SECTION III

ENGINEER'S ROLE IN WATER MANAGEMENT

by

A. Maheswaran BSc, BSc (Eng), CEng, MICE, FIE (SL)

and

Dr. W. D. Joshua

1. Introduction

Irrigation can be said to be the "lifeblood" of the country. The art of irrigation has been practised in the country for centuries. Several irrigation schemes costing millions of rupees have been constructed in the recent past and several more major schemes are being implemented or planned for implementation in the next few years. At the moment about 500,000 acres are being irrigated under major schemes and about 400,000 acres under village irrigation schemes. Are we making the best use of the water that is stored and conveyed to the farmers at great cost to the country? A truthful answer is "No". What can be done to remedy the situation? The solution is not simple but the engineer can play a definite role in salvaging the situation. The Engineer (meaning the Irrigation Engineer inclusive of the T.C.E.O. Engineers dealing with irrigation schemes) is the custodian of the water and it is he who should be the prime mover in planning, distributing and utilising the water for ensuring an efficient cultivation. In order to understand the role that the Engineer has to play in these activities, the existing practices and legislation for such practices will be presented. Then an analysis of the problems will be made and suggested procedures to be adopted will be outlined. For the present, the presentation will be restricted to the procedures to be adopted in major irrigation schemes only.

2. Existing Irrigation Procedures

A major irrigation work means "an irrigation work constructed and maintained by or under the authority of the Director of Irrigation out of monies provided by Parliament". 1

Every Engineer is familiar with the normal operating pattern in major irrigation schemes. During October each year, or immediately after the tank fills up to a safe level, he receives a notice from the G.A. (or an Official authorised by him) informing him of a "Cultivation Meeting" to decide on the dates for cultivation procedures. On the appointed day the Engineer presents himself at the meeting and tenders advice on the extents that can be cultivated with the storage available and the prospects for the season. The cultivators then proceed to make their decisions regarding dates for the various farming operations, varieties of seed paddy to be used, acreage to be cultivated etc. The same series of decisions are made for the Yala Cultivation also, which would be at a meeting held in about April each year. At these meetings the Engineer's advice may or may not be accepted.

The Engineer goes back to his office after the meeting and issues instructions to his Technical Assistant to open the sluices, for the acreages to be cultivated, on the dates fixed at the cultivation meeting. The Technical Assistant carries out the instructions and all seems to go well. When some farmers complain about shortage of water to their farms, additional water is sent down the channel or some clearing of the waterway is carried out to ensure an adequate supply of water. On the appointed day, the sluices are closed unless the revenue authority extends the last date of water issue by an administrative order. Everything is done in a democratic way and all are happy.

What then is the problem?

3. Problems in Water Distribution

All Engineers know that practically most irrigation tanks in existence are designed for supply of water for Maha irrigation only. Any water remaining in the tank, at the end of the Maha cultivation, is used for a Yala cultivation. If water is "wasted" during Maha season, the amount available for Yala cultivation will consequently be reduced thereby causing a reduction in the extents to be cultivated, for the Yala season. It is there-

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1. Section 118 of the Irrigation Ordinance (Chapter 453) as amended by Act No. 48 1968.
fore evident that utmost care has to be taken in the use of water so that the maximum possible acreage of crops could be cultivated with a given quantity of water in the reservoirs.

The problems that arise are:

(a) **Initial Delay in Cultivation**

In accordance with the decisions made at the cultivation meeting, the engineer opens the sluice on the "appointed day". The farmer, for various reasons, such as non-availability of farm machinery and implements, delay in obtaining "credit" etc., is not ready to commence his cultivation operations. Only a few farmers work their fields and in the meantime irrigation water goes to waste through the drainage.

(b) **Best Use of Effective Rainfall**

For cultivation during the Maha season, irrigation water is basically meant for supplementing the rainfall. If the farmer delays his cultivation operations he misses the rainfall in the early part of the season and large doses of irrigation water are required to mature the crop in the dry months of February and March.

(c) **Seed Paddy**

The variety of paddy to be sown is determined at the cultivation meeting. However, this decision is not strictly adhered to and the farmers use longer term varieties for various reasons viz. non-availability of the required variety, desire to get higher yields from long-term variety of seed paddy etc.

(d) **Insufficient Land Preparation**

The farmer’s field is invariably not properly prepared for efficient irrigation. The land is not properly levelled thereby needing more water to irrigate the high spots in his field. The lilydale ridges are not properly made resulting in excessive dyke leakage.

(e) **Over-Application of Irrigation Water**

The farmer, through ignorance of water requirements, tends to over-irrigate his crops.

(f) **Damage to Irrigation Channels and Channel Structures**

In order to get a little more water to his field, some farmers cause damage to channels and channel structures (sometimes structures are damaged to obtain water for illicit cultivations). These actions cause problems in controlling water issues thereby leading to waste of water.

4. **Suggested Solutions and Procedures**

In order to be successful in the distribution of water, the Engineer should have intimate knowledge of—

(i) **The Irrigation Scheme**: The Engineer should know the layout of the scheme, capacities of canals, locations of control structures etc.

(ii) **The Cultivators**: He should know the Chairman of the APCC in the area, members of the cultivation committees, and other known leaders among the cultivators. These representatives of the farmers should have confidence in the Engineer’s ability to assess the situations, as they arise, and help them in their operations.

(iii) **The Paddy Plant**: He should know the various stages of growth of the paddy plant and the requirements of water at such stages. (See annex).

(iv) **Laws and Regulations**: The Engineer should have intimate knowledge of Laws, Ordinances and regulations that are available to regulate the use of water and the cultivation practices. The Engineer should have the following in his office for reference:

The Irrigation Ordinance (Chapter 453) as amended by Act No. 48 of 1968.

The Agricultural Productivity Law No. 2 of 1972.

When the Engineer tenders his considered technical opinion at a Cultivation Meeting, the cultivators should make their decisions within the scope of the recommendations given by the Engineer. If the decision made by the cultivators is detrimental to the national interests, then the presiding officer has powers to over-rule such decisions. This is provided for in Section II, Sub-section 3 of the Irrigation Ordinance which states as follows:

"At a meeting of the allottees and tenant cultivators, and where there are no allottees or tenant cultivators of any lands, the proprietors of those lands; within any irrigable area or tract, a majority of those present at such meeting shall have power— to decide, before the commencement of the cultivation season, and subject to the approval of the Government Agent, such matters pertaining to cultivation as:—

(i) the dates of the commencement of cultivation operations including ploughing, sowing and reaping, and

(ii) arrangements for the annual maintenance of irrigation works, and any other matters relating to the execution of rules made under subsections (i) and (ii)."

In this connection an extract from "A Manual of Practice and Procedure on Maintenance of Irrigation Works" by Mr. S. Arumugam is given below:

"Divisional Irrigation Engineers should in particular note the new regulations 14; framed under the ordinance and published in the "Ceylon Government Gazette" No. 1090 of December 15, 1930 whereby:

"Divisional Irrigation Engineers should in particular note the new regulations 14; framed under the ordinance and published in the "Ceylon Government Gazette" No. 1090 of December 15, 1930 whereby:
The Government Agent shall, in consultation with the Divisional Irrigation Engineer determine the dates for the commencement and completion of cultivation in each season of the land to be cultivated under any major irrigation works.

Where the Government Agent, after consultation with the Divisional Irrigation Engineer, is of opinion that by reason of the scarcity of water or for any other cause, the cultivation in any season of the entire extent of land which is capable of cultivation under any major irrigation work is not practicable, he may:

(a) specify the tract or tracts that may be cultivated in that season, or
(b) specify the proportion of each proprietors’ land that may be cultivated in that season.

When consulted, the D.I.E., should make a well considered recommendation taking into account the tank storage, anticipated fluctuations in storage due to weather and other local factors. The responsibility of such recommendations should be borne well in mind and repercussions due to errors well realised”.

(a) Initial Delay in Cultivation
Under the present difficulties encountered by the farmer, it would not be possible for all the farmers or even a substantial number among them to commence cultivation on the due date as decided at the cultivation meeting. Though it is obligatory on the part of the Engineer to open the sluice on the prescribed date, he need not do so unless he gets a written requisition for the water from the authorised representative of the farmers.

In this connection the following extracts from the “A Manual of Practice and Procedure on Maintenance of Irrigation Works” by Mr. S. Arumugam may be of interest to the Engineer:

“68 At Major Irrigation Schemes: The Irrigation Department Maintenance Overseer of the scheme is in responsible charge of issues at the Head Sluice. He should operate this for purposes of issue, on receipt of written communications from the cultivation officer working under the Revenue Officer responsible for the cultivation under the scheme. These communications should be confirmed by the Engineer or Officer-in-charge”.

It has been observed that indiscriminate opening of the sluices has led to situations where the tanks had been almost emptied even before the farmers have actively commenced their operations. The farmer’s representatives should be made to intimate the extents which are ready to receive water under specified channels so that the Engineer can determine the quantities to be sent down under such channels.

(b) Use of Effective Rainfall
If the Maha cultivation is commenced early in October, it would be possible to grow the crop with very little use of irrigation water. The farmer could be given a limited issue of irrigation water to “dryplough” his field. This practice coupled with the use of weedicides could make a large saving in irrigation water. However, limitation on the availability of foreign exchange for the import of weedicides and the farmer’s reluctance to commence a cultivation without seeing an adequate quantity of water in the tank, are factors which usually hinder the introduction of such programmes.

(c) Seed Paddy
The selection of the variety of seed paddy should be done judiciously. It is the responsibility of the Agricultural Extension Service to ascertain the availability of the different varieties of seed and intimate the cultivators for them to arrive at an appropriate decision at the cultivation meeting. The decision to be made at the meeting should take into consideration the availability of water, seed paddy and the time factor. Issue of seed paddy from Government Sources should be controlled so that only approved varieties for the particular area are issued. Further fines or total withdrawal of irrigation water should be imposed on farmers who disregard the decisions reached, by the Revenue Authority in order to prevent widespread disregard of the collective decisions reached at the cultivation meeting.

(d) Insufficient Land Preparation
The farmer’s land has to be well graded, almost level, after division into liyaddes of convenient size. If this is not done, uniform application of irrigation water will not be possible and considerable over irrigation will take place resulting in wastage of water.

The liyadde ridges have to be strong and leak-proof in order to retain the water without loss. Special care should be taken with the outer ridges as leakage through these will be to the drainage streams.

(e) Over Application of Irrigation Water
The Engineer should be well aware of the time and quantity of water required for the crop. He should advise the farmer and at the same time have effective control over the distribution of water. Please see annex regarding the management of water at farm level.

(f) Drainage to Irrigation Channels and Control Structures
In an ideal scheme, where the farmers as well as the Engineer are well aware of the requirement of water for the crop and the water distribution is carried out rationally, instances of damages to the canal system will not be experienced. If the Engineer establishes his interest in the welfare of the farmers, most of the problems get automatically solved.

However, this situation cannot always be established in practice. Isolated instances of damages will take place. When these take place, prompt action should be taken to repair the damage so that loss of water is prevented. The revenue authority should be notified of the damage so that inquiries could be held and action taken in terms of the provision of the Irrigation Ordinance.
5. Conclusion
The Engineer has a special function to perform in bringing about increased productivity of the lands in our irrigation schemes. He should identify himself with the interests of the farming community and work with them as a group. He should work out effective systems of measurement of water, rotational water issue and monitoring of water issues. Recent experiences, in times of crisis, have shown that this could be done with a little additional effort on the part of the Engineer.

Guidelines for Action

1. Cultivation Meetings
   Attend (or send representative) with recommendations for extents to be cultivated. For paddy use 4 Ac. ft. for Maha and 6 Ac. ft. for Yala if previous statistics of cultivation are not available.

2. First Date of Water Issue
   (a) Await requisition for water from A.P.C.C. Cill for details of acreage, indicating acreage under each field channel.
   (b) Compute water required for initial flooding as follows: sluice discharge \( Q = \frac{x}{1.5} \times A \times \frac{(t2/t)}{T} \times x \) 1.5

3. Water for Mudding
   (a) Check an area where mudding operations are to be done.
   (b) Compute water required: \( Q = \frac{x}{1.5} \times A \times \frac{(t2/t)}{T} \times x \) 1.5
   Where: \( Q = \) Discharge in cusecs
   \( A = \) Area in acres
   \( T = \) Time of issue in hours
   The factor 1.5 is to allow for conveyance losses between head sluices and the farms. This value has been arrived at after carrying out preliminary studies at Rajangana.

4. Water for Plant Growth
   Compute water requirement \( Q \) on the basis of rotational program proposed.
   Allow for each field channel on the basis of 2 1/2 to 3 1/2" (for details see Table III of annexure) water issue during 16 hours and then shut down for the rest of the week. Add 30% of F.C. requirements to obtain main channel discharge.

5. Last Date for Water Issue
   Check on maturity of crop under each F.C. and cut off water (2 weeks before harvest).

6. General
   (a) Get M.O.O to maintain dates on which water was first issued to each F.C.C.
   (b) Maintain record of type seed paddy used by each farmer and date of sowing.
   (c) Maintain record of yield in each paddy lot.

WATER MANAGEMENT FOR RICE AT FARM LEVEL

Introduction
In Sri Lanka irrigated paddy is traditionally grown with standing water in the fields. Due to the common practice of irrigating the fields from liyadde or liyadde and due to bad maintenance of liyadde bunds, (dykes) water in the fields often flows freely into the drainage streams. As a result of these conditions, large amounts of water are wasted by surface run-off and deep percolation, with attendant losses of valuable fertilizers in the drainage water.

Recent studies in other tropical countries have very convincingly shown that paddy can be grown under intermittent irrigation, without causing any serious yield depression provided soil moisture is maintained close to saturation. Further, these studies have proved beyond any doubt that flowing water in the field is not a necessity as long as the fields have adequate drainage. Since conditions in Sri Lanka are not very different from those prevailing in the countries in which these studies have been done, it could be assumed that intermittent irrigation could be profitably adopted in Sri Lanka.

Presently the actual amount of water used by farmers for rice cultivation, is far in excess of what is actually required. The main causes of poor water management in rice cultivation are:

1. Insufficient control of water issues along the channel system to match water discharge with acreage cultivated.
2. Farmers demanding too much water in the mistaken belief that standing water is essential for rice cultivation and that the growth and yield of rice increases indefinitely with the amount of water applied.
3. Wastage of large amounts of water into drainage streams due to badly maintained liyadde bunds.
4. Unequal water flow to farms from the field channels, i.e. when all farm outlets under a field channel are open, flow rates through farm outlets at the tail-end are usually lower than those at the head of the field channel. Field channels are kept open to supply the required amount of water to farms at the tail-end of field channel thereby wasting water in farms at the upper end. Farmers at the head of the channel usually draw more water than is necessary thereby depriving the tail-end farmers of their share of water.

Taking these points into consideration, a tentative field guide for improved water management at farm level, based on experimental data as well as experiences in the Dry Zone of Sri Lanka, is given below.

Land Preparation
Land preparation has to be staggered within the scheme as water cannot be issued in sufficient quantities to the entire scheme at the same time due to limited capacity of the channel system. It is also practically impossible for all farmers to carry out land preparation
work at the same time, due to various other constraints such as non-availability of tractors, buffaloes etc. Therefore water issues for land preparation have to be scheduled in rotation to each farm. The water duties to be adopted are shown in Table 2. The total water requirement of 7 inches for land preparation given on Table 2 may not be sufficient for soils with high percolation rate. Therefore water issues for land preparation should be adjusted according to the soil type occurring in the area. However, care should be taken to avoid excessive issue of water in order to prevent waste of water into drainage streams.

Duration of land preparation should be limited to two weeks and water issue of a total of 7 inches should be made during this period as follows:

1. Initial issue of 5 inches in 36 hours for soaking and preliminary tillage (i.e. 0.149 cusec/acre).
2. Second issue of 2 inches in 36 hours after 4 or 5 days for puddling operations (0.06 cusec/acre).

During the period of land preparation farmers should be instructed to repair and strengthen all lyadde bunds to minimize losses by leakage.

Irrigation of Fields

Since these guidelines are meant chiefly for the existing irrigation schemes the method of irrigation considered for the paddy fields will be the lyadde to lyadde system as this is the most prevalent method in the country. Water from the farm outlet will flow into the top-most lyadde from which it will flow into the adjoining lyadde via the opening in the lyadde bund and so on to the last lowermost lyadde. The lowermost lyadde will have no outlet into the drainage. Once the last lyadde has accumulated sufficient standing water (approximately 2.5 inches), the opening in the bund separating it from the next upper lyadde is closed with earth so that water accumulates in this adjoining upper lyadde. This procedure is followed till the lyaddes are irrigated to have standing water of about 2.5 inches with all openings between adjoining lyaddes closed. Immediately before the next irrigation schedule, openings between adjoining lyaddes are restored and the procedure is repeated.

During the latter stages of the intervening period between irrigations, there will be no standing water in the field, but the irrigation is so scheduled that the soil moisture does not deplete to more than 70% of saturation before the next irrigation. In this soil moisture range, there is no adverse effect on plant growth or yield. By saturation it is meant that the soil is fully soaked with water even when there is no standing water. This condition can be identified in the field by taking a handful of soil and squeezing the sample by exerting pressure with the fingers. If the soil is saturated, water will flow out between the fingers easily.

Field Water Requirement

Evapotranspiration of rice at each stage of growth was obtained by multiplying the evapotranspiration of the standard reference crop (gross) by a crop factor appropriate to the stage of growth of the rice plants. The evapotranspiration of the reference crop itself was calculated from climatic data using the modified Penman’s Method. The variation in monthly average evapotranspiration of the reference crop is relatively small during the Maha and Yala growing seasons. Therefore the maximum value for each period (i.e. 7 inches per month for yala and 5 inches per month for maha) was used in the calculation. Consequently the evapotranspiration of rice calculated in this way would be a slight overestimate and could be reduced when further experimental data become available. Water losses due to deep percolation and dyke leakage are assumed to be 3 inches per month based on experimental and permeability data. However, this figure needs refinement after further investigations.

It should be clearly understood that the field water requirements thus calculated are based on soil and climatic data of Maha Illuppallama. These conditions are generally representative for the most parts of the dry zone. However, in instances where there is marked variations in soil and/or climatic conditions, the field water requirement will have to be modified accordingly.

To facilitate field operations, frequency of irrigation is maintained constant at 7 days and only water duty is adjusted for different growth stages of the rice plants. In order to identify the growth stage in the field, some plant characteristics and other relevant information are given in Table 1.

Water Duty

All water duties are calculated on the basis that the field water requirement for each farm can be met within a 36-hour irrigation. In order to attain uniform irrigation of all fields, it is very essential to ensure equitable discharge in each farm outlet and the correct estimated flow at the field channel inlet. Table 3 gives the field water requirements and the duties for a 7 day rotational issue of water and a 36-hour irrigation.

If all the farms under each field channel are to be irrigated in 36 hours, it is very essential that the field channel should have sufficient capacity to carry the discharge according to the duty given in Table 3. If the field channel capacity is small or conversely if the irrigable extent under a field channel is large, the duration of irrigation and the field channel issues have to be adjusted accordingly.

Example of a 36-hour issue for a 7 day rotation

| Total acreage under field channel | 21 |
| No. of Farms | 14 |
| Designed F.C. Discharge | 91 cusec |
| Age of Paddy | Mid stage — Yala |
| Water Duty (Table 3) | 11.3 acres/cusec or .088 cusec/acre. |

Regular field channel issue to 1.24 cusec. Block field channel after the 7th farm outlet and issue water to the first 7 farms for 36 hours. At the end of 36 hours, block the 7 outlets of the farms which was irrigated and
issue water to the balance 7 farms. Therefore the field channel should carry water for 72 hours (3 days) to irrigate 28 acres for a 7-day rotation.

(b) If the field channel can carry only .93 cusecs, then this flow can irrigate only 10 acres according to duties given in Table 3. Therefore block field channel after the 5th farm outlet and issue water to the first 5 farms for 36 hours. After 36 hours, block these 5 farms' outlets and block field channel after the 10th farm outlet and issue water for 36 hours to farms Nos. 6 - 10. Then block farm outlets Nos. 6 - 10 and reduce field channel discharge to .7 cusecs and irrigate farm Nos. 11 - 14 in the next 36 hours.

### TABLE 1

<table>
<thead>
<tr>
<th>Growth Stage</th>
<th>Variety</th>
<th>Period after sowing days</th>
<th>Plant Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Stage</td>
<td>4 months</td>
<td>0 - 30</td>
<td>Planting and early tillering</td>
</tr>
<tr>
<td></td>
<td>3 months</td>
<td>0 - 20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 months</td>
<td>0 - 20</td>
<td></td>
</tr>
<tr>
<td>Crop Development Stage</td>
<td>4 months</td>
<td>30 - 70</td>
<td>Active Tillering and Heen Bundy</td>
</tr>
<tr>
<td></td>
<td>3 months</td>
<td>20 - 50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 months</td>
<td>20 - 45</td>
<td></td>
</tr>
<tr>
<td>Mid Stage</td>
<td>4 months</td>
<td>70 - 115</td>
<td>Maha Bandy, flowering and Heading</td>
</tr>
<tr>
<td></td>
<td>5 months</td>
<td>50 - 80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 months</td>
<td>45 - 75</td>
<td></td>
</tr>
<tr>
<td>Late Stage</td>
<td>4 months</td>
<td>125 - 155</td>
<td>Maturing</td>
</tr>
<tr>
<td></td>
<td>3 months</td>
<td>80 - 100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 months</td>
<td>75 - 90</td>
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### TABLE 2

**WATER DUTY FOR LAND PREPARATION**

<table>
<thead>
<tr>
<th>Water Issue</th>
<th>Field Water Requirement inches</th>
<th>Duty Acres/Cusec</th>
<th>Cusec/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st issue for soaking and preliminary tillage</td>
<td>3</td>
<td>7.2</td>
<td>0.149</td>
</tr>
<tr>
<td>2nd issue or puddling &amp; levelling</td>
<td>2</td>
<td>18</td>
<td>0.036</td>
</tr>
</tbody>
</table>

### TABLE 3

**WATER DUTY FOR PADDY IRRIGATION**

36-hour farm water issue for a 7-day rotation

<table>
<thead>
<tr>
<th>Growth Stage</th>
<th>Field Water Requirement inches</th>
<th>Duty Acres/Cusec</th>
<th>Cusec/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yala</td>
<td>Maha</td>
<td>Yala</td>
<td>Maha</td>
</tr>
<tr>
<td>Initial Stage</td>
<td>2.80</td>
<td>2.54</td>
<td>12.86</td>
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<tr>
<td>Crop Development Stage</td>
<td>5.10</td>
<td>2.49</td>
<td>11.39</td>
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<td>Mid Stage</td>
<td>3.18</td>
<td>2.57</td>
<td>11.35</td>
</tr>
<tr>
<td>Last Stage</td>
<td>2.65</td>
<td>2.18</td>
<td>15.38</td>
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