample farms. Besides, the chenas at Padaviya are generally large and are concerned more with cultivation of highland paddy.

The importance of chena in the farm economy of settlers in places such as Mahawilachchiya and Mahakandarawa is indicated in many ways. For instance, in Mahawilachchiya, income from chena constitutes three quarters of the gross income in yala, and one-third in maha. In terms of cash chenas provide half the total cash earnings of the settlers in both yala and maha seasons at Mahawilachchiya.

Chenas, apart from providing reasonably high levels of cash income to the farm households also make a valuable contribution to the settler economy by generating a regular cash flow over a much longer period than does paddy. In the case of paddy, though the income is much larger, it is restricted to one particular point of time and that too only in maha. In this respect chena with a multiplicity of crops maturing at different times provides quite a contrast with the income flow stretching out for a much longer period. In cash deficient economies such as the present case, this type of staggered cash flow is certainly an added advantage. In addition, the type of chena cultivation practised here uses hardly any cash inputs. The major production input involved is the farmer's family labour, most of which is used for land clearing and preparation. These operations are undertaken at a time when employment opportunities for farm labour in other spheres of activity are currently non-existent. In other words, under present cropping calendars, the opportunity cost of family labour-use in the initial activities in chena is almost zero.

Looking across the study areas there appears an interesting correlation between the incidence of chena and the degree of certainity of raising a successful paddy crop on allotted lowlands. At the one extreme, Padaviya, with favourable water supply conditions, is assured of water for a full cultivation of allotted lowlands in maha and at least one acre of lowlands in yala. At this location, despite the availability of jungle lands suitable for chena farming in the neighbourhood of the settlement scheme only 6% of the settlers were found to be engaged in chena work in the maha season. At the other extreme, both at Mahawilachchiya and Mahakandarawa, with the heavy risk of inadequate water for lowland paddy cultivation, settlers are heavily involved with chena work in the maha season. At Mahawilachchiya in particular where lowland cropping is fairly regular but yields very low, the settlers commute long distances (4-7 miles) to chenas from the homesteads. Of the other schemes, at Vavunikulam, settlers having access to lift irrigation facilities are preoccupied with cash crop farming on highland allotments in maha season.

Data presented in the baseline studies on the timing of chena cultivation tend to confirm the TIMP appraisal's anxiety that concentration on chena activities would tend to conflict with attempts to bring forward the start of the paddy season. (cf. Mahawilachchiya report).This may have particularly adverse implications for the introduction of early tillage on the first rains.

Yet, if our suggestion that chena activity diminishes with increasing stability of lowland production is correct, the enhanced incomes from paddy that the TIMP envisages may lead farmers to reduce their chena involvement with little resistance. It is conceivable also that other land development policies aiming to stabilise established chenas and to curtail the destruction of heavy forest will contribute to a reduction in chena activity. Much will depend on whether farmers can be convinced that the TIMP's innovations will generate substantial and sustainable improvements in farm income. If they can, a transfer of resources from chena to early preparation of lowlands will be easily achieved, as experience at Mahakandarawa in maha 1980-81 has shown. Whether similar transfers can easily be obtained elsewhere remains to be seen. Mahawilachchiya, with its currently heavy involvement in chena, will be the most critical test case. Whilst we suggest that chena activity is likely to decline in significance in the vicinity of the 5-Tanks for the future, the prospects for intensification of cultivation on settled highlands remain to be examined.

3.4 Cultivation of settled highlands

Highland allotments in the 5-Tanks account for some 21,000 acres of land, yet in four of the five Tanks, the proportion of gross annual income from highlands (mainly from the sale of tree crops) is low: at Mahawilachchiya it is 6%; at Mahakandarawa and Padaviya 11% and at Pavatkulam 15%. Only at Vavunikulam, with intensive cultivation of highlands under lift irrigation, is the proportion of income derived from highlands substantial (70%). At the other four schemes, highlands tend to be left under low-intensity tree crops. Some rainfed cultivation of paddy is practised on highlands, particularly in areas whose location might permit them to benefit from accumulation of drainage water or from illicit access to supplementary irrigation from channels. Vegetables and pulses are sometimes grown on the kitchen garden scale, but other potential uses of highlands, for instance, for livestock production, are almost totally neglected.

We suggest that current use-patterns of highlands constitute a serious under-exploitation of land resources not identified in the TIMP appraisal, and explore below various options for their more efficient utilisation.

3.4.1 Lift Irrigation

By far the most costly and most intensive use of highlands would be the replication of the Vavunikulam lift irrigation. By contrast with gravity systems, lift irrigation is widely held to provide high returns to water, yet doubts have arisen as to its profitability with the recent escalation of fuel prices. It would be inopportune here to digress too widely into the economics of lift irrigation, but simple analysis of data readily available at the Vavunikulam Irrigation Engineer's office yields interesting results.

At Vavunikulam, a total of seventeen 6" and 8" pumps were installed in 1973 by the Irrigation Department (5 and 12 on Left and Right Banks respectively), with a total commanded highland area of 868 acres (L.B.=310; R.B. = 558). The pumps are generally utilised between February and September to supplement rainfall and permit cultivation of chillie and onion crops. Owing to rehabilitation works, only the R.B. pumps operated in 1980, irrigating a total of 182 acres of chillies and a similar area of onions. Precise areas of the respective crops are difficult to demarcate, since some interplanting is practised, but the

Table 2

Budget for an acre of chillies under lift irrigation, Vavunikulam 1980

1 At market prices

Lift irrigation costs –	labour	288.46
	repairs/spares[2]	46.43
	fuel & lubricants	836.65
Material inputs		4161.73
Labour inputs[3]		3770.88
Total costs/acre		9104.15
Gross revenue/acre (10 cwts at Rs.10.50/lb.		11760.00
Net revenue/acre (after deducting imputed family labour cost)		2655.85
Net revenue/acre (not deducting any family labour cost)		5169.77
Net revenue/man-day of family labour (not deducting any family labour cost)		40.39

2 At shadow prices[4]

Total costs/acre	11267.75
Gross revenue/acre	11760.00
Net revenue/acre (after deducting imputed family labour cost)	492.25
Net revenue/acre (not deducting any family labour cost)	3006.17
Net revenue/man-day of family labour (not deducting any family labour cost)	23.49

Notes:

1 Irrigation cost data supplied for 1980 by I.E., Vavunikulam. Other input cost data adapted from Department of Agriculture Cost of Production Studies, 1979-80, for chillies in Jaffna (mainland). Yields assumed to be 10 cwt/acre, given in Vavunikulam baseline report, and farm gate price taken as Rs.10.50/lb. (ARTI, Market Research Unit, pers. comm.)

2 Since the lift irrigation system at Vavunikulam was installed some 15 years ago, it is assumed that the capital value of the infrastructure has already been written off, and that the only expenditure on capital items is that of repair and spare parts to keep the system running.

3 Including family labour. All labour is costed at Rs.19.64/day (Department of Agriculture 1980). At Vavunikulam, it is assumed that total labour input will be 192 days/acre – 10 days less than the Dept. of Agriculture figure because part of the water management function is performed by Irrigation Department labour. Of the 192 days, two-thirds are assumed to be provided by the family, following findings of the baseline survey.

4 To remove such market distortions as fuel and fertilizer subsidies, market prices are multiplied by a set of (albeit very crude) weights, as follows: fuel and lubricants x 2; fertilizer x 4; tractor x 1.5.

total area irrigated in 1980 was 364 acres, and a simple budget is drawn up below (Table 2) for lift irrigating an acre of chillies using 1980 actual costs for the R.B. system, and 1980 cost of production and returns data obtained from another source.

Our analysis suggests that it would remain profitable at market prices and (albeit crudely imputed) social values to continue operating the Vavunikulam lift irrigation scheme. The installation of a completely new system would, however, involve much higher costs which would render the exercise unprofitable. Recent costings (Huntings,1980) suggest that with higher assumed crop yields than observed at Vavunikulam, a new 50 - hectare lift irrigation unit would yield a Net Present Value of Rs.978,600, or Rs.396.60/acre/year over a 20-year life at 12% discount. This is considerably lower than the estimated return to alternative enterprises, mainly based on tree crops which have the added advantage of low management requirements.

A broader question of motivation and feasibility should also be raised regarding the prospects for intensive production of highland crops through lift irrigation at the other 4 Tanks. As discussed earlier, there is very little tradition of irrigated production of non-paddy crops outside the north of the Island. Our discussion of the prospects of cultivating irrigated subsidiary crops in paddy lands during yala also touched upon issues of motivation. Whilst there is abundant evidence that farmers in those areas with a tradition of irrigated subisdiary crop production are able and willing to invest the necessary expertise, capital and labour in, for instance, chillie production, there are no explicit grounds for such optimism in other areas. It would thus appear particularly unwise to risk undertaking what appears to be at best an only marginally profitable investment in lift irrigation in areas where the necessary motivation and experience may be lacking.

3.4.2 Perennial crops

There are several factors which militate against successful introduction of annual crops on rainfed highland allotments. Apart from the vagaries of rainfall, these include heavy input costs, and a strong demand for labour when it will be needed in paddy cultivation. For the subsistence farmer, the risks and effort inherent in settled highland cultivation appear to be too great and this explains to some extent the lack of success of highland development programmes hitherto. A consideration of the physical and economic environment of the settler shows the desirability of introducing crops which exhibit adaptability to a wide range of soil moisture conditions. The introduction of seasonal crops sensitive to soil moisture stress would be less than satisfactory. The study locations appear subject to extreme drought conditions once in 4 - 6 years. During such droughts it is not uncommon to see mature tree crops such as coconut and jak withering away. Despite extreme drought conditions some tree crops such as mango, papaw, cashew, tamarind and castor seem to be well adapted to the environment. Furthermore, in many of the highland allotments investigated,soil management had received scant attention so far, resulting in considerable erosion of top soil with resultant loss of fertility. This again militates against the successful introduction of rainfed annual crops. In risk-prone environments, it is clearly those crops with low cash and management requirements that will appeal to farmers

Based on the above reasoning, a programme for expansion of permanent and semi-permnent crops on highlands, deserves consideration. Field observations indicate that crops such as papaw, mango, cashew and castor have a high comparative advantage at the study locations. Possibilities also exist for inter-cropping mango with crops such as banana, lime and papaw. All of the above crops have moderately low labour requirements and hence would also have the added advantage of not distracting the family labour from their lowlands during peak demand periods.

Therefore as an alternative to lift irrigation we would advocate measures designed to obtain rather lower productivity levels from highlands in the remaining 4 Tanks, but which, nontheless, raise productivity substantially above present levels, and at the same time are compatible with the aspirations of the settler communities.

Such a production strategy could take several forms. All, however, will have to depend on rainfall only. Perhaps the best feasible system is already being practised in parts of Padaviya where small areas of tree crops are under cultivation. The principal innovation here is the planting of papaw for papain production, which has a ready market in urban areas, and a high value: weight ratio. It is also relatively unperishable - all desirable qualities for crop production in such remote areas.

Under existing conditions, cost of cultivation of papaw for papain production is negligible. Apart from sporadic weeding required in the early stages of crop growth, the chief labour requirement is for "tapping" each fruit on (approximately) a weekly cycle over two-year life of the trees. Planting material is virtually cost-free. On the other hand, the returns from this enterprise are quite attractive. With plant densities about 400 trees per acre, gross incomes from papain in 1980 are estimated around Rs.2500 - 3000 per acre in Padaviya. This represents a substantial addition to the family farm income.

Another possibility is that of fruit production. Mango trees, for instance, are known to withstand excellently long periods of drought and the fruit has the advantage of expanding market prospects. On the other hand, it suffers the disadvantage of extreme seasonality and perishability. From the seventh year onwards a matured tree is capable of yielding around 400 lb. and with a farm gate price of 40 cts a lb, an acre (with 35 to 40 trees) would yield gross incomes of Rs.5000 - 6000 per annum. Such incomes have the added advantage of not requiring heavy production costs. An efficient marketing network would have to be established to cope with the peak production season, not to mention the effort necessary to distribute appropriate seedlings and extension advice. A substantial demand for both mango and planting material appear to remain unfilled due to supply bottlenecks. Thus a conscious attempt to overcome such shortcomings is a pressing need. The distribution of planting material, particularly for fruit trees, needs far better organisation than at present.

3.4.3 Fodder production

Finally, the possibility exists for rainfed production of high-protein animal feeds on highlands. The influx of tractors at TIMP has probably pre-empted the case for intensive draught animal production, at least for the short-term. Arguments have been advanced for its promotion in the medium term (Ceylon Daily News, 13-14/11/80) and TIMP monitoring exercises may wish to keep under review the prospects for improved draught animal production in the currently unstable fossil fuel market. Current proposals for the development of animal draught elsewhere (eg. in Mahaweli System "A"; Agrar and Hydrotechnik, pers. comm.) may with advantage be considered by the TIMP in such eventualities.

3.5 Non-paddy crops - some conclusions

Our discussion of the cultivation of non-paddy crops raises a number of issues which suggest that performance should not be expected to reach appraisal targets, largely because of excess optimism in drawing up the initial cropping programmes. We would contend in particular that there is no evidence to suggest that proposals for the TIMP settlers to cultivate 8500 acres of subsidiary crops under gravity irrigation in paddy fields will succeed where numerous previous attempts at other locations have failed. We anticipate a decline in the significance of chena cultivation with increasing reliability of lowland cultivation and in response to efforts to stabilise and restrict shifting cultivation. The only area for optimism lies in the more efficient use of highlands, probably under tree crops, since their high security/low input/low payoff characteristics appear to conform best with settler aspirations within a risk-prone environment. A vigorous draught animal improvement effort could utilise part of the highland for fodder production, (possibly from crop residues) and this may become an increasingly attractive option with rising fuel prices, and a rising age-profile of tractors. However, it requires substantial forward planning, and the development of contingency plans even at this stage may not be premature.

4. THE TAIL END PROBLEM

The characteristics of under-exploitation of the potential irrigation infrastructure in the lower reaches of command areas are familiar enough: delays in the timing of water issues, frequently exacerbated by the need to fill intermediate storage (often purana tanks) within the channel network before water can pass downstream; inadequate volumes of water when it finally does arrive, excessively long gaps in the irrigation schedule; damaged structures and uncleared channels, resulting from frustration and apathy among farmers and officials alike, and so on. Given the TIMP objectives of providing a more equitable water distribution (Appraisal, p.9), the extent to which the tail end problem can be alleviated as a result of the modernisation will act as a direct measure of the TIMP's success. It is therefore an important criterion for future evaluation.

Below we attempt to quantify the gap in farming performance between top and tail ends. Second, we attempt to analyse in more depth the causes of the disparity.

4.1 The gap in performance between top and tail ends

An absolute non-availability of irrigation water (or a high risk of its non-availability during the season) will generate an extreme form of the tail end problem - i.e. complete absence of cultivation. Less severe water shortages may contribute to a reduced cropping intensity, particularly in yala, and/or to reduced yields in those areas that are cropped. An overview of the problem can only therefore be obtained by considering all three symptoms: uncultivated areas, low annual cropping intensity and reduced yields. Let us consider these in turn:

4.1.1 Low cropping intensity and uncultivated land

Readily-available data on cropping intensity at the 5 tanks are summarised in Table 3 below. The situation is clearly critical, with only two of the tanks obtaining more than the equivalent of one crop per year.

A tract-wise breakdown of planted acreages would provide deeper insight into the problem. However, this is not readily available for most of the 5 tanks. For Padaviya, a breakdown has been attempted by Farrington et al (1980) and is reproduced in Table 4. The total actual acreage for the scheme as a whole does not differ markedly from the BOP estimate, but wide differences within the command area exist, encroachment in the upper tracts generally resulting in a larger actual than planned acreage (and therefore consuming more water than anticipated) and unirrigable areas in the lower tracts resulting in the non-cultivation of large areas initially designated for cultivation.

4.1.2 Yield disparities within command areas

Various sources of data exist to permit analysis of yield variations between top and tail ends. These are drawn together in Table 5. The data are both incomplete and season-specific; some caution is therefore necessary in their interpretation. However, they suggest trends which correspond with what might be expected from existing knowledge of those tank characteristics relevant to yields. Perhaps, above all, they indicate the diversity of conditions among the 5 Tanks. At Mahawilachchiya, for example, the short main channels (each under 5 miles) and relatively favourable ratio between normal tank volumes and command area result in little variation in yield between top and tail ends. Some difference emerges within the L-B, but the extent to which irrigation inadequacies might be responsible has not been established.

At 3 of the other tanks, a trend of declining yields with

Table 3 : Summary of planned and actual paddy acreages at the 5 Tanks.

	BOP Acreage	Maha 1978-79 planted acreage[1]	Yala 1980 planted acreage[2]	% Annual cropping intensity (actual/ BOP x 100)
Mahakandarawa	6000	3649	nil	61%
Mahawilachchiy	2600	2514	1400	151%
Padaviya	12500	12500	nil	100%
Pavikulam	4400	2637	nil	60%
Vavunikulam	6000	4196	1070	88%

Notes:

1. Provided by TIMP, Anuradhapura. These Maha data are thought to provide a good indication of normal Maha cropping intensities.

2. Yala data give an unduly unfavourable impression at some locations: thus at Padaviya, some 4000 acres are normally cropped in yala under bethma. This would raise the annual cropping intensity there to 132%

Yala data provided by M. Long, TIMP, Anuradhapura.

PADAVIYA

Table 4 Acreages planned for irrigation and actually irrigated in a typical maha season, by tract[1]

Tract No. Lower Main Channel	Paddy acreage envisaged in blocking out plan	Acreage un-irrigable or abandoned	Acreage encroached[2]	Actual acreage irrigated in a typical Maha.
1	123	9	40	154
2	453	5	120	523
3	261	60	30	231
4	108	12	15	111
5	624	50	30	604
6	2097	90	200	2207
7	567	45	35	557
8	423	20	35	438
9	1071	150	250	1171
10	710	40	90	760
11	455	50	20	425
12	908	353	0	555
12A	146	40	0	106
13	700	412	0	288
Sub Total	8646	1381	865	8130
Upper Main Channel				
A	495	15	70	550
B	403	50	50	403
C	654	60	60	654
D	522	40	85	567
E	1936	120	200	2016
Sub Total	4010	285	465	4190
TOTAL	12656	1666	1330	12320

Notes:

1. BOP data were supplied by the Irrigation Engineer, Padaviya. Areas un-irrigable or abandoned were obtained from field records maintained by the Irrigation Department Staff. Some inaccuracies may result from rounding of individual observations, and particularly by the encroachment by neighbouring farmers onto any parts of the allotments which remain irrigable, in spite of officially being recognised as unirrigable.

2. Reliable data on encroachments are not available; the data presented were obtained from discussions with Irrigation Department field staff and from their indications of areas encroached on the Blocking Out Plan. They, and the resultant "actual acreages irrigated" in column 4, should therefore be treated with caution.

worsening water supply is evident: at Mahakandarawa, a report has been given of widespread abandonment of allotments in tracts LB, 4A, 5, 6 and RB 3A, and 5 (ARTI, baseline study) as a result of inadequate water supplies. Yields on these tracts appear to be 25% - 50% lower than in the top end tracts. Under Padaviya Lower Main Channel, the tract numbering corresponds directly with distance from the headworks, and with the severity of water-inadequacy. Again, the yield in tracts 12-13 is 25% - 50% lower than in the top end tracts. At Vavunikulam, the yields at the tail end of the L.B main channel (Stages IV & V) are less than half those obtained in the better-irrigated parts of the scheme.

4.2 Monitoring the gap

As we suggested in the opening paragraphs of this section, wide disparities in output and yield do commonly exist within major irrigation schemes, and their reduction or removal is a prime function of the TIMP. We have suggested the criteria of cultivated acreages, cropping intensities and paddy yields as practical and useful quantitive indicators of the incidence and severity of tail-end problems. The data we present are, however, far from complete. They might usefully be supplemented from existing (unpublished) records at the TIMP and elsewhere. What is important is that future data collection and presentation should be designed to permit close study of tail-end conditions. Only if cultivated acreage, cropping intensity and yield data are presented on a tract-wise (or tract-grouping) basis can any Project impact on within-scheme imbalances be measured. Unfortunately, this problem-oriented presentation of data has not been adhered to in the past (only the final 2 of the 5 ARTI baseline studies gave a tract-wise presentation of paddy yields) and current monitoring exercises at the TIMP do not present crop cutting (or any other) data in this way. Urgent (and possibly retrospective) revisions to this procedure are essential to supplement the baseline data presented here and to provide a measure of future TIMP impact.

4.3 Causal factors

An important remaining question concerns the causes of poor performance among tail-end farmers. Our implicit assumption, and that of the appraisal report, is that water has been the most important

Table 5 Yield Variations Within Command Areas

	Mahakandarawa		Mahawilachchiya		Padaviya		Padaviya Contd.		Vavunikulam	
	Location	Yield [1]	Location	Yield [1]	Location	Yield [2]	Location	Yield [3] (Bu/ac)	Loca-tion	Yield [2] (Bu/ac)
TOP END	LB Tr.		LB Top	32.06	Tr.		Tr.			
↑	1	57.06	Tail	24.76	LMC 1	74.4	1	80.7	St.I	54
	2	56.07			2	54.5				
	3	30.74			3	75.8				
	4	40.94	RB Top	25.19	4	75.7			St.II	56
	4A	37.78			5	61.0	6 Upper	52.2		
	5	49.44			6	46.4				
			Tail	27.58	7	54.6			St.III[4]	51
	LB Tr.				8	51.5				
	1	53.57			9	52.8	6 Lower	80.8		
	2	35.87	ALL Top	28.37	10	55.2			St.IV	22
	3	16.06			11	53.5				
	3A	25.00	Tail	26.06	12	42.5				
	4	30.40			12A	46.6			St.V	20
	5	0.75			13	34.0	12	57.6		
↓					UMC A	57.3			St.VI	47
					B	46.5				
					C	55.0				
TAIL END					D	50.9			Centre ch.	48
					E	50.5				

Source: 1. Foster, N.(1980), Mahawilachchiya categories are designated by Foster by splitting his sample on each main channel into equal numbers of upper and lower-end farmers Data for 1978-79 maha.

2. ARTI baseline studies - vol.IV, Vavunikulam; vol. V, Padaviya. Unfortunately, a similar presentation of data is not given in vols.I-III. Data for maha 1977-78 and maha 1978-79 respectively.

3. Farrington et al (1980). Data from maha 1979-80.

4. At Vavunikulam, States III and IV are particularly prone to water shortages. (ARTI baseline study).

Note: Data for Pavatkulam not available.

constraining factor. Whilst there is no evidence to invalidate this assumption, its pre-eminence should not lead to neglect of other possible causes.

Moore, for instance, (pers. comm.) has suggested that "the tail end paddy grower is a victim of a complex of interacting causal sequences, not just poor water supply". Among the other key elements, he identifies poor roads which make crop extraction and access difficult, and long distances between the homestead and paddy allotments and between the homestead and service centres which make it difficult to obtain the necessary inputs on time. The combined effect of these is likely to be a key component in the familiar syndrome of low inputs, late cultivation, low yields, indebtedness and loss of control over allotted land.

Inevitably, the individual impact on yields of each of these components is difficult to quantify, and is likely to vary over time and space. That important differences in these yield-influencing parameters do exist between top and tail ends is, however, beyond dispute: as far as road conditions are concerned, no quantitative evidence from the 5 Tanks is available, but investigations currently in progress under the ARTI/Reading University Farm Power Study suggest that in another major irrigation scheme (Kaudulla) approximately 15% of roads in the upper half of Stage I but 35% of roads in the lower half are impassible even for tractors in the monsoon and that distances from homesteads to allotments and from homesteads to service centres in the lower half are much longer than in the upper half. As far as farm power is concerned, already published data for 3 major tanks (Farrington et al 1980) show that tractor populations are conventionally concentrated at the top ends of command areas.

All of these factors will undoubtedly have a negative effect on yields and cropping intensities and are as likely to occur within the 5 Tanks as elsewhere. Their impact, vis à vis that of irrigation water, is likely to vary in severity from one location to another. In the present context, however, it is clear that only part of the disparity in farming performance (particularly in yields) between top and tail ends is likely to be attributable to irrigation inadequacies. An improvement in irrigation facilities may therefore need to be supplemented by improved road conditions and easier access to farm imputs at the tail ends if the gap is to be narrowed. Certainly, a keen tank-by-tank awareness of the likelv significance of these factors is essential to a rehabilitation programme. At the most basic level, it is apparent from informal investigations at Padaviya and Kaudulla under the Farm Power Study that middle and senior level scheme staff are far more familiar with conditions in the upper reaches of the command areas than at the tail ends. Yet it is the latter which offer greatest potential for productivity increases and therefore will require disproportionate attention if productivity levels are to be raised. To ensure that staff simply pay more visits to the tail end at critical periods is a first, basic requirement, yet it is a difficult enough task for the apparently trival, but in practise very important reason that their Offices are located predominantly near the headworks.

The extent to which the yield gap between top and tail ends can be narrowed is perhaps the acid-test of a rehabilitation programme. It can hardly be over-emphasised that this is a complex task, requiring simultaneous organisational effort on several fronts. The indications are that it has not received adequate attention to date in the TIMP. A more rigorous quantification of the problem and its causes at each tank is but a first essential step in its solution.

REFERENCES

1. ARTI (1979-1980) A study of five Settlement Schemes Prior to Irrigation Modernization
   Vol.I - Mahawilachchiya (Research Study No.28)
   Vol.II - Mahakandarawa (-do- No.31)
   Vol.III- Pavatkulam (-do- No.38)
   Vol.IV - Vavunikulam (-do- No.42)
   Vol.V - Padaviya (-do- No.39)
   Agrarian Research & Training Institute, Colombo.

2. Burch, D. (1979) Overseas Aid and the Transfer of Technology: A Case Study of Agricultural Mechanisation in Sri Lanka. Thesis submitted for PhD., Institute of Development Studies, University of Sussex.

3. Carr, M.N. (1975) Patterns of Tractorisation in the Major Rice-Growing Areas of Sri Lanka. D. Phil. Thesis (unpublished). Institute of Development Studies, University of Sussex.

4. Department of Agriculture (1980) Cost of Cultivation of Field Crops, Maha 1979-80. Agricultural Economics Division, Department of Agriculture, Peradeniya.

5. Farrington, J. & Abeysekera, W.A.T. (1979) Issues in Farm Power and Water Use in Sri Lanka. Occ.Pub.No.17, ARTI, Colombo.

6. Farrington, J., Abeyratne, F., Ryan, M., & Bandara, S. (1980) Report on Farm Power and Water Use in the Dry Zone - Part I: Study Methodology and some Preliminary Results. Research Study No.43, ARTI, Colombo.

7. Fieldson, R.S. (Forthcoming) Farm Labour Input in the Dry Zone. Research Study Series, ARTI, Colombo.

8. Foster, N. (1980) Two Studies of Mahakandarawa and Mahawilachchiya Irrigation Schemes - Maha 1976-77 and 1978-79. TIMP, Anuradapura (mimeo).

9. Harriss, B. (1977) Tractors, Profits and Debt in Hambantota District, in Farmer, B. (ed:) Green Revolution? London.

10. Jogaratnam T. (1971) Report of the Re-survey of the Elahera Colonisation Scheme in Ceylon, 1971. Department of Agricultural Economics and Farm Management, University of Ceylon, Peradeniya.

11. Huntings Technical Services Limited. (1980) System C final Design and Detailed Cost Estimates. Working paper No.5. Potential for Lift irrigation in System C. Colombo, November 1980.

12. Parker, R.N. (1978) Characteristics of Existing Tractor Operations. Mimeo, TIMP, Anuradhapura.

13. World Bank (1976) Sri Lanka: Appraisal of the Tank Irrigati[on] Modernization Project. Report No.951a-CE, Washington D.C

Appendix 1.

Farmers' attitudes towards dry sowing

The ARTI baseline survey questioned farmers on their attitudes towards various methods of crop establishment and, where dry sowing was not a preferred method, attempted to obtain farmers' reasons for its disfavour.

The responses to this enquiry are summarised below. They must, however, be interpreted with some care. First, they reflect farmers' attitudes towards dry sowing under the pre-rehabilitation standards of water management and infrastructure. In these circumstances the favoured strategy is security-oriented and involves waiting until sufficient water is available in the tank to permit its adequate conveyance to the most remote corners of the command area. Improved water management should permit greater precision in the timing and placement of water, so that the vagaries of early-season rainfall can be compensated. This, in itself, should remove some of the farmers' expressed reservations about dry sowing, providing that sufficient confidence can be established in scheme staff's ability to manage water accurately. This is an essential step in transforming dry-sowing from a strategy which is adopted faute de mieux (as at Vavunikulam in the baseline report) to one which is actively preferred by farmers.

Second, farmers' reservation regarding weed control problems and reduced yields remain as an important obstacle to the adoption of dry sowing. Sufficient data are not yet available to assess the impact of dry sowing on yields and input (e.g. herbicide) costs. Where yields under mud-sowing are already low (e.g. at Mahakandarawa) there may be little reduction in profitability in the maha, with the prospect of higher cropping intensity in yala. Elsewhere (e.g. Padaviya) where yields are much higher, the reduction in profitability may be more acute, and dry-sowing may appear a much less attractive strategy. For instance, the yields obtained under dry sowing among a sample of farmers at Pulmoddai averaged 37 bu/acre, whereas Padaviya farmers practising mud-sowing conventionally obtained some 65 bu/acre. (Farm Power Study, unpublished data)

All that can safely be said at this stage is that the profitability of dry sowing will vary according to local conditions of water availability. Only a programme of large-scale trials will establish in which areas it represents the most profitable strategy for the individual farmer and to the national economy. It would seem unwise to assume that conditions even at the 5 tanks are sufficiently homogeneous to warrant its universal introduction there.

Table 1.1 Method of planting preferred at the 5 tanks

	Farmers reporting (%)				
	Mahakandarawa	Mahawil-achchiya[1]	Padaviya	Pavat-kulam[2]	Vavuni-kulam
Mud sowing (broadcast)	57	30	78	61	73
Transplanting					
(a) Ordinary	35	{58}	20	{29}	{8}
(b) In rows	3		0		
Dry Sowing	5	4	2	3	19

Notes: 1 8% of farmers preferred mud sowing in rows
2 7% of farmers gave no response

Source ARTI baseline reports.

Table 1.2 Reasons advanced by farmers for the unacceptability of dry sowing

	Mahakandarawa	Mahawil-achchiya	Padaviya	Pavat-kulam	Vavuni-kulam
Farmers regarding dry sowing as unacceptable	Information not available	90%[1]	84	65%[1]	Information not available
Reasons (including multiple responses):					
- difficulty of weed control		46	78	47[2]	
- uncertain weather		50	44	69	
- low yields		2	22	34	
- farm power shortages		2	4	41[3]	
- others		-	2	-	

Notes: 1. Precise figures not given.
2. Pavatkulam responses referred to "aftercare", which is interpreted here as weed control.
3. Pavatkulam farmers were reported as saying "needs timely land preparation"

Source: A.R.T.I. baseline reports.

Appendix 2. Farm power ownership and use levels at Padaviya

Table 2.1 Padaviya - Farm Power Ownership by Tract - I. Power owned by allottees only.

Lower Main Channel

Tract No.	Estimated Maha Paddy Acreage	No. Owners	No. Tractors	No. Owners	No. Tractors	No. Owners	No. Animals
1	154	3	4	3	3	14	213
2	523	7	7	10	10	9	108
3	231	6	7	1	1	9	106
4	111	7	7	1	1	17	327
5	604	15	20	5	6	23	413
6	2207	23	25	44	44	66	1215
7	557	9	9	11	11	33	528
8	438	4	4	3	3	26	415
9	1171	7	8	29	29	41	716
10	760	9	10	4	4	27	536
11	425	1	1	1	1	7	75
12	661	2	2	2	2	30	400
13	288	0	0	1	1	0	0
Sub Total	8130	93	104	115	116	302	5052

Upper Main Channel

Tract No.	Estimated Maha Paddy Acreage	No. Owners	No. Tractors	No. Owners	No. Tractors	No. Owners	No. Animals
A	550	2	2	2	2	17	296
B	403	6	6	2	2	7	135
C	654	3	3	3	3	16	296
D	567	2	2	6	6	18	196
E	2016	5	5	5	5	207	1499
Sub Total:	4190	18	18	18	18	265	2422
Total	12320	111	122	133	134	567	7474

Source: All tables in this Appendix are extracted from Farrington et al (1980)

Table 2.2 Padaviya - Farm Power Ownership by Tract - II. Power owned by non-allottees only

Lower Main Channel

Tract No.	4 W.T. No. Owners	4 W.T. No. Tractors	2 W.T. No. Owners	2 W.T. No. Tractors	Buffalo No. Owners	Buffalo No. Tractors.
1	17	21	3	3	10	150
2	1	1	0	0	0	0
3	0	0	0	0	0	0
4	4	5	0	0	0	0
5	10	13	0	0	33	605
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	2	2	1	1	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
Sub Total	34	42	4	4	43	755

Upper Main Channel

A	4	7	0	0	0	0
B	1	2	0	0	0	0
C	0	0	0	0	0	0
D	0	0	0	0	0	0
E	0	0	0	0	0	0
Sub Total	5	9	0	0	0	0
Total	39	51	4	4	43	755

Table 2.3 Padaviya

Farm Power densities per 1000 acres of paddy (as cultivated in Maha 1978-79) by tract groupings at increasing distance from headworks.

(A) Power owned by allottees only — Nos.per 1000 Acres

Tract Nos.	4 W.T.	2 W.T.	Buffaloes
1 - 5	27.7	12.9	719.0
A - D	6.0	6.0	424.6
6 - 10	10.9	17.7	664.3
E	2.5	2.5	743.6
11 - 13	2.2	2.9	345.7
All tracts	10.0	10.9	606.7

(B) Power owned by allottees and non-allottees resident on-Scheme. — Nos.per 1000 Acres

Tract Nos.	4.W.T.	2 W.T.	Buffaloes
1 - 5	44.4	14.7	811.7
A - D	10.1	6.0	424.6
6 - 10	13.8	17.9	782.2
E	2.5	2.5	743.6
11 - 13	2.2	2.9	345.7
All Tracts	14.1	11.2	668.0

Table 2.4. AVERAGE NUMBER OF HOURS WORKED PER POWER UNIT FOR THE PERIOD 26TH AUGUST 1979 to 19TH JANUARY 1980.

			4 wt			2 wt			Buffalo Pair		
			Location within command area **			Location within command area			Location within command area.		
	Word done for:	Operation category:	Top	Bottom	All	Top	Bottom	All	Top	Bottom	All
UDA WALAWE	Self :	(Agriculture *	3.2	18.8	8.0	35.5	15.5	28.1	12.8	0.8	6.3
		(Non-Agriculture	28.7	-	14.3	50.4	6.9	34.3	-	-	-
		(Both	31.9	18.8	22.3	85.9	22.4	62.4	12.8	0.8	6.3
	Loan or Hire	(Agriculture	61.6	111.2	86.4	103.6	147.6	119.9	188.6	80.1	129.8
		(Non-Agriculture	289.5	73.7	181.6	105.8	43.7	82.8	-	-	-
		(Both	351.1	184.9	268.0	209.4	191.3	202.7	188.6	80.1	129.8
		Total hours/power unit	383.0	197.7	290.3	295.3	213.7	265.1	201.4	80.9	136.1
KAUDULLA	Self :	(Agriculture	25.3	52.3	32.8	121.3	133.5	127.9	131.5	130.5	130.8
		(Non-Agriculture	34.3	31.0	33.1	35.1	66.5	49.5	-	0.3	0.2
		(Both	59.6	83.3	65.9	156.4	200.0	177.4	131.5	130.8	131.0
	Loan or Hire	(Agriculture	94.2	84.3	93.7	22.6	22.0	23.4	13.7	4.9	7.5
		(Non-Agriculture	85.7	39.1	77.8	15.7	36.7	24.8	-	-	-
		(Both	179.9	123.4	171.5	38.3	68.7	48.2	13.7	4.9	7.5
		Total hours/power Unit	239.5	206.7	237.4	194.7	258.7	225.6	115.2	135.7	138.5
PADAVIYA	Self:	(Agriculture	47.5	103.1	64.7	155.6	160.0	156.9	68.6	96.9	75.1
		(Non-Agriculture	12.6	43.7	22.3	27.8	51.6	34.8	-	-	-
		(Both	60.1	146.8	97.0	183.4	211.6	191.7	68.6	96.9	75.1
	Loan or Hire	(Agriculture	150.3	229.9	175.0	102.5	129.8	110.7	42.9	103.3	56.6
		(Non-Agriculture	38.1	51.3	42.7	15.4	50.9	26.0	-	-	-
		(Both	188.4	281.2	217.7	117.9	180.7	136.7	42.9	103.3	56.6
		Total hours/power Units	248.5	428.0	304.7	301.3	392.3	328.4	111.5	200.2	131.7

* Agricultural operations are defined to include the transport of agricultural goods.

** For Uda Walawe, top includes Tracts 2-7 and Embillipitiya Town
For Kaudulla, top incudes the upper end of Tract 1 and the sample drawn from Minneriya.
For Padaviya, top includes Tract 2, Padaviya Town, Tracts 7-9 & E.

Appendix 3

Some equity implication of 4-wheel tractor ownership.

In systems where heavy reliance is placed on the private ownership and hiring of 4-wheel tractors, a number of effects related to the acquisition of productive resources - especially land - may emerge which may be incompatible with broader social and political objectives. Owners of 4-wheel tractors will till their own fields first, and will be in a position to expand the acreage they control precisely because, with continuing lack of priority for 2-wheel tractor and animal draught technologies under the TIMP, the means of timely cultivation will be almost exclusively in their hands. The previously-independent owners of draught power sources of small specific output (2-wheel tractors, buffaloes) may thus be reduced to relying to a higher degree upon 4-wheel tractor hire services if dry sowing is to be successfully introduced.

Work already published (Farrington and Abeysekera 1979, reviewing Harriss 1977, Carr 1975, and Burch 1979) alongside current field observations from the ARTI/Reading University Farm Power Study, all suggest that particularly 4-wheel tractors are a productive asset which give their owners an advantage in the timeliness of land preparation. These tractors have a performace which would permit several paddy allotments of standard size to be cultivated in a single day, thus facilitating and encouraging accumulation of further productive assets in the hands of tractor owners. This is particularly true of land, where it is common for the acreage of paddy land controlled by tractor owners to increase by a factor of 2 or 3 within a few years of tractor purchase. Data from the 4-wheel tractor owning sample members in the baseline studies suggest the following increases.

Table 3.1 Land Holding Characteristic of 4 w.t. owners

Location	No.of Observa-	Average land holdings (ac) at survey		before owning tractor.		Percentage increase	
		High land	Low land	High land	Low land	High land	Low land
Mahakandarawa	6	14.7	1.0	13.0	1.0	14	0
Mahawilachchiya	4	2.3	3.9	2.3	3.4	0	15
Padaviya	10	9.8	6.5	5.3	2.7	85	141
Total	20	9.8	4.3	7.0	2.3	40	87

Unpublished data from the ARTI/Reading University study suggest a more substantial accumulation of land at Padaviya. Data presented by Parker (1978) indicate, at the other extreme, an increase of some 20% since ownership. Give the sensitive nature of such information, it is reasonable to expect some under-reporting of increased land holdings in single-interview investigations, and we suggest that at least a doubling of acreage under 4-wheel tractor owner's control is to be anticipated within the first five years of tractor ownership. We would suggest that the evidence allows further conclusions of particular relevance to the TIMP proposals to be drawn: not only do 4-wheel tractors lead to land accumulation per se, they are especially likely to do so when farming conditions are such as to place a premium on rapid cultivation. Thus at Padaviya, several tractor owners were observed to have gained control of more than 20 acres of rainfed paddy land, both within the scheme and on its periphery, a level of acquisition exceeding that at 2 other study locations where the scope and need for rainfed paddy cultivation are more restricted. If similar levels of accumulation are not also to occur within the early-planting programme of the TIMP, adequate safeguards will have to be maintained.

Only those advocating 'equity' in its most rigorous application would suggest that some additional assets, including productive resources such as land, should not be acquired by tractor owners as a reward for their investment and enterprise. But even a moderate view is beset by two problems: to define what constitutes an acceptable level of accumulation of land within the broadly egalitarian settlement philosophy of Sri Lanka, and to delineate acceptable sources and methods of land accumulation from those which are not. There can, for instance, be little doubt that acquisition of an acre of otherwise unutilised Crown Land by a tractor owner is, in the short and medium term, less inegalitarian than would be a similar acquisition at the expense of a co-settler who is temporarily disadvantaged. Yet acquisitions of the latter type abound - whether by the loan of Rs.200 - Rs.300 during the barren yala of 1980 at Padaviya against use of an acre of land in maha, or through commonplace informal lending arrangements whereby land is demanded as collateral by tractor owners and mudalalis and frequently forfeited, or by over-hasty cultivation of their entire allotment by tractor owners, as at Kaudulla in yala 1980, who were then in a position to demand Rs.1000/acre for handing over the land to bethma nominees.

9214

Appendix 4 Organisational Issues At The TIMP

Many components of the TIMP programme have suffered from inadequate synchronisation. Some of the early advisory staff were in post before construction equipment had been imported. Local priorities for the Mahaweli development project have placed a strain on resources that have resulted in shortages of local staff and equipment for the TIMP. Inevitably, these difficulties have led to delay in the reconstruction and agricultural programmes. The former is complete at only two of the five tanks, whereas the appraisal envisaged completion at all tanks by 1980. Similarly, there have been delays in establishing a Project Manager's office. This was staffed three years after the 1976 proposal.

These delays have important implications: first, the anticipated benefits from the project will be delayed, and future evaluations will have to take account of this. Second, the early completion of those aspects of the project which have been on schedule has generated among farmers (and perhaps among junior officials) an impression that timeliness implies priority, and some unfavourable comments have been received from farmers on the apparent priority attaching to the construction of staff offices, and acquisition of vehicles, and so on. Some effort on the part of TIMP staff to allay these fears might be appropriate.