PROGRESS REPORT ON THE

TECHNICAL ASSISTANCE STUDY (TA 846 SRI)

IRRIGATION MANAGEMENT AND CROP DIVERSIFICATION

(Sri Lanka)

OCTOBER 1988

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PROGRESS REPORT ON THE TECHNICAL ASSISTANCE STUDY (TA 846 SRI) OCTOBER 1988

I. INTRODUCTION

Context of the Study

This study of Irrigation Management and Crop Diversification is being carried out under a Technical Assistance Agreement (T.A. No. 846 - SRI) dated 27 November 1987, between the Government of the Democratic Socialist Republic of Sri Lanka (GSL), the International Irrigation Management Institute (IIMI), and the Asian Development Bank (ADB). The study is being implemented by IIMI in the Kirindi Oya and Uda Walawe projects in the southern part of Sri Lanka in close collaboration with the agencies in charge of development and management of these projects. It addresses, through field-level research, priority issues of importance and relevance to the two projects in the processes of irrigation system management, with particular attention given to the requirements of crop diversification.

Commencement of the Study

The study commenced on 1 February 1988 and is of 26 months duration. The field research in Kirindi Oya project started in early March. The first water issue in the research area was made in late January and the season continued upto June. The study could cover part of the season. The field research in Walawe project commenced in April and continued throughout the yala season which ended in September. The maha season of 1988-89 started in both projects in October 1988 and will continue up to March 1989.

Progress Report

An Inception Report was submitted in mid-March 1988 at the end of stage 1 of the study. It contained the findings of the literature review, research proposals, and programs detailing data collection, field observations, analysis and expected results, and other details of implementation for stage 2 of the study covering four seasons of field research. The identification of two sub-systems for research, one each in Kirindi Oya and Walawe projects, was also part of the research planning described in the report.

When the Inception Report was discussed at the first meeting of the Study Advisory Committee (SAC) in Colombo on April 7, it was suggested that it would be useful to have a progress report on the study at the end of the first season of field research instead of waiting for the Interim Report due, as per the reporting requirements, in April 1989 at the end of two seasons of research.

This progress report was prepared in October 1988 and describes the progress in the implementation of the research, and preliminary findings and analysis. It should be read in conjunction with the Inception Report and the research proposals described in it. The report is organized to describe the research of the first season in Kirindi Oya project in Chapters II to VI and in Walawe in Chapters VII to X. In the Walawe project, the first season data collection program has just ended in September and there was not adequate time to analyze the data and report on the findings of research on some dimensions; they will be presented in the Interim Report.

The Appendix to Chapter 1 provides extracts from the inception report on selection of sub-systems and Figures 1.1 to 1.8 for easy reference regarding field research locations.

Implementation of the Study

Field Offices

A house was located in Tissamaharama in February 1988 to serve as a field office and provide partial residential accommodation to some of the research staff working in Kirindi Oya. We were also allowed by the Deputy Director (Research), Angunakolapelessa, to use for some time one of the quarters in the Agricultural Research Station, Wirawila as a field office. Later we vacated it as it was needed by the staff of the research station. We were then allowed use of another quarters by the Project Manager (Settlement).

We hired a house from 1 May 1988 in Embilipitiya also to serve as a field office and provide residential accommodation to research staff. Resident Project Manager (Walawe) also provided us quarters nearer to the field site to serve as a field office.

Staffing

International Staff:

The following senior staff of IIMI continue to work on the study.

Dr P.S. Rao, Engineer/Team Leader
Dr S.M. Miranda, Engineer
Dr C.R. Panabokke, Agronomist
Dr D. Merrey, Social Scientist
Dr M. Kikuchi, Agricultural Economist

National Staff:

Research Associate: Mr W.A.A.N. Fernando (Irrigation Engineer) is in charge of field operations and coordination and supervision of research activities in both Kirindi Oya and Walawe projects. He is based in Tissamaharama.

Research Assistants:

Mr B.R. Ariyaratne (Agricultural Engineer) and Mr P.G. Somaratne (Sociologist) work in the Kirindi Oya project. In the Walawe project Mr K. Jinapala (Sociologist) has been working and continues to be there; Mr Neil Fernando (Agricultural Engineer) worked from April through August. After he left Mr R.A.D. Kemachandra (Agricultural Engineer) has taken his place since August. Mr L.R. Perera (Sociologist) has also been assigned to work in Walawe since August. Mr A.P. Keerthipala (Agricultural Economist) has been working in both Kirindi Oya and Walawe projects.

Counterparts for the Study:

Miss D.M.L.C. Diyagama, Irrigation Engineer, was nominated by Mahaweli Economic Agency as counterpart engineer from Walawe project for the study. Mr B.K. Jayasundera, Senior Irrigation Engineer, was nominated by the Irrigation Department as counterpart for the study in Kirindi Oya project.

Committees

The Study Advisory Committee (SAC) met in Colombo on 7 April; the Study Coordination Committee (SCC) for Walawe project met in Embilipitiya on 10 May 1988 and the SCC for Kirindi Oya project met on 11 May in Tissamaharama. The Inception Report was discussed in all the meetings and useful suggestions regarding research were made by the members of the committees. Issues of coordination of research activities and collaboration with the various agencies were also discussed.

We have received excellent cooperation in our research from all the agencies, officers, field level staff, and farmers in both Kirindi Oya and Walawe projects.

The next meeting of the SAC is scheduled for 8 December in Colombo. The SCCs will meet in January.

Collaboration with Department of Agriculture

In regard to the research component on 'On-farm Irrigation Management for Upland Crops,' we had meetings with the staff of the Department of Agriculture (i) on 24 May 1988 at Wirawila, (ii) on 5 July 1988 at Wirawila, and (iii) on 3 August 1988 at Hambantota. Development of the Agricultural Research Station (ARS) at Wirawila and on-station and adaptive research programs were discussed. The collaborative efforts have been successful in expediting the work on land levelling and field canal construction at the field research station at Wirawila. More details are given in Chapter V.

Workplan

The workplan and schedule given in the Inception Report remain the same except for the addition of a SAC meeting in December 1988. Details of changes in the data collection programs for various research components are provided in the respective chapters that follow, if there are any changes from the first season program given in the inception report.

Interim Report

The maha season 1988/89 has commenced in the two projects in October 1988. The progress of land preparation seems to have somewhat slowed down because of the disturbed conditions in some parts of the project areas. But the maha season crops are most likely to be harvested by March 1989. The Interim Report will be submitted by 30 April 1989, one month after the end of the second season. It will contain supplementary analysis of the data from season 1 in addition to what is reported in this progress report, preliminary findings of season 2, and updated research proposals and the work programs for the remaining two seasons.

Problems and Issues

The major issue of concern is the unsettled social and political situation in the project areas. There have been frequent disturbances. There is apprehension that the situation may become more unstable and it may have adverse repercussions on the progress of this study.

The second concern, also raised in the Inception Report is about the accuracy of the data on socio-economic, institutional and behavioral aspects of research. It may be somewhat biased in the current situation and environment obtaining there.

Comments are Welcome

We would welcome comments and criticism of the contents of this report. It would help further the cause of research.

Appendix

(Extract from inception report)

Selection of Subsystems

The study envisages the selection of one sample subsystem in each of the two projects, Kirindi Oya and Walawe, for intensive data collection and analysis (the intensive sample), supplemented by extensive and intermittent monitoring at the next higher level subsystem (extensive sample). Each sample sybsystem should comprise the total command area of one distributary canal and its field canals and should also include both upland (well drained) and lowland (poorly drained) soils. The subsystem for Kirindi Oya should be selected in the newly developed Phase 1 area. The subsystem for Walawe should be relevant to addressing rehabilitation research issues. Based on these considerations the following subsystems have been selected for the study.

Kirindi Oya Project. The intensive subsystem consists of the Distributary Canal 2 (DC 2) of Branch Canal 2 (BC 2) on the Right Bank Main Canal (RBMC). It serves a command area of about 91 ha in Tract 5. Each farmer has an allotment of 1 ha. There are thus 91 farmers. BC 2, from which DC 2 takes off, has a command area of 528 ha. The schematic layouts of BC 2 and DC 2 are shown in Fig. 1.4 and Fig. 1.5 respectively. The blocking-out plan for DC 2 is shown in Fig. 1.6. While DC 2 will form the intensive sample for the study, BC 2 will provide the basis for the extensive sample from the next higher level subsystem.

Walawe Project. The intensive subsystem consists of the command area served by Distributary Channel 8 (D8) of the Chandrikawewa Block (Figs. 1.7 and 1.8). It has 107 allotments each of 1.2 ha (3 acres) and therefore an official area of 128 ha. the actual area served is estimated to be 10% more than this (about 140 ha total) because of encroachment. The Chandrikawewa Branch Canal has 18 distributaries serving nearly half of the Chandrikawewa Block, which has a total command area of over 2300 ha. This branch canal provides the basis for the extensive sample. D8 is one of the 18 distributaries. In addition to nine turnouts, there are a large number (nearly 50) of direct outlets from D8. Farmers have also built a number of bunds across D8 at various places to raise the water level. The rehabilitation will substantially change the shape of the water distribution system in D8.

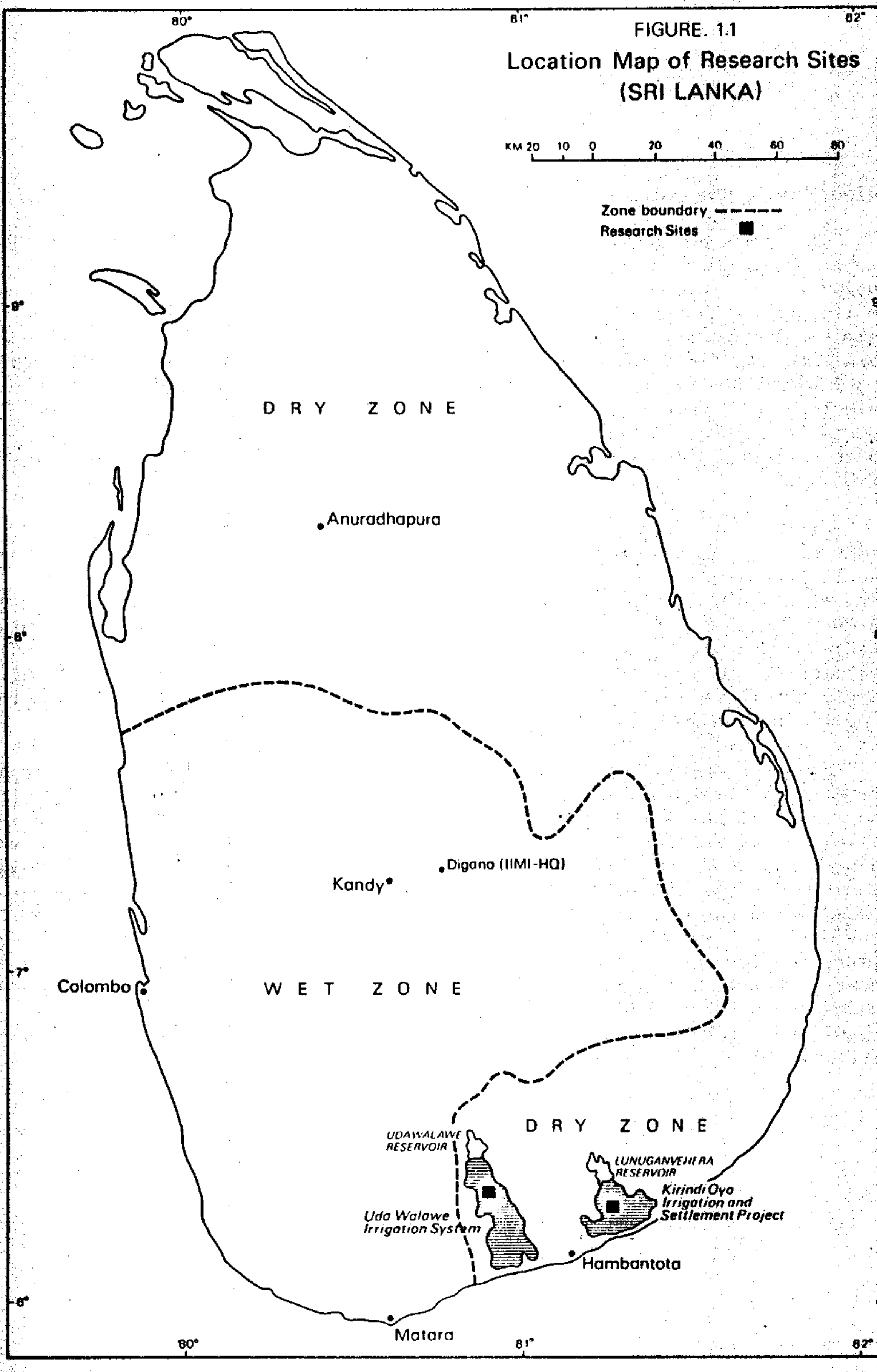


FIGURE. 1.1
Location Map of Research Sites
(SRI LANKA)
KM 20 10 0 20 40 60 80
Zone boundary
Research Sites
80°
81°
82°
9°
8°
7°
6°
DRY ZONE
Anuradhapura
Digana (IIMI-HQ)
Kandy
Colombo
WET ZONE
DRY ZONE
UDAWALAWE RESERVOIR
LUNUGANVEHERA RESERVOIR
Kirindi Oya Irrigation and Settlement Project
Uda Walawe Irrigation System
Hambantota
Matara

FIGURE 1.2

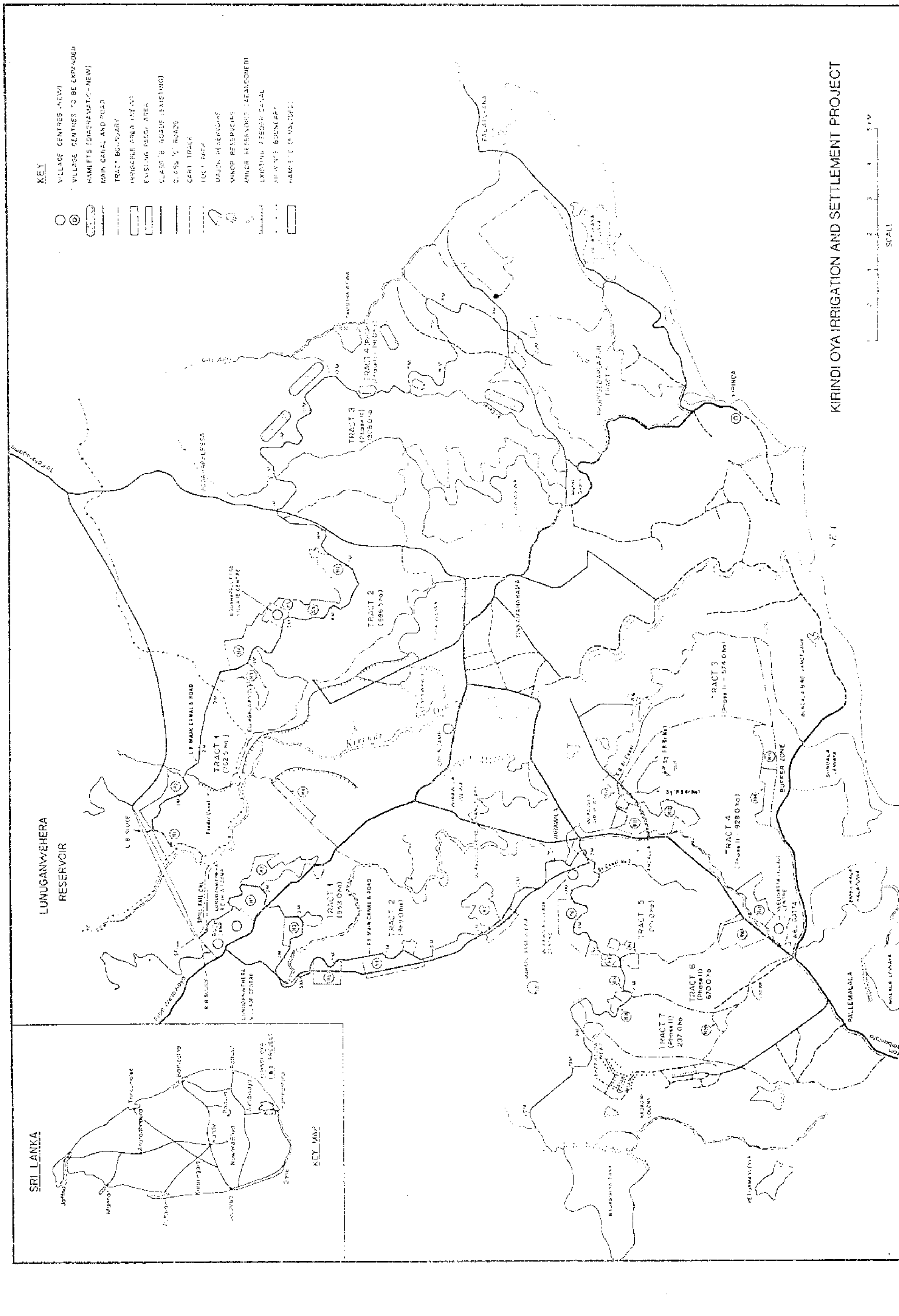

KIRINDI OYA IRRIGATION AND SETTLEMENT PROJECT
KEY
SCALE
LUNUGANWEHERA RESERVOIR
SRI LANKA
KEY MAP

Figure 1.3

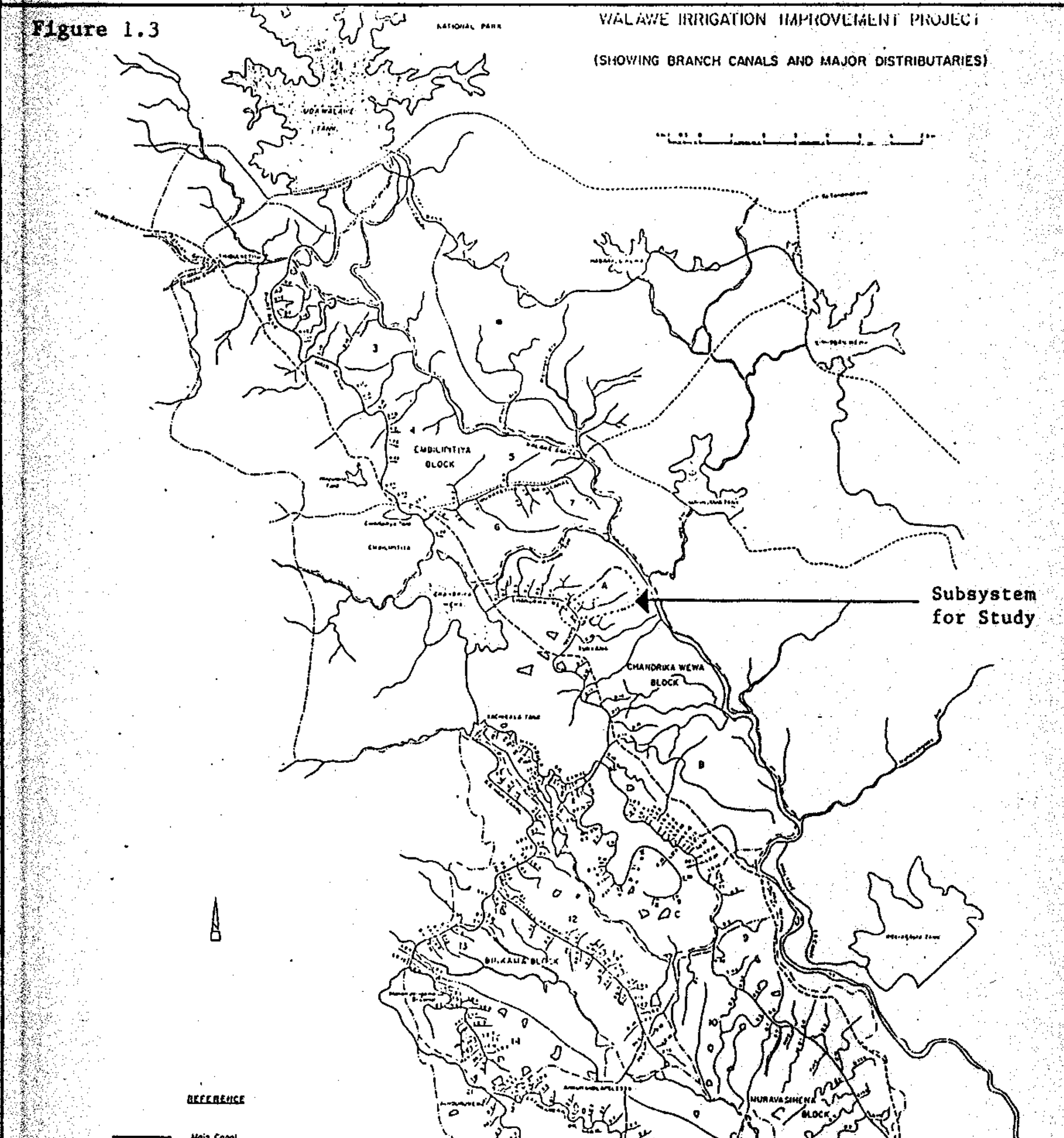
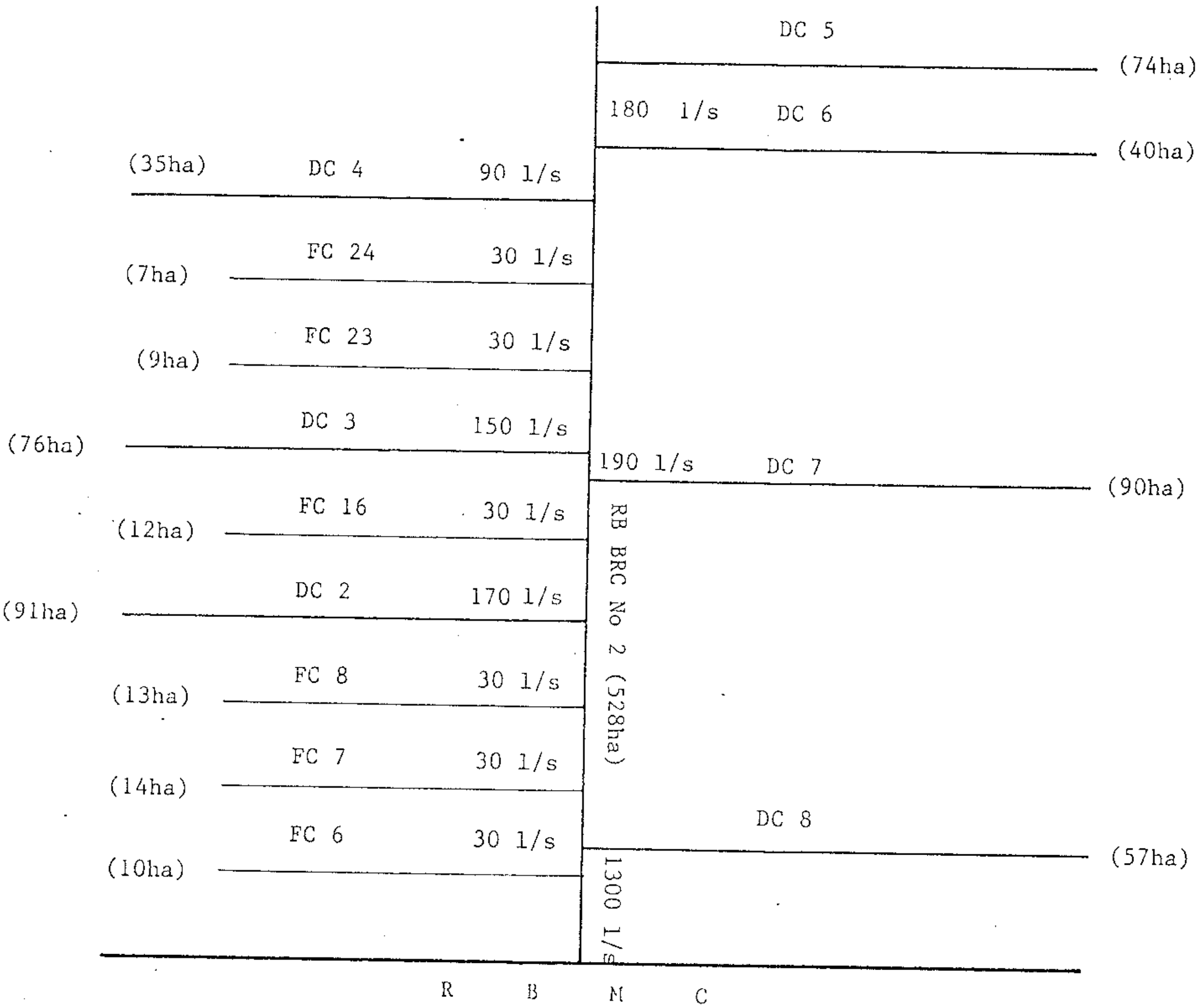
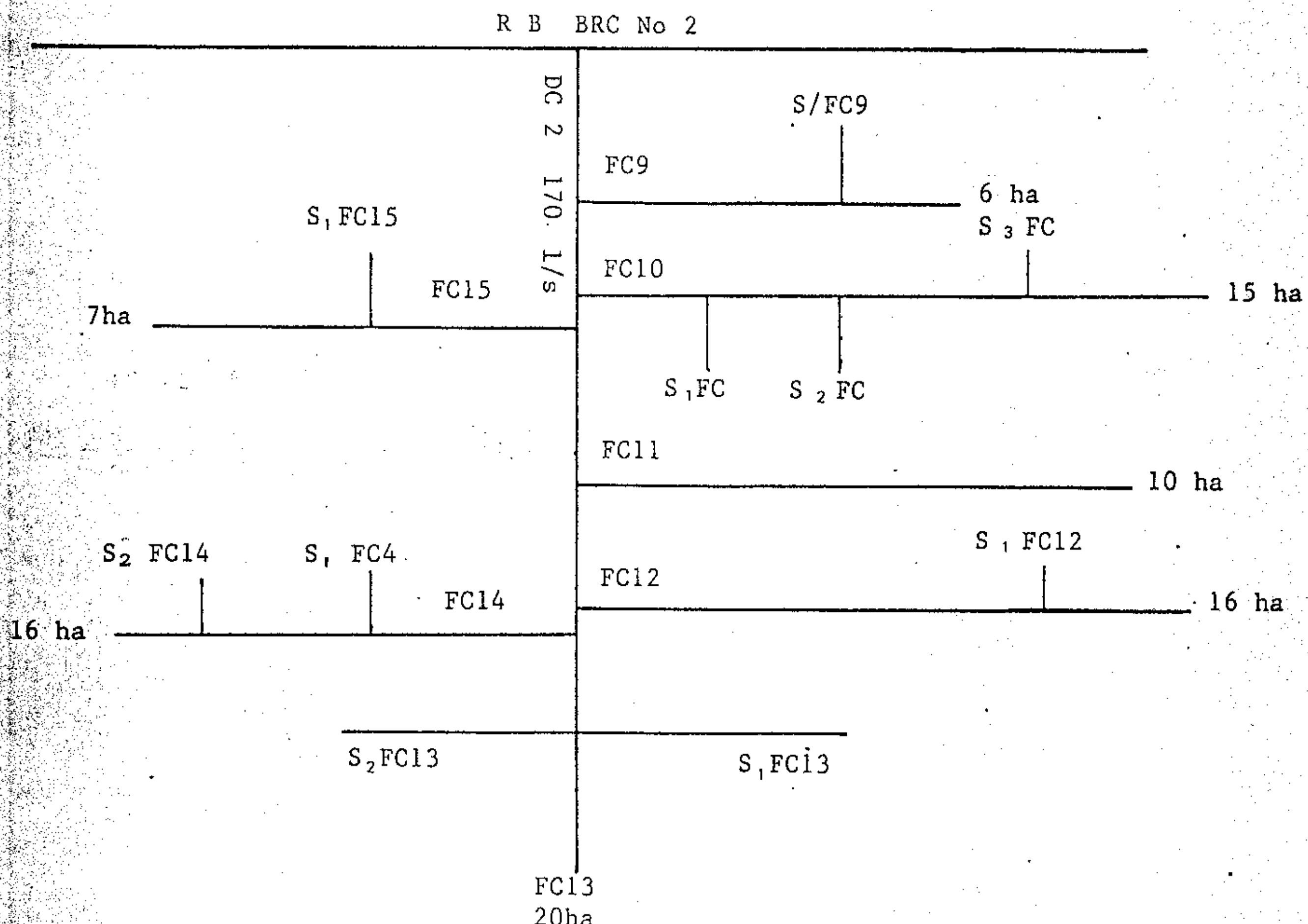

WALAWE IRRIGATION IMPROVEMENT PROJECT
(SHOWING BRANCH CANALS AND MAJOR DISTRIBUTARIES)
NATIONAL PARK
EMBILIPITIYA BLOCK
CHANDRIKA WEWA BLOCK
BILKAMA BLOCK
MURAVASIHENA BLOCK
ANGUNAKOLAPELESSA BLOCK
Subsystem for Study
REFERENCE
Main Canal
Branch and Major Distributary
Distributary Canal
River
Reservoir or Tank
Main Road
Other Road
Block Boundary
Tract Boundary
Tract Number

Figure 1.4



Schematic Layout of RB Branch Canal No 2, Tract 5, KOISP

Figure 1.5



Schematic Layout of DC2, Tract 5 KOISP

FIGURE 1.6

Blocking-out Plan for DC2 Branch No. 2, of Kirindi Oya Right Bank

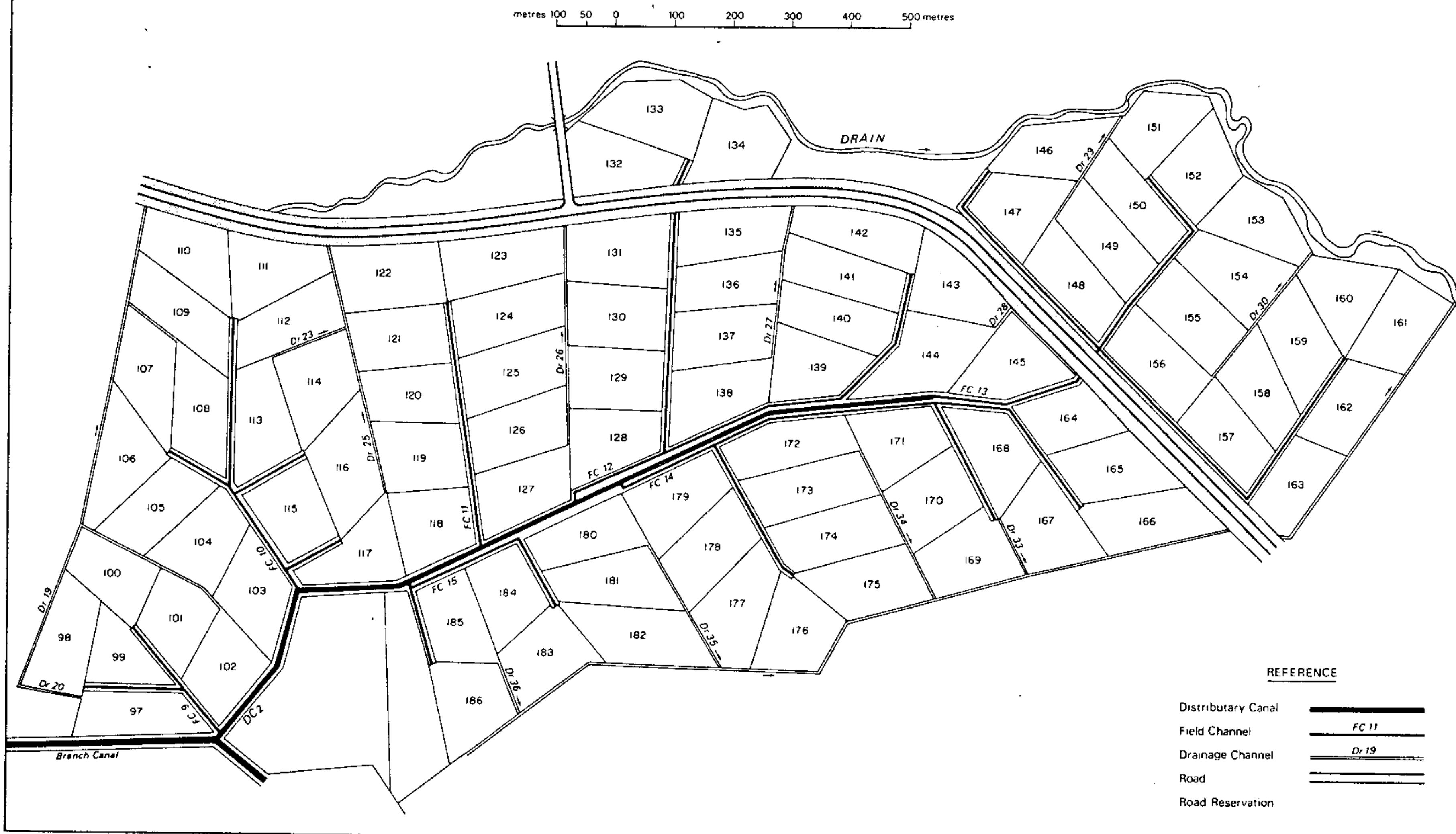


Figure 1.7

ISSUE TREE OF CHANDRIKAWEVA, MAIN CANAL

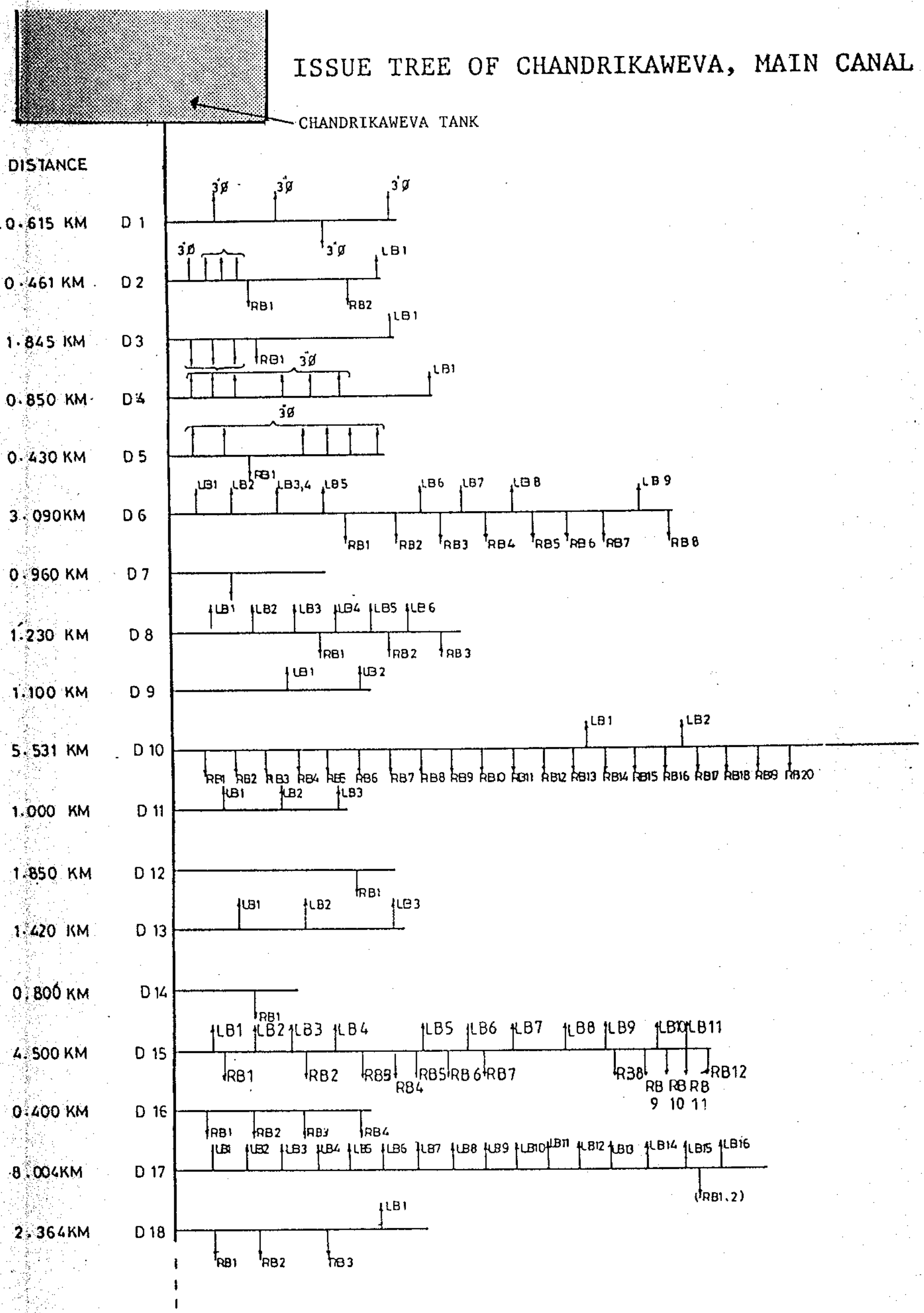
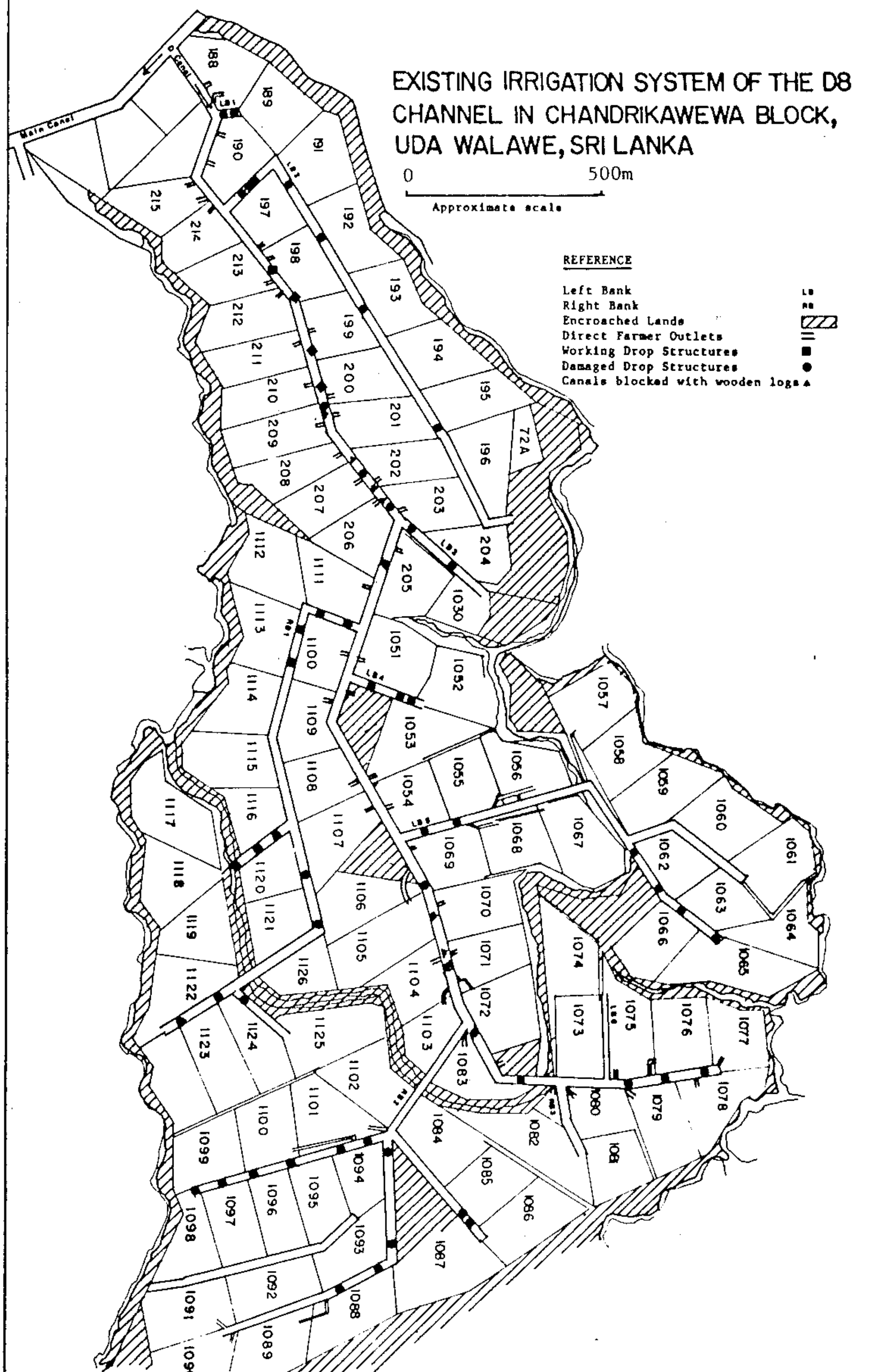


Figure 1.8


EXISTING IRRIGATION SYSTEM OF THE D8
CHANNEL IN CHANDRIKAWEWA BLOCK,
UDA WALAWE, SRI LANKA
0
500m
Approximate scale
REFERENCE
Left Bank LB
Right Bank RB
Encroached Lands
Direct Farmer Outlets
Working Drop Structures
Damaged Drop Structures
Canals blocked with wooden logs
Main Canal
D Canal

11. IRRIGATION WATER DELIVERY PERFORMANCE AND DESIGN-MANAGEMENT INTERACTIONS-KIRINDI OYA - 1987/88 MAHA

INTRODUCTION

The water issues to RB Tract 5 in the previous 1987/1988 maha (Mid) season commenced on 25 January 1988 according to the decisions arrived at the cultivation meeting held on 18 January 1988. However our systematic data collection and water flow measurements started only in the first week of March 1988, missing the land preparation period completely. Therefore this paper does not present full quantitative data and findings for the land preparation period of the season under study. For the same reason, data on total volumes of water used during the entire season are not available.

The presentations on irrigation water delivery performance are based on actual field measurements and observations, on interviews of farmers and regular discussions with the Irrigation Department (ID) officials, who are responsible for the operation of RB system. The findings on design-management interactions are basically from the study of existing and actual design guidelines and practices of the ID on irrigation system design and system operation and also from periodic interviews of ID staff. While the findings are based on a study of all the data collected, only a selected set of figures are included in this chapter.

DATA COLLECTED

Design-management interactions

The data collected under this research module are

(a) Operational and institutional assumptions made in the design of FCs and turnout areas.

(b) Procedures, assumptions and parameters adopted for the design as well as for the preparation of water delivery schedules.

Irrigation water delivery performance

The major data collected under this research module are

(a) Discharge measurements at the heads of BC 2, DC 2, DC 8, DC 5 and at the heads of each FC served by DC 2 as well as at three intermediate locations in DC 2 taken twice a day.

(b) Daily observation of evaporation and rainfall.

(c) Measurement of seepage and percolation (S&P) by sloping gauge method in nine allotments in the DC 2 command area, representing well drained (RBE), moderately drained and poorly drained (LHG) soils.

(d) Observation of daily water levels (above or below the surface level) by perforated tubes installed in nine allotments in the DC 2 command area, representing head, middle and tail reaches of DC 2 as well as of three selected FCs. This commenced in early April.

(e) Half hourly observations of water flows at the head of DC 2 and all FCs in DC 2, during two rotation periods in April and May.

FINDINGS

Design-management interactions

Design and operational assumptions

The irrigation canals and turnout areas are designed according to the procedures laid out in the Technical Note No. 6 of the Irrigation Department. The key parameters and operational assumptions adopted for the design are,

(1) The canal duties(in l/s/ha) are based on the daily peak water requirements for mixed cultivation of paddy and other selected OFCs in the following combination.

   (a) Lowland areas (LHGs) are cultivated entirely with 135-day paddy in maha and 105 day paddy in yala.

   (b) 80 percent of the upland area (RBE) is cultivated with 135-day lowland paddy in maha and 90-day cowpea in yala.

   (c) 20 percent of the upland area (RBE) is cultivated with 135-day upland paddy in maha and 150-day chillies and 90-day cowpea in yala, with 75 percent of farms under cowpea and 25 percent under chillies.

(2) The cropped area is staggered into three equal staggers with a time lag of two weeks between the commencement of each successive stagger.

(3) The time allocated for land preparation in the design is two weeks, which includes one week for land soaking and one week for puddling and transplanting.

(4) The 75 percent probability evapotranspiration and effective rainfall values at Mahailuppalama Agriculture Research Station are used in the computation of crop water requirements. The S&P losses are assumed as 3 mm/day for maha and 5 mm/day for yala for lowland farms. The farm losses for upland farms are assumed as 0.8ET.

(5) The conveyance efficiencies assumed in the design are 65 percent, 75 percent and 80 percent for unlined main/branch, distributary and field canals respectively.

(6) The canal duties derived from the above assumptions including mixed combination of cropping patterns are 2.0 and 1.8 l/s/ha for main/branch and distributary canals respectively, and 1.8 and 3.5 l/s/ha for FCs serving entirely lowland (LHGs) and entirely upland (RBEs) farms, respectively.

(7) However, the design capacity of a DC is determined on the basis of the number of FCs served by it. It is the sum of discharge capacities of all FCs served by it, adjusted for conveyance losses in the DC.

(8) The design capacity of a FC is usually standardized to 30 l/s (1 cusec) but can occasionally exceed 30 l/s depending on the proportion of RBEs and LHGs of the turnout area served by the FC. The implicit operational assumption in the FC size of 30 l/s is that 15 l/s (half cusec) is the maximum stream size for a 1 ha (2 1/2 acres) allotment, and the farm turnout will deliver the whole supply in the FC to two individual allotments in equal amounts at a time.

(9) The size of the turnout area served by a FC is determined basically on the operational assumption that the whole supply in the FC is delivered to two individual allotments in equal amounts at a time, and all the allotments under the FC can be served with the daily peak water requirement in one day during the rotation period for the FC. This leads to maximum and minimum turnout areas of 16 ha and 8 ha served by a standard FC of 30 l/s capacity. The maximum corresponds to a turnout area consisting of 100 percent LHGs and minimum consisting of 100 percent RBEs. The true size of the turnout area therefore depends on the proportion of RBEs and LHGs within the area.

Preparation of water delivery schedules for the season

(1) The period allowed for land preparation at the cultivation meeting was six weeks commencing from 25 January up to 05 March 1988. But the water delivery schedules of ID had been prepared for a total land preparation period of five weeks in the entire RB command area, assuming the commencement and progressing of land preparation in three staggers, with a time lag of one week between the commencement of each successive stagger area.

(2) The time allocated for land soaking and puddling in the irrigation schedules were one and two weeks respectively. Thus the land preparation period for each stagger was three weeks.

(3) The first, second and third stagger areas were assumed to be 20, 60 and 20 percent of the command area respectively.

(4) The land soaking and puddling requirements assumed for the water schedules were 3.6 and 5.7 mm/day for LHGs and RBEs respectively.

(5) In the absence of field verified data, S&P losses were assumed as 3 and 6 mm/day for LHGs and RBEs respectively.

(6) The 75 percent probability evapotranspiration values deduced from pan evaporation data, at Angunukolapelessa Agriculture Research Centre were used for the computation of crop water requirements.

(7) Effective rainfall was ignored.

(8) The conveyance efficiency of the main canal was assumed as 85 percent and that of the BC, DCs and FCs as 93 percent. The application efficiency assumed was 70 percent.

(9) The above assumptions resulted in peak land preparation requirements of 2.55 and 1.70 l/s/ha at the farm turnout for RBE and LHG soils respectively. The computed peak irrigation water requirements at the farm turnout during crop growth period were 2.1 and 1.6 l/s/ha respectively.

(10) The schedules were prepared for continuous delivery during land preparation period followed by rotational delivery during crop growth. It was intended to implement rotation among and within FCs and to have continuous but variable flow in DCs. The flow in FCs was supposed to be varied in quantity, with constant duration of flow in FCs and also constant delivery time to allotments within a FC, throughout the crop growth (fixed time - variable discharge). The fixed delivery duration was determined on the basis of the time required to deliver the peak weekly crop water requirements. The schedule for DC 2 as prepared by the ID for the period of peak requirements during crop growth is indicated in Table 2.1.

(11) A rotation interval of 7 days within the FC was assumed.

(12) The time required to supply the peak irrigation requirement during the rotation interval (7 days) for a 1 ha allotment in RBE soils was calculated to be 12.5 hours. It was 9 hours for a 1 ha allotment in LHG soils. Those durations were computed for irrigation of one allotment at a time, with full FC flow of 28.32 l/s (1 cusec). This is contrary to the design assumption of irrigating two allotments at a time with 14 l/s (0.5 cusecs). The delivery durations for the rest of the growth period were supposed to be kept constant at the same values, and flow in FCs and discharge rates through the farm turnouts were planned to be reduced in proportion to the irrigation requirement in any given week to the peak requirement.

Some design-management implications

It is seen from Table 2.1 that the command areas under each of the FCs in DC 2 were assumed as either exclusively RBE or LHG soils, for the preparation of irrigation delivery schedules. Field verification of soil types in DC 2 command area does not justify this assumption. We understand that the ID had deduced the above soil distribution from the available soil maps, but it seems that a close study of soil distribution in the FC command areas is necessary.

what is the soil distribution w/ diff. FC

The standard ID design procedures and guidelines (Technical Note No.6) specify the design capacity of a DC as the sum of discharge capacities of all FCs served by it. The DC 2 feeds six FCs of standard 28.32 l/s capacity and one FC of 42 l/s capacity (FC 13-1.48 cusecs). The sum of the design capacities of FCs in DC 2 totals to 212 l/s (7.5 cusecs), with no consideration for losses, and to 282 l/s (9.9 cusecs), with a 75 percent conveyance efficiency. The existing design capacity of DC 2 at full supply level is only 170 l/s (6 cusecs) with a design bank-full discharge capacity of 210 l/s (7.5 cusecs). Thus the existing design capacity of DC 2 is not adequate. As a result, DC 2 does not provide for flexibility in simultaneous sharing of water among the FCs served by it, without a certain degree of overloading.

what is the actual discharge

Analysis of the water delivery schedules in Table 2.2 shows that peak requirements during land preparation period (in week 3) and during crop growth (in weeks 13-16) exceed even the design bank-full flow capacity of DC 2, had the schedules been prepared for 75 percent conveyance efficiency as recommended in the ID standard design guidelines, instead of 93 percent that was assumed. Under as-built conditions, DC 2 appears to have adequate capacity in the head reach and in several other reaches due to deep cutting, but in reaches where the exact design section exists, it imposes limitations for operation.

This does not seem to be true?

how?

It is also seen from Tables 2.1 and 2.2, that with 93 percent efficiency, DC 2 had to be overloaded for 1.5 days in each rotation week during weeks 9-16 of the season in order to meet the crop water demand. The canal had to be overloaded by 15 percent during this period in the schedules. The required degree of overloading during the peak land preparation requirement was 25 percent for the same conveyance efficiency.

The inadequacy of the design capacity of DC 2 and minimal flexibility of operation associated with it compels the irrigators to deliberately overload the canal. It was observed during the season that DC 2 overflowed on many occasions, especially in between the off-takes to FC 15 and FC 11, and below the off-take to FC 14, due to overloading of the canal. The degree of overloading might further increase and operation may become difficult in future with the gradual deterioration of the canal and decline of conveyance efficiencies. As shown below the conveyance efficiency of DC 2 for the season varied between 69 and 74 percent with an average value of 71, which is far below the assumed value of 93 percent but close to the recommended figure in the design standards.

Half hourly flow observations

The flow of water at the heads of DC 2 and of the FCs under it were observed every half an hour between 7:00 am and 6:00 pm during two rotation periods in the season. The first rotation period spanned 26 April to 04 May, while the other between 16 to 22 May. The half hourly flow fluctuations at heads of FCs 9 and 13 observed during the first rotation period are indicated in Figures 2.1 and 2.2.

A review of the observed flow patterns for both rotation periods indicates sudden jumps of discharge on 28 April afternoon and on 19 May, in BC 2, DC 2 and in all FCs. This was a result of deliberate increase of discharge in RBMC and BC 2 by the ID, to facilitate studies conducted by IIMI for a separate research program on main system management.

The second rotation period also reflects a sudden remarkable decrease of flow followed by an increase in DC 2 and FCs, except in FCs 9, 11 and 15, within few hours on 17 May. FCs 9, 11 and 15 had been kept closed on this particular day. The daily flow hydrograph for BC 2 also indicates a similar pattern between 15 to 17 May.

The degree of flow variation in DC 2 for both rotation periods was moderate, with steady flow conditions prevailing for significant periods during the day. The micro variations during near steady flow periods may be partly attributed to possible measurement errors in the field.

The study of half hourly flow variations at the heads of FCs for both rotation periods indicates a lesser degree of flow variations in FCs 9 and 10, and a comparatively high degree in the others. The variations in FC 15 are apparently not realistic due to doubtful accuracy of flow measurements at the head of the FC, caused by the regular blocking of FC 15 by a farmer immediately downstream of the outlet, in order to feed his allotment at higher elevation.

The near steady flow conditions in FC 9 and 10 and comparatively high degree of daily flow variations in FCs 11, 12, 13 and 14 reflects an increasing trend of unsteady conditions from head to tail end of the DC. It is noted that FC 13 suffered the highest degree of half hourly flow variations. It is the tail most FC and functions as the continued last reach of DC 2.

Irrigation Water Delivery Performance

Operation with respect to targets. Our discussions with ID officials revealed that water issues to Tract 5 were commenced on 25 January as agreed at the cultivation meeting, but with 30 percent of the scheduled delivery because most of the farmers did not start farming activities until they were convinced by water flowing in canals. However the releases were subsequently increased to 100 percent on the request of farmers.

The ID plan was to deliver a continuous supply during the first five weeks of land preparation period and then to implement rotational delivery. There were substantial delays by farmers in completing land preparation due to delays in obtaining bank loans and seed paddy. As a result, the continuous delivery prevailed until about 28 March, but with periodic reduction of discharges, according to ID officials.

However, the implementation of the proposed rotation schedules in terms of target quantities and time in BC 2 and DCs under study were not successful during the season. Water was available in abundance during the season in comparison to the scarcities and hardships experienced during the previous season. Therefore, apparently both ID and farmers had somewhat relaxed attitudes in regard to strict compliance with the rotation schedule.

The implementation of the rotation on BC 2 was greatly hindered by the use of BC 2 by the ID as a drainage by-pass for RB main canal, in order to protect the coffer dam erected across RBMC for phase 2 construction activities in the downstream reaches. This practice masked the typical operation pattern and flow behaviors of the study area, to a considerable degree.

Our research on irrigation institutions reports that lack of supervision of the duties of irrigators by work supervisors and technical assistants, the lack of a systematic and well- geared monitoring-communication-feedback system within the ID as well as between ID and farmers, and lapses in performing the tasks by farmer representatives are among the other causative factors for the partial failure of the implementation of the rotation schedules. The efforts of ID staff were almost fully concentrated on achieving the construction targets, leaving them little time for systematic operation.

Actual delivery against targets. Figures 2.3 to 2.7 indicate the actual daily deliveries at the heads of BC 2, DC 2, DC 5, DC 8 and FC 12 under DC 2, compared with the target deliveries. The quick conclusion that can be drawn from those figures at a glance is the strict non-compliance to the schedule in actual operation. Instead, an erratic supply prevailed during the season.

The summary of findings from daily flow hydrographs is tabulated in Table 2.3. It implies that supply to BC 2 from RBMC was below the targets for 68 percent of the time captured by the research. However, it is interesting to notice that DC 8, which is in the head reach of BC 2, was undersupplied for 64 percent of the duration, while DC 5 in the tail end was undersupplied for only 20 percent of the time, and DC 2 in the middle for 15 percent of the time. This contradicts the accepted belief that head reach is usually favored with oversupply compared to the tail end. It was observed that the total area under DC 8 was not cultivated during the season and the targets should be adjusted for the actual area cultivated for a sensible comparison with actual deliveries. This is not possible because the actual area cultivated under DC 8 was not monitored by ID or by us. The high degree of oversupply in DC 2 and DC 5 was due to the ID practice of diverting excess water in RBMC to BC 2. As a result BC 2, DCs 8, 2 and 5, as well as FCs in DC 2 received heavy deliveries at times, as recorded by the flow hydrographs.

The daily flow hydrographs reflect two periods of remarkable water shortages, from 20 to 22 March and again from 10 to 18 April, though it was reported that continuous delivery was maintained until about 28 March. Our discussions with ID officials revealed that on the first occasion the shortage occurred as a result of reducing the main sluice releases to RBMC on 20 March, for the sudden implementation of rotation by RE (RB) on 21 March, without any prior communication with SIE or intimation to the farmers. The irrigator in DC 2, with no instructions received from his immediate supervisor, had no other alternative except to shut down FC gates either fully or partially, in order to respond to the reduced supplies in BC 2 and DC 2. This erratic operation created difficulties for some of the farmers, who had been waiting to irrigate their allotments after having them sprayed with weedicides. The flows were restored after 22 March, with the increase of main sluice discharges to the main canal, after ID realized the impact of its premature decision to implement the rotation. This incident suggests communication gaps in the ID, as well as between the irrigators and farmers, as further documented in the chapter on institutions.

The second occasion of water shortage occurred as a result of the cutoff of supply from the main sluice after rainfall (79 mm) on 09 April, to prevent damage to canals and canal structures. However the operation of the system seemed to become virtually paralyzed during this period due to continued closure of the sluice for about 5-6 days. This resulted from the absence of most of the officers and irrigators for their usual annual leave for Sinhalese New Year festival.

It is also apparent that the flow in the canals had been rapidly increasing from 28 April until it reached a peak on 03 May. The figures also indicate peak discharge once again on 19 May. These peaks occurred due to deliberate increase of main sluice releases by ID for a separate IIMI research study on main system management.

Table 2.4 is a comparison of weekly irrigation water requirements as per ID schedules, with the average weekly deliveries made at the heads of FCs under DC 2, for weeks 7 to 18. It shows that FC 9 was the most undersupplied while FC 12 was the least undersupplied. It is also seen that all FCs under DC 2 were severely undersupplied during weeks 8 and 12. Week 8 corresponds to the period during which the ID suddenly implemented the rotation, while the latter corresponds to New Year period. Some FCs received less than targeted during weeks 7, 9, 10 and 11, but the rainfall might have compensated for the small deficits.

Weeks 13 to 16 on average correspond to the period of peak crop water requirement, during which the DC 2 capacity was likely to be inadequate to deliver the total requirements of FCs under it. Some FCs were undersupplied during this period except in week 15, during which the rainfall was 108 mm. The exact reason for the undersupply during this period was not clear.

Water table fluctuations. The water table above or below the paddy allotments was measured during 07 April - 03 June, in each of the selected allotments in FCs 10, 12 and 13. Figure 2.8 shows the water level fluctuations in a tail end allotment under FC 12.

If the number of continuously drained days out of water in excess of three are defined as stress days, all allotments except FC 12 at the tail suffered crop stress for varying durations between 10-22 April, as a result of the main sluice closure. The analysis of water level fluctuations in other selected allotments indicates crop stress during 16 May to 03 June (weeks 16-18). However Table 2.4 does not indicate any short supply during this period, except for FC 12 in weeks 17 and 18. The reason for this was not clear.

Table 2.5 is a summary of findings on water table fluctuations in FCs 10, 12 and 13 compared with the average yield obtained from each allotment. The number of stress days and the average yield do not follow a well defined relationship with each other. Other factors such as use of fertilizers, weedicides etc. and pest attack might have influenced the yield to a greater extent.

However, selected farmers whom we met after the season did not complain of water shortages except for the two specific instances that were mentioned earlier. Some tail-enders complained that they did not receive their due share from the FC most of the time, but they did not have any shortages as they were able to tap seepage and drainage water to feed a major part of their allotments. Though FC 9 had been the most undersupplied out of all FCs, farmers did not complain of any water shortage, because of the seepage from BC 2. From farmers' point of view, the adequacy or availability of water during the season was satisfactory.

Conveyance losses. The daily supply hydrograph at the head of DC 2 and the sum of daily supply hydrographs at the heads of FCs under DC 2 are shown in Figure 2.9. The difference in daily hydrograph ordinates is a measure of losses during the period under study.

An interesting feature is the indication of virtually "no loss" situations during the periods of rapidly increasing or decreasing discharges. At higher discharges this may be due to inaccuracy of measuring large flows under submerged weir conditions.

The steady state periods between 11-19 March, 24 March-07 April and 22-28 April in Figure 2.9 correspond to conveyance efficiencies of 69, 74 and 69 percent respectively with an average of 71 percent. This value is close to the recommended assumed value of 75 percent in canal designs, but far below the value of 93 percent adopted by the ID in water delivery schedules for the season. The average loss in DC 2 is therefore about 5170 cubic meters per day which corresponds to a loss rate of 0.6 cubic meters per day per square meter of wetted area (6.94 cumecs per million square meters of wetted area or 22 cusecs per million square feet of wetted area).

Seepage and percolation losses. The measurement of seepage and percolation losses in the paddy fields could not be carried out successfully during the season. The inflows and outflows from the selected liyaddes in sample allotments could not be managed to suit our interests due to irregular and unexpected interventions and farming activities by farmers. The heavy rainfall at times affected the reliability of measurements taken. On some other occasions, particularly when fields were irrigated after a long dry spell, standing water rapidly got lost from the allotments, before the second observation of sloping gauge reading. The high loss rates from the liyadde dykes through crab holes further affected the accuracy of measurements. The prevailing situation in the area prevented any field observations after day time. Therefore no conclusive S & P values can be presented here.

CLIMATIC DATA

The daily rainfall at Weerawila from 01 March to 30 July is indicated in Figure 2.10. The highest rainfall of 79 mm occurred on 09 April. The daily pan evaporation values are presented in Figure 2.11.

CONCLUSIONS

The operation during the season could not achieve the ID's expectations due to,

(a) The abundant availability of water in comparison to the previous season, which resulted in a relaxed interest of ID to implement rotation.

(b) The lack of supervision and monitoring of operation by ID staff, because of their preoccupation in achieving construction targets.

(c) The lack of a systematic monitoring-communication-feedback mechanism and practice.

(d) The lapses by farmer representatives in performing the duties expected of them by the ID.

(e) The use of BC 2 as a drainage by-pass.

(f) The inadequate design capacity of DC 2.

(g) The irrigation schedules being prepared on the basis of an unrealistic conveyance efficiency and turnout areas of homogeneous soil distributions, resulting in either oversupplied or undersupplied delivery schedules.

As a result of the above factors the operation of BC 2 and the DCs under study was erratic, which resulted in inadequate supply to some allotments. However the low number of farmer complaints on inadequacy of water indicates that the deficits in supply below targets (and requirements) had apparently been fairly compensated for by the rainfall and by seepage and drainage water. However the operation did result in some crop stress during the canal closure between 10-18 April.

The study of micro-variation of flow in FCs in DC 2 indicates that steady flow conditions do prevail for considerable periods as long as there is no fluctuation of head in the parent canal and/or no interventions with prevailing gate settings. It also shows an increasing tendency of flow fluctuations from head to tail.

The average loss rate in DC 2 is about 0.6 cubic meters per day per square meter of wetted area which corresponds to a conveyance efficiency of about 71 percent. This is close to the recommended value in the design.

Table 2.1 The Rotational Delivery Schedule of ID
For DC 2 of BC 2 in Tract 5

FC NO.	AREA (ha) RBB	AREA (ha) LHG	TOTAL AREA (ha)	PEAK REQUIREMENT (l/s/ha)	DELIVERY RATE (l/s)	DESIGN DISCHARGE (l/s)	DELIVERY DURATION (Days)	WEEKLY SCHEDULE MON.	TUE.	WED.	THU.	FRI.	SAT.	SUN.
9	6.0	-	6.0	2.1	30	28.32	3.16	********	********	********	*			
10	-	15.0	15.0	1.6	30	28.32	6.02	********	********	********		********	********	********
11	-	10.0	10.0	1.6	30	28.32	4.01				********	********	********	********
12	-	16.0	16.0	1.6	30	28.32	6.42	********	********	****	********	********	********	********
13	20.0	-	20.0	2.1	45	42	7	********	********	********	********	********	********	********
14	-	16.0	16.0	1.6	30	28.32	6.42	********	********	********	********	********	*****	****
15	7.0	-	7.0	2.1	30	28.32	3.90			****	********	********	********	
TOTAL				2.16	195							^^^^^^	^^^^^^	
DC 2	33.0	57.0	90.0	1.85	165	170	7	********	********	********	********	^	^******	********

Note :- (1) The above schedule is for the peak weekly crop water requirement.

(2) Schedules for rest of the period are obtained by adjusting the discharges at heads of FCs in proportion of crop water demand in any week to that during peak (fixed time).

(3) Time schedule of delivery is indicated by ********

(4) Overloading is indicated by ^^^^^^^^

Table 2.2 Irrigation Schedule of ID (1987/88 Mid season).

PC NO.	Area (ha) Upland	Area (ha) Lowland	Week No 1 #	2 #	3 #	4 #	5 #	6	7	8	9	10	11	12	13	14	15	16	17	18
Irrig. Requirements																				
Upland			0.5	2.02	2.55	2.39	1.89	1.75	1.82	1.9	1.95	2.07	2.07	2.07	2.1	2.1	2.1	2.02	1.46	0.34
Lowland			0.33	1.35	1.7	1.62	1.31	1.25	1.33	1.39	1.46	1.51	1.56	1.59	1.61	1.61	1.6	1.51	1.06	0.25
Discharge at Head																				
FC09	6		3.23	13.03	16.45	15.42	12.19	11.29	11.74	12.26	12.58	13.35	13.35	13.35	13.55	13.55	13.55	13.03	9.42	2.19
FC10		15	5.32	21.77	27.42	26.13	21.13	20.16	21.45	22.42	23.55	24.35	25.16	25.65	25.97	25.97	25.81	24.35	17.10	4.03
FC11		10	3.55	14.52	18.28	17.42	14.09	13.44	14.30	14.95	15.70	16.24	16.77	17.10	17.31	17.31	17.20	16.24	11.40	2.69
FC12		16	5.68	23.23	29.25	27.87	22.54	21.51	22.88	23.91	25.12	25.98	26.84	27.35	27.70	27.70	27.53	25.98	18.24	4.30
FC13	20		10.75	43.44	54.84	51.40	40.65	37.63	39.14	40.86	41.94	44.52	44.52	44.52	45.16	45.16	45.16	43.44	31.40	7.31
FC14		16	5.68	23.23	29.25	27.87	22.54	21.51	22.88	23.91	25.12	25.98	26.84	27.35	27.70	27.70	27.53	25.98	18.24	4.30
FC15	7		3.76	15.20	19.19	17.99	14.23	13.17	13.70	14.30	14.68	15.58	15.58	15.58	15.81	15.81	15.81	15.20	10.99	2.56
Total FCs	33	57	37.97	154.42	194.68	184.10	147.35	138.71	146.10	152.61	158.68	166.00	169.06	170.90	173.19	173.19	172.58	164.23	116.77	27.39
Delivery at Head of DC 2																				
with 93% efficiency.			40.83	166.04	‡ 209.33	‡ 197.95	158.45	149.15	157.09	164.10	170.62	‡ 178.49	‡ 181.79	‡ 183.77	‡ 186.23	‡ 186.23	‡ 185.57	‡ 176.59	125.56	29.45
with 75% efficiency.			50.62	‡ 205.89	‡ 259.57	‡ 245.46	‡ 196.47	‡ 184.95	‡ 194.80	‡ 203.48	‡ 211.57	‡ 221.33	‡ 225.42	‡ 227.87	‡ 230.92	‡ 230.92	‡ 230.11	‡ 218.97	155.70	36.52

Note :- (1).Irrigation requirements are at Turn-out level & are in l/s/ha.

(2).Discharge at head of FCs are in l/s adjusted for a conveyance efficiency of 93 %.

(3).# - indicates land preparation period.

(4).‡ - indicates the exceedence of the design capacity of 170 l/s.

Table 2.3 Comparison of Actual Delivery with Targets

DESCRIPTION	BC 2	DC 2	DC 8	DC5	FC 9	FC 10	FC 11	FC 12	FC 14	FC 15
PERIOD OF OVER SUPPLY (%)	32%	85%	36%	80%	35%	37%	11%	58%	49%	46%
PERIOD OF UNDER SUPPLY (%)	68%	15%	64%	20%	65%	63%	89%	42%	51%	54%
PERIOD OF SUPPLY DURING WHICH SUPPLY IS BELOW 75% TARGET	23%	12%	42%	92%	100%	75%	92%	62%	42%	44%
DAYS OF EXTENDED SUPPLY (days) *	7	7	7	7	7	7	2	5	3	0
DATES OF PEAK DELIVERY	3MAY	3MAY	19MAY	3MAY	30APR	6MAY	5MAY	3-4MAY	3MAY	3MAY
DATES OF ZERO DELIVERY	14-15APR	13-16APR	9-12MAR 13-15APR	9-12MAR 13-17APR	9-10,13-16 21-22APR	22MAR 13-17APR	17MAR 5-6,13-17APR 26-27APR 16-17MAY	22MAR 13-17APR	22MAR 13-17APR	13-17APR
CANAL CAPACITY (l/s)	1189	170	113	142	28.32	28.32	28.32	28.32	1	1
MAXIMUM DELIVERY (l/s)	1444	396	170	238	1.3	2.8	0.93	2.24	1.9	1.85

Note :- * Indicates the extra number of water issue days after the agreed last date of issue.

Table 2.4 Target and Actual Weekly Average Water Deliveries (mm / day)

Weeks	Rainfall (mm/week)	FC 9 Target	FC 9 Actual	FC 10 Target	FC 10 Actual	FC 15 Target	FC 15 Actual	FC 11 Target	FC 11 Actual	FC 12 Target	FC 12 Actual	FC 14 Target	FC 14 Actual	FC 13 Target	FC 13 Actual
7	17	15.72	13.46 ‡	11.49	11.71	15.72	18.43	11.49	13.73	11.49	15.99	11.49	6.67 ‡	15.72	18.98
8	33	16.42	7.46 ‡	12.01	6.91 ‡	16.42	11.27 ‡	12.01	6.04 ‡	12.01	7.17 ‡	12.01	8.91 ‡	16.42	15.68 ‡
9	39	16.85	12.22 ‡	12.61	8.20 ‡	16.85	20.58	12.61	13.50	12.61	12.96	12.61	12.22	16.85	17.51
10	2	17.88	12.62 ‡	13.05	14.14	17.88	21.30	13.05	12.45 ‡	13.05	16.96	13.05	15.21	17.88	22.07
11	26	17.88	6.42 ‡	13.48	7.34 ‡	17.88	35.11	13.48	13.28	13.48	14.75	13.48	15.14	17.88	13.38 ‡
12	91	17.88	4.19 ‡	13.74	1.17 ‡	17.88	5.71 ‡	13.74	3.74 ‡	13.74	2.01 ‡	13.74	1.71 ‡	17.88	1.38 ‡
13	14	18.14	7.71 ‡	13.91	11.19 ‡	18.14	18.20	13.91	13.02	13.91	19.98	13.91	13.63	18.14	19.74
14	2	18.14	45.73	13.91	32.64	18.14	46.28	13.91	14.87	13.91	24.87	13.91	21.53	18.14	27.37
15	108	18.14	16.69 ‡	13.82	30.03	18.14	33.00	13.82	19.25	13.82	24.21	13.82	16.68	18.14	20.52
16	2	17.45	17.12	13.05	17.50	17.45	12.39 ‡	13.05	8.07 ‡	13.05	21.16	13.05	19.16	17.45	16.84 ‡
17	0	12.61	41.15	9.16	22.24	12.61	31.72	9.16	13.45	9.16	26.24	9.16	19.50	12.61	21.50
18	5	2.94	11.86	2.16	5.47	2.94	18.20	2.16	5.98	2.16	18.40	2.16	13.14	2.94	14.40
19	0		2.11		3.16		0.00		0.00		3.92		1.22		0.00

‡ represents the weeks durring which supply had been below targets.

Table 2.5 Summary of Water table Fluctuations

Water-table bellow the ground level	FC10			FC12			FC13		
	HEAD	MIDDLE	TAIL	HEAD	MIDDLE	TAIL	HEAD	MIDDLE	TAIL
0 - 10cm.	7	4	5	0	10	6	3	26	3
10 - 20cm.	8	0	3	1	1	1	3	10	1
20 - 30cm.	4	2	2	2	3	0	3	4	1
30 - 40cm.	4	2	1	6	4	2	1	0	2
40 - 50cm.	5	1	0	0	6	1	1	0	3
Bellow 50cm.	0	3	0	0	6	0	0	0	6
Total measured days	54	55	55	55	54	55	50	55	55
Number of Stress days	28	12	11	12	30	7	11	21	16
Yield (Kg /Ha)	4393	4737	3679	3158	3498	4459	4134	3859	3171

Note :- The water table fluctuations were observed from 07April to 07June .

Figure 2.1 - Half hourly flow variation at head of FC 9.

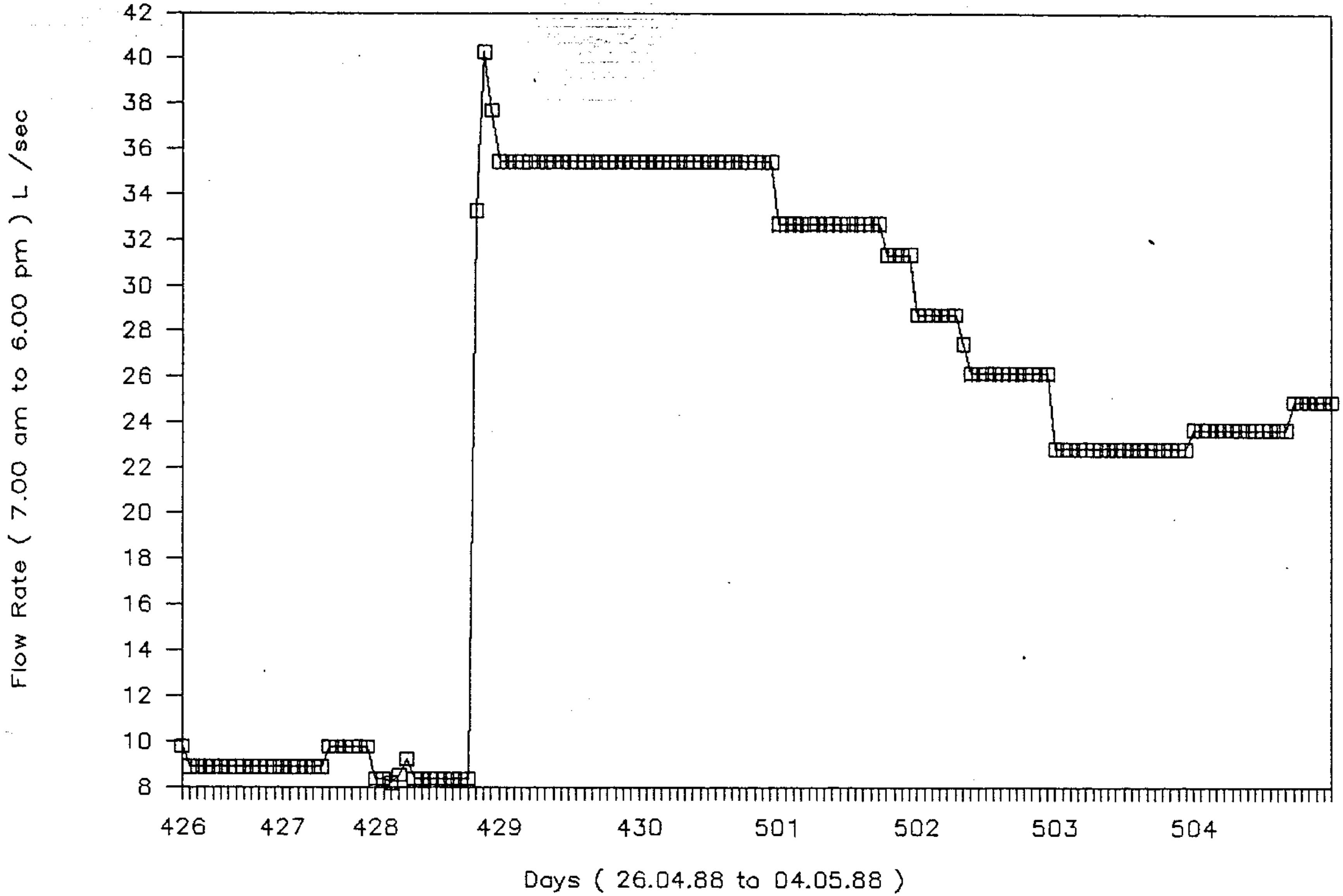


Figure 2.2 - Half hourly flow variation at head of FC 13.

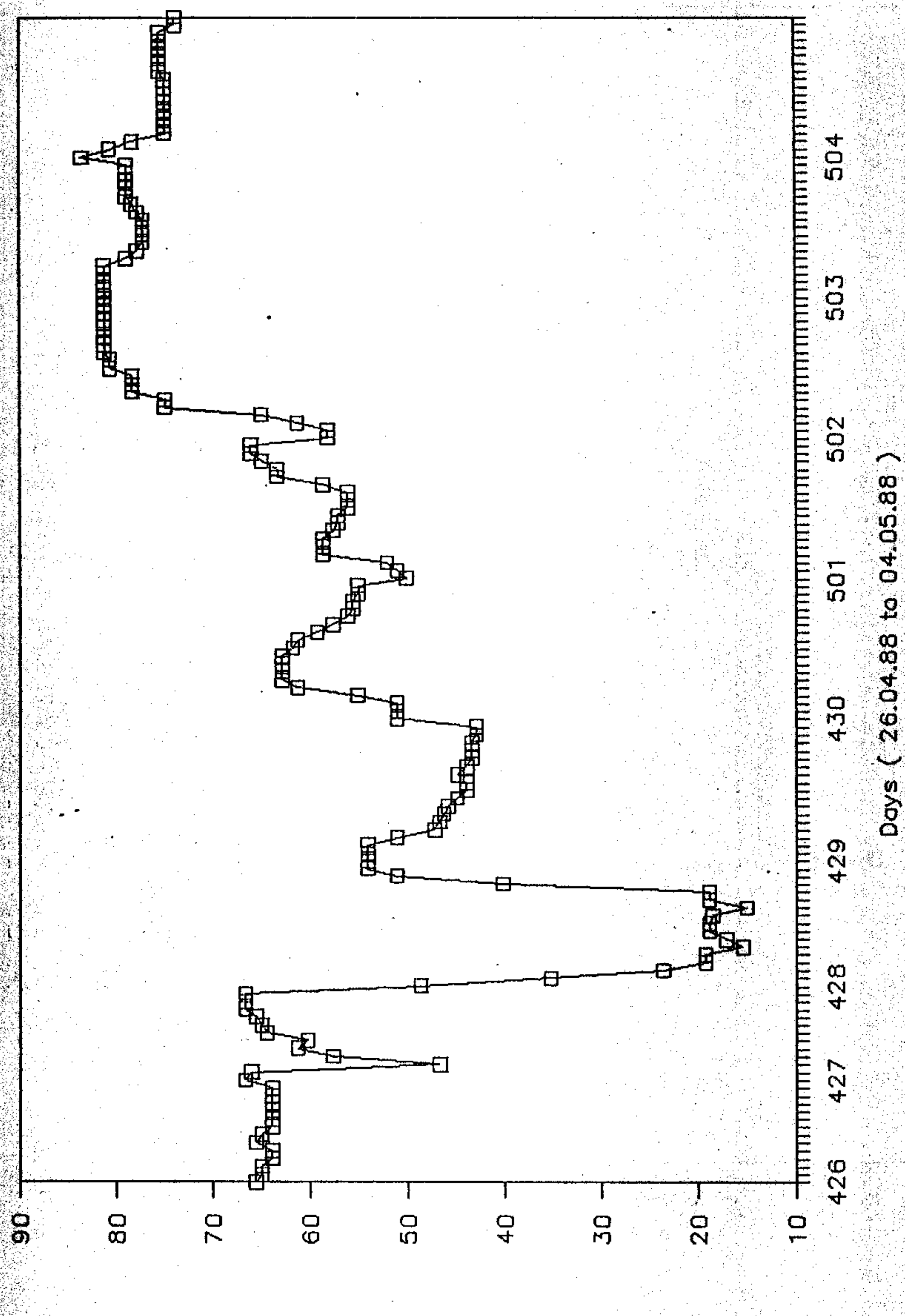


Figure 2.3 - Target and actual discharges at head of BC 2

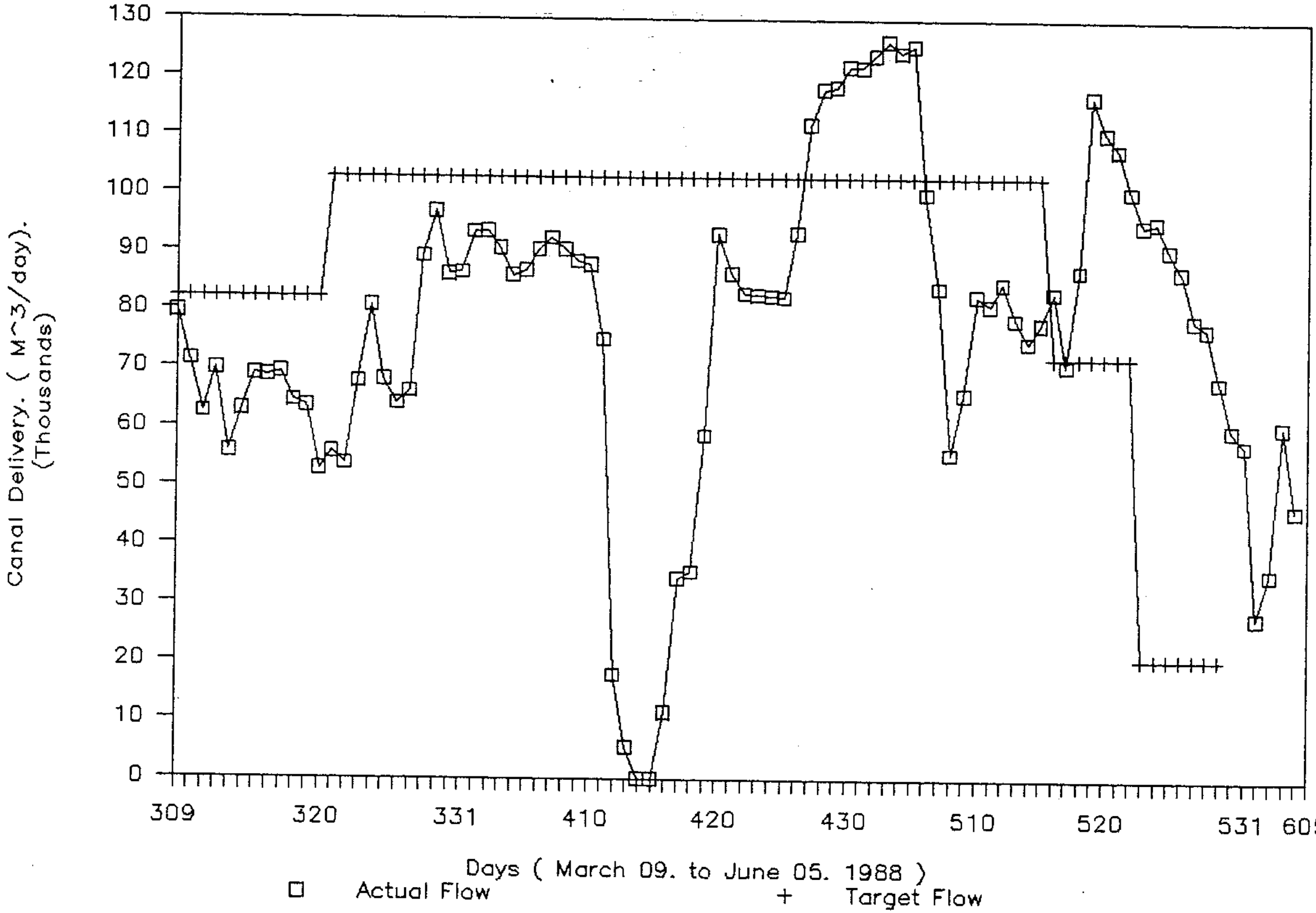


Figure 2.4 - Target and actual discharges at head of DC 2

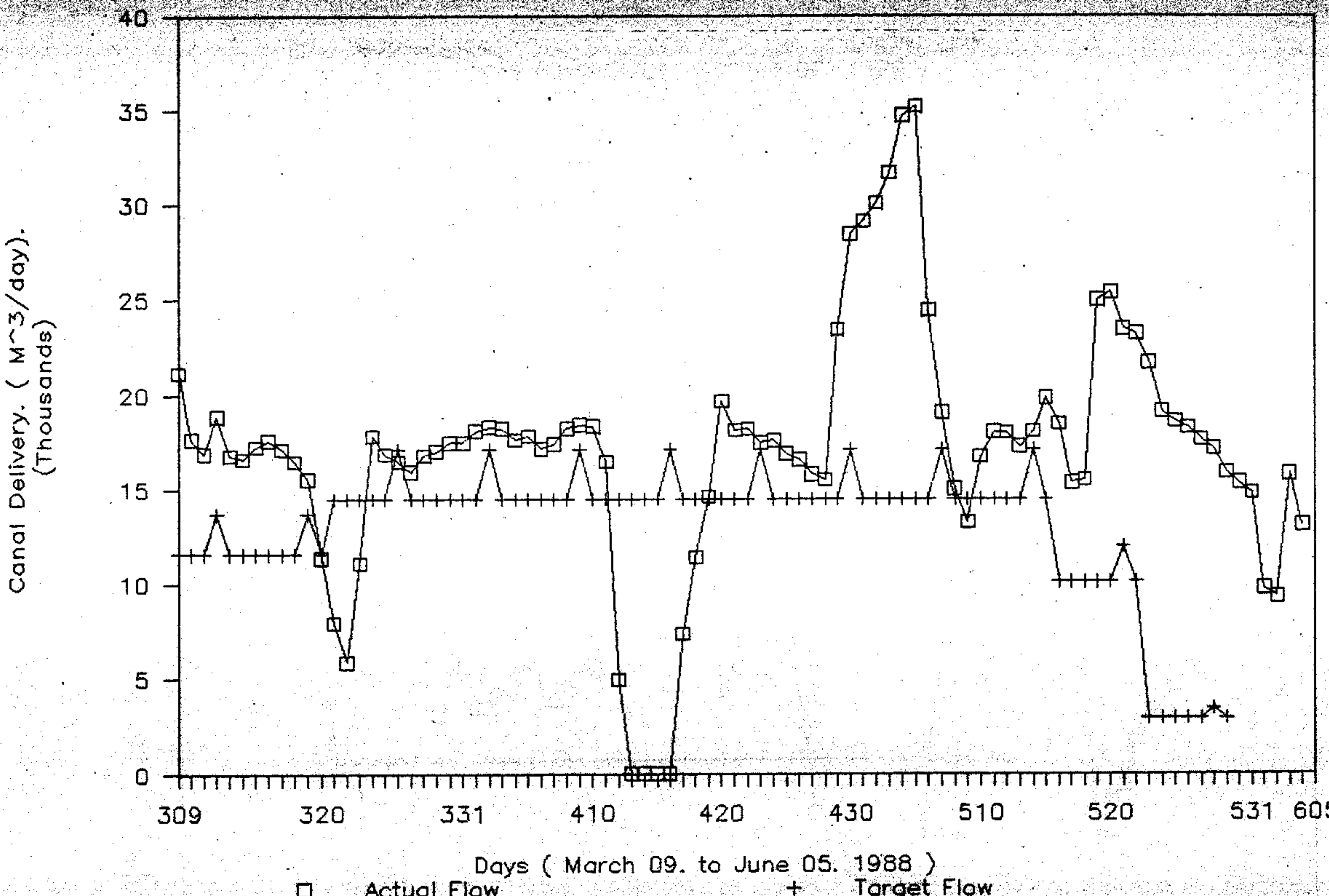


Figure 2.5 - Target and actual discharges at head of DC 5

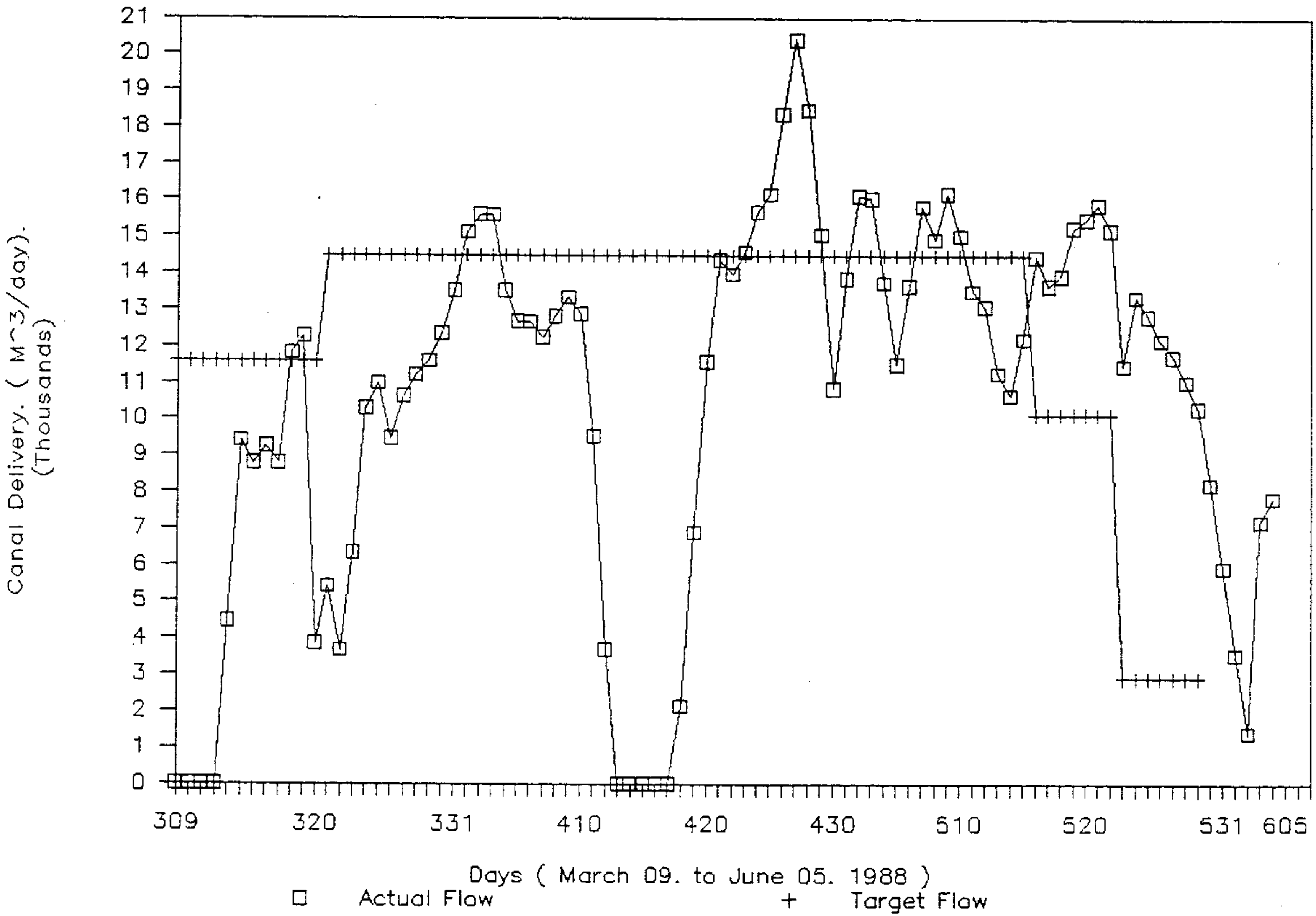


Figure 2.6 - Target and actual discharges at head of DC 8 under DC 2

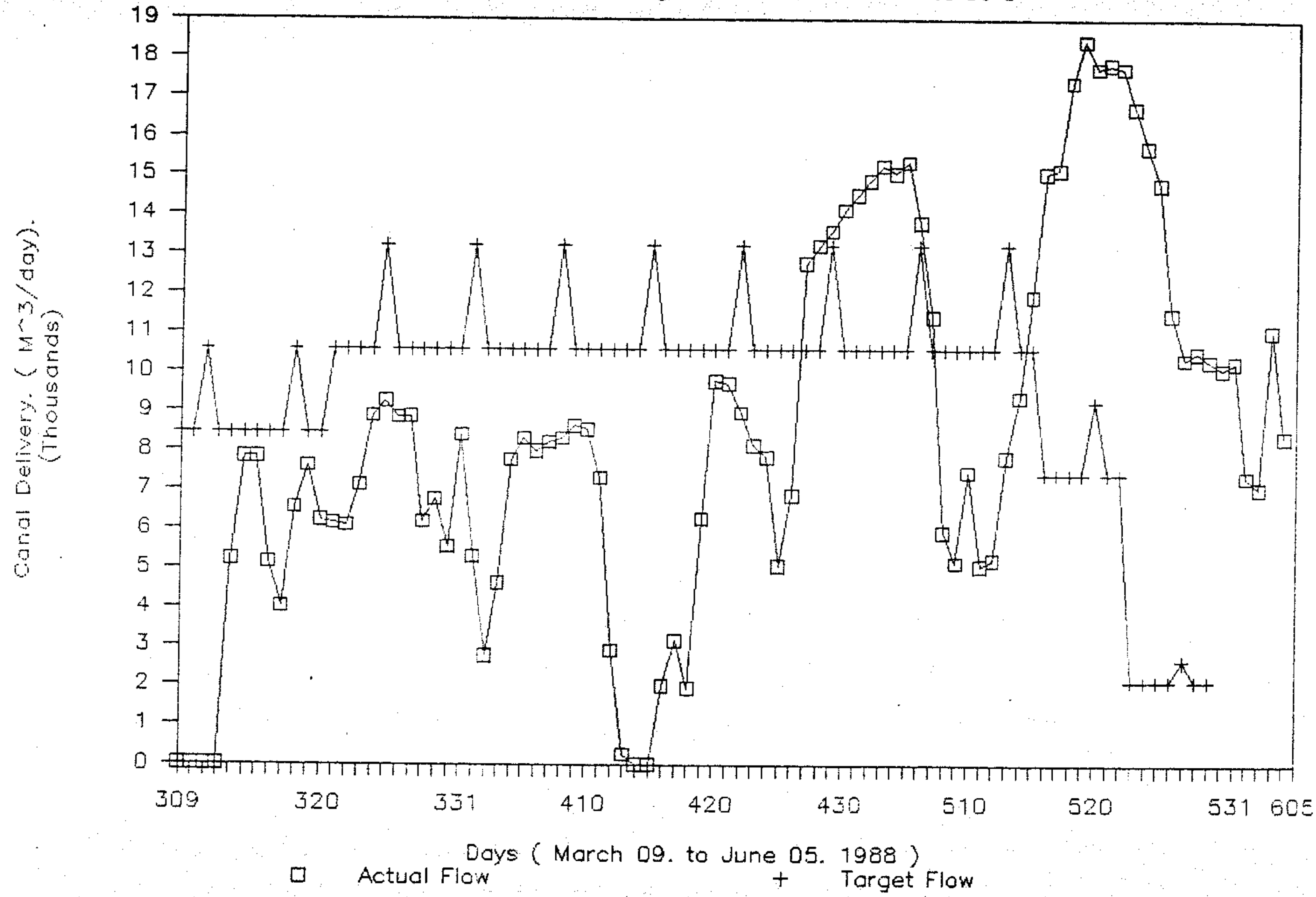


Figure 2.7 - Target and actual discharges at head of FC 12 under DC 2

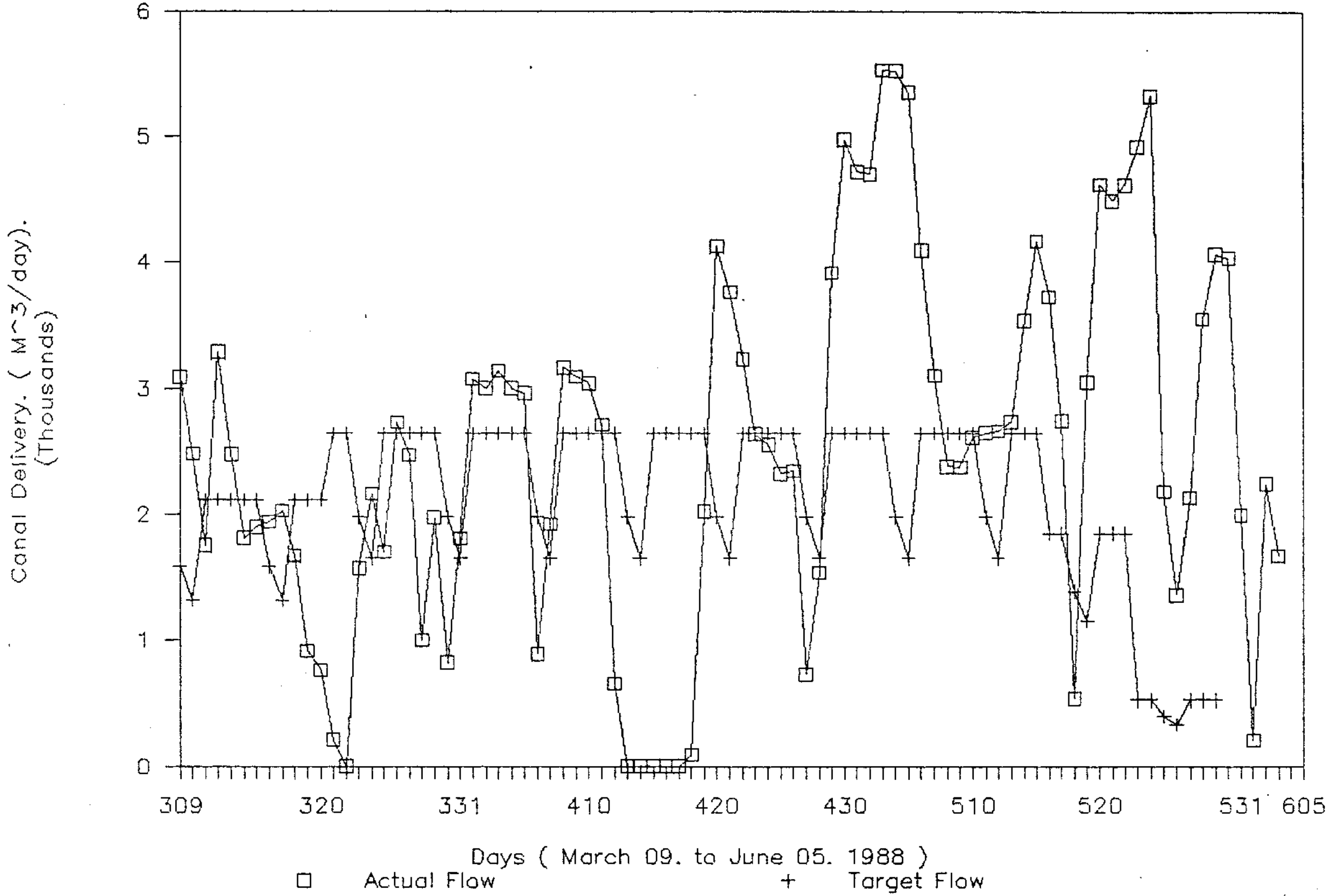


Figure 2.8 - Water level fluctuations of Tail-end of FC 12

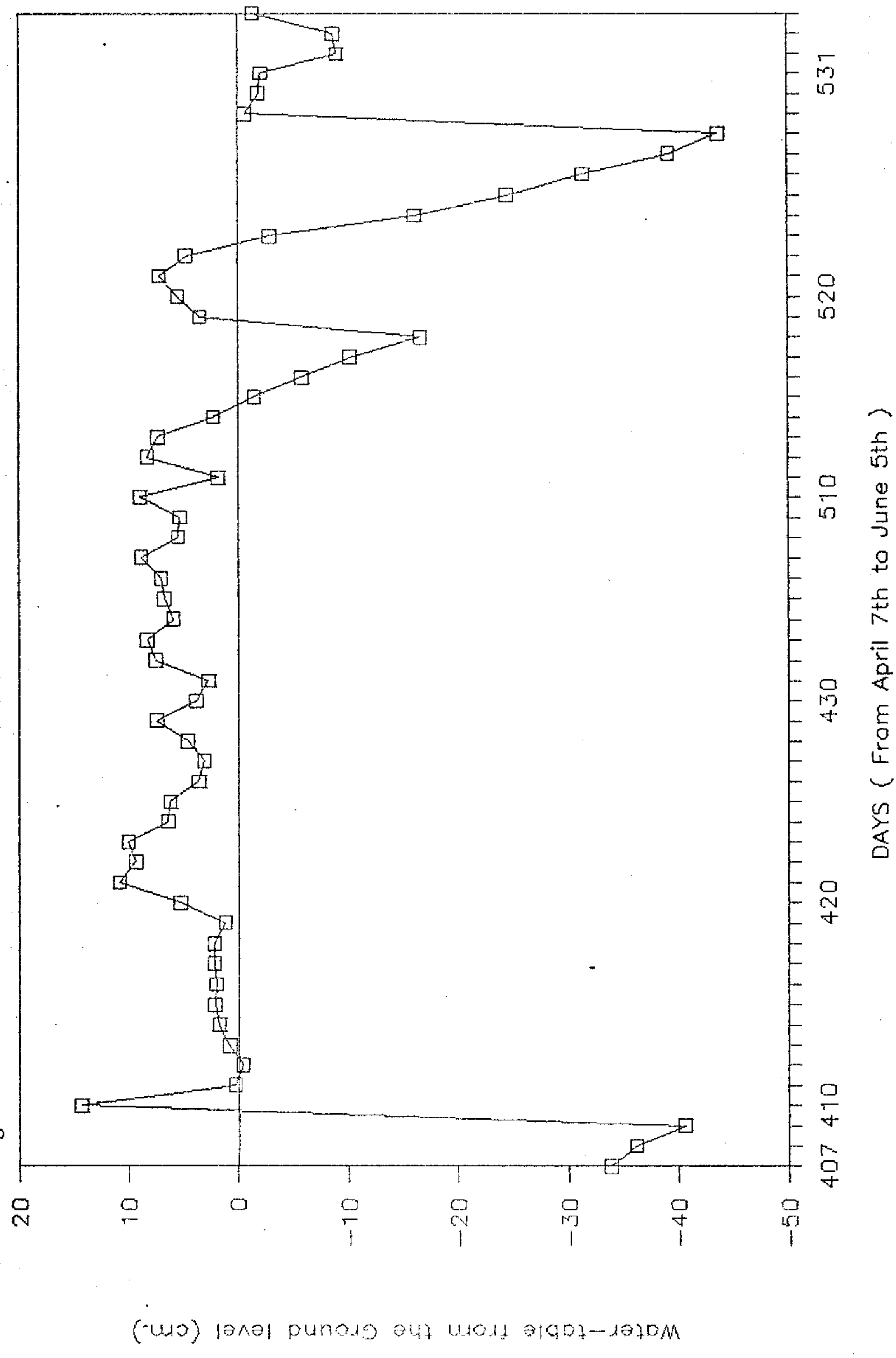


Figure 2.9 - Conveyance losses in DC 2

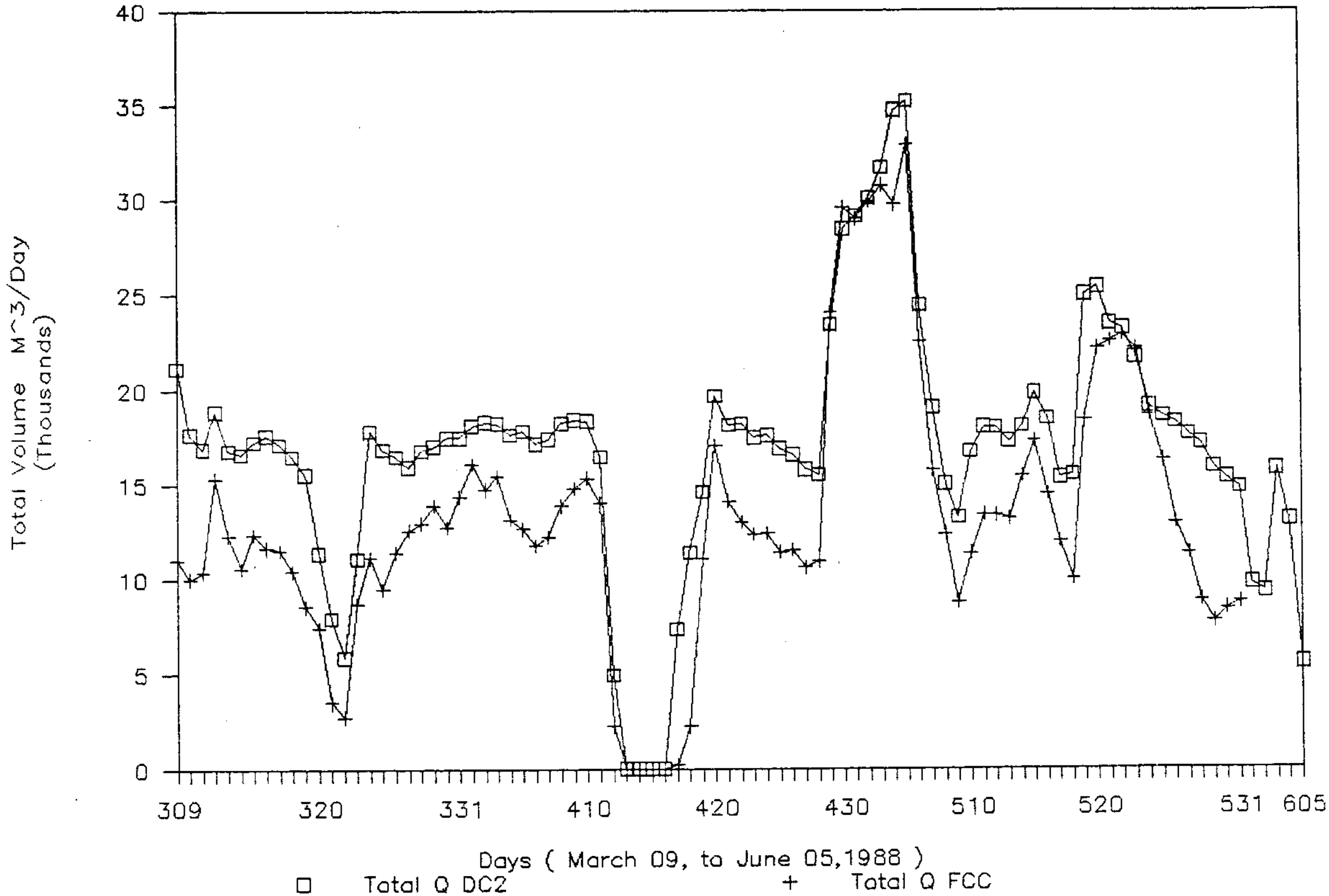


Figure 2.10 - Rainfall distribution of Weerawila

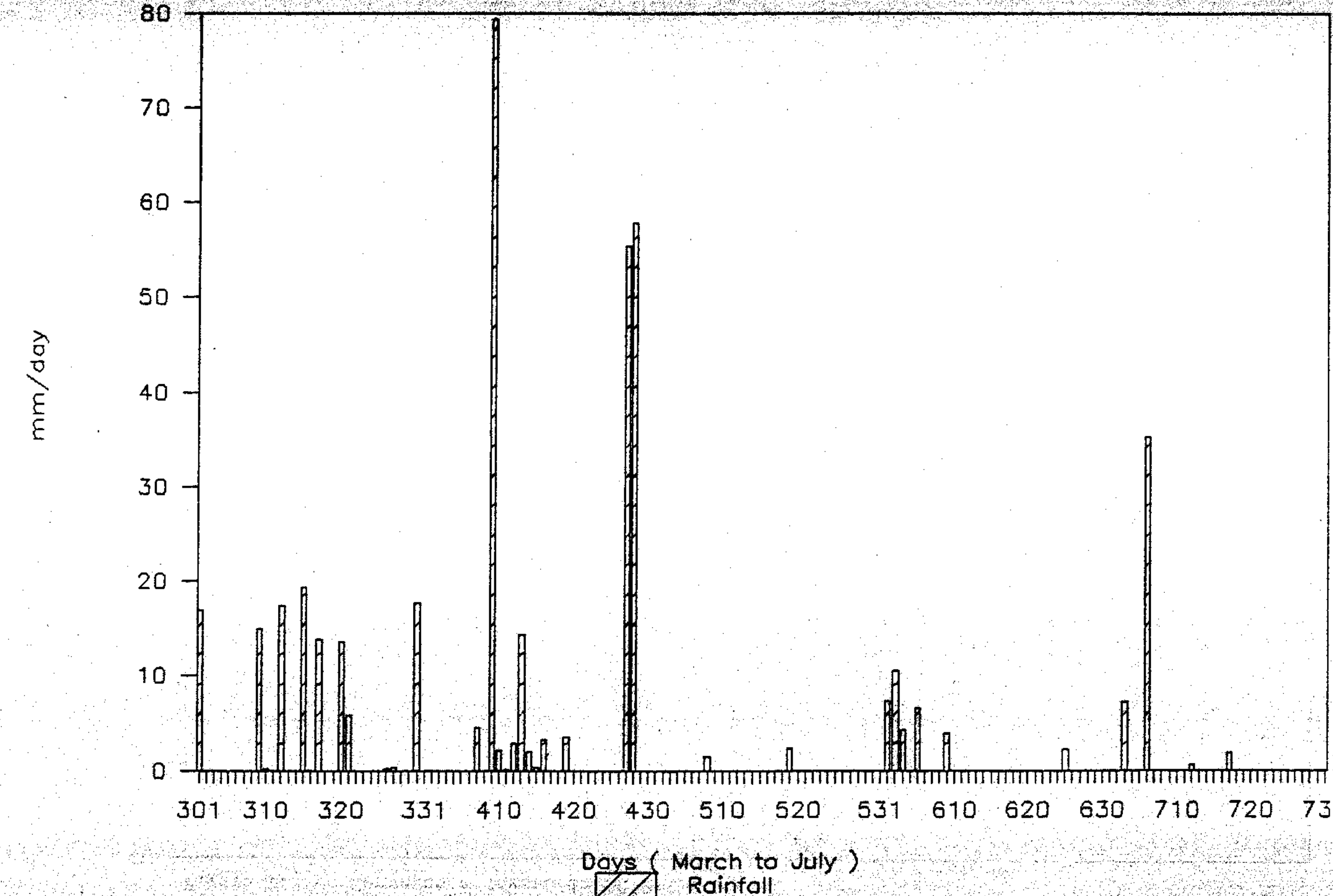
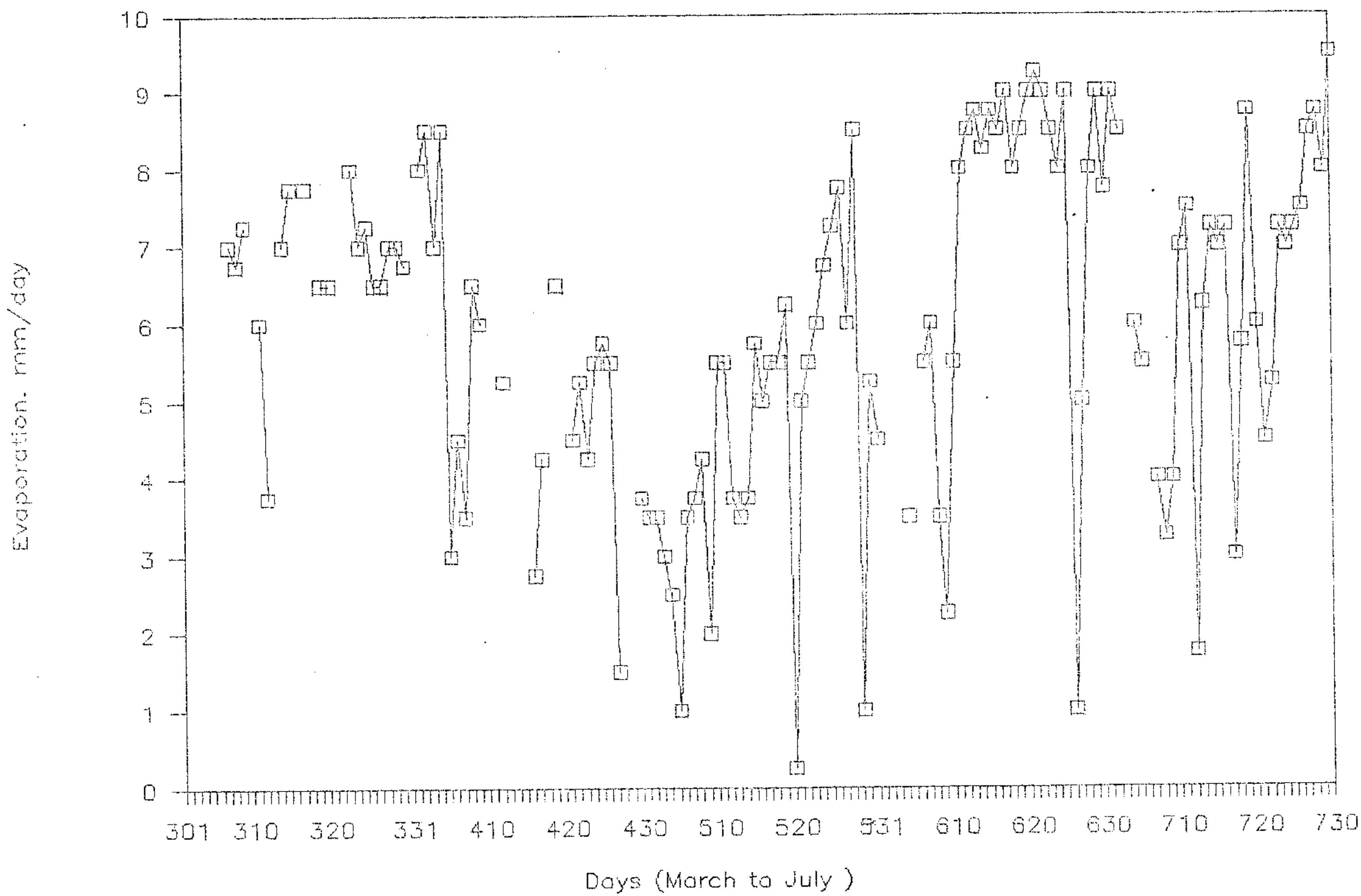


Figure 2.11 - Open pan evaporation at Weerawila



III. RICE PRODUCTION IN KIRINDI OYA, 1987/88 MAHA: SOME PRELIMINARY RESULTS FOR SYSTEM PERFORMANCE AND CROP DIVERSIFICATION

INTRODUCTION

The economics component of this project has two major objectives: to assess irrigation system performance through analyzing the performance of irrigated agriculture in the system, and to analyze, mainly based on data from on-farm experiments, the relative profitability of non-rice crops that could be grown by farmers in the system in pursuit of crop diversification. In the last season, the 1987/88 maha, all the farmers in the system planted rice, and the on-farm experiments were not set up yet. This interim report, therefore, presents the results mainly related to the first objective, i.e., agro-economic performance of rice production in the system. However, to the extent possible, attention is paid to such conditions as factor markets that would have important influences on successful crop diversification in the study area. Rice should in any case be the standard crop with which other crops contest for diversification.

The first objective is attained by linking the agro-economic performance of irrigated agriculture with agro-hydraulic parameters that are controlled by the system management. However, since measurements of hydraulic factors in our sample sub-system commenced two months after the first issue of water in the last season, attempts to link the two in a reasonably meaningful way must be postponed to the following seasons. We report here the agro-economic performance of rice production in the sample sub-system in such a way as to provide as much information as possible for the future synthesis of agro-hydraulic and agro-economic factors.

Samples and Data Collected

The necessary data to attain the first objective were collected from the farmers cultivating sample allotments in the sub-system under study, BC 2, Tract 5. Of the eight DCs in Tract 5, DC 2 is the sample DC wherein our intensive monitoring of hydraulic performance is carried out. Forty percent of the allotments in DC 2 area were drawn as the sample for data collection, after stratifying the population according to location along the DC and soil type (Table 3.01). In addition to DC 2 that is located at the middle portion along BC 2, samples were drawn, with lower sampling ratios, from allotments in DC 8 and DC 5, in order to have more general ideas on farming in the sample sub-system as a whole. DC 8 represents the head-end distributary canal along the branch canal and DC 5 represents the tail-end.

The following are the major items for which data were collected under this module:

1) Basic characteristics on the allotments and cultivating farmers, such as a) drainage water use, b) channel route from DC to allotment, c) area cultivated other than the sample allotment, d) tenure status, and e) the extent affected by salinity problem in the last season;

2) Basic data which are necessary to estimate costs and returns in rice production, i.e., data on output and inputs for rice production, and on prices involved;

3) Data on farming practices, such as dates of land preparation and planting and frequency of fertilizer application; and

4) Data on output disposal and on credit.

Aside from the data collection for the sample allotments, crop-cut surveys were conducted for 100 percent of the allotments in DC 2 and for the sample allotments in DC 5 and DC 8. Although each allotment in this system is designed to be a one-hectare paddy field, actual area varies from allotment to allotment. Therefore, area surveys were made for all allotments that underwent the crop-cut survey.

RICE FARMING IN STUDY AREA AS COMPARED TO SOME OTHER REGIONS

First, let us observe briefly how rice farming in the study area compares with that in other regions in Sri Lanka. Some indicators related to rice production in the 1986/87 maha season are summarized in Table 3.02 for five different regions, together with the summary results of our Kirindi Oya 1987/88 maha data. The data for the five regions are from a cost-production sample survey of agricultural crops conducted by the Department of Agriculture (DOA).

As is well known, there are two distinct agro-climatic zones in Sri Lanka; the wet zone and the dry zone. Among the five regions shown in the table, Kegalle belongs to the wet zone, Matale to the wet-dry intermediate zone, and the other three regions to the dry zone. The table reveals some interesting differences in rice production not only between the wet and dry zones but also between regions in the dry zone.

All regions, except Kegalle, commonly recorded rice yield per hectare of more than 4 tons in the 1986/87 maha season. It was 4.3 tons in Hambantota, the sample of which covers Kirindi Oya study area. Heavy application of fertilizers, which would be an important explanatory variable for the high yield of rice, also commonly characterizes rice farming in the regions. The level of nitrogen use was as high as 80-100 kg per hectare. Although the level of usage differed, probably depending on the degree of pest-insect outbreak, farmers in all region applied pesticides. Other farming practices, however, show some zonal or regional differences.

For instance, transplanting is the major method of crop establishment in the wet zone, whereas it is broadcasting even in the maha season in the dry zone. The dry zone farmers commonly use herbicides and are less dependent on manual weeding, while weeds are controlled in the wet zone mainly by manual labor without using herbicides. The factor payment to fixed capital services also differs from the wet zone to the dry zone; it is higher in the latter than in the former. This difference is due mainly to the difference in fixed capital used for land preparation and post-harvest operations between the two zones. The wet zone farmers use draft animals as the principal power source, while their dry zone counterparts are more dependent on the 2- or 4-wheel tractor.

Above all, the most striking differences are found in labor intensity and sources of labor. The total labor use in terms of labor days per hectare was as high as 226 in Kegalle, and as low as 82 in Hambantota. There is a clear tendency that labor intensity is high in the wet zone and low in the dry zone. Even within the dry zone, rice farming in its northern part (Kalawewa) seems to be more labor intensive than in its southern part (Uda Walawe and Hambantota). As a result, the regional difference in labor productivity is much more pronounced than that of land productivity. The regional differences in the sources of labor, i.e., family and hired labor, follow a similar pattern; the dependence on hired labor is least in the wet zone, intermediate in the northern dry zone, and most in the southern dry zone.

To some extent, the difference in labor intensity of rice production among regions could be explained by agro-climatic factors. There would be certain agro-climatic advantages for the wet zone farmers to adopt such techniques as transplanting, manual weeding, and animal land preparation, all of which are more labor intensive farming methods than those adopted by the dry zone farmers. A more important factor, however, seems to be the scarcity of labor. Although, generally speaking, the level of wage rate in rice farming in these regions are all low, there are substantial wage differences among the regions as shown in Table 3.02. There is a close negative correlation between the level of wage rate and the level of labor intensity across regions, suggesting that the labor intensity is determined largely by the scarcity of labor which is reflected by the wage rate.

It is more difficult to ascertain reasons behind the regional differences in the sources of labor for rice production. The size of cultivation could be one explanatory factor. It is a universal phenomenon that, *ceteris paribus*, the larger the farm size, the higher the dependence on hired labor. Among the regions listed in the table, this trend is clearly observed. The different patterns in family-hired labor use among the regions, however, appear to be beyond the difference in farm size. More decisive factors must be sought in the structural differences of rural society in which rice farming is being practiced.

Whatever the reasons, these differences in labor scarcity and sources of labor should have important implications for irrigation management and crop diversification in the study area. At least three implications can be pointed out immediately. First, being in the high wage region, non-rice crops to be introduced in the study area for crop diversification should not be too labor intensive, or, more accurately, they should be able to generate returns to labor as high as those generated in rice production; in terms of wage rate, 50 rupees per day.

Second, the study area belongs to the region where the dependence on hired labor in rice production is highest. More than 50 percent of total labor inputs is supplied by hired laborers who capture nearly 20 percent of total rice output as their wages. This implies that there is a need to takethese hired laborers into account while diversifying crops away from rice. Unless due consideration is given to them, their welfare position might deteriorate due to crop diversification.

As is the case in rice production in other parts of Asia, the labor tasks in which hired laborers are most popularly employed in the study area are crop establishment and harvesting-post harvesting activities. Unlike production processes in industry, the processes of which can easily be standardized as in the factory system, production processes in agriculture are difficult to standardize and require personal judgments on infinite variations in plants, water and soil. Rice production is not an exception, but the above tasks have common characteristics relatively easy-to-standardize and easy-to-monitor. In contrast, crop care operations such as fertilizer and chemical applications require more specific decisions, so that these activities are least dependent on hired labor not only in the study area but in all rice growing regions in Asia. Generally speaking, non-rice crops require more attention for crop care than rice. It is therefore important that, while searching for suitable non-rice crops for diversification, attention should be given to crops where labor operations can be standardized as much as possible, in order to preserve employment opportunities for hired laborers, who in most cases belong to the poorest and the most vulnerable section of rural society.

Third, as a corollary of the second point above, it is necessary for the system management to take hired laborers into account, both as the beneficiaries of the irrigation system and as the subjects of system maintenance. The farmers are one of the agents whom the system management should deal with. As shown in Table 3.02, rice farmers in the study area receive about 50 percent of the rice output as their income. The ratio of farmers' income to hired laborers' income as a group was 5:2 in Hambantota in the 1986/87 maha, and it was indeed 2:1 in the case of our Kirindi Oya sample in the 1987/88 maha.

RICE PRODUCTION IN KIRINDI OYA

As shown in the last column of Table 3.02, the average rice yield of the sample allotments in Kirindi Oya in the 1987/88 maha season was 3.7 tons per hectare, a bit lower than the yield reported for Hambantota in the 1986/87 maha season. The lower yield might have resulted from more serious occurrence of crop pest and disease in the season as indicated by the heavier use of pesticide by our sample farmers. Also, our sample farmers used less fertilizer than the Hambantota sample farmers. Although it is rather difficult to compare directly because of differences in the methods used for data collection, our sample farmers applied more labor per hectare than those in the Hambantota sample. The pattern of labor use by source, however, is very similar between the two samples. In what follows, we summarize the data for the 1987/88 maha season obtained from our sample farmers in Kirindi Oya.

Yield Performance

The average rice yield per hectare for the allotments in the DC 2 area, estimated from the 100 percent crop-cut survey, are shown in Table 3.03 by location along the DC and by soil type. The following points should be noted:

1) The average yield for the entire area of DC 2 was 3699 kg per hectare, while that for the sample allotments was 3850 kg per hectare (Table 3.04).

2) As expected, the nearer the allotments to the head-end, the higher the yield, on the average (the last row). However, the difference in yield among the locations is statistically significant only between the head- and tail-ends for the poorly drained allotments (the third row).

3) There is also a tendency that the better the drainage, the higher the yield (the last column). The poorly-drained allotments recorded a significantly lower yield than the well-drained allotments. The poorest average yield was observed for the poorly-drained sections of the tail end, while the highest yield was recorded in the well-drained allotments of the tail end.

4) All this suggests that water was rather abundant in the last season. The major problem for farmers was not how to get enough water to their fields but how to drain excess water from the fields. As a matter of fact, the salinity due to waterlogging was a serious problem for some of the poorly drained allotments, as shown in the following sections.

5) Similar anomaly was observed for the yields among the DCs as well. As shown in Table 3.04, the average yield among the DCs surveyed is highest in the tail-end DC 5 and lowest in the head-end DC 8.

Before analyzing in more details the factors that affected the yield differences among DCs, locations and soil types, let us observe the input structure of rice production in the last season.

Farming Practices and Production Inputs

The levels of major inputs per hectare are summarized in Table 3.04, by D canal, by location, and by soil type. The levels of labor use by operation is given in Table 3.05. Similar to the yield level, the pattern of input use shows some variations among DCs, locations along the DCs, and soil types.

In the last season, the water issue to RB Tract 5 commenced on 25 January 1988. The land preparation in the DC 2 area ended by 1 March, including generally two times of plowing and a final land leveling. It ended by 9 March in the tail-end DC 5 area. In spite of their head-end location along BC, the end date of land preparation for many sample farms in the DC 8 area was as late as mid-March, the latest one being 20 March. On the average of all samples, 54 labor days per hectare were spent for this operation (Table 3.05). Considering the fact that all farmers used the tractor as the means of plowing, this level of labor input seems to be too high. This is due partly to the long fallow since the last maha season caused by the serious drought in 1987. The tractor land preparation is mostly done as a custom work, since very few farmers own a tractor. As a result, nearly 50 percent of labor for this operation was supplied by hired laborers. Among the strata for DC and soil type, DC 8 farmers and farmers cultivating the poorly drained soil used significantly less labor for land preparation.

Before or right after the water issue, the farmers spent about two days for clearing weeds along their field channels. It is interesting to note that the tail-enders along the DCs worked significantly longer hours than others for clearing weeds. This work was mainly done by family labor or the farm operator himself, but some farmers hired laborers even for this purpose.

Immediately after land leveling, seeds were sown by broadcasting method. The seeding rate was, on the total average, 131 kg per hectare (Table 3.04), which was about 30 kg higher than the seeding rate by the transplanting method (see Table 3.02). The labor requirement for crop establishment was 14 labor days, more than 60 percent of which was from hired labor.

As already pointed out, the fertilizer use by our sample farmers in the last season was lower than the DOA's Hambantota sample farmers in the 1986/87 maha season. The nitrogen and potassium inputs per hectare were still as much as 82 kg and 30 kg, respectively, on the total average. In the case of phosphorus, however, the fertilizing rate of our sample was just one half of the level of the Hambantota sample. Typically, the farmers in Kirindi Oya apply fertilizer three times; once as basal, usually V fertilizer just before sowing, and twice as top dressing, usually urea about three weeks after sowing and TDM about one month after sowing. Some farmers add one more top dressing. As a result, the total average frequency for fertilizer application was 3.3 times. The farmers in the DC 5 area applied significantly more P and K with significantly more frequency of application than the farmers in other sample DCs. Compared to the farmers cultivating the well drained allotments, the frequency of fertilizer application of those cultivating the poorly drained allotments was significantly less.

Weed control in the study area is done with herbicide application and with hand weeding. If herbicide is used, it is applied usually only once as post-emergence weed control, about one month after sowing. Though many farmers adopt both methods, the two methods of weed control are obviously alternative in nature; the more herbicide is used, the less manual weeding labor, and vice versa. The DC 5 farmers and the farmers cultivating the poorly drained allotments have a clear tendency to resort more to herbicide.

On the average, the sample farmers applied pesticide 4.5 times with the total value of 927 rupees per hectare, which was slightly more than the value spent for fertilizers. Aside from scheduled spraying within a few months after sowing, many farmers had to apply pesticides even at the later stage of plant growth in May and June. Among the farmers in different categories, the farmers in the DC 8 area, cultivating the tail-end allotments, and cultivating the poorly drained allotments applied relatively lower amounts of pesticides.

The crop care labor as a whole, including fertilizer application, weed control and pesticide spraying, totaled 17 labor days per hectare on the average, nearly 80 percent of which was carried out by family labor. Depending on the methods adopted for weed control and on frequency of chemical applications, however, the amount of labor used for this purpose varies significantly among strata in each category.; the farmers in the DC 2 area, cultivating the allotments at the middle portion along the DCs, and cultivating the well drained allotments used more crop care labor than other respective counterparts.

Contrary to the crop care labor, nearly 80 percent of harvesting and post-harvesting labor work was done by hired labor. As expected, not much variance is observed across strata and categories as far as the total labor days for these activities are concerned.

As to the labor use for rice production in general, the following points are worth noting. First, of the total labor use, 39 percent was from family labor, 6 percent from exchange labor, and 55 percent from hired labor, on the average of total sample. Though the share of exchange labor was relatively high for such farm tasks as crop establishment and harvesting-post harvesting, altogether the labor exchange tradition in rice farming is of less importance in the study area. Second, in terms of labor use, the DC 8 farmers reveal a remarkable difference from those in other DC areas. They did not use exchange labor at all. Moreover, their dependence on hired labor was significantly higher; of the total of 112 labor days, 87 days were supplied by hired laborers, whereas only 26 labor days utilized their own labor. Such a distinct pattern of labor use in the DC 8 area suggests that the rural society to which the DC 8 farmers belong has characteristics very different from those in the other sample DCs.

The fixed capital services the farmers in the study area employ are those derived from the 2- or 4-wheel tractor used for land preparation and post-harvest operations. As explained earlier, these services for most of the farmers take the form of custom service contracted based on area. Usually, the payment for such a contract includes not only the payment for the tractor itself but the wages for tractor operators and the cost of fuel for running the tractor. The value of fixed capital services shown in Table

3.04 is the pure tractor rental per hectare after deducting the wages and the fuel cost by using the respective market rates. For the farmers who used their own tractor, its service is imputed at the market rental rates. Therefore, the figures in Tables 3.02 and 3.04 for our sample are not directly comparable with those of other regions in Table 3.02, the figures of which include the three components in the contract payment. The use of fixed capital thus estimated shows remarkable uniformity across the strata for all the categories examined, except for the DC 8 farmers who used it significantly more than others. However, since our data collection in the last season commenced after the land preparation period, the detailed analysis of fixed capital related issues, such as the relationship between water availability and extent of land preparation and its impacts on yield, should wait for the following seasons.

As explained so far, it is found out that there are some differences in the pattern of input uses among the allotments in different strata of the categories examined. Attempts were made to test if these differences could be supported statistically after controlling other factors. The tests were made through regression analyses in which the level of certain inputs per hectare was regressed on a set of factors: DC, location, soil type, tenancy, and salinity. If all independent variables are dummy variables, this is nothing but performing the analysis of variance. Here, all factors are defined as dummy variables, except salinity which is defined both as a dummy and as a continuous variable showing the percentage of area affected by salinity in an allotment. The results are summarized in Table 3.06. Note that an intercept in the table shows the average of dependent variable for the allotments having all of the following characteristics: DC 2, head-end, well-drained, free of salinity, and tenant-operated. The following points are confirmed:

1) Seeding rate was higher, other factors being equal, for the farmers in the DC 5 and DC 8 areas.

2) Fertilizer use, as the total value of all kind of fertilizers, was higher for the DC 5 and DC 8 farmers, and the incidence of salinity lowered it. In terms of nutrient element, the levels of nitrogen and phosphorus were higher in DC 5 and DC 8, and lower on the poorly drained allotments.

3) The farmers cultivating the poorly drained allotments used more herbicide.

4) Pesticide application was less for the DC 8 farmers and those cultivating the poorly drained allotments.

5) The farmers cultivating the poorly drained allotments used less labor. The owner operators used more labor than the tenant farmers, either leaseholders or sharecroppers.

6) The total cost of rice production defined as the total factor payments (see the last section) did not show any factor specific effect.

Factors Affecting Rice Yield

It was suggested in Table 3.03 that the rice yield of tail-end allotments along the DCs and of poorly drained allotments was significantly lower than that of other allotments. To test whether this fact is retained after controlling other factors, regression analyses similar to the input regressions in the previous section were attempted. The results are summarized in Table 3.07.

The first two equations are estimated using the yield data on all allotments for which the crop-cut survey was conducted, i.e., all allotments in the DC 2 area and the sample allotments in DC 5 and DC 8. Regression 1 confirms that the yield of poorly drained allotments was significantly lower than other allotments even after the DC and DC-location factors are controlled. It also shows that the yield of DC 5 allotments was higher than others. The location factors do not show any significant impact on the yield.

Regression 2 in which the salinity dummy is included reveals that the incidence of salinity lowered rice yield by about 800 kg per hectare. The coefficient of poorly-drained dummy is still negative and significant. This implies that, aside from the salinity problem that occurred exclusively on poorly drained allotments, the poorly drained allotments had certain other factors that caused the low yield.

The last two equations are estimated with the data obtained from the sample allotments. Regression 3 shows that, although the coefficient of DC 5 dummy turns out to be insignificant, essentially the same structure as in Regression 2 is detected by the data from the sample. In Regression 4, tenancy dummy and input variables are added in the linear form. The production inputs are divided into the major nutrient elements of fertilizers and the non-fertilizer cost. The addition of inputs makes the coefficient of poorly-drained dummy insignificant. Salinity dummy, however, remains significant. These results suggest that the farmers cultivating the poorly drained allotments reduced their level of inputs accordingly in the course of production process. As shown in Table 3.06, the level of input use on the poorly drained allotments is significantly less for many production inputs examined. In the case of salinity, since the problem arose in the later stage of the production process, its adverse effect on yield is picked up by the dummy variable even after excluding the effect of differences in input use.

In the same regression, the coefficient of DC 8 dummy turns to be significant, the sign being negative. This means that there are some factors that explain the low yield of the allotments there other than the inputs and other factors introduced in the regression. As observed in the previous section, the timing of land preparation in the DC 8 area was delayed by more than one month. This might have caused the low yields. It was also observed that the DC 8 farmers exhibited distinct characteristics in their input use pattern, particularly for labor, which seemed to stem from their social structure. The unrevealed factors behind the dummy variable could be such social traits, or more specifically, it could be due to a relatively lower level of rice growing technology as a reflection of such traits.

At least, the following two implications are derived from the regression results above: first, reflecting the fact that the water was generally abundant in the last season, the head-tail problem was not serious at all both for the BC and for the DCs. As a matter of fact, the BC head-enders, i.e., the DC 8 farmers, attained significantly lower yield than others, and the location factors along the DCs revealed no yield effect.

Second, the problem was how to drain excess water. If the system management could solve this drainage problem under abundant water supply, the productivity of the system would be increased through three routes: first, it is increased directly by reducing the incidence of salinity; second, it is increased indirectly by letting the farmers cultivating the poorly drained allotments increase their use of production inputs and third, the water saved can be used elsewhere in the system for increased production.

Credit

Before presenting the economic performance of rice production in the system, let us have a brief look at the farmers credit situation, since information on it is necessary for obtaining one of the economic performance indicators. Related information is summarized in Table 3.08.

For the sample as a whole, 70 percent of the farmers obtained loans either from institutional or from informal sources, or from both, during the last season. On the average per farmer, the amounts borrowed from institutional and informal sources were 3500 rupees and 2500 rupees, respectively, totaling 6000 rupees. The interest rate of the institutional bank loan was 9 percent per year or 4.5 percent per season. Of the 2500 rupees from informal sources, more than 50 percent was the interest-free loan, while the rest was with interest, the typical rate of which was 120 percent per year or 60 percent per season.

There are some difference in farmers' borrowing patterns among the sample DC areas. Here again, the DC 8 farmers show a pattern clearly different from the farmers in other DC areas. The major source of credit for the DC 2 and DC 5 farmers was institutional; around 80 percent of farmers got their loans from banks. In contrast, less than 20 percent of the DC 8 farmers relied on this source. Instead, nearly 65 percent of their loans were interest-free loans from such informal sources as relatives and close friends.

It is difficult to divide these loans to the farmers into production and consumption purposes. This is especially so in the case of informal loans, a substantial part of which would have been spent for consumption purposes. Even a part of bank loans, which were made definitely for production purposes in farming, could have been diverted for consumption purposes. In the following section, we assume that all loans were for production purposes in rice farming, and that they were made at the beginning of the last season.

Economic Performance

There could be various indicators by which the economic performance of agricultural production in an irrigation system is evaluated. Farmers' average income from particular production, often popularly called 'net returns to farmers', is one possible indicator. A few of them are shown in Table 3.09.

The first set of indicators is the factor payments and the operator's surplus in rice production. Viewed from one side, the factor payments are nothing but the costs of production, counting all factor inputs used in a production process as factor costs. Factor inputs are either purchased in respective factor markets or self-supplied within a firm. Self-supplied inputs are to be valued at their opportunity costs. The difference between the gross revenue and the total factor payments is, by definition, the profit, or the operator's surplus. Viewed from the other side, the factor payments are nothing but income of owners of the factors. This applies in a strict sense to two primary factors, i.e., labor and land, since payments for factors can further be divided into payments to primary and non-primary factors. The factor payments as such of rice production in the last season are presented in the table. Production factors are classified into four categories; current inputs, fixed capital, labor, and land. Self-supplied inputs are valued at respective market prices, assuming the prices are the best measure of their opportunity cost. The market prices used for imputation are listed in Table 3.10.

The current inputs are such inputs as seeds, fertilizers and chemicals, the value of which is transferred to the output and exhausted during a production process. The difference between the gross revenue and the current inputs is the value added. Since the value added is the income that is generated by a production process and distributed among the owners of resources involved in the production, this can be an indicator of economic performance of irrigation agriculture and hence of the system.

The third indicator listed in the table is the farmer's income from rice farming. This indicator is derived from the factor payments. The labor productivity of rice production is also shown in the table as the fourth indicator.

The average labor productivity of the 1987/88 maha rice production in the study area was 112 rupees per labor day. Compared to other regions listed in Table 3.02, this level is higher than the level in the wet zone and comparable to the level in other dry zone regions except Hambantota. Because of the long fallow preceding the last season, farmers in the study area had to spend more labor for land preparation than in an ordinary maha season. If there had been no drought in 1987, the 1987/88 maha labor productivity in Kirindi Oya would have been slightly higher than actually attained. Among the sample strata, the highest labor productivity was recorded by the DC 5 allotments and the lowest by the DC 8 allotments.

On the average for the whole sample, the value added per hectare was 11 thousand rupees, or 77 percent of the gross revenue. Compared to the DOA's 1986/87 maha samples in Uda Walawe and Hambantota, the value added produced by the Kirindi Oya farmers was nearly two thousand rupees less. Since the cost of fuel for the tractor is not deducted from the value added in the DOA's data, the two sets of data are not comparable. Even if the DOA's data are adjusted by assuming the same rate of fuel consumption as in our Kirindi Oya sample, however, the value added in the study area was still lower. Within our sample, the value added in DC 8 was substantially lower than in other sample DCs.

In terms of the factor payments, a distinct feature of Kirindi Oya rice production in the last season, as compared to other regions listed in Table 3.02, is the large payments to labor. Indeed, the factor payments to labor, or the labor income from rice production, is higher in Kirindi Oya in the 1987/88 maha than in other regions in the 1986/87 maha, except the extreme case of Kegalle. In terms of the factor share of labor, the share in Kirindi Oya is as high as 40 percent, while it is around 30 percent in other regions. Whether this feature of Kirindi Oya rice production is specific to the last season or more enduring should be checked carefully in the future seasons.

Within the system, the factor share of labor does not show much variation across the sample strata. The division of the labor income between family and hired labor, however, differs very much among the sample DCs. The hired labor share was about 20 percent in DC 2 and DC 5, whereas it was as high as 34 percent in DC 8. This means that nearly 80 percent of the labor income generated in the rice production in DC 8 was captured by hired laborers, while the ratio was about 50:50 in other sample DCs.

Another distinct feature of Kirindi Oya rice production revealed by the factor payments is that the factor share of land was as low as 22 percent. This level of factor share of land is low, compared to other land scarce countries in Asia where the factor share of land in rice production usually falls in a range of 30-50 percent. Unfortunately, in the DOA's data shown in Table 3.02, data on the land income are not available. Judging from the estimates of 'Land & surplus' for the regions listed, however, it appears that the real level of factor share of land would be higher than the estimated level of 22 percent. Should this be true, it suggests some imperfections exist in the land market. In any case, this point also needs careful examination in the future study.

Only 1 percent of the gross revenue, on the average for the whole sample, was left as the operator's surplus in the last season. On the long run equilibrium, the operator's surplus, or the profit, must be zero, provided that all related markets are perfect. A negligibly small amount of operator's surplus, therefore, could be taken as a sign to indicate that the markets are functioning well. From what we have examined so far in this report, however, it is rather difficult to judge that the rice farmers in Kirindi Oya operated under conditions that ensure a long run equilibrium. As a matter of fact, the farmers in the DC 8 area incurred substantial losses, or negative profits, in their rice production. A more definite idea in this respect will be obtained after more investigations are made on the labor and land markets using data from the forthcoming seasons.

The farmer's income from rice production can be obtained by summing up all payments to the factors owned by him and the operator's surplus. The average farmer's income thus obtained is shown in Table 3.09, assuming that the typical Kirindi Oya farmer is an owner operator cultivating a one hectare allotment. It was 5971 rupees, or 42 percent of the gross revenue, on the average for the entire sample. If a farmer is a tenant operator of the same size, his income is 2757 rupees (family labor income + operator surplus), less than 50 percent of the owner operator's income. If a farmer is an owner operator having his own tractor, his income is increased by the amount paid to fixed capital, totaling to 7643 rupees. As expected, the income from rice production of the DC 8 farmers was substantially lower than that of the DC 2 and DC 5 farmers. Their income was even less than the amount paid to hired laborers.

Comparing in terms of farmer's income per hectare, the Kirindi Oya farmers earned less in the last season than those in other regions in the 1986/87 maha. This lower farmer's income from rice production is due to two immediate factors. First, the value added in rice production was lower. Second, the share of income taken by hired laborers was higher.

The farmer's income after deducting interest payments for production loans is also shown in Table 3.09. This adjustment reduces the unadjusted farmer's income by 10 to 15 percent, which seems to be a 'moderate' reduction. Such a moderate reduction is due to the fact that institutional as well as interest-free informal loans were available to farmers. If all loans had been from informal sources with interest of 60 percent per season, nearly 60 percent of the farmer's income would have been paid out as interest for the loans. This illustration may suggest the importance of providing farmers with institutional loans when farmers plan to grow non-rice crops for diversification.

Table 3.01. Population and sample allotments in distributary canals under study in Tract 5 of Kirindi Oya, by location along distributary canal and by soil type.

Soil type	Location along DC Head	Middle	Tail	Total
	------ Number of sample/Population ------			
DC 2:				
Well drained	7/10	10/16	3/ 3	20/29
Intermediate	0/ 8	0/15	0/ 6	0/29
Poorly drained	5/ 8	7/11	6/10	18/29
Total	12/26	17/42	9/19	38/87
DC 5:				
Well drained	1/ 1	0/ 1	2/ 4	3/ 6
Intermediate	0/ 5	0/ 4	0/10	0/19
Poorly drained	4/13	0/ 8	7/17	11/38
Total	5/19	0/13	9/31	14/63
DC 8:				
Well drained	1/ 1	0/ 0	1/ 6	2/ 7
Intermediate	0/ 2	0/ 1	0/ 6	0/ 9
Poorly drained	3/ 6	0/ 2	7/19	10/27
Total	4/ 9	0/ 3	8/31	12/43
Total:				
Well drained	9/12	10/17	6/13	25/42
Intermediate	0/15	0/20	0/22	0/57
Poorly drained	12/27	7/21	20/46	39/94
Total	21/54	17/58	26/81	64/193

Note: Canceled and uncultivated allotments are excluded.

Table 3.02. Output, inputs, and factor payments per hectare, farm income per hectare and per farm, and prices, in irrigated rice production in selected regions in Sri Lanka and study area.

Region	1986/87 Maha[1]					1987/88 Maha
	Kalawewa	Matale	Kegalle	Udawalawe	Hambantota (Kirindi Oya)	Kirindi Oya[2]
Yield (kg)	4 748	4 663	3 623	4 512	4 323	3 747
Seed[3] (kg)	120[6]	95[7]	104[7]	160[6]	133[8]	131[8]
Fertilizer						
Total value (Rs)	1 112	1 282	1 151	1 035	1 182	831
N (kg)	77	98	90	64	100	62
P (kg)	28	45	42	41	42	21
K (kg)	29	40	45	37	41	30
Herbicide (Rs)	383	-	-	348	751	184
Pesticide (Rs)	351	175	400	483	577	927
Labor(days)						
Family	88(64)	111(70)	189(84)	59(50)	30(37)	57(45)[11]
Hired	49(36)	43(30)	37(16)	60(50)	52(63)	70(55)
Total	137(100)	160(100)	226(100)	119(100)	82(100)	128(100)
Gross revenue (Rs)	17 046(100)	16 368(100)	14 202(100)	16 064(100)	16 086(100)	14 351(100)
Factor payment(Rs):						
Current input[4]	2 510(15)	1 937(12)	2 117(15)	3 200(20)	3 127(19)	3 335(23)
Labor: Family	3 343(20)	3 662(22)	6 290(44)	2 646(16)	1 557(10)	2 636(18)[11]
Hired	1 856(11)	1 483(9)	1 241(9)	2 721(17)	2 513(16)	3 373(24)
Total	5 199(31)	5 145(31)	7 531(53)	5 367(33)	4 076(26)	6 009(42)
Fixed capital[5]	2 576(15)	1 606(10)	1 518(11)	2 454(15)	2 129(13)	1 672(12)
Land & surplus[6]	6 761(40)	7 680(47)	3 036(21)	5 043(31)	6 754(42)	3 335(23)
Value added[7](Rs)	14 536(85)	14 431(88)	12 085(85)	12 864(80)	12 959(81)	11 016(77)
Farmers' income[8](Rs)	10 104(59)	11 342(69)	9 326(66)	7 689(48)	8 311(52)	5 971(42)
Area cultivated (ha)	0.86	0.56	0.77	0.98	1.25	1.19
Actual farmers' income[9] (Rs/farm):	8 689	6 352	7 181	7 535	10 389	7 105
Price:						
Paddy rice[10](Rs/kg)	3.59	3.51	3.92	3.56	3.72	3.83
Seeds (Rs/kg)	5.53	5.05	5.44	4.56	4.63	5.80
Nitrogen[11] (Rs/kg)	9.3	6.6	6.5	6.3	6.4	6.5
Wage rate[12](Rs/day)	37.9	32.1	33.3	45.0	49.6	48.9
Labor productivity[13](Rs/day)	124	102	63	135	196	112

Note: 1) Data are from Department of Agriculture(DA). Climatic-geographycal specification of the regions: Kalawewa: Dry Zone, North-Central, Matale: Wet-Dry Intermediate Zone, Central, Kegalle: Wet Zone, Central, Udawalawe: Dry Zone, South, Hambantota: Dry Zone, South.

Table 3.02 (Cont..d)

2) Data are for the sample farmers in our survey.
3) Superscripts B and T stand for broadcasting and transplanting, respectively. Although both methods coexist in all regions listed, only major one is reported in this table.
4) Seed, fertilizer, herbicide, pesticide and fuel. Fuel for tractor is not included for the data from DA.
5) Fixed capital services such as draft animal and tractor. For DA data, fuel is included here.
For Kirindi Oya data, the returns to services for fixed capital owned by farmers are imputed using the market rate, but not for DA data.
6) Gross revenue - (current input + labor + fixed capital).
7) Gross value added (Gross revenue - current input).
8) Family labor + land & surplus. Assume that all farmers are owner-operator.
9) Farmers' income per ha x area cultivated.
10) Farm-gate price of rice output.
11) Based on urea price.
12) Average for all operations.
13) Gross revenue/total labor days.
14) Includes exchange labor.

Source: Department of Agriculture(1988). Cost of Cultivation of Agricultural Crops-Maha 1986/87, Vol.1 (Peradeniya: Department of Agriculture).

Table 3.03 Average rice yields (kg/ha) in the DC2 allotments in the 1987/88 maha season, by location along the D canal and by soil type, based on the 100% crop-cut survey.

	Location			
	Head	Middle	Tail	Average
Soil type:				
Well drained	4110 (11)	3808 (16)	4609 (3)	3999 (30)
Intermediate	3596 (8)	3717 (12)	3619* (5)	3658 (25)
Poorly drained	3768 (8)	3569 (8)	2973**+ (10)	3413** (28)
Average	3857 (27)	3716 (38)	3424 (18)	3699 (83)

Note: 1) Figures in parenthesis are the number of allotments in each category.

2) Yields with * and ** are statistically different, at the 5% and 1% significance levels respectively, from the largest yield in the same column.

3) Yields with + are statistically different, at the 5% significance level, from the largest yield in the same row.

Table 3.04 Yield and inputs per hectare in rice production for sample allotments in Tract 5, 1987/88 maha, by distributary canal, by location along distributary canal, and by soil type[1].

	Total Average	DC			Location			Soil type	
		2	5	8	Head	Middle	Tail	Well drained	Poorly drained
Yield[2] (kg)	3 747	3 850	4 026	3 047*	3 852	3 833	3 604	4 057	3 536*
Current inputs:									
Seeds (kg)	131	119*	153	147	135	112*	142	124*	137
Fertilizer:									
Total value (Rs)	831	763	1138*	812	831	800	913	918	813
Nitrogen (kg)	82	76	103	75	82	78	86	86	80
Phosphorus (kg)	21	16	36*	20	19	19	25	25	19
Potassium (kg)	30	28	38*	27	29	28	32	32	29
No. of appl.	3.3	3.2	3.9*	3.0	3.5	3.4	3.2	3.6	3.2*
Herbicide:									
Total value (Rs)	184	165	290*	116	210	139	193	86	248*
No. of appl.	.86	.87	1.0	.64	.91	.82	.84	.60	1.0*
Pesticide:									
Total value (Rs)	927	1050	915	519*	985	1117	750*	1173	766*
No. of appl.	4.5	5.1*	4.1	3.2	4.9	5.1	3.8*	5.4	3.9*
Fuel[3] (Rs)	633	621	684	602	615	607	662	635	631
Labor (days[4]):									
Family	50	57	51	26*	50	58	45	58	45*
Exchange	8	8	12	0*	7	10	7	12	5*
Hired	70	67	63	87*	69	66	74	74	67
Total	128	132	126	113	126	134	126	144	117*
Fixed capital[5] (Rs)	1 672	1 636	1 656	1 801*	1 616	1 666	1 725	1 668	1 676

Note: 1) In each characteristics group, a figure with * is statistically different from the other(s) at the 5% significance level or higher.

2) Data are from crop-cut survey.

3) Fuel for tractor.

4) One labor day = 8 hours.

5) Fixed capital service for tractor use in land preparation and post-harvest activities. In the study area, no draft animal is used. Costs for fuel and operator are not included. Service from owned capital is imputed at the market rental rate.

Table 3.05 Labor use per hectare in rice production for sample allotments in Tract 5, 1987/88 maha, by distributary canal, by location along distributary canal, and by soil type[1].

	Total Average	DC			Location			Soil type	
		2	5	8	Head	Middle	Tail	Well drained	Poorly drained
	days/ha								
Land preparation:									
Family	26.7(49)	28.0	33.6	13.3*	27.8	28.2	24.7	30.9	23.8*
Exchange	1.4(3)	1.7	1.8	0*	1.5	2.1	0.9	2.4	0.8*
Hired	26.2(48)	26.2	21.4	32.3*	26.0	24.9	27.3	31.8	22.6*
Total	54.3(100)	55.9	56.8	45.6*	55.3	55.2	52.9	65.1	47.2*
Crop establishment:									
Family	2.5(18)	1.9*	3.5	3.2	3.1	2.1	2.3	1.6	3.1*
Exchange	2.7(20)	2.7	4.8	0*	2.4	3.0	2.7	4.6	1.5*
Hired	8.5(62)	8.1	7.6	10.9*	9.7	6.9	8.5	7.7	9.0
Total	13.7(100)	12.7	15.9	14.1	15.2*	12.0	13.5	13.9	13.6
Crop care[2]:									
Family	13.7(79)	18.8*	6.6	5.1	11.8	19.6*	11.3	18.0	10.8*
Exchange	0.8(4)	1.2	0.4	0	0.4	2.2*	0.3	1.4	0.5*
Hired	2.9(17)	2.6	3.2	3.3	2.8	2.4	3.2	2.9	2.8
Total	17.4(100)	22.6*	10.2	8.4	15.0	24.2*	14.8	22.3	14.1*
Harvesting and post harvesting:									
Family	5.6(14)	6.7	5.6	1.9*	6.2	6.5	4.5	6.7	4.9
Exchange	2.7(7)	2.8	4.5	0	2.5	2.5	2.9	3.6	2.0
Hired	32.0(79)	30.2	31.0	39.3	30.2	31.0	34.3	31.2	32.5
Total	40.3(100)	39.7	41.1	41.2	38.9	40.0	41.7	41.5	39.4
Channel clearing:									
Family	1.6(84)	1.4	1.8	2.2	1.3	1.6	1.9	1.2	1.9*
Exchange	0 (0)	0	0	0	0	0	0	0	0
Hired	0.3(16)	0.3	0.2	0.8	0.1	0.2	0.7	0.4	0.3
Total	1.9(100)	1.7	2.0	3.0	1.4	1.8	2.6*	1.6	2.2
Total:									
Family	50.1(39)	56.8	51.1	25.7*	50.2	58.0	44.7	58.4	44.5*
Exchange	7.6(6)	8.4	11.5	0*	6.8	9.8	6.8	12.0	4.8*
Hired	69.9(55)	67.4	63.4	86.6*	68.8	65.4	74.0	74.0	67.2
Total	127.6(100)	132.6	126.0	112.3	125.8	133.2	125.5	144.4	116.5*

Note: 1) In each characteristics group, a figure with * is statistically different from the other(s) at the 5% significance level or higher. One labor day = 8 hours.

2) Fertilizer-chemical applications, manual weeding, and fencing.

3) Threshing, winnowing, and hauling.

Table 3.06 Factors affecting input uses per hectare, 1987/88 maha: Summary of regression analyses[1].

Regression No.	1	2	3	4	5	6	7	8
Dependent-variable	Seeds[3]	Fertilizer(value)	N	P	Herbicide	Pesticide	Total labor	Total cost[2]
Sample size	63	63	63	63	63	63	61	61
D-canal dummy:								
DC 5	27.1***	432***	31.3***	23.7***	66.3	28.1	4.5	550
DC 8	20.7**	187**	6.4	12.1**	-91.1	-308*	-2.7	27.6
Location dummy:								
Middle	-12.7	53.2	3.7	4.8	-44.2	21.7	-1.6	-94.7
Tail	0.9	63.0	2.2	4.8	-37.2	-138	7.2	166
Soil-type dummy:								
Poorly drained	1.8	-175	-12.8**	-10.8**	171***	-300**	-25.5***	-738
Salinity:								
Dummy			7.5		16.7	-42.6		
% affected		-9.5*		-0.5			-0.4	-73.7
Tenancy dummy:								
Owner operator	0.6	-54	-5.9	-1.3	-91.4	-107	18.3*	1101
Intercept	124	829	80.2	18.9	123	1231	115	13328
R^2	0.348	0.442	0.266	0.378	0.219	0.301	0.241	0.161
R^2(adjusted)	0.279	0.371	0.172	0.299	0.120	0.212	0.141	0.050
F-value	4.99	6.22	2.85	4.77	2.21	3.38	2.41	1.45

Note: 1) Regression coefficients with *, **, or *** are statistically significant at the 10%, 5%, or 1% level, respectively.
2) Total factor payments.
3) Sarinity dummy is not included.

Table 3.07 Factors affecting rice yield per hectare, 1987/88 maha: Summary of regression analyses[1].

Regression No.	1	2	3	4
Sample size	108	108	62	62
D-canal dummy:				
DC 5	527*	507*	271	-157
DC 8	-435	-141	-465	-676*
Location dummy:				
Middle	-140	-203	-226	-381
Tail	-261	-243	-130	-123
Soil-type dummy:				
Intermediate	-332	-284		
Poorly drained	-564***	-423*	-385*	-191
Salinity:				
Dummy	-792**			
% affected	-38*	-36*		
Tenancy dummy:				
Owner operator	-209			
Fertilizer:				
N				7
P				29**
K				-42
Non-fertilizer cost[2]				0.01
Intercept	4110	4121	4211	4497
R^2	0.147	0.201	0.252	0.352
R^2(adjusted)	0.096	0.145	0.170	0.193
F-value	2.90	3.60	3.09	2.22

Note: 1) The yield data are from the crop-cut survey. Regression coefficients with *, **, or *** are statistically significant at the 10%, 5%, or 1% level, respectively.

2) Total factor cost less fertilizer cost.

Table 3.08 Sources of credit for and amount borrowed by sample farmers, by distributary canal, 1987/88 maha.[1]

	Institutional (bank loan)	Informal		
		With interest	Without interest	Total
DC 2:				
Sample size 36(100)				
Non-borrower 6(17)				
Borrower	30(83)	15(42)	11(31)	26(72)
Average amount borrowed per farmer (Rs)	4166	1330	912	2242
DC 5:				
Sample size 14(100)				
Non-borrower 3(21)				
Borrower	11(79)	2(14)	7(50)	9(64)
Average amount borrowed per farmer (Rs)	3814	643	1129	1772
DC 8:				
Sample size 11(100)				
Non-borrower 3(27)				
Borrower	2(18)	2(18)	6(55)	8(73)
Average amount borrowed per farmer (Rs)	891	900	3280	4180
Total:				
Sample size 61(100)				
Non-borrower 12(20)				
Borrower	43(70)	19(31)	24(39)	43(70)
Average amount borrowed per farmer (Rs)	3495	1095	1389	2484
Typical interest rate (%/season)	4.5	60.0	0	

Note: 1) Figures in parenthesis are percentage of the total samples.

Table 3.09 Gross revenue, factor payments and gross value added per hectare, farm income per hectare and per farm, and labor productivity in rice production, 1987/88 maha, by distributary canal, by location along distributary canal and by soil type.[1]

	Total Average	DC 2	DC 5	DC 8	Location Head	Location Middle	Location Tail	Soil type Well drained	Soil type Poorly drained
	Rs								
Gross revenue[2]	14 351	14 746	15 420	11670	14 753	14 680	13 803	15 538	13 551
	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
Factor payment:									
Current input[3]	3 335	3 289	3 914	2 902	3 424	3 313	3 342	3 531	3 253
	(23)	(22)	(25)	(25)	(23)	(23)	(24)	(23)	(24)
Fixed capital[4]	1 672	1 636	1 666	1 801	1 616	1 668	1 725	1 668	1 676
	(12)	(11)	(11)	(15)	(11)	(11)	(12)	(11)	(12)
Labor: Family[5]	2 636	3 038	2 765	1 148	2 603	3 112	2 344	3 273	2 203
	(18)	(21)	(18)	(10)	(18)	(21)	(17)	(21)	(24)
Hired	3 373	3 231	3 228	4 022	3 448	3 073	3 507	3 499	3 265
	(24)	(22)	(21)	(34)	(23)	(21)	(25)	(23)	(24)
Total	6 009	6 269	5 994	5 170	6 051	6 185	5 851	6 772	5 468
	(42)	(43)	(39)	(44)	(41)	(42)	(42)	(44)	(40)
Land[6]	3 214	3 264	3 215	3 042	3 176	3 372	3 139	3 106	3 285
	(22)	(22)	(21)	(26)	(22)	(23)	(23)	(20)	(24)
Operator surplus[7]	121	288	631	-1 245	486	142	-254	461	-151
	(1)	(2)	(4)	(-10)	(3)	(1)	(-2)	(3)	(-1)
Gross value added[8]	11 016	11 457	11 506	8 768	11 329	11 367	10 461	12 017	10 298
	(77)	(78)	(75)	(75)	(77)	(77)	(76)	(77)	(76)
Farmers' income[9]:									
Unadjusted	5 971	6 590	6 614	2 945	6 265	6 626	5 229	6 840	5 337
	(42)	(45)	(43)	(25)	(42)	(45)	(38)	(44)	(39)
Interest adjusted	5 157	5 605	6 057	2 365	5 459	5 641	4 509	5 938	4 577
	(36)	(38)	(39)	(20)	(37)	(38)	(33)	(38)	(34)
Labor productivity[10]	112	111	122	104	117	110	110	108	116

Note: 1) The factors owned by farmers are imputed at the respective market prices. Figures in parenthesis are factor shares or percentage of the gross revenue.

2) Yield per hectare x rice price at farm-gate.

3) Seed, fertilizer, herbicide, pesticide, and fuel for tractor.

4) Capital service of tractor for land preparation and post-harvest operations.

5) Includes exchange labor after imputed at the market wage rates.

6) Land rent, paid or imputed.

7) Gross revenue - total factor payments.

8) Gross revenue - current input.

9) Assume that farmers are owner-operator cultivating one hectare on the average. Unadjusted income: Interest payments for production loans are not adjusted. Family labor + Land + Operator surplus. Adjusted income: Interest payments for production loans are deducted. The amount of production loans from institutional and informal sources and respective interest rates are assumed as shown in Table 8.

10) Gross revenue divided by total labor days.

Table 3.10 Market prices used for imputation.

Rice(paddy) price[1] (Rs/kg)	3.83	Wage rate (Rs/day):	
		Land preparation	41
Seed(paddy) price (Rs/kg)	5.80	Planting	41
		Fertilizer application	40
Fertilezer (Rs/50kg bag):		Weeding: Male	62
V_1	150	Female	34
Urea	150	Harvesting: Male	49
TDM	150	Female	43
		Post harvest	64
Tractor rental rate (Rs/ha):			
Land preparation	1168	Interest rate (%/season):	
Post harvest	503	Institutional	4.5
		Informal	60
Land rent (Rs/ha)	3214		

Note: 1) Farm-gate price of rice output.

IV. KIRINDI OYA: IRRIGATION INSTITUTIONS SEASONAL REPORT FOR MAHA 1987/88

OVERVIEW OF IRRIGATION INSTITUTIONS FOR OPERATION AND MAINTENANCE

The Irrigation Department (ID) and the Irrigation Management Division (IMD) under the Ministry of Lands and Land Development (MLLD) are the two institutions directly responsible for the operation and maintenance (O&M) of the Kirindi Oya Irrigation System. O&M down to FC turnouts is the responsibility of the ID; management below the FC turnouts is supposed to be done by the FC groups organized and initiated by the IMD. The ID, at this stage of the project, is engaged both in O&M and residual work in the phase I area and in construction work in the phase I and II areas.

IMD had sent two project managers to Kirindi Oya before the 1986 yala cultivation season (the first season in the new area of the project). One was to be in charge of the RB system and the other the LB system. They had no field staff until one institutional development officer (IDO) and thirteen institutional organizers (IOs) were assigned to the project in 1988. One year after the appointment of the IMD project managers (PM), the PM in charge of the Left Bank area was reassigned to be in charge of the older Ellegala and Badagiriya systems, leaving the other PM to handle both the right and left bank areas of the project.

The PMs were supposed to form FC groups and distributary (DC) organizations for water management and other related activities in the turnout areas, and establish project committees for each canal system. These committees were to facilitate inter-agency coordination and should include representatives of all agencies involved in the promotion of agricultural crop production within the system, with an equal number of farmer representatives (ADB 1986:27). It is evident from the ADB report that IMD project committees are supposed to achieve agency coordination in each canal system, hence three IMD project committees for three systems (LB, RB and old). In this sense system coordination and project coordination for O&M define the limits and boundaries of authority.

ID Organization Structure for Operation and Maintenance

The ID organizational set up for O&M proposed in the ADB (1986) Appraisal Report (II) comes into effect after the completion of the Phase II construction work. At present, O&M is handled by the same ID staff engaged in the construction of Phase II. Figure 4.1 illustrates the structure of the project level ID organization for O&M.

Figure 4.1. O&M organizational structure at project level.

CRE
(Head of Construction and O&M)

-----> SIE (WM) ----> WM Consultants

RE (RB) (Construction & O&M)	RE (HW) Maintenance of HW	RE (Rehab.) O&M	RE (LB) Construction & O&M)
IE (O&M) handles construction in Tract 6			IE (O&M)
3 TAs (O&M)	TAs	TAs	2 TAs
3 WSS	WSS	WSS	WSS
Irrigation Laborers (39)	Laborers	Laborers	Laborers

Procedure for Operation of the System

In yala 1986 and maha 1986/87, the operation, maintenance and distribution of water, monitoring the discharges, and all other activities relating to water management were handled by resident engineers (REs) of the respective canal systems. Even the water issue schedules were prepared by them and they had the authority to instruct the RE (HW) for main sluice operation for discharges. Even though the REs are still responsible for most of these activities now, duties such as the preparation of water issue schedules, water allocation from the reservoir, and control of the sluice gate operation have been assigned to the senior irrigation engineer for water management (SIE [WM]). According to the chief resident engineer (CRE), the SIE is in charge of the operation of the irrigation systems and late this season had been delegated the authority to instruct REs with regard to the

SIE is in charge of the operation of the irrigation systems and late this season had been delegated the authority to instruct REs with regard to the operation of the system.

This modification of the O&M structure of the ID by assigning the SIE as the person in charge of operation of the systems was done because the ID was not prepared to use the water management consultants' computer model for systems operation or preparation of water issue schedules. The data used in developing the draft O&M manual were not considered realistic and reliable; hence the water issue schedules were not considered usable. Therefore the SIE, who was originally assigned as a counterpart to the water management consultants, was entrusted with the preparation of water issue schedules, control of discharges from the reservoir, etc., in order to operate the irrigation system in the absence of reliable guidelines.

The SIE, with the assistance of three irrigation engineers (IEs) and four technical assistants (TAs), prepares water issue schedules prior to the commencement of the season and sends them to the respective REs for implementation. RE (RB) or IE (O&M) distribute the schedules to TAs with the necessary instructions. A copy of the water issue schedule for a particular DC or FC is given to the water issue laborer in charge of that canal by the TA, indicating the water level to be maintained in the FC or DC during the season (different water requirements for different growth stages are indicated by giving varying heights of the water level from the weir to the water surface), and also the instructions for rotational water issues. A copy of the same schedule is sent to FC leaders to distribute water among farmers. The ID did not prepare a timetable for rotation within FCs this season as it did in maha 1986/87.

The irrigation laborers had been given a form to be filled in daily, indicating the discharges made to FCs and DCs under their charge. They were supposed to submit the form to the IE (O&M) once a week (every Monday morning). These completed forms were supposed to be sent to the SIE once a week but were in fact not sent this season. An irrigation laborer who worked independently from other irrigation laborers was employed to do gauge reading and take water measurements at offtakes from the RBMC in order to monitor the discharges. We understand this was given up later because the IE found that the irrigation laborer had given him wrong information without even going to the field. Therefore, the only monitoring system in Kirindi Oya, if any, was the random check on discharges occasionally done by SIE's staff.

Water Management on DC2

Water issues to Tract 5 began on 25 January 1988 with 30 percent of the water requirement for land preparation being issued at the beginning; this was increased later to 100 percent when the farmers asked for more water from the REs. This practice was adopted because most of the farmers were away from the hamlets when water issues began. The ID had plans to issue water continuously for a period of five weeks for land preparation, and implement rotational issues thereafter. But this could not be done in Tract 5 because there were delays on the part of farmers due to non-availability of seed paddy and delays in the issue of bank loans. The irrigation laborers had been instructed to increase the discharge if there were requests from FC leaders during land preparation period, but this continued even afterwards.

When the IE (O&M) received schedules for implementing rotations among FCs in mid-March, he instructed the TAs and irrigation laborers to implement the rotation. The rotation was implemented on 21 March 1988 without informing farmer representatives. Since the irrigator in DC2 had not been briefed on the rotation by the TA or IE, he had closed FCs 10, 11, 13, 14, and 15 instead of closing FC 9 on this day. As a result of confusion and lack of information about closures and rotations on RBMC, farmers who had sprayed weedicide and were waiting to irrigate land had difficulties. Since they had not been informed of the implementation of the rotation in order for them to adjust to it and use weedicides, farmers were against the rotation. The irrigation laborer also apparently did not know how to adjust the BC2 gate discharge to the canal as per the schedule given to him.

When we interviewed the SIE on 22 March, he was not aware of the implementation of rotations in Tract 5. Though schedules had been sent to REs, he had not expected the RE to implement it yet. He wanted to hold training classes for farmers, TAs, work supervisors, and irrigators before implementing rotations. He claimed he had instructed the RE (RB) not to implement rotations until classes were held, and said there was supposed to be continuous issue until 28 March.

There was a similar kind of shortage of water in DC2 from 10-18 April after the rains. RB main sluice had been closed during this period as a preventive measure to avoid possible damage to canals and tanks by rain. The farmers had not been informed of this by the ID and many of the ID officials were on leave for the Sinhala New Year holidays. Some farmers believed there was not that much rain and that scarcity of water affected the crop.

The proposed rotational issue did not work even after 28 March. The main reason for this was the diversion of excess water in RBMC into BC2. The only instruction the irrigators had from TAs at this time was to maintain full supply depth (FSD) at cross regulators and save the coffer dam below the BC2 offtake. There was no other alternative to save it except by diverting excess water to BC2 and its DCs and FCs.

There was no regular monitoring of discharges, or supervision of irrigation laborers by TAs. No work supervisor was involved in the operations, and irrigators in DC2 went to the extent to say that they have nothing to do with him; he (the work supervisor) is there to supervise maintenance gangs. We met the TA in DC2 on only one day, after complaints from FC 15 farmers about the scarcity of water. The scarcity occurred because the irrigator in DC2 was absent from 11 to 14 May and the canals were kept as they were on the 11th until the TA came to the field with another laborer to adjust the gates. There were no acting arrangements made for the laborer who was absent.

The intervention at times by the SIE and his staff in the RB system is also noteworthy. When unusual fluctuations in RBMC and discrepancies in discharges at offtakes were observed by the SIE and his staff on occasional visits to the field, they instructed the irrigators to adjust the gates. From the point of view of the SIE, he felt he had to do this because nobody else was monitoring discharges. However he reported that on some occasions, he felt frustrated with the irrigation laborers for being reluctant to carry out his orders, and with other staff for not supporting his actions.

Preliminary Conclusions on the O&M Organization

The present organization structure for the operation of the system appears to have the following problems:

1) REs in charge of canal systems concentrate more on achieving construction targets which is the basis used by the ID in evaluating performance of its officers. Even the IEs in charge of O&M handle construction work in phase II and TAs and work supervisors too are officially or unofficially engaged in construction work. Hence O&M receives less attention.

2) There are no incentives for O&M staff and no clear indicators to measure the performance of the staff.

3) The authority over operation of the system is divided among REs and the SIE, so no one is responsible for the operation of the entire system.

4) Though the SIE is assigned to be in charge of operations, the IE (O&M) in charge of RB is apparently not aware of this, leading to conflicts in the organization. According to the IE (O&M), the SIE is responsible only for the preparation of water issue schedules. This would suggest there is a communication problem within the ID management system.

5) The present system of operation by the SIE via RE (HW) and REs needs an effective communication system. There is no such communication system in Kirindi Oya.

6) There is no communication even among the TAs in charge of the tracts. What happens upstream or downstream on the RBMC is not known by other parties engaged in operations.

7) There is no effective feedback from the field to REs other than requests by farmer representatives for increasing the discharge at a time of scarcity. This is mainly because channelling of information from irrigators and work supervisors via TAs to the IE does not occur as there is no system for communication feedback.

8) The actual operation lies entirely in the hands of unskilled laborers temporarily hired for this purpose. There is not much guidance or supervision of them by senior field staff.

9) There is no system for monitoring discharges other than random checks by the SIE's staff.

Maintenance of the Irrigation System

The maintenance of the irrigation system after a cultivation season is supposed to be done by the ID down to the FC turnout. Broken irrigation structures in FCs too are repaired by the ID. The farmer representatives (FRs) have been complaining of various defects in the canal system at the IMD project committees, and Hamlet 11 FC leaders had forwarded them in writing to the RE (RB) in March 1987. The secretary of the DC organization had received a letter from the RE (RB) in August 1987 stating that the maintenance work would be completed soon, with instructions to the TAs to make field inspections and prepare estimates in cases where necessary. When we inquired about the maintenance program, we were told that these irrigation problems had been directed to the TAs for necessary action. BC and DC cleaning work for the next season had been started by farmers hired by the ID on a daily paid basis in August 1987. DC leaders organized labor gangs for canal clearing. The BC2 and DC2 roads had also been repaired, but not those on other DCs in Tract 5. However there was some unhappiness among farmers who felt that the irrigation difficulties reported to the RE through the DC organization had not been addressed.

The Role of IMD in Operation and Maintenance at System Level

The task of the two IMD project managers is to form farmer organizations and develop linkages for coordination among various agencies involved in agricultural implementation. The activities of the two PMs are supposed to be confined to the canal system on which the project committee is based (there are two project committees now but there will be three in future for the three canal systems, RB, LB and Ellegala). The following are our preliminary observations with regard to the role of IMD in the project.

1) Both IMD PMs in Kirindi Oya are unaware of the coordinating arrangements proposed in the ADB Appraisal Report II, and feel that the present arrangement of coordination through the project Coordinating Committee (PCC) undermines the role of the IMD and the PM in the new area, in addition to being a hindrance to the promotion of farmer participation in the management of the system. This was mainly because the PCC does not discuss issues relating to agricultural implementation and programming in detail, and does not have a program for such things other than the cultivation of paddy in maha and other food crops in yala. Water issues for a season are discussed just one month or so prior to a season and recommendations are made. But the ID program for the maintenance of the system, and the achievement of the objectives of IMD in promoting farmer participation are not discussed here. The attempts by the PM (IMD) in the new area to get farmers to participate in this committee failed and led to conflicts and contradictions among some officials.

A project-level official, commenting on this issue, said at a recent PCC meeting that the IMD PMs can "represent" farmers at the committee, a role quite contrary to the philosophy of IMD. This remark suggests the view of the bureaucrats towards the IMD, and the status of IMD project managers with no authority in a hierarchical organization in which authority matters a lot.

2) Though the organizational arrangements of the project confine the IMD PM's activities to a particular canal system (a lower level coordination compared with project-level coordination), almost all the officers are of the view that the coordination necessary for agricultural implementation should be done by the IMD project managers, and the failures are due to their inability to "handle it fully." It is difficult to expect that the IMD project committees can handle system level coordination under the proposed set up, even with other line agencies' cooperation.

3) None of these committees considers the Ellegala system as a project concern with regard to agricultural implementation. The administrative and O&M functions are under the Range Deputy Director (Irrigation), Hambantota, not the CRE. The PCC discussion in this respect, is limited to rehabilitation aspects of the old system. The Badagiriya system has been denied water from the main system in a recent decision because of the likely scarcity of water after the completion of Phase II. In this case priority is being given to settlers anticipated to come within the next two years, depriving a settlement (Badagiriya) established some 25 years back of water.

4) Our observations at IMD-established DC committees revealed that they cannot solve a lot of problems presented by farmer leaders without direct involvement of higher level project officers. Problems like non-construction of main drainage canals and delays in lot development (land levelling) have been there since 1986 with little progress made until very recently (after this season was completed construction of drainage canals was initiated). IMD project committee minutes substantiate that this had been presented to the ID and to the notice of officers concerned. In addition, minor irrigation difficulties, settlement problems, issues relating to community welfare, input and credit supply are also discussed at these committees.

The variety of problems discussed at IMD project committees may suggest to an observer new to the system that these committees deal with all these problems, even things not in the purview of IMD. However since there is perceived to be no mechanism to solve non-agricultural problems, the FRs representing their community (it is not only an irrigation community but also a settlement community) try to find solutions to their problems in these committees because they are the only organizations functioning at least to a certain extent at this stage. (The earlier kattinayake system no longer works in Hamlet 11 or any other hamlet in Tract 5).

However, problems, though discussed, remain unsolved, so there are no visible benefits to the farming community of the FC groups or DC organizations. Some farmers believe the function of the DC organization is to pacify them. This situation, and the lack of interest of other agencies in solving these problems, have driven FRs to blame various agency officials for not attending to their problems. Unfortunately, blaming and making accusations are now the main function sustaining the DC organization in the absence of solutions to the farmers' problems.

The involvement of the IMD project committee in agricultural implementation is limited to attempts at problem-solving in times of crisis such as shortage of seed paddy, agrochemicals and other inputs, delay in payment of bank loans, and compensation for crop failures. The attempts by the IMD PM in the new area to prepare an agricultural program has failed in part because the agricultural officer of the project had not provided the services of the KVSs to collect field data in collaboration with FC leaders. The shortages and delays in providing agricultural inputs, credit, and other services occur as a result of the non-existence of a pre-set program for agricultural implementation, a thing about which decisions are taken at the last moment, without allowing line agencies concerned to prepare for a season beforehand.

The Farmer Organization Program

There are may problems such as FC roads and small drainage canal repairs which could be solved by farmers with assistance from IMD. Though they are minor things, they bring visible benefits to the community. The failure of DC level organizations to undertake them can be summarized as follows:

1) The temporary residence of the farmers in hamlets because of the lack of facilities such as drinking water, schooling for children, and health facilities keeps about 60 percent of the settlers in Hamlet 11 away from the hamlet between cultivation seasons, and contributes to frequent absences even during the cultivation season as family members still live in the original villages. Many settlers, though trying to conceal this, apparently have lands in their original villages. Only landless peasants stay in the hamlet to face hardships. This situation makes it more difficult to organize farmers for FC group meetings or to do shramadana campaigns.

2) The drought and crop failures too have affected the community in such a way that they have to go to their original village to find temporary employment or have to work as wage laborers in construction work in the project. The economic backwardness itself is a real constraint for them to think of organizations (see Merrey and Somaratne 1988).

3) The PM (IMD) in the new area had originally launched a hasty program to select FC leaders and form DC organizations within a period of one year, as instructed by his superiors. He was not assisted by IOs at that stage. Though some FC leaders were active in the sense that they

attended DC meetings, there was no active participation by farmers at FC level. Since there was no training for FC leaders, and no FC group meetings under the guidance of an IO, the roles of FC leaders and the farmers were not very clear to them. In short the organization was something organized from above and not below.

More than 60 percent of the farmers in our sample deny membership in DC organizations, telling us that FRs are the members. The activities of DC organizations are limited to presenting problems to various line agencies for solutions. No attempts are made by leaders to do something by themselves. In most cases, the secretary or the president of the DC organization plays an active role by meeting agency officials for solutions to some of the problems. In Hamlet 11, the secretary's role looks more like that of a patron. The farmers come direct to him without going to their FR because they believe that the secretary has close contacts with agency officials. They do not go to the president because he has no such contacts.

4) Most of the leading men in the DC organizations had been village-level political leaders before coming to the settlement. Though they have the organizing capability for political purposes, these leadership qualities may not suit the new organization. Therefore, the IMD organizations in Kirindi Oya reflect the pattern of a political organization, with an IMD project manager instead of a Member of Parliament to whom farmers can go and appeal to influence bureaucrats. The solutions to farmers' problems in this IMD organization are perceived as lying with leaders and not with the ordinary farmers.

5) Since the concept of farmer participation has been introduced without a reorientation in the bureaucracy's long tradition of paternalistic decision-making, IMD project managers who are keenly interested in such organizations are themselves likely to deviate from the IMD mandate and may not be able to form useful farmer organizations in the absence of line agency cooperation. Since the IMD PMs have no authority to instruct other agency officials or influence them, they have to fall back on farmers to claim legitimacy as the only project manager amidst several project managers with more authority. This fragmentation of authority continues to affect efforts to work with settlers and gain their confidence, i.e. to establish some legitimacy.

6) Because the amount of water actually issued was more than the demand, the FC leaders did not have to get very involved in water distribution, for example by organizing rotations, this season. Five tail-end farmers of FC 14 did have difficulties because of excessive water use by head-end farmers. The FC leader could not solve this problem and tail-enders resorted to stealing water at night. Simultaneous sharing of water was the practice throughout (see Merrey and Somaratne 1988).

The Committee System for Project and System Management

"System" here refers to the canal system, and "project" to the entire Kirindi Oya Project, consisting of LB, RB and Ellegala systems. The IMD Project Committee has been discussed above, in some detail. Some brief, preliminary observations on other committees follow:

The Project Coordinating Committee (PCC). This is the committee proposed in the ADB Appraisal Report II to take decisions regarding almost every project activity. Though it is chaired by the Government Agent (GA), the proceedings are conducted by the PM (Settlement). District-level and project-level higher officers attend committee meetings. It is dominated by officers of the Land Commissioner's Department including the Additional Land Commissioner from the Colombo head office. The construction and settlement programs are discussed in detail and evaluated at monthly meetings of this committee, but the committee does not go into detail on O&M or agricultural implementation issues. The farmer representatives are not allowed to participate in this committee though there were attempts by the IMD to get their participation (Merrey and Somaratne 1988).

The Subcommittee of the Project Coordinating Committee. This was formed in mid-August 1988 to discuss the agricultural programming for the project in detail. The project authorities had understood by this time that there should be a pre-set program to achieve project objectives. The committee is chaired by the PM (Settlement). The members of the committee are the two IMD project managers, the CRE, the agriculture officer of the project, and the Assistant Commissioner (Agrarian Services). The decision of the committee regarding a cultivation season is intimated to the DAC subcommittee (see below) to be discussed with the farmers. The PM (IMD) for the new area proposed that farmer representatives be allowed to participate but the idea was rejected by both many officers and certain consultants. One official claimed that the PM (IMD) can represent farmers' ideas. The decision regarding water issue for maha 1988/89 was taken at this committee.

The DAC Subcommittee. This is the decision-making body for agricultural programming and implementation in the district. All IMD project managers, irrigation engineers, and agricultural officers of the district attend this meeting. Farmer representatives from all the projects in the district attend this meeting. The meeting is chaired by the Additional GA on behalf of the GA and the secretary is the Range Deputy Director (ID). The CRE and PM (Settlement) for Kirindi Oya do not participate in this meeting.

Progress Control Meeting. This meeting is chaired by the PM (Settlement). The members are the field level officers of LCD supervising non-irrigation construction and settlement work. The progress of construction and settlement activities are discussed at this meeting. The ID and banks send representatives to this meeting but not other line agencies.

Other Departments. There was some dissatisfaction among farmers regarding the operations of certain other departments. For example, there was no effective Agricultural Instructor (AI) in Weerawila Division during this season. The acting AI had no transport. Even the KVS in our sample area was an acting officer as there was no permanent KVS assigned to Hamlet 11 irrigation area. The Training and Visit Program did not work at all this season. There was nobody to give advise on pest control, resulting in severe problems documented in the research on economics of paddy cropping. The situation was showing some improvement by the end of the season, when extension staff became available.

As the cultivation season started suddenly, the Agrarian Services Centers were not ready with the input requirements such as fertilizer and other agrochemicals, despite very great efforts. The farmers were not in agreement with the arrangements of the Agricultural Insurance Board for the estimation of damages to the crop. The practice adopted by the Board was to send a field officer to the individual paddy fields and make recommendations regarding payment. The farmers felt that the officer concerned cannot do it satisfactorily alone, and requested a committee comprised of KVS, a cultivation officer, a FC leader, and the field officer of the Board to make recommendations regarding payment of compensation. This was agreed to but was not implemented this season.

The Agricultural Insurance Board has so far been unable to provide insurance cover for other field crops, though the matter was taken up at the Central Coordinating Committee in Colombo. There is no possibility for farmers to get bank loans without the insurance cover.

RESEARCH PLANS FOR MAHA 1988/89

During the last season, the institutional component of the research attempted to cover both the agency and farmer levels about equally. During the maha 1988/89 season, the Research Assistant concentrating on this component will continue to attend key planning meetings of the project. However, interviews and observations will concentrate more heavily at the field level. A series of questionnaires have been developed to systematically interview the sample farmers; all the FRs in DC2 plus a wider sample of FRs on the Right Bank; and a sample of field-level officials of the ID, IMD (including IOs, IDOs, and PMs), LCD, Agriculture Department, and Department of Agrarian Services.

For the sample farmers and FRs, the questions concentrate, among other things, on water problems, the effectiveness of the farmers' organizations, views regarding future levels of responsibilities for farmers,, and potential interest in growing non-paddy crops. For the field-level officials, the questions concentrate on their own views and perceptions about their jobs and their relationships with farmers, their views on the effectiveness and sustainability of the present farmers' organizations, and their views on future levels of responsibility for farmers. Questions for IMD officials also ask about the performance monitoring and evaluation procedures, and degree of support from higher up, for doing their jobs.

It is expected that these data will provide a basis for systematically identifying strengths and weaknesses at the field level, and possible innovations that could be implemented to overcome problems.

V. ON-FARM IRRIGATION MANAGEMENT FOR UPLAND CROPS - KIRINDI OYA

The main activities were connected with providing the necessary guidance and support to the Department of Agriculture in (a) planning the layout and development of the Agriculture Research Station at Wirawila, and (b) developing adaptive research trials for the forthcoming maha season in farmers fields.

AGRICULTURAL RESEARCH STATION, WIRAWILA

1. During the visit to the above station on 10 May 1988, we met with the DDR Angunakolapellessa and his staff and outlined to them the scope and objective of the IIMI's studies as outlined in pages (22-25) of the Inception Report.

   An important outcome of this meeting was the nature of the development plan for the research station which would help to meet both the short and long term objectives of the research plan as outlined in the Inception Report, and also the longer term requirements of a research station that would serve the future needs of the Kirindi Oya Project. Broad agreement was reached on the physical layout of the station fields and the on-farm irrigation layout that would serve both immediate and long term needs.

2. A follow-up visit to the Land and Water Use Division of the Department of Agriculture was made on 13 May 1988 where the preliminary plans for the field layout and channel system of the 5.3 ha research station were examined and some modifications and improvements were suggested. A preliminary cost estimate (bill of quantities) for this work as prepared by the Soil Conservation Division of the Department of Agriculture amounting to approximately Rs. 500,000/- was also examined and some items of less importance were deleted from the bill of quantities.

3. At the next visit to the Agricultural Research Station, Wirawila on 24 May 1988, where DD Extension and his staff, the DD Research and his staff, and the Head, Land Use Division and his staff, all of the DOA, were present, the layout plan prepared by the Soil Conservation Division was examined and discussed together with a visit to the field in order to relate the proposed plan to existing ground conditions.

   It was agreed that the land be levelled and prepared in the form of cross-levelled graded terraces, and that the field channels be lined and have a drop structure-cum-field outlet to each individual terrace. The location and alignment of field channels, field ditches, drainage channels, roads and perimeter fencing as shown in the proposed layout plan was matched with ground conditions, and some modifications were suggested. A detailed soil survey was also recommended so that the layout of the field channels would command all three soil types in the toposequence. This was subsequently done by the Land and Water Use Division of the DOA and the layout of fields and field channels was modified accordingly.

4. Because of unsettled conditions in June, it was not possible to get the Department of Agriculture and Irrigation Department personnel together to follow up the implementation phase of the earlier plans and discussions. A meeting was, however, organized at the adjacent District Training Center Wirawila of the Agriculture Department on 5 July 1988, which was chaired by the Additional Deputy Director Research (Ad DDR) from Peradeniya, and at which the Chief Resident Engineer (KOISP) and other key officials were present. Allocation of responsibility for implementing land shaping, construction of irrigation channels, flow measuring structures (flumes and weirs), road network, fencing and constructions between the respective departments was agreed upon, and provisional deadlines to complete the work were also set.

   It was agreed that the responsibility for carrying out the irrigation and road network, fencing and other construction will be borne by the CRE (KOISP) who will execute the work through contractors, and that the land shaping activity will be the responsibility of the DOA. It was also decided that every attempt be made to complete the work by 30 September 1988, so that the proposed maha program for 1988/89 could commence by the first week of October 1988.

ON-STATION RESEARCH AND ADAPTIVE RESEARCH IN FARMERS FIELDS

1. The On-Station Research for maha 1988/89 will be the same as described in page 3, Appendix VIII of the Inception Report. Every attempt will be made to implement this plan for at least one transect with a view to testing a range of upland crops on the well drained and imperfectly drained RBE soils during this season.

2. At the meeting held on 24 May 1988 at the ARS Wirawila at which the DD Extension (DOA) and DD Research (AP) were present, it was proposed that a special Regional Technical Working Group (RTWG) be held for requirements of the Kirindi Oya Project area. It would be chaired by DDR (AP) and be attended by staff of Agriculture (Extension), Irrigation Department, and IIMI staff, and will be held in late July to early August. According to the staff and financial resources presently available it was agreed that the adaptive research in farmers' field in the maha season will essentially consist of testing rice varieties of the 3 to 3 1/2 month age class and that some testing of rice varieties for salinity tolerance would also be carried out. The extension staff will locate the farmers fields on which the testing will be done. In addition, the extension field staff will conduct some exploratory trials in farmers fields with crops such as banana, sweet potato and small extent of onions. It was noted that crops such as chillie, green gram, gingelly and cowpea were already being grown by farmrs in small extents.

Copies of 'Guidelines for Carrying Out Adaptive Research Trials' taken from the Sri Lanka Agricultural Research Project (World Bank Report No. 6217-CE) were given to the concerned officers present at this meeting, and some general principles were also briefly explained.

3. A special Regional Technical Working Group (RTWG) meeting to discuss Kirindi Oya Project problems and research was held on 3 August 1988, in the office of the Assistant Director Extension (Hambantota). It was chaired by DDR (AP) and staff from DOA, ID, and IIMI were present.

Some outstanding matters relating to the development of the ARS Wirawila were cleared at the commencement of this meeting. This was followed by a general overview of the crop production performance and irrigation problems encountered since yala 1986 which was presented by the AD Extension and the Senior Agricultural Officer KOISP.

It was reported that an average rice yield of 80 bushels/acre (4.0 t/ha) was recorded both in yala 1986 and maha 1986/87 when water supply was adequate, but that the average yield in maha 1987/88 had dropped to 57 bushels/acre (2.85 t/ha) because of water inadequacy. However, 605 ha of other food crops (OFC) were grown on the rainfed non-irrigated upland during this Maha season. The present thinking of the DOA was to grow 3 and 1/2 month varieties of rice in the new areas under KOISP, and permit the growing of 4 month varieties in the old area under the Ellegala system.

The importance of keeping within the accepted sowing to harvest period for each season was highlighted especially in relation to minimizing pest and disease problems and capturing the optimum benefits of the rainy periods and dry periods. Well considered decisions on the dates for commencement of the season, first issues of water for land preparation and age class of rice varieties, were therefore of crucial importance in maximizing rice production.

Adaptive research trials by DOA on rice for maha 1988/89 will be mainly testing of the new 3 to 3 and 1/2 month rice varieties from Ambalantota Rice Research Station. This will include testing of the new generations of salinity tolerant varieties in selected locations, and testing of the new releases in the shorter age class from the national rice research program.

For non-rice crops or OFCs, the extension staff of DOA plan to conduct only exploratory trials consisting of five types of crop combinations in 34 demonstration plots of 1 acre each during this maha season. These crop combinations are made up of chillie, green gram, cowpea, sweet patato, groundnut, vegetables (okra) and banana.

Within the sub system area in which IIMI's studies are being conducted, there will be two or three demonstration plots of one acre each and they will be closely monitored for amount of water use and relevant economic data for the different crop combinations. Monitoring of economic data will be done by Research Officer Economics of DOA, and IIMI will carry out a few water use measurements on selected crop combinations.

VI. IRRIGATION SYSTEM PERFORMANCE: KIRINDI OYA 1987/88 MAHA

The purpose of this chapter is to present the major findings of the analysis in the previous chapters on several dimensions, to weave an integrated picture of the system performance, and to focus on salient systemic interactions. It represents the results of the study of only part of a season where the emphasis was on understanding the system and the constraints to performance.

SYSTEM

The sub-system studied is a small part of the Kirindi Oya Irrigation and Settlement Project (KOISP). In a hierarchical view of the system, at the first level, it is an irrigation water conveyance and delivery system which consists of the physical infrastructure of canals and gates, the irrigation agency personnel who operate the system and deliver water, and the farmers who receive water and grow crops. At the second level, it is an irrigated agricultural production system. The farmer, who is the producer, makes decisions and combines with water and land the various inputs like seeds, fertilizers, pesticides etc, obtains credit, procures labor, grows crops and finally produces the crop yields. He markets the crop and seeks to improve his well being with the resulting economic benefits. At the third level, there is the social system in which the other two systems are embedded. The social values, beliefs and attitudes, the customs and traditions provide the basic framework for the behavioral patterns and the institutional settings of the system. These systems are also embedded in the wider environment with its natural, economic, social and other dimensions.

As we go higher up in the hierarchy of systems from the first level onwards, the complexity of the systems and the interactions increase, the proportion of hardware in the system decreases, and the degree of control and our ability to manipulate the system decreases.

The system has many attributes and characteristics: the scale, size and variety of the components like the canals, structures, soils, crops; the complex interactions among water, fertilizer, crops, prices, markets and behavior patterns; the dynamic nature of the processes - no two seasons are alike; the effects of uncertainties: hydrologic, economic, political; the multiplicity of persons making decisions at various levels; the competitive nature of resource allocation situations especially in the context of large scale public systems serving large number of beneficiaries, some of them newly settled.

PERFORMANCE, OBJECTIVES, CRITERIA

Performance of a system has to be evaluated in terms of the goals and objectives set for it and the degree to which they are attained. Performance criteria have to be established and where measurable and quantifiable, targets need to be set. Performance monitoring and feedback provides information necessary to review the targets, the criteria, and, in some cases, even the objectives. Setting broad national objectives for projects is relatively simple. But to disaggregate these and to set objectives, criteria, and targets for a number of public agencies and to coordinate their actions to achieve the larger objective is a complex and difficult task.

In dealing with performance of large-scale and complex systems, it is necessary to analyze the performance on various dimensions and at various hierarchical levels of the systems. And then, an effort has to be made to integrate them and take a holistic view. The insights so developed would help provide useful guidelines for the improvement of system performance. The next stage would be implementation of the improvements, first, on a small scale to make sure that they work and improve performance, and then on a wider system level.

MAJOR FINDINGS

Irrigation Water Delivery

Water supply. There was abundant supply of water into the branch canal and to the three distributaries during the total period of the Study. This does not mean that water supply was always above the targets. There were varying durations of undersupply compared to the targets. But that was more an operational problem in the distribution rather than a problem of resource availability. There was water available in storage in the reservoir and it was a very comfortable situation.

Water delivery targets. Water delivery schedules were prepared by the Irrigation Department based on assumptions on (i) commencement and progress of land preparation in three staggered steps with one week time lags; (ii) continuous delivery during land preparation period followed by rotational delivery during crop growth period; (iii) water requirements during land preparation and crop growth stages in well-drained soils (RBEs) and poorly drained soils (LHGs), based on evaporation data from Angunukolapelessa research station; and (iv) conveyance and application efficiencies and seepage and percolation values. All the area served by a given Field Canal (FC) was assumed to be one type of soil (LHG or RBE). A rotation interval of seven days was assumed at the FC level and within FCs. The flow in FCs was supposed to be varied in quantity, with constant duration of flow in FCs and also constant delivery time to allotments within a FC. Fixed time and variable discharge thus characterize the operation at FC level and within allotments served by a FC. The fixed delivery duration was determined on the basis of the time required to deliver the peak weekly crop water requirements. The flows in the distributary canals (DC) were intended to be continuous but variable. They were computed as the sum total of the discharges of the FCs served by a DC at any given time. Effective rainfall was ignored. The water delivery schedules were handed to the Technical Assistants (TAs) and Irrigators (unskilled laborers) at the beginning of the season. They provide the water delivery targets and instructions on operation of the gates at various levels of the distribution system from FC upwards to DC and BC.

Water delivery operations. Water deliveries were made on a continuous basis throughout the season and the proposed rotational schedules were not implemented. There were a number of reasons for the change in the mode of operation from what was intended. First, there was more than adequate supply of water from the reservoir. Second, construction activities were going on and achievement of construction targets received a high priority and operation of the water delivery system received very little attention in terms of monitoring and supervision. The efforts of most of the irrigation department staff were concentrated on achieving construction targets which were clear. The performance of the staff is judged by the degree of achievement of construction targets. On the other hand, there are no clear targets to be achieved in utilization of water in irrigation. There is an assessment of the water delivered at the head sluice of the reservoir and, for example, a gross indicator of water duly of 6 to 8 ac.ft per acre is considered a reasonable figure for yala cultivation. But that sort of measure is too gross and aggregated and does not provide sufficient motivation for efficient operation of the system and saving water in the reservoir. Third, a coffer dam made of earth was constructed across the Right Bank Main Canal (RBMC) for Phase 2 construction activities in the downstream reaches of the canal. In order to protect the coffer dam, all excess flows in the RBMC were drained through Branch Canal, BC 2. This has made it possible for BC 2 to supply occasionally more than target flows to the distributaries served by it.

The change in operational mode from rotational to continuous flow was not a deliberate decision made at the end of the land preparation phase. The land preparation phase continued beyond the expected period. Due to some communication gaps among the Irrigation Department officials, there was an attempt to implement rotations on 21 March without prior intimation to farmers. It created some difficulties for farmers who complained; and continuous flow was restored after 22 March. There was no further attempt to introduce rotations.

The irrigation schedules and targets were not modified because of the non-implementation of the rotations and the implementation of the continuous flow mode of operation which got extended beyond the land preparation period. Thus they lost any significance as operational guidelines and for monitoring the performance. Further, the irrigators were asked to respond to farmers' requests and complaints and increase or decrease the supply of water. And generally they did respond except on one important occasion when most of the officers and irrigators were away on their usual annual leave for the Sinhalese new year festival for about five to six days. Just prior to that, there was a rainfall of 79 mm on 9 April and the supply was cut off from the main sluice at the reservoir to prevent damage to canals and canal structures. The operation of the system was left unmanned for about five to six days.

Water delivery performance. The system operation at the levels of the distributaries and field canals was not systematic. It was not monitored or supervised on a regular basis. The schedules lost their validity as a reference for assessing performance of the water deliveries in a quantitative way.

In a qualitative sense, however, water was considered adequate and in many cases even abundant and farmers' complaints were few and far between. There were in fact some low lying poorly drained soils which had the problem of excess water supply and salinity problems. The exception was the period around the new year where everyone complained and crops were stressed for water. There were some tail-end allotments in some field canals which complained of not receiving their share. Some of them had received water drained from upper reaches, which helped them to overcome shortages. At the distributary level, the tail-end distributary DC 5 received more than its due share, especially because the branch canal, BC 2, was used as a drainage bye-pass. The head-end distributary DC 8 actually received less water in comparison with DC 2 and DC 5. Part of the reason was that the total area under DC 8 was not cultivated during the season and the demand was therefore less. The targets themselves should have been adjusted.

Design issues and limitations

Steady flow conditions. It was observed that it was possible to maintain easily steady flow rates into field canals located at the head of the distributary. Fluctuation of water level in the distributary was insignificant. At the tail-end of the distributary, the fluctuations in flow rates into field canals were more frequent though there were also quite a few periods of near constant flow rate. The system has the capability to deliver steady flow rates to the field canals with controlled interventions and gate settings. It is possible to deliver predictable and reliable discharges provided capacity constraints do not exist at the level of the distributary canals. Unfortunately there are doubts on that score.

Turnout operations. The irrigation schedule for a turnout was based on the assumption that the turnout areas are entirely in either lowlands (poorly drained LHGs) or uplands (well drained RBEs). Many turnouts in fact serve both well drained soils in the upper reaches and poorly drained soils in the lower reaches and the mix of the two may have different proportions in different turnouts. The result is that the turnouts which are assumed to serve a homogeneous soil class of RBEs in the entire command area are oversupplied compared to their requirements and those assumed as homogeneous LHG soil class are undersupplied. In DC 2, three turnouts are assumed to serve upland RBE soils and account for a total of 33 ha whereas four turnouts are assumed to serve lowland LHG soils and account for a total of 57 ha. More accurate soil data is needed to obtain better schedules for each of the turnouts.

Distributary capacity. The distributary canal, DC 2, has seven field canals six of them have a standard one cusec (28.32 l/s) capacity and the seventh has a capacity of 1.48 cusec (42 l/s). The sum of the design capacities of the seven field canals totals 7.5 cusecs (212 l/s). If a conveyance efficiency is assumed at 75 percent as per the design guidelines, DC 2 would need at the head a discharge capacity of 9.9 cusecs (282 l/s) in order that its capacity does not constrain the simultaneous supply of design discharges to all the field canals. Of course, all the field canals do not need to draw their full design capacity. Some of them serve small commands of 6 to 7 ha. Still, if they happen to be located at the head of the distributary, farmers tend to draw the maximum possible discharge during the land preparation stage and even at other peak periods. Even as per the irrigation schedule prepared for the last season, the maximum discharge capacity needed at the head of DC 2 (with 75 percent conveyance efficiency) was 259.57 l/s. And in ten out of eighteen weeks, the discharge capacity needed was more than 210 l/s.

The existing design capacity of DC 2 at full supply level is 6 cusecs (170 l/s) with a design bank-full discharge capacity of 7.5 cusecs (210 l/s).

As a consequence of this underdesign, the canal will often run above its design capacity (overloading) and encroach into the full freeboard at least in those sections where the bank-full discharge capacity is limited to 210 l/s. It also explains the observed overflowing of the water from the canal into adjoining areas in some sections of its length.

This has at least two implications. First, if all the distributaries are underdesigned like DC 2, all of them may have to be run to their bank-full discharge capacities very frequently leading to faster deterioration of the shapes of the sections which, in turn, leads to higher maintenance requirements. Second, it may be found, on closer scrutiny (we have not done it) that similar underdesign characterizes the branch and the main canal capacities. If this aspect is also combined with an increase in the rugosity coefficient (Manning's n value) from the assumed 0.025 to about 0.040 as tentatively indicated by another study in progress at IIMI on the modeling of hydraulic behavior of the Right Bank Main Canal, then it could result in serious capacity constraints of the main canal especially after the development of Phase 2 areas for cultivation. This, we would urge, deserves the urgent attention of the Irrigation Department.

Why was the distributary underdesigned? The design details and the 'as-built' drawings are not available. They were lost in the fire that consumed the records in the Chief Resident Engineer's office in the arson and disturbances of July 1987. One plausible explanation seems to be that the entire command area of 90 ha served by DC 2 was assumed as a mix of soils and a duty of 38.3 acres/cusec was then adopted. That would give a discharge capacity of 5.86 cusecs which was then rounded off to 6 cusecs (170 l/s). It needs to be further examined how far this is in accordance with the design guidelines.

Conveyance efficiency. The design guidelines suggest using a conveyance efficiency of 75 percent for the distributary canal, pending the availability of experimental results. Based on three sets of observations of canal flows, we have found an average value of conveyance efficiency of 71 percent - (the variation was between 69 and 74 percent). It validates the suggested parameter in the guidelines. We have observed that a much higher value of 93 percent was used in the preparation of the irrigation schedules. That requires revision. The conveyance efficiencies assumed in canal duties used in the design also deserve further examination.

Agricultural production and economics

An important objective of the Kirindi Oya project is to promote production of diversified non-rice crops in the long run. Its achievement is essential in order to make efficient use of land and scarce water resources of the project and benefit the large number of farmers, farm laborers and the society at large. It is recognized as a difficult objective to achieve, requiring a complex combination of efforts on many fronts: agricultural research and extension; improved irrigation water deliveries; coordinated supplies of necessary inputs for crop production, including institutional credit, farm labor and farm machinery; remunerative prices for the produce and ready markets; crop insurance facilities; and a host of organizational and management factors connected with all these activities. However, in the short run, before the complete development of the project command area, farmers would like to grow rice. Increased yields and improved profitability of rice farming are the criteria for judging the performance of irrigated agriculture in the system. The important findings of this Study on agro-economic performance are summarized here. The data for five regions in Sri Lanka from a cost-production sample survey of agricultural crops conducted by the Department of Agriculture (DOA 1988) during 1986/87 maha is used for providing a basis for comparison (Table 3.02)

Yield performance. The average yield for the entire area of DC 2 was 3.699 t/ha while that for the sample allotments in DC 2 was 3.850 t/ha. The total average for all the sample allotments in three DCs surveyed was 3.747 t/ha. The comparable average yield for Hambantota region in 1986/87 maha reported in the DOA survey was 4.323 t/ha. The yield performance can be considered reasonably satisfactory.

But there is obviously scope to obtain higher yield levels. On the average, the allotments nearer to the head-end registered higher yields. However the difference in yield among the locations is statistically significant only between the head - and tail-ends for the poorly drained allotments. Also, the poorly-drained allotments recorded a significantly lower yield than the well-drained allotments. The poorest average yield was observed for the poorly-drained sections of the tail-end, while the highest yield was recorded in the well-drained allotments of the tail end.

The average yield among the distributary canals (DCs) surveyed was highest in the tail-end DC 5 at 4.026 t/ha and lowest in the head-end DC 8 at 3.047 t/ha.

All this suggests that water was rather abundant in the season. In fact, excess water and salinity created problems for some of the poorly drained allotments. If the management could solve the drainage problems of the low lying lands partly by more precise regulation of water supplies, the productivity of these lands would be increased through two routes: first, it is increased directly by reducing the incidence of salinity, and second, it is increased indirectly by letting the farmers cultivating the poorly drained allotments increase their use of production inputs. Further, the water saved can be used elsewhere in the system and help increase the productivity of the system.

Farming practices and production inputs. There are some differences found in the patterns of input use among the allotments in different strata of the categories examined. The following factors were considered: DC, location, soil type, tenancy and salinity. The following findings emerge: i) Seeding rate was higher, other factors being equal, for the farmers in the DC 5 and DC 8 areas. ii) Fertilizer use, as the total value of fertilizers, was higher for the DC 5 and DC 8 farmers, and the incidence of salinity lowered it. In terms of nutrient elements, the levels of nitrogen and phosphorus were higher in the DC 5 and DC 8, and lower in the poorly drained allotments. iii) The farmers cultivating the poorly drained allotments used more herbicide. iv) Pesticide application was less for the DC 8 farmers and those cultivating the poorly drained allotments. v) The farmers cultivating the poorly drained allotments used less labor. The owner operators used more labor than the tenant farmers, either leaseholder or sharecropper. vi) The total cost of rice production defined as the total factor payments did not show any factor specific effect.

The DC 8 area stands out as different from the other two areas on some farming practices, labor use and credit. In spite of their head-end location along the BC, the end-date of land preparation for many sample farms in the DC 8 area was as late as mid-March (water was issued first on January 25). DC 8 farmers also used significantly less labor for land preparation. They did not use exchange labor at all and their dependence on hired labor was significantly higher. Such a distinct pattern of labor use in the DC 8 area suggests that the rural society to which the DC 8 farmers belong has characteristics very different from those in the other sample DCs. This has perhaps to do with the settlement history of the farmers in DC 8 and will need to be studied in more detail. While the major source of credit for the DC 2 and DC 5 farmers was institutional and around 80 percent of the farmers got their loans from banks, less than 20 percent of the DC 8 farmers got their loans from banks. Instead, nearly 65 percent of their loans were interest-free loans from such informal sources as relatives and close friends.

Economic performance. There could be various criteria and indicators by which the economic performance of agricultural production in an irrigation system is evaluated. The land and labor productivities are basic indicators. From the farmers' viewpoint of profitability from his farming activities, farmer's average income from production, is an important indicator. Since the 'value added' is the income that is generated by a production process and distributed among the owners of resources involved in production, it is, from the national point of view, an indicator of the economic performance of irrigated agriculture and hence of the system. The incomes earned by land and labor called the factor payments on these two primary factors can be another criterion.

The relevant details of the economic performance of the subsystem under study are given in Table 3.09. A comparison of this performance with the DOA's data for five regions in 1986/87 maha is given in Table 3.02.

i) Labor productivity. The average labor productivity of the 1987/88 maha rice production in the study area was 112 rupees per day. Compared to the regions listed in DOA survey (Table 3.02), this level is higher than the level in the wet zone and comparable to the level in other dry zone regions except Hambantota. Because of the long follow preceding the last season, the farmers in study area had to spend more labor for land preparation than in an ordinary maha season. Among the sample strata, the highest labor productivity was recorded by the DC 5 allotments and the lowest by the DC 8 allotments.

ii) Farmers' income. A Kirindi Oya farmer in the sample who is an owner-operator cultivating a one hectare allotment earned Rs 5971. It was the average for the entire sample and was 42 percent of the gross revenue. This was the sum of the payments for the family labor he supplied, the land he owned and the operator surplus (profit or loss incurred in the production). If the farmer owned his own tractor, his income would increase to Rs 7643, as it includes the amount paid on the tractor (fixed capital). If a farmer was a tenant-operator of a one hectare allotment, his income was Rs 2757 and was less than 50 percent of the owner-operator's income. The Kirindi Oya farmers earned less in the last season than those in all the regions in the 1986/87 maha reported in DOA survey. This lower farmers' income from rice production is due to two immediate factors. First, the value added in rice production was lower. Second, the share of income taken by hired laborers was higher.

iii) Value added. The value added per hectare was Rs 11000, on the average for the whole sample. Compared to the DOA's 1986/87 maha samples for Uda Walawe and Hambantota, the value added in the rice production by the Kirindi Oya farmers in the study was nearly Rs 2000 less. Within the study sample, the value added in DC 8 was substantially lower than in the other two sample DCs: Rs 8768 in DC 8, Rs 11457 in DC 2 and Rs 11506 in DC 5. Compared to DC 5 and DC 2 farmers, the DC 8 farmers had spent more on hired labor and less on current inputs and obtained much less gross revenue. They had actually incurred a significant loss (negative value of operator surplus) due to their agricultural production.

iv) Factor shares of land and labor. The factor share of land in Kirindi Oya rice production was 22 percent. This is a low value. It appears that the real level of factor share of land would be higher than the estimated level of 22 percent. Should it be true, some imperfections would exist in the land market. This point needs a careful examination in the future Study.

The factor payments to labor, or the labor income from rice production, is higher in Kirindi Oya in the 1987/88 maha than in other regions in the 1986/87 maha, except an extreme case of Kegalle. In terms of the factor share of labor, the share in Kirindi Oya was as high as 40 percent, while it was around 30 percent in other regions. Whether this was specific to the last season should be checked carefully in the future seasons.

Irrigation Institutions

The Irrigation Department (ID) and the Irrigation Management Division (IMD) under the Ministry of Lands and Land Development (MLLD) are the two institutions directly responsible for the operation and maintenance (O&M) of the Kirindi Oya irrigation system. The ID is responsible for O&M of the system upto the field channel (FC) turnouts while management below the turnouts is the responsibility of the FC groups of farmers organized by the IMD The ID, at this stage of development of the project, is engaged both in O&M work in the completed Phase 1 area and in construction work in the Phase II area. Some of the preliminary conclusions of the study are presented here on (i) O&M organization of ID, (ii) role of IMD in O&M at system level, (iii) farmer organization program and (iv) the committee system for project and system management.

O&M Organization of Irrigation Department

The following characteristics of the Irrigation Department that affected the system and O&M in the last season were observed:

i) The officers and staff of the department concentrated on achieving construction targets and O&M received less attention;

ii) Because of clear targets in construction, the performance of the officers is evaluated on the basis of the achievements in construction. There are no targets to achieve in O&M and hence no indicators to measure the performance of staff; there are no incentives for O&M staff;

iii) There was divided authority over operation of the system among the Resident Engineers (REs) and the Senior Irrigation Engineer (SIE) and there appeared to be some ambiguity regarding their respective roles, functions and responsibilities;

iv) The actual operation was in the hands of the irrigators who were unskilled laborers temporarily hired for the purpose; they did not receive much guidance or supervision from the senior field staff;

v) There was no system for monitoring discharges other than random checks by the SIE's staff;

vi) Communication among the ID staff and between ID and farmers was not effective; and

vii) The maintenance work which was expected to be completed by ID had been delayed causing some unhappiness among farmers.

The Role of IMD in Operation and Maintenance at System Level

The task of the IMD Project Managers (PM) is to form farmer organizations and develop linkages for coordination among various agencies involved in agricultural implementation. The activities of the PMs are supposed to be confined to the canal system on which the Project Committee is based. The following are some preliminary observations on the role of IMD in the project:

i) There is a Project Coordinating Committee (PCC) charged with the coordinating function in the project. It has been doing its job as it perceived its role and function;

ii) The introduction of IMD Project Managers with the objective of promoting farmer organizations and coordinating among line agencies for agricultural implementation has led to role conflicts among some officers;

iii) The concept and philosophy of IMD and the role of its Project Managers seemed liable to various interpretations not only by officers of other departments but by the incumbents of the office themselves;

iv) The expectations regarding what can be achieved by farmer organizations and project managers of IMD in solving farmers' problems are such that they cannot be sustained. The problems are much too complex to be solved that easily at least in the initial and formative years of the organization;

v) IMD Project Committees may appear to deal with all types of problems concerning farmers, and IMD Project Mangers may be seen as representatives of or spokesmen for farmers. These two tendencies are responses to the lack of alternatives, but are sources of confusion which do not seem to have helped the farmers' cause much.

vi) The involvement of IMD Project Committees in agricultural implementation is limited to attempts at problem-solving in times of crisis.

Farmer Organization Program

The farmer organizations were launched by the Project Manager (IMD) in the new area within a period of one year. He was working alone without any assistance from Institutional Organizers (IOs). Field Canal (FC) leaders were selected and distributary canal (DC) organizations were formed. Though some FC leaders were active in the sense that they attended DC meetings, there was no active participation by other farmers at FC level. The activities of DC organizations were limited to presenting problems to various line agencies for solutions. Many settlers were found to have gone away from the hamlet to their native villages in between the cultivation seasons; even during the cultivation season they were frequently absent from the hamlet. Part of the reason was the drought and inadequacy of facilities in the hamlet. Under these circumstances, it was more difficult to organize farmers for FC group meetings or to do shramadana campaigns.

Because of the experience in political organization of the leading men in the DC organizations, the IMD organizations in Kirindi Oya reflect a pattern where the farmers go and appeal to PM (IMD) to influence officers. The solutions to farmers' problems in the IMD organization are perceived as lying with leaders and not with the ordinary farmers. In the absence of clear benefits resulting from farmer organizations, farmers have become sceptical of the organizations and the motives for establishing them. A majority of sample farmers denied being members of a DC organization.

As there was no shortage of water during last season, involvement of FC leaders in water distribution was not found necessary and farmers generally shared the water below FC level without any serious problems.

The Committee System for Project and System Management

The Project Coordinating Committee (PCC) takes decisions regarding almost every major activity and is responsible for the coordinating function. The construction and settlement programs are discussed in detail and evaluated at monthly meetings of the committee, but the committee does not go into detail on O&M or agricultural implementation issues. A subcommittee of the PCC was formed recently in mid-August 1988 to discuss the agricultural programming for the project in detail. Both the PCC and the subcommittee consist of only officers of various departments.

There is a DAC subcommittee which is the decision-making body for agricultural programming and implementation in the district. All IMD project managers, irrigation engineers, and agricultural officers, and farmer representatives from all the projects in the district attend this meeting.

The Government Agent (GA) has the final responsibility for the coordinating function and the Project Manager (Settlement) is the key officer in really effecting the coordination. Farmer representation on the PCC and its sub committee has been a much debated and contentious issue.

INTEGRATED PICTURE OF SYSTEM PERFORMANCE

The major findings reported so far have either a disciplinary viewpoint or an emphasis on an aspect or process of irrigation system management. What is attempted here is to take an integrated view of the system performance with some emphasis on the systemic interactions. At this level, the evaluation of performance cannot be normative because, at present, such norms simply do not exist. It has to remain subjective. Not only that, it depends on the perspective of the evaluator -- whether it be a donor or lending agency, or a national planning and policy agency, or an irrigation agency, or water users, or researchers. Depending on the perspective, different conclusions are likely to be drawn. Being subjective, the evaluation is not value-free.

Environment

The study area has not had cultivation during yala 1987 and the maha 86/87 crop was severely damaged. The maha 87/88 cultivation commenced late in January 1988. The settler farmers had thus gone through a difficult period caused by drought. Many of them went back to their native villages in search of employment.

There were social and political disturbances in mid-1987 in the Kirindi Oya project neighborhoods of Deberawewa and Tissamaharama. The social tensions and difficult security situation continued thereafter with varying degrees of intensity. The situation could not be considered normal. The officers of the various agencies were working under difficult conditions and various constraints.

Performance

Water was available abundantly in the reservoir and irrigation water supply was either adequate or more than adequate in the study area except for one period of water shutdown during the Sinhala new year. In fact there was excess water in lowland areas which created problems of salinity in some of them.

Given the pressure of construction targets to be achieved and the relative abundance of water, the Irrigation Department found it necessary to concentrate on construction and O&M received much less attention. If the water availability becomes more restricted than in the past season, there would be greater demands on the management capacity of the department. There are some indications that the department is making improvements for managing O&M in the next season.

As the cultivation season commenced late in January 1988, all the farmers were not able to get good and certified seed paddy. There was delay in getting bank loans. Then there were pest attacks. They could not get in time either extension advice or right types of chemicals to combat the pests. With all these problems and difficulties, they achieved an average yield in the sample allotments of 3.747 t/ha. It should be considered good performance by the farmers.

The value added in rice production and farmers' income are less than satisfactory. Especially in the sample from DC 8, the value added was very low and the farmers had incurred a significant loss due to rice production. The DC 8 farmers seem to have different and special social and settlement characteristics that need further research to understand. But the case of DC 8 farmers is a good example of systemic interactions resulting in low productivity in spite of adequacy of water.

There have been some problems of effective coordination. Some of them are structural in nature and some the results of the nature of interactions among different agencies and officers. But there have been positive developments like the formation in mid-August 1988 of the subcommittee of the Project Coordinating Committee to discuss the agricultural programming of the project in detail. The social environment and its impact should not be under- estimated in the task of obtaining effective coordination which is difficult even at the best of times.

Crop Diversification

The objective of achieving crop diversification is important to the success of the project. There is progress in planning for agricultural research, both in the research station and on farmers' fields in the next season. On-farm irrigation water management is a component of the research.

Other questions also need to be addressed by relevant agencies if crop diversification is to be successful. Ready markets and remunerative prices for non-rice crops to induce farmers to grow them are important but they are part of larger policy framework. It also needs to be examined if the relative scarcity of labor constrains the growing of non-rice crops of a labor-intensive type. The selection of the crops seems very important. The availability of credit to farmers from banks was raised as a problem. The agricultural insurance for the crops is a pre-requisite for the banks to provide loans for those crops. This problem is being addressed by the Central Coordinating Committee of the project.

VII. IRRIGATION WATER DELIVERY SYSTEM
CHANDRIKAWEWA BLOCK, WALAWE -- YALA 1988

PROJECT LEVEL IRRIGATION SYSTEM OPERATIONS

Decision-Making for Commencement of the Season

The decision for commencement of the yala 1988 season was taken at the cultivation meetings (kanna) held at block level. Yala 1988 was quite different from the previous season (1987/88 maha), which had started with a near-empty reservoir and expectations of future rains (by the time of the 1987/88 maha kanna meeting, storage in the reservoir was down to just 14,000 acre feet [17.28 mcm]).

For yala 1988 water was not a constraint and therefore both farmers and MEA field level officials expected to start the season before 14th April 1988. But the decision makers of MEA did not accept the farmers' suggestion for an early start for two reasons:

1. harvesting was going on in some areas of the system until the end of March, leaving too little time for pre-season maintenance work;

2. Most of the farmers are Sinhalese and would therefore be busy with the New Year festival. If water issues are made during the New Year festival, efficient water use will not be achieved by the farmers for land preparation.

Though the majority of farmers did not in fact agree, two of the farmers suggested an official date of 20 April for first water issues, which was approved by MEA, to fulfill the legal requirement of the cultivation meeting.

Irrigation Network of the Project

The Walawe right bank main canal (RBMC) services about 11-12,000 ha through a single bank canal. For administration purposes the entire RB canal command area has been divided into five blocks. Embilipitiya is the head reach Block, served by 26 DCs directly from RBMC and one branch canal (Moraketiya). The Chandrikawewa reservoir is located on the 15th km post from the Walawe reservoir. The RBMC passes through the reservoir to feed the tail end blocks (Binkama, Murawashihena and Angunakolapelessa). After Chandrikawewa, RBMC crosses the Kachchigala tank and runs towards the tail end.

The operation of the DCs and branch canals (BCs) off RBMC is the responsibility of the Operation and Maintenance (O&M) Division of the project office (RPM's office). The Chief Irrigation Engineer (CIE) is responsible for overall operation of the system. He is assisted by two Irrigation Engineers (IEs), one Technical Officer (TO), and nine "irrigators" (water laborers). This division is responsible for preparation of the water schedules for the season, and issuing the water requirements of the blocks. The water requirement for the season is calculated by the O&M Division based on the field data provided by each BM.

BLOCK LEVEL OPERATIONS: CHANDRIKAWEWA

Rotations and First Water Issues

By the time of the kanna meeting, Chandrikawewa reservoir had started spilling. As mentioned above, MEA decided to make the first water issue on 20 April 88 but at the request of the farmers during the kanna meeting, MEA agreed to issue a little water for domestic use. Accordingly Chandrikawewa main sluice was opened on 12 April and the RB sluice on Chandrikawewa on 11 April. MEA could not refuse the farmers' requests because by that time Chandrikawewa reservoir had started spilling. But the scheduled official date for first issue of water by MEA was 20 April for the entire RBMC area.

No rotation was operated during the first two weeks of land preparation. All the BCs and DCs (direct from RBMC) were kept open. After two weeks the rotations started for the entire system. But Chandrikawewa Branch Canal and Mamandala Branch Canal continued to be given constant issues.

According to the water issue timetable adopted at the kanna meeting, the last water issue date was to be 5 August, but MEA had to continue issuing water until 30 August. The reasons for additional water issues were:

1) MEA recommended using three and a half month varieties of paddy if land preparation is completed before 10 May. Three month varieties were recommended for all other farmers. However, 100 percent of the farmers completed their land preparation <u>after</u> 10 May but still used the three and a half month varieties.

2) Due to physical defects on some DCs, tail-enders got water about 10-15 days later than the head-enders and therefore their land preparation went on until the second week of June. As a result these farmers had to be given additional water issues.

Operational Procedure at Block Level

Supply of the required quantity of water for the command area in the block is the responsibility of the O&M Division. Internal distribution within the block is done by the block management. One IE is posted in each block, assisted by EAs, UMs, FAs, and irrigators for on-farm water management.

In the Chandrikawewa Block once the O&M Division releases water from the Chandrikawewa sluice, water issues for each DC within the block are made by a separate block technical officer. Water distribution within DCs is the responsibility of a team in each unit that includes the UM, FA and irrigator. Some units in Chandrikawewa are comprised of one or two DCs while others include only part of a DC, depending on the size of the command area. For example, Chandrikawewa unit one includes DC 1 to DC 5, while DC 10 -- one long DC -- is divided between two units.

Water issues for the 18 DCs along Chandrikawewa Branch Canal are done according to a scheduled rotation. However, within the DCs, the most common pattern is a lack of irrigation officials' intervention. Except for four DCs (D 6, D 10, D 15, and D 17), none of which is among IIMI's sample distributaries, there was no internal rotation system for distribution. The rotations on the four DCs are implemented by the FAs in each unit; even the IE and EA are not well aware of them.

Block level irrigation officials express the view that due to the physical defects in the canal system, specific schedules for distribution within the DCs cannot be prepared. The responsibility is given to FAs to take whatever measures are possible to provide sufficient water to the farmers. FAs are assisted by irrigators in each DC to do distribution. In most DCs in Chandrikawewa Block, no internal rotations were in operation; irrigators and FAs have little involvement in distribution. Once DCs are opened, internal distribution is in the hands of the farmers. Lack of the necessary structures was the reason given for not operating rotations within the DCs. Farmers have responded to this laissez faire policy by constructing brushwood weirs in certain locations to create head for diverting water into their fields.

Major Operational Problems in Chandrikawewa Branch Canal and Officials' Attempts at Solutions

There is no doubt that the physical condition of the canal is the main hindrance to efficient distribution among and within the 18 DCs. Even within head DCs, head and tail farmers do not share water equally. The head-enders on these DCs have additional opportunities for irrigation compared to tail-end farmers because most of them have been given direct farm outlets from the DC.

MEA field level irrigation officials understand this behavior but claim the defective system does not permit them to operate rotations within the DC. Therefore excess requirements have to be made available, particularly to the longest DCs. Thus, in Chandrikawewa Block, D 6, D 10, and D 15 were closed only once a week and D 17 had a constant flow. At the same time, MEA closed many of the short DCs 3-4 days per week to facilitate water issues for the long DCs. According to the water issue timetable, towards Sunday every week nine short DCs are closed and excess water is released to D 6, D 10, D 15, and D 17. FC rotations are operated only in these four DCs.

Even with these arrangements, farmers still had difficulties in sharing water on the long DCs during FC rotations. The TO responsible for operating the 18 DCs in Chandrikawewa Block discussed the problem with the O&M

Division to seek other solutions. The O&M Division agreed to increase the normal quantity in branch canals on Thursdays and Fridays.

Despite all these efforts to improve the supply of water for long DCs, the farmers in D 10, D 15, and D 17 could not all do land preparation simultaneously. MEA had to stagger water issues and requested head-enders to complete initial land preparation activities first; therefore tail-enders had to undergo a delay of about 15 days. All the farmers used similar seed varieties, resulting in the need to provide extra water issues at the end of the season.

Since 1985, the year rehabilitation activities began in Walawe, funds allocated for pre-season maintenance have been reduced. Therefore, a lot of urgent work like strengthening of weak and damaged places of DC bunds, levelling of farm outlets, and desilting and jungle clearing of BCs and DCs has been neglected. This has resulted in even more unequal distribution within the DCs because some farmers cut the damaged and weak places of the DC bund. Silted canals reduce the flow to the tail end. This season no money was allocated for maintenance work for D 1 - D 10 (Tract A) as rehabilitation was proposed to be started in this area. Only jungle clearing was done in the other DCs (D 10 - D 18). But farmers in D 10 complained to MEA and later MEA decided to do jungle clearing there. We observed that in some DCs farmers had organized shramadana (self-help) campaigns to do some maintenance work in their DCs (for example, DC 6).

Impact of Operational Problems in Chandrikawewa Block

It is undoubtedly true that the physical defects in the system adversely affect the operation. Because of these defects, official attempts to solve problems are seriously inhibited. There are one IE, two EAs, two TOs and 13 FAs engaged full-time in water management in the block. Field and block level irrigation officials' contacts with farmers are low and internal distribution of many DCs is automatically handled by the farmers. This would not be a problem if water management is officially handed over to well-organized farmer groups. But in Walawe there are no well-organized farmer groups. There are various conflicts among farmers over water distribution within a defective system. Disadvantaged farmers claim that if officials intervene, these problems can be solved to some extent. But field level officials are of the view that within such a physically defective system they can do nothing. This noninterventionist behavior of irrigation officials may, however, be creating two kinds of problems:

1) Farmers are led to form an impression that officials are not interested in their work. The absence of trust between the two parties (farmers and officials) may be detrimental to implementing any future improvement program.

2) Farmers use whatever measures they can to irrigate their fields. Most of them are not bothered about equal sharing of water with their fellow farmers. This behavior may seriously affect the formation of water use

groups and introduction of rotations after rehabilitation. Both farmer and officer behavior must change -- but bringing about this change will be a difficult task, requiring clear, well-implemented policies and thorough training for both farmers and officers.

WATER MANAGEMENT ON DC 8

Physical Layout of the DC

Compared to other DCs on Chandrikawewa Branch Canal, DC 8 is one of the most dilapidated canals. There are no structures remaining to maintain the flow and as a result the canal is seriously eroded. The upper part of the DC is deep. There are six FCs on the left bank of DC 8 and three FCs on the right bank. Except on RB 1, no FC turnout gates are available. In addition to official turnouts there are two or more unofficial openings in five FCs (LB 2, LB 3, LB 6, RB 2, and RB 3).

In many places both DC and FC bunds are weak and narrow due to severe erosion and poor maintenance. About 48 farmers have been given direct farm outlets and some of them do not have pipes for outlets, so they irrigate by cutting or tunnelling the DC bund. Along the DC and FCs, approximately 20 farmers (20 per cent of the total) have no pipes for their outlets. They also use the same method for irrigation. The 48 farmers who have direct outlets use wooden logs to block the DC in order to raise the water level. Eight such places have been identified, each serving 5-6 farmers.

Operational Procedure

During the land preparation period, no rotation was operated for the first two weeks. The proposed date for the first water issue approved at the cultivation meeting was 20 April, but water was issued on 12 April due to spilling of the reservoir. Therefore the farmers had the opportunity to begin their land preparation eight days prior to the scheduled time. Since there was sufficient rain during this period no major irrigation problems were reported by the farmers (water requirements may have been low part of this time, because of celebration of Sinhala New Year).

DC 8 was closed every Thursday and Friday after the first two weeks. As there were no FC gates, with the exception of RB 1, operating a rotation within DC 8 was not possible. Rotation started on RB 1 after land preparation. It was closed on Mondays by the irrigator of DC 8, to provide extra water to the tail of the DC.

Distribution problems

DC 8 was otherwise completely neglected by block officials. The FA felt that his intervention would not be fruitful, as noted above. One FA said, "Our visits are not effective. The canal is completely defective. However farmers want to irrigate their fields. Unless rehabilitation is done we can't do water management. Let farmers do their own management."

From our observations, there was no scarcity of water in yala 1988 as MEA was releasing a little more than the designed amount. Internal distribution was the major problem faced. There are two main constraints to equal water sharing:

1. direct farm outlets given from the DC; and
2. lack of regulating structures.

Farmers who have direct outlets build wooden structures to raise the water level. This practice adversely affects the tail-enders, especially of RB 2 and the extreme tail end of the DC. The head-enders, however, had no other choice. In some places the wooden structures were about 1.5 meters in height; water has to flow over the structures. Three head-enders used sand bags to raise the head of the water in the DC.

Because of this practice by the head-enders, the tail-enders in turn had to seek suitable methods for irrigation. Therefore they irrigate in the night by destroying the wooden logs. On the following day the head-enders rebuild the structures. This practice is common throughout the season, and has been observed by IIMI since maha 1986/87.

Unequal distribution among FCs is also common on DC 8. The reasons are the lack of turnout gates and the breaching of the DC bunds. As a result, some FCs get extra water. LB 2 and LB 3 illustrate this. The LB 2 official turnout did not function properly so it was given additional water through a tunnel under the DC bund. In addition it had the opportunity to capture the DC 8 flow through another DC breach. The situation on LB 3 was also serious though it feeds only two allotments. The DC 8 bund near this FC had a break in it which helped it to capture additional water.

In addition to the DC flow, LB 2 and RB 1 had chances to capture drainage and seepage water from higher-level allotments. The allotments located above LB 2 and RB 1 were given farm outlets from the DC itself and they had chances to over-irrigate. This resulted in the discharge of excess drainage water to LB 2 and RB 1 FCs.

The irrigation behavior on the head-end FCs adversely affected equal distribution as a sufficient quantity for the tail-enders could not be released. At the request of the farmers in the tail end during 1987 yala, the FA had decided to rotate RB 1 as that was a difficult season for Walawe farmers. Due to severe drought the quantity released to DC 8 had been reduced and distribution had been a problem for the tail enders of DC 8.

In yala 1988 this rotation continued after land preparation. RB 1 was closed on Mondays each week. This decision did not have any adverse impact on RB 1 farmers, but helped reduce the irrigation problems of DC 8 tail-enders.

Thus, the major patterns of irrigation behavior observed on DC 8 were that while the canal was neglected by the irrigation agency, there were no farmer organizations to implement equal water sharing; the dilapidated system did not permit equal distribution, but various individual attempts were made by farmers to irrigate their fields; and none of the officers interfered with any farmer applying his own methodology for irrigation.

We suggested above that canal operation should not be neglected just because of physical defects. Officials, particularly FAs, for example, could make frequent visits to the area and try to develop improved working relationships with farmers if MEA encouraged them to do so. This could have a positive impact on system performance in the long run. If rehabilitation is delayed for another season, MEA definitely should consider repairing the broken DC bund and FC gates, at least for LB 2 and LB 3.

IRRIGATION WATER MEASUREMENTS

The water issues to Chandrikawewa block in yala 1988 commenced on 11 April 1988, nine days ahead of the date agreed at the cultivation meeting held at block level. Though MEA planned to commence water issues on 20 April 1988 as agreed, the farmers requested the agency to issue water early, because Chandrikawewa reservoir had been spilling during the second week of April 1988. The sluice was opened on 11 April accordingly.

Our systematic data collection on water flows started on 23 April 1988, immediately after the commencement of water issues. We were able to capture almost the entire season for the study. However, the irrigation system was in a dilapidated condition, which limited the full range of flow observations and measurements, that were required to understand the flow behaviors and patterns in the DCs and FCs. Thus the data presently available on this research component provide only a tentative picture of the quality of operation and water use, but will be useful as baseline information for comparison of various performance parameters before and after rehabilitation of the irrigation system.

DATA COLLECTED

The major data collected under this research module are:

a) Discharge measurements at the heads of DC 3, DC 8, DC 18 and at the heads of each FC served by DC 8 as well as at three intermediate locations in DC 8 taken twice a day. The three intermediate locations were selected in such a way that, the area served below the first, second and third locations in DC 8 are 75, 50 and 25 percent of the command area under DC 8 (140 ha).

b) Daily observation of evaporation and rainfall. The observation of evaporation was started in early July.

c) Measurement of seepage and percolation (S&P) by sloping gauge method in nine allotments in the DC 8 command area, representing well drained (RBE), moderately drained and poorly drained (LHG) soils.

d) Observation of daily water levels (above or below the surface level) by perforated tubes installed in nine allotments in the DC 8 command area, representing head, middle and tail reaches of DC 8.

IRRIGATION WATER DELIVERY PERFORMANCE

Operation in general

A schedule of water delivery was prepared by Chandrikawewa block office before the season. This schedule described the water issues for the 18 distributary canals under Chandrikawewa branch canal on rotation. However, these schedules indicated only the days of opening and closing of DC outlets from Chandrikawewa canal, with no indications on the quantities to be delivered or the size of the gate opening or closure.

No irrigation schedules were prepared for internal distribution within DCs. No rotations were implemented within the DCs under study. We understand that implementation of a systematic rotation in DCs under study was not possible, even if such a schedule was prepared. The dilapidated condition of the canals, lack of flow regulators, lack of field canal and farm turnouts and the large number of illegal farm outlets directly from the DCs were the main inhibitors of systematic water distribution and sharing within DCs and FCs.

No rotation among DCs was implemented during the first two weeks of the land preparation period. Instead, all DCs received a continuous supply from the branch canal. The rotation was introduced after two weeks from the commencement of season. It was observed that MEA implemented the rotation in strict compliance to the schedule with regard to the dates of opening and closing of the DC outlets.

However, water was abundantly available throughout the season. As a result operation of the branch canal and DCs under it was not difficult for MEA.

Reliability and predictability of supply

The variations of daily discharge at the heads of DC 3, DC 8 and DC 18 are shown in Figures 7.1, 7.2 and 7.3 respectively. It is not possible to compare the actual deliveries at the heads with targets, as target deliveries were not computed by the MEA. It is also not possible to compare those with the actual requirements, as reliable data on S&P could not be collected.

However, these figures show a definite and a well defined pattern of water deliveries by MEA at heads of DCs, implying strict implementation of the rotation. The deliveries at the heads of DC 3 and DC 8 were reduced after the land preparation period but the delivery at the head of DC 18 had increased after the land preparation period. A possible explanation for this difference is that, DC 18, being the tail-most DC in Chandrikawewa branch canal, received only the residual flow in the branch canal during the land preparation period, but received comparatively high discharges after deliveries to the upstream DCs were subsequently reduced. The figures indicate almost near constant deliveries at the heads of DCs on the dates they received water within the rotation interval. In essence, the operation of Chandrikawewa branch canal was both predictable and reliable to the farmers with regard to the timing of operation and quantities of water received from the main system.

Equity in water use

The weekly average deliveries during the season at the heads of DC 3, DC 8, and DC 18 are shown in Figure 7.4. DC 8, which is in the middle reach, received more water in comparison to what were received by tail end (DC 18) and head end (DC 3). It is interesting to note that DC 3, being the head DC, received less water than DC 18 (tail) and DC 8 (middle) during weeks 8-16. The reason for this difference was not clear.

It is also seen that during first five weeks of land preparation period, there were differences in average weekly deliveries received by DCs and also variations of deliveries at the heads of each DC. But during the crop growth period these differences were almost constant and variations were low. The weekly average deliveries at the heads of DCs were in the range of 20-35 mm/day during the crop growth period. This degree of water use does not seem to be very high with regard to the existing condition of the canals. This suggests a certain degree of drainage reuse within the FCs and among the allotments.

The weekly average water use in the four quarters of the DC 8 canal is shown in Figure 7.5. The analysis of this figure indicates that the first 25 percent of the command area or the head-end reach of the command area was privileged to consume more water than the rest of the area, during the crop growth period. The second and third quarters consumed less water with alternating priorities during the crop growth period. The interesting feature is the water use by the tail-most reach of the command area. This reach received almost a constant supply, but remarkably low flows compared to the upper reaches. This implies a certain degree of inequity along the DC 8.

Supply at heads of FCs

The discharge at the heads of FCs were monitored during the season. The data collected are yet to be processed and analysed. However, firm conclusions may not be drawn from that information. Some FCs do not exist after some distance from the off-take from DC 8. Almost all FCs receive drainage return flows from paddy fields. Thus analysis of the data is difficult and it makes no sense under the existing condition. However, the discharges at the heads of FCs would be used as base line information to assess the impact of rehabilitation on quality of operation, water use and irrigation water delivery performance.

SEEPAGE AND PERCOLATION

The measurement of S&P losses in the paddy fields could not be carried out during the season. The inflows and outflows from the selected liyaddes in sample allotments could not be well managed to suit our interests due to irregular and unexpected interventions and farming activities by farmers. The heavy rainfall at times affected the reliability of measurements taken. On some other occasions, standing water got lost rapidly from the allotments, before the second observation of sloping gauge reading. The losses through crab holes further affected the accuracy of measurements. Therefore no conclusive S & P values can be presented here.

CLIMATIC DATA

The daily rainfall at Thunkama, Embilipitiya from 23 April to 03 September 1988 is shown in Figure 7.6. The highest rainfall (36 mm) during the period occurred on 24 April 1988 during the early land preparation period. The daily evaporation values are presented in Figure 7.7.

CONCLUSIONS

The findings on irrigation water delivery performance in the selected DCs in Chandrikawewa Block of Uda Walawe scheme imply that:

a) The internal rotation below the heads of DCs was not possible due to dilapidated and defective canal system.

b) MEA did prepare a schedule for distribution of water among DCs in Chandrikawewa Block, but no indication on the amounts to be delivered was given in the schedules.

c) The operation of Chandrikawewa Branch Canal was done in strict compliance to the schedule.

d) The supply to DCs from the branch canal was both predictable and reliable to the farmers.

e) There is no large inequity of water use between head, middle and tail of the Chandrikawewa Branch Canal. However, the degree of inequity within DC 8, especially between head and tail was considerable.

Figure 7.1 - Daily discharge at head of DC 3

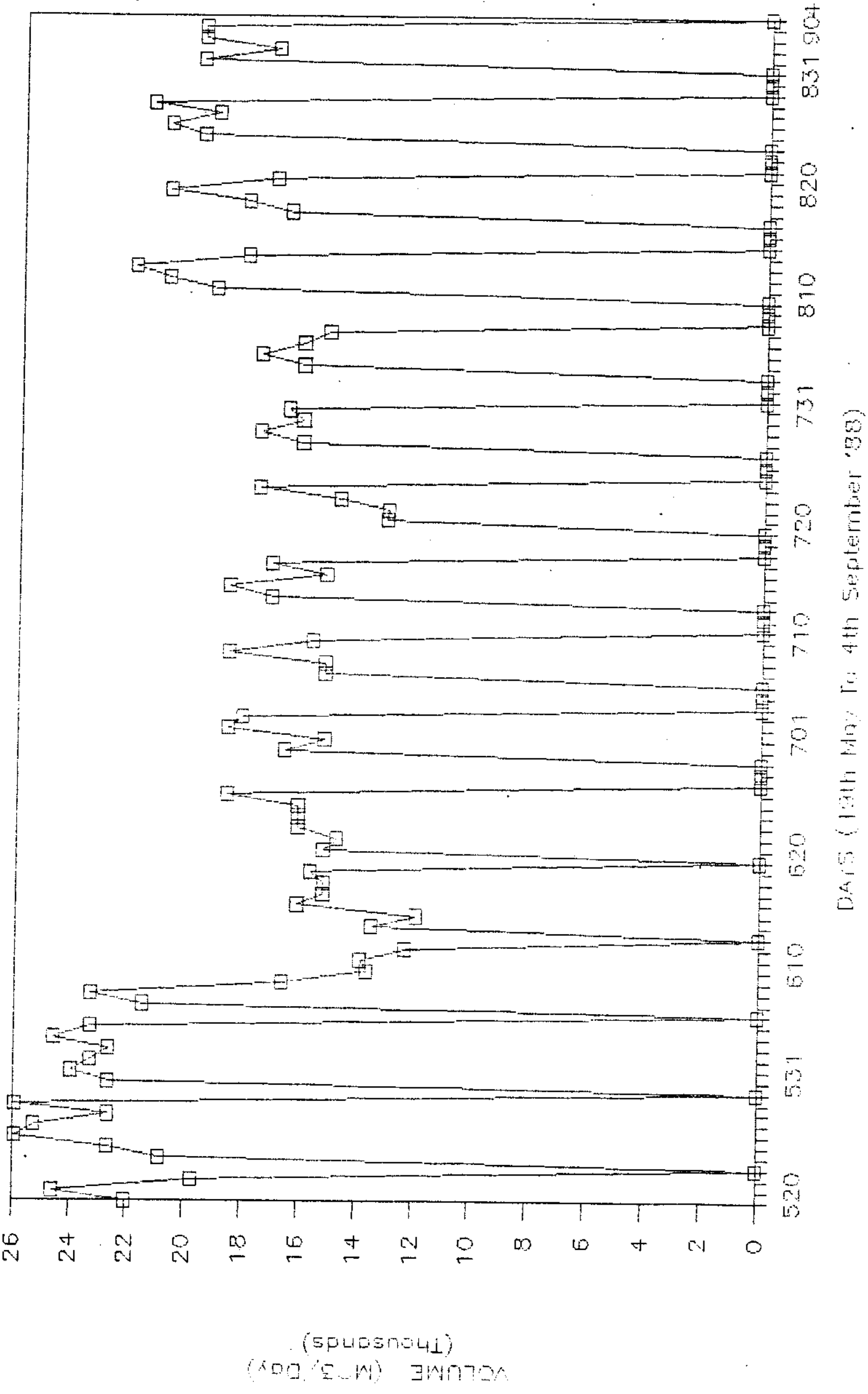


Figure 7.2 - Daily discharge at head of DC 8

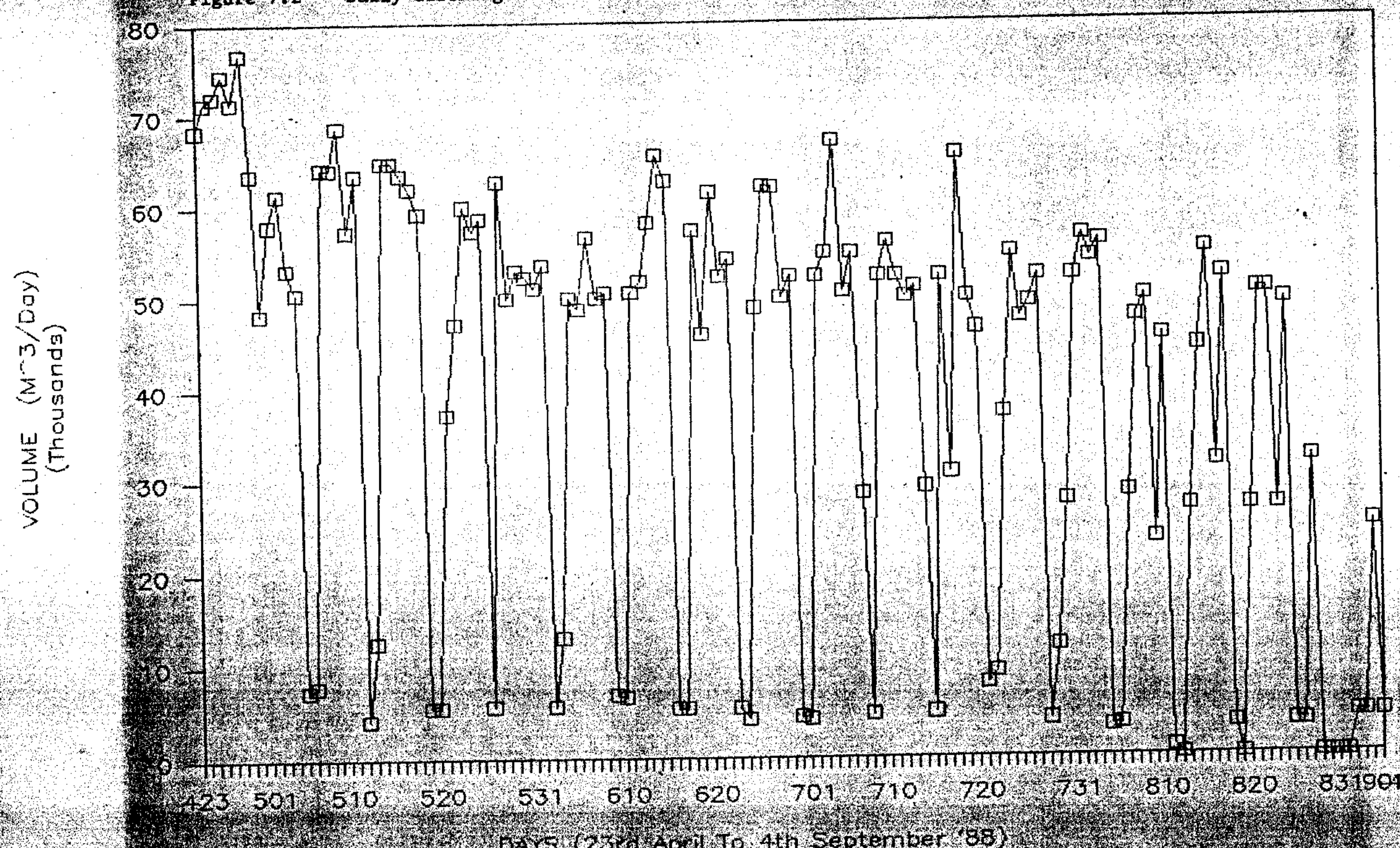


Figure 7.3 - Daily discharge at head of DC 18

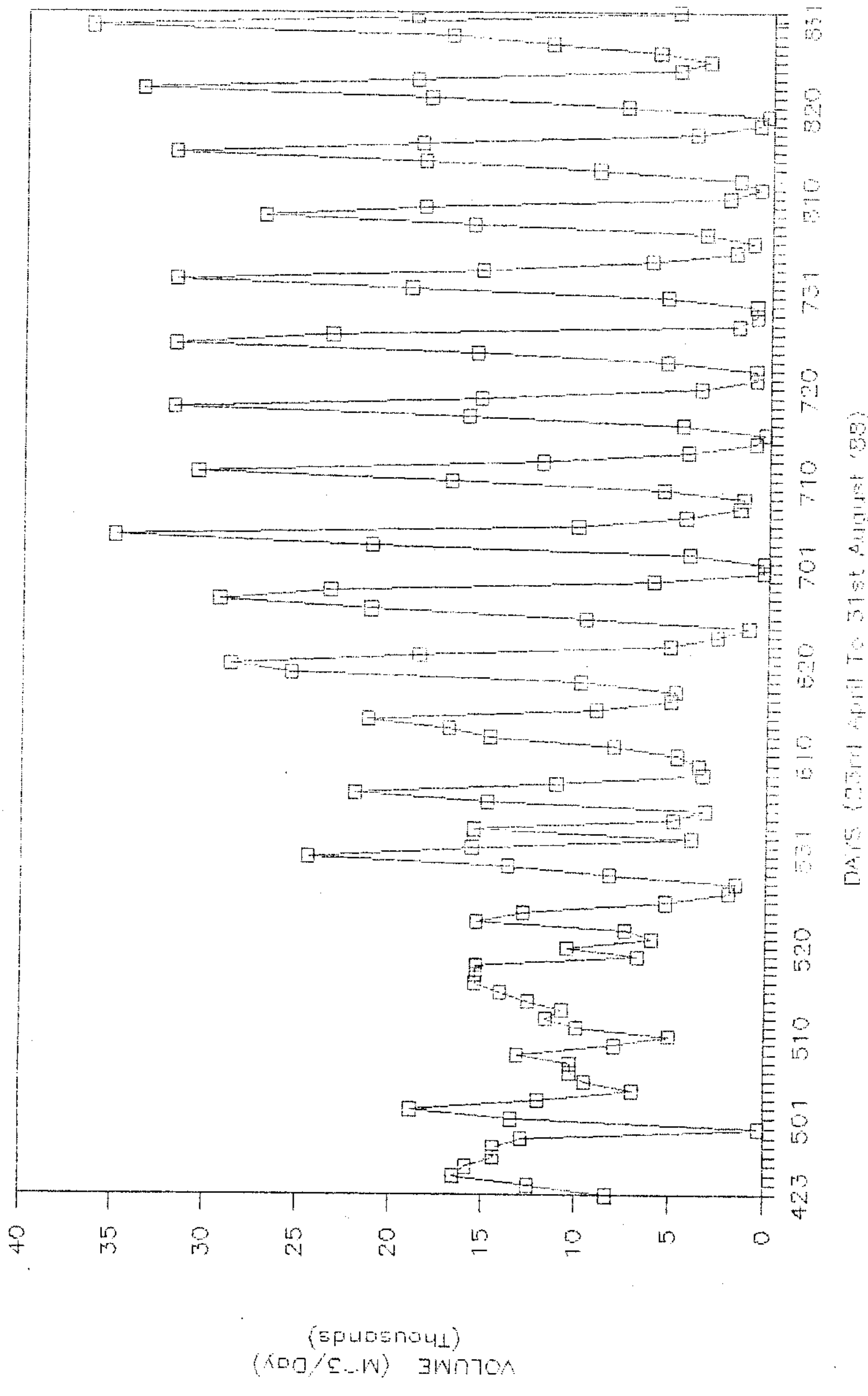


Figure 7.4 - Weekly average deliveries at head of DCs

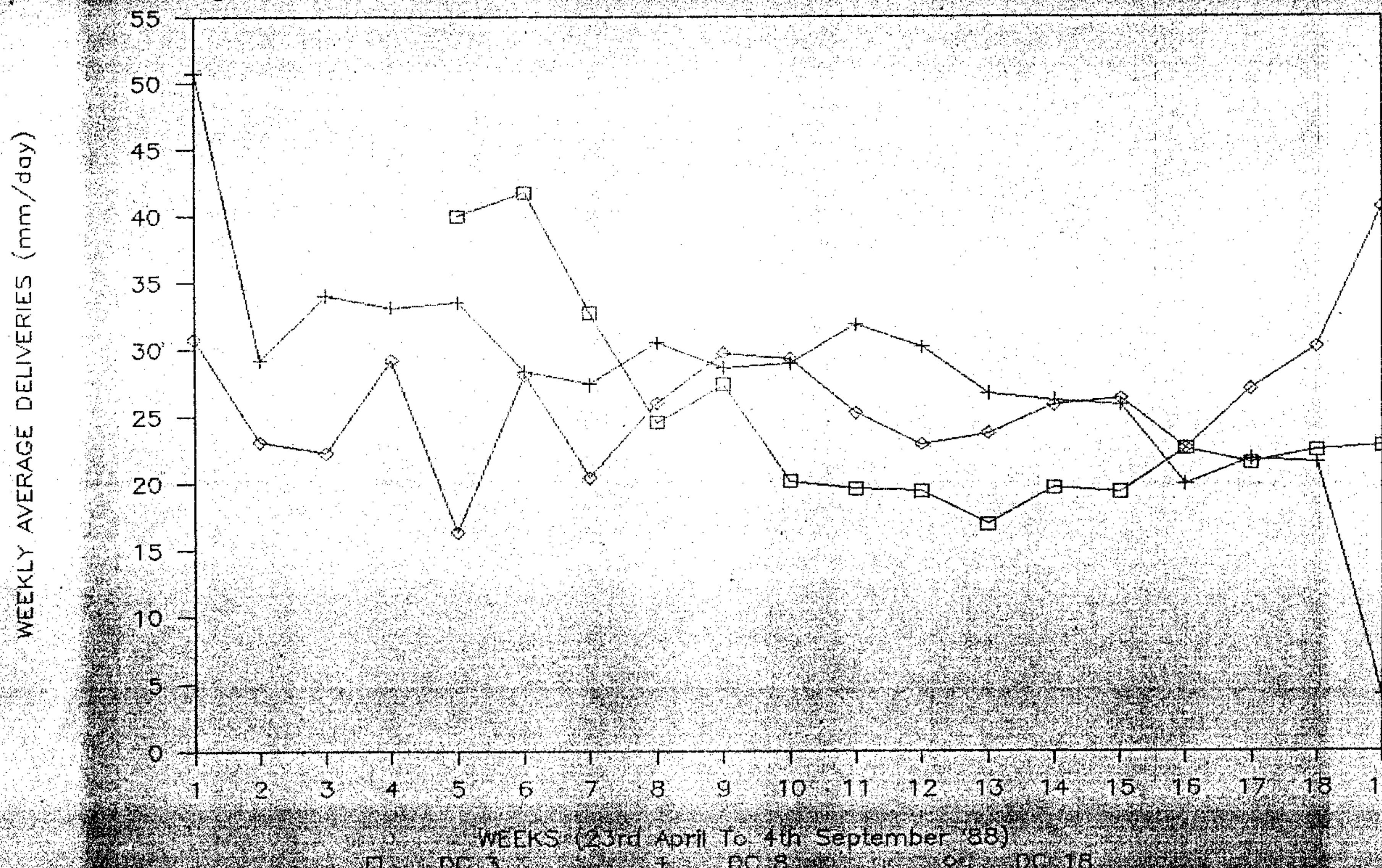


Figure 7.5 - Water use along DC 8

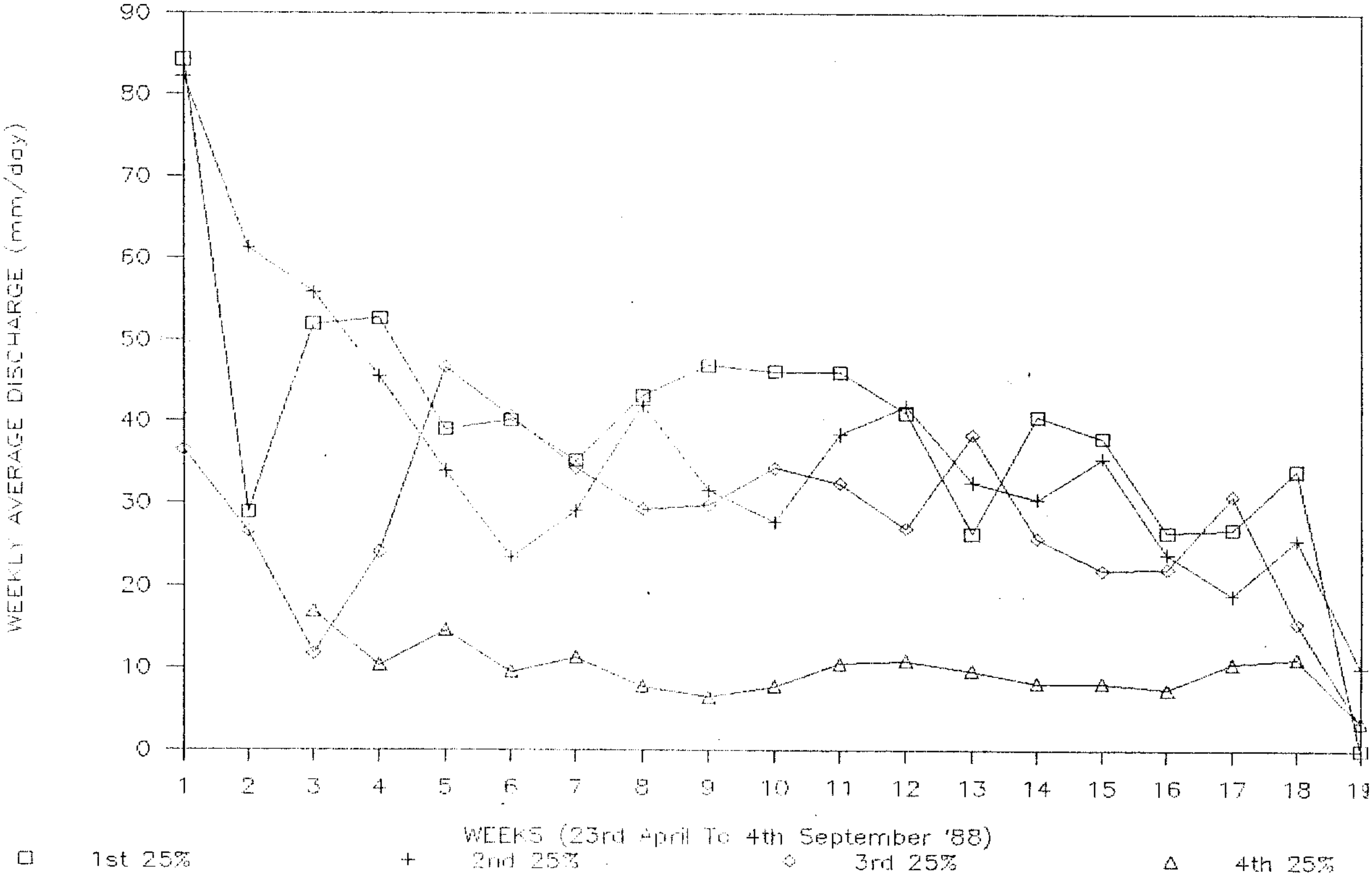


Figure 7.6 - Rainfall distribution at DC 8

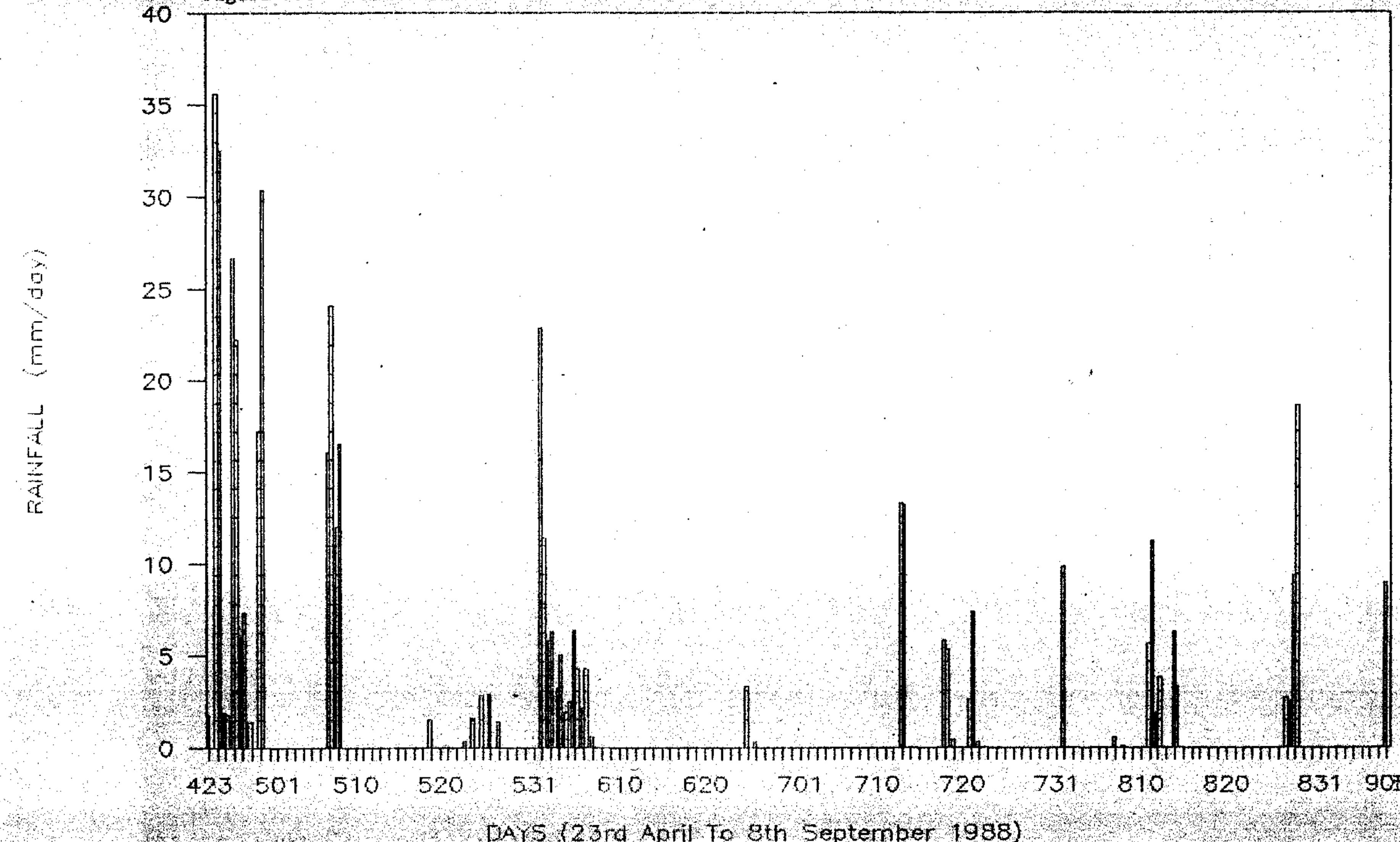
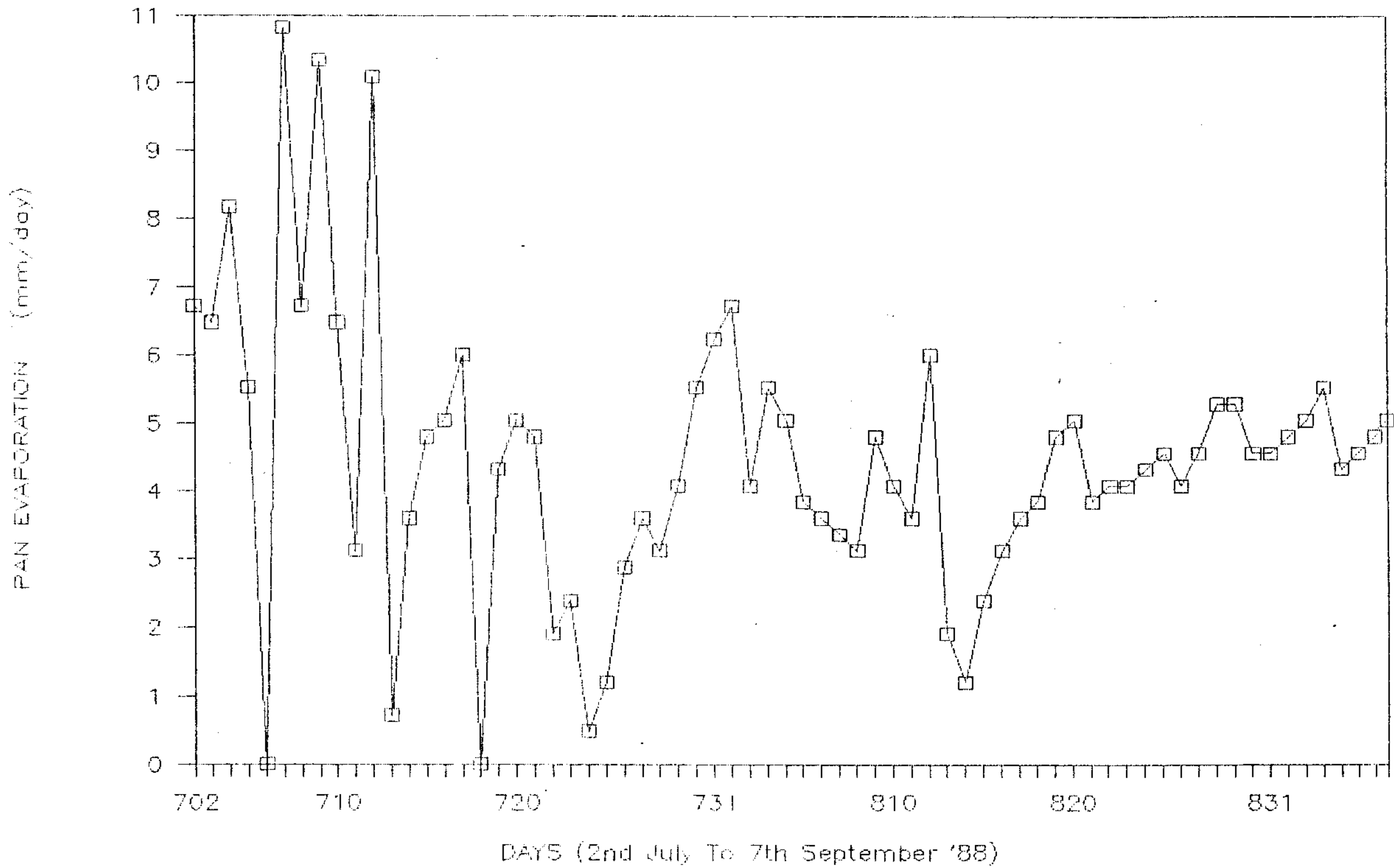


Figure 7.7 - Open pan evaporation at DC 8



VIII. IRRIGATION INSTITUTIONS -- WALAWE: YALA 1988

INSTITUTIONAL EVOLUTION OF THE WALAWE PROJECT

From the beginning up to 1982, the implementing agency of the Walawe Irrigation Scheme was the River Valleys Development Board (RVDB); except for middle and minor grade employees involved in agricultural extension work, senior RVDB employees were not absorbed by the Mahaweli Economic Agency (MEA) when the management was turned over to it in 1982. Therefore we were unable to meet any former RVDB officer from the top management level to get a clear understanding of the organizational set up then. We met one former middle grade RVDB employee, now absorbed in MEA, who provided an overall picture, but could not explain the RVDB organizational structure in detail.

A Brief Overview of the RVDB Organization Compared to MEA

The Resident General Manger (RGM) was the head of the scheme. His authority was similar to that of the present Resident Project Manager (RPM) of MEA, but the RGM did not have Government Agent's authority. During the latter part of the RVDB period, two Sri Lanka Administrative Services (SLAS) officials were seconded to the project with the powers of a GA.

RVDB had Deputy General Managers (DGMs) for agriculture and land matters who were similar to Deputy Project Managers (DRPMs) under the MEA set up. There were no deputies for community development and marketing sections. For irrigation matters a few irrigation engineers were posted to the RGM's office.

For administrative purposes there were project offices under separate Project Managers. The functions of the project offices were similar to the present block offices. The Project Manager had a few sectional heads for agriculture, land matters, and Irrigation (technical assistants). There were no sections for community development and marketing and no engineers for irrigation.

The functions of unit managers (UMs) under the MEA were fulfilled by krushi viyapathi sevakas (KVSs; field-level agricultural extension officers) during the RVDB administration. There were cultivation officers and each cultivation officer had 5-6 KVSs. They were all engaged in agricultural extension work. In addition to the project offices, there were two separate offices for the cultivation officers in Moraketiya and Gange Yaya.

The duties of MEA field assistants (FAs) were also under the RVDB Cultivation Officers (COs). Therefore on-farm water management was an additional responsibility of the agricultural extension workers (COs and KVSs). During the latter part of the RVDB administration this practice was changed and "Jalapalaka" (on-farm water management officials) were recruited and assigned water distribution responsibilities at the field level.

MEA - Overall Organizational Structure at the Project Level

The Resident Project Manager (RPM) is the head of the project and has overall responsibility for all project activities. There are five deputies to assist the RPM in land administration, agriculture, irrigation (O&M), marketing, and community development. In addition to these five deputies there are separate accounts and administration divisions, directly under the RPM. To facilitate implementation activities, seven administrative blocks have been set up with block managers (BMs) in charge.

Each DRPM has his subordinate group, both in the project office as well as in the block offices, which are as follows:

(1) DRPM (Agriculture)

1. AO (Statistics and Bee-keeping)
2. AO (Paddy)
3. AO (Plant Protection)
4. AO (Other Field Crops [ofcs])
5. AO (Farms)
6. AO (Animal Husbandry)

The six Agricultural Officers (AOs) posted in the DRPM's office assist the block-level AOs in their specialized areas. The AO (Statistics and Beekeeping) is engaged full-time in the preparation of a three year agricultural implementation program. He keeps monthly records of agricultural development progress and estimated targets in each block. These data are provided by the block AOs with the assistance of their UMs.

The responsibility of the AO (Paddy) is to encourage farmers to utilize MEA-recommended varieties. Farmer education on weeds and disease control is the responsibility of the AO (Plant Protection). Implementing of the crop diversification program in the entire scheme is the responsibility of the AO (ofcs). Supervision of separate MEA farms is handled by the AO (Farms). Encouraging the second generation of settlers for animal husbandry as another income source is the responsibility of the AO (Animal Husbandry).

These six AOs are posted in the project office. Each block also has one AO. In addition to these six AOs, there are two additional AOs assigned full time duties for the rehabilitation work.

The six project office AOs implement their activities with the assistance of the AOs posted in the blocks. They use pre-season officer training and monthly farmer training meetings (unit level) to communicate the seasonal program in their respective areas to be implemented. The UMs are instructed by the six AOs on their intended programs and also materials for farmer training are prepared by the AOs and provided to the UMs for implementation in the field.

None of the AOs in the RPM's office engages in practical field operations other than the preparation of implementation programs in their specialized areas. They are not in a position to evaluate the progress made in the field in their respective areas. Therefore they must depend on the data provided by the UMs.

2) Chief Irrigation Engineer [CIE] (Head O&M Division)

1. two irrigation engineers (IEs)
2. one technical officer (TO) posted in the RPM's office; there is also one IE in each block.

The O&M Division is responsible for preparation of the water requirement budget of the scheme. Two IEs prepare the water budget with the assistance of the TO, guided by the CIE. BMs provide information on the irrigated area and water requirement to the O&M Division. Operation of the main and branch canal is also done by the O&M Division (this is discussed in detail in below).

3) Manager Land

Three land officers (LOs) in the project office; each block has a LO). But under the present Manager (Land)'s new administration, all the land matters are going to be handled by the RPM's office (centralized management system).

Under the administration of the previous Manager (Lands), BMs had the authority to regularize encroachments. One LO was posted to assist the BM. The present Manager is of the view that as land matters are associated with rules and regulations, similar specific procedures should be exercised for each and every land problem. Therefore the authority should be handled by one person. He has withdrawn the authority previously given to the BMs for land matters, and blocks are now used only to report on land matters to the RPM's office. All the LOs are stationed in the RPM's office and collect the necessary information by periodic visits to the blocks.

4) DRPM (Community Development)

Two Community Development Officers (CDO) in the project office; one CDO is posted in each Block.

The Community Development Division has no specific duties like the O&M and Agriculture divisions. It assists the government and non-governmental service agencies to implement their programs in the area. Under the DRPM (Community Development)'s guidance the CDOs organize the following:

a) educational programs for settlers and their children (agriculture, community, health, etc.);

b) training of second or third generation unemployed youth for self-employment (dress-making, cookery, etc.);

c) helping the settlers with drinking water facilities; and

d) organizing sports activities and improving the abilities of children of the settler facilities.

The DRPM trains the UMs at pre-season officer training meetings at block level to implement the above mentioned activities in the field. CDOs do not have close contacts with settlers because they do not visit the field. They try to get their activities implemented by the UMs. In promoting WUGs, Community Development officials could perhaps play an important role. Officers from the Community Development Division do not presently assist the WUG program.

(5) Project Marketing Officer (Head, Marketing Division)

No marketing assistants are posted to the RPM's office; each block is given one marketing assistant.

The main function of the Marketing Division is to help the farmers to dispose of their produce for a good price. In Walawe, input facilities are provided by the Agriculture Division (seeds, fertilizer, etc). Under the supervision of the Project Marketing Officer there are marketing assistants posted in each block.

We observed that though the Marketing Division invites the Paddy Marketing Board (PMB) to purchase the produce, due to the low price, quality requirement (PMB requires less than 14 percent moisture content), and the delay in payments, farmers usually choose to sell their produce to private traders.

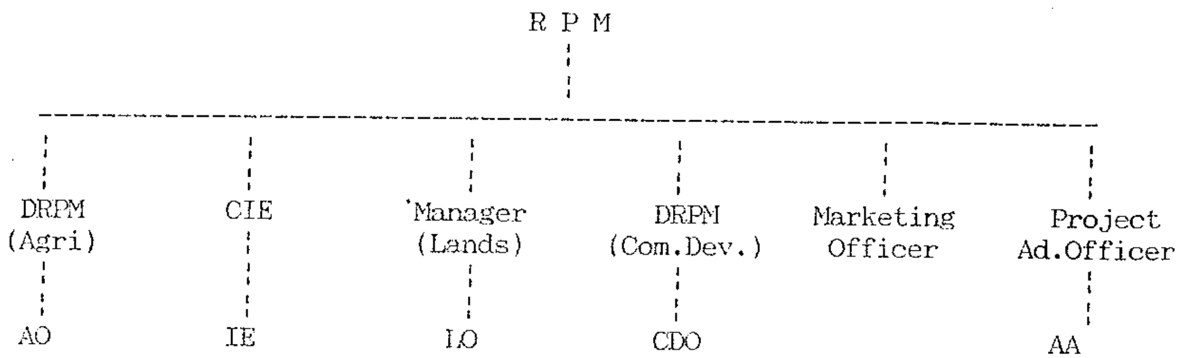
(6) Project Administrative Officer

One administrative assistant (AA) has been posted in the RPM's office and each block is also provided with an AA.

The Project Administrative Officer is responsible for attending to all the administrative and personnel functions of the project. Transfers, increments, and promotions are attended to by him on the recommendations of the respective DRPMs and the RPM. The block AA fufills the same function at that level.

The organizational structure of MEA at Walawe is shown in Figure 8.1.

Figure 8.1. Organizational Structure of MEA, Walawe



Organizational Structure at Block Level

The block manager (BM) is the head of the block. Until recently he was assisted by five sectional heads (AO, LO, CDO, IE, marketing assistant), and an administrative assistant; with the transfer of the LO to the project office, there are now four section heads. Within each block, Unit Managers (UMs) are posted at unit level. Each UM handles the agriculture, land, community development, marketing, and irrigation matters of the unit; thus they are supposed to assist the block sectional heads. A unit is comprised of 80-120 settler families. In Chandrikawewa Block there are 18 units.

There are two Technical Officers (TO), two Engineering Assistants (EAs) and 14 Field Assistants in Chandrikawewa Block to handle irrigation matters under the IE's supervision. An additional TO is responsible for the operation of the Chandrikawewa Branch Canal, under the O&M Division. The EAs assist the block IE in O&M. TOs and EAs have no official role in unit management. Though the FAs are directly under the EAs and IE, they are supposed to work with the UMs. Field level water management and maintenance is the responsibility of the FAs. Finally, in addition to the above, there is one AA to assist the BM in his administrative functions.

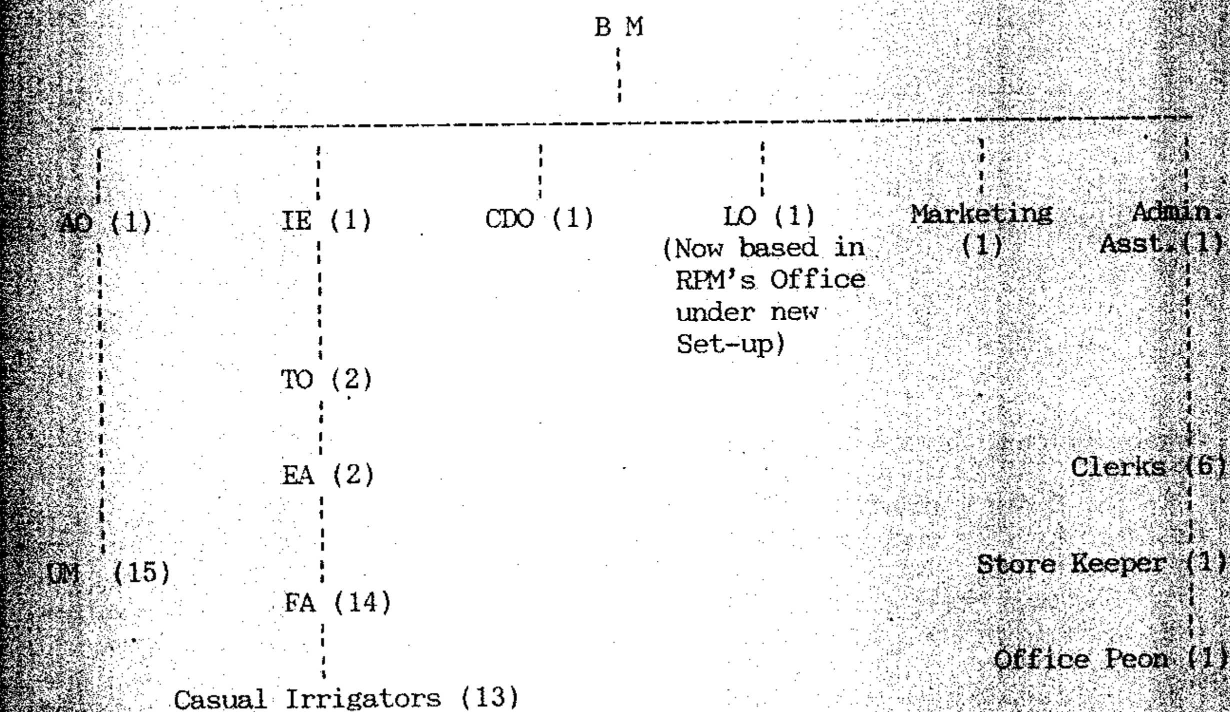
Figure 8.2 shows the organizational structure of Chandrikawewa Block.

Decision-Making Authority

Project Level. Decision-making for each cultivation season is done by the project office. The MEA Colombo office is not involved in the decision-making process of each cultivation season; the RPM has the authority for this. In this process he is assisted by his deputies.

All other policy decisions common to the Mahaweli systems are taken at the Colombo (MEA) office and conveyed to the RPM for implementation.

Figure 8.2. Organizational Structure of Chandrikawewa Block



Note: At the time of the study, there were 15 UMs for 18 units.

Block and Unit Levels. The BM is not supposed to take any decisions. His main function is the implementation of decisions taken by the RPM's office regarding the cultivation seasons, and the common policy decisions communicated from higher levels of management. He provides feedback on the progress and constraints to implementing the higher level decisions.

The BM has no authority to take decisions regarding management or administration functions. He is solely an implementor and monitor, with the assistance of his subordinate officers.

COMMUNICATIONS, COOPERATION, AND CONFLICT AMONG DIVISIONS AT PROJECT AND BLOCK LEVELS

Communication Patterns

Other than informal communication among the deputies at the project office, the major formal means of communication is the monthly staff meeting. BMs and deputies of the RPM attend these meetings to receive instructions and to discuss their field operational problems.

A similar communication pattern is also found at the block level. Regarding day-to-day matters, sectional heads of the block speak directly to the BM. For formal communication, weekly meetings are held in the block. All the field officials (FAs and UMs) and section heads attend these meetings. The BM uses these meetings to convey to the field officials the decisions of the RPM and the Colombo office to be implemented at the field level; field level problems are also discussed with UMs and FAs (land, agriculture, community development, and irrigation).

The communication link between the block and the RPM's office is the BM. He is supposed to represent the operational problems of the entire block at the monthly staff meeting.

Preliminary Observations on Communication Problems

1. There are few opportunities to discuss practical field problems at the project-level monthly meetings. Field-level officials (UMs and FAs) do have some understanding of practical field problems. They participate at the block meetings where they have limited opportunities to discuss these problems. Block meetings give priority to discussions of the decisions taken by the deputies of each section (Agriculture, O&M, Community Development, and Marketing) in the RPM's office. There is no effective method to record the unit-level farm problems and convey them to the BM. As BMs are busy with office work they do not have sufficient time to visit the field frequently. Therefore it is doubtful whether these problems are really conveyed to the top level project management by the BMs. If there were a system to record and prioritize unit level field problems and submit them to the relevant deputies of the RPM, or more direct communication betwen these deputies and the block and field level officials, many problems could be identified and solved more effectively.

2. Other than monthly staff meetings at the project level and weekly block staff meetings, there are no other formal opportunities for face-to-face communication among MEA staff at Walawe. There is little discussion of technical matters either among deputies of the RPM or among sectional heads in the block office. Such discussions could be effective for improving management performance. The deputies of the RPM and the section heads of the blcok do use circulars, written orders, memos, letters and informal telephone conversations to communicate.

3. There are no effective measures to collect data on farmer problems. Monthly farmer training classes are held at the unit level to discuss field problems. But those classes are conducted by the UM in the unit and farmers do not have the opportunity to discuss their problems with section heads. We have also observed that the problems discussed at the classes are often not reported to the relevant authorities. Hence the top level project authority does not have access to the problems as discussed at these classes.

Collaboration and Conflict among Divisions at the Project and Block Levels

1. Our findings suggest that the team work and cooperation of deputies of the RPM and section heads of the block could be improved. For example, the O&M Division seems reluctant to contribute to the programs organized by the Agriculture Division (water management week, farmer training, and officer training), and vice-versa. Division and section heads sometimes tend to emphasize the importance of their own section. This is a natural tendency, but we suggest that the performance of each could be enhanced by a higher level of mutual cooperation. As suggested by a recent exchange of articles in a national newspaper, the heads of the Agriculture and O&M Divisions have very different views on the key factors underlying the performance of the Walawe system (articles in The Island 20 June and 2 July 1988).

2. Other divisions contribute little to the agriculture implementation program. Officer and farmer training on agriculture and water management could be a joint venture of Agriculture, O&M, and Community Development sections, but in Walawe it has become the entire responsibility of the Agriculture Division. It seems that each division tries to fulfil its own mission, narrowly defined, and collaborative efforts are rare.

3. At the field level, collaboration between the Agriculture and O&M Divisions for water management is also rare. The block-level AO and IE work separately. The crop water requirement for each stage of the crop is not considered for releasing water. In fact, we observed that the same volume seems to be released throughout the season in DC 8 canal (Chandrikawewa).

FARMER ORGANIZATIONS

There were no effective farmer organizations in Walawe before 1985. The concept of farmer organizations was brought to Walawe by the ADB-funded rehabilitation program in 1985. MEA attempted to form farmer organizations in the 1986/87 season and established about 21 groups in the entire scheme (left and right banks). But these attempts were not successful. No activities could be organized. We believe the reason was that MEA did not have specific objectives to convince the farmers of the necessity of groups. The main objective of farmer groups was to turn over the O&M of FCs to the farmers after rehabilitation. Although by that time design activities were going on, no farmer involvement in the planning stage of the rehabilitation project was sought. MEA finally decided to stop the activities until construction started in the project.

In 1988, with the commencement of the implementation of rehabilitation, MEA decided to re-initiate the formation of water users' groups (WUGs). Rehabilitation implementation activities are being used by MEA as a vehicle to reach the farmers. Farmers are being told by MEA that they can have a major role in implementing the rehabilitation project.

MEA officials have apparently concluded that MEA is not influential enough to convince the farmers to accept the full responsibility for O&M of the FCs within the existing dilapidated system. The Walawe farmers expect to do water management with the involvement of MEA officials. It is unliklely that they would have accepted a WUG program whose main objective was to share water within the present defective system.

MEA is attempting to convince the farmers that WUGs will bring them visible benefits from the on-going rehabilitation program. At many of the meetings with the farmers, the MEA officers in charge of WUGs have tried to create pride in their work among farmers and assigned them larger responsibilities. They have requested the farmer representatives (FRs) to do informal supervision of the rehabilitation construction activities and inform MEA if any work goes wrong. This has helped to stimulate interest in the WUGs among the FRs.

The methods used by MEA to promote WUGs among farmers are as follows:

1. The MEA officials in charge of WUGs organize training sessions for the FRs and convey to them that the success of about Rs 570 million worth of rehabilitation will depend on farmer organizations. This helps create pride among farmers. At the training class each FR is given a field book and a pen. If the money value is considered this is immaterial, but the way the books are presented to the FRs results in creating a positive impression among the farmers towards the program. Farmers have been taken to the headworks in MEA vehicles and introduced to the headworks MEA officials, who explained the operation system of the reservoir to them. These steps are helping win the confidence of the farmers.

2. FRs are invited for ceremonial functions organized by the MEA and are treated equally as other visitors are treated. This helps to build social contacts amongst officials and the FRs.

The personality and approach of the officer in charge of the WUG program has a great influence in introducing the above mentioned measures to form WUGs. We observed that he was able to convince the farmers of the importance of farmer organizations. To assist him three UMs have been released full time. Two of them are recently transferred personnel from System H and the third is a senior UM in Walawe. As two UMs are new to the farmers, it is easier to convince the farmers; farmers believe that it is really a new program introduced by new officials under the rehabilitation program.

At present, the rehabilitation implementation activities have begun in Embilipitiya and on a portion of Chandrikawewa Block (Tract A) and therefore WUGs have been formed only in these two blocks. FRs have been nominated. There are 69 FC level groups in Tract A of Chandrikawewa and 166 groups in Embilipitiya.

Effectiveness of WUGs

MEA is trying to focus the present WUG activities on the rehabilitation implementation process. Two kinds of responsibilities are assigned to WUGs:

1. Farmers are being educated on the new design criteria. FRs are being trained on how O&M will be done after rehabilitation and their responsibilities under the new system. In addition to class room training, the UMs assigned to this work full time also meet the FRs informally and train them.

   We have observed that only MEA agricultural extension officials conduct this training. At the beginning a recently recruited engineer with little experience participated, but only for a few sessions. If experienced engineers in the existing O&M system participate at FR training sessions, it would be more effective. At these classes farmers ask a lot of questions about the new changes in the system and express their own experiences in on-farm water management. Those contributions can be utilized for future O&M of the system.

   Though it is too late to consult the farmers on the changes being introduced through the rehabilitation program, the WUG program will at least help them to understand the changes during its implementation phase.

2. FRs bring numerous complaints to the MEA office regarding the poor quality of the contractors' work. These complaints have resulted in some changes in CECB's supervision. Walawe MEA management expressed their displeasure on the construction to CECB through the MEA Colombo office. This action resulted in changing the supervisors' behavior. CECB increased their local supervisors and promised the farmers to test the construction work once again.

We further observed that WUGs in Embilipitiya and Chandrikawewa were able to organize a few meetings with the CECB and MEA to get some of their doubts clarified on the new rehabilitation changes. This issue is discussed further in the section on the rehabilitation process.

The Expectation of Officials and Farmers in Regard to WUGs

Officials have understood that strong farmer participation is necessary to operate the system after rehabilitation. They have gained much experience on this in the pilot field canal of the rehabilitation project at Moraketiya (Merrey and Jinapala 1988). MEA will need to improve the level of farmers' participation in O&M after rehabilitation. Otherwise there will be serious distribution problems under the new system, and the sustainability of the system would be in doubt.

There are other future expectations of officials with regard to WUGs. But at present those objectives are not explained to the farmers by the MEA. MEA is of the view that the first step is to organize them by getting them involved in the rehabilitation implementation work.

At present, MEA officials try to convince the farmers that informal supervision of construction work is the main responsibility of WUGs. During the yala 1988 season WUGs did not focus on any other activities than observing the physical construction and bringing shortcomings to MEA's notice. They expect to get good work done by using this authority granted by MEA. FRs do not know to what extent their complaints will be considered by the rehabilitation program. Therefore they complain about each and every thing to MEA and the CECB supervising engineers. Some CECB engineers have understandably expressed displeasure with this arrangement.

Finally, it seems clear that MEA has not developed a long term plan for WUGs. What will be their authority and responsibility? This topic ought to be addressed in the near future.

PROBLEMS AT THE FARM LEVEL

During the 1986/87 maha we had carried out a 100 percent household survey of the farmers in DC 8 of Chandrikawewa Block. To identify any changes between that time and yala 1988, we selected ten households (ten percent of the total) and re-administered the same questionnaire used in the 1986/87 maha season. We found no significant changes had occurred in the household structure and activities (education, other occupations).

Because of the prevailing political situation, many farmers now avoid political activities. In 1986/87 we found almost every farmer was involved in political activities. Farmers are now reluctant to state that they are involved in politics. All the farmers are members of a funeral association. As they are not relatives like in Sri Lankan "purana villages", funeral associations help them out in times of distress.

Land Tenure

In yala 1988 we observed that the land tenure pattern is changing. The changes can be summarized as follows:

1. Original land owners are either dead or old. Therefore their elder sons have become operators. Eight out of our sample of ten are sons of original operators. These operators are also over 50 years old. They have grown children, some of whom are also married. But many of them have not been nominated as successors, as is required under the law.

   We found that the original allottees find it difficult to nominate the present operator as a successor because they have other children. Nomination is a serious problem. The alternative used by the original allottee is to nominate his spouse as the successor. After the death of the original allottee and the nominated successor (his spouse), MEA is faced with a serious problem. All the children claim the allotment. Unless the children come to an agreement to nominate one of them, it remains an unsettled problem.

2. We found that the original allottees are often compelled to lease out a portion of land for their survival, because they realize that their children have commitments to their own families and therefore nothing can be expected from them. In our sample, six original allottees have leased out at least one acre (0.4 ha) to non-relatives (See Table 8.1 for the land ownership pattern).

Yield

We collected farmers' reported yields for the previous season. In the 1987/88 maha we found variations, locality wise. Reported tail-end yields are better than those at the head. The average farmer-reported yield is about 65 bushels per acre (3.37 t/ha) in the head end, and about 105 bushels per acre (5.45 t/ha) in the tail end.

FINDINGS OF SAMPLE HOUSEHOLD SURVEYS IN EXTENSIVE SAMPLE

Land Tenurial Pattern based on the Household Structure

The extensive sample consists of 11 households each in DC 18, near the tail of the Chandrikawewa Branch Canal, and in DC 3, near the head. Since Chandrikawewa is an older settlement scheme incorporated later in the Walawe System, the original settler families have expanded to the third generation. As is true for the DC 8 settlers, the original allottees find it difficult to share the 1.2 ha of irrigated land among the children.

In the DC 18 sample, the average number of members in a household is eight. This is a serious problem for the original allottees. They cannot nominate one son or daughter for their allotments as a successor, as it creates a lot of family problems.

Table 8.1. Land Ownership in DC 8, Chandrikawewa

Allot. No.	Is he an Ori.allottee	If not who operates	Who is the Successor	No.of Members in the family
1065	No	3rd Son	Spouse of Ori. Allottee	05
1051	No	5th child (son)	Pres. Operator	10
210	No	1st Son	Pres. Operator	06
1121	No	7th child (son)	Spouse of the Ori. Allottee	10
1077	No	6th child (son)	Spouse of the Ori. Allottee	14
1086	No	1st & 2nd sons	Spouse of the Ori. Allottee	10
1097	No	1st Son	Spouse of the Ori. Allottee	07
Encroach-ment	Yes	Allottee	Non-relevant	07
213	Yes	Allottee	Spouse	04

DC 3 households face the same difficulty in nominating successors for their allotments. But there is also a different category in DC 3. Four operators cultivate the lands of private land owners (nindagam). They have become permanent operators but do not have legal rights to the land.

The household structure and the land ownership of the present operators in our extensive samples in DC 3 and DC 18 is shown in Table 8.2.

Farmer-Officer Contact

We have elsewhere discussed the reasons why officials seem to do little to try to improve water management at the FC level. Our findings from household surveys and interviews with field level staff on this subject can be summarized as follows:

1. The BM is an office worker more than a field worker. Therefore he has very limited opportunities to deal directly with the farmers' problems. But some farmers do meet the BM directly for their land matters in the block office.

2. Section heads in the block office also have very limited contacts with farmers. Most of them implement their field level functions through the UMs and FAs. One objective of farmer training classes at unit level is to give the opportunity for section heads to participate and make their services available for the farmers, but this rarely happens.

The only officials who have direct contact with farmers are UMs and FAs. UMs and FAs have to attend to some essential business of farmers. As discussed elsewhere, given a defective canal system they have little to do regarding water management. But these unit level officers are compelled to meet farmers for:

1. farmer training classes;

2. crop insurance and farmer pension scheme (services of the Agricultural Insurance Board);

3. credit facilities (UMs have to certify the loan application for bank loans); and

4. to collect data required by the sectional heads of the block.

Farmer-officer contact at the block level is documented in Table 8.3.

Table 8.2. Landholding Pattern in Extensive Sample Area (DC 3 and DC 18)

DC 3				DC 18			
No.mentioned in household	No.of houses	%	Ownership for Land of present operator	No.of members in household	No.of houses	%	Ownership for Land of Present Operator
04	02	18.2	04 Allotments belong to the operators' fathers', 01 allotment to husband; and 06 others belong to the present operators.	04	02	18.2	Only one opera -tor who is the original allo- ttee, others are sons of the original settlers.
05	01	9.1		05	01	9.1	
06	02	18.2		06	01	9.1	
09	02	18.2		07	01	9.1	
10	03	27.3		08	01	9.1	
12	01	9.1		09	01	9.1	
				11	01	9.1	
				12	01	9.1	
				13	01	9.1	
				14	01	9.1	
105	11	100.0		93	11	100.0	

Table 8.3 Contacts of Farmers and Officials in DC 3 and DC 18

DC 3 & 18	No.of farmers said-have contact	% of the Total Sample (22)	No.of farmers said-Have no useful contact	% of total Sample	No.of farmers said have useful contact	% of Total Sample
BM	4	18	2	9	2	9
IE	8	36	5	23	3	14
LO	5	23	3	14	2	9
Marketing Asst.	3	14	1	5	2	9
AO	9	41	7	32	2	9
CDO	8	36	5	23	3	14
UM	19	86	11	50	8	36
BA	3	14	2	9	1	5
TO	8	36	6	27	2	9
KA	12	55	3	14	9	41
Irrigator	20	90	11	50	9	41

Note: According to the above table a negligible percentage of farmers have contact with sectional heads (AO, LO, CDO, IE). Except the LO, farmers do not have direck contact with the others. But on some occasions when the BM is not available in the Block office, farmers do contact the sectional heads to get confirmation on how they could contact BM. Land problems are common in Chandrikawewa and farmers bring frequent complaints to the Block office. LO has to attend to these problems.

RESEARCH PLANS FOR MAHA 1988/89

During this season IIMI plans to continue the research with two social science research assististants. One will focus on the study of the rehabilitation processes, with additional attention to MEA management processes as well, at the project level. The other will focus on the institutional aspects at the level of the farmers and the unit and block in Chandrikawewa. IIMI staff will systematically document the interactions and communications among divisions at the project and block levels, and between the field and block level versus the project level, as these relate to irrigation management. IIMI will also pay special attention to the process of development of WUGs, both as they relate to implementing the rehabilitation, and for future operations.

As in Kirindi Oya, during this season IIMI will systematically interview sample farmers, FRs in Chandrikawewa, and field and block level staff. For the sample farmers and FRs, the questions concentrate, among other things, on water problems, the effectiveness of the farmers' organizations, views regarding future levels of responsibilities for farmers, and potential interest in growing non-paddy crops. For the field-level officials, the questions concentrate on their own views and perceptions about their jobs and their relationships with farmers, their views on the effectiveness and sustainability of the present farmers' organizations, and their views on future levels of responsibility for farmers.

These data should provide a basis for better understanding the present problems and opportunities for change, and possible innovations that could be adopted and tested in future.

IX. MANAGEMENT OF THE REHABILITATION PROCESS IN WALAWE

PROJECT PLANNING PHASE

Six years after the commencement of the Uda Walawe irrigation scheme, ADB provided US$33.6 million for improvement and extension of irrigation facilities and social and agricultural development. But the expected objectives were not fully achieved. Because of settlement and operational problems, with the farmers preferring to grow rice irrespective of soil types, excessive water consumption, and inequitable distribution, the irrigated area was limited to about 8,000 ha on the right bank and 3,000 ha on the left bank (MMP [1987], Design Criteria).

The present ADB-funded Walawe Irrigation Improvement Project was initiated in 1984 by the Mahaweli Economic Agency (MEA) as executing agency. Design preparation of the project was assigned to Sri Lankan engineering consultants, Central Engineering Consultants Bureau (CECB), part of the Mahaweli Authority of Sri Lanka. Overall supervision of designs, preparation of the O&M manual, and studies of possibilities of crop diversification was handed over to foreign consultants (MMP).

Design Preparation

In 1986, CECB started design preparation of the entire project. It was scheduled to complete the design phase within a 15 month period but for various reasons this took almost two years. The reasons included political disturbances, inadequate staff of CECB for design preparation, non-availability of required data such as BOPs, and difficulties in tracing out the correct boundaries of FCs and allotments in neglected areas in the tail end of the system. Nevertheless, the designs were reported as substantially completed by June, 1988.

Role of MEA in Design Preparation

Except for a few top level MEA officials, middle level and field level officials have had rare opportunities for involvement in design activities. Only MEA Colombo officials and a few top Walawe management officials have been involved by participating in monthly rehabilitation progress meetings and other occasional meetings held either in Colombo or at Embilipitiya. There has been no mechanism for involving others.

The CECB design engineers attempted to prepare designs with the guidance of blocking out plans (BOPs) obtained from MEA. Block level and field level MEA officials were not involved in the design preparation activities. One former BM claimed that the CECB design team did not seek the involvement of his staff in design preparation. An Engineering Assistant who earlier worked for MEA in Chandrikawewa Block was attached to CECB for rehabilitation work. Since he knew the area perhaps the design team did not see any necessity of seeking field level officials' assistance.

The former BM (Chandrikawewa) expressed his unhappiness about this arrangement. He wanted to explain some serious problems he felt should be addressed by the rehabilitation program to the design team, but there were no opportunities to provide this information to the design team.

The situation in the tail-end blocks was different from the two head-end blocks (Chandrikawewa and Embilipitiya). Most of the land in the tail-end has been neglected for a long time, often not cultivated for some years. Therefore tracing of boundaries was a problem and the design engineers were compelled to seek experienced field level officials' assistance to complete their work.

We interviewed all the field assistants (FAs) and unit managers (UMs) in Chandrikawewa Block to ascertain their involvement in the design preparation phase. The UMs and FAs claimed they too had had no opportunity to even learn about the rehabilitation project during the design phase. The BM had mentioned it, but even he was not able to explain it to them in detail. Out of the 15 UMs in the Chandrikawewa Block, only three had visited the field along with the rehabilitation personnel. One went with an MMP consultant, the other two with the CECB design team.

The UMs were thus not able to answer farmers' questions regarding the rehabilitation program. A majority of the UMs we interviewed were only aware that the canals and roads will be rehabilitated with ADB assistance. As they did not have a clear understanding, they were reluctant to make promises to the farmers regarding reliability and equal supply after rehabilitation.

Many UMs wanted to discuss irrigation problems with the design team but did not have an opportunity. For example, one UM wanted to solve the irrigation problems of 24 hectare (ha) of land outside the BOP in his unit. But neither he nor the BM could take up this problem with the CECB. After the design phase was over, they forwarded it to CECB, but CECB did not respond.

The design team seemed not to want to consult the farmers especially in the head-end blocks because there are no neglected lands. Therefore the design team could manage with the BOPs. The situation in the tail-end was quite different; many allotments have been neglected and the tracing of boundaries was a problem. Design engineers were compelled to consult both field level MEA officials and farmers.

We also interviewed 27 farmers in DC 8 (Chandrikawewa - our research sample). Twenty three out of 27 said that no design team member spoke to them. Four farmers had spoken to the design engineers. But according to the farmers' point of view, the engineers were not interested in listening to their opinions. The design team had indicated to them that the canal system and access facilities will be improved. Since the design team visited the field alone, farmers did not have opportunities to contact them through MEA field officials.

Major Changes in the Physical Canal System

To address the physical problems, the rehabilitation program is intended to improve the RB main canal and other branch DCs and FCs. Large regulators are to be constructed and the capacity of Mamandala Branch Canal is also to be increased. Direct outlets from the DCs will be eliminated and replaced by parallel FCs. This is a major change in the physical structure and will have an impact on water distribution. The other FC gates, turnouts and drop structures are proposed to be rebuilt as necessary and the damaged structures are to be repaired. Measuring devices for the main, branch, DCs and FCs have been proposed. The capacity of each FC will be one cusec (28.3 liters per second) and the maximum command area will be less than 15 ha.

Proposed Operation of the System

Rotational water issues for field channel water management are proposed. The special feature of the proposed operational procedure is to stagger the FCs for land preparation. The entire responsibility for FC water management is to be turned over to the water user groups (WUGs). It is expected that farmer representatives (FRs) will be trained for this.

PROJECT IMPLEMENTATION PHASE

Key Actors in the Implementation Phase

1. Two contractors have so far been awarded contracts for the improvement of the physical irrigation system of some areas in Walawe. Construction of RB main canal in Embilipitiya and part of Chandrikawewa Block (DC 1 - DC 10 - Tract A) have been assigned to a Chinese construction firm; another contract may be awarded to a Sri Lankan company (Ceylon Development Engineers).

2. Road construction of the entire RB area has been awarded to two Sri Lankan contractors (SDECC and Carsons).

The overall responsibility for supervision of the construction lies with CECB. The executing agency of the entire project is the MEA though it is not directly involved in any construction or supervision work.

Role of the Supervisors

CECB is responsible to assure the agency on the standard of work of the contractor. CECB has posted field level supervising engineers and local supervisors to oversee the work in the field, and recommendation of payments for the contractor according to work done is also the responsibility of CECB.

Role of the Contractors

The main function of the contractor is to do the construction according to the designs and other guidance of the CECB. The Chinese contractor has started work and has brought professional and technical staff from China. By May 1988 it had brought 82 Chinese employees - engineers, managers, and other technical officers. It hires local supervisors from the area (at present some university undergraduates have been hired). Labor for the work is obtained from the area itself.

Role of the Executing Agency

Handing over the work sites to the contractors is the main role of MEA. MEA has released one agricultural officer (AO) full time for this purpose. Acquisition of encroached reservations is another MEA responsibility.

Farmers' Role during the Implementation Phase

As was true for the design phase, there is little opportunity for farmers to get involved in implementation activities of the rehabilitation project. Contractors are supposed to obtain their own labor for the work. We did observe that the unskilled labor is obtained from the area itself.

MEA's water user group (WUG) program has created one kind of opportunity for farmers' "participation" in the implementation of the rehabilitation program. MEA has requested the farmer representatives (FRs) to do informal supervision of the contractors' work, and make their views known to MEA officials. Therefore FRs made frequent complaints to MEA. CECB staff have indicated they are not happy about this arrangement.

Communication, Interaction, and Conflict among Key Actors

During the design preparation phase of the project, we observed that there was no close communication or effective interaction with MEA middle level and field level officials. The BMs did not know when design work was going on in their blocks. They were unhappy about this arrangement and the former BM (Chandrikawewa) had requested that the CECB design team be instructed to contact block officials.

Now, during the implementation phase, CECB must communicate with MEA to take over the work sites. Many MEA field level officials feel that the arrangement for doing this is not correct. During the design preparation phase they did not have the opportunity to learn of the new changes being introduced. But when implementation started they were requested to clear the sites to be handed over to the contractor. Within such a short period, obtaining withdrawal of the residences of encroachers, for example, was not possible. Conflicts over such issues have affected the relationships of farmers and field level MEA officials.

As requested by MEA, FRs want to do informal supervision of the construction work. But this arrangement has led to some unhappiness of the CECB. Walawe authorities informed the Colombo MEA office of the poor quality of some contractors' work based on the information provided by some middle level field officers and farmers. In response to this action CECB was compelled to increase its local supervisors to do close supervision and also several meetings were organized by FRs with MEA to clarify issues.

IIMI researchers participated in two such meetings (one at DC 4 - Chandrikawewa and the other one at DC 7 - Moraketiya). At those meetings FRs raised several problems, including the following:

1) lack of understanding of structures which are to be rebuilt or repaired;

2) the contractor, according to farmers, does not properly repair the structures and compaction of canal bunds is not satisfactory;

3) no understanding as to whom farmers should complain about problems, or who is really responsible for the work; and

4) farmers' preference for concrete lined canals.

As CECB officials also were present at these meetings, MEA officials requested them to respond to the farmers. The CECB official present expressed the view that this kind of meeting should have been organized earlier. But they could not do so because they were given only a 15 month period for design preparation. He explained to the farmers of DC 7 (Moraketiya) that if the quality of work is poor, CECB will not recommend payments for the contractor and will request them to re-do the work. He asked farmers to bring problems to the attention of his supervising engineers.

He further stated that concrete lining is not possible due to limited funds. In fact, he said some work already estimated may have to be dropped. He gave some examples, such as earthwork to the end of FC bunds will not be done. Earthwork for the tail-end of the FC bund is not recommended by ADB but he promised the farmers some arrangements will be made to do at least the earthwork, if not all the concrete structures. He expressed satisfaction about the meeting and requested the MEA officer in charge of the WUG program to organize such meetings in other areas also.

The Chinese contractor has a language communication problem. Both farmers and other actors in the project find it difficult to communicate with the Chinese. Except for one Chinese engineer, the others cannot speak English and must use interpreters. If the Chinese field officers could explain the changes to the farmers (some of the farmers' children can understand English), it might help to reduce frequent farmer complaints to

MEA. The other possible alternative is to educate the MEA field level officials in the rehabilitation design criteria and convince the farmers through these officials.

At the initial stage of the construction, the Chinese contractor started work in several scattered places of Chandrikawewa and the Embilipitiya Blocks. They did not complete construction in a single DC. They completed only a part of the DCs in some distributaries. The MEA FAs worried that it would be difficult to distribute water with two separate physical conditions on the same DC. Recently, at the request of MEA, CECB has asked the contractor to fully complete the work in DCs where they start work. The contractor has stopped his scattered work and moved to Embilipitiya Block.

FARMER KNOWLEDGE OF THE REHABILITATION PROJECT

During the design phase, the designs were not explained to the farmers and also the design team did not meet them or expect their contribution. Therefore farmers did not have any way to learn about the rehabilitation and its changes. Since the FAs and UMs did not know much about design changes they also could not explain the plans to farmers. What farmers understood from their UMs at farmer training and informal meetings in the field was that the canal system would be rehabilitated with ADB assistance. During the design phase, farmers did not know whether the ADB assistance is a loan or a grant. Farmers also had no understanding about the parties involved in the project.

We noted above that of 27 farmers interviewed in DC 8 (Chandrikawewa) to find out about their knowledge of the rehabilitation project during the design phase, only four farmers (15 percent) said that they had spoken to the design team. The balance 23 had gotten the message from either the UM, FA or fellow farmers. Not one farmer knew that the design was being done by CECB. (Farmers tended to identify the design team as ADB officials). We inquired from the farmers their source of knowledge about the rehabilitation project. Twenty-one (78 percent) replied that it was from the UM and one unknown MEA officer (this unknown MEA officer was a UM released full time for WUG work). Six farmers did not have any understanding because they had leased out their allotments and are not active farmers.

By the time we conducted this survey, MEA had begun forming farmer groups and therefore some major changes were understood by the farmers, such as removing of direct outlets, installation of parallel FCs, recovery of encroachments on the canal right of way, building and repairing of structures and equal distribution of water as a future principle.

PRELIMINARY RECOMMENDATIONS FOR THE PRESENT WALAWE REHABILITATION

Since the project planning and design phases are over and the implementation phase has just started, it is too late to make recommendations for the planning and design stages (see next section). A few possible measures which can be considered to improve the effectiveness of the present project are:

1) The contractor can be requested to complete the physical construction of one DC and MEA can test the proposed operational procedure of the rehabilitated DC in 1988/89 maha. The experience of the DC should be carefully recorded and utilized for designing the operational procedures of the system. If changes are required, they can be applied to the rest of the system.

2) The WUG program should be used to educate the farmers on major changes in the system and proposed O&M procedures. In this process MEA should take further steps to strengthen the WUG program by providing additional staff and time.

3) The key implementing actors of the rehabilitation program (contractors, CECB and MEA) should organize frequent dialogues on the current problems encountered to seek solutions.

4) MEA should respond positively to the complaints brought by the farmers about ongoing construction work and attempt to discuss all legitimate problems with CECB. If both CECB and MEA conclude that the farmers' problems are not reasonable they should convince them; otherwise they should solve them.

5) The involvement of field level MEA officials would strengthen the rehabilitation project. At present they feel they have been neglected. They should be trained and motivated to create a positive impression about the program. Their training will help them to explain the changes in the system to the farmers and build up close contacts with the farmers (at present farmers believe that MEA field level officials do not know anything about the rehabilitation program).

PRELIMINARY LESSONS FROM THE WALAWE REHABILITATION PROJECT: PRESENT AND FUTURE

1) The experience and knowledge of the water users and the irrigators should be more effectively utilized for the design preparation, proposed physical changes, and new operational procedures.

2) All the key actors of the rehabilitation project including contractors, consultants, water users, and irrigators should have an understanding of the methodology of the rehabilitation project.

3) Proposed new designs and O&M procedures should be discussed with water users and the irrigation agency operators before implementation. If important changes in the proposals are required based on these discussions, they should be revised prior to implementation.

4) The executing agency should plan to allocate sufficient time and capable staff to educate the water users and its field level staff on the proposed improvements. This should start from the project planning stage itself.

5) An effective communication system should be developed among water users, field level staff, and the project planners to exchange their views on the proposed program.

6) Key assumptions of the program should be tested in the field, monitored carefully, and recorded to evaluate their validity. This pilot project should be implemented in at least one distributary canal. The experiences of the pilot project should be carefully used for adjusting on-going project activities.

7) The responsibility of each actor of the project should be made known to the other actors.

8) To achieve the objectives of the project, water users and field level staff should be carefully trained. If it is assumed that water users will do FC water management, they should be organized and motivated to do so. To play their official roles according to project O&M procedures, all the relevant field officials should be trained.

9) Water users and field level staff should not be allowed to think that they have been neglected. These parties should be given equal opportunities to contribute whatever is possible, according to their capacities.

10) Project implementation schedules should be carefully prepared and planners should provide sufficient times for each phase of the program. Otherwise the executing agency may face problems with the water users.

11) The executing agency should try to eliminate suspicions of the water users regarding the proposed program, and continuous efforts should be made to insure the sustainability of the program.

PRELIMINARY CONCLUSIONS

The major problem we have observed from the beginning of our research in Walawe in October 1986 is that the rehabilitation program is being implemented with minimal involvement of both the executing agency and the farmers.

Physical construction alone will not lead to sustainable improvements in an irrigation project. Irrigation projects are not like other construction programs; they are socio-technical systems of which water users' and irrigation agency staff behavior are an integral component. If the physical changes are not accepted by these two parties the sustainability of the program will be jeopardized.

The first ADB-funded project (1969-1971) could not fully achieve its objectives. RBMC head-end water users are still over-consuming and areas recommended for other field crops are still sown with paddy in both seasons. (MMP [1987], Design Criteria, Walawe Irrigation Improvement Project, p. 1). Various consultants who have studied the Walawe irrigation project recommended that two fundamental problems should be addressed. They are physical re-construction and institutional strengthening (see: PRC/ECI [1982]; Wolf [1983]).

Since the Walawe irrigation problems are not only physical, to achieve sustainability of the physical improvements, careful attention should be paid to organizational strengthening. In this process the field level staff and the water users should have an understanding of the new changes and their existing behavior should be changed through training and organizing to achieve the objectives of the project.

RESEARCH PLANS FOR MAHA 1988/89

For the rehabilitation processes component, IIMI staff will continue to observe the communications and interactions among MEA, CECB, consultants, contractors, and farmers, through participant observation, informal interviews, analysis of designs and other documents, etc. IIMI will also systematically interview middle and field level officials and a sample of farmers including farmer representatives for their assessment of the progress of the rehabilitation activities, and views on its adequacy, appropriateness (degree to which it addresses problems of concern to users and operators), and likely sustainability. IIMI will also observe the training of operators and farmers for operating under the new rules. Finally, IIMI will continue to pay special attention to the efforts to organize WUGs, since these are seem as a key ingredient in the future of Walawe (see research plans for institutional component as well).

X. SUMMARY REPORT ON WALAWE RESEARCH -- YALA 1988

The major findings of the research in Walawe project in Yala 1988 are summarized in this chapter. It includes preliminary analysis and conclusions from research on irrigation water delivery system, irrigation institutions and management of the rehabilitation process. The data on agricultural production and economics is yet to be processed and analyzed. Yala 1988 was the first season of interdisciplinary study of the system. The emphasis was on understanding the system; the findings are tentative and may be modified by further research.

IRRIGATION WATER DELIVERY SYSTEM

Block level operations: Chandrikawewa

The decision for commencement of the yala 1988 season was taken at the cultivation meeting held at block level. There was abundant water in storage in the reservoir. It was decided to commence water issues from the reservoir on 20 April, though the majority of farmers wanted an earlier date around 14 April. MEA agreed to issue some water for domestic use earlier than 20 April. Accordingly Chandrikawewa main sluice was opened on 12 April.

No rotation was operated during the first two weeks of land preparation. All the BCs and DCs were kept open. After two weeks the rotations started for the entire system. The last water issue date was decided to be 5 August, but MEA had to continue water issues until 30 August. The delays in land preparation and the use of three and a half month varieties by all the farmers were the reasons for extension of water issues beyond 5 August.

The operation of the BCs and DCs on the main canals is the responsibility of the O&M Division of the project office (RPM's office). The Chief Irrigation Engineer (CIE) is responsible for overall operation of the system. The water requirement for the season is calculated by the O&M Division based on the field data provided by each BM.

In Chandrikawewa Block, once the O&M Division releases water from the Chandrikawewa tank sluice, water issues for each DC within the block are made by a separate block technical officer. Water distribution within DCs is the responsibility of a team in each unit that includes the UM, FA and irrigator. Some units in Chandrikawewa are comprised of one or two DCs while others include only part of a DC, depending on the size of the command area.

Water issues for the 18 DCs along Chandrikawewa Branch Canal are done according to a scheduled rotation. In most DCs in Chandrikawewa Block, no internal rotations were in operation, and irrigators and FAs have little involvement in distribution. Once DCs are opened, internal distribution within the DC is in the hands of the farmers.

The physical condition of the canal system is the main hindrance to efficient water distribution among and within the DCs. Even within head DCs, head- and tail-end farmers do not share water equally. MEA field level officials understand the distribution problems and to compensate, more water is made available particularly to the long DCs.

Since 1985, the year rehabilitation activities began in Walawe, funds allocated for pre-season maintenance have been reduced. Therefore, a lot of urgent work like strengthening of weak and damaged places of DC bunds, and desilting and jungle clearing of BCs and DCs has been neglected.

Water management on DC 8

DC 8 is one of the canals where the system is in very poor shape. There are no structures to maintain and regulate the flow. The canal is seriously eroded. No FC turnout gates exist except in one FC, RB-1. In addition to official turnouts there are two or more unofficial openings in five FCs. In many places both DC and FC bunds are weak and narrow due to erosion and poor maintenance. About 48 farmers have been given direct farm outlets and some of them do not have pipes for outlets, so they irrigate by cutting or tunnelling the DC bund. Farmers use wooden logs and brushwood weirs across the DC to raise the water level. Eight such farmer-made structures were identified, each serving 5-6 farmers.

During the land preparation period, DC 8 operated continuously for two weeks. Afterwards, it was closed every Thursday and Friday. There was no rotation within DC 8 except in one FC, RB 1, which was closed on Mondays by the irrigator of DC 8, to provide extra water to the tail of the DC.

There was no scarcity of water in yala 1988. The DC received adequate supply at the head of the DC. The internal distribution among FCs was difficult and has led to inequities. There were no farmer organizations to implement equal water sharing practices. In addition to the supply from the DC, some allotments had access to drainage and seepage water from higher-level allotments.

Irrigation Water Delivery Performance

The water measurements and preliminary analysis provide a tentative picture of the quality of operation and water use. They will be useful as baseline information for comparing the water delivery performance before and after rehabilitation of the system.

The water delivery schedules described the water issues for the 18 DC canals under Chandrikawewa Branch Canal on rotation. However, they indicated only the days of opening and closing of DC outlets from branch canal, with no indications on the quantities to be delivered or the size of the gate opening. No irrigation schedules were prepared for internal distribution within DCs. It is not possible to compare the actual deliveries at the heads of DC or FC with target deliveries, as no targets were computed or specified by MEA. It is also not possible to compare them with actual requirements, as reliable data on seepage and percolation could not yet be collected. Even then, conveyance and distribution efficiencies of a system in such a poor shape are difficult to ascertain or assume.

It was very gratifying to note that the operation of the Chandrikawewa Branch Canal was done in strict compliance to the schedule; the supply to DCs from the branch canal were both predictable and reliable; and there is no significant inequity in water use among distributaries located at the head, middle and tail of the branch canal. However, the inequity in water distribution within DC 8, especially between head and tail, was found to be considerable. It is this inequity which is expected to be reduced by the rehabilitation, apart from increasing the water use efficiency in general.

IRRIGATION INSTITUTIONS

Organization at Project Level

The Resident Project Manager (RPM) is the head of the project and has overall responsibility for all project activities. The project has seven administrative blocks with Block Managers (BMs) in charge. Each block is divided into units. A Unit Manager (UM) is in charge of a unit comprising 80-120 settler families. Each UM is responsible for implementing all the activities at the unit level and handles all matters concerning agriculture, irrigation, land, community development, and marketing. He is the manager in contact with farmers most of the time.

The RPM is assisted by five Deputy RPMs (DRPMs) in land administration, agriculture, irrigation (O&M), marketing and community development. They provide the technical and specialist support at the project level. Each DRPM is supported by a subordinate group of officers at the project and block levels. The block level technical staff called section heads provide technical and specialist support to the BM at the block level.

The organization structure has clear lines of authority and roles are well-defined. Coordinating mechanisms are well defined at the project and block levels.

Decision-making for each cultivation season is done by the project office. MEA head office is not involved in this. MEA head office makes policy decisions common to all Mahaweli systems and conveys them to the RPM for implementation. The BM's main functions are to implement decisions taken by the RPM's office regarding the cultivation season, and provide feedback on the process and constraints to implementation.

There are formal means of communication: monthly staff meetings in RPM's office attended by BMs and DRPMs and weekly meetings held at the block level by BM and attended by all the field officials and section heads. Monthly unit level training classes for farmers are held to discuss field problems.

It was observed that informal communications are not frequent, technical matters are not discussed much at the block level meetings and there is not much collaboration at the field level in water management between the agriculture and irrigation (O&M) sections.

Organization of Water User Groups

There were no effective farmer organizations in Walawe before 1985. The concept of farmer organizations was brought to Walawe by the rehabilitation program in 1985. Some attempts made by MEA to organize farmer groups before (in 1985) were not successful. In 1988, with the commencement of rehabilitation, MEA decided to re-initiate the formation of water user groups (WUGs). Rehabilitation implementation activities are being used by MEA as a vehicle to reach farmers. Farmers are being educated on the new design criteria and new features of the irrigation system after rehabilitation. Farmer representatives (FRs) are being trained on how O&M will be done after rehabilitation and on their responsibilities under the rehabilitated new system. It was observed that WUGs in Embilipitiya and Chandrikawewa were able to organize a few meetings with the CECB and MEA to get some of their doubts clarified on the new rehabilitation changes. In order to get the involvement of farmers in the rehabilitation work, MEA officials tried to convince the farmers that informal supervision of construction work is the main responsibility of WUGs. This has, not unexpectedly, led to a number of complaints on the alleged shortcomings on the construction work from FRs to MEA and to the CECB supervising engineers. This has potential to create conflict situations which require careful and sensitive handling by the management. However WUGs were able to stimulate discussions with CECB regarding their problems, rehabilitation proposals and construction activities.

Farmer Level Problems

Land tenure problems have become prominent. The difficulties of nominating one son or daughter as legal successor to the right of allotment have led to conflicts among the second or third generation children for ownership of land. This creates problems for the agency in settling ownership issues. It was also observed that some of the original allottees lease out a portion of land to non-relatives.

Farmer-Officer Contact

The Block Manager and section heads in the block office have limited opportunities to deal directly with the farmers. The only officials who have direct contact with farmers are Unit Mangers and Field Assistants.

MANAGEMENT OF THE REHABILITATION PROCESS

Major changes in the physical canal system were planned in the rehabilitation program. They include large regulators on the main canal, FC gates, turnouts and drop structures on DCs; and removing of direct outlets from DCs and installation of parallel FCs. On O&M, the entire responsibility for FC water management is to be turned over to the WUGs and rotational water issues for field channel water management are proposed. FRs are to be trained for this. During the construction phase, encroachments on the canal right of way need to be recovered before turning over the site to contractors.

In order to achieve the objective of rehabilitation to improve the operation and performance of the system and to sustain the improved performance, the people who operate and manage the system, whether they are from the agency operating the system or the farmers, need to understand their roles and participate cooperatively. A rehabilitation project could use the opportunities provided in planning, design and implementation of the rehabilitation to foster the feeling of involvement and to invoke cooperative behavior from the agency personnel managing the system and the farmers.

Normal project planning, design and construction schedules generally do not provide adequate time for using these processes for institution building and participation by beneficiaries which are somewhat time consuming. The same thing has been happening in this project also.

The CECB and the consultants are required to work to tight schedules and prepare plans, designs, estimates and tender documents. To obtain BOPs and get the surveys done on time was itself difficult. Consultation with agency officials and farmers would have needed much more time. They could not do it; they did not have time, as they themselves said at a meeting later with farmers organized by MEA. The block level and unit level officials also felt neglected. Farmers did not know the details of the rehabilitation plans. Even at this stage, involvement of field and block level staff, through training, regular meetings, and joint meetings with farmers, could be very useful.

By the time the survey under this study was conducted, MEA had begun forming farmer groups and therefore some major changes were understood by farmers like installation of parallel FCs, removing of direct outlets and recovery of encroachments on the canal right of way.

It would be very desirable if one of the DCs could be rehabilitated completely and its operation tested in maha 1988/89. The experience can be used to greatly benefit the further implementation of rehabilitation in the same project. Involvement of MEA officials who would have to operate the system later on, organization of WUGs, and training imparted to both would strengthen the rehabilitation project. It is worth spending time, effort and resources in this direction. Improvement of physical structures without corresponding strengthening of the operating agency and WUGs is not likely to lead to sustainable improvements in system performance.

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