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APPROACHES TO IMPROVING WATER MANAGEMENT ON LARGE-SCALE IRRIGATION SCHEMES IN SRI LANKA

M.P. Moore

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AGRARIAN RESEARCH AND TRAINING INSTITUTE

P.O. Box 1522

Colombo

Sri Lanka

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APPROACHES TO IMPROVING WATER MANAGEMENT
ON LARGE-SCALE IRRIGATION
SCHEMES IN SRI LANKA

By

H.P. MOORE

(Institute of Development Studies, UK.,
and Agrarian Research and Training
Institute, Colombo)

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FOREWORD

In Sri Lanka, as in many other countries in this region, adequate attention was not paid to the question of water management when the earlier irrigation schemes were established. It was thought that once the irrigation officials let the water out from the reservoir into the distributary canals the farmers would make use of such water in a rational way. However, it has now become evident that the actual field situation is quite different from what was envisaged and as a result there is large scale mismanagement and waste of water in irrigation schemes thereby causing innumerable problems for the colonists.

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The economic and social benefits that would follow from proper water management has become a topical subject of interest among research workers. This study on approaches to improving water management on large scale irrigation schemes in Sri Lanka was undertaken by Mr.M.P.Moore, a consultant of the ARTI/Reading University Research Project on "Farm Power, Water Use and Criteria for Decision Taking in the Dry Zone Farming in Sri Lanka." The author has identified several fundamental and deep-rooted constraints that inhibit efficient water management in the irrigation schemes in this country. 'Some of them are, the faulty design and construction, the lavish water use and the absence of qualified permanent staff for efficient water use and management. The author also says that in order to facilitate channel maintenance and the distribution of water between individual farmers there is a need for organisation of farmers into groups at the field channel level.

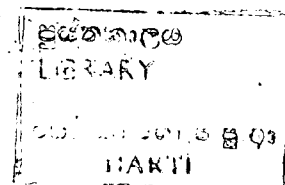
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This necessity to mobilise local resources for water management has been accepted by the government and therefore several experiments on organisation of farmers for water management are being tried out at present. One such experiment is done under Tank Irrigation Modernisation Project where the newly elected tract leaders have been made responsible for the distribution of water among the various users. In the Mahaweli H area an elected/nominated farmer representative system is being tried out for the same purpose. Under the Water Management Project at Gal Oya, the farmers are formed into viable "water user groups" to manage the allocation of water among themselves.

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The author is to be complimented for his effort in bringing together the various approaches available for improving water management. It is hoped that the authorities concerned will make use of the information made available in this document in their effort to introduce a better system of water management.

T B SUBASINGHE
DIRECTOR- ARTI



INTRODUCTION

This paper is the product of research undertaken as part of the Agrarian Research and Training Institute/University of Reading research project on Farm Power and Water Use in Sri Lanka. It draws on the work of very many people, including: discussions and field investigations with members of the Farm Power and Water Use Project, especially R.Amarakoon, John Farrington, Ishak Lebbe and many field investigators; valuable conversations with engineers and other professionals involved in irrigation, especially Digby Bevan, Gamini Gunasekera, Dennis Holmes, Adrian Laycock, A.Maheswaran, J.L.Merriam and Bruce Withers; a range of published and unpublished papers cited in the bibliography, notably those by Murray-Rust and Cramer (n.d.), Parker (1978), and Wickham (1978); the constant stimulus provided by the author's colleagues Robert Chambers and Robert Wade; the author's previous field research;¹ and critical comments on an earlier draft of this paper by David Korten, C.M.Wijayaratne and several of the persons named above. The author is grateful to them all.

PURPOSE AND PERSPECTIVES

As is the case in so many ^{areas} of policy, the problems and issues in the field of water management have changed but little in recent decades. What is new is the recent spurt of interest in the topic outside the circles of local irrigation engineers. The realisation that there are enormous potential economic benefits to improving water management is an Asian-wide phenomenon, and, in Sri Lanka as elsewhere in Asia, partly reflects the persistent inquisitiveness of foreign aid donors and international agencies. In consequence of this increased interest, the problems and issues in water management in Sri Lanka are now fairly well documented. Unfortunately, and with only a few exceptions, almost all the information is contained in unpublished papers and official reports, few of them widely available, and some of restricted status.² The limited availability of this material has two adverse consequences. The first is that the diagnoses, ideas, and proposals are available only to a very narrow range of people, excluding many others who have a professional, academic or more general interest in the subject. Existing work is for that reason less effective. The second adverse consequence is that administrators, foreign aid missions and researchers new to the field do not realise how much solid work has been done and are wasting a great deal of time, theirs and other peoples', by asking much the same questions again and again of the same people, both in Colombo and in the field.

One purpose in writing this paper is therefore to alert those new to the subject to the issues, the solutions which have been proposed, and the large volume of existing experimental work. To this end the paper is structured as a commentary on each of the main reforms which have been proposed or attempted. In some cases the author is relying less on written reports and his own field experience than on the fruits of discussions with public servants and others involved in water management. In part he is acting as their mouthpiece.

This paper is not however simply an annotated list of issues. While every attempt has been made to be comprehensive and unbiased, the paper necessarily reflects the author's personal experience and perspectives. Here two points need to be made clear from the start. The first is that the author is an economist / sociologist with experience of research in rural Sri Lanka, but no training in the technical disciplines relating to water management, notably engineering, hydrology, hydraulics and agronomy. As has been so often noted, one of the great problems about water management is that the social, institutional and technical issues interact especially closely. No single professional discipline can provide an adequate grasp of the issues.³ While attempting to do justice to the technical issues, the author has necessarily concentrated on the areas with which he is most familiar, the social and institutional issues. The belief that these are at the present time the most important is widely shared by technical specialists, and thus reflects more than the author's own biases.

The second point about the author's perspective is more fundamental and requires rather more elaboration. It is easiest if one starts by going back to the observation about the important role of foreign aid donors in stimulating reports on and research into water management in Sri Lanka. Most of the literature on the subject is the product of foreign consultants and researchers. There is a certain common style and approach about this literature which closely reflects the experience and work situation of the expatriate researcher or consultant. In the first place, he (never she) is likely to have experience of countries where irrigation systems work relatively efficiently, notably the USA or, in Asia, Taiwan or South Korea. There is every incentive to see the undoubtedly-large efficiency gap between these countries and Sri Lanka as the consequence of Sri Lanka's 'failure' to have management systems like theirs. If one adds to this the point that expatriate consultants and researchers are always very short of time, one can see how strong the pressures are to recommend both a standard foreign model and a standard package of foreign-aided technical and institutional

components⁴ in order to approach nearer the foreign model. A further major aspect of the expatriate consultant# researcher's job is that he is not personally concerned with implementation. It is of course true that some of the major problems in water management are, for example, lack of discipline among farmers, interference in water management by politicians, and lack of concern with agricultural issues on the part of irrigation staff. It is easy to say that, for example: government should enforce discipline among farmers and prosecute those who break structures or steal water; government should stop political interference in water management; and government should enforce coordination between the departments of irrigation and agriculture. But the same things have been said for years, even decades. And attempts have often been made somewhere in the public service to implement these ideas. The fact that they have had little effect is fundamental to any feasible programme.

The dominant perspective on water management, especially among expatriates, is to specify what 'ought' to be done in order to reach some desired level of performance in water management, leaving the critical implementation problems in the lap of the government. The perspective which governs this paper is different. It takes as its starting point the present situation in Sri Lanka: the physical state of irrigation systems; the existing institutions of water management; and the political, social and administrative factors bearing on the distribution of power and the ability of various agencies and levels in the government to pursue certain kinds of policies. Given all the constraints to effective action in any sphere, what can feasibly be done to improve water management? The aim is modest improvement. What this means in practice should become clearer below.

Any comprehensive list of constraints on better water management is necessarily long. Were there not so many (interacting) constraints, the situation would probably have been remedied years ago. The crucial question is however which constraints are removable. In our necessarily-subjective view there are seven constraints which are fundamental and deep-rooted, and which jointly explain why no dramatic improvements in water management can be expected within the foreseeable future:-

1. Existing irrigation systems, excluding only those built in recent years, were designed and constructed in such a fashion as to make efficient water management almost impossible. The central physical features of the older schemes are: very long distributory and field channels designed to command as large an area as possible as cheaply as possible; lack of clear distinct-

ion between the various levels of channels - main channels, distributory channels and field channels; relatively few control structures on channels and, above all, scarcely any cross-regulation structures. The relationship of this design to poor water management is elaborated at various points below. It is adequate for present purposes to mention: the severe problems encountered in getting water to the tail-ends of long distributory channels and field channels; the difficulties of designing fair rotational schedules; and the impossibility of controlling water flows without cross-regulators and intermediate storage between the main reservoir and the field. Two sets of historical circumstances jointly explain why schemes were constructed in this way. The first set relate to the economic and political context of the establishment of irrigation colonies in the Dry Zone. It was imperative to settle as many families as possible with limited financial resources. At the same time, the emphasis was on the settlement, in an all-round sense, of the new colonists.⁵ Public expenditure per settler on housing, roads, services, infrastructure, etc. was high and the subject of continual debate and criticism.⁶ With the emphasis on settlement and the relief of Wet Zone landlessness rather than on production, the irrigation system itself did not receive a great deal of priority in financial allocations. At the same time, it was felt appropriate to provide every allotment with water from a field channel. The cheaper alternative, common elsewhere in Asia, of leaving farmers to construct their own field channels or rely on field-to-field flow of water, was not entertained. The budget for irrigation layout was thus stretched very thinly, encouraging the cheapest design, with long channels and few control structures. This skimping on physical structures does not however appear to have aroused a great deal of concern at the time, and to explain this one must turn to the second set of historical circumstances: the Irrigation Department's limited involvement in water management.

The central point here is that, although existing as a separate agency since 1900, the Irrigation Department has always been mainly concerned with the construction of irrigation systems rather than operating them. In the years before rapid motor transport was widely available it was not feasible to have public officials deeply involved in water management, and certainly not well-paid professional engineers.⁷ The management practices for the large scale irrigation schemes begun in the 1930s were inherited from the existing smaller schemes. Before each season a Water Meeting was held to decide on timing of water releases and related matters such as dates during which buffaloes would be excluded from fields and arrangements for fencing and crop-watching. This meeting was attended by farmers and chaired by the Government Agent, the 'prefectorial' local agent of all government departments. The decisions of the water meeting and the actual distribution

were of water/implemented by farmers, above all by the ubiquitous Vel Vidanes (Irrigation Headmen). On the larger schemes the Irrigation Department was responsible only for the opening and closing of the sluice from the tank to the main channel. It was concerned with water issues, not water use; the 'human relations' aspect of irrigation - sharing out water, mediating disputes and prosecuting offenders - was let to the Vel Vidanes and the Revenue Department (Government Agent). The Irrigation Department maintained an attitude of technical professionalism, leaving to others the agronomic and human relations aspects of efficient water use.⁸

Not being involved in the operation of the systems it was constructing, the Irrigation Department was not fully aware of the defects of its designs. It became more conscious as the increasing size of new schemes and the abolition of Vel Vidane system forced it to become more deeply involved in system operation. The establishment of a separate Mahaweli Development Board to plan and construct the large Mahaweli project provided the occasion for a group of engineers to evolve a new design layout which eliminates some of the worst problems of the old design, notably long field channels (see below). This new design has become standard for all new schemes, but in the meantime, the old design must be lived with. Some of the costs of living with them are elaborated below.

2. Leaving aside these broad problems of system design, there are in a narrower sense design and construction faults on many schemes which, although remediable through expensive rehabilitation, have currently to be endured.⁹

3. It is a corollary to the traditional lack of involvement in water management of the Irrigation Department (see above) that the ethos, training, experience and traditions of irrigation staff lead to a concentration on design and construction work at the expense of interest and expertise in water management.¹⁰ Although this is an area of major potential for improvement, change will at best be slow (see below).

4. Whatever heartening examples of very efficient irrigation water use may be set by such untypical schemes as Iranamadu,¹¹ most Ceylonese farmers are thoroughly wedded to lavish water use, especially for field preparation and weed control. Extravagant as their habits appear to outsiders, it seems extremely unlikely that they will be persuaded to change radically to water-sparing practices.¹² The implication is that techniques of dry land preparation and dry seeding, on which considerable research has been conducted, are unlikely to be widely used in the foreseeable future.

5. More and better local farmers' organisation is a prerequisite for any big improvement in water management. Past experience and other factors elaborated below however suggest that prospects for rapid progress in building farmers' organisations are poor.

6. International comparisons strongly suggest that the more efficient canal management organisations are those which control only a single water basin, are in some direct fashion accountable to the farmers they serve, and have permanent staff who develop a thorough acquaintance, social and physical with the area in which they work.¹³ The Sri Lankan practice of operating canals through an ordinary government department, with regular transfer of senior staff and lack of direct accountability to the farming population, is not the best point from which to introduce high standards of water management. One recent observer has suggested the partial introduction of private sector management.¹⁴ For political reasons this is extremely unlikely, and reform proposals would best assume the perpetuation of the existing management structure.

7. Whatever happens in the sphere of farmers' organisation or reforming the irrigation service, it will remain essential for water managers to exercise discipline and control both internally and externally; to ensure that their own staff adhere to procedures and instructions; to deprive farmers of water on occasion even when they want or need it badly; and to turn a deaf ear to the interventions of politicians and other powerful outsiders. This implies a relatively authoritative public service, responsive to its internal hierarchy and independent of political pressures from outside. That for good or ill, is not the Sri Lankan situation. Power is widely dispersed: within the public service hierarchical authority is severely limited; involvement of politicians in the decisions of the public service is the rule at all levels; the ability of either politicians or the public service to coerce the public is low. Leadership of any kind and at any level must rely more on bargaining and persuasion than coercion or automatic obedience. Some years ago it was this wide dispersion of power which led to Sri Lanka's being described as a 'soft state' and despaired of by the international community of aid and development experts. But fashions change, and Sri Lanka is now widely admired for its democracy, welfare policies, attention to the basic needs of the poor, and non-authoritarian style of administration. It is being held up as a model for other developing countries. However these features are evaluated in international fashion, the non-authoritarian characteristics of the Sri Lankan polity remain, and should be considered in designing policies for water management.

These points made above are not intended to induce black pessimism. For the remainder of this paper indicates that there are a number of possible avenues for progress, and, as has often been pointed out, the potential economic and social returns to quite small improvements in standards of water management are large.¹⁵ A certain pessimistic realism is however the best stance from which to select effective policies. Some observers might find grounds for greater optimism in the results of pilot water management projects, but the basis is very shaky. Even if not funded at very generous levels, pilot projects invariably receive far greater administrative and institutional support, supervision and commitment than is possible on a general scale. In the sphere of water management several countries seem to cherish the tale of the one great success which shows the way to the future. In Sri Lanka this slot is filled by the activities of the Irrigation Department Water Management Field Unit in Rajangane Tank in the Yala 1976 season. With great effort the team managed to enforce tighter discipline and save a large area of paddy which would otherwise have dried out. The effort was impressive, but whether it is replicable is open to question. Only inspection of the files can reveal the very great effort involved, while the published account¹⁶ shows the relatively high density of staff involved and how, even then, the final outcome was long in doubt and achieved only in the face of strong continual resistance to the idea of cutting down water issues or acreages served. And the Water Management Field Unit were committed professionals well aware of the challenge and importance of their task. One simply cannot expect that sense of commitment and level of interest and administrative effort to be repeated season after season on most schemes. One has to work with the people and the institutions which one has. For similar kinds of reasons, one must be wary of the results of various pilot projects on farmer organisation or field channel layout discussed below.

IS ANYONE TO BLAME?

When undertaking a critique of any organisation it is difficult, given even the best of intentions, to avoid entirely the appearance of heaping blame on one set of individuals or groups. To try to apportion blame is, however, counter-productive. As the author has demonstrated elsewhere,¹⁷ the interaction of physical and social factors in irrigation management and the ease with which one may become involved in vicious circles of poor management, physical deterioration of the system and mistrust between farmers and staff are such as to make it extremely difficult to trace cause or assign blame. It is however important to recognise that, because of the mistrust which has arisen, there is a certain tendency for farmers and officials to

lay the blame for poor water management mainly on parties other than themselves. And it is mainly the engineers' views which get represented in the literature, where it may be argued that the main causes of poor water management lie entirely in spheres outside engineers' control: in politicians who interfere with water management schedules in response to farmer requests, prevent prosecutions for damaging gates, and refuse adequate maintenance budgets; and, above all, in the contrary and undisciplined behaviour of farmers, who sow late, demand excessive water, waste it, and interfere with and damage control structures. Each of these problems is serious, but any view which excludes the irrigation staff organisation from scrutiny is extremely misleading (see below). Engineers, farmers, politicians and foreign consultants are part of the problem as well as part of the solution.

POLICY OPTIONS

We turn now to the listing and evaluation of the various policy options which have been suggested or attempted. The order of listing is determined by the flow of the arguments rather than the intrinsic importance of the various ideas or policies. As will become evident, many of the suggested options are interdependent; they are separated out for discussion purposes.

The choice of which issues to discuss is determined by the perspectives set out above. Above all, the focus is on ways through which better standards of water management might be attained in practice, rather than technical experiments designed to demonstrate the feasibility of using less water at the farm level. The central problem is not a technical one of finding cropping patterns and farm practices which require less water, but a managerial problem of reducing high rates of water use and supplying water in such a way that it can be used more effectively.

1. DISCIPLINE

One of the most common recommendations for improving water management is greater discipline: enforcement of agreed schedules for water release; refusal to extend issues beyond agreed dates; the enforcement of rotational issues, involving the denial of water to some farmers at some times; more effective patrolling of channels and the prosecution of farmers found breaking structures or altering gates; and the denial of water to those cultivating paddy on encroachments or other unscheduled plots. To some degree such measures are essential, and are rarely suggested on their own. It is however important to spotlight the limitations of any approach which relies heavily on the tightening up of discipline.¹⁶ For the idea is not new. At various points in the past

influential politicians have taken an interest in water management, and a call for greater discipline has often resulted.¹⁹ Yet the effects have not been great. One response is to claim that 'political will' or 'commitment' was lacking. That this is not a very illuminating description of the situation can be demonstrated by attempting to stand in the shoes of a Chief Irrigation Engineer instructed to tighten up discipline on the schemes under his control. Let us start by imagining that the problem of 'political interference' has been solved: that local politicians and administrators are all so convinced of the benefits of greater water discipline that they turn a deaf ear to farmers' demands for intervention on their behalf.

Let us first look at the physical means for controlling water available to an engineer. It was pointed out above how the practices of water management and system design have historically developed in tandem, and in a context where the Irrigation Department could exercise control only at the head sluice from the tank. 'Water management' involves two separate processes. The first is the process of arriving at and implementing decisions about opening and closing the head sluice, i.e. the dates when the cultivation season will begin, the period of full flow of water permitted for land preparation, and the period of reduced flow during crop growth. The locus of this decision remains the Water Meeting, and the Irrigation Engineer, along with the Government Agent, are fully involved. Historically, their involvement more or less stopped at this point. They were very little concerned with the second process: the allocation between farmers of water released from the main sluice. This was the duty of Vel Vidanes (Irrigation Headmen) or labourers employed by the Irrigation Department. It however was not a very difficult or complicated process, for little attempt was made to control water. The main concern was to try to see that each farmer obtained adequate water all the time there was some available. The operating principle was 'free flow' of water along all channels. Little else was possible, for few control structures were provided, and scarcely any cross-regulators. Water was thus provided to the field directly from the main reservoir. This, for technical reasons, is a practice which makes detailed control of water and efficient use almost impossible (see below).

A 'free flow' system without intermediate storage or any attempt to maintain constant channel water levels is not only relatively inefficient when operated as originally intended, but is also somewhat unresponsive to attempts to operate it in a more water-economising fashion. Growing concern about water management has led to the adoption of two practices intended to conserve water:

the practice of rotations, and the occasional closure of the main sluice gate to save water, especially after heavy rain. The two practices may be combined. For example, a main channel may, at least in principle, be operated according to the following weekly schedule: issue to half of all distributary channels for three days, to the other half for three days, and then closure for one day. Some of the main problems encountered in attempting to run old systems in water-sparing ways are as follows.

Let us take first the practice of rotations. The purpose of rotations is not simply to reduce the period of water issue to a given area. That could be achieved by closing the head sluice for a number of days and then issuing to the entire scheme for a number of days. The purpose of rotational issues is to concentrate an adequate 'head' of water along individual channels to force water along to the tail-ends. For the most evident and chronic problem with old-style designs is that, because of the great length of many distributary and field channels, water does not reach the ends. It is expropriated by other farmers on the way. However, one immediate problem is that many systems were not built to accommodate rotational issues. Rotations involve a larger delivery of water through channels at a given point in time, and thus the attempt to enforce rotations may overload channels, leading to their erosion and the washing-out of control structures. A second problem with rotations is that they cannot be effective without cross-regulators on main channels (if rotations are between distributary channels). For example, one cannot fully implement a schedule which requires that the first four distributary channels be supplied for a given period and then the last four for an equivalent period unless one can close off the main channel between the fourth and the fifth distributary channels. A third problem with rotations lies in the lack of clear distinctions between the different levels of channels: main channels, distributary channels, and field channels respectively. Each merges imperceptibly into the other. Some so-called 'field channels' are bigger than other 'distributary channels', while some field channels feed directly off main channels. It is thus extremely difficult to evolve a rotational schedule which is demonstrably fair and equitable, for one distributary channel or field channel may serve many times the acreage of another.²⁰

The practice of closure of the main sluice may serve two different purposes. When integrated into a rotational schedule, it represents an implicit admission that an effective water-sparing rotational issue cannot be enforced and constitutes simply an attempt to save water by the most direct means possible. When practised after heavy rain it represents an apparently-reasonable attempt to substitute rainfall for tank water. Unfortunately, detailed studies²¹ have

shown that, however praiseworthy the intentions, the consequences can be adverse. The basic problem arises from the fact that no attempt is made to maintain water levels in the main channel. The level may drop very low, and it may take sometime to build up again after the sluice is reopened. Until it builds up there is inadequate head of water for much to reach the tail ends. The author's research shows that the time required for water to reach the tail ends of systems after the main sluice is opened is typically a multiple of the theoretical design figures, mainly because of the poor physical condition of canals. Thus the practice of periodic sluice closure is likely to starve tail-enders of water. This is especially likely when this occurs as a result of the attempt to save water after heavy rain, and when combined with rotational issues. Recent research has shown that, contrary to widespread opinion, rainfall can be very localised, and thus miss entirely parts of schemes covering only a few thousand acres.²² Head sluices may thus be closed as a result of heavy rainfall near the tank, while tail ends receive no water. If this occurs at an unfortunate point in the rotational cycle, tracts which did not receive rain may also be cut off from irrigation water for a week or more. This is enough time for crop damage to occur.²³

There are thus features intrinsic to the design of most existing irrigation schemes which make control of water and the adoption of water-saving management practices extremely difficult. There is in fact a degree of unreality about the decisions which are made in Water Meetings about rotational issues in particular. For the reasons given above, rotations are very difficult to enforce to the letter. The attempt to do so is likely to deprive some farmers of water. In practice the implementation of publicly-agreed schedules involves a continuing series of decisions and compromises on the part of the junior Irrigation Department staff responsible for the opening and closing of gates on a day to day basis - especially Works Supervisors and Labourers (Watchers).²⁴ They are so heavily involved in decision-making that it is an underestimate to say that they are merely implementing the decisions of the Water Meeting or the instructions of professional staff, i.e. Technical Assistants and Engineers. Where these junior staff, especially the Works Supervisors, are experienced men familiar with the system - as most are - then it seems more accurate to say that they are the ones who manage it. It is they who know automatically which field channels are regularly short of water, which gates are operational, and by how many turns of the screw the head sluice must be opened to raise the water in the main channel to a given level. The professional staff rarely attain this kind of skill, both because they are not called on to take these day-to-day decisions and because, unlike the junior staff, they are subject to regular

transfer.

It is the pivotal role of junior staff in water management which makes the call for military-style 'discipline' unrealistic from an institutional point of view. Let us look first at the issue of control.

The proponents of 'discipline' would tend to argue for more vigilance at all levels, and regular checks at all levels on the performance of subordinate staff, backed by credible threats of punishment. This approach is premised on the idea that the more senior the staff, the more informed and skilled they are in the field of water management, and thus best placed to formulate and enforce procedures and decisions. Unfortunately the reverse tends to be true. More senior irrigation staff are: less likely to originate in the dry zone areas where large scheme irrigation schemes are located; more likely to be transferred rapidly between posts; less likely to have their families living in the locality; spend more time away in Colombo or other areas of the wet zone seeing their families. Thus local experience, knowledge and social contacts, all of them essential for effective water management, are the prerogative of junior rather than senior staff - Works Supervisors and Labourers rather than Engineers and Technical Assistants. Similarly, it is the junior staff who actually undertake water management, i.e. take all the regular decisions about opening and closing gates, and actually perform the operation. The more senior the staff, the more they are involved in administration and construction work, and the less the experience they have with water management and the allied work of maintenance.²⁵

With their superior experience, local knowledge and social contacts, junior staff are better placed than senior staff to assess the viability of different procedures and proposals for water management. Junior staff are also well placed to evade attempts to exert discipline on them in ways they dislike. The functioning of systems seems to depend heavily on the acquired experience and informal knowledge and contacts of junior staff. They are often able to mediate in disputes among farmers, to encourage groups of farmers to clear channels, or decide on the basis of experience how water might best be distributed. If pressured from above they would be able to use this local knowledge and experience in obstructive ways, withdrawing cooperation if necessary, yet in no way violating their work regulations. More senior staff implicitly recognise this and try to leave all but the major decisions on water management in the hands of junior staff. There seems to be a general understanding that staff will try to resolve issues themselves, and only refer them to superiors if they are unable to do so or find the attempt difficult in personal terms. The system operates to consistently suppress information about what actually happens from

those taking a 'top-down' view, i.e. senior staff and casual visitors. Analogous conclusions can be reached if one examines the means available for obtaining information about actual water use. And information is of course crucial to control. Any call for discipline involves a more careful allocation of water over time and between different parts of the command area of a scheme. In order to make that careful allocation one needs to know about the water supply/ requirement situation on different parts of a scheme, always bearing in mind that local differences in rainfall, soil permeability and access to water released from the head sluice can be very considerable. There is a range of choice about the kind of information on water supply/ requirements one opts to collect. One option is measurement of deliveries by volume. This is achieved most accurately by constructing measuring flumes or weirs in the channels. Very few exist currently, and many of those are damaged or washed out. The alternative is gauge posts, which are less accurate, require regular recalibration, and, as experience has shown, are very vulnerable to vandalism, use as buffalo-hitching posts, etc. Whichever system one chooses it is feasible only to measure down to the level of flows of water entering into distributary channels. One still needs further information on water availability at field level. More importantly, one has to put faith in junior field staff both to take regular readings of measuring devices rather than invent figures, and to resist any inducement which may be offered to manipulate readings in order to make a case for increasing the supply of ^{water} to the area concerned. Even more vulnerable to such abuses is the alternative information feedback system: regular reporting on the general state of fields and the progress of cultivation on an area by area basis - whether water is adequate, whether land preparation is complete, etc. Tight control is premised on information, yet the accuracy of that information depends on the commitment and honesty of field staff in the face of temptations to invent or falsify figures. Some regular checks are possible, but would be of little use unless means could be found to ensure that most of the staff were doing their job well most of the time without the threat of checks from above.

'Discipline' as a strategy for better water management thus turns out to be more or less empty when examined carefully. It is physically difficult to control water on many existing schemes because of their design. Inadequate maintenance expenditures and physical damages to control structures, especially gates, by farmers exacerbates the problem. Further, the concentration of knowledge and thus power at the lower levels of the staff hierarchy is such that attempts to enforce military-style discipline from above can easily be subverted.

A greater degree of sustained high level political interest is essential to improved water management. This is required for the exploration of options and the evolution of feasible policies for reform. Prime among those policies should be measures to elicit greater willing cooperation and effort from irrigation staff, especially at junior levels, by providing them with incentives, recognition and a sense of professional commitment (see below). One ultimately has to trust them, for there are no feasible alternatives.²⁶ The dramatic display of "political and administrative will" - the issue of firm orders, calls for discipline, talk of being on a 'war footing', etc. - is unlikely to lead anywhere. It is not as if this has not been attempted. Orders of this nature have often been issued. The fact that they have had little impact does not mean that there was no real 'commitment', but that there is no way of enforcing them.

2. FARMER GROUP ORGANISATION

Perhaps the most striking single change in water management policies in recent years is the widespread acceptance of the need for the organisation of farmers into groups at the field channel level in order to facilitate channel maintenance and the distribution of water between individual farms. This change in attitude appears to have taken place in several other Asian countries,²⁷ and similar causes seem to operate in all cases:-

- (i) There is a growing realisation that, under typical small-farm Asian conditions, it is impossible for irrigation staff to police the distribution of water down to the level of the individual farm. Not only would this require enormous and expensive inputs of staff time but, would be impossible without active farmer cooperation, for at the field channel level it is very easy for farmers to break bunds, temporarily block channels, or otherwise obtain water in illicit ways. The physical structures at that level are so fragile that may easily be broken or by-passed.
- (ii) On the wider scene, covering far more than irrigation, it is being realised the farmer group organisation is a promising means of alleviating some of the major administrative and institutional problems posed in trying to deliver services to multitudes of small poor farmers.²⁸ In principle farmer group organisation offers two main kinds of benefit. Firstly, it offers a leadership which may operate as the point of contact for officials. Instruction, advice, requests or complaints may be channelled to and from individual farmers through this leadership, thus saving the time of officials and making their efforts more effective. Secondly, according to somewhat more radical

theorists, group organisation increases the bargaining power of the farmers, giving them more leverage over local level officials, leading hopefully to better performance. The combined complaints, demands or protests of a group are more effective than the activities of a number of individuals. Thus one version of this theory, applied to water management, is that organised farmer groups might be able to force officials to operate irrigation systems more efficiently.²⁹

- (iii) The slogan of 'popular participation' in development now fashionable in international development circles is often invoked to justify the formation of democratic farmers' groups, and seems often to lead to a marked preference among aid donors for irrigation programmes incorporating the principle of democratic group organisation.³⁰

It is difficult to say what exactly is the current state of play with group organisations for water management in Sri Lanka, for there appear to be more proposals than actions, and the outcome of experiments is not always easy to determine. A variety of proposals have been made and pilot projects attempted. The size of the groups varies. Some proposals involve only one tier of group organisation at the field channel level, while others involve one or more additional tiers. Some explicitly attempt to combine in one person the 'contact farmer' roles in relation to both extension system and water management. Some involve the nomination of the contact farmer by local officials and some argue for formal democratic election, although one suspects that in practice both principles are combined, in some degree. Among the main recent and current experiments and proposals are :-

- (a) Attempts to establish a three-tier system of democratic representation for the management of the five schemes under the IBRD/UK-funded Tanks Improvement and Modernisation Programme ("Five Tanks Programme").³¹
- (b) The introduction over the last two years of the principle of the elected/nominated / nominated 'representative farmer' (representing a field channel or a part thereof) on the H System of the Mahaweli Project (Mahaweli Development Board), Padaviya scheme (Irrigation Department), Uda Walawe scheme (River Valleys Development Board), and perhaps elsewhere.
- (c) The recent decision of the Agrarian Services Department to become involved in water management at the field channel level on major

schemes, leading to the current process of appointment of 'Vel Vidanes' from among cultivators. One might note that these are appointed on the basis of one per Grama Sevakas' division. These divisions often cross-cut irrigation tracts. These new 'Vel Vidanes' are much less dense on the ground than the 'representative farmers' mentioned above, and the relationship between them is yet to be clarified.

- (d) Proposed experiments with alternative types of local farmer organisation by the Agrarian Research and Training Institute under an American-funded project for the rehabilitation of the Gal Oya scheme.
- (e) Various proposals for a relatively elaborate statutory structure of elective water management organisations,³³ including those in the draft of the new Irrigation Ordinance.

The experiment with 'representative farmers' on the Mahaweli H system is perhaps the most significant, for it coincides with the introduction of a new field layout intended to obviate some of the problems of the old design discussed above. The core of the new design is the one cusec field channel. This supplies a 'turnout area' of between thirty and fifty acres, depending on topography and soils. There are no more long field channels, and no field channels fed directly from main channels. Two aspects of this new design impinge very directly on water management practices. One is the small size of the turnout area. Given that new settlers are each allocated two and a half acres of paddy land, the turnout area comprises between a dozen and twenty farms. Although the new design was chosen purely on technical criteria related to the observed need to avoid long field channels, the result is to create an environment apparently-favourable for the establishment of 'turnout groups', i.e. small, manageable farmers' organisations at the field channel level. The second innovative aspect of the design is that it almost requires effective turnout groups for efficient functioning. For the one cusec field channel is intended to supply adequate water to the turnout area on the basis of a three-day supply period into the field channel each week, and rotations within this time between pairs of farmers, each receiving water for about twelve hours once (per three days rotation, and thus once per week). In order to supply adequate water during a twelve hour period, the farm turnout pipes are made larger than before - 6" as opposed to 3" or 4" in diameter. Some kind of farmers' organisation is therefore essential because, given the large size of the farm outlet pipes, the abandonment of rotations leaves top-enders in an excellent position to take even more water than

they could have done with the older smaller outlet pipes. Thus two of the core design concepts are field channels big enough only to provide an 'adequate' supply of water to the turnout area as a whole, given a three-day rotation, and the essentialness of effective rotational schedules between farms. It might be described as a 'high risk, high return' strategy.

It is too early to pass judgement on the performance of 'turnout groups' in the H system. The experiment has however run into many problems, despite three supportive factors not experienced elsewhere: the small compact turnout area; the loss to be incurred if the rotation system is not made to work; and the practice of paying a cash remuneration to the 'representative farmer' responsible for enforcing the rotation and ensuring the maintenance of the field channel. In the light of this evidence, it is scarcely surprising that the experiments with 'representative farmers' at Padaviya and Uda Walawe have been almost total failures. This was revealed by the author's recent fieldwork. The simplest evidence of their failure was that very few farmers were aware of the existence of such functionaries and, with scarcely an exception, those who were aware said that the persons concerned were doing nothing for water management. The reasons given by the farmers are quite plausible: the 'representative farmers', being unremunerated, have little incentive to do any work, and even less to attempt to confront top-enders taking excessive water or persons failing to clear their section of the field-channel. Further, they have no legal power to enforce decisions.

It is true of course that the lack of legal powers can be remedied, and that it is intended that the new Vel Vidanes, like those of old, should be paid in kind (paddy) by each of the farmers they serve. It would however be unreasonable to expect any great progress to be made in organising farmers for water management at the local or field channel level. There are at least four reasons for expressing such reservations.

The first is that effective farmer organisation at times requires confrontation with neighbours, especially with top-enders taking excessive water. The threat of physical violence is always present, and it takes an exceptionally committed and well-supported local-level organisation to enforce practices for the benefit of tail-enders in the face of such threats. The job is also very time-consuming.

The second reservation derives from an examination of the record of attempts

to establish formal local level rural associations in Sri Lanka over the last few decades. The record, is, in sum, not encouraging. Whether one is talking of Rural Development Societies, Cultivation Committees, Peoples Committees, Agricultural Productivity Committees or Cooperatives, the general picture is of some local success, but of the failure of the institutions to take root on the expected scale, and of low levels of performance in their allotted functions. Many people have their views on the reasons. Some might focus on cultural factors,³⁴ others on sociological variables,³⁵ or others on the general political environment. And there are no doubt particular reasons for the poor performance of each of the sets of institutions listed above. It would however be unwise to ignore the lessons of history and put all one's trust in getting it right next time. It is likely that the reasons are fairly deep rooted. This has been implicitly recognised in the recent reorganisation of the main local farmers organisations. The 1979 Agrarian Services Act in the main abandons the idea of farmers' organisations, and reverts to the use of public officials (Cultivation Officers) to perform the tasks formerly the responsibility of the Cultivation Committees.

It seems likely that the actual record of local farmers' organisations is less dismal than it formally appears. For it seems characteristic of Ceylonese villagers not to work for long periods of time through the same formal institutions: each tends to have a life of its own, and disintegrates when the original proponents lose interest.³⁶ The other side of the coin is that a considerable amount of organised collective activity is never formalised. The scanty evidence available on local level water management strongly suggests this. Cultivators in some places abide by the decisions of a 'Vel Vidane' (irrigation headman), long after the formal post was abolished. Other kinds of ad hoc and informal leaders emerge, while in some places the junior irrigation staff, labourers and overseers, seem able to encourage groups of farmers to clear channels and reach agreement on procedures for inter-farm water distribution.³⁷ Lack of formally recognised institutions does not imply lack of collective action. The policy implication is that the legal and procedural provisions for farmers' groups ought to be formulated and implemented in as flexible a way as possible in order to 'capture' within the formal institutions as much informal collective activity as possible. That may not be a very significant conclusion, but experience suggests that there are no easy answers or magic solutions in the sphere of farmer organisation.

The third main reservation about reliance on farmer groups is more important in the sense that there is greater scope for remedial action. The concern is that the organisation of farmer groups will distract attention from the more crucial institutional problem in water management: the factors which cause irrigation staff to operate main (and distributary) channels at low levels of efficiency. There is here a fundamental difference in the diagnosis of the causes of poor overall water management performance, and it is advisable to make the disagreement as explicit as possible. One view is that low efficiency levels are in the main the consequence of adverse behaviour on the part of farmers (see above). It is hoped that farmer groups will help remedy the situation by developing procedures for the equitable distribution of water and resolution of disputes, and by encouraging farmers to undertake channel maintenance work at the field channel level at least. The alternative view, shared by this author,³⁸ is that: (a) farmers are neither unusually virtuous nor unusually sinful, but that much of their adverse behaviour - scrambling for water, breaking structures, neglecting maintenance, etc. - can be explained by the way in which the main channels are managed, and the consequent uncertainty of supply and unreliability of published schedules; (b) it is of little use to try to allocate blame for the very difficult situation of staff-farmer mistrust and hostility which has arisen, but important to recognise that it is only the irrigation service which can take the initiative to change the situation and put relationships on a new footing.

Some explanation of the 'rationality' of farmers' apparently adverse behaviour has been given elsewhere.³⁹ Just one example might be useful here. The widespread complaint that farmers neglect the maintenance of field channels is fully justified. Yet look at the problem from the farmers point of view. There is no point in clearing a channel long before water releases actually begin, or weeds will quickly grow again. If when the season begins water is allowed to flow in abundance -- as it so often is -- then there is little need to clear the channel as water will probably reach the farm anyway. Conversely, if water is very scarce then it may not be worthwhile to clear the channel as water won't arrive anyway.⁴⁰

This stark characterisation somewhat dramatises the situation. The central point however is that a guaranteed flow of water in the right quantities is the best device that exists to encourage farmers to undertake maintenance. Similar kind of arguments explain other types of adverse behaviour by farmers, and there are facts to back them up:

"It is significant that when water supplies become more regular in late July

the frequency of these acts (of vandalism - MPM) diminished rapidly. It would appear that it was the frustration created by the uncertainty of the water situation rather than overall scarcity of water supplies that led to the farmers' behaviour."⁴¹

The concern about excessive reliance on farmer groups is that they may be unable to tackle the basic causes of adverse farmer behaviour; that this behaviour is in part a response to the way in which the main system is operated; and that improvements in main system operation (see below) must go hand in hand with farmer group organisation.

The fourth reservation about farmer group organisation derives from the fact that the idea is in part premised on a false image of the social composition of irrigation colonies. The image is that each group of farmers served by a field channel know one another from a long experience of cultivating in the same area, and that this familiarity provides a basis for group organisation. This is however to ignore the instability of the personnel actually cultivating. Despite their illegality, the practices of renting and mortgaging allotted land are widespread. Estimates vary widely, but it is clear that there is a substantial regular turnover. When one takes into account the equally high rates of encroachment of land not originally intended for cultivation, one understands why it is so difficult for officials to, for example, arrange elections for representative farmers: they simply do not know who is in fact cultivating land under a field channel. Official records are no guide. It is for this reason that one of the first tasks of the new Water Issue Labourers on the Uda Walawe scheme (see below) has been to find out these basic facts.

3. INCREASING THE DENSITY OF IRRIGATION FIELD STAFF

In tandem with the promotion of local farmers' water management organisations, and with much the same objective in view, the appointment of additional water management field staff has been official policy for the last couple of years. Financial constraints appear to have prevented the Irrigation Department from appointing many of this new cadre of Jala Palaka Sevekass (Water Issue Labourers), and, to the author's knowledge, it is only on the Uda Walawe scheme, run by the River Valleys Development Board, that the idea has been fully tested. The first batch of Jala Palaka Sevakas (JPSs) were given a thorough three month training about two years ago. Another batch have been trained since, and it is intended eventually to have a relatively dense coverage, with one JPS (and one subordinate labourer) for each 250-300 acres of paddy land. Preliminary

evidence suggests that the JPS system has had some modest success in re-allocating scarce water more equitably and efficiently among tail-enders, even if excessive rates of water use by top-enders have not been curbed. There are however two local factors which help account for this modest success. One is the thorough training and moral support given by a senior water management official with years of experience on the scheme. The second is that, before the introduction of the JPS system, the procedures for managing water were especially unfortunate. At the field level decision-making power was vested in agricultural extension staff, who showed little interest or commitment. Above them were Project Managers, each responsible for the general administration of a large area, and having no special interest or expertise in water management. Under this arrangement the central water management unit was almost powerless. The JPS system has for the first time given it field staff under its own control. This situation was however unique to the River Valleys Development Board operating (only) the Uda Walawe scheme. On other schemes the Irrigation Department (and the Mahaweli Development Board) already have their own field staff responsible for water issues. The author's enquiries on schemes managed by the Irrigation Department suggested that no strong need was felt for more field staff. If appointed the JPS would be doing the same job as the existing Irrigation Department permanent labourers (Watchers).

4. FARMER REPRESENTATION AT SCHEME LEVEL

It was pointed out above how existing procedures for water management, and especially the seasonal Water Meeting, have their historical origins in the practices adopted on small-scale schemes in the last century. The only concession to large scale is that on schemes the size of Uda Walawe and Gal Oya separate localities have their own meetings instead of the one large meeting covering the whole scheme.

The most favourable interpretation of the system of Water Meetings runs as follows: they are open to all farmers; chaired by the Government Agent; reach agreement about the programme of water releases for the coming season - the date of opening the sluice, the length of the period during which full flow of water is provided for land preparation, and the date of ceasing water issues, when crop growth should be complete; these decisions are reached on the basis of farmers' opinions and the advice of irrigation and agricultural extension staff on water availability, type of paddy variety to be sown, fertiliser, seed and draft-power supplies, etc. The reality is somewhat different.⁴² Although only a tiny percentage

of farmers normally attend such meetings (with no procedure for representation), the numbers run into dozens at least, and this makes the meeting too large to be a decision-taking assembly in the true sense of the term. In fact the main role of the farmers is to voice complaints, while it is the opinions of the agriculture and irrigation staff which mainly determine the decisions about water release schedules. This is inevitable on large schemes with several separate meetings. These decisions do not therefore command the moral support of the mass of cultivators, for they have little say in arriving at them. Further, these are once-off decisions taken on the basis of information available at the time. It is however centrally characteristic of water management decisions that they must be continually adjusted in the light of changing local circumstances, especially water availability. There exists no representative institution to advise on or take part in decision-making on a continuing basis.

The current arrangements for seasonal meetings are in fact obsolete. They reflect the conditions of the early part of this century before the present large-scale irrigation systems were constructed (or reconstructed) and are inappropriate today. In the first place, they cannot be representative and authoritative on large schemes where thousands of cultivators are involved. In the second place, since they meet only once per season, they are excluded from considering the crucial day-to-day decisions about how, for example, rotations are in practice to be implemented. The power of these meetings is mainly a mirage. In the third place, they are held too late to assist in effective planning for the provision of agricultural inputs, especially credit and seed. A meeting just before the season was appropriate when everyone knew that paddy was to be grown, and there was no public-sector agricultural credit to arrange. It has long been policy to encourage farmers to grow water-sparing non-paddy crops (cotton, chillies, soya beans, onions, vegetables, gram, peanuts, cowpea, etc.) in the water-scarce Yala seasons. Yet such crops have high credit requirements, need different kinds of land preparation, and involve large calls on seed. A decision to grow a non-paddy crop in Yala cannot be taken just before the season is to begin, for it is then too late to make the necessary arrangements. There is evidence that cultivators are becoming more willing to consider non-paddy crops; the reliance on Water Meetings and the consequent lack of forward planning however constitutes a major obstacle to growing them.⁴³

The need for some more permanent and formally-representative body to manage schemes has been recognised before,⁴⁴ and just such an arrangement has been

introduced on the five schemes covered by the Tank Irrigation Modernisation Project. These Tank Committees appear however to have been concerned mainly with planning the rehabilitation projects. How far they have become involved in water management is not clear. They were also intended to be part of a three-tier structure, with elected committees at the tract and local level. How far this idea has been put into effective practice is also unclear. The draft of the new Irrigation Ordinance also talks of committees at the tract/distributary channel level to coordinate the work of the local elected committees; it does not however propose to 'cap' this with scheme-level committees, and implicitly reflects the belief that farmers' organisations have a water management role only at the local level, leaving scheme management to professional staff.

5. REPRESENTING JUNIOR STAFF AT SCHEME LEVEL

Recognition of a farmer's role in scheme management would represent progress. So too would an attempt to give junior irrigation staff, especially Works Supervisors, a place on Tank Committees. As has been explained above, Works Supervisors play a major role in water management. Yet in Water Meetings they have no role. The senior staff speak for the Irrigation Department, and the farmers speak for themselves. The main reservoir of experience in managing water is not tapped at all.

6. THE INVOLVEMENT OF THE REVENUE DEPARTMENT IN WATER MANAGEMENT

One practical obstacle to the proposals for Tank Committees mentioned above lies in reverberations this would have at the level of district administration. It has been explained above how the Government Agent came to have a role as chairman of the Water Meetings, and how this formed part of a wider division of labour in which the Irrigation Department confined its role as far as possible to that of technical involvement with things, leaving the human relations aspects of water use and management to other government agencies, especially the revenue department.⁴⁵ The perpetuation of that arrangement currently gives rise to a number of problems.

The first concerns the proposed replacement of Water Meetings with permanent Tank Committees. Such Tank Committees would necessarily meet regularly. This would rule out the presence of the Government Agent, for they are currently far too busy to be so engaged. The problem is then to find some other officer able to command the respect of farmers and enforce coordination and cooperation on the separate departments and agencies concerned

with irrigation and cropping decisions, notably Irrigation, Agriculture, Agrarian Services, and the public sector banks. One possibility is the local Assistant Government Agent (AGA). The AGA however has little prestige or authority, and has no special competence on water management or detailed local knowledge to offset this disadvantage. A second possibility is to ask the Irrigation Engineer to take over this role, thus removing the screen between farmers and the Irrigation Department which the Revenue Department has historically provided. Such a step would have wider repercussions, for it would also oblige the Irrigation Department to assume responsibility for another human relations aspect of irrigation: prosecution of offenders.

The idea of supplanting the Revenue Department in the 'human relations' aspect of irrigation meets with a great deal of resistance among engineers, for it runs directly contrary to their traditions and training. Yet there is a strong case for it. Part of the justification is given above in the analysis of Water Meetings. Another part is derived from examining the effect on inter-departmental relations of the increasing involvement of Members of Parliament and other politicians in the day-to-day decisions of the public service. This has happened no less in water management than elsewhere, and is a persistent subject of complaint. Whether or not this is on balance a good thing is something of an idle question as the trend is clearly irreversible. The fact that it has happened is however reason for re-thinking the role of the revenue department in water management.

The problem arises from the fact that cultivators now have two channels through which to put pressure on irrigation department staff for more water: politicians and the regular administrative structure of GAs, AGAs and Colonisation Officers. If the one fails they can turn to the other. This becomes a problem because it makes for an unstable bargaining situation between the agencies concerned. In practice, as opposed to the legal or formal situation, the functioning of the public service depends heavily on the existence of implicit bargaining relations between officers and departments.⁴⁶ No less than in everyday life, a public officer will tend to cooperate with another department by, for example, forwarding information requested if he knows that he can rely on the same cooperation in return to meet his needs. Applying this to water management, one can see that there is scope for cooperation and mutual adjustments between the irrigation staff embodying the 'technical' approach and the institution, the GA or the MP, representing farmers. The engineer will be prepared to accede to an MP's requests if he knows that, in return, the MP will

refuse to pass on the more outrageous demands from farmers, and perhaps help to facilitate the flow of maintenance funds or permit the prosecution of irrigation offenders. Whether or not such mutual accommodation is reached depends on many factors. It is however, more likely to be achieved in a two-actor than in a three-actor situation. In a three-actor situation there is much greater scope for misunderstandings or for one actor to play the other two off against one another.

The role of the revenue department in water management has inevitably declined somewhat following the increasing involvement of politicians and the growth of the GA's duties in other spheres. It may be time to end it formally, giving the local MP a more institutionalised role, and hoping that in consequence MPs will come to understand the problems of water management better and intervene more constructively. At present they have power without responsibility, a common recipe for irresponsible behaviour.

7. REFORMING THE IRRIGATION SERVICE

It has been argued above that (a) the widespread view that water management problems lie anywhere but within the government departments actually responsible is false, and (b) that a critical issue in improving water management is more reliable and effective operation of main channels. These two arguments relate to the belief that institutional factors relating to the structure of the Irrigation Department, River Valleys Development Board and the Mahaweli Development Board in large part explain the low interest and poor performance of field staff in water management, and thus the low efficiency rate of many systems. An analysis of the recruitment, training, career, incentive, and social background factors affecting the performance of water management staff has been published elsewhere,⁴⁷ and need not be repeated here. It is useful however to summarise the conclusions about the five ways in which the variables listed above impede effective performance :-

- (i) The social and regional backgrounds and educational experiences of irrigation staff combine with the personnel structure to adversely affect work performance. The service itself is internally divided into sets of cadres - engineers, technical assistants, overseers and labourers - which are mainly self-contained and very separate in terms of background, education, work experience and professional identity.

This helps to reduce and formalise social contact between members of different cadres, and thus minimise the kind of rapport, feedback, trust which an efficient water management operation requires.

- (ii) The more senior irrigation staff in particular, - engineers and technical assistants, - have little in common with the dry zone farmers they serve, and spend so little time in field posts that they are unable to develop social contacts . (See also above.)
- (iii) The criteria for recruitment select persons able to pass written examinations, but do not in the least test for skills relevant to water management work, especially human relations ability.
- (iv) There are few positive incentives to good work performance, and those which do exist mainly encourage attention to visible tasks, i.e. construction and, secondly, maintenance work. Performance in water management tasks is difficult to check and little rewarded.
- (v) The selection, training and work experience of professional staff (i.e. engineers and technical assistants) encourages attention to an excellence in investigation, design and construction activities. Political pressures point in the same direction. Interest and experience in water management is not encouraged. The same is true , to a lesser degree, of maintenance work.

Many of these obstacles to better water management are more or less inherent in the fact that the managing agency is a branch of the public service. International comparisons suggest that irrigation systems are best managed under some alternative system which gives greater autonomy to the management of individual schemes and relates the salaries and rewards of staff more closely to the effectiveness with which they perform their tasks. However, the implications of moving in these directions are very considerable, and not worth discussing at the present juncture. (See above) There is however one policy implication of the above analysis which is worth discussing. That is the notion that performance in water management duties is harmed by the fact that they are combined with investigation, design and construction activities which absorb most time, for which more training is given, and for which there are greater rewards. Why not establish a separate cadre of water managers, preferably incorporating maintenance activities, with its own career structure ? There are four main arguments in favour of such a policy:-

- (i) As mentioned above, the present system of combining all roles in the same cadre almost inevitably discriminates against water management.
- (ii) Engineers in particular spend only a small fraction of their working time in water management duties, and thus rarely develop experience and competence.
- (iii) There is at present no way of rewarding members of junior staff who show expertise in water management; promotion to professional grades is very difficult for those who have not successfully completed civil engineering courses.
- (iv) The present personnel situation makes the creation of a new cadre relatively easy. There is a great shortage of trained engineers for investigation, design and construction work. This is a consequence of both of the 'brain drain' and the rapid acceleration of irrigation and other new construction activity within the country in recent years. The shortage is far less acute in the case of technical assistants, and does not affect lower ranks. This would seem a good moment to begin to create a separate irrigation operations (i.e. water management and maintenance) service, recruiting in particular from technical assistants and other more junior staff experienced in operations. The process of establishing a new service would inevitably take some years, but should not be unusually difficult. Engineers are unlikely to resist the loss of relatively unpopular field posts involving water management duties. The creation of a new service would provide an opportunity to introduce desirable reforms in recruitment and promotion procedures. The efforts of the newly re-opened Irrigation Department training school at Galgamuwa could be concentrated on staff who were going to be involved full-time in operations, and not dispersed on staff liable to be transferred to posts with few or no such responsibilities.

The case for a separate operations and maintenance cadre is not unchallenged. There is one major argument against, which is that schemes should be constructed by the same persons and institutions who will be responsible for operating them. The history of irrigation in Sri Lanka (see above) provides eloquent warning of the bad design which can result if the two institutions are divorced. Yet the present situation is very unsatisfactory also. It is not difficult to imagine institutional arrangements

which fall short of actually splitting the Irrigation Department in two but which, by establishing two distinct services, provide more equal incentives to good performance in the two main areas of its professional work, i.e. operations and maintenance and investigation, design and construction, respectively.

8. PROCEDURES FOR SYSTEM OPERATION

There appear to be wide differences between schemes in operational procedures: in the use of the rotational principle; in the level at which rotations are applied (i.e. field channels, distributary channels or main channels); in the practice of closing the main sluice regularly during the cultivation season to save water; in the practice of closing the main sluice after heavy rain; in the de facto allocation of authority to take decisions about opening and closing gates; in the use of the bethma⁴⁸ principle in Yala seasons, etc. Five aspects of procedure seem however to be common to all schemes: the considerable de facto authority of experienced junior Irrigation Department staff (see above); the almost total lack of written procedures; the absence of attempts to measure water and deliver by volume; the high degree of flexibility in the actual application of any stated procedures or formal decisions; and the absence of attempts to maintain water levels in main channels, leading to regular changes in levels and limited ability to control rates of flow at any point further down the system.

Present procedures thus rank very low on formality, information and control. The natural reaction of those used to different systems is to ask for more of all three. This may however be attempted in various different ways. A minimal strategy might involve small specialist teams visiting each scheme and attempting to draw up, in the light of the physical condition of each, written procedures for rotations, closure of the head sluice after rain, use of small tanks within main channels for intermediate storage, and development of systems for monitoring water levels, requirements, etc. Such procedures would require continual modification in the light of experience and of physical improvements in the system. For the physical rehabilitation of many systems seems both urgent and likely within the next five to ten years, and foreign aid funds to support such a programme are likely to be relatively easy to obtain if a major attempt to improve management can be seen to be under way.

A more ambitious strategy, and one which would require more supporting physical rehabilitation, would be to attempt to operate systems on the

basis of constant main channel water levels in order to permit greater control and more immediate response to local demands, e.g.:

"An essential feature of the main and branch canals must be that water is always available equitably to all demands over their whole length. To ensure this the canal should be operated on a system which maintains constant upstream water level at each cross-regulator at all times, irrespective of the discharge in the channel. The responsibility of the water-control staff at each cross-regulator will have the following order of priority:

- a. To maintain the correct pool level upstream of the regulator.
- b. To satisfy the demand in the reach of the main or branch canal downstream of the regulator.
- c. To satisfy the demand of distributary channels taking off from the reach above the regulator. This demand should in general terms comply with the indent approved for the period by the management organisation.

The water control staff of a given regulator should have no control over off-takes downstream of the regulator, however close they may be.

All demand from the regulator staff for additional or reduced supplies of water to maintain the pool level should be made to the staff of the regulator immediately upstream. Thus the movement of water down the canal is controlled in detail by the regulator staff in communication with each other down the length of the canal. In order to allow overall control from the project management, gauge levels upstream and downstream of all regulators, gate settings and D-channel off-take settings should be reported at regular intervals to the office of the engineer in charge, where they should be recorded. Any spillage from the canal should also be reported.⁴⁹

This particular set of procedures is not sacrosanct, but is indicative of the difference between existing practices and what might be described as 'best practice'.

Whatever procedures are adopted, one question which will always arise is how to assess water deliveries. One view is that these should be measured

decide to permit a full flow of irrigation water for the first month of the season for land preparation. Equally regularly, even those farmers whose cultivation seasons are not seriously out of joint do not all complete land preparation until about six weeks after the first day of water issues.⁵⁴ The period of full flow is extended to accommodate them, and the main reason given for lateness is lack of adequate draft power. At the same time, existing draft power stocks are utilised at relatively low average rates, partly because of the seasonal peaking of demand for them.⁵⁵ It has occurred to more than one observer⁵⁶ that a planned staggering of cultivation schedules between irrigated land units promises in principle to save on both water and power. Water could be issued to each unit only for a month, and power concentrated on each unit in turn. This would increase the effective working period of power units, decrease the time required for owners to recoup initial outlays, and, hopefully, lead to a fall in hire charges per unit of time. Not only are there no apparent losers, but the idea is administratively simple. Two decisions have first to be made: the size of the unit between which staggering takes place, and the staggering interval. Experience would probably modify initial decisions, but the range of options is anyway fairly narrow. Let us take first the question of the level of staggering. There are in principle three options: between adjacent schemes; between main channels on individual schemes; and between distributary channels. The first is probably not feasible at present because of likely farmer resistance and problems of administrative coordination; it is anyway viable only in a few areas, especially the interlinked chain of tanks in Polonnaruwa district and on the E area of the Mahaveli scheme. The third option requires better physical control structures and more precise managerial control of water than currently available. It would be feasible only as part of a much 'tighter' water management regime, involving operation of main canals at constant water levels (see above). The option of staggering between main channels on individual systems however does not run into these kinds of objections. It is difficult to understand why the suggestion has never been taken seriously, for it apparently offers an easy and almost costless method of making more efficient use of both water and farm power.

The second decision concerns the staggering interval. Here it is a matter of striking a balance between two conflicting imperatives. The need to spread out the demand for farm power as evenly as possible suggests a long interval, while the need to sow paddy as near as possible to the (climatically-determined) optimum date suggests as short an interval as possible. These considerations, along with farmer resistance to the

idea of falling far behind their neighbours for fear of being left without water, might lead to an interval of about two weeks where there are only two units of land concerned. The larger the number of staggering units, the smaller the interval.

10. PROCEDURES FOR MANAGING THE MAHAWELI SYSTEM

The above discussions of operating procedures implicitly relate to the typical large-scale irrigation system in Sri Lanka. This has a single main storage tank fed solely from its own catchment and distributing water to its command area by means of one or two main channels. Such a self-contained system is however becoming decreasingly typical, for one of the distinctive features of the current Mahaweli Project is that it links up a number of water basins hitherto separate, making possible the shipment of water by canal/tunnel from one basin/irrigation scheme to another. Linking of schemes is not entirely new. There are several examples of tanks fed in part from the drainage water of other schemes, while canal conveyance of water between Minneriya and Kaudulla and Kantalai tanks respectively has been practised for some time. The Mahaweli Project will however completely change the scale of this operation, and will raise major problems of management of water at the level of a complex system rather than a single scheme.⁵⁷

Two major issues arise: the development of operational criteria for water allocation; and the development of institutional procedures to ensure that decisions taken in the interests of the system as a whole are observed. There will be strong pressures on engineers to satisfy the demands of the schemes for which they have direct responsibility before water is passed on to other schemes lower down the system, i.e. there may be a 'tail-end' problem on the Mahaweli Scheme as a whole. The first step must however be to decide how water should be allocated. Two issues make this a very complicated programming exercise. The first is the need to continually revise and update distribution schedules in the light of rainfall patterns over the catchment and command areas. The second is the desirability of building into inter-tank allocation decisions some incentive for water-saving. Freed of this constraint, the management of each tank will have no reason not to use as much water as is available each season, and then request as large an allocation as possible for the next season on the grounds that they currently have none. While the success of the Mahaweli project requires more economical use of water than is the current norm, the inter-linking of tanks in itself threatens to decrease the incentives for sparing use.

11. SYSTEM DESIGN

All the policy issues discussed above relate mainly to institutional and management considerations. There is however an alternative approach to the whole problem: the search for physical improvements in scheme layout which will either complement or even substitute for managerial/institutional improvements. In general the extent to which Sri Lanka ought to emphasise one approach rather than the other will depend very heavily on the real cost to the economy of the capital required to rehabilitate and improve existing schemes or build new ones. Irrigation projects are relatively attractive to aid donors, and are likely to become even more so in the future.⁵⁸ If taking into account the grant element in aid and likely rates of inflation and writing-off of debts, the Sri Lankan government can raise capital for irrigation at little cost, then the case for pursuing the path of physical improvements is strong. However, the single-minded pursuit of this path can easily lead one into the wilderness: without improved management and maintenance, systems which have been rehabilitated can quickly deteriorate, leaving one after a few years with no more efficient water use and large debts.⁵⁹

In general one can divide proposed design improvements into two categories: those affecting channel layout, and those affecting the total system. It is on the first category that most attention has been concentrated, and this will be discussed first. The new 'Mahaweli design' revolving around the one cusec field channel serving a turnout area of about forty acres has already been described above. Intended principally to provide water to tail-end farmers by avoiding long field channels, it has in large part succeeded, at least at that level. It seems however that "the 'tailend problem' is usually transposed to the distributary channel level as farmers on each field channel try to extract more water than the design flow. Field channels at the end of a distributary channel often receive no water at all".⁶⁰ The intention of supplying all farmers with a sparing quantity of water, inadequate for full wet land preparation and weed control, has not yet been achieved. This new design makes very high demands on management, and permits top-end farmers to take extremely high quantities of water should the rotational schedule fail (see above).

Various alternatives to the Mahaweli layout are currently being tested, although it is recognised that all involve higher capital costs per acre:-⁶¹

- (i) One of the more obvious strategies is water re-use, such that one farmer's drainage water becomes another man's main

supply of irrigation water. This is 'obvious', at least to the irrigation engineer, because of the relatively low rate of re-use of water on most schemes. In general, water is used once and goes straight to the drains. Drainage water may be picked-up and re-used in separate systems lower down the catchment (e.g. Rajanagana from Kalawewa), or by farmers cultivating encroached land within schemes or land below schemes. Substantial designed water re-use within the same system is however rare. The most prominent example is the Kaudulla scheme, in which a substantial proportion of distributary channels are fed, towards their lower ends, by drainage ditches. This seems however to have been an expedient adopted because of the unusually flat terrain in the command area. It has not been used elsewhere. The main alternative possibility for designed re-use lies in the construction of contour channels, the lower ones being supplied with water from the drainage of those above them. There is a certain amount of historical experience with contour channels, notably with an area of contour field channels on the Uda Walawe project. Two objections are commonly raised against them. The first is that they impede drainage, leading to water-logging on their upward sides. The second is that they are prone to flood-induced cumulative down-the-slope breaches along the beds of valleys. A further drawback is that they anyway require a facility for direct supply of irrigation to the lower channels in the event of drainage water being inadequate. This both raises the per acre capital cost and demands a relatively sophisticated management procedure for 'back-stopping' drainage water supply to the lower channels without supplying them with more water than they require. There is also uncertainty about the physical potential for interception of drainage water. This is high only if most drainage water is not 'lost' in deep percolation rather than surface run-off. Experiments are currently taking place with contour distributary channels for the interception of drainage water on the H area of the Mahaweli project.⁶² The results are not yet available, but, for the reasons given above, it does not appear that this device will provide a means of side-stepping managerial problems even if it proves generally successful on technical grounds.

- (ii) Alongside the interceptor system discussed above, experiments are underway with a dual channel system, with separate distributary channels to supply water for non-paddy crops on the more elevated and better drained soils, and paddy on the lower more water-retentive soils.⁶³ Attempts to zone land for non-paddy and paddy

crops have been made on existing schemes and failed, most notably on Uda Walawe, which was originally intended in part for cotton cultivation. The dual channel system provides some physical hardware to support a zoning policy, and in this sense may ease the managerial problem. It cannot however solve it, for there are no means of physically preventing management from submitting to pressure to provide adequate water to grow paddy on the land scheduled for highland crops.

- (iii) Both the experiments discussed above are relevant to new construction. They have no application to the rehabilitation of existing schemes, where the main single problem is very long field channels with large command areas (see above). The method which has been evolved to tackle this problem on the current Five Tanks rehabilitation project is the division of existing large field channel areas into two or three turnout areas each served by a separate new field channel. The turnout areas are as near as possible to the standard forty acres in the 'Mahaweli design', and the field channels, which run parallel from the distributary channel, are of the standard one cusec capacity. The replacement of the one original field channel with two or three new ones in parallel could require considerable extra land. The land requirement has been reduced by using bricks for channel constructing, separating the channels only with a brick wall. These structures are relatively expensive to construct and repair, easily damaged, and permeable.
- (iv) By far the most radical of the new designs currently being tested involves the abandonment of attempts to limit the quantity of water supplied to the farmer, and its replacement with a system which gives the farmer control over the amount of water he uses.⁶⁴ The physical core of this proposal is the replacement of the open field channel by a concrete pipe, with individual controllable outlets for each farmer. Essential accessories are automatic float-operated gates from main channel to distributary channels and cross-regulators. For the concept will work only if main and distributary channels are kept constantly full of water. The intention is that farmers will be able to obtain water whenever they require it simply by turning on their outlet tap. It is recognised that the farmer has no direct incentive not to use more water than he requires, and that rates of use are likely to be high. To cope with this it is intended to have a dense network of small pumps to take water from the drains back up to the channels.

Part of the analysis behind this concept is very persuasive. This is that any attempt to deny farmers water is intrinsically undesirable and likely to lead to low rates of water use efficiency. In the first place, the individual farmer, each with his own cropping pattern and schedule, soil type and plot layout, knows far better than any public official what his farm's water requirements are. In the second place, current management practices, however well-intentioned, lead to very unstable and unpredictable patterns of water supply, and perhaps cannot be greatly improved. The main focus of the case is the more efficient use of water, rather than, for example, the maximisation of the area irrigated. It is only the proposal for pumping water back from the drains which makes the concept acceptable in principle, given the need to supply irrigated land to as many settlers as possible. However, it is this pumping element which has generated the most scepticism about the proposal. Observers find it difficult to believe that, taking account of all the institutional problems, this will be feasible. There are further doubts about the capital costs, which will be clarified on completion of experimental systems on the H area of the Mahaweli system and on the Five Tanks project.

There are clear parallels and causal connections between: the concentration of new design experiments on the distributary and field channel levels; the high level of activity in designing new water management institutions for the same levels; and the focus of most water management research on 'on-farm' issues. In each case the implication is that the main causes and solutions to problems are to be found at the farmer level.

The lack of fundamental questioning of the basic concepts of main system design is in some ways surprising, for conventional design in Sri Lanka (and South Asia generally), is in certain respects unusual.

The core of all large-scale systems, excluding the trans-basin shipment of water under the Mahaweli Project (see above), is as follows: a large storage reservoir created by constructing an earthen bund across one or more natural watercourses; and a network of main, distributary and field channels feeding off this reservoir and serving the farmer. All storage functions are served by the reservoir, while the channel network serves two distinct functions at the same time: the conveyance of water to different parts of the command area in preparation for use, and the delivery of water to the farmer. That the channel network performs these two functions

conjointly may seem too obvious to require any comment or question until one examines irrigation systems in other parts of the world. Water is very commonly conveyed in two distinct stages: from main source to intermediate storage, whether that be a reservoir or a farmer's cistern, and from thence to the field as required. Such systems are much easier to operate than those in which there is no intermediate storage. The actual application of water to fields can be decided locally and does not directly involve main system management. The operation of the main system can be focussed on the replenishment of intermediate storage, while delay in doing this need not have any adverse consequences if an adequate margin for error and delay is written into procedures.

"Decentralised control could be achieved in two ways: by providing water to the central points, at whatever level of decentralisation, according to a specified rule with and without intermediate storage. In both cases the decentralisation reduces the need for effective information flows and for coordination throughout the entire system. Both can reduce the 'administrative' losses of water associated with fluctuating releases."

"Decentralisation with intermediate storage has the effect of reducing short-term demand fluctuations on the basic supply. Depending upon the location and the amount of the intermediate storage there will be variable reductions in needs for communication, for coordination and for management skills. Intermediate storage should permit local flexibility in delivery scheduling, thus providing increased flexibility of cropping schedule and irrigation practice. Many examples of this combination of primary supply and intermediate storage exist in China (where these are called 'melons in the vine' systems, in Taiwan, in the United States and in Brazil."⁶⁵

In practice the operation of existing systems at constant water levels in main channels (see above) would to some degree achieve the same goal as intermediate storage: the ability to respond immediately to local needs. A constantly full main channel constitutes a kind of intermediate storage. It does not however fully separate the function of conveying water through the system and supplying it to farmers. Many Sri Lankan systems do have within them some kind of intermediate storage, mainly small village tanks which were integrated into new large-scale systems. Little attempt is however made to use them for intermediate storage, and general policy in recent years has been to avoid the incorporation of existing small tanks into new large scale systems. This is consistent with the

historical tradition of water-management with its focus on the control of the head sluice, and resistance to procedures and physical structures conducive to more decentralised control. It is however interesting that at least one observer believes this set of practices to violate a much older tradition :-

".....at the time when the ancient Sinhalese irrigation development was at its highest, large reservoirs such as Kalawewa and Padaviya were built to carry water to village tanks and not directly to irrigate lands as in recently designed projects. In the course of modern irrigation development hundreds of abandoned tanks, which early must have been the foci of villages, have been flattened to provide paddy lots in modern 'blocking out plans'. The basic design has been wrong."⁶⁶

The author's own very fragmentary field experience suggests that farmers are generally in favour of the construction of small storage tanks along main channels, and often have ideas as to where ought to be constructed. The potential for doing this is unknown, and seems not to have been seriously explored.

12. NON-RICE CROPS

One of the most persistent themes in discussion of irrigation in Sri Lanka is the observation that a great deal of water could be saved if only farmers could be persuaded to grow crops requiring less water than rice, especially in the Yala cultivation season and on the more porous soils. Many projects have included a substantial non-rice element in their proposed cropping pattern, and experiments are underway with separate feeder channels for rice and non-rice crops respectively (see above).

Why farmers insist on growing rice has been much debated. Some might point to the apparent rice bias in Sinhalese culture, others to the rationality of providing one's family with food before growing cash crops, others to the poor marketing arrangements for non-rice crops, and others to the very heavy public subsidies given for the cultivation of rice but not other crops.⁶⁷ The bias against crops other than rice implicit in the present system of Water Meetings has been discussed above.

There is increasing evidence that farmers shift to non-rice crops when their relative profitability increases. The lesson seems very clear: that the best way to induce farmers to grow non-rice crops is to make

them more remunerative. Substantial steps have been taken in this direction recently with the strengthening of the scheme for the public purchase of so-called 'subsidiary food crops'. The mechanisms have been extended, the guaranteed prices increased, and an explicit commitment made publicly to consider the interests of the producer as well as the consumer in pricing policy. The general direction seems correct. Any further steps to encourage the production of water-sparing non-rice crops must involve the increase in the publicly-provided subsidy paid to producers or the restriction of imports with the aim of increasing open market prices. This seems more promising than the construction of separate channels for non-rice crops or attempts to 'educate' the farmer.

13. OTHER ISSUES

There are a range of other issues and debates in water management which are not discussed here in any detail either because the author has nothing to contribute or because they are not felt to be amenable to much progress. Among them are the following:-

- (i) **COMMUNICATION** :- Poor communication (and transport facilities) constitute a major physical obstacle to the development of the kind of flexible and reactive management practices required for efficient water use. The case for the provision of telephones, radio systems and motorcycles to irrigation field staff is strong.
- (ii) **DOMESTIC WATER SUPPLIES**:- Channel water issues are the main source of supplies of drinking and bathing water for people and animals on most schemes. Estimates of the proportion of total water used solely for this purpose in inter-seasonal issues vary widely, as do appraisals of the possibility of finding alternative (non-saline) sources by digging wells. The need to do something in this area is a point which recurs regularly.
- (iii) **ENCROACHMENTS**:- Estimates of the encroached (i.e. non-planned) rice acreage supplied by illegal use of irrigation water also vary widely. Preliminary data obtained by the ARTI/University of Reading project on farm power suggest much lower rates than commonly alleged. There is also a range of attitudes to such encroachments. One recurrent recommendation is the use of aerial photography or the Landsat system to identify encroachments. This may be backed by the recommendation to legalise all

existing encroachments but rigidly reject others in future.

- (iv) **WATER CHARGES:-** Many economists in particular are prone to believe that the problem of excess water use can be solved by charging farmers for water on a unit basis. This is a red herring. It is physically and institutionally impossible to even measure water use by individual small farmers. Suggestions for charging on a group basis pose major institutional problems, and do not obviate the political problem of resistance and the near-impossibility of constructing a tamper-proof measuring system.
- (V). **REPRESENTATION OF TAIL-ENDERS:-** One suggestion for alleviating the 'tail-ender' problem is to give them more leverage on decision-making by over-representing them on elected or nominated consultative or management committees of the kind mentioned above. The success of such a measure would require that the formal processes of such committees could over-ride the greater wealth and power of those cultivating at the top ends of systems.
- (vi) **WATER MANAGEMENT TRAINING:-** The evident need for training for both existing staff and new recruits may be met by the recent decision to re-open the Irrigation Department training school at ^{Galgamuwa.}
- (vii) **UNIFIED SCHEME MANAGEMENT:-** Large-scale irrigation colonies have a common managerial life cycle. In the early stages of construction the development agency - the Land Development Department, the River Valleys Development Board or the Mahaweli Development Board - exercises almost complete administrative power over the area and its population. As the scheme matures the regular government departments become more numerous and established, and the authority hitherto concentrated within one agency is fragmented. For example, the Colonisation Officers who were formerly pivotal figures in local administration on irrigation schemes are left with few duties or powers.

This fragmentation of authority often gives rise to concern among those interested in water management. The existence of separate departments concerned with irrigation, agriculture, rural institutions (Agrarian Services Department), land tenure (Land Commissioner's Department), rural credit (banks), and general community development (Revenue Department and Rural Development Department) appears to militate against that kind of unified

management which efficient use of irrigation facilities seems to require. The logical response is a demand for a return to a unified area management structure, with some single agency having local authority over all government departments.⁶⁸

An attempt to introduce this principle on the Five Tanks Project quickly failed, and it is difficult to imagine the idea receiving a great deal of support from any quarter.

CONCLUSION

The general tone of the conclusions of this paper is neither particularly optimistic nor particularly pessimistic. There are major obstacles to improving water management, but also many opportunities. The main message is perhaps a questioning of whether the right balance of strategies has been found. At the level of institutions, the concentration of effort on the level of the farmer and the field channel is, judging by experience, unlikely to be worthwhile until more attention is paid to main system management and thus to the structure and procedures of the government agencies responsible. Similarly, current experiments with innovative channel layouts for new and rehabilitated schemes do not promise to circumvent management problems, and have not been matched by an equal concern to experiment with alternative main system designs.

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NOTES

1. See CH₂M Hill (1979) and Moore (1980)
2. Among the unpublished items listed in the bibliography, Wickham (1978), Kemper (1978), UNDP/FAO (1975), CH₂M Hill Inc. (1979) and Murray-Rust and Cramer (n.d.) are perhaps the most comprehensive and useful diagnoses of water management problems.
3. See Chambers (1978) and Moore (1980).
4. Bottrall (1978, p.43) illustrates the similarity of aid packages for water management.
5. For example, D.S. Senanayake: "It is essential that when a colonist is placed on the land he must be provided with a complete farm", quoted in Iriyagolle (1978), p. 68.
6. For a contemporary account, see B.H. Farmer (1957).
7. Wade (1980) pp.22-23.
8. Harriss (1977), pp. 366-368.
9. e.g. Iriyagolle (1978), p.70.
10. Moore (1980).
11. Iranamadu is a 'prize' tank in that levels of irrigation water use are consistently a fraction of those on almost all other schemes. This is achieved by preparing the land for cultivation without irrigation, whereas on most schemes a large proportion of all water use takes place during land preparation.
12. One of the most recent attempts to introduce semi-dry land preparation on the Tank Irrigation Modernisation Project ('Five Tanks Project') has more or less failed.
13. Wade (1980).
14. Laycock (1980).
15. e.g. Chambers (1978), p. 64 and World Bank, quoted in Cabinet Memorandum (1978), pp. 2-3: "The current water duties are estimated in an average of 5 acre feet/acre in the Maha season and 8 acre feet/acre in the Yala season. As several of the pilot studies carried out by the Irrigation Department indicate, the current water duties can be reduced to less than 4 acre feet per acre for Maha and 6 acre feet per acre for Yala merely by cutting down on some of the obviously wasteful practices. (My emphasis.) Thus with minimal additional physical investment it should be possible to add at least 50,000 acres to the cultivated area in the Maha season and 100,000 acres in the Yala season. On an annual average yield of 60 bushels per acre the additional cultivated area in major irrigation schemes alone could add 9 million bushels to the annual paddy production in Sri Lanka."
16. Shanmugarajah and Atukorale (1976).
17. Moore (1980), p.95.
18. This section is an implicit criticism of, among others, Robert Chambers for his advocacy of 'political and administrative will' (Chambers, 1976) as a partial solution to water management problems. This criticism does not detract from the importance of other aspects of his work, and of his major role in publicising the potential for improved water management.
19. Confidentiality prevents the quotation of precise instances and documents.
20. Murray-Rust and Cramer, (n.d.) p.16.
21. Merriam, (1979) p. 2; R.J. Dawson (Hydraulic Research Station), private communication.
22. Holmes et al. (1979), p. 12.

23. The drying-out of previously wetland paddy results in a change in the root system, a diversion of energy, and thus a loss of yield.
24. The author is drawing here mainly on his own research and Murray-Rust and Cramer (n.d.).
25. Moore, (1980) *passim*; CH₂M Hill (1979) pp.4.16-4. 20; Murray-Rust and Cramer, (n.d.) *passim*.
26. The work of R.Wade (1980) on very similar canal system in South India reveals this very clearly.
27. Lazaro et al. (1978), p.6.
28. The most common and widespread operational illustration of the group organisation principle is the Benor or Training and Visit system of agricultural extension now practised in Sri Lanka and many other countries. The point of contact for the extension fieldworker (KVS) is the 'contact farmer', who is responsible for passing information, requests, inputs, etc., between the KVS and the farmers he represents. The KVS in turn has a precise schedule for regular visits to the 'contact farmer'.
29. Hart (1978).
30. Lazaro et al. (1978) p.6.
31. Parker (1978b).
32. Uphoff et al., (1980); Agency for International Development (1979).
33. Including Radiosevich (1979).
34. e.g. Moore, (1979).
35. e.g. Ryan et al. (1958).
36. Ibid.
37. Murray-Rust and Cramer, (n.d.); CH₂M Hill Inc (1979) p.4-23; Harriss (1974) p.13; Uphoff et al (1980) p.5.
38. For Sri Lanka see also: Parker (1978a) p.1; CH₂M Hill Inc (1979) *passim*; Murray-Rust and Cramer (n.d.) pp.15-16; Harriss (1974) pp.15-16; Wickham (1978). For other Asian countries see Bottrall (1978) p.44; Chambers (1980) p.9, and Lazaro et al (1978) pp 4-6.
39. Moore (1980).
40. Wickham (1978).
41. Murray-Rust and Cramer (n.d.) p.9.
42. Ibid p.23.
43. The experience of planning the Yala 1980 season on the Kaudulla scheme, which the author observed, provided a graphic illustration of these problems.
44. e.g. Parker, (1978a) and Chambers (1977) p.110.
45. On large-scale irrigation colonies the Colonisation Officer, an official of the Land Department, has also been heavily involved in 'human

relations', often serving as a channel for farmer demands in relation to irrigation.

46. Moore 1980.
47. Ibid.
48. Bethma involves the allocation to all farmers of temporary cultivation rights on the tracts of land which can most easily be irrigated. It is adopted when water is scarce, and occurs regularly in the Yala seasons on a few schemes.
49. Hunting Technical Service Ltd., 1979b, p.138.
50. CH₂M Hill Inc., 1978, p.5-6.
51. Doubts about the value of measuring flows are elaborated by Murray-Rust and Cramer, n.d., p.17 and Hunting Technical Service Ltd., 1979b, p.138.
52. In Sri Lanka the typical soil cataena runs from well-drained Red Brown Earths on ridges to the more retentive Low Humic Gleys in valleys. The new 'Mahaweli' design with small turnout areas generally involves field channels which run directly across contours rather than falling more gently at an oblique angle. The consequence is a sharper juxtaposition on the same field channel of farmers cultivating on the Red Brown Earths and those cultivating on the Low Humic Gleys. (Hunting Technical Services Ltd., 1980, pp.19-20).
53. See Chambers (1978), *passim*.
54. Detailed investigation of this issue has recently been conducted by ^{et.al.} R.Tinsley/at the Maha Illupallama Research Station (Cropping Systems ^{Research})
55. Finding of the ARTI/University of Reading research project.
56. See Chambers (1978), and Farrington and Abeysekera, (1979), p.32.
57. An illustration is provided in the account of the operation of the Polonnaruwa complex in the Yala 1979 season (Murray-Rust and Cramer, n.d., pp.7-8.).
58. All major reports on the world food problem or development aid seem to emphasise the need for greater investments in irrigation, while World Bank spending in this area has recently increased very fast.
59. e.g. Korten (1980).
60. Hunting Technical Services, (1980), pp.19-20.
61. Ibid. p.20 and p.51.
62. Hunting Technical Services Ltd., (1979a) and (1980).
63. Ibid.
64. Merriam (1978)
65. Levine (1979), p.10.
66. Iriyagolle (1978), p. 69.
67. ILO (1971), pp. 109-111.
68. e.g. Parker (1978a).

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