INTERIM REPORT ON THE

TECHNICAL ASSISTANCE STUDY (TA 846 SRI)

IRRIGATION MANAGEMENT AND CROP DIVERSIFICATION

(Sri Lanka)

APRIL 1989

INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE
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INTERIM REPORT ON THE TECHNICAL ASSISTANCE STUDY (TA 846 SRI) APRIL 1989

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 (GOSL), 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 southern 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.

Progress of the Study

The study commenced on 1 February 1988 and is of 26 months duration. The first season of field research in Kirindi Oya project was conducted from March to June 1988 and corresponded to the delayed _maha_ season of 1987/88. The study could cover part of the season. There was no irrigation in the research area during _yala_ season. In the Walawe project, the first season of field research commenced in April 1988 and continued throughout the yala season which ended in September 1988. The maha season of 1988-89 started in both projects in October 1988 and continued upto March 1989. This was the second season of field research in both the projects. However, during most of the season, there were frequent disturbances to law and order in the region and the social and political situation was unsettled. The security situation became very difficult and field research had to be discontinued from November 1988 to February 1989. The research staff were withdrawn from the field in November 1988. Though they had returned to the field offices in mid-January 1989, the security situation was considered still too difficult upto March 1989 for them to venture into the field and conduct research. Thus the opportunity for field research during the maha season was mostly lost. All that could be salvaged were the crop cut surveys for yield estimation in sampled allotments and interviews with some farmers and officials.

The yala 1989 season commenced in the Kirindi Oya project with the first issue of water issues in the research area on March 15, 1989. In Walawe, the first water issue for the yala 1989 season commenced on April 20, 1989. The field research for the season has commenced in the two projects and will continue till August or September 1989.

Interim 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.

An Interim Report was due, as per the reporting requirements, in April 1989 at the end of two seasons of research. But it was decided at the first meeting of the Study Advisory Committee (SAC) in Colombo on April 7, 1988 that it would be useful to have a Progress Report on the study at the end of the first season of field research without waiting till April 1989 for the Interim Report. Accordingly a Progress Report was submitted in October 1988. It described the progress in the implementation of the first season of field research in the two projects, and preliminary findings and analysis.

This Interim Report was prepared in April 1989. It includes an analysis of the first season data especially on the economics of rice production in Walawe; preliminary findings of the limited field research conducted during the tail-end of the last season which update the findings previously reported on the irrigation institutions; an anlysis of the rehabilitation management process; and findings of desk-study of documents on the rehabilitation issues pertinent to Walawe project. Crop cut surveys for yield estimation in the two projects had just ended in March 1989 and there was not adequate time to analyze the data and report the findings; they will be presented in the next report. The Interim Report does not repeat the material presented in the Progress Report of October 1988, though references are made to it; it should be read in conjunction with the Progress Report and the Inception Report.

The second chapter summarizes the major findings which are reported in detail for Kirindi Oya in Chapters III and IV, and for Walawe in Chapters V to VIII.

The Appendix to Chapter I 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

The houses rented in Tissamaharama and Embilipitiya continue to serve as field offices for research staff and also provide residential accommodation for the research assistants.

Staffing

International Staff:

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

Dr P. S. Rao, Engineer/Team Leader
Dr C. R. Panabokke, Agronomist
Dr D. J. 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: The following research assistants continued to work in the two projects.

Kirindi Oya project

Mr B. R. Ariyaratne, Agricultural Engineer
Mr P. G. Somaratne, Sociologist
Mr A. P. Keerthipala, Agricultural Economist

Walawe project

Mr R. A. D. Kemachandra, Agricultural Engineer
Mr K. Jinapala, Sociologist
Mr L. R. Perera, Sociologist
Mr A. P. Keerthipala, Agricultural Economist

Counterparts for the Study:

Miss D.M.L.C. Diyagama, Irrigation Engineer, who was counterpart engineer for the Walawe study has been seconded by Mahaweli Economic Agency (MEA) to the Central Engineering Consultancy Bureau. A new counterpart is yet to be nominated by MEA for this study. Mr B.K. Jayasundera, Senior Irrigation Engineer, who was counterpart engineer for the study in Kirindi Oya project has been transferred and his successor Mr Sarath Wijesekara is expected to be nominated as the new counterpart for the study.

Committees

The Study Coordination Committee (SCC) for the Kirindi Oya project met on 7 March 1989 in the office of the Chief Resident Engineer in Deberawewa; the SCC for the Walawe project met on 8 March 1989 in the office of the Resident Project Manager in Embilipitiya; the Study Advisory Committee (SAC) met in Colombo on 16 March 1989 in the office of the Project Director, Irrigation Management Division. Mr T.C. Patterson, Manager, Asia West Division 1 of the Asian Development Bank, participated in the SAC meeting and also visited the field research locations in the two projects on 13-15 March. The Progress Report submitted in October 1988 was discussed in all these meetings and useful comments and suggestions regarding research were made by the members of the committees. Issues of collaboration with various agencies and coordination of research activities for the forthcoming yala season were also discussed.

In spite of the sensitive security situation and difficult circumstances under which they were functioning, the officers and the field level staff in both Kirindi Oya and Walawe projects have offered excellent cooperation and assistance for the conduct of the field research.

Collaboration with Department of Agriculture

In regard to the research component on 'On-farm Irrigation Management for Upland Crops', to be conducted in collaboration with the Department of Agriculture (DOA), the efforts made upto October 1988 were described in the Progress Report (page 3, and pages 79-82). The unsettled conditions in the area have disrupted the progress of work in the development of the Agricultural Research Station (ARS) at Wirawila. Though some limited progress has since been made in field canal construction and land levelling on part of the fields of the ARS, it is now clear that it will not be available for conducting research on diversified crops in the yala season of 1989. More details are given in Chapter IV.

Workplan

The workplan and schedule given in the Inception Report (Appendix V) remain the same except for the timing of the SAC meetings. The second meeting of the SAC was held in March 1989 and the third will be held sometime in September-October 1989. Many of the data collection programs for various research components described in the Progress Report could not be done in maha 1988/89 and are being attempted in yala 1989.

Final Report

A Draft Final Report will be prepared and submitted by January 15, 1989. It will analyze the results of the first three seasons including yala 1989 and provide a preliminary assessment of the work during the fourth and last season, maha 1989-90. It will be reviewed at a tripartite meeting (ADB, GOSL and IIMI) within one month after its submission. The Final Report, incorporating views and comments of the tripartite meeting will be submitted by March 31, 1990. It will contain further analysis as well as recommendations for improvements and any follow-up studies which may be considered necessary.

In between the Interim and Draft Final Report, a seasonal report containing an updated workplan for the maha 1989-90 season will be sent to the Bank (ADB) and the Government (GOSL) by 30 October 1989.

Problems and Issues

In spite of continuing sporadic incidents of violence, it is hoped that the situation in the project areas will remain reasonably normal and peaceful and field research in yala 1989 can be conducted without any interruption. In the remaining project period, this is the only full season of research and it is crucial to provide the lessons we want to learn in this research.

It seems particularly unfortunate that it will not be possible to conduct research on diversified crops in ARS, Wirawila in yala 1989 as the fields will not be levelled and ready for the season. One of the important objectives of the field research will remain unrealized.

Comments are welcome

We would welcome comments and criticisms of the contents of the report to 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 subsystem 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 (DC 8) 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. DC 8 is one of the 18 distributaries. In addition to nine turnouts, there are a large number (nearly 50) of direct outlets from DC 8. Farmers have also built a number of bunds across DC 8 at various places to raise the water level. The rehabilitation will substantially change the shape of the water distribution system in DC 8.

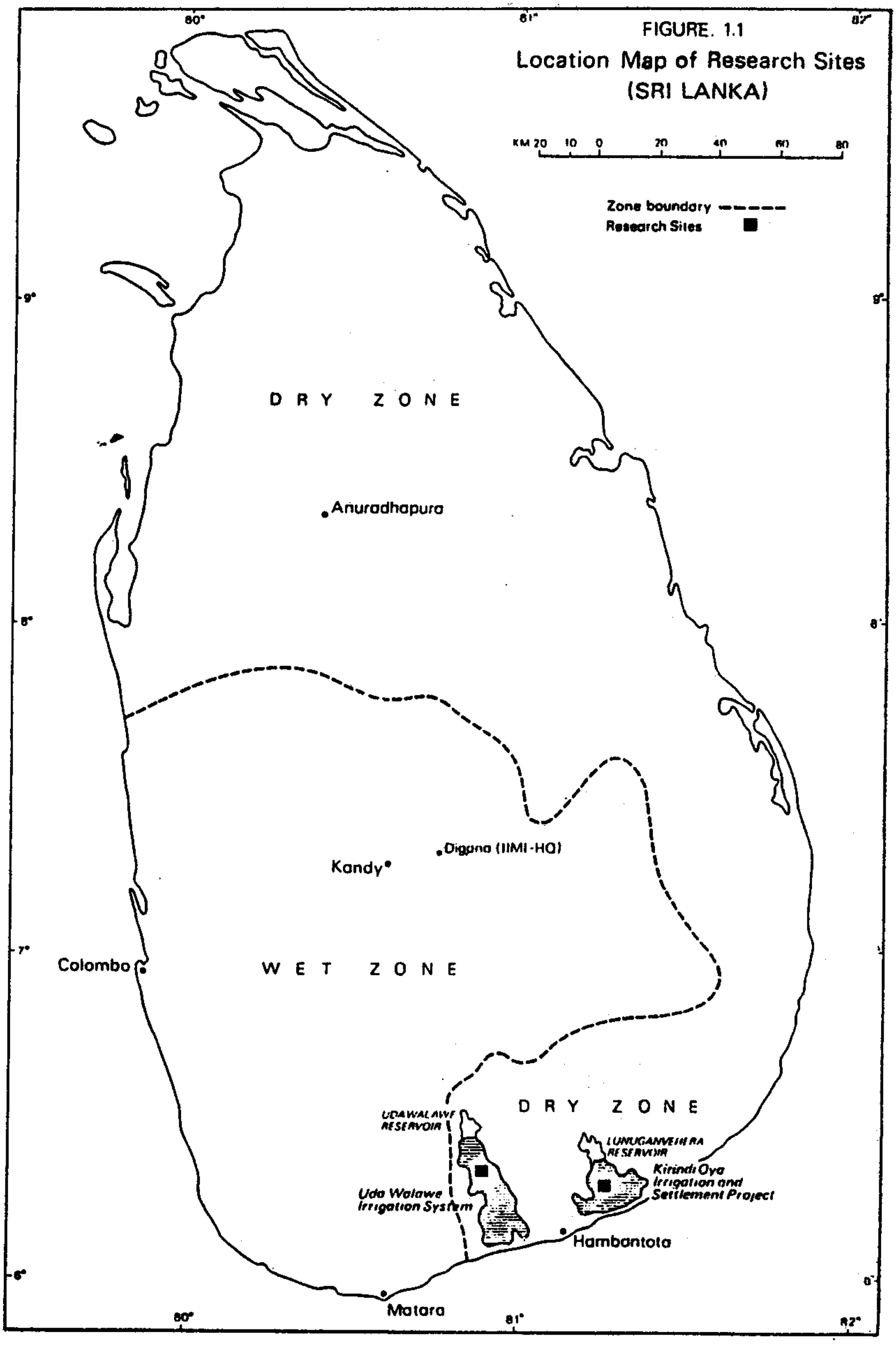

80°
81°
82°
9°
8°
7°
6°
FIGURE. 1.1
Location Map of Research Sites
(SRI LANKA)
KM 20 10 0 20 40 60 80
Zone boundary
Research Sites
DRY ZONE
Anuradhapura
Digana (IIMI-HQ)
Kandy
Colombo
WET ZONE
DRY ZONE
UDAWALAWE RESERVOIR
LUNUGANVEHERA RESERVOIR
Kirindi Oya Irrigation and Settlement Project
Uda Walawe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

Figure 1.2

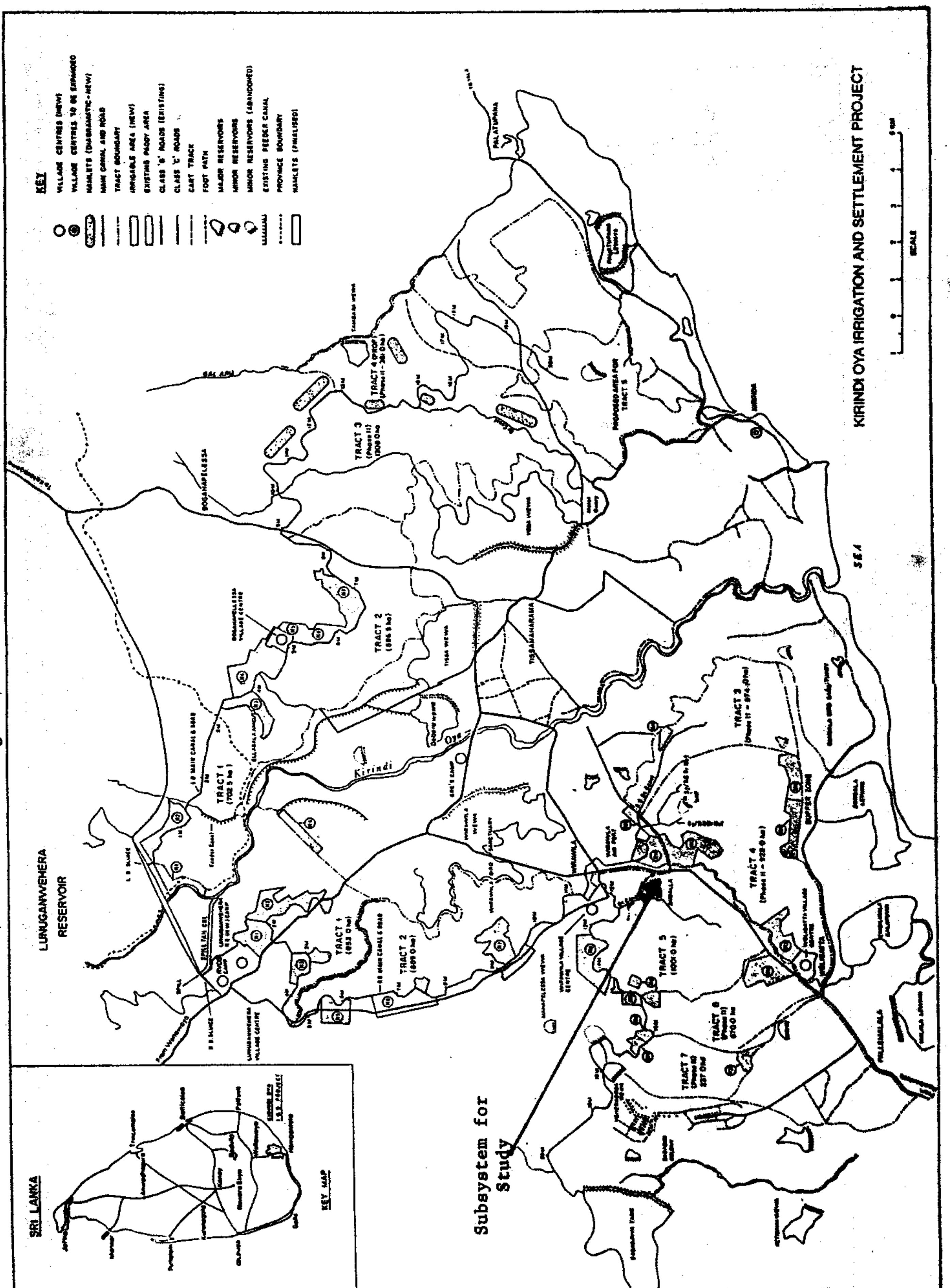

KIRINDI OYA IRRIGATION AND SETTLEMENT PROJECT
KEY
LUNUGANWEHERA
RESERVOIR
TRACT 1
TRACT 2
TRACT 3
TRACT 4
TRACT 5
TRACT 6
TRACT 7
Kirindi
Oya
TISSAMAHARAMA
SEA
SCALE
Subsystem for
Study
SRI LANKA
KEY MAP

Figure 1.3

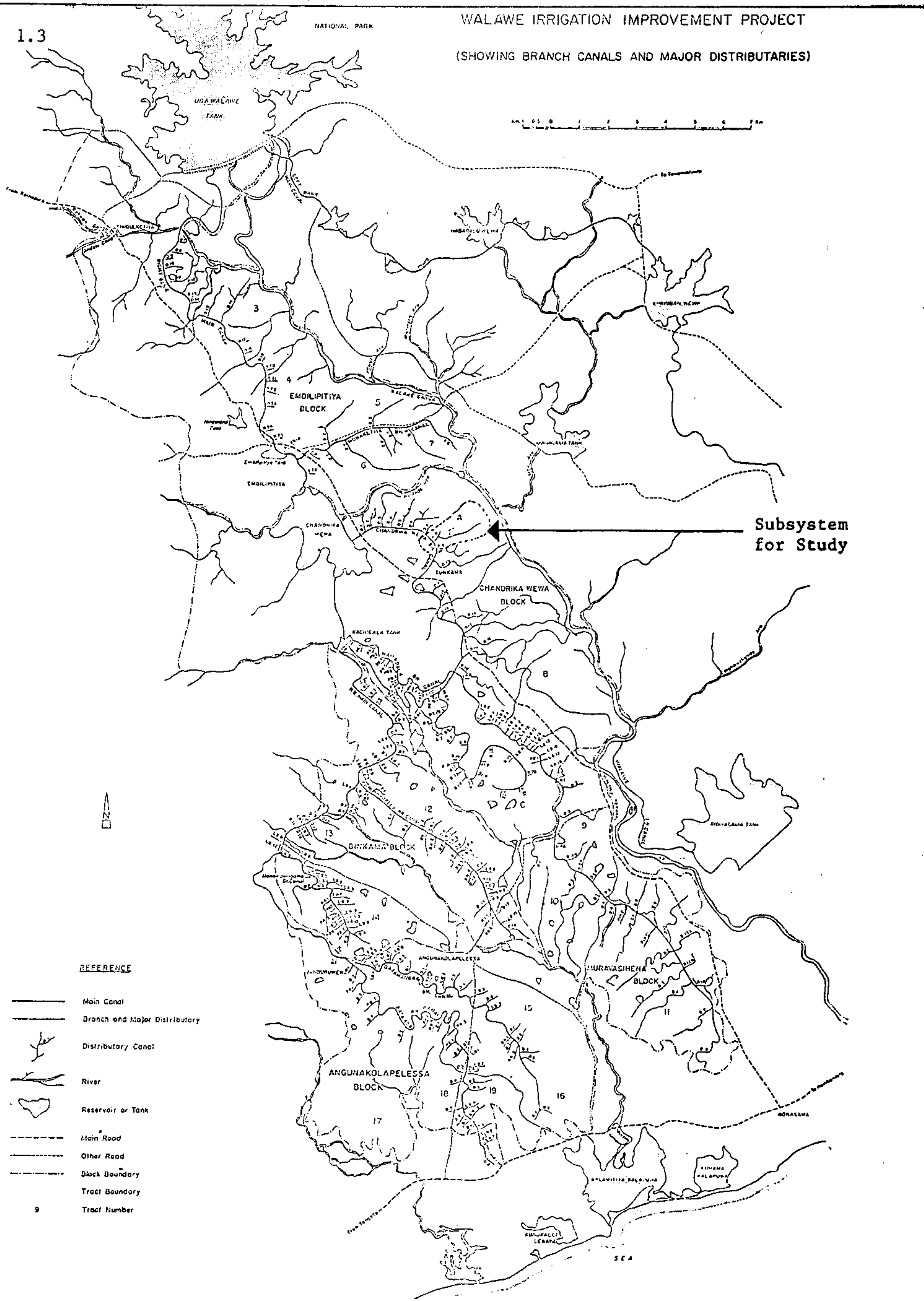
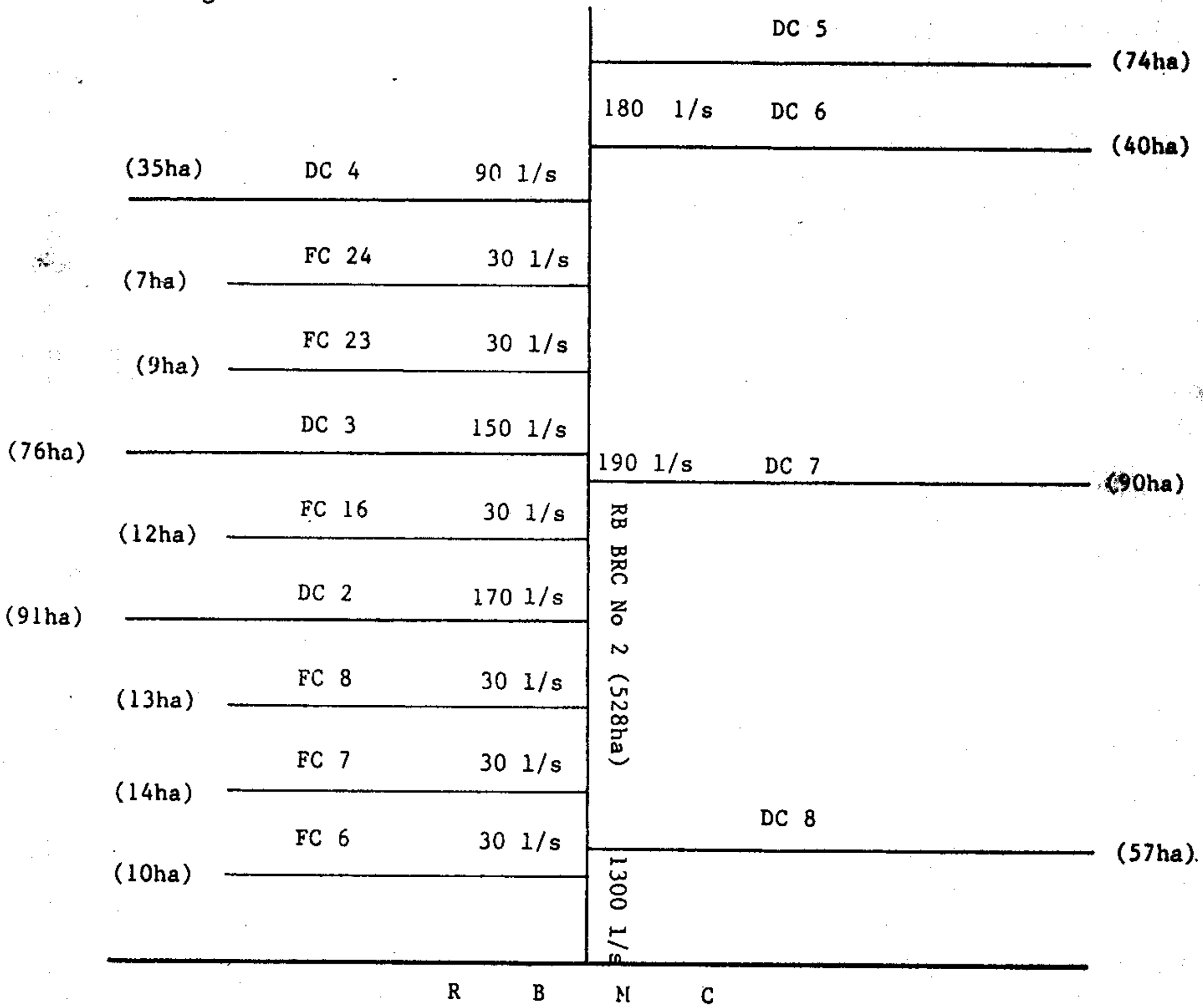
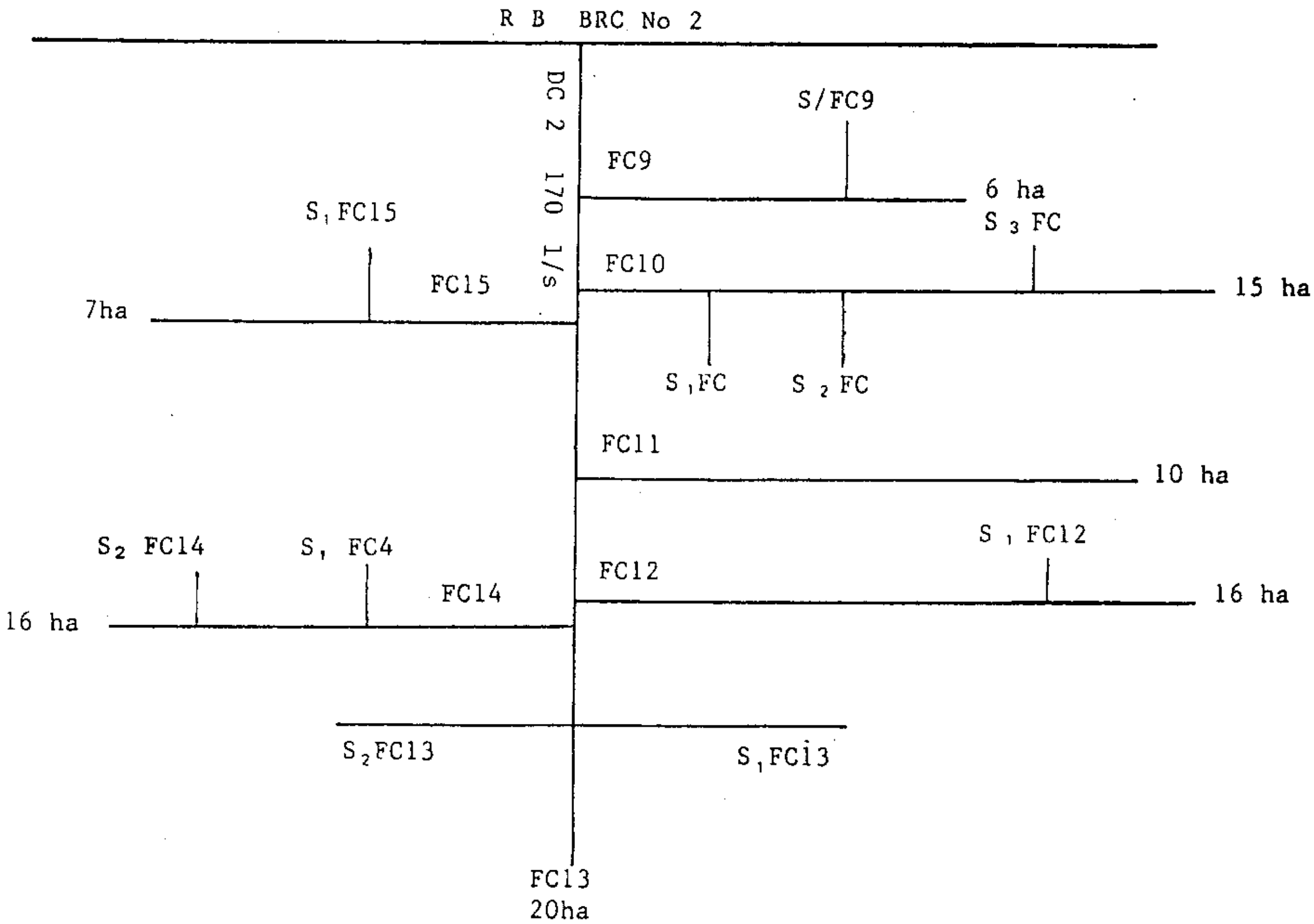

WALAWE IRRIGATION IMPROVEMENT PROJECT
(SHOWING BRANCH CANALS AND MAJOR DISTRIBUTARIES)
NATIONAL PARK
UDAWALAWE TANK
Subsystem for Study
EMBILIPITIYA BLOCK
CHANDRIKA WEWA BLOCK
BINKAMA BLOCK
MURAVASIHENA BLOCK
ANGUNAKOLAPELESSA BLOCK
ANGUNAKOLAPELESSA
SEA
REFERENCE
Main Canal
Branch and Major Distributory
Distributory Canal
River
Reservoir or Tank
Main Road
Other Road
Block Boundary
Tract Boundary
9 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 D2 Branch No. 2, of Kirindi Oya Right Bank

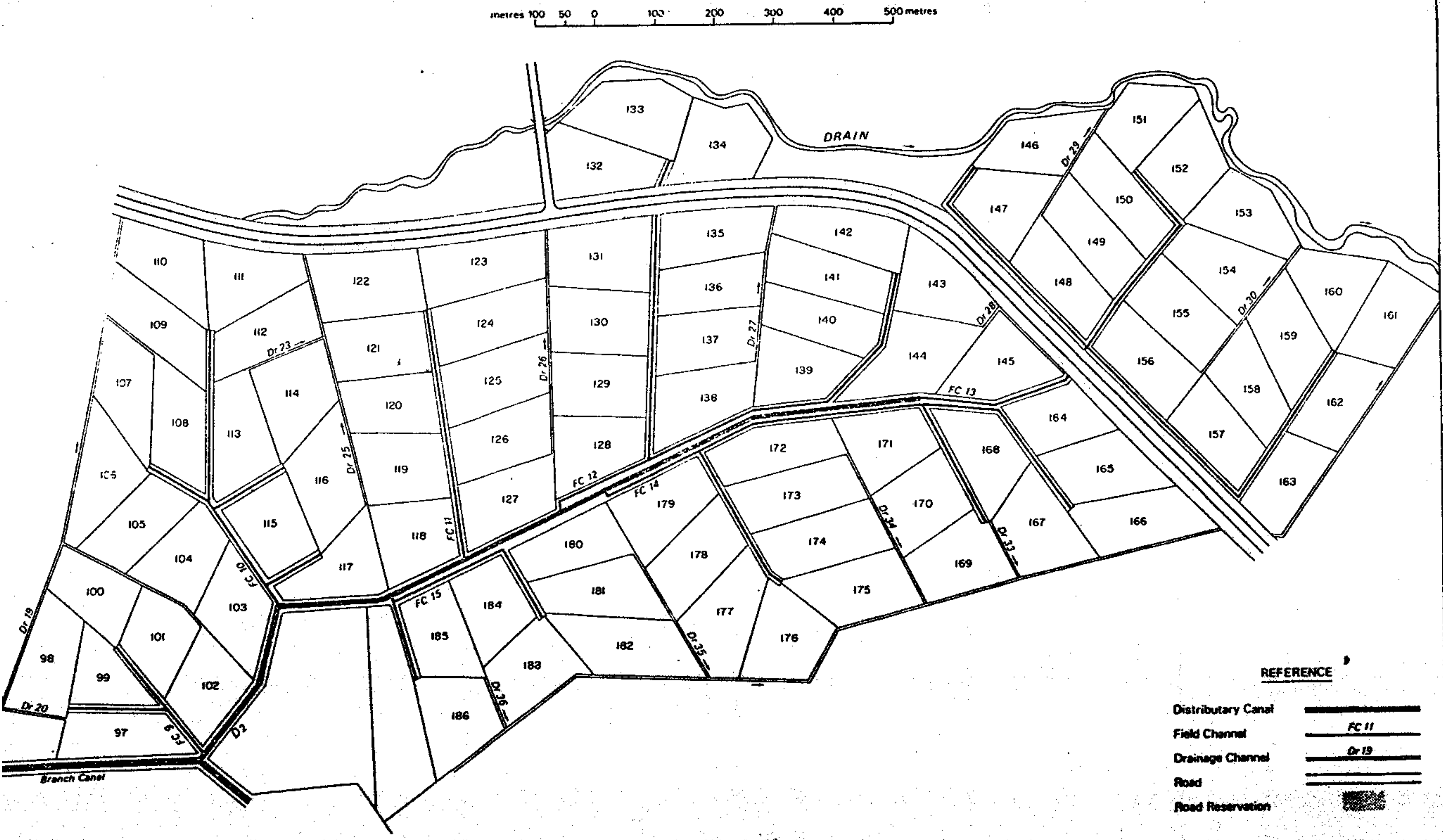


Figure 1.7

ISSUE TREE OF CHANDRIKAWEVA, MAIN CANAL

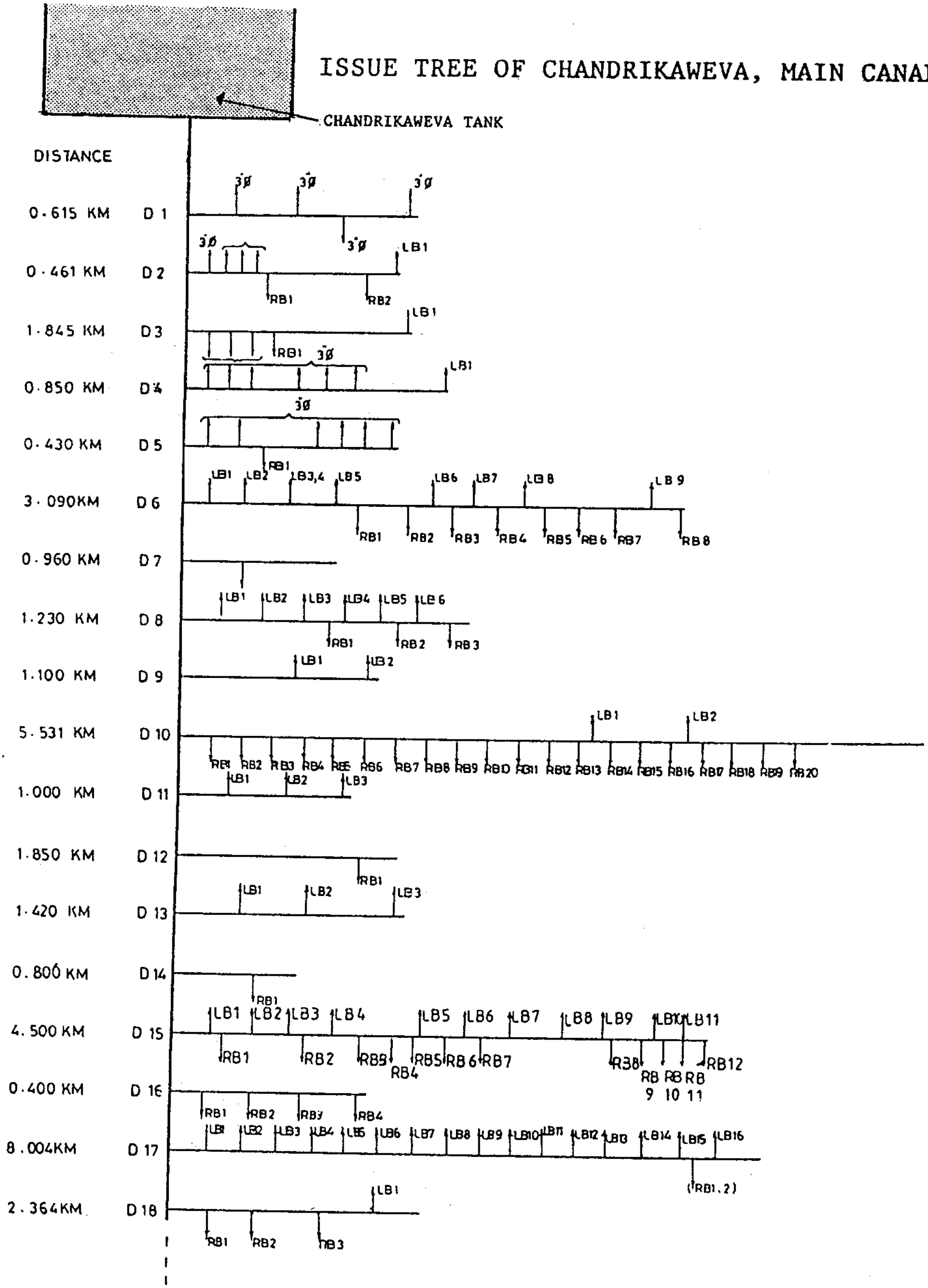
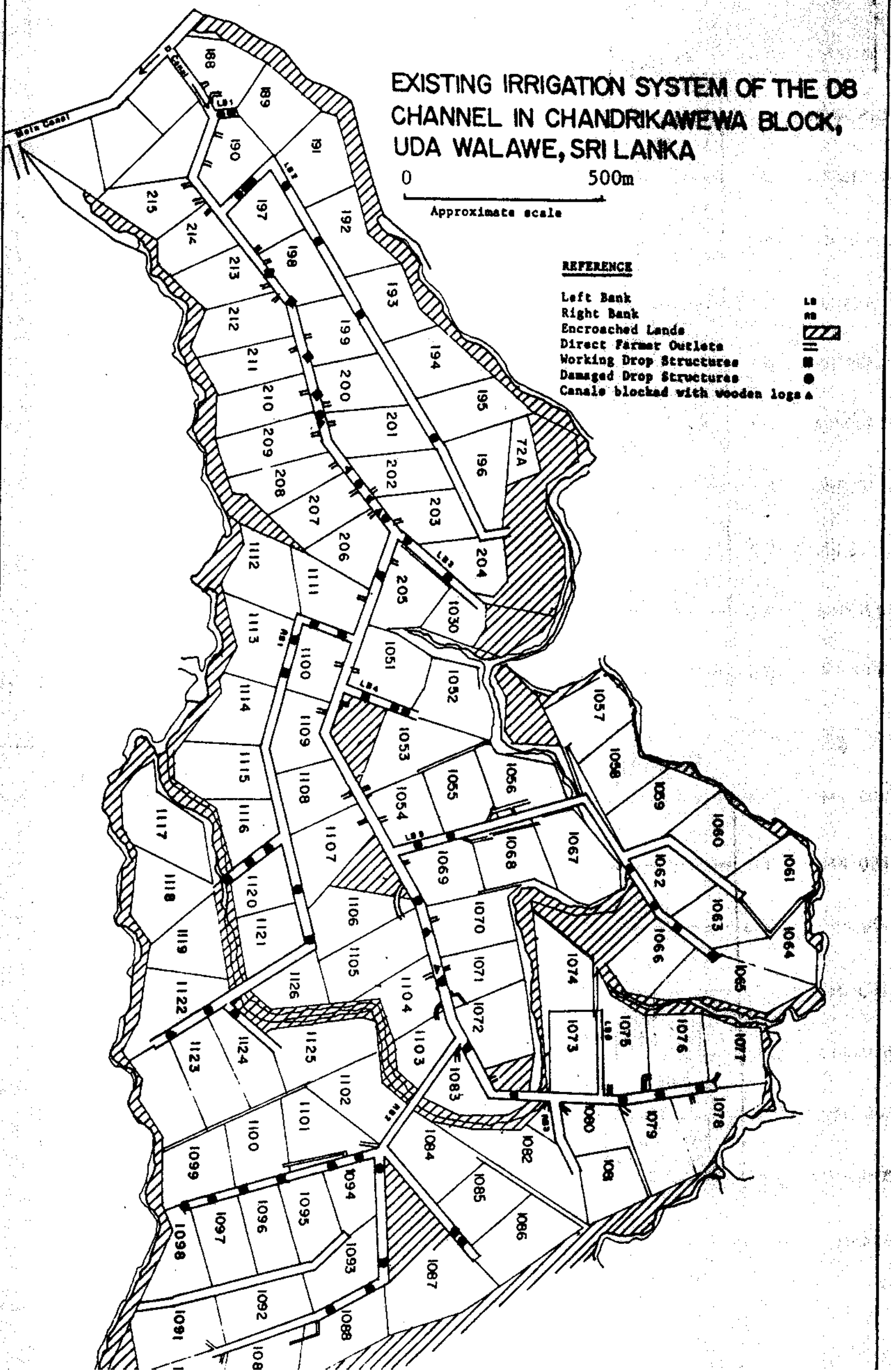


Figure 1.8


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

II. SUMMARY REPORT ON RESEARCH RESULTS - MAHA 1988/89

The major findings and results of the research of the last season, maha 1988/89, are summarized in this chapter. They are described in detail in the subsequent chapters.

IRRIGATION INSTITUTIONS IN KIRINDI OYA

In a new irrigation scheme like Kirindi Oya, the process of institutional development is not simply a matter of creating 'organizations' but of institutionalizing these organizations, and the set of values, conventions and understandings about appropriate norms and rules of behavior. Institutional development, i.e., the infusion of value as part of a process of building capability, is a long term process requiring considerable investment of time and skilled human resources; but it is essential for long term sustained productivity of an irrigation system. Assessing the performance of irrigation institutions, or more precisely and narrowly 'irrigation organizations', is more difficult than measuring irrigation system performance in terms of water deliveries, yields and incomes. If water is not delivered according to the expectations of farmers and crop needs by the irrigation agency, the agency's performance may be said to have been below expectations. But in order to understand why this is so, it is necessary to investigate both the overall structure of the organizations, and the internal processes of setting objectives, obtaining and using information, making decisions, motivating and controlling personnel, monitoring the results, and making adjustments. Beyond this, one must also investigate the functional 'fit' between the technology and the management requirements, the structure and the processes of the organizations managing the physical system, and the social, economic, and natural environment.

The overall structure of the irrigation organizations in Kirindi Oya has been described in the Progress Report (IIMI 1988b: 67-78) and also in Merrey and Somaratne (1989) and Stanbury (1989). This report builds further on the material already presented in these reports and discusses some innovations in the organizational structures and procedures that were introduced during the maha 1988/89 season, and provides an overview of the behavior of farmers and officers during this season. It concludes with some observations relating to the findings of the research so far with the research questions identified in the Inception Report (IIMI 1988a: 17-18).

Two organizational changes were made: 1) a Subcommittee of the Project Coordinating Committee was established in mid-August 1988 to discuss agricultural programming at the project level. After some discussions at the Ministry level between the Director of Irrigation Management Division (IMD) and the Project Managers (Settlement and IMD), agreement was reached to include farmer representatives on this subcommittee. Since the subcommittee has only met twice till now, its effectiveness cannot be evaluated; it will be monitored during the next season. 2) Effective on 1 January 1989, the Irrigation Department (ID) implemented a reorganization of its O&M staff: a separate O&M organization under the Senior Irrigation Engineer (water management) (SIE) has complete responsibility over all O&M matters; the SIE is assisted by two Irrigation Engineers (IEs), one each for left bank and right bank; one technical assistant and one work supervisor look after each tract; there is one turnout attendant (irrigator) for about 200 ha; each O&M section has been allocated specific vehicles, machinery and other equipment. This reorganization is certainly an important step towards establishing and institutionalizing an effective capacity for O&M in Kirindi Oya project. The ID has also made provision to improve communication, monitoring and feedback. 'Complaints books' are located at the field offices, so that farmers can register their problems in writing. These changes are indicative of a change in attitude within the ID, one that is placing more emphasis on improving performance of the irrigation system. The results of these changes will be monitored in the research of the next season.

Tentative conclusions and answers to the seven research questions listed in the Inception Report (IIMI 1988a:17-18) are briefly described below.

1. In general, we find that the management structure does inhibit management efficiency. Within the various agencies, there are factors that affect the incentives for good services, and that reduce management efficiency. In addition, coordination and cooperation among agencies is often problematic, and the mechanisms for achieving coordination are not always adequate. A stronger management structure with substantial authority and resources and strong ties with farmers' organizations will be required in order to achieve a high-performance system.

2. We have not fully addressed the question of performance monitoring and evaluation of personnel. However, we have noted the need to improve information sharing and internal communication within the departments as well as between the departments and farmers. Staff meetings within departments and officials regularly attending meetings of distributary channel (DC) organizations and the IMD Project Committees will help to improve communication.

3. It appears that the communication and cooperation are quite adequate for implementing construction work and the Project Coordinating Committee is effective in achieving this. But in achieving irrigated agricultural production, there does not seem to be sufficient active cooperation among the various departments. It can be illustrated by their inability to agree on a plan of action for operating the system to promote non-rice crops. We would suggest that the government consider establishing a high-level project manager for Kirindi Oya who would have the seniority and authority to work with all line agencies and parties to establish a common plan of action, and insure effective cooperation among the departments and agencies for achieving the objectives of that plan.

4. Regarding the program to form water users' groups at the field channel level and above, we find that the effort is quite inadequate and ineffective to date, despite real efforts by the officials at the project level. There are many problems but some of the more important are: inadequacy of financial and human resources, internal weaknesses of the IMD establishment in Kirindi Oya, and lack of clear commitment of other departments to work with farmers' groups.

5. Focussing on the patterns of communication, cooperation and collaboration between the agencies and water users' groups, we have documented a pattern of resistance to the IMD-formed groups among some officials, resistance to farmers' representatives participating in project-level committees, and lack of attendance by officials at meetings of farmers' groups.

6. On the more complex question of relating the level of cooperation among farmers to the technical requirements of the system, we have only begun to address the issue. But the design of the field channels and distributaries requires a certain amount of cooperation among farmers to share water; also, farmers need to cooperate to maintain the field channels. The present level of cooperation among farmers varies between channels, but on many channels is clearly inadequate for insuring equitable water distribution and good channel maintenance. There is a definite and clear lack of 'fit' between the technical requirements and assumptions, and the present level of institutional development. On the other hand, there are sufficient examples of cooperation among farmers to show that it is not impossible to achieve.

7. The final research question is also complex, as it asks what the relationship is between the performance of the irrigation system and the institutional factors. We have only begun to address this question too. Since water supply has not been a serious constraint in Tract 5 during the seasons we have observed, it is difficult to make a clear connection.

ON-FARM IRRIGATION MANAGEMENT FOR UPLAND CROPS - KIRINDI OYA

Regarding the development of the fields for research on upland crops at Wirawila Agricultural Research Station (ARS), the ID completed the irrigation and road network, fencing and field structures by end of September 1988. The DOA staff were however, not able to complete their share of work which involved land shaping and layout of the cross-levelled graded terraces. It was not possible under these circumstances to conduct any on-station trials for the maha of 1988/89. No progress was made in further development work for the next four months because of the intervening elections and the deteriorating security situation which hindered staff movement and use of earth moving equipment. Though a renewed attempt was made by the DOA staff in March 1989 to have the land shaped and terraces developed for the yala season, the fields will not be ready for conducting research in yala 1989.

The extension field staff of DOA had made plans for conducting some exploratory trials in farmers' fields during the maha 1988/89, consisting of five types of crop combinations in 34 demonstration plots of 1 acre each. Again, due to unsettled conditions, they were not able to accomplish their program. Nearly all farmers who had been selected for conducting these trials on a part of their allotments had switched over to growing rice in the whole allotment. However, a few farmers had successfully grown chillies, green gram and some vegetable crops in the well drained portion of their allotments, or on land above the command area which was irrigated by lifting water from the adjacent channel. They had thus demonstrated the technical feasibility of growing successful non-rice crops during the maha season in this environment. The extension staff of DOA have plans for carrying out 37 demonstrations in tracts 2 and 5 during the yala 1989 which will consist of one acre size demonstrations with four crops namely green gram, red onion, chillie and cow pea. However, the decision made at the kanna meeting to issue water for paddy to a restricted number of irrigation tracts during the yala season does not help promoting the non-rice crops or even the demonstrations by DOA.

ECONOMICS OF IRRIGATED CROP PRODUCTION

First, the results of rice production in Walawe for the 1988 yala season are summarized. Second, the profitability of non-rice crops relative to rice production is examined on the basis of the available data; also examined are the possible difficulties that the farmers in the study areas might encounter when they try to introduce these non-rice crops. The objectives are: 1) to provide base line information on the economic performance of irrigated crop production under the existing pre-rehabilitated conditions of the Walawe system; and 2) to devise strategies to promote non-rice crops under irrigation after the rehabilitation of the system with limited quantity of water but better control and regulation.

Yield Performance

The average rice yield of the sample farmers in Walawe in the yala season of 1988 was as high as 6.1 t/ha, nearly 2 tons more than the yield reported for Walawe in the 1986 yala season. It was found that neither location along the distributary nor soil type made any significant difference in yield. Our water delivery data reported in the <u>Progress Report</u> (IIMI 1988b: 105 and 111) showed that, although there was no significant inequality in water distribution along the branch canal, there existed considerable inequity in distribution along DC 8. This fact and the fact that there was no significant yield difference among the locations along DC 8 may together imply that water supply was so abundant that the inequity in water distribution along the distributary did not matter.

A preliminary result of the crop-cut survey for the Walawe 1988/89 maha season indicates an average rice yield of nearly 7 t/ha.

Agronomic Practices

Land preparation in yala 1988 season stretched over a six week period. Ninety-two percent of the farmers used tractors for land preparation; 22 percent of the farmers used their own tractors. Crop establishment was done mostly through direct sowing with only 5 percent of the farmers adopting transplantation method. Almost all farmers planted 3-3.5 month duration varieties of paddy. 94 percent of the farmers applied V-mixture fertilizer at the time of planting and all the farmers applied urea during the growing stage either as a single dose (22 percent) or in two split applications (78 percent). Top Dressing Mixture was applied by all farmers during the booting stage of the crop. Weed control by herbicides was adopted by 97 percent of the farmers. Manual weeding was practiced only by 4 percent of farmers who adopted transplanting. There was no serious outbreak of pests and diseases in the season. Ninety-seven percent of farmers applied chemicals of various kinds 1 to 5 times mostly for preventive purposes.

Production Structure

The production structure in terms of the major levels of inputs was rather homogeneous in the study area across different DCs and different soil types. The differences in these input use levels were not statistically significant among the categories examined.

The high seeding rate in the study area, 191 kg/ha on the average was nearly twice as high as the DOA's recommended level of 105 kg/ha for direct sowing. The total value of all three kinds of fertilizers used by the farmers was Rs 1129/ha on the average, with no significant variation over DCs, location along DCs, and soil types. The level of herbicide use was high and in value terms, a total of Rs 888/ha worth of herbicides was applied on the average. The value of pesticides applied averaged Rs 343/ha. The total labor use for rice production on the average for the study area was 102 days/ha, which was comparable to those reported for the DOA's samples in high wage-rate regions. The most distinctive feature of the labor use pattern in the study area is found in its extremely high dependence on hired labor. On the average, hired labor constituted 95 percent of the total labor requirement. This fact must have profound implications if crop diversification is to be promoted in the study area. Sixty percent of the farmers obtained loans either from institutional sources or informal sources or from both. Walawe farmers relied heavily on informal sources rather than institutional loans even though the interest rate in the former, 135 percent per year, was much higher than the latter, 9 percent per year. The amount borrowed by Walawe farmers was much smaller than that borrowed by the Kirindi Oya farmers in the 1987/88 maha season.

Economic Performance

The average gross revenue per hectare was Rs 28,000. The high yields of more than 6 t/ha combined with 20 percent increase in the government support price of rice during yala 1988 accounted for such high revenue. The average labor productivity was as high as Rs 272/day. The factor share of current inputs was around 15 percent. As a result, the gross value added ratio was around 85 percent. The farmer's income was Rs 18,000/ha on the average; it was Rs 20,000/ha for an owner operator who owned a tractor; and it was Rs 13,000/ha for a tenant farmer. Thus, in all measures, the economic performance of rice production in Walawe in yala 1988 was excellent. Although land and labor productivity are undoubtedly high, the water productivity in the system is not known. Because of the deteriorated condition of the physical system and difficulties in water regulation and control, water would certainly have been wasted to a substantial degree; after rehabilitation and more efficient use of water, the water saved can be used more productively in the lower sections of this large system.

Crop Diversification

A preliminary examination on the possibility of crop diversification in the study areas reconfirms the difficulties that have been pointed out repeatedly by researchers who have studied crop diversification under irrigated conditions elsewhere in Sri Lanka. Among others, salient difficulties pointed out include: i) labor constraint and low labor productivity of alternative crops; ii) capital and credit constraint; iii) market and price uncertainties; and iv) in view of high productivity in rice production in the study areas, among conventional non-rice crops, only a narrow selection of substitution crops can compete with rice in terms of income generating capacity.

DESIGN-MANAGEMENT INTERACTIONS IN WALAWE

Introduction

The ongoing rehabilitation of Walawe irrigation system was implemented to: 1) improve the physical infrastructure by rehabilitation and rationalization of the right bank (RB) canal system; and 2) strengthen water management on the RB to enable irrigation supplies to be provided more efficiently, which in turn would lead to increased agricultural production on the RB and further development of irrigated agriculture in the left bank (LB).

The data, assumptions and criteria adopted for the rehabilitation design and the operation of the system and the institutional requirements and procedures for the water management and operation of the rehabilitated system are documented in the "Design Criteria" and "Draft Water Management and Operation Manual" prepared by Sir M. Macdonald and Partners Ltd, the consultant to the project. (MMP July 1986: Draft Water Management and Operation Manual; MMP February 1987: Design Criteria)

Findings

Design and operational assumptions: The design of the field canals and turnouts and the operation of the rehabilitated system are based on a set of fundamental operational and institutional requirements which require a radical change in the present irrigation practices and regulation of the physical system and behavioral requirements of the farmers as well as the operating staff. These changes are tied up with system-wide monitoring of crops, climatic parameters and flow of water in the system with feedback and necessary adjustments to control and regulate the system. The basic questions that emerge from the study of these design assumptions and the intended mode of operation are: 1) the appropriate mechanism to build up the proposed operation and monitoring procedures on the present system, an area which has not been adequately addressed by the above reports; 2) the degree of institutional capacity and organizational capability required to motivate and direct both the farmers and the agency staff to follow the intended procedures, at least in order to ensure the realization of the fundamental operational assumptions on which the design is based and the success of operation depends; 3) the accuracy of some crucial parameters adopted in the design and their impact on the performance of the system; and 4) the possible consequences for system operation if the basic operational assumptions are not realized as anticipated.

Operation and monitoring procedures: The Draft Water Management and Operation Manual describes in detail the staff requirements, staff responsibilities, duties and tasks required to carry out the new operation procedures and monitoring of crops, climatic variables and water flows in canals. It also lays out the sequences of action in monitoring, the formats to be used, and the rules for adjustments of the system for monitored parameters. These look very logical and appropriate for the enhancement of the levels of performance. But at present, the system is heavily dilapidated and this condition has created a permissive environment both for the farmers and the agency staff to refrain from any systematic way of handling the system to achieve high levels of performance. Both parties at present show very relaxed interests and do not tax themselves with extra efforts to save water or follow rotations strictly because they do not feel any necessity of doing so. The proposed new operation is therefore a radical change in the present mood of work, the present irrigation behavior, and the present understandings of the system. The change from the present phase to the new phase needs a sound mechanism with much effort by the agency. This issue needs to be addressed and a proper mechanism devised.

Operational assumptions: The irrigation schedules for the FCs and DCs as well as the computed design discharges in the DCs and FCs are based on the primary assumption that the first irrigation or the commencement of land preparation on any individual FC is done in two steps staggered by one week; this is followed by a second assumption which requires the division of DCs under a BC into two groups; one group of DCs deliberately delays the commencement of land preparation by two weeks with respect to the other. Five to six farmers are expected to share water in the FC at a time, while the operating staff would rotate the issues to FCs from the DC, on a predetermined schedule which presumes the realization of the intended staggering of the first irrigation in the turnout areas.

This is an area which needs further thought. These assumptions may be hard to realize without a change of the behavioral patterns of the farmers which can only be achieved through institutional building and strengthening. One may question whether the efforts so far taken to build the institutional capacity are sufficient to create an environment which would promote the required levels of cooperation and participation by farmers as well as the operating staff in the intended mode of operation. It is observed that failure to realize these operational assumptions may lead to the occurrence of peak irrigation requirements more than anticipated which may eventually lead to excessive overloading of the FCs and DCs.

Design issues and limitations: The parameters which crucially influence the capacity of DCs and the design discharges and duties for each turnout area are the various efficiency terms and the seepage and percolation (S&P) through the liyaddas. It is observed that these two parameters have not been field tested and verified adequately before adoption in the design and the preparation of irrigation schedules for the turnout areas. As a result the conveyance efficiency assumed for a typical DC (DC 8 in Chandrikawewa Branch Canal) is likely to be as high as 96 percent. This value does not reconcile well with the value recommended in the Irrigation Department design guidelines (Irrigation Department: Technical Note no. 6) and the value found from experiments in a typical DC in Kirindi Oya project by IIMI (Progress Report IIMI 1988b: 23). On the other hand no due consideration has been paid to the different S&P rates in well-drained RBEs versus poorly-drained LHGs typically found in any conventional turnout area. This may lead to capacity constraints in some canals, and overloading of the canals during operation over and above the limits envisaged in the design. As the turnout structures have been designed to respond well to the design limits of overloading, any excessive overloading may lead to operational difficulties at least during the peak periods of water demand.

Flexibility in operation: The size of the farm turnout in Walawe is 75 mm with a capacity of 5-6 l/s. This facilitates the intended simultaneous sharing of water by five or six farmers under a FC. However it is observed that if three farmers or less instead of six wish to irrigate their allotments simultaneously, the delivery of peak on-farm requirement would be difficult with the capacity of the turnout. On the other hand, when there is a mix of paddy and other field crops in a turnout, the small stream size catered by the farm turnout facilitates the irrigation of OFCs which requires a relatively smaller stream size than paddy.

IRRIGATION INSTITUTIONS IN WALAWE

There are no significant structural or management changes in the Walawe project since the time of the Progress Report (IIMI 1988b: 115-131). The political disturbances in the area gradually increased during the maha season of 1988/89, especially from November to mid-December 1988. The activities of the Mahaweli Economic Agency (MEA) and other government institutions were very much affected. Field visits were no longer possible for the MEA field officers and system operation was disrupted. But the MEA officials kept the gates open and ensured that there was abundant and continuous water supply in the distributary canals even at the peak period of troubles. Farmers were happy with the continuous water flows. There was no significant difference reported in the irrigation behavior of farmers due to the disturbances since the system normally lacks close officer involvement and is normally controlled by individual farmers especially along the distributaries. Water supplied during the disturbed period probably greatly exceeded the irrigation requirements.

According to farmers, most of the time private dealers had ready stocks of agricultural inputs of fertilizer and agro-chemicals and therefore there was hardly any shortage of supplies. Though the farmer training classes could not be held during this period, this did not affect the cultivation as the farmers had the necessary knowledge and experience in identifying crop diseases and applying inputs.

Tentative conclusions and answers to the seven research questions listed in the Inception Report (IIMI 1988a: 17-18) in so far as they pertain to Walawe are described below. They are subject to further refinement as the research progresses further.

1. In the Progress Report (IIMI 1988b: 115-122) we described the overall management structure of MEA at the project level. We identified some structural factors that do inhibit management efficiency and the incentives to provide service. There is nothing more to add at this point, as we could not do further research.

2. Similarly, the Progress Report documents some of the processes of decision making and communication flows up and down and laterally within the managing agency. We suggested these are not as effective as one would wish and made a few suggestions for improvement which will stand. We will address this question further in future research.

3. Not applicable to Walawe.

4. In the Progress Report (IIMI 1988b: 122-125) we have provided a brief description of the efforts to establish water users' groups; this clearly relates closely to the chapter on rehabilitation processes. The disturbed conditions not only prevented much work on establishing farmers' groups, but we suspect have set the process back somewhat. In any case, as we noted in the Progress Report, the efforts to organize water users' groups are inadequate in terms of manpower and other resources, are not effectively integrated into the rehabilitation work, and in the absence of a clear MEA policy regarding the roles, authority, and relationship with MEA of farmers' groups, little success can be

expected. We suggest a major rethinking of this effort is required, and if MEA wishes to form effective groups, a major reorientation of the effort, with commitment of resources, will be required.

5. On the patterns of relationships between agency officials and farmers, there are no effective farmer groups at present and no interactions that occur between field level officials and the nascent groups as groups; there are no areas in which the agency deals with groups or their leaders as opposed to individual farmers.

6. The present level of cooperation among farmers in the sample area is not very high. Occasionally, small groups do coalesce to solve immediate shared problems, such as the construction of a structure to increase distributary channel water levels by head-end farmers, or the destruction of the same structures by tail-enders during the night. The present condition of the system, where almost every other farmer has a separate outlet to get water from the channel to his allotment, does not need much cooperation among farmers. The big question is whether farmers will change their behavior and cooperate for sharing water equitably and maintaining the channels during the post-rehabilitation phase.

7. Finally, it is difficult at this stage to draw firm conclusions regarding the relationships between institutional factors and performance of the irrigation system.* However, attention to strengthening the organizational and institutional aspects would have a large impact on the long run.

MANAGEMENT OF THE REHABILITATION PROCESS IN WALAWE

The Progress Report (IIMI 1988b) made a preliminary attempt to describe the rehabilitation process as we have observed it. Since that report was written, there has not been much progress or changes to report because of the disturbed conditions in the project area. In this report, an attempt is made first, to review some recent literature on rehabilitation experiences in Sri Lanka and elsewhere to establish a framework for analysis; second, to analyze the rehabilitation process in Walawe; and third, to offer some preliminary conclusions, structured as responses to the research questions included in the Inception Report (IIMI 1988a: 20-21).

The Walawe rehabilitation and improvement project is reviewed in the light of the findings and consensus view of recent rehabilitation literature and the criteria that can be used for evaluation. Following the critical review and evaluation, we may say the following about the Walawe project as implemented to date:

1. Despite suggestions from various consultants and Bank (ADB) teams at the early stage, the project has not taken an integrated and

multidisciplinary approach to rehabilitation, and has instead been viewed as a construction project;

2. Farmers and system operating personnel have not been involved in all stages including planning; the new policies have not been communicated to them before project implementation, and they have not necessarily agreed to the project objectives;

3. No serious attempt was made to diagnose the problems, or to pilot test solutions;

4. A new O&M manual has been developed; its practicality is questioned by many officials; insufficient attention has been paid to the question of, whether and how to build on the present system and improve its effectiveness;

5. The project design and implementation schedule has been inflexible and rigid; this is a classic "blueprint" rather than "learning process" project;

6. The coordination and communication among the various organizations has not been adequate;

7. There is no effective monitoring and evaluation system of the project;

8. There has been no serious consideration of the long term sustainability of the improvements; and

9. The rehabilitation process has not been used as a vehicle to strengthen farmer's organizations, and farmers have not been given any participatory role and decision making authority.

Preliminary responses to the research questions in the Inception Report (IIMI 1988a: 20-21) are described below:

1. On the first question on the project planning decision-making process, we do not know exactly why it is that the recommendations of the Project Evaluation Mission (ADB 1982) and most of the consultants that institutional and management issues be the focus of the project were not followed. We have answered to a large degree the other questions on the consultants' recommendations and the choices that were made. Some deeper work to clarify certain points is still needed.

2. We have documented here and in the Progress Report the strategic choices made after project implementation had begun, on such issues as design and construction procedures, farmer involvement etc. Further interviews and document analysis are required to discover adequately all the reasons behind the choices.

3. We have documented fairly comprehensively the roles of the key actors in the project, i.e., agency officials, consultants, contractors, and farmers. We have shown that the communication among these actors has not been fully effective.

4. On the role of the farmers in the rehabilitation process, we have shown that in the pre-construction phase, farmers did not learn much about the rehabilitation plans, and even now do not know the details of what will happen on their own channels. They are not consulted on the designs, and are not informed about the proposed operational changes; that they will accept these is an untested assumption. The only role they are playing in construction is as informal monitors of construction, and as paid laborers in many cases.

5. At this point, we cannot answer the question on the likely impact of the rehabilitation on system performance, or whether project objectives will be achieved. We can express serious doubts about the likely sustainability of the improvements, given the lack of consultation with farmers, the lack of any viable farmers' organizations, the skepticism of the O&M staff about the changes, and the inadequate O&M budgets.

Is it possible to recommend any course of action that might improve the on-going Walawe rehabilitation project, recognizing that it has already come a long way, and many commitments have been made in terms of awarding of contracts, expenditure of funds, etc? It may seem almost too late to do much. However, continuing in the present direction is not likely to achieve all that is hoped for, and the improvements achieved are unlikely to be sustainable. A high powered mid-term review by the Bank and the Government of Sri Lanka may be a useful mechanism to explore this question. This could help to bring together all the agencies and parties concerned, i.e., the MEA, CECB, consultants, contractors, researchers, and farmer representatives, and involve them in an open discussion of the current status and possible options for improvements in the on-going rehabilitation process within the existing constraints.

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III. IRRIGATION INSTITUTIONS IN KIRINDI OYA

INTRODUCTION

This component of the research has two broad objectives:

1. to document and assess the present functioning, strengths, areas needing further strengthening, and impediments to improvement in the irrigation institutions at the project and farmers' level; and

2. to propose structural and management innovations that could be adopted in the short run to improve project performance, and others that could be tested and adapted over a longer period that would strengthen efforts to achieve the project goals (Inception Report; IIMI 1988a:17).

"Irrigation institutions" is defined here as those institutions directly related to the operation and management of the water conveyance, i.e., irrigation, system. This definition thus excludes such agencies as the Land Commissioner's Department, the Agriculture Department, and the Department of Agrarian Services. These departments are essential to the success of the Kirindi Oya Scheme, but are not directly involved in management of the irrigation system.

The water conveyance system requires some form of organization, and some set of understandings or conventions about behavior patterns required in order to make use of it; hence, irrigation systems have been characterized as "socio-technical processes" (Uphoff 1986a: Chapter 1). On large government-managed systems, there is normally an irrigation management agency; and in most cases there are either formal or informal groups of farmers with some management responsibilities, at least at the tertiary level. These responsibilities may be implicit or explicit.

The terms "institution" and "organization" are often used interchangeably, as in the preceding paragraphs. However, social scientists usually make a distinction between the two terms (Uphoff 1986b:8-10). Following Uphoff, "organizations" are "structures of recognized and accepted roles." Thus, in Kirindi Oya the "irrigation organizations" include the Irrigation Department, the Irrigation Management Division, and the (nascent) farmers' organizations.

"Institutions," whether organizations or not, are "complexes of norms and behaviors that persist over time by serving collectively valued purposes." Institutions persist because they are valued as well as useful. Thus, there are institutions that are not organizations, for example "the legal system", or the warabandi rotation system in northern Indian and Pakistani irrigation systems. There are organizations that are not (or not yet) institutions, for example a new law firm, or the newly created farmers' organizations in Kirindi Oya; to anticipate a conclusion of our research, these have not become sufficiently valued to qualify as "institutions."

Finally, there are organizations that are institutions (or vice versa), i.e., have a normative value beyond the technical requirement at hand or the immediate benefits people derive. Organizations that have institutional status in peoples' minds, that are legitimate and valued, are likely to be more stable and more capable of solving problems over time than less valued, less institutionalized, organizations will have.

In a new irrigation scheme like Kirindi Oya, the process of institutional development is not simply a matter of creating "organizations", but of institutionalizing these organizations, and the set of values, conventions and understandings about appropriate norms and rules of behavior. Thus institutions cannot be constructed in a mechanical manner, within the constraints of a time-bound project, following a blueprint, as in the case of the physical conveyance system. Institutional development, i.e., the infusion of value as part of a process of building capability, is a long term process requiring considerable investment of time and skilled human resources; but is essential for long term sustained productivity of an irrigation system. Since "institutionalization" is a process, not a category or thing, there are degrees of institutionalization. Effective institutions are those that are so much a part of peoples' lives and ways of thinking, including the categories in which they think, that their premises are not questioned, and life without them is unthinkable (Douglas 1986). By definition, special efforts for institutional development, such as the use of catalysts for forming farmers' organizations, will not be required once the organizations become institutions.

The performance of the irrigation institutions may be assessed in numerous ways. In this report, the performance of a part of the physical system is assessed by comparing actual water deliveries to the requirements of the crops, and to the objectives of the irrigation management agency; the performance of the agricultural system is assessed by measuring actual yields; and the performance of the agricultural economic system by assessing profits of agricultural production. These are all output measures.

For assessing the performance of the irrigation institutions, or more narrowly and precisely "irrigation organizations," it is more difficult to identify simple quantitative criteria that all observers would agree constitute appropriate measures of the institutions themselves. Indirectly, all of the other measures mentioned above are measures of the performance of the irrigation organizations: if water is not delivered according to the expectations of farmers and crop needs by the irrigation agency, the agency's performance may be said to have been below expectations. But in order to understand why this is so, it is necessary to investigate both the overall structure of the organizations, and the internal processes of setting objectives, obtaining and using information, making decisions, motivating and controlling personnel, monitoring the results, and making adjustments.

Beyond this, one must also investigate the functional "fit" between the technology and its management requirements, the structure and processes of the organizations managing the physical system, and the social, economic, and natural environment. If, for example, the water conveyance technology is designed in a way that requires constant monitoring of flows, and rapid decisions and interventions to change flows, but the organization is designed as an hierarchical one, with all decisions emanating from a central place, in the absence of an effective communication system, then we may suspect that the "fit" between the technology and the organization is not very good, and performance of the water conveyance system is likely to be poor.

Another example of lack of fit -- particularly relevant in Sri Lanka -- is that if the water conveyance system is designed and managed by the government agency on the assumption that farmers will maintain the field channels and will operate a rotation system, but no appropriate measures are taken to ensure that farmers have the institutional capacity to fulfill these functions, the government's expectations will be disappointed, and the performance (and maintenance) of the system likely to be below expectations.

The overall structure of the irrigation organizations in Kirindi Oya has been described in the Progress Report (IIMI 1988b:67-78) and also in Merrey and Somaratne (1989) as well as Stanbury (1989). This report does not repeat this description. Rather, building on the material presented in these reports, here we discuss some innovations in the organizational structures and procedures that were introduced during the maha 1988/89 season, and provide an overview of the behavior of farmers and officials during this season. We conclude with some observations relating the findings of the research so far with the research questions identified in the Inception Report (IIMI 1988a:17-18).

It is important to stress here the impact of the extremely unsettled political situation during most of the maha 1988/89 season on the irrigation organizations, on the farmers and officials, and on the research itself. As noted in our previous reports, the unsettled situation has made collection of sociological data somewhat problematic. People are understandably reluctant at times to discuss sensitive matters, suspicious of the real intentions of the researchers, and often so distracted by other things that they exhibit little interest in discussing mundane irrigation matters. Further, the extreme situation faced during maha 1988/89 severely affected the behavior of officials and farmers, and placed serious strains on the irrigation organizations. It is clear that the "performance" of these organizations was seriously reduced by the conditions under which they had to operate; and it may not be amiss to pay tribute to those officers and farmers who continued to try to carry out their duties in such a situation.

Finally, in spite of the unsettled conditions and severe pressures faced by government officials in particular, it is also appropriate to emphasize the very high degree of cooperation and willingness to be of assistance in the research, within the constraints they faced.

CHANGES IN INSTITUTIONAL STRUCTURES AND PROCEDURES DURING MAHA 1988/89

Since the time of the Progress Report, two organizational changes have been implemented within the management structure of the system. Although it is still too early to evaluate the impact of these changes, or the degree to which they are likely to be institutionalized, they are indicative of efforts to solve some of the management problems of Kirindi Oya.

The Committee System

In previous reports (Merrey and Somaratne 1989; IIMI 1988b) we had documented problems with inter-agency coordination, and with regard to the effectiveness of the Project Coordinating Committee and the Irrigation Management Division (IMD) Project Committee. The Project Coordinating Committee, whose primary function is to oversee construction and settlement activities, was not fully effective in dealing with management problems in the completed Phase I areas; and the IMD Project Committees were also ineffective for various reasons.

At least partly in response to observations made on these problems in Merrey and Somaratne (1989), a Subcommittee of the Project Coordinating Committee was established in mid-August 1988 to discuss agricultural programming issues at the project level. This was reported in the Progress Report (IIMI 1988b:76). Chaired by the Project Manager (Settlement), the subcommittee initially included the two IMD Project Managers, the Chief Resident Engineer (CRE), the agricultural officer of the project, and the Assistant Commissioner (Agrarian Services). The Project Managers (IMD) had proposed including farmers' representatives on the basis of one representative from each tract, but some of the members were not in favor of this innovation.

After some discussions at the Ministry level between the Director of IMD and the Projects Managers (Settlement and IMD), agreement was reached to include farmer representatives on this Subcommittee. The Project Manager (Settlement) is the chairman and one of the IMD Project Managers is secretary. All line agency heads at the project level involved in agricultural implementation are supposed to attend the monthly meetings of the subcommittee, which are held just after the project coordinating committee meetings. Since the subcommittee has only met twice as of the writing of this report, we cannot evaluate the effectiveness of this innovation, but will monitor it during the next season.

Organization for O&M within the Irrigation Department

In both previous reports (Merrey and Somaratne 1989; IIMI 1988b) we had highlighted the impact on O&M resulting from the lack of separation of Phase I O&M from Phase I and II construction activities, a problem ID officials were also aware of. During yala 1988, the Irrigation Department (ID) had attempted a partial solution to this problem, by assigning the Senior Irrigation Engineer (SIE) (Water Management) responsibility for system operation, but certain anomalies in the assignment of responsibilities and in the lines of authority had reduced the effectiveness of this change (IIMI 1988b:68-72).

Effective on 1 January 1989, the ID implemented a reorganization of its O&M organization. The major features of this reorganization are:

1. Establishment of a separate O&M organization under the SIE who has been delegated complete responsibility over all O&M matters, including administrative and financial control. He reports to the CRE, and is to keep the CRE informed of his work;

2. Appointment of one irrigation engineer (IE) for each of the two new subsystems (left bank and right bank). The IE (O&M) receives his instructions directly from the SIE for O&M work, and exercises financial and other authority for all O&M matters in his respective area;

3. Appointment of one technical assistant (TA) and one work supervisor for each tract who will be responsible for supervising O&M work under the supervision of the IE (O&M). Turnout attendants (irrigators) have also been appointed on the basis of one for approximately 200 ha, to be supervised by the work supervisors; and

4. Allocation of specific vehicles, machinery and other equipment to the O&M section.

The IEs for O&M will continue to operate out of the resident engineers' (REs') offices and remain under the REs for certain administrative purposes. They are required to keep the REs informed of their O&M work. This may be an attempt to make use of the REs' greater experience and expertise to guide the IEs, while still enabling the REs to concentrate on completing the Phase II construction work.

This reorganization is certainly an important step towards establishing and institutionalizing an effective capacity for O&M at Kirindi Oya. The CRE has also proposed that there be further training of O&M staff and that some incentives be paid to staff for work on weekends and holidays and for recognizing good results in O&M work. These latter changes would probably require changes in government rules, not a simple matter.

Further, in recognition of the problems created by the lack of a systematic communication, monitoring and feedback system, especially between farmers and the ID officials, the ID has made provision for "complaints books" at the field offices, so that farmers can register their problems in writing; the ID has also undertaken to organize meetings with farmers more regularly. These innovations, by themselves, will probably make only a minor contribution to improving system performance, but they are an important beginning. We had hypothesized that farmers are unlikely to register written complaints, out of fear of reprisals in the future, but there is some evidence these <u>are</u> being used by farmers, though the response of the department is not yet documented. And it is not clear whether the ID intends to organize its own meetings with farmers, or to use the organizations the IMD has been trying to form.

Nevertheless, these changes are indicative of a change in attitude within the ID, one that is placing more emphasis on improving performance of the irrigation system through greater attention to O&M and developing means to have more effective communication with farmers. In the next season, IIMI will continue to monitor the results of these changes, and will assist the Department by providing some feedback on their effectiveness, and suggestions for further improvement.

OVERVIEW OF MAHA SEASON 1988/89

Decision-Making for the Season

The pre-kanna meeting for Tracts 2 and 5 on the right bank to discuss the issues relating to the season was held on 12 August 1988 with the participation of line agency officials and farmer representatives on the initiative of the project manager (IMD). The farmer representatives who met at the IMD project committee had discussed these issues in detail and had come to an agreement to propose that the first water issue for the season be made on 05 September 1988. The farmer representatives justified the demand for this early issue with three reasons:

1. Their yields had been very low in all the previous seasons because of pest attacks and diseases which were the result of not cultivating during the normal appropriate seasons. Water issues from 1986 onwards had been made for a late maha or an early yala because of the scarcity of water in the reservoir;

2. They were aware that many irrigation problems had been presented to the ID by farmers' organization for solutions in addition to normal maintenance and improvement work to be undertaken by the ID before the commencement of the season. Since they had been presenting these problems since 1986 without much results from their point of view, they pressed for an assurance that the work would be undertaken if the water issues were to be delayed; and

3. The farmers preferred to cultivate 4 to 4.5 months paddy varieties for better yields.

The ID on the other hand had the following problems with early water issues and proposed 20 September 1988 as the earliest possible date of water issue:

1. Water had been issued to Tract 1 (RB) for a late yala on the request of farmers; the ID had to supply water to the area till mid-September 1988. As a result ID would have to wait until this issue was over

before undertaking improvement and maintenance work in the head reach of the main canal;

2. The ADB allocation for Phase I improvement and maintenance work had to be used by 31 December 1988. Therefore, if the work were not undertaken before the commencement of maha 1988/89, the maintenance and improvement program would suffer from future financial constraints.

The farmers agreed to the date proposed by the ID on the assurance of the RE(RB) that he would do his utmost to solve the irrigation problems that could be attended during this short period.

The project coordinating committee, the main decision-making body of the project, met on 15 August 1988, just three days after the pre-kanna meeting. The ID officials explained their practical problems regarding water issues in early September. The CRE pointed out that he needs at least one month for the maintenance and improvement work from the last date of water issues to Tract 1 (RB). Some of the committee members questioned whether the decision regarding the cultivation season should be taken only on the demand of the farming community or on some "rational" ground. Because of the complexity of the issues regarding agricultural implementation, a subcommittee of the project coordinating committee was formed on the instructions of the Government Agent to discuss and make recommendations. As noted above, some of the officials rejected the proposal by the IMD project manager to include farmer representatives on this subcommittee (they were included only later).

The subcommittee decided to hold kanna meetings and arrive at a decision after explaining the problems to the farmers. Accordingly, the kanna meeting was held and 20 September was declared as the date for the first water issue. Unfortunately the ID could not complete the main canal improvement work by 20 September, so water issues for the season did not begin until 25 September. However, the ID did complete a lot of improvement work, especially land levelling work in nearly 528 allotments with irrigation difficulties, construction of some drainage canals, and solving some minor irrigation problems. The leaders of the DC organizations worked with ID staff cooperatively and were of great assistance in identifying and solving these problems, according to the RE in charge of the right bank system.

Despite the requests from the farming community for early water issues, and the decision of the kanna meeting that field channels were to be cleaned by 15 September, in our sample area the FC cleaning had not been completed even by the end of September. The ID did not release a full supply of water to the Tract 5 area for land preparation because the majority of farmers were still not in their fields. The ID provided a reduced supply from 25 September to 04 October 1988 as a water saving technique until there was a demand from the farming community for more water. However, this practice discouraged some farmers who tried to follow the cultivation calendar. Later, on the request of the farmer organizations, the Government Agent amended the cultivation calendar on the recommendation of ID, declaring 05 October 1988 and 15 February 1989 as the first and last days of water issues respectively.

The ID had plans to issue water continuously for a period of five weeks for land preparation and introduce a rotational issue thereafter. Because of the social unrest and disturbances prevailing in November and December, the ID had to give up these plans and had to limit its operational functions to the minimum.

Irrigation System Operation during Social Unrest

As the SIE (water management) explained to us, the system operation was done with a limited number of irrigation laborers stationed at ID field offices. One irrigation laborer was stationed at the Tract 5 unit office who provided information to the SIE on the availability of water in the area. There was little operation of cross regulators and distributary gates during this time. Sluice gate operations and cross regulator operations when required were done by the SIE himself to encourage irrigation laborers who were scared to attend to this work. Both the resident engineers (RB and LB) were present during the disturbances, though the situation did not permit them to participate much in operations.

How the Farming Communities Adjusted to the Situation

When the disturbances in the area developed, the land preparation work was still being done. There was a scarcity of tractors even prior to the disturbances because the tractors that farmers normally bring from their original villages in Matara could not be brought as a result of disturbances in the Matara District itself. There was also a shortage of fuel for tractors. These problems delayed the land preparation at the very beginning of the season.

The situation became worse in November when banks and government institutions were unable to function normally. Some farmers had been issued the first portion of their bank loans by this time for land preparation work. However, since neither the Agrarian Service Center nor the private trading organizations could function properly, many farmers were unable to apply fertilizer. At the same time some farmers reported that they had to buy seed paddy twice because the seeds which they had initially germinated were spoilt as they could not be sown due to curfew and disturbances. The second portion of the bank loans were issued very late; as a result there were delays by some farmers in the application of urea.

However, other farmers were able to get credit from people in the surrounding areas to buy inputs and food, but at a high interest rate. Though the IMD project manager remained in the project area during the disturbances, he was unable to contact the relevant agencies to provide necessary services. Some institutional organizers (IOs) and field level officers of the Land Commissioner's Department, especially the Hamlet 8 and 9 officers, were present in the hamlets during this period and tried to help farmers in whatever way possible.

There is no doubt that the farmers had to suffer a lot during this time. They adjusted to the circumstances in various ways. The strategy of the very poorest farmers was to delay cultivating until they could get bank loans and other inputs. In general, none of the farmers whom we interviewed were able to follow the cultivation calendar. Therefore, water issues had to be extended to 28 February 1989 officially, but were in fact continued until 13 March. An additional reason for this further extension was the ID had to provide extended issues to DC7 in which the cultivation had been further delayed as a result of erosion of the channel bund.

There is a general tendency among farmers as well as officers to claim that there was no problem regarding the distribution of irrigation water in this season because the ID staff did not interfere in the operational activities. Some go to the extent to say that it was a "farmer-managed system" those days. However, our interviews with a lot of tail-end farmers of DCs contradict this general perception. According to these interviews, there were severe scarcities at the tail end of distributaries, not because of the non-availability of water in DCs, but because of the interruption by farmers on head-end field channels who lifted the FC gates to take more water.

Conclusions Regarding the Seasonal Decision-Making Process

Seasonal decision-making is still a problem in Kirindi Oya. As the above discussion highlights, the general procedure for decision-making is as follows:

1. DC organization meetings. Farmer representatives propose dates for water issues and make suggestions regarding the season. Since only the IMD officers attend these meetings, other agency officials, such as Agriculture Department and Irrigation Department representatives, do not have the opportunity to put forward their views. The decisions taken are unaffected by official views and are farmer-biased. This is our observation, which is despite specific instructions from the head office in Colombo asking ID officials to participate in these meetings.

2. IMD project committee meetings. Farmer representatives propose the dates for the cultivation season. Though technical assistants attend these meetings, they are not aware of the views of higher officers regarding the issue of water; again, there are instructions from the head office requesting participation in these meetings. The decision taken here are also farmer-biased.

3. Pre-kanna meetings. The problems relating to the issue of water are explained to farmers by agency officials. However, the line agency officials attending the meeting may hold different views since they often have had no opportunity to discuss the matter among themselves before coming to the meetings. In most cases a rational decision cannot be arrived at this meeting.

4. Project coordinating committee. This committee discussed the issues relating to the season just after the pre-kanna meeting had been held, in which an assurance was given to farmers over water issues. The committee wanted to change the decision taken at the pre-kanna meeting. In our view the issues and possible scenarios should have been discussed here a few months prior to the commencement of the season. Since no farmers are included on this committee, it is official-biased.

5. Subcommittee of the project coordinating committee. This subcommittee was just being established at the beginning of the season, and did not play a significant role this time. In future it can be used to discuss the officials' proposals with the farmer representatives and to get farmers' feedback regarding the implementation of the previous cultivation season. Line agency heads can explain their problems relating to water issues, input supplies, and other matters to the farmer representatives at this meeting.

5. Kanna meeting. The function of this meeting is to ratify the decisions taken at the pre-kanna meeting. It is the only step in the above process that is an "institution", i.e., it is legally sanctioned and normatively expected by farmers. On the other hand, it is often too large and unwieldy to be an effective forum for rational discussion and decisions; it works best as a forum to announce and legitimize decisions made earlier.

Since the present process leads to many conflicts, the following recommendations may assist in institutionalizing a rational and legitimate decision-making process regarding the cultivation season. These suggestions are based on the assumption that the government will try to make the existing framework operate more successfully, rather than drastically change the framework itself.

1. Hold DC organization meetings with farmer representatives, with the participation of officials from other agencies, particularly the Irrigation and Agriculture Departments, so they can influence the decision-making process. Attempts to convince farmers to grow other food crops, including discussion of problems and possible solutions to the problems, should begin in these meetings and carry into higher-level meetings. This presupposes the agencies have a proposed plan before these meetings;

2. Participation of higher level line agency officials, such as the SIE (water management) and the IEs for O&M, at IMD project committee meetings, particularly when decisions regarding a season are to be taken;

3. Hold a meeting of the subcommittee of the project coordinating committee to discuss the issues relating to the season and arrive at a decision in consultation with the farmer representatives on this subcommittee before holding pre-kanna and kanna meetings;

4. Hold pre-kanna meeting on the basis of the subcommitee decisions; and finally,

5. Ratify the decision of the pre-kanna meeting at the kanna meeting.

We do not feel that a decision-making process can work successfully unless it allows all parties to the cultivation season -- government officials and farmers -- to participate actively in the discussions. If the decision is biased towards one party or the other, it will not have much legitimacy and may not be adhered to. Establishing a decision-making process that is accepted by all as legitimate is a necessary, though not sufficient, step in institutionalizing an effective management system, including implementation of plans for other field crops, at Kirindi Oya.

OBSERVATIONS ON THE IMD PROGRAM FOR PROMOTING WATER USERS' GROUPS

The IMD program for the formation of water users groups was launched this season by the IMD project manager for the new area of the project with the assistance of one institutional development officer (IDO) and 13 IOs. Three IOs were posted in the LB area and ten in the RB. Their major function at this stage was to establish themselves in the community, initiate FC and DC group meetings, and explain to the farmers the necessity of such organizations to find solutions to their irrigation and agricultural problems.

Since the IMD project manager had already formed FC groups and DC meetings before the introduction of the IO program, the IOs' function was to strengthen these organizations. As discussed in the <u>Progress Report</u> (IIMI 1988b:74-75), these organizations, having been hastily organized when there was only one person for the whole area, already had an inherent weakness because they had been organized from the top and not the bottom; i.e., the DC level had been organized without adequate attention to the foundation at the FC level. Many of the ordinary farmers were not aware of the role of the organization, their own role, or the role of the FC leader in it. Since the potential visible benefits of the organization was irrigation problem solving, farmers and FC leaders did show some interest in the organization when such problems were attended to by ID on the initiative of IMD.

Just before the beginning of this season, there was a maintenance and improvement program implemented by the ID with the involvement of DC organizations. The secretaries and presidents of the organizations helped the ID technical staff to identify irrigation problems and when the program was implemented they played an active role by participating in the work. However, the majority of the FC leaders took no interest or had not identified the farmers' irrigation problems for inclusion in the program. They started accusing the leading men in the DC organizations of working only for bribes and other kinds of personal benefits. Though the IOs were present during this period, we did not observe most of them taking action to resolve these conflicts.

Such conflicts arose in three hamlets in Tract 5 where we conducted our research. In two hamlets, the DC organization stopped functioning as a result of the conflicts that emerged during the maintenance program. In one hamlet the organization was sustained because of the efforts of the IO who took a keen interest of the IMD program, but the leadership of the DC organizations was changed by the farmers. However, when the program was over the enthusiasm the farmers had for the organization faded away. DC leaders as well as FC leaders did not try to mobilize farmers for regular canal cleaning and FC maintenance work at the beginning of the season.

The DC organization in Hamlet 11 (our intensive sample) became defunct by the end of the season for the following reasons:

1. Criticism of the leading men of the organization by some FC leaders and farmers for taking advantage of their position, which finally led to their resignation from the organization. Though there were accusations by some individuals, in our view, both leaders, the secretary and the president, were committed men on whose shoulders the entire organization had rested;

2. There was no incentive for the members to work in the organization. Instead there were accusations by the farming community who had the misconception that it is the responsibility of the leader to work for them;

3. There were threats on the lives of the DC leaders for presenting some land problems such as encroachments, illegal transactions, etc to the IMD project committee and project coordinating committee;

4. Some active FC leaders too were discouraged by the lack of cooperation by the farming community for FC maintenance and other relevant work. They avoided DC meetings as a protest;

5. Some FC leaders treated regular meetings as of no use, since they were attended only by IMD officials; other officials did not participate. In Hamlet 11, there were conflicts between the DC leader and field level officer of the Land Commissioner's Department. This too discouraged many farmers as well as FC leaders from participating in the meetings. The IO was helpless and could not resolve this conflict; and

6. As a result of lack of participation by other line agency officials at DC meetings, all the local level problems had to be taken up at meetings of the IMD project committee, the subcommittee of the coordinating committee, and sometimes the project coordinating committee itself. DC meetings could not solve even minor problems. This further discouraged those who had participated at such meetings.

Other Problems with the IO Program

We had plans to study the IO program in detail this season but the disturbances made this impossible. But the following basic problems with regard to the program can be identified:

1. The IOs are graduates recruited for the program on contract basis for a period of two years. The program does not offer them any future career prospects from their point of view. Though some IOs have shown interest in the work, they were still more interested in finding a permanent appointment. Out of the thirteen IOs appointed to the project, six got teaching appointments and left the service. This pattern of losing most of the IOs before the end of their two year contracts has been a major problem at Gal Oya and presently in the Irrigation Systems Management Project in Polonnaruwa District. It should be noted that some of the IOs had established themselves well in the farming community, a necessity for effective implementation of the program;

2. Working with some of the IOs in the project especially in Tract 5, we began to question whether they possessed the necessary qualities and values demanded by the program. Many were highly pessimistic of any possible change in the ideology of the peasantry, whom they view as a "corrupted lot", i.e., people unable and unwilling to adopt "modern" ideas. This raises fundamental questions about the recruitment and training of IOs, which we are unable to answer;

3. We were not able to participate in the weekly discussions the IMD project manager had with the IOs. However we believe these discussions are important for identifying the practical problems associated with the formation of effective farmers' groups and for guiding the IOs to overcome their difficulties as change agents.

TENTATIVE CONCLUSIONS AND ANSWERS TO THE RESEARCH QUESTIONS

In the Inception Report (IIMI 1988a:17-18) we listed seven research questions that would guide the research on irrigation institutions. In this section, we review the tentative conclusions and answers to these questions which we have arrived at to date. They are subject to further refinement and modification as the research proceeds.

1. In our previous report (Progress Report, IIMI 1988b) and in a forthcoming publication based on research that preceded this research project (Merrey and Somaratne 1989), we have outlined the overall organizational structure of the agencies involved in irrigation management at the project/system level. In the present report we have identified two recent structural changes. In general, we find that the management structure does inhibit management efficiency. The project is being implemented through line agencies, not all of which are even in the same ministry. These agencies

have traditions regarding their functions that have built up over many years, and they do not always mesh with each other well, and are not always conducive to achieving the performance wished for, particularly since the expectations at Kirindi Oya are higher than had been true for new systems in the past. Examples include the greater value given to construction over O&M work, lack of rewards for people who work particularly hard or whose achievements are beyond the normal range, and lack of accountability to the clients, the farmers who are receiving the services. That is, within the various agencies there are factors that affect the incentives for providing good services, and that reduce the management efficiency. In addition, coordination and cooperation among agencies is often problematic, and the mechanisms for achieving this coordination are not always adequate.

For example, we had identified the conflict between construction and O&M as having reduced the efficiency of the Irrigation Department. As we have reported, the Department has taken steps to reduce this problem, by establishing a separate organization for O&M. This should help, but as the Department officials themselves note, the incentives for field level officials to perform their jobs at a high level are still inadequate. We believe that a thorough review of the management procedures and of the incentive structure and procedures for establishing objectives and monitoring performance of personnel, and a reform of these procedures and structures could lead to significant improvements. This question goes beyond Kirindi Oya, and is being addressed by other projects.

A major problem among agencies remains the clarification of the role of the Irrigation Management Division, and the relationships between this Division and the other agencies working in Kirindi Oya. This remains a problem despite official circulars from Colombo. Again, recent changes, such as establishing the subcommittee of the project coordinating committee and admitting farmer representatives into this committee are positive steps. However, this seems a temporary expedient: a serious question remains as to the future management structure for Kirindi Oya. If the hopes for a high-performance system supporting productive commercial agriculture are to be realized, then a stronger management structure, with substantial authority and resources and strong ties with farmers' organizations will be required.

2. In our various reports we have described the decision-making processes and information flows characteristic of the project. We have not fully addressed the question of performance monitoring and evaluation of personnel. We have identified serious problems with the flow of information and with the decision-making processes, which we attribute primarily to the organizational weaknesses. For example, we had noted before that officials within the Irrigation Department do not have good internal information sharing, and do not adequately inform the farmers on the water supply and the options faced by farmers. We had suggested that regularly scheduled staff meetings at various levels of the Irrigation Department would be very useful as information sharing forums.

Perhaps more serious, because of the weakness of the farmers' groups, and the lack of attendance of officials from line agencies at meetings with farmers, the sharing of information is not effective. We had suggested that agencies take action to insure their officials do regularly attend meetings of DC organizations and the IMD Project Committee.

3. Related to the first two research questions, the third question focuses specifically on the patterns of communication, cooperation, collaboration, and conflict among the different agencies for setting and achieving project goals. For implementing the construction work, it appears that the communication and cooperation are quite adequate, and the project coordinating committee is effective for this. However, as noted above and documented in our previous reports, there has been some conflict between the Land Commissioner's Department and Irrigation Management Division, and a general lack of sufficient cooperation in an active sense between the IMD, ID and Agriculture Department. The conflict between the Land Department and IMD seemed to result from a lack of clear understandings about their respective roles, and seems to be less serious now. The insufficient active cooperation among the other departments can be illustrated by their inability to agree on a plan of action for operating the system to promote non-rice crops.

The government has tried to deal with these problems by means of workshops and by issuing instructions from Colombo. These are useful, but we would suggest the government consider establishing a high-level project manager for Kirindi Oya who would have the seniority and the authority to work with all parties to establish a common plan of action, and insure effective cooperation among the departments and agencies for achieving the objectives of that plan.

We are unable to assess the effectiveness of the Central Coordinating Committee, which meets regularly in Colombo, since we have not had occasion to attend these meetings. Its major responsibility is coordination of the construction program, not O&M. We have the strong impression, however, that communication of essential management information, such as performance of various aspects of the system, and key issues and the alternative views on these issues, are not communicated adequately to this Committee. This may be improved through the proposals for programming and monitoring of the management consultant (Wanasinghe 1989).

4. The fourth research question is really a series of questions relating to the program to form water users' groups at the field channel and above. Our two previous reports and this one have focused much attention on these questions. In general, we find that the effort is quite inadequate and ineffective to date, despite the real efforts by the officials at the project level. The farmers' groups are weak, not very effective, and not highly regarded by their presumed members. We have drawn attention to the fact that farmers are becoming discouraged about the possibility of farmers' groups as a result of the continuing weaknesses.

There are many problems, but the key ones include: the inadequacy of the financial and human resources to achieve the objectives of the project; related to this, the internal weaknesses of the IMD establishment in Kirindi Oya such that the project manager is overtaxed with attendance at farmers' meetings, rather than supervision of IOs, the IOs are not well-trained, sometimes poorly motivated, and as a result ineffective; and perhaps most serious, there is a lack of a clear commitment to work with farmers' groups by other departments.

This lack of commitment is the result of the absence of a clear plan with clear objectives, a lack of a vision as to what will be the role of the farmers' groups and what will be their relationship with government agencies, and a lack of clear incentives for agencies to work with farmers. Rather, the problem of promoting farmers' groups is seen as peripheral to the overall project objectives, and seen as something only IMD is responsible for -- a marginal agency (in many officials' eyes) to deal with a peripheral problem.

5. The fifth research question follows from the fourth, and focuses on the patterns of communication, cooperation, and collaboration between the agencies and the water users' groups. We have documented a pattern of resistance to the IMD-formed groups among some officials, resistance to farmers' representatives participating in project-level committees, and lack of attendance by officials at meetings of farmers' groups; and we have suggested some possible measures to solve these problems, above.

6. The sixth question is more complex, as it attempts to relate the level of cooperation among farmers to the technical requirements of the system. We have only begun to address this issue. But the design of the field channels and distributaries requires a certain amount of cooperation among farmers to share the water. The design assumes rotations on field channels, with two allotments to be irrigated simultaneously at a given time. Farmers may choose to modify this, for example through equal sharing by dividing the flow into small streams for crop maintenance (Merrey and Somaratne 1989). This is perhaps workable. But if farmers at the head of a field channel, or farmers on field channels at the head of the distributary, choose to take an undue share of water, they can, and sometimes do, deprive tail enders of their share of the water. Further, the government expects farmers to maintain the field channels cooperatively, and given low maintenance budgets, farmers may have to maintain distributaries as well.

The present level of cooperation among farmers varies from channel to channel, but on many channels is clearly inadequate for insuring equitable water distribution and good channel maintenance. Thus to return to the discussion in the introduction to this chapter, there is a definite and clear lack of "fit" between the technical requirements and assumptions, and the present level of institutional development. On the other hand, there are sufficient examples of cooperation among farmers to show that it is not impossible to achieve. As the system becomes fully developed, and water becomes scarcer and more valuable, there will be good reasons for farmers to cooperate. Government can assist by investing a greater effort to promote and strengthen farmers' organizations, and developing a viable plan for inclusion of farmers' representatives on the management of the project.

7. The final research question in this component is also complex, since it asks what the relationship is between the performance of the irrigation system and the institutional factors. We have only begun to address this question too. Since water supply was not a serious constraint in Tract 5 during the season (January to May 1988) we observed, it is difficult to make a clear connection. But it seems quite likely that as the full area of the system is developed, and water becomes a severe limiting factor, the institutional weaknesses and their impact on system performance will become clear. We have documented shortfalls in organizational performance at all levels.

CONCLUSION

We return briefly to the discussion of "institutions" in the introduction to this chapter. Particularly in a new irrigation scheme, "institutional development" is an important process that will determine the long term productivity, profitability and sustainability of the irrigation system. Presently, this process is at an early stage. We find "organizations" such as the various departments concerned with water, land, agriculture, and promoting farmers' organizations; and we find some farmers' "organizations", albeit rather weak. But we do not find strong and effective institutions either at the project or the farmer levels. For farmers, their participation in the management of the irrigation system through FC and distributary organizations is not at all unthinkable -- they are not yet convinced. And even management without the Irrigation Departments and Irrigation Management Divisions is not entirely unthinkable in the minds of some people, since no commitment to these has yet been established.

Large investments are made in the tangible, concrete physical structures such as canals and the reservoir. These are objective, and it is easy to measure progress. Institutional development is intangible, non-material, complex, frustrating, and involves subjective as well as objective views; it takes a very long time and a great effort to initiate and carry through the process. But without this investment, the project objectives will remain unrealized.

RESEARCH PLANS FOR YALA 1989

The research plan proposed in the Progress Report (IIMI 1988b) would be undertaken this season because we could not cover the whole program as a result of the disturbances and social unrest last season. However, there will be more emphasis on how the new organization for O&M works and the achievements of the subcommittee of the project coordinating committee.

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IV. ON-FARM IRRIGATION MANAGEMENT FOR UPLAND CROPS

The main initiatives taken by IIMI senior staff up to September 1988 in assisting the DOA research staff at Wirawila ARS in developing the station for conducting the On-station and Adaptive Research trials in farmers fields have been described in the previous report.

Although every attempt was made to have the on-station development works completed by the end of September 1988 in order to enable the proposed maha program for 1988/89 to commence by the first week of October, the unsettled conditions in the area and the difficulties experienced by the field staff of DOA resulted in a failure to achieve the desired objective.

As reported earlier in the Progress Report (1988: 80), the Irrigation Department through the CRE (KOISP) undertook the responsibility for completing the irrigation and road network, fencing and field structures. They were able to complete the foregoing work by end of September. The DOA staff were, however, not able to fulfil their share of the work which involved land shaping and layout of the cross-levelled graded terraces. It was not possible, under these circumstances to conduct any on-station trials for the maha of 1988/89.

No progress was made in further development work for the next four months because of the intervening elections and the deteriorating security situation which hindered staff movement and use of earth moving equipment.

A renewed attempt was however made by the DOA staff in March 1989 to have the land shaped and terraces developed for the yala season. The newly appointed Research Officer to the station had done his best under the prevailing conditions, but the lack of essential guidance and supervision that should have been provided by a more experienced officer had resulted in distortions to the originally conceived layout plan.

During the visit to Wirawila ARS by IIMI senior staff in early March 1989, the importance of having at least one segment ready by 1 April 1989 in order to make a start on the yala program was emphasized. The Senior Deputy Director Research of DOA was addressed on the urgent remedial measures that needed to be taken in order to have this one segment ready by 1 April.

The DOA made use of the opportunity of the presence of Dr. J. Wolf, Consultant to the US-AID funded Diversified Agricultural Research Project (DARP) of the DOA to examine the quality of the on-going development work at the station. At the meeting of the DOA, Water Management Sub-Committee on Wirawila held on 3 April 1989 at Peradeniya, and chaired by the Senior DD Research, the following decisions were arrived at:

1. Terraces to be re-laid in a manner so that they will be along the contour in a 'herring-bone' pattern, and the width of each terrace to be between 12-15 meters.

2. Grading and levelling to be re-done completely in the proper fashion using grade stakes and operations to be closely supervised by an experienced officer.

3. Terrace orientation to be modified so that the present brick-lined, cement plastered irrigation supply channel could deliver water to each terrace without the need for having a down-slope bund adjacent to the supply channel as would be the case in the present layout.

4. Flow measurements from the supply channel to each terrace will be made using portable flumes rather than the presently intended 'vee-notch' weirs.

In view of the foregoing considerations, it will not be possible to conduct the proposed on-station program for this yala.

The extension field staff of DOA had made plans for conducting some exploratory trials in farmers' fields during the maha 1988/89, consisting of five types of crop combinations in 34 demonstration plots of 1 acre each. Again, due to unsettled conditions they were not able to accomplish their program. Nearly all farmers who had been selected for conducting these trials on a part of their allotments had switched over to growing rice in the whole allotment. However, one farmer had successfully established a crop of chillir on the well drained portion of his allotment which was planted by 10 October 1988. By early March 1989, he had already taken 6 pickings of chilli, and the quality of the standing crop at this stage was very good. At least this single demonstration shows the technical feasibility of growing successful non-rice crops during the maha season in this environment. Similarly, one could observe a few other locations within the study area where farmers had grown chillie, green gram and some vegetable crops in the well drained portion of their allotments, or in land above the command area which was irrigated by lifting water from the adjacent channel.

The extension staff of DOA have plans for carrying out 37 demonstrations in Tracts 2 and 5 during this yala 1989 which will consist of 1 acre size demonstrations with four crops namely green gram, red onion, chillie and cowpea.

One of the very real problems faced by the extension staff is that of the counter-productive decision made at the kanna meeting to issue water for paddy to a restricted number of irrigation tracts during the yala season. This does not help in promoting the growing of non-rice crops. If farmers were to be informed that water deliveries will be made only once a week during the crop growth period then there would be a better opportunity for growing non-rice crops. However, this decision has to be taken in sufficient advance in order to enable the DOA extension staff to organize the timely supply of seed material and other inputs. However, it is very hopeful that the extension staff of DOA will be able to carry out the demonstrations planned for this yala.

V. ECONOMICS OF IRRIGATED CROP PRODUCTION: AN INTERIM REPORT

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 two study systems; and to analyze, based on the data from the sample farmers and from on-farm experiments in the Kirindi Oya System, the relative profitability of non-rice crops that could be grown by farmers in the systems in pursuit of crop diversification.

Since the commencement of this research project, the two study systems have each completed two cropping seasons; for the Kirindi Oya System, 1987/88 maha and 1988/89 maha, and for the Walawe System, 1988 yala and 1988/89 maha. At present, both systems are going into the third season; 1989 yala. In the last two seasons, the farmers in both systems grew rice, except a few farmers who planted non-rice crops on a part of their allotments. The extent of non-rice crop cultivations in the 1989 yala season is yet to be known in both systems.

The results of the Kirindi Oya 1987/88 maha season were summarized and reported in our Progress Report in October 1988, with special reference to the agro-economic performance of its rice production. Although the report was intended mainly to fulfill the first objective, that is, to assess irrigation performance through analyzing the data on rice production in the season, the data were summarized in such a way that the profitability of rice production can easily be compared with other non-rice crop productions. The structures of such factor markets as labor and capital, the information of which is crucial when the farmers try to introduce some non-rice crops in addition to rice, was also presented to the extent possible.

In this Interim Report, we first summarize the results of rice production in the Uda Walawe 1988 yala season in a similar way as for the Kirindi Oya 1987/88 maha season. In the second section, we examine, based on the available data, the profitability of non-rice crops relative to the rice production, as well as possible difficulties that the farmers in the study areas might encounter when they try to introduce these crops. Finally in the third section, we present briefly our future research plan of this component in the project towards the final report. Unless otherwise stated, the data used in this report are those obtained in our survey under this project.

RICE PRODUCTION IN WALAWE, 1988 YALA

The economic evaluation of crop production in the Walawe System has two specific objectives: 1) to provide base line information on the economic performance of irrigated crop production under existing conditions in the system (pre-rehabilitation conditions); and 2) to device strategies to promote non-rice crops under irrigation after the rehabilitation of the system with limited quantity of water but with better control.

These two objectives are closely related to each other. As to the first objective, the performance of the existing system is first evaluated in terms of economic performance. Hydrological, social, and institutional data will be supplemented at a later stage to reach a comprehensive system performance evaluation. In the same time, the economic data, together with other set of data, should provide the necessary information by which the strategy is set forth in a holistic manner to promote crop diversification after the rehabilitation.

In this section, we summarize the results of rice production in the 1988 yala season, based on the data collected from the farmer sample in the Chandrikawewa Block of the Walawe System. The primary objective here is to assess the economic performance of irrigated agriculture in the study area. Since crop diversification is supposed to be promoted during the yala season, however, it is expected that the data on rice production in this yala season provide base line information to which the production structure and profitability of possible alternative non-rice crops are compared at a later stage of this research.

Samples and Data Collected

The pertinent data for this analysis were collected from the farmers cultivating the allotments served by the Chandrikawewa Branch Canal. Of the 18 distributary canals (DCs) along the blanch canal (BC), the sample was drawn from the allotments served by three distributary canals, DC 3, DC 8, and DC 18, which are located head, middle, and tail of the branch canal, respectively. The sampling ratios in each distributary canal were determined according to the intensity of data collection in other components of this research project. In DC 8 where intensive hydrological monitoring was carried out a sample of 40 percent of total allotments were selected, while a 30 percent sample was drawn from DC 3 and DC 18 where the relatively extensive monitoring of irrigation performance was carried out. After choosing the sample distributaries, the samples for each distributary canal were drawn randomly stratifying the populations according to the location along the distributary canals (head, middle, and tail), and to the soil type (well drained, intermediate, poorly drained). In order to keep the sample size manageable, the intermediately-drained allotments were not included both for intensive and for extensive samples, and so were the middle-location allotments along the distributary canals for the extensive samples. The sample distribution is shown in Table 5.01.

The following data were collected from the sample farmers:

i) Basic characteristics of 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, and d) tenure status;

2) Basic data that are necessary to estimate costs and returns in agricultural production, i.e., data on agricultural outputs and inputs, and respective market prices;

3) Data on farming practices, such as dates of land preparation and planting, seed varieties, frequencies of fertilizer and chemical applications, and etc.; and

4) Data on output disposal and on credit.

In addition to the data above, an area survey and a crop-cut survey were carried out in order to avoid the under-reporting of the area planted and of the production attained. An area survey was necessary for two reasons. First, although the allotments in this system were originally designed to be 1.21 ha (3 acres), the actual acreage of many allotments at present diverges from the original one due mainly to encroachment of surrounding canal reservations. Second, land fragmentation and incidence of tenancy have been in progress so that there are many allotments where more than one farmer share one allotment. In the intensive study area (DC 8), the crop-cut survey was carried out for all allotments including the sample allotments, while in DC 3 and DC 18 it was confined to the sample allotments.

Rice Farming in Walawe as Compared to Other Region

Before presenting the results of our survey, let us have an overview of the yala rice production in Sri Lanka based on the Crop Production Cost Survey of the Department of Agriculture (Department of Agriculture 1987). Some indicators related to rice production in the 1986 yala season are summarized in Table 5.02 for four different regions in Sri Lanka.

Rice yield per hectare ranges from 3-3.5 tons for North-Central and Central regions to about 4 tons for the southern dry zone regions. It was 4.1 t/ha in Uda Walawe which includes our study area. Generally speaking, rice yield in Sri Lanka is higher in the maha (wet) season than in yala (dry) season, unlike in other parts of Southeast Asia. This is exactly the case when the 1986 yala season (shown in this table) is compared to the 1986/87 maha season (shown in Table 3.02 of our Progress Report). The yield difference between the two seasons was smaller for the southern dry zone than for the northern dry zone. For each region listed, the average area cultivated in the yala season was smaller than that in the maha season. However, this difference too was smaller for the southern dry zone, suggesting a better yala season water availability in these southern regions than in northern regions.

Production structure in terms of factor shares varies rather substantially between the regions, but for each region it seems not to differ much between the two seasons. The different patterns of labor use in rice production between the regions are also observed in the 1986 yala as in the

1986/87 maha; labor intensity is higher in the regions where the wage rate is lower, and the dependence on hired labor is higher in the southern dry zone regions.

Yield Performance in the 1988 Yala

As shown in the last column of Table 5.02, the average rice yield of the sample farmers in Walawe was as high as 6.1 t/ha, nearly 2 tons more than the yield reported for Uda Walawe in the 1986 yala season. Table 5.03 presents rice yield per hectare for the allotments in the DC 8 area, based on the 100 percent crop-cut survey. The average yield for the entire DC 8 area was 6.2 t/ha. The abundant water supply in the system throughout this season, as reported in the Progress Report (IIMI 1988, pp.97-113), may explain to a significant extent such a high average yield.

It is indicated in the table that neither location along the distributary nor soil type made any significant difference in yield. Our water measuring data show that, although there was not significant inequality in water distribution along the branch canal, there existed a certain degree of inequity along the DC 8 (IIMI 1988, p.105 and p.111). This fact and the fact that there was no significant yield difference among the locations along DC 8 may together imply that water supply was so abundant that the inequity in water distribution along the distributary did not matter. However, as will be seen, DC 18 allotments recorded significant lower yield than those in the other two distributaries.

Agronomic Practices and Production Structure

<u>Agronomic practices</u>: In the 1988 yala season, water was first issued on April 11. The majority of farmers, however, started land preparation after the Sinhala-Hindu New Year at the mid-April. The farmers began land preparation following an initial period of land soaking for about 3-7 days depending on the soil conditions. Land preparation consists of two times of plowing (by tractor/buffalo), bund repair, and puddling and leveling, stretching over a 3-6 week period. Ninety two percent of farmers used tractors and 14 percent of them used buffalos for land preparation. Tractor land preparation was mostly carried out as a custom work, though 22 percent of farmers used own tractor.

Immediately after puddling and land leveling, followed crop establishment which was done mostly through direct sowing. Only 5 percent of the farmers adopted transplanting method. The crop establishment commenced during second and third week of May, and by the end of May the entire areas under study finished planting. Almost all farmers planted paddy varieties of 3-3.5 month duration. The most popular variety was BG 94-1 which was planted by 58 percent of the farmers. Other popular varieties were BG 351 and BW 350, with adoption rates of 22 percent and 10 percent, respectively.

Three kinds of fertilizers were used. Ninety four percent of the farmers applied V-mixture (3-30-10) at the time of planting. Remaining 6 percent used no V-mixture, though its application is very essential for initial establishment of crop and root system development. Urea was applied during the growing stage. All farmers applied it either as a single dose (22 percent) or in two split applications (78 percent). TDM (Top Dress Mixture; 30-0-20) was applied by all farmers during the booting stage of crop.

The method of planting and the method of weeding were closely related. Since the majority of farmers adopted direct sowing, weed control by herbicides was the major method adopted by 97 percent of farmers. Manual weeding was practiced only by 4 percent of farmers who adopted transplanting. There was no serious outbreak of pests and diseases in this season. Ninety seven percent of farmers applied chemicals of various kinds 1 to 5 times mostly for the preventive purpose.

Production structure: The levels of major inputs are summarized in Table 5.04, by DC, by location along DC, and by soil type. The pattern of labor use by operation is given in Table 5.05.

The production structure in terms of the levels of major inputs was rather homogeneous in the study area across different DCs, different locations along the DCs, and different soil types. Except for a few cases, the differences in these input use levels were not statistically significant among the categories examined.

The high seeding rate is a general characteristics of the rice farming not only in the study area but also in the Uda Walawe region as a whole as shown in Table 5.02. In our study area, it was 191 kg/ha on the average, which was nearly twice as high as the Department of Agriculture's recommended level of 105 kg/ha for direct sowing.

The total value of all three kinds of fertilizers used by the farmers was Rs 1,129/ha on the average, with no significant variation over DCs, location along DCs, and soil types. The rate of nitrogen application on the average was 109 kg/ha, while phosphorous and potassium were applied at a rate of 36 kg/ha each. These levels of fertilizer application in the study area were comparable to those in other regions (Table 5.02), though the level of nitrogen use in the study area was slightly higher, and those of phosphorous and potassium were slightly lower, than the other regions (particularly North-Central and Central regions). Within the study area, the farmers cultivating the allotment located at the middle portion of the DCs used significantly less phosphorous and potassium (Table 5.04).

In value terms, a total of Rs 888/ha worth of herbicide was applied at 1.2 frequency, on the average. The level of herbicide use in the study area was higher as compared to other regions, reflecting the higher wage rate in the area; for weed control, the farmers depend more on herbicide use than manual weeding. Within the study area, the DC 3 farmers spent significantly more herbicide than others.

The value of pesticides applied averaged Rs 343/ha with a frequency of 2.4. In contrast to herbicide, the level of pesticide application was higher in DC 8 than in the other DCs, and in the middle location along the DCs than in the other locations. However, the difference was marginal, not giving any appreciable impact on the respective yield levels. The levels of fuel for tractor, as well as of fixed capital services from tractors and draft animals, were quite uniform within the study area.

The total labor use for rice production on the average for the study area was 102 days/ha, which was comparable to those reported in Table 5.02 for the Department of Agriculture's samples of the high wage-rate regions. Comparing to the labor use by operation in the Kirindi Oya 1987/88 maha season reported in the Progress Report, that of the study area in this yala season showed less labor for land preparation and more labor for harvesting and post-harvesting operations.

The most distinctive feature of the labor use pattern in the study area is found in its extremely high dependence on hired labor. On the average, 95 percent of the total labor requirement were worked by hired labor, and the remaining 5 percent or 5 days/ha by the family labor. The share of hired labor was particularly high not only in harvesting-post harvesting and crop establishment operations, for which the dependence on hired labor is commonly high in all rice growing regions, but also in land preparation. Being located in the high wage regions, it is expected for the study area to show high dependence on hired labor, as in Kirindi Oya and in Uda Walawe as a whole. But, the dominance of hired labor in the study area is far more than in these regions. An income effect that is due to the extremely high productivity of rice production and larger cultivating size in the study area, as compared to that of the ordinary farmers in Kirindi Oya and Uda Walawe other than study area, might explain partly such a high dependency on hired labor; i.e., rich farmers whose opportunity cost of labor is high substitute hired labor for their family labor. Whatever the reasons are, this fact must have profound implications if crop diversification is to be promoted in the study area. As long as this incidence of high dependency on hired labor in this area is a structural phenomenon, rather than temporary happening, crop diversification is not merely a matter of the farmers but of the hired laborers as well.

The first column of Table 5.04 shows rice yield per hectare by DC, by location along DCs, and by soil type. Reflecting the fact that the production structure is by and large homogeneous within the study area, no significant difference in the yield level is observed among different categories, except for DC 18 where the yield was significantly lower than the other two DCs. As far as the average levels of inputs are concerned, it is difficult to identify the reason why the yield was lower in this section of the system. The reason for this seems to be sought in the specific characteristics that this distributary canal has: much longer than the others; lined canal, unlike the others which are earth canal; and with many broken and deteriorated structures which are difficult to repair. As a result, the problem of inequitable water distribution along this DC is much more serious than the other DCs.

Credit: The information on the credit that the sample farmers obtained for rice production during the 1988 yala season is summarized in Table 5.06.

Sixty percent of the farmers obtained loans either from institutional sources or informal sources, or from both. A distinctive feature in the Walawe farmers' borrowing, as compared to the Kirindi Oya farmers reported in the Progress Report, is that the Walawe farmers heavily relied on informal sources rather than institutional loans, even though the interest rate in the former (135 percent/year) was much higher than the latter (9 percent/year). There are two possible reasons for this; first, there were in the study area a number of tenants who were not eligible to institutional loans; and second, among the owner operators, there were many farmers who were not eligible to institutional loans because of defaulting previous loans. On the other hand, 40 percent of the farmers did not obtain any credit. This could be either because they had no access to loan, or because their financial position was sound enough so that they did not have to borrow. Considering the high productivity of rice production in this area, the latter was a more likely reason. The amount borrowed by the Walawe farmers was much lower than that borrowed by the Kirindi Oya farmers in the 1987/88 maha season (IIMI 1988, p. 64).

Economic Performance

Some indicators by which the economic performance of rice production is evaluated are presented in Table 5.07. The market prices of the output and the inputs used for calculating these indicators are shown in Table 5.08.

The average gross revenue per hectare was Rs 28,000, which is considerably higher than the other regions in the 1986 yala season listed in Table 5.02. One reason for such a high revenue was of course the good yield performance attaining more than 6 t/ha. The other reason was a better output price. In the course of the 1988 yala season, the government support price of rice was raised by about 20 percent.

Reflecting the high gross revenue and the relatively low level of labor use, the average labor productivity was as high as Rs 272/day. Even for DC 18 where the rice yield was significantly lower than the other sample DCs, it was more than Rs 200/day. Compared to the regions listed in Table 5.02, it was two to five times higher.

The factor share of current inputs was around 15 percent. As a result, the gross value added ratio was around 85 percent, or Rs 23,500/ha on the average. As compared to other regions and other crops, this level of income generated in an agricultural production can safely be said high. As to the farmers' income per hectare, defined as the summation of returns to family labor and land plus operators surplus, it was Rs 18,000 on the average. For tenant farmers, the income is estimated to have been Rs 13,000/ha, which is still much higher than for the owner operators in the regions listed in Table 5.02. For the owner operator who owns a tractor, it would have been about Rs 20,000/ha. Since the average cultivating size was 1.2 ha on the average, the income actually received by an average owner operator without tractor would have been about Rs 19,700, after adjusting the interest paid.

Thus, in all measures, the economic performance of rice production in the Walawe 1988 yala season was excellent. It should be noted that such a high performance was attained under the dilapidated canal network with which better control and management of water can hardly be practiced. As pointed out earlier, the DC 18 farmers recorded significantly lower yield than the other DC farmers due mainly to an inequitable water distribution along the DC. Had better water distribution been possible, the performance could have been even better.

However, at least two qualifications should be made in this regard. First, although the land and labor productivity were undoubtedly high, it is not known how the water productivity was in the system. As already mentioned, water was abundant throughout the season. It was almost apparent that in all sections under study water was consumed much more than what the rice crop actually required. Being unable to make better water control because of the deteriorated canal-channel structures, water would have inevitably been wasted to a substantial degree, water which could have otherwise been utilized more productively in the lower sections of this large system.

Second, a question should be raised as to whether the good economic performance in this season is on its secular trend or just a very lucky, one-time phenomenon. Conflicting evidences are at our hands.

As shown in Table 5.07, the share of operators' surplus in the rice production of this season was, on the average, as large as 46 percent of the gross revenue. Since zero surplus is to be expected in the long run, provided that all related markets are perfect, such a large surplus may be taken as a sign indicating that the production in this season deviated upward from the equilibrium due to certain windfall gains. At least, one source of such windfall gains is known; that is, an increase in rice price during the season. To the extent that this price increase was not expected by the farmers, it would have resulted in an increase in the operators' surplus as 'quasi rent'. Such a disequilibrium would induce adjustments to restore the long run equilibrium through an increase in the land rent, not necessarily reducing the economic performance. It seems, however, that the magnitude of operators' surplus was more than what can be explained by this quasi rent.

On the other hand, a preliminary result of the crop-cut survey for the Walawe 1988/89 maha season indicates the rice yield of nearly 7 t/ha. If this is the case, such high yields for two consecutive seasons may suggest that they were not accidental.

In any case, the future performance of this system should carefully be observed in order to answer this question.

SOME PRELIMINARY EXAMINATION OF CROP DIVERSIFICATION IN THE STUDY AREAS

Thus far, we have summarized the results of our surveys on rice production in the Kirindi Oya 1987/88 maha season (Chapter 3 of the Progress Report) and in the Walawe 1988 yala season (the previous section of this report). Although the last season data on rice production in the systems are now being processed and analyzed, and our data collection in the on-going season including rice as well as non-rice crop productions is still under way, we have accumulated rather enough knowledge on the rice production in the study areas. In this section, we make some preliminary analysis on relative profitability of non-rice crops in comparison to rice.

The analysis here is not intended to be comprehensive one in which non-rice crops that are best suited to the soil-climatic as well as the socio-economic conditions in the study areas are to be identified. Such an analysis will be done after collecting data on non-rice crop productions from the sample farmers as well as from on-farm experiments yet to be conducted in the Kirindi Oya study area. What is intended here is to give a broad idea as to how the potential profitability is of non-rice crops grown popularly in Sri Lanka during the dry season under irrigated conditions and what specific production structure these crops have in general, supplying thereby basic information necessary for our future research on crop diversification specific to the study areas.

Production Structure of Major Non-Rice Crops Under Irrigated Conditions

Data on yield, labor requirement, and costs and returns of selected non-rice crops grown on the irrigated fields in the dry zone during the 1986 yala season are summarized in Table 5.09, the original data of which are from the Crop Production Cost Survey conducted by the Department of Agriculture (Department of Agriculture 1987). Unfortunately, this cost survey reports the costs of irrigated non-rice crops neither for Uda Walawe nor for Hambantota. For each crop shown in the table, the data are picked up, among a few regions (Districts) for which the cost data are available in the survey report, for the region that showed the best yield performance.

Several points are worthy of notice in the table. First, the gross revenue per hectare, or land productivity, varies tremendously from crop to crop, and so do the gross value added and farmers' income per hectare. Among the crops shown, Bombay onion recorded the highest gross revenue of Rs 81,810/ha, while that of soybean was as low as Rs 9,910/ha. The farmers' income per hectare ranges from Rs 5,660 for ground nut to Rs 68,650 for Bombay onion. Second, the areas planted with these non-rice crops in the yala season are very small, far less than the extent the farmers cultivate in the maha season. As a result, the income per farm is considerably lower than the income per hectare, ranging from Rs 10,990/farm for Bombay onion to Rs 1,350/farm for cowpea.

Third, variation in factor intensity is also large across the crops. Some crops, such as Bombay onion and chilli, require more current inputs than other crops, such as cowpea and soybean. For cowpea and ground nut, farmers used no fertilizer. Ground nut and Bombay onion require rather expensive seeds or seedlings. Labor requirement also varies tremendously, from 139 days/ha for soybean to more than 500 days/ha for Bombay onion and chilli. Fourth, although labor requirement varies across crops, labor intensity is generally high for the non-rice crops, which makes labor productivity of these crop productions rather low. Even for the highest case of Bombay onion, it is only Rs 148/day, and for other five crops it does not reach Rs 100/day. Fifth, although these non-rice crops are planted in a small size, 10 percent to 30 percent of the total labor requirement is supplied by hired laborers.

It should be noted that seasonal or yearly variation in costs and returns could be very high for the non-rice crops for which the variation is brought in both from yield fluctuations due to water and climatic conditions and from price fluctuations due to market conditions. Judging from the estimated factor share of land and operators' surplus, it seems that for some crops the cost-return structure shown in the table does not represent the ordinary or stationary situation. For instance, the returns to land and operator surplus for Bombay onion might have included some windfall gain specific to this season either due to better yield or due to better output price, or due to both. On the other hand, the production of cowpea and ground nut might have incurred certain unexpected loss. In fact, an examination of the 1985 yala season record (Department of Agriculture 1986) reveals better yield (2,010 kg/ha) and better price (Rs 10.83/kg) for ground nut for the same region, resulting in Rs 9,170/ha of factor payment to land and operator surplus (or factor share of 42 percent) and Rs 14,370/ha of farmers' income. Similarly, the 1985 yala data from the same source gives Rs 1,250/ha of factor payment, or 14 percent of factor share, for land and operators' surplus for cowpea in Kalawewa. However, the characteristics of the non-rice crops pointed out above are invariable across these checks.

Yield Level of Non-Rice Crops in Kirindi Oya

As mentioned earlier, the non-rice crop production cost data of Department of Agriculture do not include regions in the southern dry zone. For the Kirindi Oya area, the Agrarian Research and Training Institute (1988) provides some information on non-rice crops grown in the area.

Ground nut, cowpea, and chilli are the most popular non-rice crops there. Table 5.10 presents their yields for a few seasons. The yields of ground nut and cowpea are more or less at the same level as reported for the northern dry zone in the previous table. In the case of chilli, the yield increased from 0.5 t/ha in 1985 yala to 0.8 t/ha in 1986 yala, but it is still lower than 1.4 t/ha recorded in Anuradhapura in 1986 yala. However, the price of chilli in 1986 yala received by the farmers in Kirindi Oya was Rs 69.43/kg, which is incredibly high, and the farmers' income was as high as Rs 42,320/ha (ARTI 1988, p.48). Labor requirements for these crops are lower than those reported in Table 5.09; 115 days, 135 days, and 280 days, per hectare, for cowpea, ground nut, and chilli, respectively. However, even for cowpea, it is higher than for rice for which labor requirement in 1986 yala was 105 days/ha (ARTI 1988, p.48). In spite of such differences, it can be said that the performance of non-rice crops in Kirindi Oya is not very different from those shown in Table 5.09.

Prospects and Potential Difficulties of Crop Diversification in Study Areas

Lastly, requirements for irrigation, labor and capital, and profitability are compared between non-rice crops and rice in Table 5.11. Duration of the non-rice crops listed ranges from 85 days for green gram and cowpea to 200 days for chilli, as compared to 90-120 days for rice. Water duty also varies from relatively low requirement of 200-400 mm for cowpea to relatively high requirement of 600-800 mm for Bombay onion. Since water duty for yala season rice is generally 1200-1500 mm, even the high water duty non-rice crops require less water than rice. There is a tendency that the crops whose water duty is higher give better gross value added and higher farmers' income per hectare.

Most non-rice crops require significantly more labor than rice. In the case of Bombay onion and chilli, labor requirement is about five times more than that for rice production. As a consequence, no crop except Bombay onion gives labor productivity higher than rice. If the rice yield per hectare in Kirindi Oya reaches 5 t/ha as in 1988/89 maha, even Bombay onion can not compete with rice in terms of labor productivity. The labor productivity of rice in the Walawe 1988 yala season is nearly twice as high as that of Bombay onion.

High labor requirement is in a sense blessing, since more labor, otherwise left underemployed, could be absorbed in agriculture. However, too much labor requirement might create a difficulty for the farmers to adopt these labor intensive crops in replacement of rice. Since the average labor force a farm family in the study areas has is less than three members (Agrarian Research and Training Institute 1986, p.5), it is difficult for a farmer to meet the labor requirement of these crops solely with its family labor, unless the extent cultivated is extremely small. The large labor requirement can be met by hiring labor from outside. But, it may entail certain transaction costs for a farmer to hire a large number of laborers.

As already pointed out in our Progress Report and in the previous section of this Report, one of the characteristics of rice farming in the study areas is relatively high dependence on hired labor; of the total labor requirement about 60 percent in the Kirindi Oya maha season and more than 90 percent in the Walawe yala season are worked by hired laborers. This means that the labor markets are relatively better developed in the study areas.

However, since the total labor requirement for rice production is relatively small, the hired labor mandays per hectare do not exceed 100 days. A sudden increase in labor demand more than this level due to the introduction of the labor intensive non-rice crops might result in an increase in the wage rate, which further reduces the profitability of the non-rice crops. Possible impacts that such an increase in labor demand would give the local labor market should be examined carefully.

For some non-rice crops, capital requirement, defined as the summation of costs for current inputs, fixed capital services (tractor and draft animal rentals), and hired labor, is larger than for rice. This is particularly so for such crops as Bombay onion and chilli which can compete with rice in terms of value added and farmers' income per hectare. The capital requirement of these crops in the table assumes that the size of cultivation of the crops is much smaller than the farmers actual land holdings. Since the cost to hire labor would become progressively higher as the cultivation size of these labor intensive crops becomes larger in order to keep profitability comparable to that of rice, the capital requirement would even be higher than the indicative figures shown in the table. This suggests a potential bottleneck in introducing these cash-intensive crops due to the capital constraint.

It is often said that there are many non-rice crops that generate better income for farmers than rice does (e.g., Dimantha et al. 1981). Such a statement, however, is not necessarily true for a very productive rice growing region such as our study areas. With the rice yield as high as in the Walawe 1988 yala season, the number of non-rice crops that can compete with rice in terms of farmers' income is bound to be limited. Should the risk and uncertainty inherent in these non-rice crop productions be taken into account, the economic advantage of these crops over rice would become even less. In particular, the uncertainty in market conditions for the non-rice crops could impede crop diversification. The good economic performance of rice production in the Walawe 1988 yala season was due partly to the good output price of which the government support level had been raised by nearly 20 percent over the level in the previous season.

In sum, our preliminary examination on the possibility of crop diversification in the study areas reconfirms the difficulties that have been pointed out repeatedly by researchers who studied crop diversification under irrigated conditions elsewhere in Sri Lanka (e.g., Dimantha 1987, IIMI 1989). Among others, salient difficulties pointed out in this section are: 1) labor constraint and low labor productivity of alternative non-rice crops; 2) capital/credit constraint; and 3) market/price uncertainty. In addition, high productivity in rice production in the study areas entails a further difficulty: 4) a narrow selection, among conventional non-rice crops, of substitution crops that can compete with rice in terms of income generating capacity.

RESEARCH PLAN FOR THE COMING SEASONS

What should be studied in the future under this research project is almost self-evident from what has been reported in the Progress Report and this Report.

As to the first major objective, attempts should be made to link economic parameters with agro-hydrological parameters in order to obtain holistic measures of system performance and productivity of water.

As to the second major objective, the production structure and relative profitability of non-rice crops should be made clear under the natural as well as socio-economic conditions specific to the study areas. To do this, it is necessary to collect data from adaptive research on non-rice crops in farmers fields to be conducted in the Kirindi Oya study site, while continuing data collection from the sample farmers. Furthermore, in pursuit of identifying viable non-rice crops to be introduced in the systems, market analyses of these crops should be carried out both at the national level and at the local level.

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Table 5.01. Population and sample allotments in distributary canals under study in Chandrikawewa Block of Udawalawe System, by location along distributary canal and by soil type.

Soil type	Location along DC			
	Head	Middle	Tail	Total
	------ Number of sample/Population ------			
DC 3:				
Well drained	7/13	0/ 0	0/ 0	6/13
Intermediate	0/ 3	0/ 4	0/ 0	0/ 7
Poorly drained	3/ 6	0/ 4	5/11	8/21
Total	9/22	0/ 8	5/11	14/41
DC 8:				
Well drained	8/16	12/24	3/26	23/46
Intermediate	0/ 0	0/ 8	0/ 5	0/19
Poorly drained	4/ 4	9/18	12/25	25/47
Total	12/26	21/50	15/36	48/112
DC 18:				
Well drained	0/ 0	0/ 8	3/ 8	3/16
Intermediate	0/ 0	0/ 3	0/ 3	0/ 6
Poorly drained	4/ 4	0/ 6	4/ 4	8/14
Total	4/ 4	0/17	7/15	11/36
Total:				
Well drained	14/29	12/32	6/14	32/75
Intermediate	0/ 9	0/15	0/ 8	0/32
Poorly drained	11/14	9/28	21/40	41/82
Total	25/52	21/75	27/62	73/189

Table 5.02. 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 yala[1]				1988 yala
	Kalawewa	Kurunegala	Hambantota	Udawalawe	Udawalawe[2]
Yield (kg)	3 184	3 443	4 235	4 123	6 094
Seed[3] (kg)	118[8]	103[7]	113[8]	179[8]	191[3]
Fertilizer					
Total value (Rs)	1 165	1 104	1 286	1 121	1 129
N (kg)	85	82	116	93	109
P (kg)	42	47	41	40	36
K (kg)	32	41	42	38	36
Herbicide (Rs)	541	270	649	835	888
Pesticide (Rs)	316	335	557	388	343
Labor(days)					
Family	63(61)	113(60)	19(22)	56(46)	5(5)[14]
Hired	41(39)	75(40)	69(78)	65(54)	96(95)
Total	104(100)	188(100)	88(100)	121(100)	101(100)
Gross revenue (Rs)	10 857(100)	11 259(100)	14 611(100)	13 276(100)	27 728(100)
Factor payment(Rs):					
Current input[4]	2 591(23)	2 193(19)	2 998(21)	3 237(24)	4 264(15)
Labor: Family	2 298(21)	3 503(31)	865(6)	2 626(20)	243(1)[14]
Hired	1 590(15)	2 185(19)	3 087(21)	3 048(17)	4 136(15)
Total	3 888(36)	5 688(51)	3 952(27)	5 674(43)	4 379(16)
Fixed capital[5]	1 731(16)	993(9)	1 268(9)	1 507(11)	2 291(8)
Land & surplus[6]	2 647(24)	2 385(21)	6 403(43)	2 858(22)	17 597(63)
Value added[7](Rs)	8 266(76)	9 066(81)	11 613(79)	10 039(76)	23 464(85)
Farmers' income[8](Rs)	4 945(46)	5 888(53)	7 268(50)	5 484(41)	17 840(59)
Area cultivated (ha)	0.57	0.62	1.34	0.87	1.20
Actual farmers' income[9] (Rs/farm):	2 802	3 670	9 739	4 771	21 408
Price:					
Paddy rice[10](Rs/kg)	3.41	3.27	3.45	3.22	4.55
Seeds (Rs/kg)	4.82	4.70	4.48	4.99	5.64
Nitrogen[11] (Rs/kg)	6.7	6.5	6.4	6.4	6.5
Wage rate[12](Rs/day)	37.4	30.3	44.8	47.0	42.9
Labor productivity[13](Rs/day)	104	60	166	110	272

Note: 1) Data are from Department of Agriculture(DA). Climatic-geographycal specification of the regions:

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 Udawalawe data, 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 (1987). Cost of Cultivation of Agricultural Crops-Yala 1986, Vol.1 (Peradeniya: Department of Agriculture).

Table 5.03. Average rice yields (kg/ha) in the DC 8 allotments in the 1988 yala 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	5837 (14)	6214 (23)	6270 (5)	6095 (42)
Intermediate	6267 (5)	6162 (7)	6328 (4)	6236 (16)
Poorly drained	6144 (3)	6452 (16)	6103 (23)	6239 (42)
Average	5977 (22)	6289 (46)	6157 (32)	6178 (100)

Note: 1) Figures in parenthesis are the number of allotments in each category.
2) Yield differences between categories are not significant.

Table 5.04. Yield and inputs per hectare in rice production for sample allotments in Chandrikawewa Block, 1988 yala, by distributary canal, by location along distributary canal, and by soil type[1].

	Total Average	DC			Location			Soil type	
		3	8	18	Head	Middle	Tail	Well drained	Poorly drained
Yield[2] (kg)	6 094	6 339	6 178	4 915*	6 000	6 289	5 963	5 997	6 141
Current inputs:									
Seeds(kg)	191	177	196	185	193	185	195	200	185
Fertilizer:									
Total value(Rs)	1 129	1 219	1 128	1 056	1 173	1 029	1 178	1 134	1 126
Nitrogen(kg)	109	114	109	102	110	101	114	116	108
Phosphorus(kg)	36	43	34	38	40	30*	37	35	37
Potassium(kg)	36	40	35	39	39	30*	39	36	36
Herbicide:									
Total value(Rs)	888	1 243*	836	777	952	790	918	908	873
No. of appl.	1.2	1.4	1.2	1.1	1.1	1.2	1.3	1.1	1.3
Pesticide:									
Total value(Rs)	343	212	398*	244	253	406*	363	355	334
No. of appl.	2.4	1.7	2.7*	1.5	1.9*	2.8	2.3	2.5	2.3
Fuel[3] (Rs)	803	809	800	810	786	784	830	809	798
Labor (days[4]):									
Family	5	11	2*	13	7	2*	7	4	6
Hired	96	95	97	96	99	89	101	100	94
Total	101	106	99	109	105	92	107	104	100
Fixed capital[5] (Rs)	1 488	1 402	1 527	1 400	1 543	1 443	1 485	1 605	1 399

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 5.05. Labor use per hectare in rice production for sample allotments in Chandrikawewa Block, 1988 yala, by distributary canal, by location along distributary canal, and by soil type[1].

	Total Average	DC 3	DC 8	DC 18	Location Head	Location Middle	Location Tail	Soil type Well drained	Soil type Poorl drained
	days/ha								
Land preparation:									
Family	1.3(5)	4.2	0.1*	3.3	2.2	0.1*	1.4	1.1	1.3
Hired	26.3(95)	22.9	28.3	24.5	24.5	26.8	27.4	29.7	23.9*
Total	27.6(100)	27.1	28.4	25.0	26.7	26.9	28.8	30.8	25.2*
Crop establishment:									
Family	0.2(2)	0.7	0.0*	0.7	0.4	0.0*	0.3	0.2	0.3
Hired	11.9(98)	12.0	11.9	12.0	12.3	11.0	12.4	11.5	12.2
Total	12.1(100)	12.7	11.9	12.7	12.7	11.0	12.7	11.7	12.5
Crop care[2]:									
Family	1.5(20)	0.9	1.8	0.8	1.0	2.0	1.4	1.2	1.6
Hired	5.9(80)	6.0	4.7	10.5	7.5	3.8*	6.4	5.6	6.2
Total	7.4(100)	6.9	6.5	11.3	8.5	5.8*	7.8	6.8	7.8
Harvesting:									
Family	0.6(2)	1.0	0.0*	2.5*	0.8	0.0*	0.9	0.4	0.7
Hired	27.1(98)	28.2	27.9	23.4	28.5	25.5	27.4	28.7	25.9
Total	27.7(100)	29.2	27.9	25.9	29.3	25.5	28.3	29.1	26.6
Post harvesting:									
Family	1.1(4)	2.9	0.0*	3.6	1.7	0.0*	1.4	0.9	1.2
Hired	24.4(96)	25.0	24.0	25.4	24.9	22.1	25.9	23.6	25.0
Total	25.5(100)	27.9	24.0	29.0	26.6	22.1	27.3	24.5	26.2
Channel clearing:									
Family	0.8(53)	0.9	0.5	1.7	0.7	0.2*	1.3	0.4	1.0*
Hired	0.7(47)	1.2	0.1*	2.9	0.9	0.1*	1.1	0.6	0.8
Total	1.5(100)	2.1*	0.6*	4.6	1.6	0.3*	2.4	1.0	1.8
Total:									
Family	5.4(5)	10.6	2.3*	12.6	6.7	0.2*	6.8	4.3	6.1
Hired	96.4(95)	95.3	96.8	95.8	98.5	89.3	100.6	99.7	94.0
Total	101.8(100)	105.9	99.1	108.4	105.2	91.6	107.4	104.0	100.1

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 5.06. Sources of credit for and amount borrowed by sample farmers, Chandrikawewa Block, by distributary canal, 1988 yala.[1]

	Institutional (bank loan)	Informal		
		With interest	Without interest	Total
DC 3:				
Sample size 14(100)				
Non-borrower 2(14)				
Borrower	3(21)	8(57)	2(14)	10(71)
Average amount borrowed				
per farmer (Rs)	2 095	5 417	2 400	4 986
per hectare (Rs)	1 651	3 449	1 898	3 227
DC 8:				
Sample size 60(100)				
Non-borrower 28(47)				
Borrower	12(20)	27(45)	1(2)	28(47)
Average amount borrowed				
per farmer (Rs)	1 538	1 623	1 000	1 612
per hectare	1 200	1 717	581	1 698
DC 18:				
Sample size 16(100)				
Non-borrower 6(38)				
Borrower	4(25)	5(31)	3(19)	8(50)
Average amount borrowed				
per farmer (Rs)	1 282	2 292	1 733	2 187
per hectare (Rs)	1 444	2 308	2 546	2 353
Total:				
Sample size 90(100)				
Non-borrower 36(40)				
Borrower	19(21)	40(44)	6(7)	46(51)
Average amount borrowed				
per farmer (Rs)	1 580	2 268	2 003	2 239
per hectare (Rs)	1 313	2 056	1 833	2 052
Typical interest rate (%/season)	4.5	67.4	0	

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

Table 5.07. Gross revenue, factor payments and gross value added per hectare, farm income per hectare and per farm, and labor productivity in rice production for sample allotments in Chandrikawewa Block, 1988 yala, by distributary canal, by location along distributary canal and by soil type.[1]

	Total Average	DC 3	DC 8	DC 18	Location Head	Location Middle	Location Tail	Soil type Well drained	Soil type Poorly drained
	Rs								
Gross revenue[2]	27 728	28 842	28 110	22 363	27 300	28 615	27 132	27 286	27 942
	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)
Factor payment:									
Current input[3]	4 264	4 534	4 276	3 941	4 279	4 114	4 378	4 395	4 164
	(15)	(16)	(15)	(18)	(16)	(14)	(16)	(16)	(15)
Fixed capital[4]	1 488	1 402	1 527	1 400	1 543	1 443	1 485	1 605	1 399
	(5)	(5)	(5)	(6)	(6)	(5)	(5)	(6)	(5)
Labor: Family[5]	243	466	111	559	301	111	306	194	279
	(1)	(2)	(0)	(2)	(1)	(0)	(1)	(1)	(1)
Hired	4 136	4 329	4 059	4 264	4 375	3 776	4 243	4 240	4 059
	(15)	(15)	(15)	(19)	(16)	(13)	(16)	(15)	(15)
Total	4 379	4 795	4 170	4 823	4 676	3 887	4 549	4 434	4 338
	(16)	(17)	(15)	(21)	(17)	(13)	(17)	(16)	(16)
Land[6]	4 966	5 532	4 880	4 805	4 787	4 927	5 142	5 005	4 937
	(18)	(19)	(17)	(21)	(17)	(17)	(19)	(18)	(18)
Operator surplus[7]	12 631	12 578	13 257	7 394	12 015	14 244	11 578	11 847	13 104
	(46)	(44)	(47)	(33)	(44)	(50)	(43)	(43)	(47)
Gross value added[8]	23 464	24 307	23 834	18 422	23 021	24 501	22 754	22 891	23 778
	(85)	(84)	(85)	(82)	(84)	(86)	(84)	(84)	(85)
Farmers' income[9]:									
Unadjusted	17 840	18 576	18 248	12 758	17 103	19 282	17 026	17 046	18 320
	(64)	(64)	(65)	(57)	(63)	(67)	(63)	(62)	(66)
Interest adjusted	16 395	16 177	17 037	11 137	16 215	18 445	14 534	15 993	16 486
	(59)	(56)	(61)	(50)	(59)	(64)	(54)	(59)	(59)
Labor productivity[10]	272	272	284	206	260	312	253	262	279

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 5.08. Market prices used for imputation, Chandrikawewa Block 1988 yala.

Rice(paddy) price[1] (Rs/kg)	4.55	Wage rate (Rs/day):	
		Land preparation	40
Seed(paddy) price (Rs/kg)	5.64	Planting (male)	40
		pesticide application	54
Fertilezer (Rs/50kg bag):		Weeding: Male	50
V_1	150	Female	36
Urea	150	Harvesting: Male	47
TDM	150	Female	45
		Post harvest	49
Tractor rental rate (Rs/ha):			
Land preparation	919	Interest rate (%/season):	
Post harvest	406	Institutional	4.5
		Informal	67
Land rent (Rs/ha)	4961		

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

Table 5.09. Yields, labor requirements, and costs and returns of selected non-rice crops grown on irrigated fields in the dry zone of Sri Lanka in 1986 yala.[1]

Crop Region	Soybean Anuradhapura	Cowpea Kalawewa	Green gram Polonnaruwa	Ground nut Polonnaruwa	Bombay onion Kalawewa	Chilli Anuradhapura
Yield (kg/ha)	1 484	1 016	921	1 316	7 377	1 457
Price (Rs/kg)	6.68	12.13	19.66	9.32	11.09	24.26
Labor(days/ha)						
Family	98(71)	266(90)	174(76)	180(76)	408(74)	417(74)
Hired	41(29)	29(10)	55(24)	57(24)	144(26)	149(26)
Total	139(100)	295(100)	229(100)	237(100)	552(100)	566(100)
Gross revenue (Rs 1000/ha)	9.91(100)	12.33(100)	18.12(100)	12.27(100)	81.81(100)	35.35(100)
Factor payment (Rs 1000/ha):						
Current inputs:						
Seeds	0.67	0.31	0.55	1.96	1.18	0.43
Fertilizer	0.56	-	0.61	-	2.63	1.96
Chemical	0.23	0.53	1.76	0.59	1.46	1.88
Total	1.46(10)	0.84(7)	2.92(16)	2.55(21)	5.27(6)	4.26(12)
Labor: Family	3.43	9.86	7.36	6.50	16.48	14.72
Hired	1.34	1.07	2.29	2.04	5.89	5.09
Total	4.77(49)	10.93(89)	9.65(53)	8.54(70)	22.36(27)	19.81(56)
Fixed capital	0.90(9)	1.98(16)	1.53(8)	2.02(16)	2.01(2)	1.54(4)
Land & surplus	2.79(28)	-1.41(-11)	4.02(22)	-0.84(-7)	52.17(64)	9.74(28)
Value added (Rs 1000/ha)	8.45(85)	11.49(93)	15.19(84)	9.72(79)	76.55(94)	31.09(88)
Farmers'income (Rs 1000/ha)	6.22(63)	8.44(68)	11.37(63)	5.66(46)	68.65(84)	24.46(69)
Area cultivated (ha)	0.46	0.16	0.21	0.35	0.16	0.23
Actual farmers' income (Rs 1000/farm):	2.84	1.35	2.39	1.98	10.99	5.63
Labor productivity (Rs/day)	71	42	79	52	148	62

Note: 1) For variable definitions, see the notes to Table 2.

Source: Department of Agriculture(1987). Cost of Cultivation of Agricultural Crops-Yala 1986, Vol.2. (Peradeniya: Department of Agriculture).

Table 5.10. Yield per hectare of rice and non-rice crops in Kirindi Oya for selected seasons.[1)]

	Rice	Non-rice crops		
		Ground nut	Cowpea	Chilli
	mt/ha			
1985 yala	2.5	1.1	0.9	0.5
1985/86 maha	3.9	1.1	0.9	0.6
1986 yala	2.4	1.3	1.0	0.8
1987/88 maha	3.7			
1988/89 maha	5.0			

Note: 1) The 1986 yala was the season when water was issued first time under the Kirindi Oya Irrigation and Land Settlement Project (KOISP). Except rice in 1985 yala and 1985/86 maha, the yield figures are for the area that was brought under irrigation by KOISP.

Source: The data for the first three seasons are from Agrarian Research and Training Institute, Kirindi Oya Irrigation and Land Settlement Project: Mid-Project Evaluation, Research Study No. 85, May 1988, p.34; and for 1987/88 maha from our Progress Report, p.57. The 1988/89 maha yield is a preliminary estimate from our crop-cut survey.

Table 5.11. Comparison between rice and selected non-rice crops: requirements for irrigation, labor and capital, and profitability.

	Bombay onion	Chilli	Ground nut	Soybean	Green gram	Cowpea	Rice		
Crop duration[1] (days)	90	200	105	90	85	85	90 - 120		
							Kirindi Oya		Udawalawe 1988
Irrigation frequency[1] (days)	3-4	6	8	10	7-10	7-10	87/88 maha	88/89 maha	yala
Number of irrigation[1]	23	20	13	7	7	5			
Water duty[2] (mm)	600-800	500-700	450-800	250-450	250-450	200-400			
Yield[3] (mt/ha)	7.4	1.5	1.3	1.5	0.9	1.0	3.7	5.0	6.1
Price[4] (Rs/kg)	11.09	24.26	9.32	6.68	19.66	12.13	3.83	4.55	4.55
Labor requirement[5] (days/ha)	550	560	230	130	220	290	128	-	102
Labor productivity[5] (Rs/day)	148	62	52	71	79	42	112	178	272
Capital requirement[6] (Rs 1000/ha)	13	11	7	4	7	4	8	-	10
Gross value added[7] (Rs 1000/ha)	77	31	10	8	15	11	11	18	23
Farmers' income[7] (Rs 1000/ha)	68	24	6	6	11	8	6	11	18

Note:
1) Data are from Somasiri(1981).
2) Rough estimates based on Dimantha(1987) and Somasiri(1981).
3) From Tables 2, 9 and 10 of this Report, and from Table 3.02 of our Progress Report.
4) From Tables 2 and 9 of this Report, and from Table 3.02 of our Progress Report. For Kirindi Oya 88/89 maha, the same price as in Udawalawe 88 yala is assumed.
5) Data are from Tables 2 and 9 of this Report, and from Table 3.02 of our Progress Report. For Kirindi Oya 88/89 maha, the same labor mandays as in 87/88 maha is assumed.
6) The summation of costs of current inputs, fixed capital services, and hired labor. Data are from Tables 2 and 9 of this Report, and from Table 3.02 of our Progress Report.
7) The same data source as note 5) above. For Kirindi Oya 88/89 maha, 80% of value added ratio and 50% of farmer income ratio are assumed.

Source: S. Somasiri, Land, Water and Crop Management under Irrigation in the Dry Zone of Sri Lanka, Department of Agriculture, Peradeniya, 1981; S. Dimantha, "Irrigation Management for Crop Diversification in Sri Lanka", in Irrigation Management for Crop Diversification, IIMI, 1987, pp.135-150.

VI. DESIGN-MANAGEMENT INTERACTIONS IN WALAWE IRRIGATION REHABILITATION PROJECT

INTRODUCTION

In March 1986, Sir M. Macdonald & Partners Ltd. produced the Walawe Irrigation Improvement Project Inception Report. This report included outline procedures and basic assumptions for the planning of rotations in the command area for water distribution and computation of irrigation water requirements at the field and distributary canal levels. It also outlined the preliminary operating rules for tuning and adjustment of the irrigation distribution system for the various rainfall events.

In July 1986, the draft water management and operation manual was produced by the consultants. This manual further elaborated the basic operational assumptions, procedures and methods for planning water distribution up to the branch canal level. This report also refined some of the proposals of the inception report regarding the operation at the field and the distributary canal levels. In the inception report, a four week stagger of land preparation with four equal staggers with one week between the first irrigation issue in each successive stagger was assumed at the field canal level. In the draft water management and operation manual, this assumption was considered difficult to realize at the field canal level, and instead a one week stagger on any individual field canal was assumed.

The draft water management and operation manual covered in detail the (a) outline procedures for water management, operation and maintenance of the rehabilitated system (b) inventories and data to be collected and (c) staff responsibilities and specific operation and maintenance tasks and functions as intended in (a) and (b) above. Some of those operational assumptions, procedures and requirements were further revised, expanded, updated and/or supplemented by the following subsequent publications by the consultant.

1. Design Criteria (February 1987)
2. Technical Note 1 : Rotation planning Embilipitiya Block (June 1987)
3. Technical Note 2 : Hydro-meteorological Data Analysis : Rainfall and Evapotranspiration (Sep.1987)
4. Technical Note 3 : Rotation planning Chandrikawewa Branch canal (December 1987)
5. Note on Rainfall Adjustments and the Planning of Main Canal Flows (December 1987)
6. Effects of Samanalawewa on the Walawe Irrigation Project Revised Draft (April 1988)
7. Interim Report on the New Operation Procedures and Rotation Planning (April 1988)
8. Inventory of Canals after Rehabilitation - Draft (Oct.1988)
9. Technical Note 4 : Cropping Pattern for Planning the Operation of the Right Bank System (December 1988)

10. Second Interim Report on the New Operation Procedures and Rotation Planning (December 1988)

Technical Note 4 on Rotation planning in Mamadala branch canal is under preparation and is expected shortly.

The design and operational assumptions presented here have been abstracted from the publications listed above. This presentation provides only a summarized overview of the procedures, data, parameters and assumptions adopted for the rehabilitation design of canals and turnouts and also for the operation of the rehabilitated system, for the study of design and management interaction of Walawe system after the intended rehabilitation.

APPROACH TO REHABILITATION

The Need for Rehabilitation

The rehabilitation of the Walawe irrigation system and its infrastructure has been necessitated mainly due to (a) wear and tear of the irrigation canals and the appurtenant structures (b) inefficient water use and distribution (c) inequitable water distribution (d) additional lands brought under irrigation (e) drainage problem and (f) longer canals which serve proportionately small areas. (MMP:Design criteria,February 1987) The present status of the project is claimed to be the collective result of those inadequacies and problems, which in turn were aggravated by the deficiencies in the original design and construction, inadequate upkeep and maintenance, cultivation of paddy in the permeable reddish-brown (RBE) soils as against the original design intentions, lack of sound operational guidelines and practices and lack of satisfactory arrangements for control and measurement of water. A rapid decline of the performance of the system has taken place to a point, beyond which the sustainability of the physical components of the system and their satisfactory functioning are in doubt without rehabilitation and improvement of the physical system and management interventions.

Therefore the ongoing rehabilitation and improvement project was implemented with multiple objectives. Those include (1) improving the physical infrastructure by rehabilitation and rationalization of the right bank (RB) canal system and (2) strengthening water management on the RB to enable irrigation supplies to be provided more efficiently, which in turn would lead to increased agricultural production on the RB and further development of irrigated agriculture on the left bank (LB).

The Features of Rehabilitation

The inception report by MMP (April 1986) indicates that the basic philosophy for the rehabilitation of the irrigation works is to repair the existing structures, as far as possible, and remodel the canals rather than to completely realign them. The present design package of rehabilitation and improvement is thus somewhat pragmatic in nature in the sense that there are no major changes in the existing canal layout. The existing layout of the scheme as designed is considered essentially sound, except in a few problem areas. The rehabilitation therefore generally follows the existing canal system. However the existing direct farm outlets (both official and unofficial) off distributary and branch canals feeding small and isolated areas of land are replaced with both new and rehabilitated field canals and farm ditches. The new canals will generally be parallel field canals and/or sub-distributary canals to concentrate offtaking canals at several rather than many locations along major canals so as to provide farm outlets only from field canals.

The existing irrigation delivery is very complicated due to the presence of direct offtakes from FCs, DCs and even from BCs, both legal or illegal, and also due to the highland lots that are being cultivated with tree crops and irrigated by unauthorized canals and check structures erected across the DCs, long FCs and farm ditches. Therefore it is necessary to agree upon a rationalized canal system and layout, before the rehabilitation criteria are laid out. The proposed package of rehabilitation includes a rationalized irrigation system and layout in order to create the capacity for efficient operation and equitable distribution of water to the farmers after the rehabilitation is over.

The existing canal system suffers from two basic operational deficiencies: there is no provision for the measurement of flows and there is no effective water level regulation on the main and branch canals. Apart from these deficiencies, the existing operating rules, guidelines and practices too are not adequate for proper functioning of the system. The rehabilitation therefore will provide for measurement and regulation of water at all levels of the canal system. The draft water management and operation manual describes the utility and the use of the canal regulating and measuring devices and structures along with rules and guidelines for the operation of the system to be as efficient as possible. One of the distinct features of the intended operation of the rehabilitation system is the introduction of rotational delivery of irrigation water, as against the almost continuous delivery at present. It is also intended to monitor regularly and continuously,the climatic parameters which influence the crop water requirements and the canal flows, and also to adjust the deliveries to accommodate for effective rainfall in day to day operation of the system. These new operational guidelines, procedures and practices are proposed to be introduced through training of the operating staff as well as the farmers.

DESIGN ASSUMPTIONS

The basic data, key parameters and operational assumptions adopted for the design of irrigation canals are detailed in the Design Criteria (February 1987), the Draft Water Management and Operation Manual (July 1986) and the Inception Report (April 1986). They are summarized below.

General

1. As far as possible the design criteria for canals and structures are in accordance with the standard Sri Lankan practice, as presented in the Sri Lankan Irrigation Department technical notes and standard drawings.

2. Canal design for DCs and larger canals follows the Irrigation Department designs, in order to reduce the amount of canal remodelling required.

3. Road access is provided along main, branch, distributary, sub-distributary and field canals. The access roads along the main, branch and longer DCs are graveled.

4. In addition to the usual regulating, control and measuring structures, the rehabilitated system will have bathing steps, cattle crossings, bridges, culverts, etc.

Estimation of Peak Irrigation Requirement at the Head of a Field Canal

1. The distributary and field canal capacities are designed to cater for 100 percent direct sown paddy for both maha and yala seasons.

2. The land preparation for yala and maha seasons begins around 15 April and 25 September respectively. The land preparation period allowed for a typical farm allotment is three weeks in both yala and maha. This includes one week for land soaking and two weeks for puddling and seeding.

3. An important operational assumption is made regarding the staggering of the first irrigation throughout the project area. It is assumed that the staggering of the first irrigation throughout the project area over a period of about four weeks is a necessary measure to reduce the peak load in the branch and main canals.

4. To achieve an overall stagger of four weeks in the project area, the allotments on any individual field canal are divided into two groups and the first irrigation for the two groups is staggered by one week. Similarly, the field canals under a distributary too are divided into two groups with the first irrigation in one group of field canals staggered by two weeks with respect to the other.
   This is illustrated in Figure 6.01. This four week staggering of planting dates or the first irrigation issue in the entire project area leads to a total land preparation period of six weeks in the project area.

5. The cropping calendar shown in Figure 6.02 is used to estimate the crop water requirements as well as the irrigation requirements at the head of

a FC. This indicates 120 days and 98 days varieties in maha and yala respectively, with irrigation water supply terminated fourteen days prior to harvesting each season.

6. The Modified Penman method with climatic data from Hambantota is used to calculate the reference crop evapotranspiration values in the computation of crop water requirements.

7. A homogeneous sequence of rainfall events at Embilipitiya with 80 percent probability of exceedance is used for the computation of FC head irrigation requirement. The effective rainfall is assumed 70 percent of this rainfall.

8. The seepage and percolation loss (S&P) is assumed as 5 mm/day with no consideration to the difference in soil types in the command. Land preparation requirements are assumed as 150 mm/week for land soaking in the first week followed by 105 mm/week for puddling in the second and third weeks in both yala and maha.

9. A filling requirement of 25 mm/week to bring the paddy field up to the full depth of water after seeding is assumed. The filling at this rate is assumed to continue for three successive weeks commencing from the fifth week after the first irrigation issue for land soaking. The total filling requirement is 75 mm.

10. The application efficiency and the field canal conveyance efficiency are assumed to be 80 percent and 90 percent respectively.

11. The above set of assumptions, data and parameters leads to a peak weekly irrigation water requirement (at the head of a typical field canal) of 2.46 l/s per hectare. This peak occurs in the second week of maha season after the first irrigation for land soaking has begun. Similar analysis based on the same data, parameters and assumptions for transplanted rice results in a peak weekly irrigation requirement of 2.51 l/s per hectare occurring in the second week during land preparation in maha season. The analysis for yala season gives the values of 2.41 and 2.46 l/s/ha for direct sown and transplanted paddy respectively.

Canal Rationalization

It was earlier mentioned that rationalization of the canal system was one of the features of the rehabilitation package. This is necessary in order to set out design criteria for the design of the canals and the canal structures as well as to serve as a guideline to minimize the disputes that are likely to arise during the rehabilitation work in the field. Some of the features of the canal rationalization are described below.

1. As far as possible the farm lots should be fed from field canals only.

2. The length of a field canal is limited to about 500 m. Where there is no other reasonable alternative, this limit may be exceeded.

3. Direct offtakes from DCs or BCs should either be linked to existing FCs or combined to form new FCs.

4. Areas designated for paddy in the original blocking out plans (BOPs) will continue to receive water from the rehabilitated system.

5. Homestead lots, canals, drains, river, tank or road reservations presently cultivated by encroachers are not to be regularized, unless specifically requested by MEA.

6. Pasture, fodder and forest reservations presently cultivated by encroachers are to be regularized wherever practical.

7. If any difficulties are encountered in fitting parallel FCs into the available space, even after reclaiming cultivated areas within the prescribed reservations, the canals are lined to reduce their width, and if this too is inadequate additional strips of reservations must be acquired.

8. Each block of private land is to be provided (where there are recognized offtakes presently or when the existing arrangements for irrigation become unworkable as a direct result of rehabilitation) only with an outlet of appropriate size at its boundary. Water is to be delivered and charged at this point.

Canal Capacity Design

In the rehabilitated system, canal classes are classified as follows.

Canal class	Typical Area served (ha)	Typical Flow l/s
Main	10,000	22,000
Branch	> 350	> 700
Distributary/sub-D	30 - 350	85 - 700
Field/Sub Field	< 15	28
Farm outlet/Ditch	1	5

Field canals. All field canals are designed to carry a discharge of 28.32 l/s (1 cusec). A standard field canal thus ideally serves 12 ha for a peak weekly irrigation water requirement of about 2.50 l/s/ha at the head of the FC. However the area served by a FC can occasionally be as large as 15 ha or as small as 3 or 4 ha. In the former case the peak irrigation requirement is delivered by overloading the FC. In the latter case the discharge in the FC is maintained at 14 l/s (1/2 cusec). Therefore all FCs are designed to carry a discharge of 28.32 l/s and are of a minimum standard section, and the same section is used for small canals. For larger field canals, the bed width and the canal slopes are varied according to the design depth of water to be maintained in the canals, in order to command farm turnouts served by them.

The existing canal system in some parts was originally laid out so as to supply FCs in RBE soils and paddy in LHG soils from separate FCs. In the rehabilitated system no such differentiation is made and FCs are designed to the standard size of 28.32 l/s capacity.

The standard section of a FC of 28 l/s capacity is of the following dimensions.

bed width	=	0.30 m
side slopes	=	1 on 1
section depth	=	0.55 m
bank width	=	3.0 m (0.6 m without O & M road)
canal bed slope	=	0.7 - 4.0 m/km

The design water depths are as follows.

Canal slope m/km	Design water depth (m)
0.7	0.22
1.0	0.20
2.0	0.17
3.0	0.15
4.0	0.14

Manning's n = 0.025 - 0.035

Distributary canals. A distributary canal is designed to have its maximum capacity in the first reach and to have progressively reduced capacities in the lower reaches. The distributary is divided into reaches for design purposes between the principal structures in the DC such as falls and regulators.

The fundamental assumption in the determination of DC capacity is that the water issues during the maha season are planned on the basis that rainfall will supply 20 percent of the total water requirement and the irrigation system the remaining 80 percent. The discharge required in a canal to supply this water is called the normal discharge (Q100) and the design discharge which determines the DC capacity is taken as the normal discharge in weeks 3-8 of the maha season. The design section of the DC is checked against the adequacy of freeboard for 125 percent of normal discharge (Q125).

The normal discharge in any reach is estimated by an exercise which involves; (a) listing the field canals and sub distributaries (sub DCs) in order down the DC with the design discharge of each of the FC and sub DC and the areas served by each of them; (b) planning weekly rotation of opening and closing of each of the FCs and sub DCs; and (c) cumulating the discharge in each reach required to be maintained in weeks 3-8 of the maha season for the planned rotation. Therefore the design capacity of any particular reach of the DC is a function of:

1. The number of field canals and sub distributaries served by that reach and by the reaches downward;
2. The areas served by each of those FCs and sub DCs;
3. The design discharge in each of those FCs and sub DCs;
4. The durations and times of opening and closing of those FCs, and sub DCs within the seven day rotation cycle during the cultivation season;
5. The transmission losses in that reach and the downstream reaches.

The design discharge and the field canal duties for 100 percent direct sown rice, used for the planning of rotations and subsequently for the determination of design discharge in the DC, are shown in Table 6.01. Those design discharges and duties are derived for 4 months direct sown paddy in maha and 3.5 months direct sown variety in yala, allowing 3 weeks period for land preparation and assuming one week stagger of planting dates on each FC and that irrigation terminates two weeks prior to harvest.

Some DCs may have offtakes to private lands as a result of system rationalization. Those offtakes are operated continuously for the period the main distributary is open. The design discharge through the offtakes is assumed as follows, for the estimation of design discharge in the DC capacity design.

Weeks 1 & 2	-	2.4 l/s/ha
Weeks 3 to 8	-	1.9 l/s/ha
Weeks 9 to 18	-	1.4 l/s/ha
Weeks 19	-	0.9 l/s/ha

The transmission losses in the DC are estimated either by assuming a loss rate of 3 l/s per 1000 sq m of wetted surface or by Lacey's formula, which gives,

$$q = 0.015 \times L \times Q^{0.5}$$

Where q = Loss in cumecs
Q = Reach design discharge in cumecs
L = Reach length in km

The standard canal design equations and procedures are followed to decide the dimensions of the canal sections in the different reaches of the DC, to suit the design discharges of those reaches. The standard irrigation department (Sri Lanka) drawings and designs are used for this purpose.

However it is to be noted that though the canal sections are designed for different reaches, the existing canal sections are not always rehabilitated to the design section. Whether an existing canal reach is reconstructed to have the design section is determined by the following criteria.

1. If the bed width of the existing canal section is greater than the water surface width at design depth of the design section, then the existing canal is reformed.
2. If the bed width of the existing canal section is less than the water surface width at design depth of the design section, than the existing canal is not reformed.

These considerations are necessary to assess water depths and levels in the DC in order to design fall, regulator and field canal turnout levels.

Branch canal. Similar to a DC, a branch canal (BC) too is designed to have progressively reduced capacities between the principal reaches. The design discharge in the tail reach of the BC is estimated by a similar exercise as for the design of a DC. The design discharge in the upstream reaches is taken as 2.15 l/s/ha excluding losses of the reach. The losses are estimated either by Lacey's formula or by assuming a loss rate of 3 l/s per 1000 sq m of wetted area.

Design of Turnouts

The turnouts from main and branch canals are designed so that the design discharge can be abstracted by the offtaking canal with 50 percent of design discharge (Q50) in the parent canal. Turnouts from DCs and FCs are designed so that Q100 can be abstracted with Q100 in the parent canal. This criteria satisfies the requirement that Q125 may be drawn with Q125 in the parent canal.

It was earlier mentioned that DCs are designed for normal discharge (Q100) with the adequacy of freeboard checked against Q125. The rationale behind this is that during a dry period, the discharge in the FCs and DCs may be increased progressively up to Q125 to supply the full requirement. In a wet period, the discharge may be reduced to Q75 or so. Therefore the main and branch canals are expected to be operated between 50 percent and 100 percent of the normal discharge and the distributary canals between 75 percent and 125 percent of the normal discharge.

The FC turnout is a controlled pipe outlet (CPO) with a broad crested measuring weir, which is designed to pass a constant design discharge into the FC. This is to fulfill the assumption of constant discharge-variable time operation and rotation of FCs.

Each farm allotment is provided with a separate uncontrolled farm offtake of 75 mm or 100 mm diameter pipes of capacity 5 l/s or 6 l/s. The implicit operational assumption here is that in a typical FC with a design capacity of 28.32 l/s and 12 one ha allotments, the flow is divided between five or six lots. In other words, five or six farmers in a FC will share the entire flow in the FC at a time.

This means that in the downstream reaches of a FC, discharges will decrease from 28.32 l/s at the head to about 5 l/s depending on the number and locations of the farm turnouts open for irrigation. In order to maintain adequate command at farm offtakes, distribution boxes with grooves to allow check board are introduced along contour section of FCs. Similarly on steeper reaches of the FCs the grooves are accommodated in the fall structure whenever there is an offtake immediately upstream.

WATER MANAGEMENT AND OPERATION

The draft water management and operation manual sets out the principles and proposed details of the new procedures for the rehabilitated irrigation system upto branch canal level starting from the turnout. The success of the intended operation basically depends on the (i) timely and accurate collection of data; (ii) accurate measurements; and (iii) timely reporting and processing of data followed by prompt response and adjustments to canal flows and deliveries. It also depends on the ability of the agency to ensure the realization of operational assumptions adopted for the planning of operation such as crop calendar, staggering of planting dates, and the intended rotation between farmers and also between the canals in the irrigation system etc. Standard procedures have been laid out as to the collection of data, seasonal planning of water issues in the command area, adjustment of canal flows for seasonal rainfall etc, with a set of standard operational rules, data, computation and instruction sheets. Thus two fundamental requirements emerge for a high degree of quality and success in operation of the rehabilitated system. They are the; (a) training of operation staff to acquire the required skills; and (b) establishment of effective water user groups to ensure the implementation of the intended rotations and staggering of planting dates. Some of the important features of operation and allied operational assumptions are presented below.

Operational Procedures: A Summary

1. Prior to the start of each season, the data on crops and the areas intended to be cultivated by each farmer are collected by the unit managers.

2. Once these data are reported to the block offices, water requirements and duties for each canal are calculated for the cropping pattern and areas intended to be cultivated, using a set of operational assumptions which will be discussed below.

3. The constraints in supplying water are then identified and adjustments discussed and agreed at the cultivation meeting.

4. The water delivery schedules for the intended rotation are planned using the suggested procedures and computational sheets, and the gate operation schedules are prepared and compiled for each of the FCs, DCs and BCs in the irrigation system.

5. The flow measurements are taken at the head of each FC turnout and at all other measuring structures.

6. The rainfall is measured daily. The adjustments for effective rainfall are computed for a set of adjustment rules, and the deliveries in the forthcoming week are adjusted accordingly.

7. The discharges into all BCs off main canal and into all DCs off BCs are reported daily to the block office.

Operational Assumptions

1. Three types of crops are assumed for the calculation of irrigation water requirements at the head of a FC, for planning of water deliveries and rotation; paddy, sugar and other food crops (OFCs).

2. The method of calculating water issues and canal duties for a combination of paddy, sugar and OFCs is such that, the areas under sugar and OFCs are converted to "equivalent areas" (EA) of paddy. ie. The area of paddy that would require the same amount of water. Equivalent area factors assumed are 0.7 for sugar and 0.6 for other field crops,i.e, if a field canal has 2.9 ha of sugar and 1.7 ha of rice, the equivalent area for computing water requirements would be:

$$EA = 2.9 \times 0.7 + 1.7 \times 0.6 + 7.0 = 10 \text{ ha}$$

It is assumed that these factors give the correct amount of water within the accuracy of flow measurement at the turnout, provided rice remains the predominant crop. However in the long run, if crops other than rice become predominant this method should be reviewed.

3. The calculation of irrigation water requirements at the head of a FC for (a) direct sown and transplanted paddy and (b) other field crops are illustrated in the draft water management and operation manual.

The other assumptions adopted for the estimation of peak irrigation water requirements for the design of canals, as described earlier are adopted in the same manner for the preparation of water delivery schedules.

Planning the Operation

The operation of the rehabilitated system upto the branch canal level is planned for:

1. Predetermined schedule of cropping and water requirements as agreed

upon at the cultivation meeting.

2. Predetermined stagger of the first irrigation issue in FCs and DCs as described above.

3. Predetermined rotation between farmers on any individual FC and between the DCs on the branch and main canals.

4. A set of predetermined adjustment rules to accommodate the effectiveness of the actual rainfall over the command area, to meet part of the irrigation requirement during the cultivation season.

Crop staggering. The draft water management and operation manual claims that it is necessary to stagger the first irrigation throughout the project area over a period of about four weeks. It also claims that it is only practicable to achieve a one week stagger on individual field canals and the overall stagger of four weeks can be achieved by staggering the irrigation issues on two group of distributary canals, by two weeks apart.

The one week stagger of first irrigation on any individual field canal needs the organization of farmers on each FC serving more than 6 ha into two groups. The farmers on these FCs should decide who will start irrigation in the first week of supply to their FC and who will start in the second week and so on.

Along the main and branch canals similar division of farmers into two groups by distributary canals is necessary, in such a way that group one starts irrigation two weeks before the other group, and the areas served by the distributaries in each group is approximately the same on each reach of the main or branch canal. This staggering may be reversed in the following year and alternated yearly thereafter.

Rotations. The planning of operation of the rehabilitated system adopts a set of rules for rotation of irrigation water deliveries at farm turnout, field canal and distributary canal levels. The staggering of the first irrigation issue on individual FCs and between the two sub groups of DCs under a branch canal imposes a grouping of farmers for a natural rotation of irrigation water during a cultivation season. Besides this rotation, the draft water management and operation manual suggests rotations at farm turnout among the farmers served by an individual field canal, among the field canals under a distributary canal and among the distributary canals on the branch and main canals. These rotations are described below.

Therefore the planning of operation of the rehabilitated system before any cultivation season involves the designation of quantity, time and period of irrigation water issue to each farmer under the rotation, leaving room for the adjustment of the releases to individual canals based on the actual rainfall received by the command area. The quantity of the releases is represented by a schedule of daily gate operations and the adjustment for the actual rainfall is done according to a set of operation rules.

The field canals in the rehabilitated system would be of a standard capacity of 28.32 l/s (1 cusec) except in a few isolated circumstances. It was earlier mentioned that the water issues during the maha season are planned for normal discharge, which is the discharge required in a canal to supply 80 percent of the total water requirement served by the canal.

Field canals in the rehabilitated system would be operated at a constant normal discharge of 28 l/s or more depending on the area served by the FC, during the periods they are kept open. The period of delivery depends on the number of duty days as shown in Tables 6.01 and 6.02. The number of duty days or the number of days per week that the canal is kept open is determined by the quantity of irrigation water required for the crop growth depending on the type of crops grown, growth stage and the areas designated to each crop etc., and for the design discharge of the canal. A typical rotation of field canals is shown in Figure 6.03. This rotation among FCs is adjusted to accommodate the effective rainfall, by increasing or decreasing the normal discharge (28 l/s) by 25 percent as described later, but keeping the duration of delivery constant. Thus the rotation and water issue among FCs is a constant discharge and variable duration schedule, with adjustment of discharge to accommodate the effective rainfall under a set of adjustment rules as described later.

Rotation between farmers in an individual field canal is such that five or six farmers share the entire flow in the FC at a time. This derives from the fact that the uncontrolled farm outlets of 75 mm diameter have a discharge capacity of about 5 - 6 l/s and the typical flow of 28 l/s in the FC can equally be divided between five or six farmers simultaneously. However on field canals serving less than six hectares such rotation is not necessary. In the latter case sub grouping for staggering will have to be between field canals, not on any individual FC.

The draft water management and operation manual also suggests that the distributary canals should be run at constant discharge as far as possible, for simplicity of operation, and adjusted only once per week. The manual claims that this minimizes the number of adjustments required at the head of a distributary canal and avoids problems with trying to deliver design discharge into individual FCs when the distributary is running at less than design discharge. However the maintenance of a near constant discharge at the head of each DC has to be done by adjustment and regulation of flow in the main and branch canals very accurately.

<u>Regulation of canal discharges</u>. On the main canal, cross regulation of flow is provided by radial gated structures in the upper reaches and by vertical lifting gated structures in the lower reaches. In the branch canals duck bill weirs will provide the regulation.

Along any distributary canal, each FC will be opened and closed once or twice a week. Although the discharge at the head of the DC is maintained at a constant value, the flow in downstream reaches of the DC may vary by 28 l/s from the design discharge. It is assumed that the criteria adopted for the design of field canal turnout structures, will fulfill the requirements to accommodate the resulting variation of water levels.

Along any field canal, the discharge will decrease from 28 l/s at the head to about 5 l/s at the tail, depending on the number and the location of the farm turnouts open for irrigation at any time. The resulting variation of flow in the FC has to be regulated by the distribution boxes provided by the rehabilitation design.

Adjustment for rainfall. The adjustment rules of the system for effective rainfall in yala and maha seasons are shown in Tables 6.03 and 6.04 respectively. In maha, if there is more than 45 mm of rain the DCs and FCs are to be closed completely for one or more days. Similarly in yala if there is more than 35 mm of rain the canals are closed. A typical canal adjustment for rainfall is illustrated in figure 6.04.

REHABILITATION OF DC 8 IN CHANDRIKAWEWA BLOCK

Existing and Proposed Design Features

The DC 8 in Chandrikawewa block is in a state of disrepair with most of the canal structures provided at the inception of the project damaged and broken beyond further use. The DC turnout structure from the Chandrikawewa Branch Canal is in working condition but in need of some repairs, including the sealing of leakage through the turnout gate when it is fully closed. The original FCs taking off from the DC are either completely or partly damaged. The DC and FC canal beds are severely eroded, and the original inlet levels of the FCs taking off from the DC 8 are no longer low enough for the command of the areas under the FCs. The farmers have resorted to tapping the DC 8 directly at more than fifty locations, in order to overcome the difficulties of irrigation. The regulation of flow in these FCs and through the illegal direct offtakes is by means of temporary and artificial stick dams erected across the DC. The banks of the DC 8 are severely eroded except along a very short stretch in the middle reach. None of the canal structures provided in the original design are in a condition to fully serve their intended purpose under the existing situation. Thus the condition of DC 8 canal structures and the FCs as it is, imposes serious constraints for proper distribution and management of irrigation water. Lack of measuring devices and adequate regulation in the original design aggravate this situation.

The rehabilitation design for the DC 8 proposes fourteen FCs, seven on LB and four on RB, as against the seven FCs provided in the original designs. The remaining three FCs in the rehabilitation system commence from the division structure at the tail- most end of the DC 8. Out of the proposed fourteen FCs five would be parallel canals to the DC 8. Turnout structures are provided at the head of each FC, except for the proposed last three FCs, which would share one turnout structure in common. Fourteen new fall structures with grooves for flow regulation and six culverts are proposed in the rehabilitation package. The DC 8 turnout structure would be repaired with the incorporation of a broad crested weir for discharge measurement at the head of the canal and with provision of a stilling pool for preventing possible erosion. The first reach of the canal from the DC turnout upto a length of about 460 m would be a precast lined rectangular canal, and the balance is earthen and trapezoidal. Some of the parallel field canals will be lined as well. The features of the rehabilitation design for the DC 8 are summarized in Table 6.05. The salient features of the entire rehabilitation package for Walawe are also indicated in Table 6.06.

SOME DESIGN - MANAGEMENT IMPLICATIONS

The research questions that would guide the design-management interactions of Walawe irrigation project are listed in the Inception Report (1988: 15). The basic information that is necessary to form background material to answer these questions has been presented in the preceding sections of this chapter. However, it is not yet possible to draw concrete conclusions on the design-management interactions of the Walawe system, without observing the actual irrigation behavior of the farmers as well as the agency officials in day to day operation in at least part of the rehabilitated system. The new management practices are yet to be tested over a few cultivation seasons before any sound implications are recognized and recommendations for further improvements are suggested. As mentioned in the chapter on management of the rehabilitation process in Walawe, the attempts made by the MEA to test the full range of design assumptions and management practices on pilot basis were not very successful, and as a result, it is yet too early to identify the impact of the design and the new management options on the operation and the overall performance of the rehabilitated system in a true sense. Nevertheless, the background information presented in the preceding sections enables us to predict to a certain degree, the most likely impacts and consequences of the design and the management options on the expected levels of performance of the rehabilitated system.

A comparison of design and operation assumptions and parameters adopted for the newly constructed Kirindi Oya system and the rehabilitated Walawe system is presented in Table 6.07. This table provides us useful information primarily to establish a framework for analysis of design-management issues in Walawe system, to compare the similarities and differences in design parameters and assumptions in the two systems, and also to identify or predict tentative implications on the interaction between design and management of the rehabilitated Walawe system. However, this analysis and comparisons are subject to further refinement and modifications as the research proceeds and at least a part of the rehabilitated system is ready for testing the proposed design and management practices.

<u>Operational and institutional assumptions in the design of turnout and field canals</u>. The irrigation schedules for the FCs and DCs as well as the computed deign discharges in the DCs and FCs are based on a primary assumption that the first irrigation or the commencement of land preparation on any individual FC is staggered by one week. This is followed by a second

assumption which claims the division of DCs under a BC into two groups and one group of DCs deliberately delays the commencement of land preparation by two weeks with respect to the other.

There is reasonable doubt as to whether these two assumptions may be realized the way anticipated. The behavioral requirements by the farmers to fulfill these assumptions need a complete change of the present practice in which each individual farmer virtually decides the first date of irrigation to his allotment, subject to the constraints of resources and within a reasonable margin of shift from the official dates agreed to at the cultivation meeting. The requirement by the agency staff to choose the two groups of DCs and to motivate and direct the farmers under those DCs and FCs to implement the intended staggering of first irrigation also would tax the staff with extra efforts and functions for which no tangible incentives are available. It is therefore most unlikely that these assumptions are realized in the operation mode unless the intended institutional building and strengthening through the formation of water user groups and the training of farmers and the operating staff are achieved fully to make both parties dedicated and disciplined to follow the intended operation rules precisely.

The failure to realize these assumptions may lead to operational difficulties. To illustrate the point, if we assume that all the farmers in any individual FC commence land preparation or first irrigation simultaneously without any staggering, then the peak weekly irrigation requirement at the head of the FC for 100 percent direct sown paddy would increase from the design value of 2.41 l/s/ha to about 3.0 l/s/ha and the occurrence of peak would shift from the second week to the first week during the land preparation period. As a result, a FC with a command area of about 15 ha would have to be operated at a design discharge of 45 l/s as against 34 l/s during weeks 1 and 2 as indicated in Tables 6.01 and 6.02. This increase would theoretically result in the overloading the FC by about 60 percent, which exceeds the overloading factor of 25 percent envisaged in the design. The design of the FC turnout structure is such that it would abstract Q125 to the FC only when the flow in the parent canal (DC) is increased by about 25 percent more than the normal discharge in that. As a result the actual operation and the adjustment of FC turnout gates in order to meet the actual demand for irrigation water in the FC would become difficult.

The most crucial parameters which influence the peak irrigation requirements in the design of turnout and the determination of the design discharges and duties in the irrigation schedules are the various conveyance and application efficiencies in the water conveyance and delivery system and the seepage and percolation (S&P) in the paddy allotments. Unfortunately, there is no evidence of verifying these efficiency parameters in the field before adopting in the design. Some experiments on S&P are claimed to have been conducted in the Walawe project area by a post graduate student, but the value adopted in the design (5 mm/day) is an average value without due consideration to the differences in S&P rates in different soil types (RBEs and LHGs) typically found in any conventional turnout area. Some other reports recommend a S&P rate of 10-15 mm/day at the top of a ridge of a FC, based on a few limited field measurements and many field observations (PRC Termination Report 1982: S-2).

Many turnouts in Walawe irrigation system in fact serve well drained RBEs in the upper reaches and poorly drained LHGs in the lower reaches, and the mix of the two soils may have different proportions in different turnouts. The result is that the turnouts which consist of a larger proportion of well drained RBEs are undersupplied and those of poorly drained LHGs are oversupplied, if the actual S&P in the two soils fairly deviate from the average value assumed in the design.

The conveyance efficiencies of DCs and FCs adopted in the design of turnouts and field canals appear to be generally high in comparison to the design values for Kiridi Oya system. To illustrate this point, the Lacey's formula applied to the rehabilitated DC 8 in the Chandrikawewa branch canal would result in a total conveyance loss of about 14 l/s over the entire canal length of 2.2 km, while the assumption of a loss rate of 3 l/s per 1000 sq m of wetted area gives a total conveyance loss of 15 l/s. Though these two values reconcile well with each other, the computed conveyance loss corresponds to a hypothetical conveyance efficiency of about 96 percent at the head of DC8 at which the design capacity is 307 l/s including losses. This value appears to be high for a severely deteriorated canal remodelled by rehabilitation. Apart from this, we have found an average conveyance efficiency of 71 percent in a typical DC (DC 2 in BC 2 in tract 5) in Kirindi Oya system (Progress report 1988: 88). This experimental value reconciled well with the figure of 75 percent recommended in the irrigation department guidelines for canal design (Irrigation department :Technical note 6). It may therefore be necessary to verify those loss rates assumed in the design by empirical field data in the first few seasons of operation and modify water delivery schedules accordingly.

The adoption of higher conveyance efficiencies in the DCs and FCs and an average value of S&P rate with no due consideration to the different mixes of typical soil types in a turnout area may eventually lead to far reaching consequences. As the degree of influence of these two parameters on the design discharges and duties in the FCs and DCs and also on the design capacities of the DCs is significant, some DCs may suffer from capacity constraints, an area which needs further verification. On the operation side, DCs and FCs turnout areas with relatively high proportion of well drained RBEs may be served with an inherently undersupplied irrigation schedule. In the latter case, when the allocation by the schedule falls behinds the actual demand in the turnouts, particularly during the peak periods, it may be theoretically required to increase the discharge in the FCs and DCs by more than the 25 percent overloading factor as envisaged in the design. The criteria adopted for the design of the turnout structures would somewhat hinder the operation under such circumstances. However during the other periods it would be possible to meet the demand by increasing the duration of delivery without overloading the canal more than envisaged. Therefore it is necessary to verify the S&P rates with due consideration to the difference in soil types.

Feasible options and flexibility in operation among farmers. The mode of operation in Walawe is such that first irrigation in the command area is staggered by four weeks and the field canals would receive water from the DC on a pre determined day of the week and for a pre determined duration even during the land preparation period, and five or six farmers in a FC turnout would share the entire flow in the FC at a time. The flow in the FC is maintained at the design discharge whenever they are kept open and the duration of delivery is adjusted over the season in order to meet the varying crop water demands. In contrast, the schedules in Kirindi Oya are prepared on the basis of continuous irrigation during land preparation followed by rotational delivery to FCs during the crop growth. Two farmers are expected to share the entire flow in the FC at a time. Though the FCs would receive water from the DC on a specific day of the week, the delivery duration in a FC is the same over the season and the discharge at the head of the FC is adjusted to meet the varying crop water demands. Therefore the operation in the FC turnouts in Kirindi Oya is based on a fixed delivery duration and variable discharge schedule, while in Walawe on a fixed discharge and variable delivery duration schedule.

The size of the farm turnouts provided in Walawe is 75 mm with a capacity of 5-6 l/s. This facilitates the intended simultaneous sharing of water by five or six farmers at a time. However it can be shown that a farm turnout of this size and capacity would require about 2.5 days to deliver the peak on farm requirement (105 mm) for direct sown paddy in yala. This means that in a typical turnout area of 12 ha size, for which the field canal duty during the peak period is 7 days, both groups of five or six farmers can easily irrigate their allotments within 3.5 days during which they are entitled to draw water from the FC. However if three farmers or less instead of five or six farmers wish to irrigate their allotments simultaneously, the delivery of the peak on farm requirement would be difficult with the capacity of the farm turnout. On the other hand, if the actual S&P rate of well-drained RBE soils is considerably higher than the assumed value, a turnout area with a high proportion of well-drained RBEs would further find it difficult to share the quota simultaneously among three or less number of farmers at a time. Thus the flexibility offered by the farm turnouts in Walawe is somewhat limited. In kirindi Oya the farm turnouts are larger and more flexibility in sharing of water is built into that.

On the other hand, when there is a mix of paddy and other field crops in a turnout, the small stream size catered to by the farm turnout in Walawe facilitates the irrigation of field crops in Walawe, whereas the farmers in Kirindi Oya would have to reduce the stream size by artificially clogging up the farm turnouts there. However it is too early to draw conclusions on this issue until the irrigation of field crops are observed for a few seasons.

Impact of the field canal and turnout design and operation on the operation of the distributary canal. In Walawe as well as in Kirindi Oya, the field canals are designed to have a standard capacity of 28 l/s. The typical turnout area in Walawe would be 12 ha in size. In Kirindi Oya the turnout size depends on the proportion of well-drained RBEs and poorly-drained LHGs served by the turnout as far as possible. Thus in the latter case, the size of the turnout with 100 percent RBEs is 16 ha and that with 100 percent LHGs is 8 ha.

Theoretically, the standard field canal design with 28 l/s capacity offers the option of maintaining a constant discharge in FCs during the periods they deliver water to the farms. This means it is theoretically possible to maintain a steady flow in the DCs, provided that the design assumptions and parameters are reasonably correct and that both the agency staff as well as the farmers cooperate fully in following the rotations and other system operation rules. However, so many institutional requirements and prerequisites are necessary to follow the operation procedures and rules in the expected manner. Unless these requirements are fulfilled and prerequisites are established, one may argue that the flows in the DCs would not be steady during a major part of the season. However, the research carried ut in the DC2 of BC2 in tract 5 of the Kirindi Oya system during yala 1988 indicated that it was possible to maintain steady flow rates into field canals located at the head of the distributary and the fluctuation of water level in the distributary was insignificant. The study also indicated that the flow fluctuations into FCs in the tail-end of the DC were more frequent.(Progress report 1988: 86).

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Table 6.01 - Field canal design discharges and duties for direct sown paddy

A) MAHA

Area Served (ha)	Duty in Days Weeks 1 & 2	Weeks 3 - 8	Weeks 9 - 18	Weeks 19	Design Discharge (l/s)
15	7	6	4 1/2	3	34
14	7	6	4 1/2	3	31
13	7	6	4 1/2	3	28
12	7	5 1/2	4	2 1/2	28
11	6 1/2	5	4	2 1/2	28
10	6	4 1/2	3 1/2	2 1/2	28
9	5 1/2	4	3	2	28
8	5	4	3	2	28
7	4	3 1/2	2 1/2	1 1/2	28
6	3 1/2	3	2	1 1/2	28
5	3	2 1/2	1 1/2	1	28
4	5	4	3	2	14
3	3 1/2	3	2	1 1/2	14

B) YALA

Area Served (ha)	Duty in Days Weeks 1 & 8	Weeks 9 - 15	Weeks 16	Design Discharge (l/s)
15	7	6	3	34
14	7	6	3	31
13	7	6	3	28
12	7	5 -1/2	2 1/2	28
11	6 1/2	5	2 1/2	28
10	6	4 1/2	2 1/2	28
9	5 1/2	4	2	28
8	5	4	2	28
7	4	3 1/2	1 1/2	28
6	3 1/2	3	1 1/2	28
5	3	2 1/2	1	28
4	5	4	2	14
3	3 1/2	3	1 1/2	14

Source: MMP (July 1986). Draft Water Management and Operation Manual

Table 6.02 - Field canal design discharges and duties for transplanted paddy

A) MAHA

Area Served (ha)	Duty in Days Weeks 1 & 2	Weeks 3 - 8	Weeks 9 - 15	Weeks 16	Design Discharge (l/s)
15	7	6	4 1/2	3	34
14	7	6	4 1/2	3	31
13	7	6	4 1/2	3	28
12	7	5 1/2	4	2 1/2	28
11	6 1/2	5	4	2 1/2	28
10	6	4 1/2	3 1/2	2 1/2	28
9	5 1/2	4	3	2	28
8	5	4	3	2	28
7	4	3 1/2	2 1/2	1 1/2	28
6	3 1/2	3	2	1 1/2	28
5	3	2 1/2	1 1/2	1	28
4	5	4	3	2	14
3	3 1/2	3	2	1 1/2	14

B) YALA

Area Served (ha)	Duty in Days Weeks 1 & 8	Weeks 9 - 12	Weeks 13	Design Discharge (l/s)
15	7	6	3	34
14	7	6	3	31
13	7	6	3	28
12	7	5 1/2	2 1/2	28
11	6 1/2	5	2 1/2	28
10	6	4 1/2	2 1/2	28
9	5 1/2	4	2	28
8	5	4	2	28
7	4	3 1/2	1 1/2	28
6	3 1/2	3	1 1/2	28
5	3	2 1/2	1	28
4	5	4	2	14
3	3 1/2	3	1 1/2	14

Source: MMP (July 1986). Draft Water Management and Operation Manual

Table 6.03 - Adjustment rules for rainfall in maha

A) Weeks 1, 2 and 19

- No adjustment for rainfall
- Canals to be run at the calculated discharge shown on Forms A2 and A3.

B) Weeks 3 to 18

Running 7 Day Total Rainfall R7 (mm)	Stop Irrigating for N days (days)
< 45	0
46 - 65	1
66 - 80	2
81 - 95	3
96 - 100	4
> 111	5

Weekly Rainfall Total	Adjustment to Flow in Next Week P (%)
< 5	125
6 - 15	115
16 - 25	100
26 - 35	85
> 36	75

Source: MMP (July 1986). Draft Water Management and Operation Manual

Table 6.04 - Adjustment rules for rainfall in yala

A) Weeks 1, 2 and 16

- No adjustment for rainfall
- Canals to be run at the calculated discharge shown on Forms A1 and A3.

B) Weeks 3 to 15

Running 7 Day Total Rainfall R7 (mm)	Stop Irrigating for N days (days)
< 35	0
36 - 50	1
51 - 65	2
66 - 85	3
86 - 100	4
> 100	5

Weekly Rainfall Total RW (mm)	Adjustment to Flow in Next Week P (%)
< 5	100
6 - 20	85
> 21	75

Source: MMP (July 1986). Draft Water Management and Operation Manual

Table 6.05 - Features of rehabilitation in DC8 of Chandrikawewa branch canal

Distributary Canal DC8 in Chandrikawewa Block		Field Canals in DC 8 after rehabilitation						
Distance Between the Reach (M)	Design Features and Dimensions of DC Sections	Field Canal No.	LB/RB	Design Capacity (l/s)	Area under the FC (ha) RBE (ha)	LHG (ha)	TOTAL (ha)	Command under DC2 beyond the reach (ha)
								152
0 - 265	Q = 307 D = 0.44 B = 1.50 F_b = 0.45 S = 0.0004 n = 0.015 Precast lined, rectangular	FC 1	LB	28.32	03	01	04	148
		FC 2*	RB	28.32	07	04	11	137
265 - 462	Q = 263 D = 0.44 B = 1.30 F_b = 0.45 S = 0.0004 n = 0.015 Precast lined, rectangular	FC 3*	LB	28.32	06	05	11	126
		FC 4*	RB	28.32	13	01	14	112
462 - 840	Q = 231 D = 0.40 B = 0.90 F_b = 0.45 S = 0.0004 Z = 1:1.5 n = 0.025 Earthen, Trapezoidal	FC 5*	RB	28.32	06	08	14	98
840 - 1370	Q = 200 D = 0.37 B = 0.75 F_b = 0.45 S = 0.0004 Z = 1:1.5 n = 0.025 Earthen, Trapezoidal	FC 6	RB	28.32	06	06	12	86
		FC 7*	LB	28.32	08	05	13	73
		FC 8*	RB	28.32	09	01	10	63
1370 - 1619	Q = 138 D = 0.36 B = 0.75 F_b = 0.45 S = 0.0004 Z = 1:1.5 n = 0.025 Earthen, Trapezoidal	FC 9	LB	28.32	07	08	15	48
		FC10	RB	28.32	06	00	06	42
1619 - 1765	Q = 90 D = 0.31 m B = 0.60 F_b = 0.45 S = 0.0004 Z = 1:1.5 n = 0.025 Earthen, Trapezoidal	FC11	LB	28.32	06	08	14	28
1965 - 2205	Q = 86 D = 0.30 B = 0.60 F_b = 0.45 S = 0.0004 Z = 1:1.5 n = 0.025 Earthen, Trapezoidal	FC12	END	28.32	03	03	06	22
		FC13	END	28.32	03	08	11	11
		FC14	END	28.32	05	06	11	00
				Total	88	64	152	
				Percent	58	42		

* Parallel FCs

Note:
- Q = Discharge in l/s
- D = Design depth in m
- B = Design bed width in m
- F_b = Freed board in m
- S = Bed slope
- Z = Side slope
- n = Manning's 'n'

Table 6.06 - Salient features of rehabilitation designs
(Adopted from Appendix A of the Interim Report of Walawe Irrigation Improvement Project by MMP)

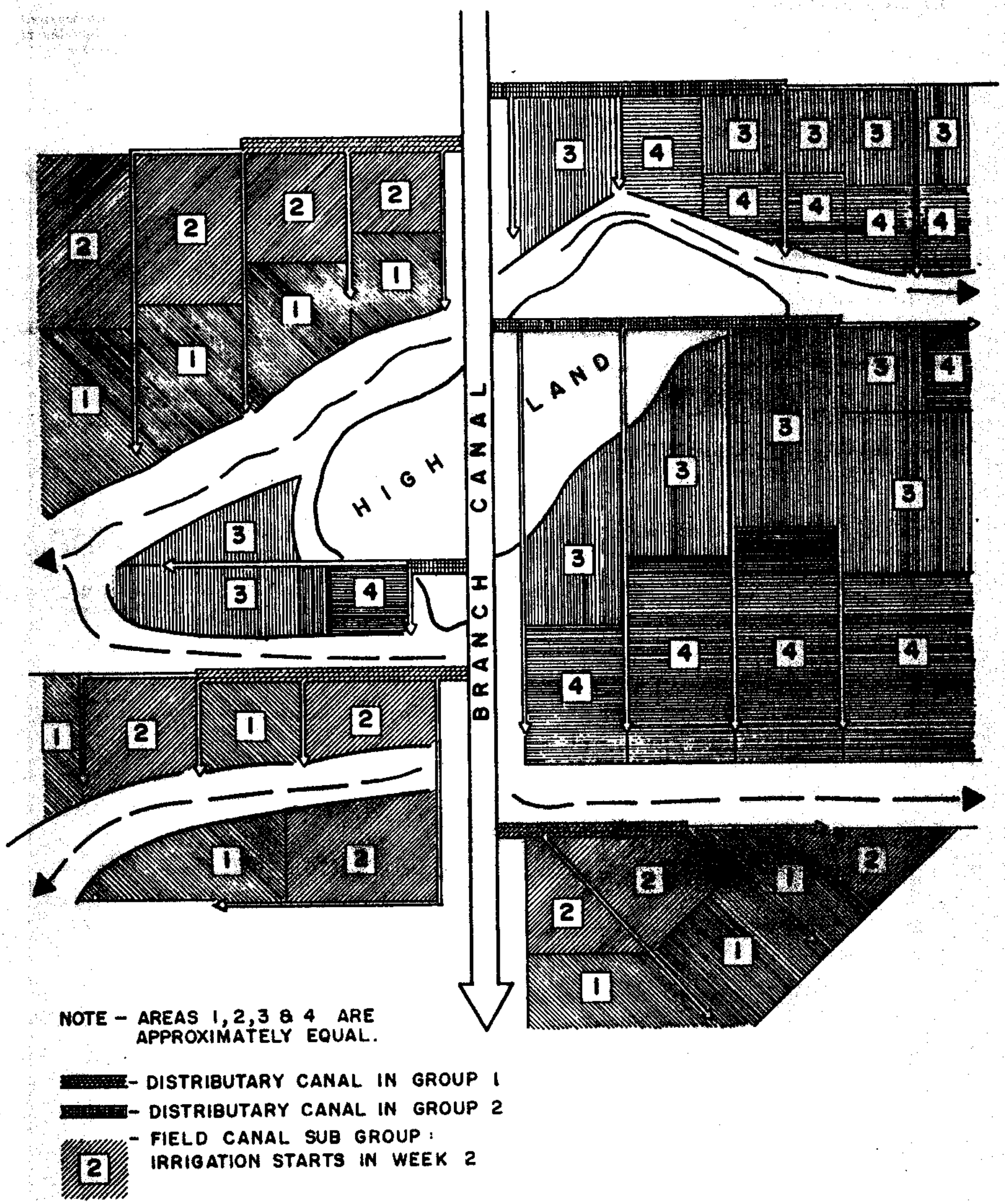
Block	E'pitiya	C'wewa	N'Hena	Binkama	A'palassa	Total	DCB in C'wewa Block
Area (ha)	1773	2494	2226	2384	2662	11539	152
Total Canal Length (km)							
Field Canals	85.0	122.6	111.9	179.6	127.1	626	6.78
D Canals	24.4	39.5	45.7	34.8	53.9	198	2.20
New Canal Length (km)	27.0	39.5	24.7	31.8	27.2	150	
FIELD CANAL STRUCTURES							
NEW Falls	827	1072	1354	1037	987	5277	100
Div. Boxes	58	57	67	93	65	340	04
Farm outlets	1050	1438	1820	1950	1690	7988	110
Culvets	32	84	65	84	47	312	
REPAIR Falls	901	328	126	609	924	2888	
Farm outlets	738	974	781	830	917	4240	
DISTRIBUTARY CANAL STRUCTURES							
NEW CPOs	5	8	6	6	9	34	09
Turnouts	159	204	198	215	239	1015	06
Falls	68	70	111	49	29	327	12
Regulators	22	40	37	42	60	201	
Culverts/Bridges	23	39	30	25	23	140	06
Bathing steps	24	14	19	22	26	105	
REPAIR CPOs	0	1	0	0	0	1	
Turnouts	18	2	26	18	13	77	
Falls	103	62	28	78	135	406	04
FIELD CANAL DENSITY							
Existing m/ha	33	33	39	62	38	61	
After Rehabilitation m/ha	48	49	50	75	48	54	45
FC STRUCTURE DENSITY							
After Rehabilitation							
Falls/1000 ha	975	561	665	690	718	708	(1520)
FTOs/1000 ha	1008	967	1168	1166	405	1060	(723)

Table 6.67 - A comparison of design and operation assumptions in Walawe and Kirindi Oya irrigation systems

Design/Operation Assumption and Parameters	Walawe Project (Rehabilitation)	Kirindi Oya Project (New Construction)
1. Canal Design Assumptions		
1.1 Crop designed for	100 percent direct sown rice in yala and maha	Mixed cultivation of paddy and OFCs in appropriate combination
1.2 Staggering of cultivation	four staggers with a time lag of one week between the commencement of each successive stagger	Three staggers with a time lag of two weeks between the commencement of each successive stagger
1.3 Land preparation period for a typical farm	Three weeks - one week for land soaking and two weeks for puddling	Two weeks - one week each for land soaking and puddling
1.4 Evapotranspiration values	By modified Penman method with climatic data from Hambantota	75 percent probability evapotranspiration values at Mahailluppallama Agriculture Research Station
1.5 Effective Rainfall	By rain fall events at Embilipitiya with 80 percent probability of exceedance; effective rainfall is 70 percent of this rainfall	By 75 percent probability effective rainfall values at Mahailluppallama
1.6 Seepage and Percolation losses	Assumed as 5 mm/day with no consideration of soil types in the command	Assumed as 3 mm/day for maha and 5 mm/day for yala for lowland (LHG) farms
1.7 Filling Requirement	25 mm/week for three weeks after sowing and transplanting	No filling requirement separately provided for
1.8 Farm Application Efficiency	80 percent	Nil
1.9 FC Conveyance Efficiency	90 percent	80 percent
1.10 DC Conveyance Efficiency/Losses	By Lacey's formula or on assumption of 3 l/s per 1000 sum of wetted surface	75 percent *
1.11 MC/BC Conveyance Efficiency/Losses	By Lacey's formula or on assumption of 3 l/s per 1000 sum of wetted surface	85 percent
2. Derived Peak Requirements and Canal Duties/Capacities		
2.1 At Head of FC	2.41 l/s/ha in the second week of maha season (during land preparation) yala season during crop growth period	3.50 l/s/ha for RBE soils and 1.80 l/s/ha for LHG soils which occurs in
2.2 At Head of a DC (Canal duty or design capacity)	Determined after planning the rotation under DC and calculating the transmission losses as indicated in 1.10 above	The sum of discharge capacities of all FCs served by the DC
2.3 Design Capacity of a FC	28.32 l/s	28.32 l/s
3. Turnout Areas		
3.1 Size of Turnout Area	Typically 12 ha	16 ha of 100 percent RBE soil type and/or 8 ha of 100 percent LHG soil type
3.2 Size of the farm turnout (FTO)	75 mm diameter uncontrolled pipe outlets, capacity 5 l/s	150 mm diameter uncontrolled pipe outlets, capacity 14 l/s

4.	Operational Assumptions		
4.1	Land preparation period in a typical farm	Three weeks, one week for land soaking and two weeks for puddling	Three weeks, one week for land soaking and two weeks for puddling
4.2	Staggering of Cultivation	One week stagger of first issue on individual FCs. DCs under a main/branch canal are grouped into two with first issue in one group commencing two weeks after the other	Three week stagger of the commencement of land preparation with a time lag of one week between each successive stagger
4.3	Land preparation period in the command area	Six weeks	Five weeks
4.4	Stagger Areas	Almost equal areas	20, 60 and 20 percent of the command respectively
4.5	Land soaking and puddling requirements	150 mm/week for land soaking (20 mm/day) and 105 mm/week (15 mm/day) for puddling	3.6 and 5.7 mm/day for LHG and RBE soils
4.6	Farmer rotations	Six or five farmers in a FC share the entire flow in the FC at the same time	Two farmers in a FC share the entire flow in the FC at a time
4.7	Field Canal Rotations	Variable delivery duration and fixed discharge at the head of FC, during the season FCs are rotated on DCs	Fixed delivery duration and variable discharge at the head of FC, during the season FCs are rotated on DCs
4.8	Distributary Canal Rotations	DCs are rotated on main/branch canals	No rotation of DCs. DCs run continuously
4.9	Variability of Flow at the head of a FC	Designed to operate at a constant discharge	Flow is varied to keep the delivery duration constant
4.10	Variability of Flow at the Head of a DC	Rotation among FCs are planned to have a steady and almost constant discharge in a DC	Discharge at the head varies to suit the deliveries to the FCs
4.11	Canal design discharges	Planned for 80 percent of the gross demand (excluding rainfall) in maha and 100 percent in yala	Planned for 100 percent of the gross demand in maha and yala, excluding rainfall
4.12	Method of delivery	Delivery is fully rotational	Delivery is continuous during land preparation period, but rotational during crop growth
4.13	Rotation interval within a FC	Rotation interval varies throughout the season	7 days within the FC
4.14	Adjustment of deliveries	Has to be done according to a set of operating rules based on the actually measured rainfall, on weekly basis	Has to be done according to a set of operating rules based on the actually measured rainfall on weekly basis.

FIGURE 6.01 – SCHEMATIC OF STAGGERING FIRST IRRIGATION



Source: MMP (July 1986). Draft Water Management and Operation Manual

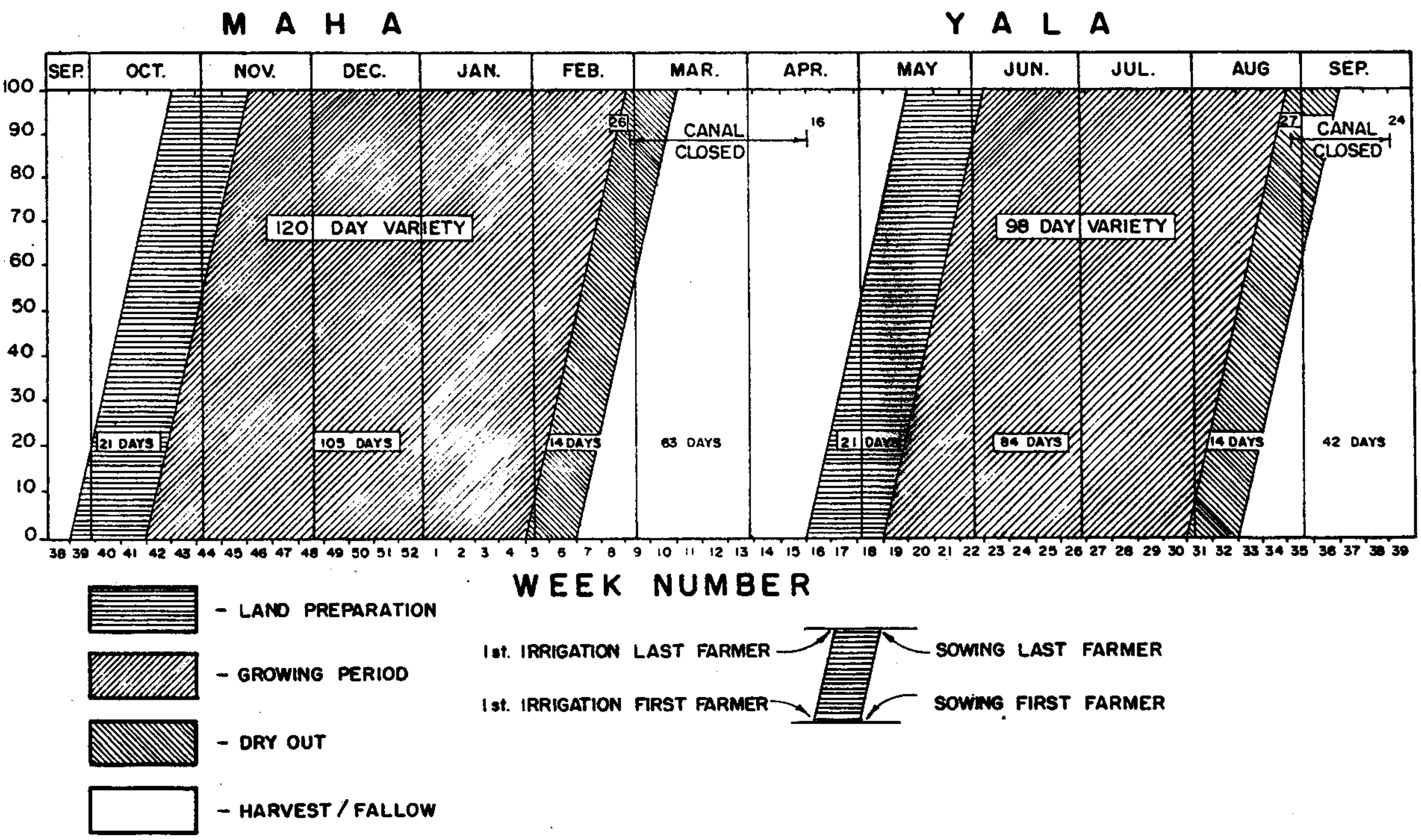
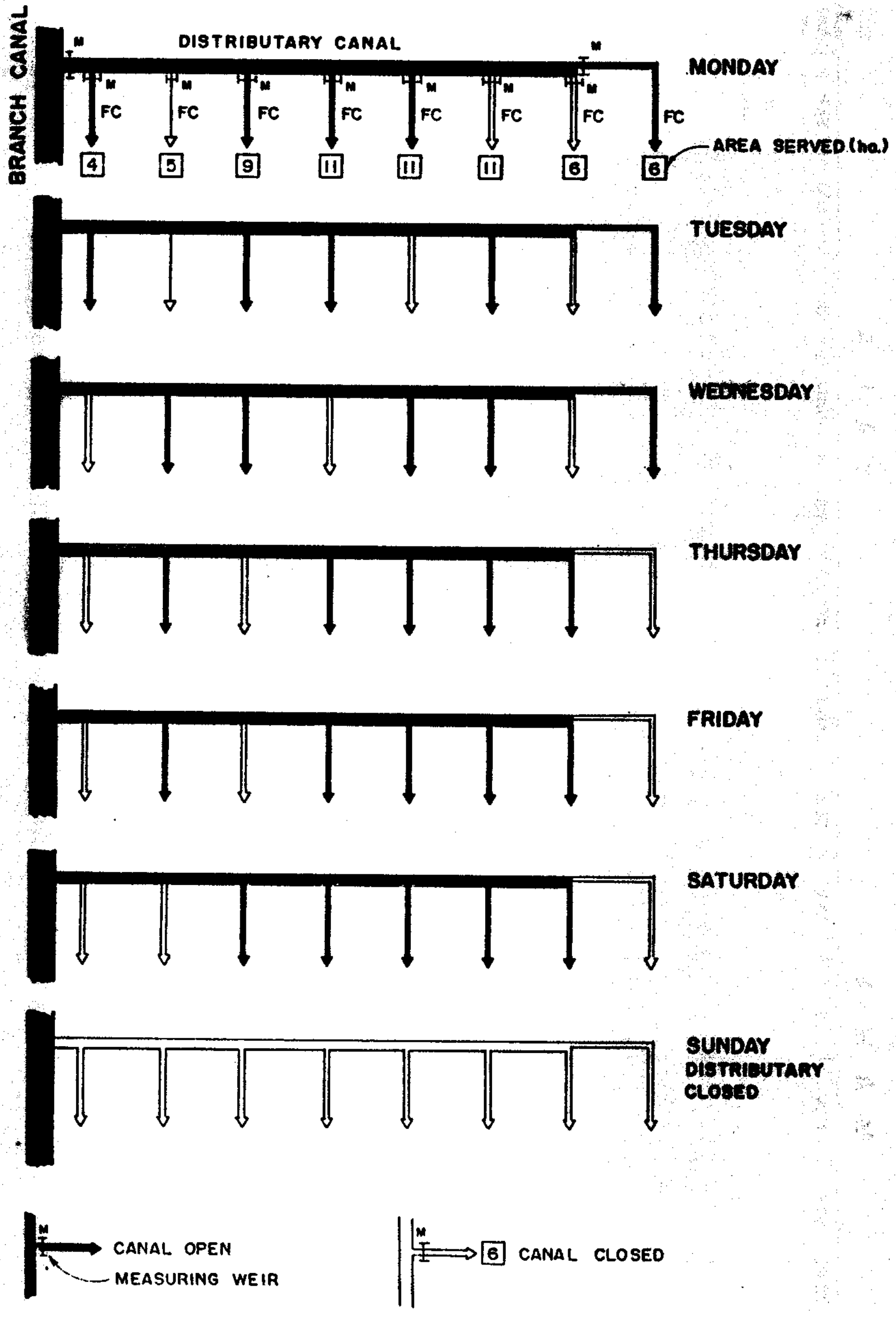


FIGURE 6.02 — DIRECT SOWN PADDY CROPPING PATTERN

Source: MMP (July 1986). Draft Water Management and Operation Manual

FIGURE 6.03 - TYPICAL ROTATION OF FIELD CANALS



Source: MMP (July 1986). <u>Draft Water Management and Operation Manual</u>

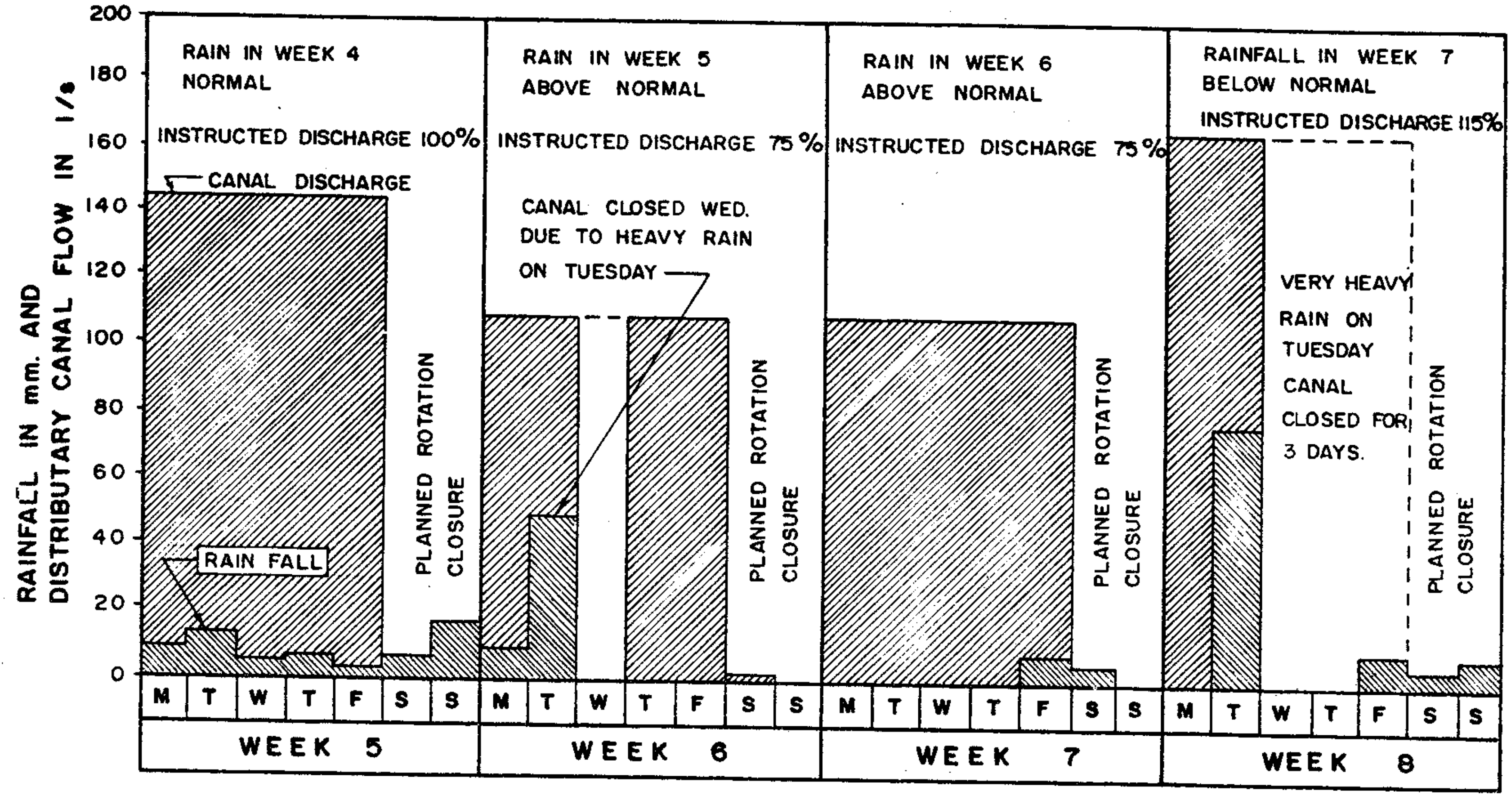


FIGURE 6.04 – TYPICAL CANAL ADJUSTMENTS FOR RAINFALL

Source: MMP (July 1986). <u>Draft Water Management and Operation Manual</u>

VII. IRRIGATION INSTITUTIONS IN WALAWE

INTRODUCTION

This chapter, like the chapter on irrigation institutions in Kirindi Oya, provides an update on developments since the Progress Report (IIMI 1988b). Unlike Kirindi Oya, there are no significant structural or management changes in the Uda Walawe Project since the time of the Progress Report that could be reported. The observations and conclusions in that Report are still valid. The remainder of this section discusses the analytical framework, which is the same as for the Kirindi Oya institutions chapter. The following section provides an account of the events of maha 1988/89, including the impact of the political disturbances of that period. The final section reviews the findings on irrigation institutions in Walawe to date, with reference to the Research Questions included in the Inception Report.

This component of the research has two broad objectives:

1. to document and assess the present functioning, strengths, areas needing further strengthening, and impediments to improvement in the irrigation institutions at the project and farmers' level; and

2. to propose structural and management innovations that could be adopted in the short run to improve project performance, and others that could be tested and adapted over a longer period that would strengthen efforts to achieve the project goals (Inception Report, IIMI 1988a:17).

"Irrigation institutions" is defined here as those institutions directly related to the operation and management of the water conveyance and delivery, i.e., irrigation, system. The Walawe system is managed by an agency (Mahaweli Economic Agency, MEA) that integrates a large number of irrigation, agriculture, economic, and social welfare functions. Therefore, for the purpose of this research, we have focused on the O&M and Agriculture Divisions as well as the block and unit levels where most of the contact with farmers occurs, since these are the units most concerned with irrigation.

The water conveyance system requires some form of organization, and some set of understandings or conventions about appropriate behavior patterns to make use of it; hence, irrigation systems have been characterized as "socio-technical processes" (Uphoff 1986a: chapter 1). On large government-managed systems, there is normally an irrigation management agency; and in most cases there are either formal or informal groups of farmers with some management responsibilities, at least at the tertiary level. These responsibilities may be implicit or explicit.

The terms "institution" and "organization" are often used interchangeably, as in the preceding paragraphs. However, social scientists usually make a distinction between the two terms (Uphoff 1986b:8-10). Following Uphoff, "organizations" are "structures of recognized and accepted roles." Thus, in Walawe the "irrigation organizations" include the O&M and

Agriculture Divisions of MEA, the block and unit offices, and to stretch a point, the (nascent) farmers' organizations.

"Institutions," whether organizations or not, are "complexes of norms and behaviors that persist over time by serving collectively valued purposes." Institutions persist because they are valued as well as useful. Thus, there are institutions that are not organizations, for example "the legal system", or the warabandi rotation system in northern Indian and Pakistani irrigation systems. There are organizations that are not (or not yet) institutions, for example a new law firm, or the farmers' organizations being promoted in Walawe as part of the rehabilitation project; to anticipate a conclusion of our work, these have not become sufficiently valued to qualify as "institutions."

Finally, there are organizations that are institutions (or vice versa), i.e., have a normative value beyond the technical requirement at hand or the immediate benefits people derive. Organizations that have institutional status in peoples' minds, that are legitimate and valued, are likely to be more stable and more capable of solving problems over time than less valued, less institutionalized, organizations will have.

In an existing irrigation scheme like Walawe, the process of institutional development is not simply a matter of creating "organizations", but of strengthening existing organizations through the introduction of structural and management innovations, and institutionalizing these changes and new values, conventions and understandings about appropriate norms and rules of behavior. Institutions cannot be modified or constructed in a mechanical manner, within the constraints of a time-bound project, following a blueprint, as in the case of the physical conveyance system. Institutional development, i.e., the infusion of value as part of a process of building capability, is a long term process requiring considerable investment of time and skilled human resources; but is essential for long term sustained productivity of an irrigation system.

Since "institutionalization" is a process, not a category or thing, there are degrees of institutionalization. Effective institutions are those that are so much a part of peoples' lives and ways of thinking, including the categories in which people think, that their premises are not questioned, and life without them is unthinkable (Douglas 1986). By definition, special efforts for institutional development, such as the use of catalysts for forming farmers' organizations, will not be required once the organizations become institutions.

The performance of the irrigation institutions may be assessed in numerous ways. In this report, the performance of a part of the physical system is assessed by comparing actual water deliveries to the requirements of the crops, and to the objectives of the irrigation management agency; the performance of the agricultural system is assessed by measuring actual yields; and the performance of the agricultural economic system by assessing profits of agricultural production. These are all output measures.

For assessing the performance of the irrigation institutions, or more narrowly and precisely "irrigation organizations," it is more difficult to identify simple quantitative criteria that all observers would agree constitute appropriate measures of the institutions themselves. Indirectly, all of the other measures mentioned above are measures of the performance of the irrigation organizations: if water is not delivered according to the expectations of farmers and crop needs by the irrigation agency, the agency's performance may be said to have been below expectations. But in order to understand why this is so, it is necessary to investigate both the overall structure of the organizations, and the internal processes of setting objectives, obtaining and using information, making decisions, motivating and controlling personnel, monitoring the results, and making adjustments.

Beyond this, one must also investigate the functional "fit" between the technology and its management requirements, the structure and processes of the organizations managing the physical system, and the social, economic, and natural environment. If, for example, the water conveyance technology is designed in a way that requires constant monitoring of flows, and rapid decisions and interventions to change flows, but the organization is designed as an hierarchical one, with all decisions emanating from a central place, in the absence of an effective communication system, then we may suspect that the "fit" between the technology and the organization is not very good, and performance of the water conveyance system is likely to be poor.

Another example of lack of fit -- particularly relevant in Sri Lanka -- is that if the water conveyance system is designed and managed by the government agency on the assumption that farmers will maintain the field and distributary channels and will operate a rotation system, but no appropriate measures are taken to insure that farmers have the institutional capacity to fulfill these functions, the government's expectations will be disappointed, and the performance (and maintenance) of the system likely to be below expectations.

It is important to stress here the impact of the extremely unsettled political situation during most of the maha 1988/89 season on the irrigation organizations, on the farmers and officials, and on the research itself. As noted in our previous reports, the unsettled situation has made collection of sociological data somewhat problematic. People are understandably reluctant at times to discuss sensitive matters, suspicious of the real intentions of the researchers, and often so distracted by other things that they exhibit little interest in discussing mundane irrigation matters. Further, the extreme situation faced during maha 1988/89 severely affected the behavior of officials and farmers, and placed serious strains on the irrigation organizations. It is clear that the "performance" of these organizations was seriously reduced by the conditions under which they had to operate; and it may not be amiss to pay tribute to those officers and farmers who continued to try to carry out their duties in such a situation.

Finally, in spite of the unsettled conditions and severe pressures faced by government officials in particular, it is also appropriate to emphasize the very high degree of cooperation and willingness to be of assistance in the research, within the constraints they faced.

OBSERVATIONS ON MAHA 1988/89

Planning

The Agriculture Division prepared the tentative agriculture program on the availability of water, after formal discussions with the O&M Division as the initial stage of commencing the season. Before the cultivation meetings were summoned to take decisions on the plan, unit level pre-seasonal farmer training classes were held. The main objective of these classes was to prepare the farmers for the oncoming season; the importance of following the cultivation calendar was emphasized. However, farmer attendance at these classes was low in Chandrikawewa Block because the farmers were still busy with harvesting and farmers had the impression that the same matters were repeated at these training classes. As the final step of the planning process, the cultivation meeting was held to formalize the decision on the commencement of the maha 88/89 season. Though some farmers requested earlier dates, 1 October 1988 was decided as the date of first water issues, with one month allowed for land preparation.

MEA carried out jungle clearing of distributary channels before the commencement of the season. But the financial allocation for DC8, the sample area, was sufficient only to clear up to LB5 (about 60 percent). The field assistant's attempts to get additional labor days failed and the tail-end of the channel remained uncleared, much to the displeasure of the tail-end farmers.

Farmers did very little maintenance work on their field channels (FCs) — to be fair some FCs hardly exist any longer. MEA also has no developed plan to get the work done; the lack of farmer unity is the main constraint. Some individual farmers clean patches of FCs but this has little impact on water issues. In DC8, uncleared FCs are not a hindrance to water distribution, so there is at present little incentive to clean FCs.

Operational Procedure

The water issues were started as programmed on October 1st but serious water delivery problems developed during land preparation because of repairs to the electrical turbine of the right bank main sluice at the Uda Walawe reservoir. The Ceylon Electricity Board, which is responsible for these repairs, started the work at the end of September but could not complete them until 18 October. As a result, the required volume of water for the command area for initial land preparation could not be released.

From the Walawe reservoir the daily water issues during the land preparation of this season dropped to 500-550 cusecs though the required amount was about 800-850 cusecs. As the required capacity could not be released to Chandrikawewa Tank, the quantity received was not sufficient to compensate the daily issues, resulting in a rapid drop of the water level. In turn, this led to reduced daily issues for the command area in the tail-end blocks.

In the previous season the initial water issues from Chandrikawewa Tank had been about 139 cusecs per day, while in this season it started at about 120 cusecs and over the next two weeks it gradually decreased to 107 cusecs. As a result, farming activities in downstream distributaries and the tail-end of some upstream distributaries were affected. Further, as there was no rain, farmers had to depend fully on the irrigation water and the dry fields required more water to start land preparation work.

In an attempt to deliver water to the downstream areas, the block irrigation officers started rotations among distributaries on the branch canal early, i.e., after 11 days of the initial water issues. This created some problems for the tail-end farmers of some upstream distributaries since they too had not received adequate water supplies. The tail-end farmers of DC8 did not receive water even 10 days after the first water issues, and the closure of the channel for this early rotation aggravated this situation. No measurements are available to support this, but it appears that the inadequate water supplies to the tail-end of DC8 was mainly the result of lack of equal distribution on the distributary, not short supply. The unexpected closure of the channel affected the land preparation activities of everyone, and the unit manager, who was not informed of the rotation decision, had to make a request to open the channel. Rotations within DC8 had still not started. Farmers on some DCs objected to starting rotations due to the inadequate water supplies. Some farmers of DC10 damaged six FC gates when the rotation first started there.

Farmer Behavior Patterns on DC8

The extreme tail-end of the channel did not receive adequate water supply to start land preparation even two weeks after the first water issue. In previous seasons, the gate of one FC, RB1, has been closed for two days per week, on Monday and Tuesday, on the agreement of the farmers there. But this season, this rotation could not be started since some farmers had not received sufficient water. Some tail-end farmers who had still not received water arbitrarily closed the gate on RB1. This infuriated the farmers of RB1 and no rotation was allowed until they had nearly finished their land preparation.

On 22 October 1988 some of the tail-end farmers damaged the distributary channel by cutting a small channel near RB2 to take water to their fields, as their water flow had been blocked there. There was no official response to this act of the farmers and the subchannel remained established. This action affected the farmers of RB2 and they responded by damaging the RB2 turnout structure to take more water. The officers cannot be blamed for ignoring this behavior because the defective system has created a permissive environment for the farmers to behave as they wish. The tail-end farmers received adequate water supplies only after the head-end farmers had completed land preparation. The farmers of RB1 themselves asked the irrigation laborer to close the gate to their channel to give water to the tail-end once they had enough. Towards the end of the month most of the tail-end farmers of DC8 began receiving adequate water and the rains also came.

Land preparation of most of the command area was not completed at the end of October as scheduled. According to the cultivation progress reports at the block office, land preparation was completed on only about 60 percent of the total land by the end of the month. In DC8 only about 10 percent of the allotments had completed land preparation. Even by the end of November, only 44 allotments (about 45 percent) had completed land preparation. The water delivery problems that occurred during the initial stage were one reason for this slow progress, especially at the tail. The other reason for this slow progress, according to farmers, is their experience that the MEA cultivation calendar is very flexible and extended water issues are always given to the delayed cultivations. Another reason for the delay was the troubled situation in the country; fuel shortages made hiring tractors for land preparation difficult. There was also a shortage of migrant laborers.

Impact of the Political Disturbances on the Season

The political disturbances in the area gradually increased during this period and by the end of October the situation was not good. Many functions came to a standstill in the country including this area. The troubles became serious from November to mid-December 1988 and most of the time the activities of MEA and other government institutions were virtually stopped. Field visits were no longer possible for the MEA field officers and system operation was disrupted. After 28 October both the branch canal and DC rotations were not operated until the third week of November. The tense situation continued to the middle of December, resulting in very low farmer officer contacts.

Since it was not possible for the field officers to visit the field and the water rotations could not be operated, the sluice gates of the branch canal were kept open with additional capacity as a temporary measure to reduce the farmers' water problems. Usually, during part of the branch canal rotation the water deliveries are increased to supply more water to the down-stream distributaries, especially DC10, DC15 and DC17 where internal rotations are operated. During the peak period of troubles the irrigation section advised keeping the gates open at that increased capacity since the officers were not able to assist in distributing water.

The Unit Managers (UMs) were compelled to close their offices but most of them were available if the farmers wanted to see them. However, those who were behind the disturbances prevented the farmers from visiting the UMs. On the other hand, the farmers too advised the UMs not to visit the fields.

The UM of our sample area said that farmer visits during this period were far below normal. No farmers came with water problems as there was plenty of water and some rain as well. A few farmers came with crop disease problems. Those farmers who visited the UM were mostly those who had received cultivation loans needing receipts to get fertilizer. These farmers were to be given fertilizer from the block office stores on the receipts issued by the UMs. But fertilizer was not available at these stores. The UMs too were cautious since the offices were supposed to be closed and the receipts were issued with past dates.

Impact on General Farming Activities

In early 1989, we selected a sample of 24 farmers on DC8 (7 at the head, 8 at the middle, and 9 at the tail) to learn how the disturbances had affected their activities, and how they adapted to this situation. According to these farmers, their farming activities were not seriously disrupted during the peak period of disturbances. Most of the crop was at the growing stage and frequent field visits were not necessary. Visiting the fields was not difficult as their hamlet is situated close to the field. Only night irrigation was stopped. However, there had been some delays during land preparation period. Only five farmers (21 percent) of the sample said that their farming activities were disrupted during land preparations. Four of them had problems hiring tractors; one farmer reported difficulty finding labor.

According to the farmers, irrigation was not a problem during the period of serious troubles, i.e., after land preparation was over, as water was abundant and continuous. Almost all the sample farmers of the head and middle sections mentioned that they had no problem with water supply as it was abundant, but seven of the nine tail-end farmers interviewed said that they were having serious problems due to inadequate supplies. The only irrigation problem that the head and middle section farmers reported was that tail-end farmers were breaking the temporary structures head and middle farmers had built in the distributary channel to raise the water level. This was mentioned by 28 percent of the head and 75 percent of the middle farmers. But this problem did not arise during the troubled period as there was an abundant continuous water supply.

The major irrigation problem reported by the tail-end farmers was delayed and insufficient water supplies during land preparation. They attributed this to the rotational closure of the distributary and overall short supply. But this problem did not occur during the period of troubles as the channel was kept open continuously. Only two of the nine tail-end farmers had some irrigation difficulties during this period, but they were not as serious as during the land preparation period. Three of the nine tail-end farmers said that they did not have to break the log structures built by the head-end farmers this time as the water flow was continuous. One farmer said that for the first time he did not have to undergo sleepless nights to irrigate his fields; another mentioned that he was able to irrigate his field during the night as other farmers did not do night irrigation during this period.

In summary, farmers were happy with the continuous water flow. Except for a reduction in night irrigation by tail-end farmers, there was no significantly different irrigation behavior due to the disturbances since the system normally lacks close officer involvement and is normally controlled by individual farmers, and water supplies during the disturbed period probably greatly exceeded crop requirements.

Supply of Inputs

Supply of seed paddy was not affected as the situation became serious only after sowing. One sample farmer had prepared about 0.3 ha of land to cultivate onion on the instructions given by the UM to put on a demonstration in the unit. Seed materials were to be supplied free of charge. This farmer suffered as MEA was not able to supply seed-onion due to the troubles.

According to the farmers, most of the time the private dealers had ready stocks of agricultural inputs of fertilizer and agro-chemicals and therefore there was hardly any shortage of supplies. However, those who had applied for cultivation loans had problems since they had to depend on MEA and the bank to get these inputs. Though those farmers were expected to buy their fertilizer from MEA stores it was not available to them. On the other hand although the bank pays cash directly to buy agro-chemicals the bank was closed during these days.

The number of farmers who had applied for cultivation loans was low; only six sample farmers (25 percent). Defaulting on repayment of previous loans was given by farmers as the main reason for not getting bank loans. Out of those who applied for cultivation loans only one farmer was able to purchase fertilizer and agro-chemicals before the situation became serious. Three had to obtain credit from private sources at higher interest rates to buy these inputs. Two farmers had purchased inputs from private dealers with their own money. One of these had serious problems in purchasing and applying these inputs in time; therefore he claimed about half of his cultivation was damaged.

Only two farmers had purchased fertilizer from the MEA stores; the others had purchased it from private dealers. Four farmers had experienced some fertilizer shortage at private dealers. Three of them had some delays in applying fertilizer due to this shortage. Altogether, eleven farmers (46 percent) had bought inputs from private dealers with their own money while twelve farmers (50 percent) had bought them on credit, or on borrowed money from private money dealers. Only one farmer (4 percent) was able to get them on cultivation loans.

Contact with the officers over cultivation problems

During the troubled period only one sample farmer had visited the UM on a cultivation problem (crop disease, mentioned above). Others said that they had no need to visit the UM on any cultivation problems as they had the necessary knowledge to identify diseases and apply suitable agro-chemicals. Thirteen sample farmers (54 percent) said that they had attended farmer training classes and the training they received was useful in identifying crop diseases and applying inputs. The remaining farmers (46 percent) said that they had the knowledge through experience. One farmer who had attended the training classes said that one leased-in farmer sought his advice to control a pest disease.

The expected farmer training classes could not be held during this period. This did not affect the cultivation because according to the farmers they had the necessary knowledge. These training classes are held under the agriculture extension program and in their view enough training had been given to the farmers on extension messages. Farmer attendance had been very low at the classes held at the beginning of the season mainly due to the farmers' view that the training was only a repetition.

Thus, though the activities of MEA and other institutions were disrupted during the troubled situation in maha 1988/89, it had no significant impact on the cultivation. Farmers had been able to get over most of the problems that arose during this period without much intervention from the officers. Minimal contact with officers is the usual pattern for farmers in Walawe in their day to day operations. According to the farmers the cultivation was rather successful during this season.

The final water issue was extended from 1 February to 25 February 1989 to give water to the delayed cultivations, not an abnormal extension at all.

TENTATIVE CONCLUSIONS AND ANSWERS TO RESEARCH QUESTIONS

In the Inception Report (IIMI 1988a:17-18) we listed seven research questions that would guide the research on irrigation institutions. In this section, we review the tentative conclusions and answers to these questions which we have arrived at to date. They are subject to further refinement and modification as the research proceeds.

1. In the Progress Report (IIMI 1988b:115-122) we described the overall organizational structure of MEA at the project level. We identified some structural factors that do inhibit management efficiency and the incentives to provide efficient service. Since we could not do further research on this point during maha 1988/89, we have nothing to add at this point; the observations, conclusions and suggestions in the Progress Report are still valid.

2. Similarly, the Progress Report documents some of the processes of decision-making and communication flows up and down and laterally within the managing agency. We suggested these are not as effective as one would wish, and made a few suggestions for improvement which still stand. We will address this question further in the final report on the research.

3. (Applicable only to Kirindi Oya)

4. In the Progress Report (IIMI 1988b:122-125) we have provided a brief description of the efforts to establish water users' groups; this clearly relates closely to the chapter on rehabilitation processes. The disturbed conditions not only prevented much work on establishing farmers' groups, but we suspect have set the process back somewhat. In any case, as we noted in the Progress Report, and in the chapter on rehabilitation processes, the efforts to organize water users groups are inadequate in terms of manpower and other resources, are not effectively integrated into the rehabilitation

work, and in the absence of a clear MEA policy regarding the roles, authority, and relationship with MEA of farmers' groups, little success can be expected. We suggest a major rethinking of this effort is required, and if MEA wishes to form effective groups, a major reorientation of the effort, with commitment of resources, will be required.

5. The patterns of relationships between agency officials and farmers is discussed in the Progress Report (IIMI 1988b:128-129). Some officials are very helpful to farmers individually in solving their problems, and some are not. There are no effective groups at present, and no interactions that occur between field-level officials and the nascent groups as groups; thus it is fair to say the agency is not presently effective in encouraging self-reliant effective water users' groups, because there is no clear policy on the groups' functions, and no areas in which the agency deals with groups or their leaders as opposed to individual farmers.

6. It is clear, from the discussion in the Progress Report and in the previous section of this chapter that the present level of cooperation among farmers in the sample area is not very high. Occasionally small groups do coalesce to solve immediate shared problems, such as the construction of a structure to increase distributary channel water levels by head-end farmers, or the destruction of the same structures by tail-enders during the night.

If one takes the condition of the present DC8 channel system as indicative of the state of the organizational capacity for O&M of the system among farmers, one must conclude the present level of organization will not be sufficient to maintain and operate the rehabilitated system. Farmers do not do even the minimum of field channel cleaning now; unauthorized changes such as extra pipe outlets, additional subchannels and temporary control structures in the distributary head are the order of the day. To a large degree farmers are forced into these actions by the condition of the system. But there is no convincing evidence that they will change their behavior and cooperate for sharing water equitably and maintaining the channels during the post-rehabilitation phase, as is presently apparently assumed. Thus, present cooperative behavior and organizational capacity does not match the technical requirements of the design.

7. Finally, it is difficult at this stage to draw firm conclusions regarding the relationships between institutional factors and the performance of the irrigation system. Lack of any organizational mechanism to insure maintenance of the physical system at the field channel level is surely one important cause of its present dilapidated condition, though not the only one. Ineffectiveness of the field level staff responsible for distributary maintenance is undoubtedly one cause of the poor condition of these channels, but again not the only one. Earlier reports had suggested the previous management agency, River Valleys Development Board, bears considerable responsibility for the poor system condition and performance. Some of these reports also advised that even under the MEA, more attention to strengthening the O&M institutions would pay greater dividends than a physical rehabilitation project alone (see chapter on rehabilitation process).

Although we cannot draw firm conclusions as yet on this score, we believe that the poor maintenance and poor performance of the present system can be attributed to a large degree to organizational and institutional weaknesses, and attention to strengthening these would have a large impact in the long run.

CONCLUSION

We return briefly to the discussion of "institutions" in the introduction to this chapter. The problem of "institutional development" is rather different in an existing scheme than it is in a new scheme like Kirindi Oya. But it may not be incorrect to say that the present condition of the Walawe scheme provides a picture of what Kirindi Oya could become if institutional development activities there are not successful.

In our view, the history of the Walawe scheme is a history of the failure to develop effective management institutions. All observers seem to agree that the previous management agency, for many reasons, was unsuccessful in developing a management system that could complete the construction effectively, in operating the system efficiently and equitably, in maintaining the system infrastructure, and in developing workable institutions at the farmer level for joint system management.

Many observers credit MEA with having brought about significant improvements in the performance of the system. But the problems we have documented within the agency management structure, combined with the serious problems faced by the rehabilitation project (see rehabilitation chapter) and the continuing lack of a clear policy towards farmers' role in system management, suggest serious institutional problems could continue to impede improving system performance to the anticipated level, and to threaten the long-term sustainability of the system.

RESEARCH PLANS FOR YALA 1989

The research plan proposed in the Progress Report (IIMI 1988a) would be undertaken this season because we could not cover the whole program as a result of the disturbances and social unrest last season. Special attention will be paid to the process of forming water users' groups.

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VIII. MANAGEMENT OF THE REHABILITATION PROCESS IN WALAWE

INTRODUCTION

The objectives of this research component are:

1. to document the irrigation system rehabilitation project in Walawe as a management process, identifying the roles of the key actors, the effectiveness of communication among them, the factors leading to particular choices regarding planning, design, and construction strategies, and the short term results of this process in selected areas of the scheme;

2. to estimate the likely long term impacts of the rehabilitation on system performance and their sustainability; and

3. to propose project design and management improvements that could be adopted in future projects (Inception Report--IIMI 1988a:20).

The Progress Report (IIMI 1988b) made a preliminary attempt to describe the rehabilitation process as we have observed it. This chapter avoids repeating materials found in that report, but tries to build upon it. Because of the disturbed conditions in the project area since that report was written, there has not been a lot of progress or changes to report. What we attempt to do here is first, to review some recent literature on rehabilitation experiences in Sri Lanka and elsewhere in order to establish a framework for analysis, second to analyze the rehabilitation process in Walawe in the light of the conclusions of this literature, and third, to offer some preliminary conclusions, structured as responses to the Research Questions included in the Inception Report (IIMI 1988a:20-21).

Our analysis is rather critical of the present rehabilitation project, particularly its overall conception and design, and the management of its implementation. We wish to emphasize that these criticisms are not directed at any particular individuals or firms; to blame individuals would be an injustice because the causes go deeper than individual errors. Rather, our analysis is a sociological analysis, looking at organizations, and the way in which unquestioned assumptions, concepts, beliefs, and perceptions which are themselves shaped by the prevailing social process, have led to a project approach that in our view is seriously flawed.

Since this research could not be done without the cooperation of many individuals, we pay tribute to their willingness to share their views even when they were aware we may take a critical view. We hope the analysis will be useful in terms of stimulating thought and actions for redirecting the present project and learning the lessons and using them to try to improve future projects.

REVIEW OF SELECTED LITERATURE

We had provided a review of selected literature on rehabilitation processes in Sri Lanka as part of the Inception Report (IIMI 1988a:24-33; also in Merrey, Rao and Martin 1988:19-27). This section is intended to supplement, not repeat, that review. The particular literature reviewed here is: Tiffen (1987); Haider (1987), Murray-Rust and Rao 1987; Wijayaratna 1987; and some of the papers presented at a very recent conference on "modernization and rehabilitation of irrigation and drainage schemes" (Hydraulics Research 1988). In the literature, "rehabilitation" has generally come to refer to projects aimed at restoring irrigation systems to some previous state, and "betterment" or "modernization" refer to projects aimed at changing irrigation systems to perform at a higher level than before, or to achieve new objectives in a changed environment. In this sense, it may be better to use the term "betterment" or even "modernization" to refer to the Walawe project, but conventional use has been to refer to it as a rehabilitation project.

What is remarkable about the recent literature is the degree to which specialists have reached a consensus regarding the requirements for successful irrigation rehabilitation, betterment, or modernization projects. This is particularly reflected in the reports on two conferences: Haider (1987) summarizes the proceedings of an "International Conference on Irrigation Rehabilitation and Betterment" (see Fowler, ed. 1987 for the papers and case studies), while Tiffen (1987) reports on the conclusions of the discussion of Rehabilitation and Modernization at the Thirteenth Congress of the International Commission on Irrigation and Drainage (ICID) held at Casablanca, Morocco, in September 1987. The papers presented at the more recent Asian Regional Symposium (Hydraulic Research 1988) confirm the developing consensus. The findings of the reports on rehabilitation project experience in Sri Lanka, as reflected in our earlier literature review, also support this consensus.

Mary Tiffen's (1987) summary of the final resolution on "Question 40" on rehabilitation and modernization, notes that it advocated:

1. the necessity of an integrated and therefore multidisciplinary approach to rehabilitation and especially modernization;

2. the involvement of farmers and operators in all stages of rehabilitation, including planning, to get agreement of all parties on the objectives;

3. carrying out careful diagnoses of the causes of the situation that has made rehabilitation necessary and testing solutions on a pilot area even if this takes time;

4. giving consideration to the balance between least-cost measures versus measures having a higher initial cost but which may be more sustainable, or may give greater flexibility to respond to changing water demands;

She says that governments, funding agencies and researchers were also asked to give attention to:

1. developing ways to improve communication among the actors at all stages of the project;

2. the conditions required for developing effective farmers' organizations;

3. developing improved criteria for deciding when and how to rehabilitate or modernize an irrigation system;

4. developing methods for ensuring adequate O&M after the rehabilitation;

5. the need to allow adequate preparation time and financial resources for the recommended integrated approach.

The conference agreed that more time and resources invested in the planning stages for consultation with users and for testing proposed solutions on a pilot basis could be worthwhile if they result in systems that are cheaper to construct, operate, and maintain, or that are more durable and productive in the long run. A proper diagnosis will often point to the priority that should be given to "software" rather than "hardware" for improving system performance. The need for such diagnosis and for institutional rather than, or more than, physical improvements applies in both developed and developing countries, as the papers submitted to the conference demonstrated. If experienced farmers and experienced operators, who after all must use the newly modernized system, do not agree on the changed objectives and changes in management, they can easily thwart the official aims.

The consultation process must be done carefully: if farmers believe others will pay the costs, they will tend to advocate expensive physical solutions such as lining; but if they are told they must prioritize, make a choice among options, or are asked to share the costs, they may emphasize more cost-effective priorities for achieving their own objectives.

USAID's Water Management Synthesis II (WMS II) Project had organized an international conference on irrigation system rehabilitation and betterment a year earlier than the ICID conference. The proceedings are summarized by Haider (1987). Again, there seems to have been broad agreement, as indicated by both Haider's summary and the volume of case studies (Fowler, ed. 1987). Haider summarizes the common problems on such projects as including:

1. inadequate attention to system O&M;

2. inflexible [project] design and a rigid implementation schedule;

3. use of inadequate, out-of-date information for planning;

4. poor coordination among the agencies involved;

5. inadequate farmer involvement;

6. lack of an effective monitoring and evaluation program;

7. inadequate consideration of the sustainability of the improvements.

Haider (1987) lists 18 guidelines and recommendations for making rehabilitation and betterment projects more effective. Without listing them all, they include all of the ICID recommendations, some stated more specifically than in Tiffen's summary. A few highlights are:

1. Rehabilitation and betterment projects should be designed as flexible processes to allow for adjustments, with greater emphasis on project planning and design, long start-up periods, and joint planning of the project;

2. The current construction orientation should be replaced with an approach that balances improving management as well as structures;

3. Farmers should be involved from the beginning, should be given decision-making authority, and there should be an effort to strengthen farmers' organizational capacities as a part of the project;

4. New policies should be formulated and communicated to the water users prior to project implementation, not during or after.

As our earlier literature review (Inception Report--IIMI 1988a:24-33) demonstrates, many of these lessons have been learned from other rehabilitation projects in Sri Lanka; indeed, Sri Lankan case studies made important contributions to these conferences (for example, Murray-Rust and Rao 1987; Wijayaratne 1987); four papers on Sri Lankan experience were presented at the most recent symposium (in Hydraulic Research 1988). Sri Lanka has been a veritable laboratory for testing diverse approaches to rehabilitating irrigation systems, and the Irrigation Department in particular has gained valuable experience. It is important to note that the consensus on how rehabilitation and modernization projects should be done are based on an implicit recognition that irrigation systems are not simply physical water delivery systems, but are, as noted in the chapter on institutions, complex socio-technical systems.

The Water Management Project in Gal Oya had a difficult start, reminiscent of some of the problems faced by the Walawe project. Over time, it came to emphasize institutional development (particularly formation of farmers' organizations as an integral part of the rehabilitation process itself), consultation with farmers' organizations on designs, prioritizing of essential construction work, and trying to develop cost-effective methods of rehabilitation (see references in Inception Report literature review). The Tank Irrigation Modernization Project (TIMP) was a source of lessons on the follies of making false assumptions about the underlying problems on irrigation systems, and trying to introduce new physical designs and operational rules without adequate testing and consultation with farmers. These lessons have had a considerable influence on the follow-on project (Major Irrigation Rehabilitation Project, MIRP) (see Murray-Rust and Rao 1987).

THE WALAWE IRRIGATION IMPROVEMENT PROJECT

Project Planning

Major investments in developing irrigation in the Walawe River Basin began in the 1960s, with the construction of the Chandrikawewa Scheme and later the Walawe reservoir, completed in 1967. The Asian Development Bank (ADB) became involved when it was requested to send an Appraisal Team in 1969; in 1970, the initial loans for the "Walawe Development Project" were approved. Although the project was to be completed by 1973, it was repeatedly extended, until 1979.

The Walawe Development Project was intended to be an integrated development project, with investments not only in irrigation infrastructure, but in settlement, roads, domestic water supplies, market facilities, etc. Unfortunately, the project did not achieve all of its objectives, and in fact faced a large number of problems that are analyzed in two official ADB documents, the Project Completion Report (ADB 1979) and the Project Performance Audit Report (ADB 1982). It is not necessary to repeat the findings here -- they are the usual litany of problems that reflect unrealistic planning assumptions, weaknesses in implementation capacity, and the impact of changed government policies (affecting the planning assumptions).

The Post-Evaluation Mission, after analyzing all that had gone wrong previously, nevertheless supported the recommendation contained in the Project Completion Report that the Bank provide further assistance to the new executing agency (MEA had replaced the River Valleys Development Board the previous year) for the rehabilitation and improvement of the irrigation system, taking into account the research and master plan preparation that a foreign firm had recently completed under a USAID contract (ADB 1982:29). The Mission recommended prioritizing the work to be done, suggested the Bank's assistance "should give priority to the improvement of irrigation management rather than to the correction of poorly designed and constructed irrigation facilities" (ADB 1982:29). Specifically, technical assistance was recommended in the following areas:

1. improving O&M by upgrading the technical and institutional capability of O&M staff and farmers through intensive training; and

2. improvement of water management at the farm level on a pilot scale in selected areas, "involving active participation of farmer-beneficiaries."

The Mission emphasized that the Walawe experience had been a source of lessons for the Bank, too, as it had enabled the Bank to evolve a number of guidelines and strategies for future lending in the irrigation sector. These included:

1. the desirability of financing low-cost quick-yielding projects such as rehabilitation and command area development projects; and

2. the importance of emphasizing the improvement of the institutional capacity and manpower skills of the executing agency to ensure efficient O&M.

The Mission also noted that more attention should be paid to the sociological aspects of major irrigation or settlement projects, and that recommended cropping patterns should be based on pilot or scheme experience; and it made a number of recommendations to MEA for strengthening its management (ADB 1982).

It is therefore clear that some Bank staff had the comprehensive "multidisciplinary" institutional-development oriented perspective recommended by the ICID and the WMS II conference. This is also true to varying degrees of many of the consultants whose work was the basis for the present rehabilitation and improvement project. For example, the USAID-financed consultancy study mentioned by the Project Evaluation Mission pointed out the institutional weaknesses that underlay the technical problems at Walawe. This firm went so far as to recommend against a rehabilitation program, suggesting that a heavy maintenance program combined with improvements in O&M procedures and in the management organization would be most appropriate (PRC 1982).

In his consultancy report, Wolf (1983) also highlighted the serious management problems, and recommended attention to these and to some main system structural improvements, rather than a full rehabilitation project. The high degree of inequity of water use observed between head end tracts such as Embilipitiya and Chandrikawewa and the tail end tracts suggest that major improvements could be attained by improving the manageability and operation of the main system. (PRC [1982] also reports on a method of "cutback irrigation" to reduce on-farm water flows that was field tested by its water management engineer at Walawe and Gal Oya.) The rather massive multi-volume report by SOGREAH (1984), the main consultant for project preparation, also offered many proposals for improving the agency's management capacity, and particularly for developing farmers' organizations which would play an important role in system management, as part of the rehabilitation project. The SOGREAH sociologist even proposed using some of the lessons from the Water Management Project in Gal Oya.

The Appraisal Report of the Walawe Irrigation Improvement Project (ADB 1984) states the objectives are "to rectify structural defects and institutional constraints" in the completed scheme, and refers to the "element of risk" regarding elicitation of farmer cooperation. It does state further into the document that a "basic feature" will be establishment of "an effective network of water user groups and water management committees at all strategic levels of Project Management" which will be delegated important decision-making powers (ADB 1984:34). Nevertheless, there is no clear provision in the description of project components for operationalizing these objectives.

Present Status of the Walawe Rehabilitation and Improvement Project

The present rehabilitation and improvement project began in 1985. The executing agency is the Mahaweli Economic Agency (MEA). MEA engaged the Central Engineering Consultancy Bureau (CECB) (also part of the Mahaweli Authority of Sri Lanka) as its consultants to carry out investigations and designs, and to supervise construction. Sir M. MacDonald and Partners Ltd (MMP) are the international consultants to provide services in design and construction supervision and irrigation management at the system level.

The project is presently far behind its original schedule. It was decided that all designs should be substantially completed before construction could begin; and delays in completing the design work therefore necessarily delayed initiating construction. There were delays in awarding of construction contracts, and now the project is facing a slower pace of construction than anticipated. This slow pace is only in part attributable to the disturbed conditions in the area. The project is also reported to be facing a cost overrun, officially attributed to an underestimation of quantities of work during the planning stage. As of early 1989, the Bank had turned down a request for additional funds to cover the overrun, leaving construction work in several tail-end tracts unfinanced at the moment. The irony of this is that while head-end tracts are being given concrete-lined field channels in many cases, the intended original beneficiaries of the project -- the tail-end cultivators -- may get no improvements at all.

Project Concept and Activities

Our analysis shows that despite the various planning and consultancy reports mentioned above, and despite occasional statements about farmers' participation for example, from the beginning the project was conceived of as a construction project. In fact, with the exception perhaps of MMP, none of the parties involved had much experience with rehabilitation projects, but they had a lot of experience in construction. Since most of the funds in the ADB loan were earmarked for construction activities, and since this is the area of expertise of most project participants, the pervasive construction project mentality is quite understandable. It means special efforts would have been required from the beginning if another concept, such as a multidisciplinary socio-technical concept, were to guide the project.

As part of this conceptualization as a construction project, and again despite some rhetorical statements, it is clear that a parallel operating assumption has been that the deteriorated physical system is the primary "cause" of poor system performance; therefore repair of the physical system will lead to improved system performance. There has been no attempt to diagnose the underlying causes, for example why the system is so badly deteriorated; and thus very little attention to other issues, particularly those related to organizational adequacy and the future sustainability of the improvements being made.

The result has been a very strong focus on completion of the design and construction works, and only peripheral attention to other issues. As the design work fell further and further behind, increasing attention was paid to this aspect, and increasing pressures applied to CECB to complete the work, as the minutes of the progress meetings would show (after the designs were deemed completed, in June 1988, these meetings were no longer held). The attempt to follow a rigid time frame, aside from being unsuccessful, led to decisions to bypass consultations with farmers as this would slow the process down further; sticking to as tight a time schedule as possible became the major concern of project management.

The design and construction work has been scheduled and implemented following a standard construction management approach. This assumes, first of all, that an adequate design is possible based on standard surveys. This assumption may be tenable for a new system, but ignores the local "ground truth" in an established system, the considerable micro-knowledge of farmers already using the system, and the normal range of error in standard surveys.

Second, the procedure, still following standard construction methods, was to substantially complete all designs before any construction contracts could be awarded. Thus, the initiation of construction was delayed for a very long time. Third, it was decided to lump most of the work by tracts and award a limited number of larger contracts, apparently on the assumption this would be easier to manage and result in more timely implementation. Since the head-end tract designs were completed first, these were the first contracts awarded. Whether these larger contracts have proven more manageable or will result in timely completion of the work is in considerable doubt.

In all of this, the early intention to test the new design assumptions in a pilot area was lost. One field channel, FC1 on distributary (DC) 1 on Moraketiya Branch Canal (Embilipitiya Block) was constructed according to the proposed design criteria, and some measurements of water deliveries were made (though we have never seen them). But there were no systematic observations to test whether the design assumptions were correct, except for the work by IIMI (Merrey and Jinapala 1988). This work raised serious questions about those assumptions, but were not taken into consideration by project management. A major limitation was that only one field channel, and not a whole distributary, was taken as the pilot area; so there was no opportunity to test the full range of innovations, such as parallel field channels, and the envisioned staggering and rotations. More recently, MEA has requested the contractors to complete one distributary area so that it could monitor the new system, but with no success to date.

Another feature of importance is that the project did not adequately prioritize the work. Aside from not diagnosing the real roots of the problem, and designing a more comprehensive approach, even among possible physical interventions there was little prioritization except in terms of the cost-effectiveness of a few technical alternatives. Thus, despite considerable evidence from Walawe itself, and experience elsewhere, that larger payoffs may be expected from improvements (both physical and managerial) in the main system than from reconstructing field channels, there was no attempt to establish such priorities. This is a major reason why, at this point in the project, it is committed to reconstruction of all head-end field channels, including lining of many of them, but funds are unavailable to insure repair of the canals to deliver water to the tail-end areas of the system.

The Irrigation Department had included the installation of parallel field channels as part of the TIMP (Murray-Rust and Rao 1987). On paper, it seems a very logical design to enhance the manageability of systems that presently have direct farm outlets along distributaries, and many rather large field channels. However, given that farmers have been using the present system for many years, have encroached upon the reservations, and that the present layout is now functionally integrated with the layout of farms and the behavior patterns of farmers, introducing such a drastic change requires the farmers' agreement. In general, the experience with introducing parallel field channels has been very mixed in Irrigation Department systems, such that the Department no longer insists on them.

This illustrates the point that the designers and managers of the Walawe rehabilitation project have not taken advantage of the experience and lessons learned in Sri Lanka, particularly by the Irrigation Department and Irrigation Management Division. This applies to the conceptualization and design of the project, the implementation of the project (for example, the Irrigation Department's management is more decentralized, and rehabilitation is now done through the existing O&M staff, augmented as necessary), and such specific matters as attention to consultations with farmers and development of farmers' groups.

The conferences and literature quoted above place particular emphasis on the importance of consultations with farmers beginning in the planning stages, having good communications with them, getting their agreement and if possible contribution, and also using the rehabilitation as an opportunity to implement a program to form farmers' groups. The new system design is based on the assumption that farmers will be organized into groups, will rotate water, and will do maintenance -- none of which is the case at this point. These assumptions involve substantial behavioral changes. As Vimaladharma (1988) notes in his review of rehabilitation projects in Sri Lanka, farmers' resistance to such changes is a source of problems on rehabilitation projects made worse by the lack of consultation with them.

MMP's <u>Design Criteria</u> (MMP 1987:8,23,33) refers to the importance of consultation with farmers, though it does not provide any detailed guidelines on how this is to be done, who is to do it, and what subjects could be discussed with farmers. Unfortunately, during the design process on the head-end tracts, there was no consultation with farmers (or even with field and middle level operational staff; see below). At the tail-end tracts, because channels and field boundary markers had disappeared, there was some informal consultation. MEA upper management, in a Progress Meeting, specifically instructed CECB not to involve itself in farmer consultations since they would take too much time; MEA would take this responsibility. But since MEA staff were not involved in the design process, they could not play this role. Further, despite some discussions of the need for farmers' organizations, including some informal suggestions and guidelines from MMP consultants, no attempt was made to develop farmers' groups as part of the design, or construction, process.

It is only more recently, parallel (but not integral) to the construction process, that MEA has assigned a few staff to motivate farmers to form groups; but the number of staff and its resources are too little. More important, MEA has not established any firm objectives for the farmers' groups, or provided any attractive incentives to farmers to participate.

The result is that on the one hand, the designs were prepared without the benefit of the farmers' local knowledge and experience, and the construction is being done without contribution from farmers except those who work as paid laborers. On the other hand, as discussed in the <u>Progress Report</u> (IIMI 1988b:134, 138), farmers have not been fully informed about the changes in the system, even though they will have considerable impact on the farmers; a recent survey by our researchers showed even farmer representatives know very little about the anticipated changes, except for the introduction of parallel field channels. There is no evidence that the farmers will change their own behavior, and accept the new system, as expected. Merrey and Jinapala (1988) provide some indication that they may not accept the changes; and our analysis of the low level of cooperation among farmers and lack of any civic sense towards the irrigation system in our sample area gives no cause for optimism (see Walawe institutions chapters, this report; and <u>Progress Report</u>--IIMI 1988b).

An opportunity to use the rehabilitation process as a period for developing and strengthening farmers' groups and farmers' interest in and sense of ownership towards the system, and farmers' cooperation to use and maintain the system well, has been lost.

Project Organization

On MEA's side, the responsibility for managing the rehabilitation and improvement project resides in Colombo. Except for the very top officials' participation in meetings etc, the project-level staff does not play any formal management role. They are to do their normal business, and provide assistance and support to the consultants implementing the project, upon request. As discussed in the Progress Report (IIMI 1988b:133-141), the project and field level staff feel they have been excluded from the project, even though they believe they could have made useful contributions.

Beyond the question of the usefulness of their contribution, is the question of whether the new system, with its new procedures and new behavioral requirements, will be accepted by the operational staff. Early interviews with various MEA staff in Walawe indicated that like farmers, they were not adequately informed on the proposed changes in the system; file-level staff are still poorly informed. Interviews suggest the MEA staff doubt the premises of the new system. They are doubtful as to whether farmers will rotate water and maintain channels as is assumed. In regard to the proposed operational manual, there is considerable skepticism that it can be implemented in the way its authors anticipate.

MMP staff appear to have developed the operational manual somewhat independently of the O&M Division staff. There are undoubtedly a number of complicated reasons for this, some beyond their control. One factor, perhaps, is that MMP's Terms of Reference states one of its tasks is to "prepare a Water Management and Operational Manual . . . ." Unfortunately, it does not ask that MEA staff prepare a manual in consultation with MMP specialists, which might have led to a different approach. The new manual is more labor-intensive than the present management system, and requires regular monitoring of crop status and water deliveries, to enable regular adjustments in flows. O&M staff in discussions with IIMI researchers have questioned the practicality of this management system in the Sri Lanka context. Aside from the question of whether these doubts have any merits, their expression is an apparent expression of unhappiness at not having been consulted and involved.

During the construction phase, CECB is responsible for supervision of the contractors' work. MEA has assigned staff to assist in "handing over" areas where work is to be done, sort out problems of encroachments, and maintain relationships with farmers. The same staff is responsible for trying to form water users' groups. Farmer leaders have been asked by MEA to act as informal monitors, and report any anomalies they observe in the construction process, a procedure that has led to considerable misunderstandings and unhappiness (Progress Report--IIMI 1988b). Relationships among the various actors -- farmers, contractors, consultants, agency officials -- are somewhat confusing and uneasy at times in this situation.

The feeling of disengagement from the rehabilitation process, i.e. the perception that they are marginal when they should be central to the whole project, is likely to preclude developing a sense of commitment and responsibility for the system among both farmers and agency officials.

CONCLUSIONS

The Walawe Rehabilitation Project Viewed from the Literature

This chapter began with a summary of the consensus view of rehabilitation projects that emerges from recent literature. It should be noted that much of this literature is very recent and based on rehabilitation projects that are still incomplete or recently completed; thus despite the consensus and apparent reasonableness of the conclusions, the "consensus view" is still not proven in a scientific sense. Nevertheless, in the absence of other material, this view provides one set of criteria by which the Walawe project may be evaluated. Using these criteria, some problems with the Walawe Project may be identified. Specifically, following from the lists of key lessons and issues given above that are derived from the ICID and WMS II conferences, we may say the following about the Walawe Project as implemented to date:

1. Despite suggestions from various consultants and Bank teams at the early stage, the project has not taken an integrated and multidisciplinary approach to rehabilitation, and has instead been viewed as a construction project;

2. Farmers and operators have not been involved in all stages -- or any stages for that matter -- including planning, the new policies have not been communicated to the farmers and operators before project implementation, and they have not necessarily agreed to the project objectives;

3. No serious attempt was made to diagnose the problem, or to pilot test solutions;

4. No consideration has been given to trade-offs between low-cost and higher-cost measures; rather, high-cost measures that may not by themselves be adequate to solve the real problems and may not be sustainable have been implemented;

5. A new O&M manual has been developed without consultation with present system operators and farmers, the question of whether and how to build on the present system and improve its effectiveness was apparently not considered;

6. The project design has been inflexible and rigid, although there has been some extension of the time frame; this is a classic "blueprint" rather than "learning process" project;

7. The coordination and communication among the various organizations implementing the project have not been adequate;

8. There is no effective system for monitoring and evaluation project implementation;

9. It is simply assumed that the system will be operated and maintained as per the O&M manual under preparation concurrently with the system rehabilitation, with appropriate training of operating personnel and farmers; there has been no serious consideration of the long term sustainability of the improvements; and

10. The rehabilitation process has not been used as a vehicle to strengthen farmers' organizations, and farmers have not been given any participatory role or decision-making authority.

Preliminary Responses to the Research Questions

1. We have only partially answered the first question on the project planning decision-making process. We do not know exactly why it is that the recommendations of the Project Evaluation Mission (ADB 1982) and most of the consultants that institutional and management issues be the focus on the project were not followed. Even in the Appraisal Report for the present project (ADB 1984) this aspect is not sufficiently highlighted and not at all operationalized. It will be necessary to interview some of the people involved to answer this question. We have answered to a large degree the other questions on the consultants' recommendations and the choices that were made, though some deeper work to clarify certain points is still needed.

2. We have documented here and in the Progress Report (IIMI 1988b) the strategic choices made after project implementation had begun, on such issues as design and construction procedures, farmer involvement, etc. We have still not adequately discovered all the reasons behind these choices -- this will require further interviews and document analysis.

3. We have documented fairly comprehensively the roles of the key actors in the project, i.e., agency officials, consultants, contractors, and farmers. We have shown that the communication among these various actors has not been fully effective.

4. This question is actually a series of questions on the role of the farmers in the rehabilitation process. We have shown that in the pre-construction phase, farmers did not learn much about the rehabilitation plans, and even now do not know the details of what will happen on their own channels. They are not being consulted at all on the designs, and are not informed about the proposed operational changes; that they will accept these is an untested assumption. The only roles they are playing in construction is as informal monitors of construction, and paid laborers in many cases.

5. At this point we cannot answer the question on the likely impact of the rehabilitation on system performance, or whether project objectives will be achieved. We can express serious doubts about the likely

sustainability of the improvements, given the lack of consultation with farmers, the lack of any viable farmers' organizations, the skepticism of the O&M staff about the changes, and the inadequate O&M budgets.

Some Tentative Recommendations

The final research question in the Inception Report (IIMI 1988a:20-21) asks what project design and management improvements could be recommended for future rehabilitation projects. The Progress Report (IIMI 1988b:139-141) has provided some initial suggestions, focused on the present project and the future. These are not repeated here. The implications of the above analysis for the design of future projects is probably clear enough anyway.

But what to do about the Walawe Rehabilitation and Improvement Project? It has come a long way, and many commitments have been made in terms of awarding of contracts, expenditure of funds, etc. It may seem almost too late to do much. However, the Walawe scheme has a great deal of potential in terms of productivity (as indicated by both official and IIMI's agricultural production data); and a large number of people depend upon the system for their livelihoods. There are also important political compulsions for doing something to improve the equity of water distribution, and the productivity of its use. Productive irrigated agriculture is still a powerful means for generating employment and incomes for people.

Continuing in the present direction is not likely to achieve all that is hoped for, and the improvements achieved are unlikely to be sustainable. Therefore, we believe that change is necessary, difficult as it may be to implement. We have some specific ideas for the future, which we plan to discuss first with MEA officials.

In order to further develop and operationalize these suggestions if any of them seem useful to MEA, or come up with alternative approaches, we recommend that the Government and the Bank organize a high-powered project review to examine the various issues and options. This review could include a planning workshop, to bring together key personnel in the present project drawn from the various agencies involved, researchers, farmers' representatives, and selected specialists from within Sri Lanka upon whose experience MEA can draw. The review and workshop should have the objective of proposing a viable strategy for implementing the project given its present status and various constraints. If some kind of special effort to redirect the project is made that is practical and to which the Government is committed, we hope that ADB will find a means to provide some additional support to ensure its success.

RESEARCH PLANS FOR 1989

We will continue to observe the rehabilitation management and implementation process closely, in order to verify present tentative conclusions, and fill in gaps in our knowledge about the project. It will be useful to interview a number of senior people involved in the early planning of the project as well.

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PRINCIPAL ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AO	Agricultural Officer
ARS	Agricultural Research Station
AI	Agricultural Instructor
BC	Branch Canal
BM	Block Manager
BOP	Blocking Out Plan
CECB	Central Engineering Consultancy Bureau
CIE	Chief Irrigation Engineer
CRE	Chief Resident Engineer
Cusec	Cubic foot per second
Cumec	Cubic meter per second
DC	Distributary Canal
DOA	Department of Agriculture
DRPM	Deputy Resident Project Manager
EA	Engineering Assistant
FA	Field Assistant
FC	Field Canal
FR	Farmer Representative
FSD	Full Supply Depth
GOSL	Government of Sri Lanka
ID	Irrigation Department
IDO	Institutional Development Officer
IE	Irrigation Engineer
IIMI	International Irrigation Management Institute
IMD	Irrigation Management Division
IO	Institutional Organizer
KOISP	Kirindi Oya Irrigation and Settlement Project
KVS	Krushi Viyapthi Sevaka (Field level agricultural extension officers [Agricultural Assistant])

PCC	Project Coordinating Committee
PM	Project Manager
RB	Right Bank
RBE	Reddish Brown Earth
RBMC	Right Bank Main Canal
RE	Resident Engineer
RO	Research Officer
RPM	Resident Project Manager
SAC	Study Advisory Committee
SCC	Study Coordinating Committee
SIE	Senior Irrigation Engineer
S&P	Seepage and Percolation
TA	Technical Assistant
UM	Unit Manager
WM	Water Management
WS	Work Supervisor
WUG	Water User Group

GLOSSARY

Kanna Meeting	Meeting of farmers and officers of government departments to decide on various cultivation aspects like cropping calendar, irrigation schedule, etc.
Liyadda	Individually bunded plot. Usually there are about 20-50 liyaddas per hectare.
Maha	Wet season associated with northeast monsoon rains beginning October or November and continuing through January.
Paddy	Unhusked rice.
Shramadana	Community self help campaign with voluntary labor
Yala	Dry season associated with minor rains of southwest monsoon usually beginning March or April.

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US $ 1.00 = Rupees (Rs) 33.66
(Approximate April 1989 value)