Seasonal Planning Procedures to Improve Irrigation Management Performance:

How Kirindi Oya Experience Can Be Transferred to NIRP Schemes

Proceedings of the Workshop on Seasonal Planning Procedures to Improve Irrigation Management Performance: How Kirindi Oya Experience of IIMI/ID Can Be Transferred to NIRP Schemes, Held at the Irrigation Department, Colombo, Sri Lanka, on 16 May, 1994

C.R. Panabokke, K. Azharul Haq and B.M.S. Samarasekera, editors

Irrigation Research Management Unit,
Irrigation Department, Sri Lanka

IIMI-Sri Lanka National Program

INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE

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Please direct inquiries and comments to:

International Irrigation Management Institute
P.O. Box 2075
Colombo
Sri Lanka.

IIMI

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Foreword

THIS WAS THE first of three workshops planned for 1994 by the Irrigation Research Management Unit (IRMU). The workshop was jointly organized by the IRMU of the Irrigation Department and the Sri Lanka National Program of the International Irrigation Management Institute (IIMI) and sponsored by the National Irrigation Rehabilitation Project (NIRP).

The objective of the workshop was sharing of experiences of researchers and implementors involved in the study conducted at Kirindi Oya with parties involved in the National Irrigation Rehabilitation Project (NIRP) and exploring the possibility of incorporating Kirindi Oya experience to NIRP schemes. Eighty seven persons from the Irrigation Department, NIRP, IRMU, the Irrigation Management Division, universities, the Department of Agrarian Services, the Department of Agriculture, the Mahaweli Authority, IIMI, Provincial Councils, and nongovernment organizations participated in this workshop.

The workshop on *Seasonal Planning Procedures to Improve Irrigation Management Performance: How Kirindi Oya Experience of IIMI/ID Can Be Transferred to NIRP Schemes; Held in May 16, 1994 at the Irrigation Department Head Office* focused on the diagnostic study carried out by IIMI at the Kirindi Oya Irrigation and Settlement Project (KOISP) in collaboration with the agencies in charge of development and management of this project. The Irrigation Department, the Irrigation Management Division, the Department of Agrarian Services and the Department of Agriculture were among the agencies involved. This study attempted to assist with improvements in the system performance and the methodology adopted was Participatory Action Research in which the system management agencies, including farmers became the implementors of the research program.

The KOISP had almost all the problems one could think of in either a new or an old irrigation system. It consists of a newly developed area with new settlers and an old system. Recognizing the overall water-short character of the system it was planned to allocate the limited inflow from the reservoir for the cultivation—as far as possible—of other field crops (OFCs) on well-drained lands. The cultivation of rice was to be confined to the poorly drained soils. Optimum utilization of the land and water resources, through the adoption of suitable non-rice and rice cropping systems for the respective seasons, was thereby envisaged.

It was recommended that for the schemes rehabilitated under NIRP, irrespective of the limited number of farmers and small commands, an operation and maintenance plan be prepared. The participants recognized that Kirindi Oya experience can contribute to the preparation of an operation and maintenance plan for all types of schemes. Given the serious water-supply constraints experienced by the Kirindi Oya System, the framework for water issues has become a useful tool to build a strong operations and maintenance organization. The workable water issue plan for Kirindi Oya can be replicated in other schemes with some site-specific alterations.

It is hoped that the workshop recommendations would be used to optimize the agricultural productivity in the schemes rehabilitated under NIRP.

B.M.S. Samarasekera
Deputy Director, IRMU

K. Azharul Haq
Technical Advisor, IRMU

Acronyms Used

ADB	—	Asian Development Bank
BCW	—	Broad Crested Weirs
CGIAR	—	Consultative Group on International Agriculture Research
CRE	—	Chief Resident Engineer
DAS	—	Department of Agrarian Services
DD	—	Deputy Director
DOA	—	Department of Agriculture
EC	—	Electrical Conductivity
EIS	—	Ellegala Irrigation System
FC	—	Field Channel
FO	—	Farmers' Organization
GR	—	Gated Regulator
ID	—	Irrigation Department
IE	—	Irrigation Engineer
IIMI	—	International Irrigation Management Institute
IMD	—	Irrigation Management Division
IMIS	—	Irrigation Management Information System
INMAS	—	Integrated Management of Major Irrigation Schemes
IRMU	—	Irrigation Research Management Unit
KOISP	—	Kirindi Oya Irrigation and Settlement Project
LB	—	Left Bank
LBMC	—	Left Bank Main Canal
LCD	—	Land Commissioner's Department
MANIS	—	Management of Irrigation Systems
MEA	—	Mahaweli Economic Agency
MOL	—	Minimum Operating Levels
MOU	—	Memorandum of Understanding
NGO	—	Nongovernmental Organization
NIRP	—	National Irrigation Rehabilitation Project
NIS	—	New Irrigation System
O&M	—	Operation and Maintenance
OES	—	Old Ellegala System
OFCs	—	Other Field Crops
PAR	—	Participatory Action Research
PMC	—	Project Management Committee
POM	—	Plan of Operation and Maintenance
RB	—	Right Bank
RBMC	—	Right Bank Main Canal
RE	—	Resident Engineer
RID	—	Restoration of Irrigation and Drainage
SAC	—	Study Advisory Committee
SCC	—	Study Coordinating Committee
SCOR	—	Shared Control of Resources
SLFO	—	Sri Lanka Field Operations
TA	—	Technical Assistant
TCEO	—	Territorial Civil Engineering Organization
TOA	—	Turnout Attendants
TOR	—	Terms of Reference
WIIP	—	Walawe Irrigation Improvement Project
WS	—	Work Supervisor

OPENING ADDRESSES

Welcome Address

B.M.S. Samarasekera[1]

THE STATE SECRETARY of Irrigation, the Director of Irrigation, Members of the Directorate of the Irrigation Department, the Project Director, NIRP, friends from IIMI, ladies and gentlemen, it is with great pleasure that I welcome you all to this seminar this morning. I can observe that a large number of my colleagues have come from various parts of our country. We tried to invite as many participants as possible for this occasion, mainly because many engineers in the Irrigation Department are very anxious to share experiences gained at the Kirindi Oya Irrigation and Settlement Project (KOISP) during the past research programs. Many engineers of the Irrigation Research Management Unit (IRMU) have had a chance to work at the KOISP during the last two decades and they are well aware of the water-short situation at this project.

The largest and most important rehabilitation project undertaken so far by the Irrigation Department is NIRP. Unlike the other projects undertaken so far, NIRP schemes spread over most parts of the island. Also, the project is benefited by the vast experiences gained by the other rehabilitation projects in the country.

Quite a measurable amount of research has been carried out at KOISP with the participation of the Irrigation Department and IIMI staff. Even though the findings are documented the results are not much known among the IRMU engineers and the officers of the other organizations who are involved with NIRP work. Hence, it is now decided to have this workshop to decide whether the experiences gained at KOISP could be applied elsewhere—especially to medium and minor schemes all over this country. I am very confident that the vast experiences gained at KOISP will help us fulfill this requirement. I have found by myself that the farmers at KOISP, especially at the old systems, are very much knowledgeable and intelligent. If they were satisfied with the seasonal planning procedures suggested by the research and implementing staff, the rest of the farmers in this country would not find it very much difficult to adopt findings at KOISP so that proper management procedures are adopted.

I once again like to thank you all very much for your presence here this morning and also wish you would contribute to every successful day of interchanging ideas for the success of our workshop.

1 Deputy Director, Irrigation Research Management Unit, Irrigation Department. Colombo, Sri Lanka.

Introduction of the Workshop

K.S.R. de Silva[2]

THIS WORKSHOP DEALS with the seasonal planning procedures to improve irrigation management performance emphasizing how the Kirindi Oya experiences of IIMI and the ID can be transferred to NIRP schemes.

NIRP is a seven-year project and nationwide in scope where rehabilitation and improvement of about 1,000 minor schemes and 60 medium/major schemes will be undertaken by the project. The main objectives of the project are to protect and increase agricultural production and incomes, and to raise the standard of living of the beneficiaries through rehabilitation and improved operation and maintenance (O&M) of existing irrigation schemes. A proper monitoring and evaluation system is a prerequisite for the successful implementation of any project. This can be realized only through proper seasonal planning. Successful seasonal planning requires information on the availability of water in the reservoir, data on the inflow and rainfall assumed for a given season, availability of inputs, cultivable extent and cropping patterns. To improve seasonal planning, water allocation principles, a technical basis for planning, and an agreement of concerned parties have to be considered.

The principal objective of the workshop is to assess the Kirindi Oya experiences with respect to the different problems and successes relating to social and institutional strategies that were promoted at Kirindi Oya.

Research on irrigation management and crop diversification has been conducted in the Kirindi Oya Project since 1987. IIMI was involved in research work in some areas related to irrigation management, even before assistance from the Asian Development Bank was obtained for its research program.

It became a complicated affair due to simultaneous operation, maintenance and construction. Kirindi Oya is one of the most water-short systems in the country. The project is not totally a newly developed one and consists of existing lands as well. Design and implementation of the data collection network were done jointly by IIMI and the ID. IIMI provided the facilities. However, the whole program was implemented completely through the ID staff as a part of their task.

One of the main factors influencing the success or failure of an operational plan is the physical condition of the canal system. There are advantages and disadvantages in any procedures, and if it helps improve the program, positive points must be taken for implementation. Pessimistic attitudes would certainly become a bottleneck in improving the performance of activities. During this long period of association, the ID staff has played an active role and when they had seen the positive impacts of the first few innovations, it became easy to implement more detailed and complicated suggestions.

With the completion of rehabilitation, farmers are supposed to take the responsibility for O&M in NIRP schemes. I hope that the Kirindi Oya experiences of IIMI and the ID will be helpful to realize the full potential of schemes rehabilitated under NIRP.

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2 Project Director, NIRP, Colombo, Sri Lanka.

Address by the Chief Guest

L. U. Weerakoon[3]

THE KIRINDI OYA Irrigation and Settlement Project had almost all the problems one could think of either in a new or an old irrigation system. It had widely varied soil conditions which complicated the construction phase. With the completion of construction, institutional problems surfaced.

The Kirindi Oya System consists of new settlers and old settlers. The Irrigation Management Division (IMD) had appointed two Project Managers while the Chief Resident Engineer was responsible for water management. In addition to the Irrigation Department (ID) and the IMD, the two main institutions mainly responsible for the operation and maintenance of the system, other line agencies such as the Department of Agriculture and the Land Commissioner's Department (LCD) are also involved in project activities. The Project Managers were responsible for coordination of activities in both the newly constructed area and the old area. As in many settlement projects in Sri Lanka with old and new areas, Kirindi Oya farmers also had problems of water sharing among themselves. The farmers in the old area, despite deriving considerable benefits they gained due to construction of the new reservoir by way of a stabilized and a more reliable water supply and increased intensity of irrigation, look upon the new settlers as invaders in their domain of influence. In the beginning, the old system and the new areas acted, to a greater extent, as two independent units without much coordination. The establishment of one Project Management Committee is a great achievement.The preparation of a water issue framework acceptable to all the parties can be considered a great improvement. The International Irrigation Management Institute (IIMI) provided all the facilities to the officials and the role played by IIMI has been quite useful. Given the serious water-supply constraints experienced by the Kirindi Oya Irrigation System, the framework for water issues became a useful tool to build a strong O&M organization. The workable water issue plan for Kirindi Oya can be replicated in the other schemes, especially in large schemes with some site-specific alterations.

The planning for different contingencies is much more important as Irrigation Managers have to face changing situations. The plan may depend on the storage position of the tank, the inflow into the reservoir, the cropping pattern and the area cultivated.

The Project Management Committee is an important instrument as it has given legal status under recent changes in the Irrigation Ordinance. Before the amendment of the Ordinance, agency staff as well as farmers' organizations faced difficulties when implementing programs in the absence of set procedures.

The participatory exercise made the best use of computer facilities. Different parties were in a position to share hardware as well as software packages and, most importantly, this practice assured on-the-job training for the staff involved in these efforts. I hope that all of you will be able to share the experiences gained from the work done by researchers at Kirindi Oya.

I thank the IRMU for having invited me to be the Chief Guest at this workshop.

3 State Secretary, Ministry of Irrigation. Colombo, Sri Lanka.

Address by the Special Guest

Nanda Abeywickrema[4]

I THANK YOU for the invitation because I am always happy to join my colleagues in the irrigation sector.

I have been witness to the presentation of research results of the Kirindi Oya experiences by the ID and IIMI staff and have been impressed with the process of internalization. This is a further step to adapt that experience to the NIRP and is therefore a very encouraging trend.

The Irrigation Department (ID) is a well-organized department with an excellent chain of command. Over the past 15 years or more the ID has gone through considerable transformation since its "rebirth" with the abolition of the Territorial Civil Engineering Organization (TCEO). I have been fortunate to be associated with this transformation.

During the past few years, the ID has lost many competent staff, but I am pleased to see new faces emerging. Given the changes in the environment, both internal and external, the ID has to be a dynamic organization to be able to face the emerging challenges.

The subject of today's workshop is based on the results of IIMI's collaboration with the ID. Hence, the deliberation as well as the immediate future of absorbing the results is a very important factor. These reflect changes in the internal environment of the irrigation sector.

Today, however, I shall deal with two aspects which I consider important for the future of irrigation development and management. These two are:

i. Investments, and

ii. Natural Resources Management.

Investments

It is becoming increasingly evident that investments in the total agriculture sector which subsumes irrigation are declining both nationally and globally.

Nationally, the share of public investment in the agriculture sector has declined between 1990 and 1993 from 12 percent to 8 percent. Within the agriculture sector itself the decline in investments in irrigation as against agriculture proper is even more marked. Since investments in irrigation in Sri Lanka are heavily dependent on the public sector and on development aid, this trend is likely to continue in the near future. Sri Lanka's economy is expanding in other sectors like highways, telecommunications, power, etc., to support increasing private-sector investments. Hence, the share available to agriculture and irrigation is not likely to increase.

This is also influenced by global trends. Most multilateral agencies like the World Bank and the Asian Development Bank that have for many decades supported agriculture and irrigation investments in a big way, are reducing their share. Over the past 10 years, agriculture's share of World Bank lending has declined from 30 percent to 20 percent and this trend is likely to continue.

4 Director, International Cooperation, International Irrigation Management Institute, Colombo, Sri Lanka.

In the ADB, with the increase in the demand for investment in the industrial and services sectors in Asia, the Bank's agriculture portfolio is taking a major downturn. The contributions by multinational and bilateral donors to Agriculture Research is declining sharply as is evident from the financial crisis the CGIAR system has been going through.

These investment declines underline the need for improving efficiency in the sector, better planning, more action research and a greater involvement of the private sector which in our countries undoubtedly include largely small farmers. In my view, all irrigation planners and practitioners have to be mindful of this significant change in the external environment and be prepared for such a change.

Natural Resources Management

Likewise, sectorally, irrigation can no longer stand alone in the milieu of development activities in a country; the linkages are becoming more and more apparent. Irrigation has to be viewed now in the context of the larger sectors, viz. the agriculture sector and the water sector. Establishing these linkages becomes significant in ensuring a balance between productivity and sustainability in the sector. The natural resources base is deteriorating due to inadequate attention to environmental factors. These are linkages both upstream and downstream that Irrigation Managers have to take note of. This is a very complex undertaking which requires, first, enhancing capability within the Irrigation Department to respond to these demands and, second, establishing linkages with other agencies, institutions and professionals. The national universities should also be brought into this effort.

The SCOR Project on which IIMI is working is an attempt in that direction not only to establish these linkages at the field level but also to involve closely the community that is either benefited or is affected by these linkages. The relationship between land, water and people has therefore to be understood and internalized by irrigation professionals.

I am confident that the ID is equal to these tasks and that through workshops of this nature it will build its capacity to meet the future challenges.

I like to congratulate the organizers and the participants for the work they have done so far in this direction.

Address

K. Yoganathan[5]

I WOULD LIKE to first thank the IRMU and IIMI, especially Mr. B.M.S. Samarasekera, DD (IRMU) and Dr. K.A. Haq, Technical Advisor (IRMU) for having chosen the subject of experiences in Kirindi Oya Project for today's workshop. This project has been a controversial issue from the silting of the reservoir up to now. Some of the problems may continue for sometime.

The Lunuganvehara Reservoir has been constructed across Kirindi Oya. The capacity of the reservoir is 183,000 ac.ft (225 million m^3). According to original designs it was proposed to irrigate about 11,000 acres (4,450 ha) of existing land and about 20,000 acres (8,100 ha) of new land. About two-thirds of the new land was to be cultivated with cotton and other field crops. The inflow into the reservoir has been generally insufficient to issue water to the entire extent. Hence, the extent of the new lands to be irrigated was curtailed to about 13,000 acres (5,260 ha).

Proposals to divert water to this reservoir from other river basins have also been studied recently.

In the meantime, it was also realized that these problems could not be merely solved by engineering structural solutions alone. Some of the problems had to be solved by improved management. IIMI assisted the Irrigation Department a great deal in this exercise. It was felt that the old settlers and new settlers had to be merged and their active participation promoted. The officials from various institutions working in the project have also to work as a team.

Initially, the organization set up at the project was also not quite satisfactory. We had a Chief Resident Engineer for the entire Project, a Resident Engineer (RE) for LB systems, an RE for RB systems and an Irrigation Engineer (IE), Tissa for the old area. Since the IE, Tissa was in charge of the irrigation systems in the old areas, his concern was only for them, and he was not interested in the new settlers. Hence, as a first move, the positions IE, Tissa and RE, LB systems were merged into one. This in turn helped these old settlers and the new settlers to get closer to each other. The IE, LB was himself responsible for the betterment of both areas.

With the stabilizing of the farmers' organization and the Project Management Committee the farmers now have more responsibility in the decision making and the management of the project.

The experiences gained in Kirindi Oya definitely show that by active farmer participation and by institutional changes, and by non-structural solutions, a large amount of the problems could be solved in an irrigation system; and that schemes that are supposed to be failures could be turned into successful projects. I am sure that the experiences gained in the Kirindi Oya Project would be helpful to a number of other rehabilitation projects coming within the National Irrigation Rehabilitation Project.

I am sure this workshop would be very useful to all of us, and I wish this workshop all success.

5 Director, Irrigation Department, Colombo, Sri Lanka.

PAPERS

Overview of the Participatory Action Research Project

H.A. Karunasena[6]

INTRODUCTION

RESEARCH ON IRRIGATION management and crop diversification has been conducted in Kirindi Oya and Udawalawe projects since 1987. Even before the start of the Asian Development Bank (ADB)-assisted formal research program, the International Irrigation Management Institute (IIMI) had been involved in research work in certain specific areas related to irrigation management. The research program (ADB Technical Assistance Projects 46 SRI and 1480 SRI) was implemented under two stages namely Phase I and Phase II and completed in 1994.

Based on the findings and the recommendations of the Phase I Study, it was felt both by the researchers and the implementors that the implementation of the recommendations was absolutely necessary to fully realize the project objectives. The donor (ADB) was of strong opinion that the realization of project objectives was not unrealistic if certain management, social and technical innovations could be introduced. After serious thinking, the implementing agencies, IIMI and the ADB decided to extend the research activities (Phase II) with a view to introducing a series of innovations to improve overall performance of this heavily invested project.

Unlike in Phase I, Phase II studies were carried out with the comprehensive participation of the agency staff. The preparation of the inception report, implementation of research activities, provision of training for the research participants, preparation of seasonal reports, etc., were carried out with the active participation of the agency staff. In the case of the Phase I Study, the IIMI staff exclusively conducted the research and the reports were then discussed with the project and headquarters staff before finalization. With the Participatory Action Research (PAR), the internalization of the research activities or the innovation was found to be very much in-built and hence very little effort was required to internalize them.

This paper discusses the PAR approach in the Kirindi Oya Project with special reference to organizational changes required to improve the performance.

IMPLEMENTATION STRATEGY AND RESEARCH MANAGEMENT STRUCTURE

Structure of Research Management

In general, the Phase II Study followed the same management structure as the Phase I Study except for the formation of study subcommittees at the project level on the basis of the subcomponent of the main activities. The organizational structure is as follows.

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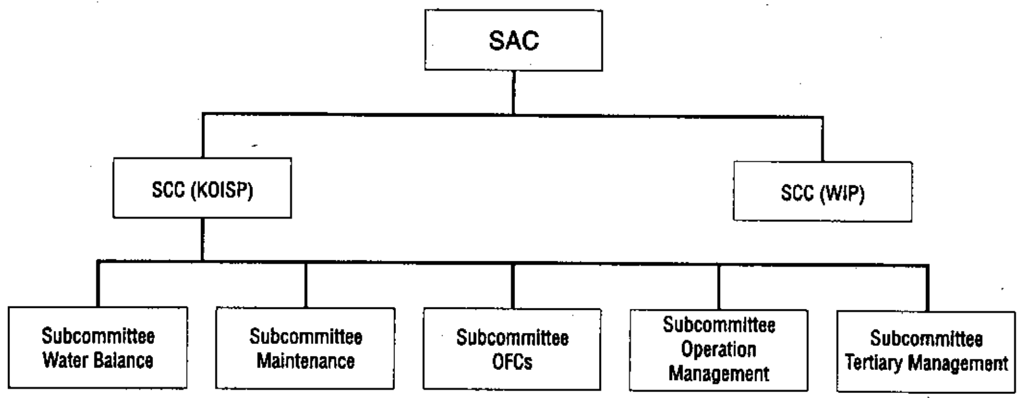
6 Chief Resident Engineer, Kirindi Oya Irrigation and Settlement Project. Sri Lanka.

Figure 1. The organizational structure of the Participatory Action Research Project.



Notes: SAC = Study Advisory Committee
SCC = Study Cordinating Committee
WIIP = Walawe Irrigation Improvement Project
OFC = Other Field Crops

Study Advisory Committee (SAC). This committee is chaired by the Director, IMD. Participants include heads of agencies or their representatives, ADB representatives, project-level senior managers and IIMI international staff members and senior researchers. Generally, this committee meets once every six months to discuss the progress of the research work and takes decisions in support of research activities. All the presentations were done by the IIMI staff members.

Study Coordinating Committee (SCC). This committee is headed by a system-level head of agency and its members are selected from the active participants of related line agencies. In addition to IIMI international staff, a few senior officers from the line agencies attend these meetings which are held once every two months at the project level. More detailed technical analysis and related research-management issues are discussed at this forum. The IIMI field researchers play the key role with the active contribution from subcommittee chairmen. In addition, this meeting is used for disseminating the findings of the research subcomponents among the members. It also provides an opportunity for interdisciplinary interactions which contribute to improve the research activities. Most often, the presentations are made by agency staff members.

Study Subcommittee. This committee is an addition to the Phase I structure. During the initial stages, the IIMI staff felt that the active participation and a genuine commitment of the agency were required in PAR type of research. This committee functions as the grass-roots level planning and implementation body of each subcomponent of the research. Most of the chairpersons of these subcommittees are leading personnel involved in the day-to-day activities of the respective divisions. This subcommittee meets as often as required. It is rather informal in nature.

Strategy Used in Research Activities

With the help of the Terms of Reference and the use of the Memorandum of Understanding with the ADB, the IIMI research staff identified the research activities needed to cover the whole spectrum of the management activities. The recommendations submitted after the Phase I Study have also formed the basis for the design of Phase II research. After a fair amount of homework had been done by the IIMI staff (particularly the field staff), a most effective and productive list of innovations was proposed to the relevant agency officials. The IIMI field-research team comprised a social scientist, an agricultural engineer, an irrigation engineer and an agricultural economist, during the later stages of the study. Under the guidance of the international staff, the field staff of IIMI initiated dialogues with the respective agency officials. These discussions went on for a substantially longer period of time than had been anticipated (about 3 weeks) in view of the enormous amount of work involved in formulating the draft proposals for the research. The response from agency staff on certain concepts indicated that the proposals were not fully acceptable to them. They also indicated that some of the innovations were impractical and were not acceptable to them or the beneficiary farmers. Nevertheless, the IIMI staff (both national and international) went on promoting the newly developed concepts in private and public discussions. It was also proposed to write short notes on various selected innovations. At the start, IIMI field staff (except for the OFC program which was drafted by the international staff) prepared the initial reports on subjects such as Water Balance, Operation Management, Maintenance Management and Tertiary Management. These reports were substantially improved by inputs from the agency staff, particularly from the Irrigation Department. Such participation motivated them to become active participants in the research activities. After the first few months, the program gathered momentum and generated a reasonably sufficient interest among the officers to implement it. In some cases, certain management activities were analyzed and reported on, with the view to highlighting drawbacks as well as potentials for further improvements.

Preparation of the Inception Report

The ideas generated by the draft reports were exchanged and shared with a wide cross section of irrigation officials to evaluate their validity under actual working conditions. Later, all these draft reports were filed together to form IIMI's First Draft of the 1991 Inception Report.

The objectives of the research were :

i. To test and assist in the implementation of organizational and management innovations which would improve the performance and sustainability of irrigation systems

ii. To strengthen irrigation management institutions including farmers' organizations to effectively participate in systems management

iii. To assist in implementing design and rehabilitation innovations and alternative systems management practices

iv. To assist in testing and implementing appropriate on-farm water management practices for diversified crop cultivation and farm income maximization

In August 1991, a workshop was held at Hambantota to discuss the Inception Report before the implementation of research activities. This was a well-attended workshop with about 90 percent participation of agency staff from the project and headquarters. Large numbers of high-ranking officials from the ID, the IMD, the DOA, the DAS, the MEA, IIMI and the Ministry of Irrigation and Mahaweli Development attended the workshop. All the proposals of the research components were presented by the respective subcommittee chairmen and this can be considered as a very important milestone in the field of action research. Participation of these officials was exceptionally good and it was evident that there were significant improvements of their skills in presenting papers and participating in discussions.

SOME IMPORTANT IMPACTS OF THE RESEARCH

In general, irrigation-related research is being carried out to investigate the issues in the area of concern in order to ascertain problems and constraints. Basically, this program envisaged such a plan of action. More importantly, the Phase II objective was to improve the performance of the irrigation system rather than to implement a traditional type of research for the sake of research. The prime objective of improving overall efficiency could only be achieved through the innovations suggested in this type of research mode. Also it is essential to internalize such innovations to guarantee sustainability. It is human nature to repulse new ideas because it is naturally convenient to follow the existing procedures and methodologies and also because implementation of such innovations is more laborious and time-consuming. On the other hand, who cares for the performance of the irrigation schemes? Top management needs only to avoid crop failures. So it is very important to get the irrigation actors to participate in the innovation processes so that they get familiarized and accustomed to the change in a less-turbulent manner. This section of the report intends to analyze the different changes which occurred in the working environment, including interdisciplinary cooperation, professional development, attitudinal changes and other related improvements in management.

Working Environment

Any development or management activity needs a healthy working environment to be able to deliver an acceptable quality and a satisfactory quantity of goods and services to the beneficiaries in an efficient manner. If the environment is not conducive to success and is full of turbulence, frictions, interdisciplinary rivalries, etc., the quality of the goods and services may not be realized as desired. As it is defined and understood today, the development and management of any project require contribution from a broad spectrum disciplines. In view of the need for mobilizing resources from different directions to a focused activity, it is absolutely essential to generate mutual understanding and respect among the multidisciplinary teams. It is also vital to note that participation and contribution become more effective and productive in a friendly environment than in an official or hostile situation.

The subcommittees and the project-level Study Coordinating Committee (SCC) have provided a good platform for agency officials and the IIMI staff to discuss problems and related issues more openly. It cannot be firmly stated that these discussions disclosed everything without any reservation. Despite such reservation, however, it was possible to bring to the surface some of the important issues in improving management. Small group discussions have been more productive because of the understanding created among the participants. Consequently, these participants have started to think more positively by realizing their weaknesses. This environment has facilitated others to comment and suggest various alternative ways and means for achieving progressively better results. It would have been much more interesting if we could include a few farmer representatives at these subcommittees and SCC meetings but it was not considered because of the language problems and the technical nature of the proceedings. However, this area must be considered seriously in the future innovations and related activities through better awareness among farmers on the importance of improved management.

At the inception of this research and even before, the critical comments made by others (IIMI or other line agency) on irrigation management issues, were not received by the concerned agencies in a positive manner. Generally, these comments were answered in a defensive manner and no efforts were made by the agency concerned to realize the need to improve their activities. When agencies started the dialogue at subcommittee level, they became more friendly and began to have an understanding of each other which has helped the group to work towards a common goal by correcting and adjusting their traditional methods. Finally, all these activities led to a change in the attitude of the officials and they have begun to address the project-level issues in an integrated manner rather than working in isolation.

Transparency and Credibility

Well-established government departments do not, generally, welcome foreign or outside interventions in their area of responsibility. They have been so trained to be uni-disciplinary that always there is a tendency to conserve and preserve longstanding traditions, procedures and methodologies. They firmly believe that their way of working is the one and only way to solving their problems because their procedures and methodologies have been tested by time. This is true to a great extent, and would remain true if the world had not changed. The dynamics of environment always necessitates changes in the procedures and methodologies. The classical example is the introduction of farmer participation in irrigation development.

It is quite usual to note that most of the irrigation-related agencies have resisted these changes because of the feeling that changes may undermine their authority and endanger their existence. Therefore, this resistance is natural. When discussions on the subject were initiated at the grass-roots level, it was noticed that the members of the committees became more aware of the nature of the changes required to improve the performances of the irrigation sector and resistance lessened.

It is natural that people do not like to be humiliated in public and also they like to share their problems, difficulties and weaknesses with some one who is in intimate terms with them. The advantage of small group discussions is that one is so intimate with the other members of the group that one shares the problems and even the weaknesses. This is the early stage of a transparency which can later be developed in the progressively higher levels of the hierarchy. When one is frank and genuine, the others would try to behave so too. If one is transparent, it is relatively easy to find solutions to the problems. This is like telling the truth and nothing but the truth to your doctor. It was observed that officers who were transparent certainly improved the working relationships among the group members and also with the beneficiary farmers. This helped improve the credibility of the institutions among clients and parallel agency counterparts.

Professional Developments

The SCC and the subcommittees were formed, as explained in the section under *Implementation Strategy and Research Management Structure* (p.15), to improve the participation by agency staff and also to internalize the innovations implemented through this research. This also addresses one of IIMI's mission statements for enhancing the national capacities in irrigation management. Although not the prime objective of the research program, the professional development which resulted from this research can be considered a valuable byproduct.

As explained previously, the committees which were formed and which functioned throughout the program, provided ample opportunities for agency officials to discuss their issues and problems. It is a well-known fact that most engineers usually keep silent in most fora and limit their discussions to their own colleagues. At the beginning, engineers were a bit hesitant to speak in English because of stage fright and language problems. Eventually, it was noticed that most of these engineers (as well as other officials) actively participated in the discussions during subcommittees and SCC meetings. Their stage fright and the language barrier disappeared gradually through participation in small group discussions initially and later at higher-level meetings. During the process, they learned how to present their views at these technical meetings and also learned how to manage meetings as chairpersons. It is noteworthy that the workshop papers on the inception report were presented by the subcommittee chairpersons. The organizers were somewhat doubtful of the ability of these chairpersons (not all) to make presentations to a much wider cross section of national and international intellectuals. But they proved beyond doubt that they were capable and that they could rise to the occasion. Some of them, especially those who could not even speak in English did quite a lot of homework, held rehearsals, etc., and performed exceptionally well. It can be stated that this workshop was the turning point in our efforts to promote professional development. Also it gives one pride to note that most of the officials who participated in this research program have become very effective speakers and research partners whose services could be used in the project area and even elsewhere in improving the overall performance of the ID. In addition to the above, they got the opportunity to write short reports, analyze irrigation-related data using computer packages and received training on recently developed computer packages.

Changes in Attitude

Attitudinal changes in irrigation bureaucracy began with the formation of the IMD. It was not a good start because the inappropriate IMD approach created much friction and an unpleasant working environment. In general, in all the major irrigation projects, the IMD organized farmers and formed farmers' organizations to supervise and police the activities of the ID staff. This approach has created an animosity between the farmers and the ID staff. The relationship between the ID and the IMD also deteriorated creating quite an unpleasant working environment. From the IMD's point of view it was the fastest way of organizing (through conflict situation) the farmers quickly.

IIMI started its activity in KOISP, Sri Lanka when the relationship between farmers, the IMD and the ID was at cross roads. The Phase II Study period was somewhat better than the Phase I period due to the longer period of association of the ID staff with the IMD and the farmer groups. The ID staff (particularly the senior members) had already been exposed to concepts on farmer participation and were prepared to participate in the proposed change.

During Phase I, the relationship between the ID and IIMI was not so good, especially during the research period because IIMI was then trying to identify problems concerning overall project management. It was to be expected that a poor relationship as well as a defensive attitude on the part of the ID officials would prevail. It was also evident that at the end of the research IIMI would formulate a long list of recommendations for adoption. These recommendations have been finally agreed upon for implementation. This acceptance shows that the ID had changed and was prepared to adopt a more positive way of thinking. The receptive quality of the key officials certainly helped in the implementation of the new methods and procedures in irrigation management. There are advantages and disadvantages in any method, procedure or innovation. If it helps improve the program, positive points should be selected for implementation. The pessimistic attitude would certainly become a drag in improving the performance of the systems. During this long period of association, the ID staff involved began to listen and to tolerate certain innovations proposed by outside organizations like IIMI. When they saw the positive impacts of the first few innovations, it became easy to fine-tune further and to implement more detailed and complicated activities.

It is very hard to separate the impact of IIMI programs and others. However, the attitudinal changes brought about in the ID staff and others, were the result of IIMI's work and other similar interventions over a long period of time. The following are the major attitudinal changes observed:

- A positive approach towards change
- A receptiveness towards new ideas
- An improved relationship with farmers
- An improved relationship with other agency officers

- Mutual respect and sensitivity to issues in other disciplines
- A dedication and commitment to improved performance

Development of Improved Procedure and Methodologies

As discussed in previous sections, it has not been easy to deviate from long existing and time-tested procedures and methodologies because of the extra effort required and also perhaps for the simple reason that this could lead to controversial situations under existing financial and administrative regulations. However, all the changes relating to the identified innovations were effected within the existing framework. The small group discussions and detailed evaluations of the existing procedures allowed all the participants to comment and contribute towards improving the present level of management. Since the groups comprised multidisciplinary members, gray areas were brought to light. They could understand the difficulties and constraints faced by the implementors. Certain conceptual ideas were discussed in detail for evaluating their applicability and practicability. The discussions held at subcommittee and SCC levels provided ample opportunity for all the members to review the existing practices critically and productively. The committee chairperson had to take the leading role. They had to put extra effort in developing the initial details before the committee meetings. When ideas were submitted to the committee, the chairman was compelled (sometimes indirectly forced) to throw the ideas out for discussion. This type of approach was very useful for initiating the other members rather than IIMI pushing new concepts which often (not always) repulsed the members. Such a strategy was useful in the implementation of the innovations. Most often, the chairperson is the most responsible officer of that activity which is a part of his day-to-day work. So this is in the correct direction. The following can be identified as the few procedural and methodological changes which were effected.

- Data collection and communication
- Daily computation and display of discharges
- Water balancing and data collection in the Ellegala Irrigation System (EIS)
- Maintenance norms
- Minimum operating levels

Improvements in Management Activities

Since the KOISP was implemented to field-test the advanced alienation it became a complicated affair due to the simultaneous dealing with operation, maintenance and construction. In addition, the situation became more aggravated due to the fact that Kirindi Oya is the most water-short system in the country. Moreover, the project is not totally a newly developed one and it is coupled with a system which has been in operation since 1870. This can be considered as the most complicated management problem. It is a good venue to try out different management alternatives to solve the problems of farmers.

During this research period, a study was carried out to evaluate the performance of Turnout Attendants (TOA) in the Right Bank System. This study focused on travel distances, time taken for operations and the service area operated by each TOA with a view to assessing distribution of work and also to readjusting responsibilities. Due to certain practical problems, management changes could not be implemented. But this is the correct approach which can be adopted in new projects in the future.

Several management changes were effected in the daily data collection program so that the subsystem managers could monitor the water situation on a daily basis by comparing data collected with designed discharge. The collection, display and communication of data were effected in the RB System and it is felt that this should be replicated at the Left Bank area. Initial work was done and the program was implemented during one season. It was not a total success due to certain difficulties related to training the TOAs and other staff. However, there is a great potential to improve the performance during the next maha season.

The procedures regarding maintenance management were changed in one subsystem with considerable support from TOA level up to the Deputy Director level. The method of identification, time frame for planning, method of execution during both cultivation seasons and off-seasons were changed to suit the present context. Also, this innovation provided sufficient room for farmer participation. On the other hand, the analysis of overhead costs and physical maintenance costs clearly disclosed the ineffective use of limited financial resources. In the light of this analysis, an economically feasible and technically viable size of an irrigation division was defined for the ID to be used in the reorganization of irrigation administrative boundaries in the future.

The formation of a technical committee for the preparation of a cultivation plan for the project is the most important milestone in this research program. Initial work was done by IIMI while the Water Management Secretariat of the ID was the driving force in this activity. The activity was implemented by the staff of the ID, the IMD, the DOA and IIMI and the committee prepared a technically sound and efficient plan. This committee filled a vacuum which existed in the project between the PMC and the line agencies. Before the PMC, this committee could meet to review the situation and to formulate a reasonably acceptable and technically sound proposal. The proposals to divide systems into zones, to predict inflow patterns and allocate water for a particular cultivation pattern were well supported and were contributed by the IIMI international staff members. Planned cultivation has become part and parcel of irrigation management. Kirindi Oya can be considered a classic example for cultivation planning under water-short conditions. This concept of cultivation planning was thoroughly discussed with farmers, politicians, higher-level administration personnel, etc. Despite the early setbacks, the practice is now deeply rooted in the minds of farmer leaders except in those of a few rebel groups.

The other important management intervention was the water balance and reservoir operational changes effected in the poorly managed Ellegala Irrigation System. Due to operation changes such as minimum operating level being introduced, spillage from the tank system became zero during the maha 1992/1993 season. Water release from the Lunuganvehera Reservoir was kept to a minimum level to absorb the local runoff. This created increased salinity in tank water, weed growth and cultivations in upstream reaches of tanks. These issues need to be dealt with in the coming seasons.

Relevance of Kirindi Oya Experience to NIRP Schemes

Participatory Action Research methodology has emerged as a suitable method for improving the existing practices and methods in irrigation systems in a more sustainable way. The process adopted in the Kirindi Oya Project can be replicated to any system where Participatory Action Research is considered as a tool to improve system performance.

Irrigation Management and Crop Diversification Phase II at Kirindi Oya: Overview of Research Results

R. Sakthivadivel[7]

BACKGROUND

IIMI WAS INVITED by the Asian Development Bank (ADB), the main funding agency for the KOISP, to assist with improvements in the system performance by carrying out a diagnostic study. The Phase I Study results were published in 1990 (IIMI 1990).

One of IIMI's major conclusions was that the irrigation water use efficiency of Kirindi Oya was low and there was a great potential for saving water if proper management policies are adopted. Major points were that water use efficiency could be considerably improved through development and implementation of a seasonal allocation plan, effective use of rainfall and drainage water, improved operation of the main system and through improved tertiary system management. Also, there would be great improvement in water use efficiency if flexible scheduling was adopted, especially during the land preparation period, to match more closely the water use pattern adopted by the farmers.

In addition, the Kirindi Oya System as a whole is short of water; water supplies were initially overestimated by about 30 percent. In view of the scarce water resources and the large area to be brought under irrigation, there was an urgent need to diversify crops to use the water resources more efficiently and to maximize farmers' production and income.

IIMI's Phase I Report proposed a series of innovations in a) water management at both the main system and tertiary system levels, b) crop diversification, and c) institutional strengthening. High-level government officers selected a few important and implementable recommendations for field-testing by IIMI through Participatory Action Research at Kirindi Oya with funds provided under the Phase II Study by the Asian Development Bank. This Phase II Study, originally designed for 27 months, was started in May 1991. A no-cost extension of 5 months was given up to February 1994 to monitor the internalization and implementation of innovations introduced into the project.

Three major areas were chosen for research under this phase: main system management, tertiary system management, and a pilot program in other field crops (OFCs). The following two key activities were selected (IIMI 1991a) for improving canal operation and maintenance.

1. Improvement of main system management through development and implementation of seasonal crop and water allocation plans, through more efficient main canal operation, through water balance and operation studies of the Ellegala Irrigation System, and through improved maintenance management

2. Improvement of tertiary system management through strengthening farmer organizations, better tertiary maintenance management, improved seasonal planning, coor-

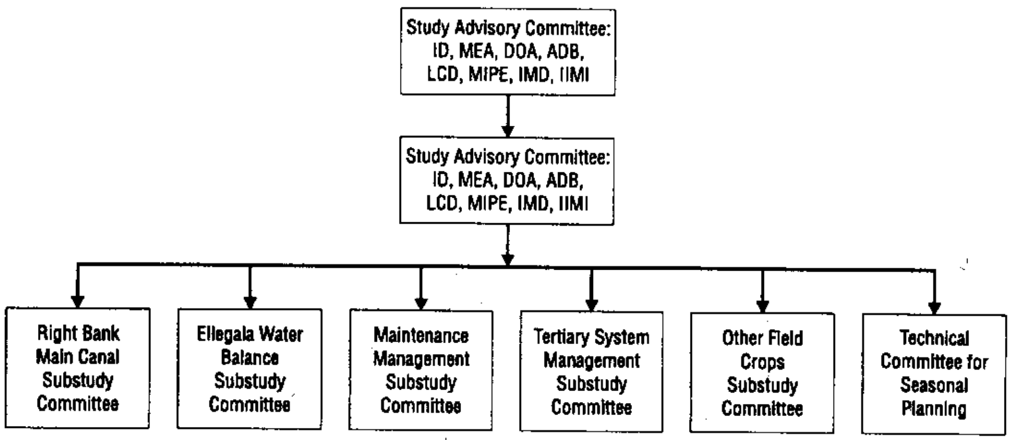
7 Senior Irrigation Specialist, IIMI/Sri Lanka Field Operations. Colombo, Sri Lanka.

dinated acquisition of agricultural inputs, and improved operations in field and distributary channels during the land preparation and crop growth periods

Organizational Setup for Phase II Research

The organizational structure used for planning and implementing Phase II research is shown in figure 1. The basic strategy adopted for getting the participation of the agency officers was the creation of subcommittees which planned, implemented and oversaw each of the research components. Coordination at the project level was provided by the Study Coordinating Committee. Monitoring the implementation of the project and dissemination of research results at the national level were achieved through the Study Advisory Committee (SAC) and the Consultative Committee of IIMI-SLFO. In addition, a one-day national-level workshop was organized by the newly set up Irrigation Research Management Unit of the Irrigation Department to discuss the methodology and results of the Kirindi Oya Project and its adaptation to other projects in the island. About 80 middle-level managers drawn from different departments (ID, IMD, DOA, MEA, DAS, universities, Provincial Councils, consultants and NGOs) participated in the workshop.

Figure 1. Organizational structure for participatory action research implementation in KOISP.



ID = Irrigation Department
MEA = Mahaweli Economic Agency
DOA = Department of Agriculture
LCD = Land Commissioner's Department
ADB = Asian Development Bank
MIPE = Ministry of Irrigation, Power and Energy
IMD = Irrigation Management Division
IIMI = International Irrigation Management Institute

SUMMARY OF RESULTS AND LESSONS LEARNED

The following is a brief summary and lessons learned from the following three activities implemented under the Phase II Study. The other research results under seasonal planning, crop diversification and salinity management obtained under this study will be presented separately.

Main System Operations Management[8]

The main objective of undertaking this component of research is to improve main canal operations to provide reliable and predictable water supplies to tertiary systems and to effect saving in water use.

Improved main system operation management was introduced through a three-stage process consisting of:

- System diagnosis
- Introduction of the data collection program and communication network
- Introduction of the computerized Irrigation Management Information System (IMIS)

Simple concepts of system analysis were used in this study to identify the lack of real-time information for the managers to formulate and implement appropriate control decisions. Also a communication network linking main canal operational centers (Unit Offices) with the Resident Engineer's Office was introduced. Through this two-way communication between the Gate Operators, Work Supervisors and the Resident Engineer, it was possible to develop and implement a management information system which makes use of the transmitted data for real-time analysis. Effective communication also allowed careful monitoring and supervision of data collection and utilization, collection of accurate data and provision of feedback to the relevant people engaged in operations.

Based upon the system diagnosis, a data collection and monitoring network was extensively discussed between the Irrigation Department and IIMI and implemented starting maha 1991/92.

To accelerate the learning and integrating the additional work of data collection and transmission into their normal functions, IIMI and the Irrigation Department staff provided the field staff with the necessary training.

The IIMI-CEMAGREF team developed a software named the Irrigation Management Information System (IMIS)—Right Bank Main Canal (RMBC), Kirindi Oya. This software helps the System Manager to make quick and appropriate decisions by facilitating computation and verification of discharges and easy storage and retrieval of data, including historical data. Provision has also been made to help the manager evaluate the performance of the system through a set of hydraulic and performance indicators.

The introduction of IMIS together with the data collection and monitoring network is a low-cost but satisfactory solution for obtaining information on current gate settings at each gated structure along the main canal and on water levels at each control point along the main canal and at the heads of offtake canals. This innovation is a great help to the manager since he is able to pinpoint trouble areas which require more attention, take better decisions and, hence, maintain a reasonable equity in water distribution. Also, there is better control over field staff and ad hoc operations are reduced. Since there is a daily monitoring program, field staff also have to improve their operations and make accurate readings.

The introduction of IMIS and the adoption of improved water management practices under this component of research have effected about a 20 percent water saving in the RBMC during maha 1992/93 when compared to maha 1990/91.

The methodology used in the RBMC was adopted in the Left Bank Main Canal (LBMC) to improve monitoring and feedback of information through a new data collection program. In applying the improved canal operation procedures, several constraints were faced. The efforts put

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8 A major part of the modeling and implementation of the main system operation management component was carried out by another study funded to IIMI by the French Government.

in by the research team and the resources provided for introducing the changes needed were not sufficient to create a sense of commitment and interest on the part of implementing personnel. Since the RID works were in progress at Ellegala, the Resident Engineer could not devote much time to understand and implement the IMIS. The main lesson learnt from this replication of proven innovation is that any innovation introduced in an irrigation project may not be internalized by itself. Even if it is internalized, it will not be successful unless the environment is conducive. Interest, commitment and incentives to operating personnel play a major role in determining whether an innovation is successful or not.

Water Balance Study of the Ellegala Irrigation System (EIS)

Before April 1991, there were no reliable measurements of water releases to the EIS and nobody knew how to calculate the amount of water from the Lunuganvehera Reservoir needed by the EIS. Without knowing this requirement, it was extremely difficult to allocate water to the new areas of Kirindi Oya, especially when it was a dry year. Because of this inadequacy of data, water releases from the Lunuganvehera Reservoir to Ellegala were made on an ad-hoc basis. It was often observed that while the new system was in dire need of water, the tanks in Ellegala were spilling as they did in maha 1991/92.

The flow measurement and water balance program initiated in maha 1991/92 under this study has provided limited but reliable flow data from which the amount of water originating from the rainfall and drainage as well as that released from the Lunuganvehera Reservoir can be determined. In addition, it has also provided information on the water released from the different Ellegala tanks from maha 1991/92 onwards.

The data collection plans were jointly designed and implemented by IIMI researchers and Irrigation Department officers. The generated information has been used to develop a new release pattern from the Lunuganvehera Reservoir to satisfy the water requirement of EIS as well as to make seasonal cultivation plans for the old and new systems based on the expected inflow into the Lunuganvehera Reservoir and agreed seasonal water allocation between the two systems.

The actual reduction in water use achieved to date is modest. However, because this study was carried out through Participatory Action Research, the results have been well accepted by both the agency and the farming community. There has been virtually no difficulty in making planning and operational changes in response to the results. The Irrigation Department officers, in particular, view the results as the product of their efforts and are proud to use them to improve operations at Kirindi Oya. In many cases, when an outside agency like IIMI undertakes a study without the participation of the agency officers, the officers distrust the results and move very reluctantly in implementing operational changes. The officers themselves now have a powerful tool for learning more and making further improvements on their own without IIMI's assistance.

This particular component of the study clearly illustrates two key points:

1. Improvements in water use efficiency can come about only when there is a good understanding of current operational procedures and of the basic hydrological relations within the system.

2. The use of Participatory Action Research as a way to get the necessary information makes it easy to implement effective changes in response to the information and makes it likely that the changes will be sustained and/or improved upon in the future.

Maintenance Management

The main focus of the research was on financial and physical management of maintenance programs and not on technical aspects of maintenance. Research was directed to obtaining tangible results by conducting interventions in managerial aspects. In fact, this proved the correct approach because some changes suggested in financial procedures and the methodology adopted for prioritizing maintenance components can be implemented without additional resources.

All activities under this component were carried out with the active participation of agency officials and farmers. This research component demonstrated that by carrying out day-to-day work in a methodical manner, better results could be achieved.

The following are some of the salient conclusions and recommendations:

1. Administrative overhead of maintenance work for the Irrigation Department is high compared with the physical work; the administrative costs are covered by using the funds provided for physical work. It was found that the administrative cost of the Tissa Division was not proportionate to the maintenance cost and this needs to be corrected. When construction activities are diminishing in a project, administrative (overhead) costs should be adjusted to suit the workload. Under administrative costs, there are certain fixed costs like salaries, vehicle maintenance, electricity, telephone, etc., which are difficult to minimize.

   To overcome this situation and to minimize fixed expenditure, the Irrigation Department should reorganize its O&M Division by bringing in more command area under each division in order to maximize the manpower utilization; such a rearrangement would lead to reduced per-acre maintenance overhead cost.

2. The preparation of work estimates on the basis of needs is well accepted by the agencies and the farmers. The preparation of detailed work plans for maintenance well in advance enabled successful maintenance implementation during the closure season.

3. Identification, prioritization and decision making walk-through surveys were found to be effective. Farmer participation increased as farmers felt their ideas and suggestions were being entertained. The environment strengthened relationships between the users and the operators. New formats designed in consultation with the Irrigation Staff and used in identification, quantification and preparation of cost estimates were found to be effective, efficient and useful for needs-based maintenance. Procedural changes provided ample opportunity for high-ranking Irrigation Managers to participate and supervise maintenance planning work. Their involvement improved the quality of maintenance planning; lower-ranking field staff were motivated and encouraged to perform better through the appreciation of the superiors and the users.

   It is recommended to internalize the concept of the diagnostic walk-through for the whole system to ascertain maintenance requirements and preparation of work plans; to implement the suggested maintenance procedure and methods used in each stage of the process within the framework of the Irrigation Department and the Irrigation Management Division and to make known at the beginning of the year, for each subsystem, the total maintenance allocation, allocation for main and tertiary systems, estimated value of work in tertiaries and shortfall in tertiary funding to be supplemented by field officers.

4. There exists a substantial difference in per-acre allocations for maintenance between Mahaweli systems and Irrigation Department systems. This difference has to be reduced.

   It is recommended that every effort be taken to motivate and mobilize farmers through training and awareness programs for getting their contribution in bridging the resources gap. Norms and standards for different kinds of maintenance activities should be revised after analyzing the progress of each activity. The existing cadre of maintenance laborers should be employed to carry out maintenance in a planned manner and their performance should be monitored with established norms.

Major Achievements

The major achievements of this study can be listed as follows:

- Developing and implementing a seasonal allocation plan which was accepted by the farming community and agency officials including politicians
- Institutional strengthening by making the Project Management Committee (PMC) as the nodal agency for making all irrigation-related decisions
- Introducing the Irrigation Management Information System (IMIS) and improving main system operation and management of the RBMC through a better communication network and monitoring
- Evolving appropriate strategies for the adoption of institutional knowledge and past experience in irrigation management for crop diversification in the RB and LB Tracts including the EIS
- Effecting water saving and minimizing salinity problems in the EIS tanks through skillful operations of the system

These achievements have led to:

- Increasing the intensity of irrigation in the Kirindi Oya System (figure 2). Although the increase has been modest due to the drought of yala 1992, there is a trend of increase starting from 1989 maha.
- Improving the water use efficiency both in the old EIS and NIS (figures 3 and 4).
- Evolving a process and a framework for improving and sustaining irrigation system performance (figure 5).

Relevance of Kirindi Oya Results to NIRP Schemes

Although the Kirindi Oya Project is a large-scale irrigation system with acute water-shortage problems, the Participatory Action Research process adopted in improving the irrigation system performance and diversification to other field crops is equally applicable to any system, big or small. Therefore, many of the findings have relevance to rehabilitation tanks undertaken under NIRP. The process and a framework suggested for improving system performance out of this research can be adopted with suitable modifications to NIRP schemes.

The following two specific innovations are directly applicable to NIRP schemes:

1. Developing and implementing a seasonal allocation plan which was accepted by the farming community and agency officials. This will consider the effective use of rainfall and inflow to the tank system for dry, average and wet years.
2. Identification, prioritization and decision-making walk-through surveys were found to be effective for carrying out effective maintenance by the farmers' organizations. The same procedure can be adopted for identifying, prioritizing and decision making of the rehabilitation components to be undertaken under NIRP.

Figure 2. Area cultivated in KOISP, maha 1987/88 to yala 1993.

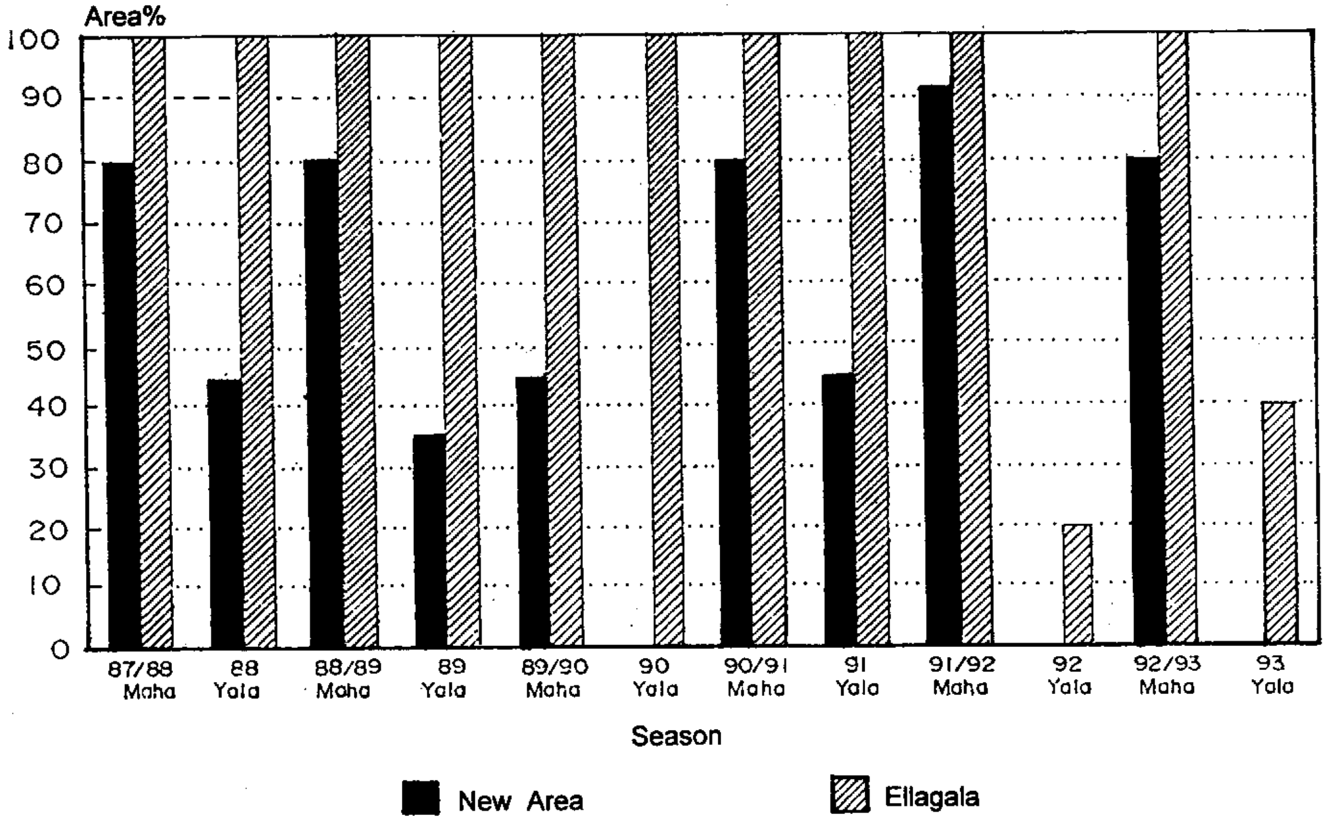


Figure 3. Water duty for rice in the Old Ellegala Irrigation System (irrigation and rainfall contribution), maha 1987/88 to maha 1992/93.

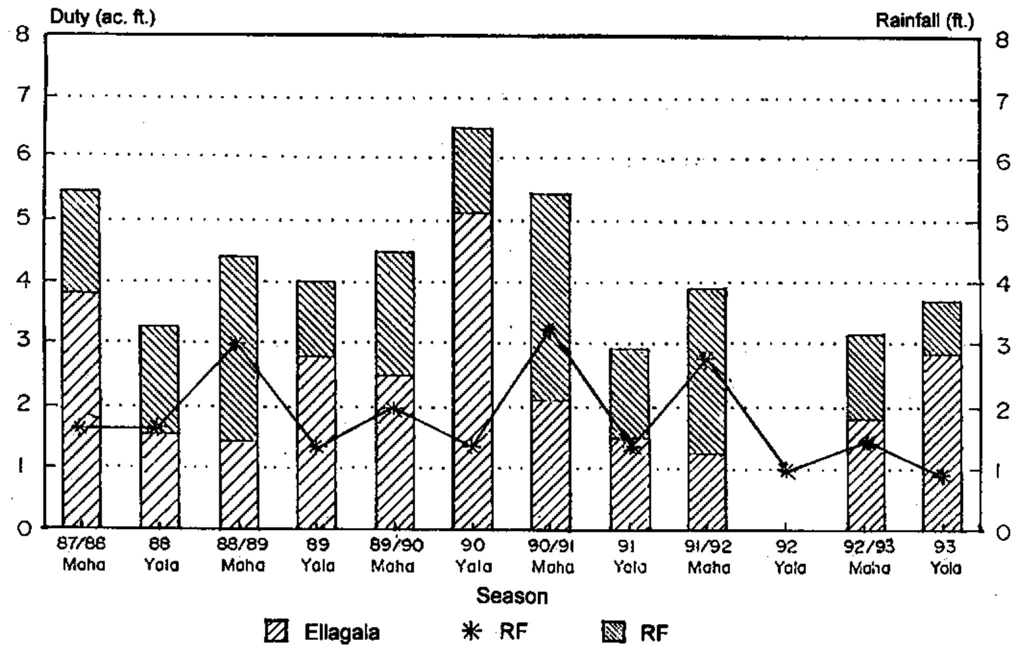


Figure 4. Water duty for rice in KOISP New Areas (irrigation and rainfall contribution), maha 1987/88 to maha 1992/93.

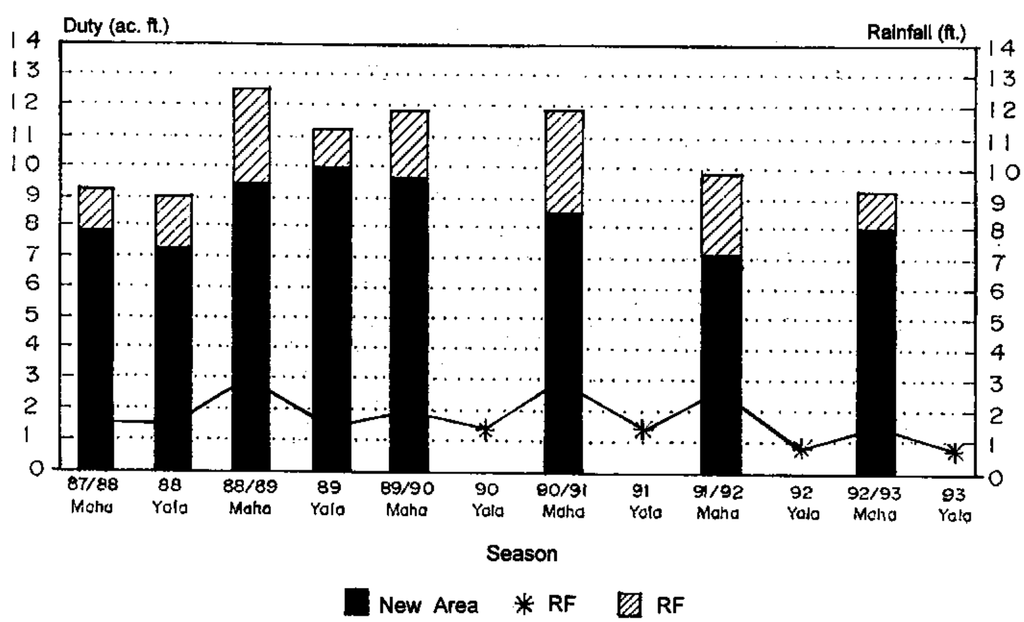
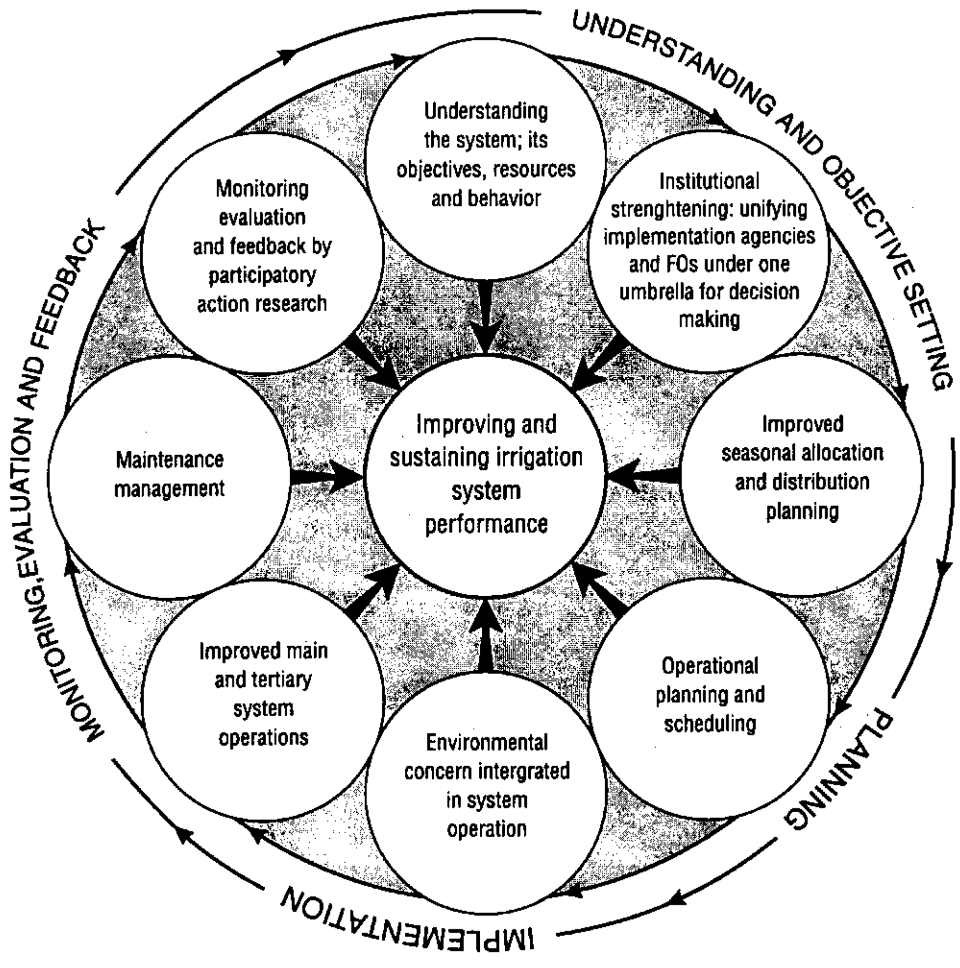


Figure 5. A framework for improving and sustaining irrigation system performance.



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Improving Seasonal Planning at Kirindi Oya

Jeffrey D. Brewer[9]

NEED FOR IMPROVED SEASONAL PLANNING AT KIRINDI OYA

ONE OF THE major problems addressed by the Asian Development Bank-funded Irrigation Management and Crop Diversification Project was the insufficient cultivation in the New Areas to justify the investment in the Kirindi Oya Irrigation and Settlement Project (KOISP). Also, farmers of the New Areas just did not get enough crops to put much effort into improved irrigation management. For Phase II, beginning in 1991, IIMI and the agency personnel decided to attempt to improve the seasonal planning methods and procedures to

- distribute water more fairly between New Areas and Ellegala
- increase overall cropping intensity

Four aspects in improving seasonal planning were identified:

- improving the technical basis for planning
- defining water allocation principles
- defining who should make the seasonal planning decisions
- combining the allocation principles and technical considerations into a seasonal allocation procedure

A fifth aspect came to be recognized as equally important:

- getting agreement of all the concerned parties

These five aspects are discussed separately below.

IMPROVING THE TECHNICAL BASIS FOR SEASONAL PLANNING

Good seasonal planning can only be done if both supply and demand for water can be calculated. Moreover, in order to get agreement for the farmers and others, the calculations must be easily understood. Improving the technical basis therefore means determining the parameters that are used for calculating supply and demand each season. These must be relatively simple so that all can understand the calculations. For Kirindi Oya there were three key concerns:

- estimating the water supply

9 Social Scientist, IIMI/Sri Lanka Field Operations. Colombo, Sri Lanka.

- defining parameters for calculating demand in the New Areas
- defining the demand in Ellegala

Estimating the Water Supply

By 1991, the estimates of water availability in the Kirindi Oya were known to be faulty. Therefore, a detailed analysis of monthly discharge records for 35 years of Kirindi Oya was carried out. As part of the analysis, outlying values were replaced by recently observed values. Data from inflows to Lunuganvehera since 1986 were also used to evaluate the inflow. The analysis was carried out for several exceedance probabilities. The cumulative values from this analysis for maha and yala are shown in tables 1 and 2. These results indicated that a reliable (80%) inflow of about 100,000 acre-feet could be expected—60,000 during maha and 40,000 during yala.

Table 1. Maha cumulative inflows at Lunuganvehera (inflows in acre-feet).

Month	Probability				
	50%	70%	75%	80%	90%
September	5467	2916	2349	1944	1188
October	20452	13122	9906	7776	5238
November	67230	47466	43116	34344	24732
December	99630	70632	63552	51354	34479
January	120690	84726	74811	60588	40608
February	134541	92421	81801	66420	43713

The results were evaluated by a Technical Committee that included officers from the Irrigation Department, the Irrigation Management Division, the Department of Agriculture and IIMI. Two key conclusions were drawn from this analysis:

- Using the 70, 75, and 80 percent exceedance figures, estimates were made for wet, normal and dry maha seasons and wet, normal and dry yala seasons.
- It was concluded that sufficient inflow into Lunuganvehera would normally be received so that irrigation issues could be made from 15 November for maha and from 15 April for yala even assuming that the reservoir starts from sill level for maha.

Table 2. Yala cumulative inflows at Lunuganvehera (inflows in acre-feet).

Month	Probability				
	50%	70%	75%	80%	90%
March	19116	10530	8691	7614	4779
April	59616	42765	41601	35802	23490
May	83268	58965	54399	45198	28026
June	90638	64392	58773	49086	30429
July	95904	68442	61770	51435	31158
August	100278	71439	64580	53946	32211

When these results were presented to the Study Coordination Committee and other local officers, they suggested that the definition of six types of seasons (3 for maha and 3 for yala) was too complicated and it did not fit the observed inflow pattern. They suggested that inflow during yala has little variability while maha inflow has two distinct regimes. As a result, inflow into Lunuganvehera can be classified into three classes:

- dry maha inflow of about 60,000 acre-feet
- wet maha inflow of 80,000 acre-feet or more
- normal yala inflow of 40,000 acre-feet

After the events of maha 1991/92 and maha 1992/93 (see Section under *Getting Agreement on a Seasonal Planning System* [p.39]), the Technical Committee suggested that at the beginning of each maha season, it would be assumed that the season would be dry. By the end of December, it would be possible to determine from the storage in Lunuganvehera whether inflow has been high enough to class the season as a wet maha. If it is a wet maha, water could be allocated for a late maha crop, sometimes called a *meda* crop, in portions of the New Areas not previously authorized for rice cultivation.

Estimating Demand in the New Areas. Prior to 1991, there were no clear parameters defining how demand for the New Areas should be estimated. Since the cropping pattern in the New Areas is expected to vary from season to season, a definition of crop classes and the amount of water to be allocated to each class is needed.

After trying several different ways of classifying crops, the Technical Committee defined the following three types of crops and water requirements for the New Areas:

- rice - 6 feet of water
- irrigated other field crops (OFCs) - 3 feet of water (6 waterings)
- rain-fed OFCs - 1.2 feet of water (2 waterings if required)

The water requirements are based on measured duties in the New Areas. By multiplying these figures by the area assigned to each crop class, the demand for water for the New Areas can be quickly calculated for any cropping pattern.

Bananas were also considered as a separate class of crop because of the long growth period but were dropped because they have not been widely adopted.

Estimating Demand in Ellegala. Prior to 1991, seasonal planning was done by assuming that Ellegala needed 56,000 acre-feet of water. Because water from certain portions of the New Areas drains into the Ellegala tanks, it was assumed that 30 percent of the water issued to the relevant parts of the New Areas went to Ellegala. There was no basis for either figure. Therefore, IIMI and the Irrigation Department collaborated on a water balance study of the Ellegala tanks to get more accurate estimates for these figures. The results of this study indicated that:

- In a wet maha, 15,000 acre-feet of water are needed for 100 percent rice in Ellegala.
- In a dry maha, 25,000 acre-feet of water are needed for 100 percent rice in Ellegala.
- In yala, 30,000 acre-feet are needed for a cropping pattern that includes 50 percent of the area in rice, 25 percent in OFCs, and 25 percent fallow.

Next >>

Combined with demand figures for the allocation to the New Areas, these figures enable the calculation of the total demand.

DEFINING WATER ALLOCATION PRINCIPLES

Rights to receive irrigation water are a key concern in defining an allocation system. In Sri Lanka, legally, all surface water belongs to the government; there is no legally recognized system of individual or group water rights. The practice is to assign water rights each season. The Irrigation Ordinance defines mechanisms for seasonal allocations.

Because Kirindi Oya is water-short, farmers of Ellegala and the New Areas had made various claims to try to secure their rights to the water and, at various times, officers have acted in ways supporting one or the other side. Therefore, it was essential to get agreement on the key principles about how water would be allocated.

Rights of Ellegala Farmers

The first major issue was the question of the rights of Ellegala farmers versus the rights of the New Area farmers. From the beginning of the KOISP, Ellegala farmers claimed an absolute priority right to water in the Lunuganvehera Reservoir on the basis that they were using Kirindi Oya water prior to construction of the reservoir. They also claimed that they had a 200 percent cropping intensity prior to completion of the reservoir although the ID records and interview data indicate that the cropping intensity was less than 150 percent. Prior to 1991, this claim had been tacitly recognized by a water allocation policy that gave priority to the Ellegala farmers.

After high-level consultation, the Ellegala farmers' claim to absolute priority was rejected so that water shortages could be shared more equitably. In recognition of Ellegala farmers' prior usage, it was decided that they should be guaranteed a cropping intensity higher than the 150 percent they had enjoyed prior to the construction of the Lunuganvehera Reservoir. The figure of 170 percent was selected.

Equity within the New Areas

The second major issue was assuring equity in the allocation of crops and water within the New Areas. This is important because water is so short that most parts of the New Areas cannot be expected to get water for rice each season. Because of the size and complexity of Kirindi Oya, *bethma*[10] was rejected as impractical. Prior to 1991, whenever water was available for the New Areas, system managers assigned it to different subareas in a crude rotation system intended to assure long-term equity.

It was decided to continue to use the rotation principle to ensure equity. To simplify rotations, the New Areas were divided into 3 roughly equal zones of 4,000 acres apiece:

Zone 1: Left Bank Tracts 1 and 2
Zone 2: Right Bank Tracts 1 and 2
Zone 3: Right Bank Tracts 5, 6, and 7

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10 Generally described as a traditional custom in small communal tanks of Sri Lanka, whereby water supplies which are not adequate for the full command area are allocated to part of the area, and all farmers are given proportional land shares in the irrigated part.

The principle adopted is that water shortages would be rotated among the zones.

Other Issues

In addition to the major issues, various minor issues came up. One was the allocation of water to the Badagiriya System which is located outside of the Kirindi Oya Basin but which can be fed by the Right Bank Main Canal. A second was the status of the Left Bank Tract 3 in the New Areas. Only a portion of this tract had been developed when construction ended in 1990. Since that time, this tract has been treated as an experimental OFC area with water guaranteed for two OFCs each year.

DEFINING THE SEASONAL DECISION-MAKING BODY

The Irrigation Ordinance of 1968 specified that seasonal planning was to be carried out jointly by farmers and officers at *kanna* (seasonal) meetings called by the Government Agent. In fact, in Kirindi Oya as in other large irrigation systems, kanna meetings have not worked effectively for seasonal allocations because the size of the system and number of farmers involved make joint decisions impossible.

Under the Participatory Irrigation System Management Policy, seasonal planning is to be taken over by the Project Management Committee. In Kirindi Oya, when the INMAS Program was introduced in 1986, two Project Managers were appointed—one for Ellegala and one for the New Areas—and two Project Management Committees (PMCs) were created. The PMCs, however, were not in a position to decide water allocations between Ellegala and the New Areas and thus could not take allocation responsibilities.

Prior to 1990, seasonal allocation decisions were made by the Project Coordinating Committee or by the Government Agent and ratified at the kanna meetings. The Project Coordinating Committee was established to oversee construction and settlement and did not include farmers.

To make participatory management effective one of the Project Managers was transferred and the two PMCs were combined into one, in 1990. Subproject Committees were created to assist the PMC.

Although most of the officers accepted the unified PMC as the legitimate seasonal planning body from the very beginning, there have been disputes among farmers over this responsibility. The roles of the government departments have been, and continue to be, providing technical advice and support to the PMC.

COMBINING TECHNICAL CONSIDERATIONS AND DECISION PRINCIPLES

When IIMI presented the report of the Phase I of the Study in 1990, a Special Task Force was created to look into the recommendations. The Task Force appointed a Subcommittee made up of high-level officers from the Irrigation Department, the Land Commissioner's Department, the Irrigation Management Division, and IIMI to resolve the seasonal planning issues. The Subcommittee made its recommendations in January 1992. These recommendations rejected absolute priority for Ellegala and suggested rotations among subareas in both the New Areas and Ellegala to distribute shortages more fairly.

Members of the Subcommittee discussed the recommendations with Farmer Representatives in May 1992. The farmers rejected the recommendations and, in a second meeting in June 1992, presented their own proposals. The farmers' proposals unrealistically asserted that it would be possible to cultivate the whole of Kirindi Oya every season through the use of more OFCs and through more stringent efforts to save water.

The local-level Technical Committee then prepared a set of proposals that took into account the improved data on water availability and the other technical considerations and simplifications described above. These proposals were used as the basis for the initially approved allocation for the 1992/93 maha season. Events during that season (see under *Getting Agreement on a Seasonal Planning System* [p.39]) led to the reconsideration of the allocation strategy by the Technical Committee. The revised strategy was discussed with farmer representatives in July 1993, and with one adjustment, has been accepted as the basis for allocation planning (see the next Section). The revised strategy includes the following provisions:

1. The New Areas (except Left Bank Tract 3) are divided into the 3 equal zones described above. At the beginning of the maha season, it is assumed that the season will be dry. Two out of three zones are authorized water for rice and the third for rain-fed OFCs. Each year a different zone, in rotation, is to be selected as the OFC. If at the end of December, the season is judged to be a wet maha, the OFC zone will be authorized water for a *meda* (late maha) rice crop following the OFC harvest. If it is a dry maha, then the OFC zone will get water for irrigated OFCs during the following yala. Zones authorized for rice during maha will normally not get water during yala.

2. Ellegala is allocated water for 100 percent rice during maha. During yala, Ellegala is allocated water for at least 50 percent rice plus some portion in OFCs.

3. Badagiriya is allocated up to 5,000 acre-feet of water during maha if there is a shortage, but will receive nothing during yala.

4. Left Bank Tract 3 is allocated water for irrigated OFCs during both maha and yala.

5. Maha water issues begin by supplying Ellegala by 1 November each year. If there is adequate water in the reservoir, both Ellegala and one of the New Area rice zones are started simultaneously. After three weeks (i.e., by 21 November), water is supplied to the second rice zone.

If the third zone in the New Areas is authorized a late maha rice crop, some of the yala inflow may have to be used for the New Areas. Thus not all of the yala inflow is reserved for Ellegala. Table 3 shows the percentage allocations for the major subareas of Kirindi Oya under this strategy.

Table 3. Percentage allocation of water to major subareas in Kirindi Oya.

Season	Percentage Allocation		
	New Areas	Ellegala	Badagiriya
Dry maha	55	40	5
Wet maha	75	20	5
Yala	20	80	-

GETTING AGREEMENT ON A SEASONAL PLANNING SYSTEM

As expected, the various interested parties did not immediately agree to the principles and the planning system described above. It took time and learning to get general agreement. Some of the more dramatic incidents included are the following:

1. The Ellegala farmer representatives at first boycotted the single PMC, fearing that it had been created to give New Area farmers the power to decide not to give Ellegala first priority for water.

2. In maha 1991/92, at the suggestion of the Irrigation Department and against the wishes of the Ellegala farmer representatives, the PMC authorized late rice cultivation for the Right Bank Tracts 2 and 5. This practice has since been adopted as a regular seasonal planning principle.

3. Against the advice of the Irrigation Department, Ellegala farmers demanded and received authorization for rice for the whole of Ellegala for yala 1992. They were urged to do so by their leaders who felt that this was the only way to protect their claim to absolute priority to water. The drought that season led to a major crop failure; at least 75 percent of the Ellegala rice crop was not harvested. This disaster taught Ellegala farmers to be much more careful about ignoring Irrigation Department advice. It also led to a major change in farmer organization leadership.

4. In maha 1992/93, based on the first version of the Technical Committee recommendations, the Left Bank Tracts 1 and 2 and the Right Bank Tract 1 were authorized OFCs by the PMC. Feeling that this was unfair, many of the farmers in these areas organized an "independent" farmer organization to work against the PMC decision. One approach taken was through politicians. Ultimately, after an interview with representatives of the "independent" farmer organization, the Minister for Irrigation authorized water issues for rice to these tracts subject to the condition that farmers complete land preparation with the rains. This condition caused conflicts between the ID officers and the farmers until the Minister amended his decision to authorize issues to all farmers in the three tracts. During the process, there were several verbal duels and at least one physical assault among various farmers. One result was the plowing under of at least 650 acres of OFCs which led to claims against the government for the loss of these crops. These events taught some key lessons: a) New Area farmers learned that they could press their claims to water with some success, b) farmers in the three tracts learned that working through the "independent" farmer organization led to fights and conflicts among themselves, and c) some politicians may have learned caution about taking part in these conflicts.

5. During yala 1993, because of the shortage of water, the ID strongly recommended to the Ellegala farmers that they adopt a seasonal plan that mixed rice, OFCs and fallowed areas. The Ellegala farmers, remembering their losses of the year before, did so, although only after considerable wrangling among themselves. The result was a successful season although the OFC crops did not turn out as well as hoped, in part because the delay in making the decisions delayed planting.

6. During maha 1993/94, the revised seasonal planning system described above had been put in place, including the adoption of the principle that if the season is a wet maha, the OFC zone would be authorized water for a late maha rice crop. The seasonal plan adopted by the PMC and based on the revised Technical Committee recommendations called for the Left Bank Tracts 1 and 2 to be the OFC zone. Some farmers

again attempted to get the decision changed through politicians. This time, however, the politicians were unsuccessful since the Minister refused to intervene and the PMC refused to change its decision. The heavy rains ensured that a late maha rice crop would be authorized so the farmers who were demanding the change did not have widespread support.

The overall result seems to be the rather widespread acceptance of the improved seasonal planning system. One of the important aspects of this system is that it guarantees the New Area farmers at least one crop a year during maha and gives the farmers an indication of when the season is likely to begin. This means that farmers will be far better able to plan than before. This system should also raise the average cropping intensity in the New Areas, so that farmers will be able to earn a better income from irrigated farming.

Compared with their situation between 1986 when Lunuganvehera was completed and 1991, the Ellegala farmers have lost something, but they are still better off than they were prior to the construction of the Lunuganvehera Reservoir. During 1993, they publicly threatened to go to courts to have their absolute priority rights recognized, but have not taken any action.

Major changes that have occurred through this process include:

- Acceptance by the Ellegala farmers of the fact that they did not have an absolute priority right to Kirindi Oya water. Over time, as they were defeated again and again, they learned that their rights would be protected only to a certain extent. The disaster in yala 1992 hastened this acceptance.
- Acceptance by virtually all farmers of the Project Management Committee as the legitimate and best body for making the seasonal allocation decisions. At times, both Ellegala farmers and the New Area farmers attempted to bypass the PMC.
- Acceptance of the planting of OFCs as a way to help conserve water in both Ellegala and the New Areas.
- An increase among the farmers in knowledge and understanding of the water supply situation and of many technical aspects of the irrigation system. In 1992, some farmers claimed that the dead storage in Lunuganvehera could be used; a year later no farmer was making such large errors.
- Reduction of suspicion about the Irrigation Department. Not only have most of the farmers come to trust data from the Irrigation Department, but most have come to respect the advice of the Department officers. In part, this respect is due to the Department officers' improved expertise due to their better knowledge of the system brought about by studies carried out under the Phase II activity. In part, it is the result of the fact that the Irrigation Department officers have not tried to take the decisions away from the PMC.

The learning process has been costly for many, including the Ellegala farmers who lost crops in yala 1992, the LB1, LB2, and RB1 farmers who lost OFCs in maha 1992/93, the officers who have had to endure harassment and abuse, and the politicians whose reputations may have suffered. However, this process has been necessary in order to get general agreement on a seasonal allocation planning system. Overall, the farmers, officers and politicians have all learned a great deal and most have come to respect the others more.

The experience of maha 1993/94 seems to imply that the seasonal allocation plan is well established and likely to endure, particularly if certain smaller problems can be solved. However, allocation of the excess water from the heavy maha rains during yala 1994 will pose a new and different challenge to this system. The evidence would imply that the PMC, if well supported by the agencies, particularly the Irrigation Department, will be able to rise to this challenge as well.

GENERAL LESSONS FROM KIRINDI OYA

The most important lesson from Kirindi Oya is that the establishment of an effective seasonal allocation system under water-short conditions is a political process, not just a technical process. The political nature of this process must be understood and planned for.

Other key points include the following facts:

1. A strong technical base is required for an effective seasonal allocation system; the necessary studies must be carried out to provide the needed knowledge. In the case of Kirindi Oya, this included the water balance study of the Ellegala tanks as well as the reassessment of inflow to the Lunuganvehera Reservoir. In addition, an interdisciplinary technical body like the Kirindi Oya Technical Committee, including irrigation, agricultural and institutional officers, should take responsibility for providing technical advice for making the seasonal decisions.
2. Farmers' knowledge of the environmental and technical limits to seasonal allocations is very important. Therefore, they should be educated about the system as much as possible. More importantly, they should be brought into the decision-making process as soon as possible and allowed to make their own decisions, with professional advice, so that they can learn from their mistakes.
3. It is important that technical aspects of seasonal decisions be clearly understood by all, including the farmers. Therefore, insofar as is consistent with technical soundness, technical parameters should be simplified and regularized. Examples are the adoption of season types (wet maha, dry maha), zones, and crop classes in Kirindi Oya. Simplifying the technical parameters reduces flexibility in planning. However, the reduction in flexibility is more than made up for by the great increase in transparency in decision making.
4. It takes time for the farmers and other interested parties to learn the limits of their power and to get the agreements necessary to make an effective seasonal allocation system work. This time should be planned for.
5. To avoid uninformed interventions by politicians or government officials, relevant politicians and government officials should be kept informed of the plans and decisions as they develop.

LESSONS FOR THE NATIONAL IRRIGATION REHABILITATION PROJECT

The National Irrigation Rehabilitation Project (NIRP) is undertaking the rehabilitation and modernization of a large number of schemes, including about 1,000 minor schemes, and 60 medium and major schemes. This experience at Kirindi Oya suggests that NIRP planners and implementors should take the following into consideration:

1. When planning operations jointly with farmers, seasonal allocations need to be considered, particularly in larger, water-short schemes. Not all schemes have allocation problems; for those which have allocation problems, special attention should be paid to this issue. Establishment of an effective and equitable seasonal allocation system will raise the productivity of the system and bring better returns to the investment in rehabilitation.

2. When seasonal allocation is a problem, it is essential that the necessary investigations be carried out so that the technical basis for planning is adequate. In addition, the technical parameters for making decisions have to be made sufficiently simple and clear so that all farmers can understand the technical issues.

3. Allocation decisions must be made by the farmers, generally through a Project Management Committee, with technical advice as needed from irrigation and agricultural officers. This means that the farmers must be allowed to make mistakes so that they can learn.

4. If allocation is a problem, there will be the temptation for some farmers to use political and other authorities to override decisions made by the legitimate authorities. There is a need therefore to inform those political and other authorities of the bases for decisions. Also, the officers should stand behind the Project Management Committee's decisions.

Clear establishment of the authority of the Project Management Committee and the establishment of a transparent and technically sound way for the PMC to make decisions are both necessary to ensure the success of a seasonal allocation strategy.

Mitigating Salinity Problems in the Old Ellegala Irrigation System

C.R. Panabokke[11]

THE PROBLEM

CONSEQUENT TO THE construction of the Lunuganvehera Reservoir upstream of the Old Ellegala Irrigation System in the Kirindi Oya Irrigation and Settlement Project, farmers in the Old Ellegala Irrigation System (4,200 ha) began complaining that their rice fields were being affected by salinity. The source of salinity they said was the soluble salts being leached out from the Kirindi Oya New Irrigation System (5,260 ha). These soluble salts, they maintained, were then collected in four major tanks and transported from them to the rice fields through irrigation supply.

Their complaints reached a peak during the maha season of 1992/1993 when several isolated but visible patches of stunted young rice plants could be readily observed in specific locations on lands situated in the flat alluvial plain of the Old Ellegala Irrigation System. This paper attempts to provide an explanation as to why the salinity problem became so acute during this particular maha season and to propose preventive measures based on a monitoring system which needs to be set in place.

ENVIRONMENTAL SETTING OF THE OLD AND NEW IRRIGATION SYSTEMS

The Old Ellegala Irrigation System is situated almost wholly within a flat alluvial plain. The Kirindi Oya cuts through the central portion of this plain. The main river course shows a distinct incised drainage. The river traverses the flat alluvial plain in a north-south direction in a slightly winding manner with two distinct meanders in the lower part of the floodplain just before the river enters the sea at the southern outfall (figure 1). The New Irrigation System in the Kirindi Oya, in contrast, is situated almost wholly within the surrounding undulating, residual 'mantled plain' as shown in figure 1.

The four major reservoirs of the Ellegala System—Wirawila, Debara Wewa, Tissa Wewa and Yoda Wewa—are located in the transitional landscape between the undulating residual plain and the flat alluvial plain. It can be observed from figure 1 that drainage waters from Tracts 1 and 2 of the New Areas of the Right Bank flow into the major Wirawila and minor Pannegamuwa reservoirs and that drainage waters from Tracts 1 and 2 of the New Areas of the Left Bank flow into the Debara Wewa, the Tissa Wewa and the Yoda Wewa. A schematic cross section across the residual plain of the New Areas, the reservoirs, the flat alluvial plain of the Old Ellegala Irrigation System and the river is shown in figure 2.

11 Senior Associate, IIMI/Sri Lanka Field Operations. Colombo, Sri Lanka.

Figure 1. The KOISP: Old and new irrigation systems.

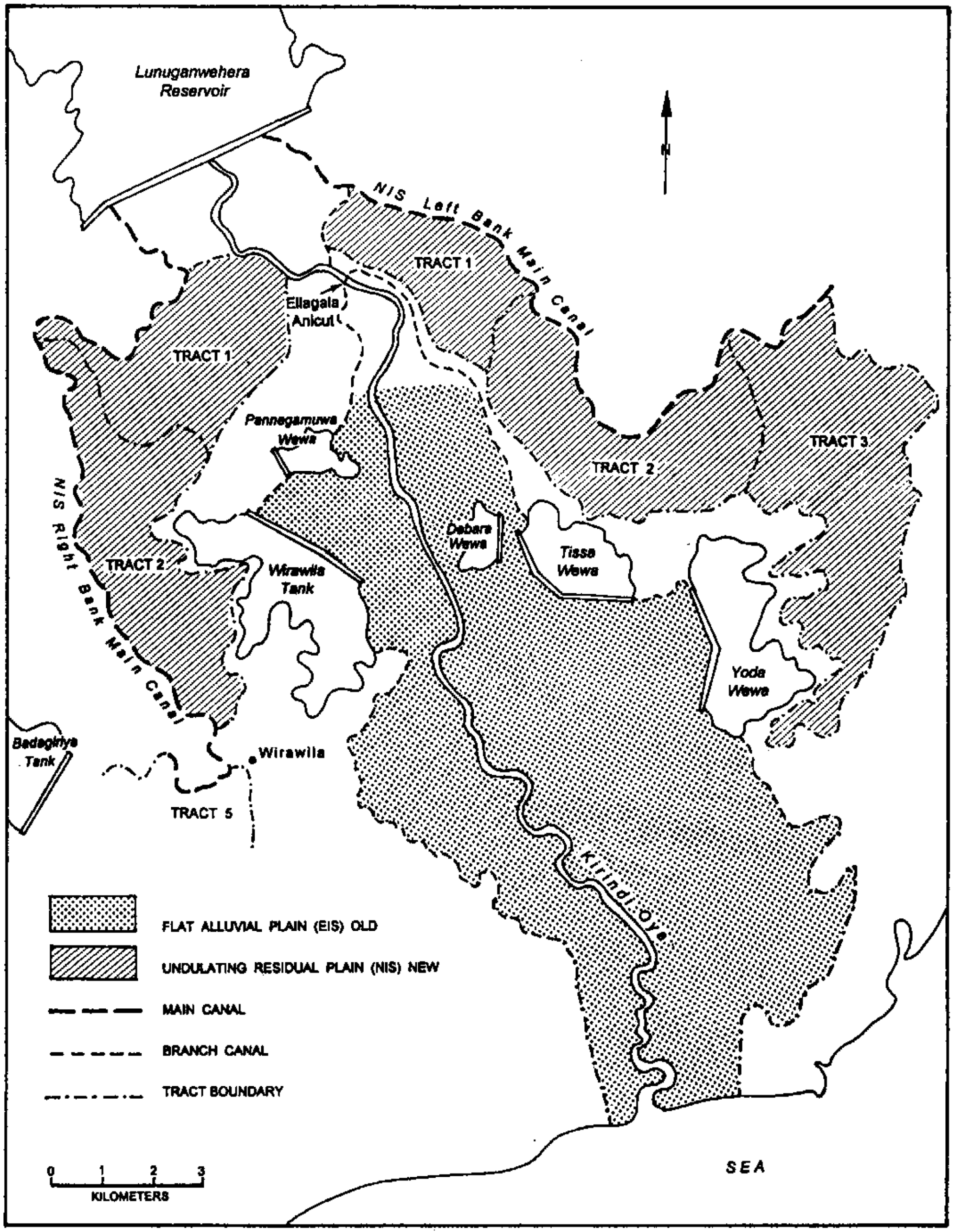
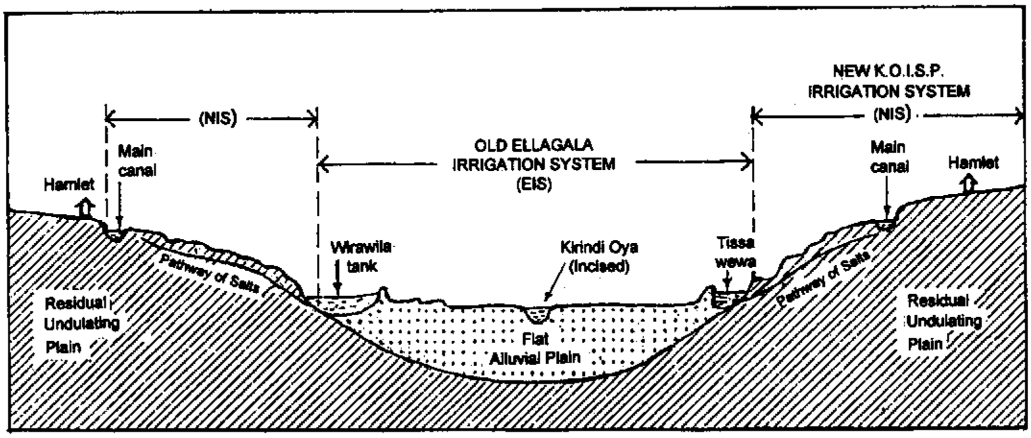


Figure 2. Schematic cross section (East-West) orientation.



The soils of the undulating residual plain are 75 percent reddish brown earths (Chromic Luvisols LVx) and 25 percent solodized solonetz (Gleyic Solonetz SNg). The latter are sodic soils with an exchangeable sodium percentage of more than 15 percent of the exchange complex. The soils of the alluvial plain are made up of imperfectly drained, brown alluvial soils in the slightly higher aspects of the micro-relief and poorly drained, grey alluvial soils in the lower aspects. The path taken by soluble salts leached from the residual plain to the reservoirs and then to the flat alluvial plain is shown in figure 2.

The mean annual rainfall in the project area (100-year average) is 970 mm with a mean annual evaporation (Class A open pan, 20 years) of 2,000 mm. The more reliable statistic of 75 percent probability of monthly rainfall together with the average monthly evaporation is given in tables 1(a) and 1(b). Evaporation exceeds precipitation every month except November, December and January. Strong dry westerly winds bring in cyclic atmospheric salts between June and September. As a result, there is a net accretion of salts in this agroecological region of DL 5 which is a semiarid tropical environment.

For the last 100 years and more, the alluvial soils of the Old Ellegala Irrigation System have been irrigated with Class I irrigation water originating from the main Kirindi Oya and diverted to the command through the Ellegala Anicut. This, coupled with the incised nature of the downstream Kirindi Oya, had prevented the buildup of salts in the irrigated command area.

The Old Ellegala Irrigation System also had a good drainage network leading to several *basnawas* (outfalls). These were disrupted following the 1969 floods and have not been repaired or properly maintained since then. It is from this time that the farmers in the lower reaches of the Old Ellegala Irrigation System report incipient occurrences of salinity in their areas. Salts are however flushed out during exceptionally wet maha seasons which occur approximately once in six years.

Table 1(a). Climatic data, Tissamaharama.

Month	Rainfall (1872–1987) mean monthly mm	75% Probability mm	Evaporation (Penman) - 20 years average mm
January	101	51	132
February	36	15	157
March	75	38	171
April	93	69	153
May	61	31	165
June	23	10	185
July	15	5	201
August	12	0	215
September	34	10	210
October	141	84	167
November	223	155	121
December	154	94	120
Total	968	562	1997

Table 1(b). Rainfall and evaporation in Kirindi Oya during 1992.

Month	Rainfall		Evaporation
	Total (mm/month)	Cumulative (mm)	Total (mm/month)
January	17.1	17.1	151
February	0.0	17.1	185
March	0.0	17.1	222
April	73.9	91.0	161
May	119.3	210.3	134
June	17.9	228.2	216
July	13.3	241.5	222
August	11.2	252.7	271
September	54.8	307.5	239
October	63.0	370.5	184
November	391.9	762.4	110
December	98.6	861.0	116

The adjacent Badagiriya Irrigation System (850 ha), commissioned in 1961, is located wholly in the residual undulating plain of reddish brown earths and solodized soils. By 1965, a very high proportion of the command area, especially the lower topographical locations, was severely affected by salinity. Provision of proper landscape drainage and widening of the main natural drainage system coupled with annual irrigation and leaching over the last 25 years have subsequently helped ameliorate these affected locations.

TRANSLOCATION PATHWAYS OF SOLUBLE SALTS TO THE OLD ELLEGALA IRRIGATION SYSTEM

In January 1990, the Department of Agriculture commenced a program to test, once every fortnight, the quality of water in the Lunuganvehera Reservoir and in the five Ellegala tanks. The results of this analysis for the years 1990 to 1993 in respect of the Lunuganvehera Reservoir, the Wirawila Reservoir, the Tissa Wewa and the Yoda Wewa are shown in figures 3 to 6.

The normal pattern is reflected in the data for 1990 and 1991 which correspond to the modal seasonal pattern of rainfall in this environment. The seasonal pattern of rainfall and inflow for 1992 were very much below normal with the two main reservoirs of the Old Ellegala Irrigation System running dry between July and October.

As indicated in figures 3 to 6, the quality of water in the Lunuganvehera Reservoir was well below the EC of 0.20 milli mhos per cm during the wet season from October to January and hovers around 0.25 for the rest of the year. Figure 4 indicates that water quality in the Lunuganvehera Reservoir, which receives its total supply from the upstream Kirindi Oya, is Class I for almost all twelve months of the year.

Figure 3. The EC of tank waters in KOISP area, 1990.

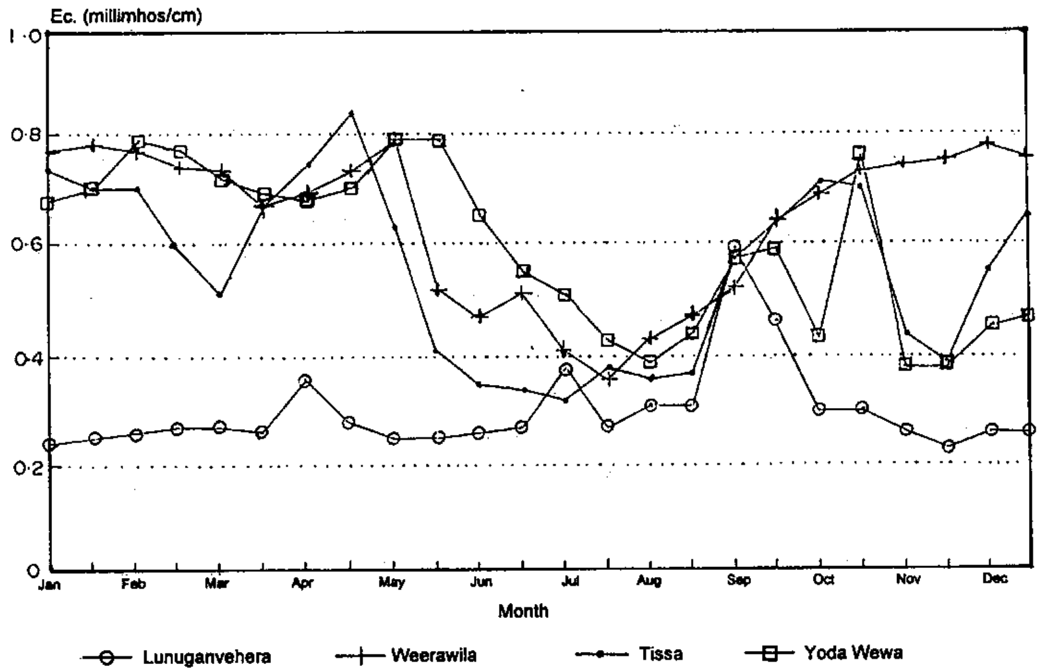


Figure 4. The EC of tank waters in KOISP area, 1991.

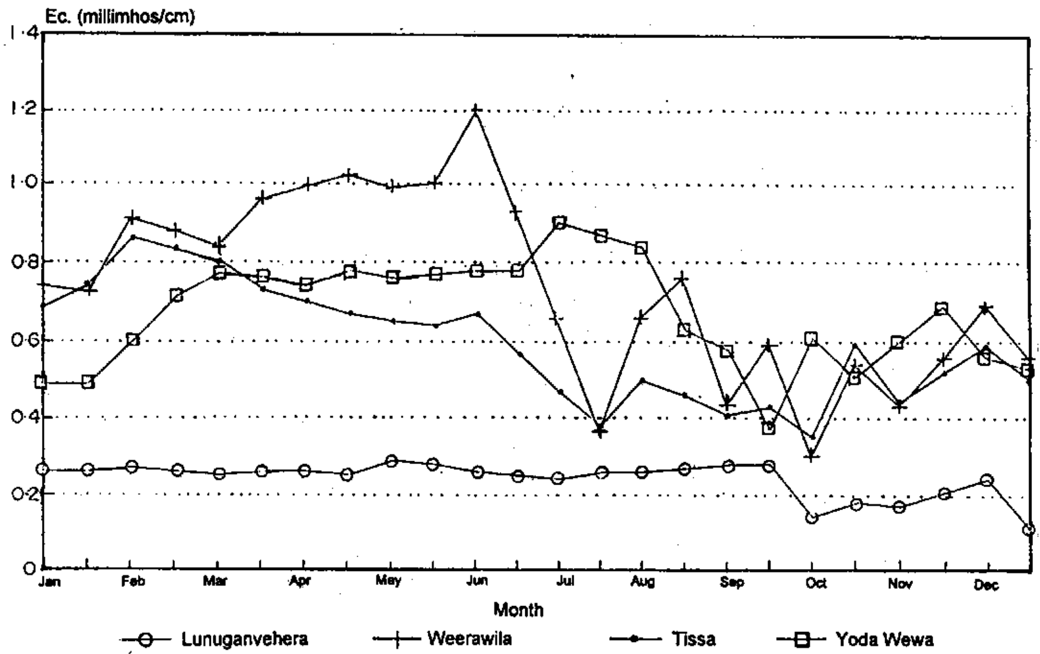


Figure 5. The EC of tank waters in KOISP area, 1992.

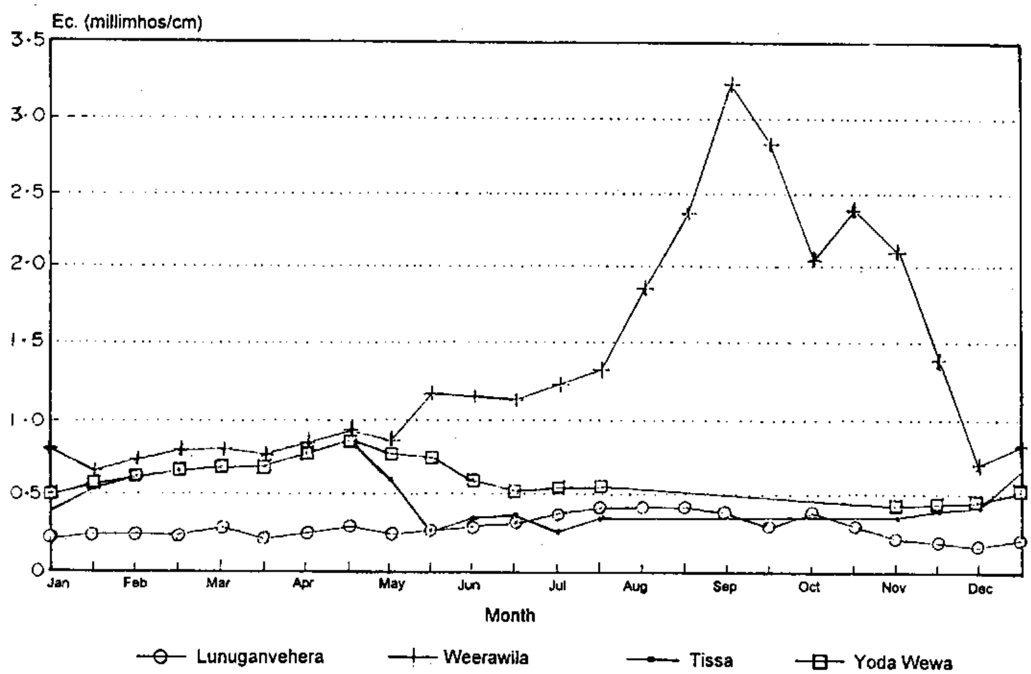
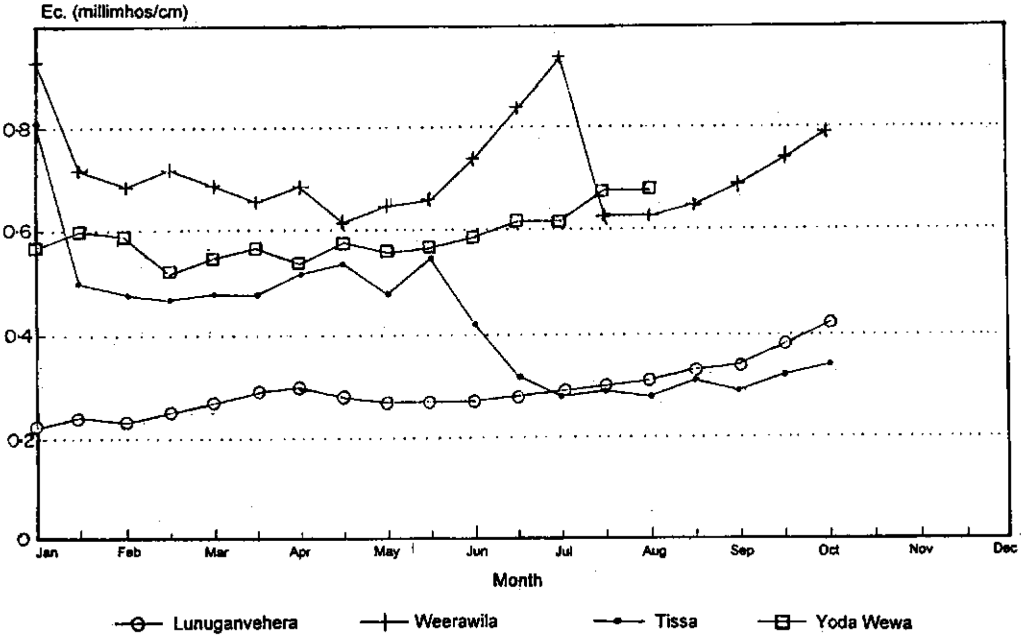


Figure 6. The EC of tank waters in KOISP area, 1993.



In the case of the Tissa Wewa and the Yoda Wewa, the EC values increased to 0.75 milli mhos per cm between March and June and between August and October while the EC values for the Wirawila Reservoir exceeded 0.75 milli mhos per cm between March and June. The major inflow of drainage water charged with soluble salts from the New Areas to these reservoirs takes place during these two periods.

During 1992, the EC values for the Wirawila Reservoir peaked between August and September due to the reservoir not receiving inflows from the Lunuganvehera Reservoir during this period. In 1993, trends were similar to 1991, with peak values for the Wirawila Reservoir recorded between June and July and between September and October, as shown in figure 6.

It can thus be observed that while the quality of water in the Lunuganvehera Reservoir can be classified as Class I, the quality of water in the reservoirs of the Old Ellegala Irrigation System fluctuates over a wide range during a season, depending not only on whether they have received considerable amounts of salt-enriched drainage water from the New Areas or not but on the amount of good quality water received from the Lunuganvehera Reservoir via the Ellegala Anicut.

Because of the inadequate landscape drainage in the Old Ellegala Irrigation System which has now to cope with added accretion of soluble salts coming from the drainage water of the new system, the Old Ellegala Irrigation System presently acts as a sink for salts coming from both the upstream New Areas and normal cyclic salts and other accretions.

Present indications are that a considerable amount of leaching of soluble salts is taking place from the New Areas. This rate of leaching may decrease with the passage of time through the continued leaching of salts, as happened in the adjacent Badagiriya System, provided drainage courses are kept in good working condition to flush out salts.

LOCATION OF SALINITY-AFFECTED AREAS IN THE OLD ELLEGALA IRRIGATION SYSTEM

The highest incidence of salinity was reported in November during the early stages of crop growth during the maha 1992/1993 season. In the affected locations, rice plants both transplanted and direct-sown suffered retarded growth and yellowing. Field examination of the affected locations indicated the following reasons for the stunted growth:

- The most severe stunting and yellowing of young rice plants were observed immediately below the upwelling locations of the major tanks where upward seepage of tank storage water takes place,
- A high degree of stunting and yellowing was observed in the poorly drained micro-depressions of the flat alluvial plain where there is net inflow of both groundwater and surface water, and
- Continuous but small extents of stunting and yellowing were observed adjacent to the major drainage courses where there was drainage congestion or drainage blocks at the tail end of the drainage system.

From these observations, it can be concluded that wherever there is upwelling or drainage congestion or impeded drainage and wherever upwelling or seepage water contains a high salt concentration, rice plants are stunted. But since upwelling, impeded drainage and drainage congestion have all existed in the Old Ellegala Irrigation System to some extent, what then caused the severe manifestation of salinity during the maha 1992/1993 season? The following section gives possible reasons.

EXCEPTIONAL INCREASE IN SALT CONCENTRATION DURING MAHA 1992/1993

A number of reasons can be adduced for the exceptional increase in salt concentration or salinity experienced during the early part of the 1992/1993 maha season. Based on quality data on tank water and measurements of soil-salinity levels at nine selected locations within the command areas of the Wirawila Reservoir, Tissa Wewa and the Yoda Wewa made at fortnightly intervals from June through December 1993, the following reasons could be suggested:

- Very little irrigation was done in the Old Ellegala Irrigation System during yala 1992 because of the exceptionally dry conditions experienced and the limited inflow into the Lunuganvehera Reservoir. There was no water in the Tissa Wewa, the Yoda Wewa, the Debara Wewa and the minor Pannegamuwa Reservoir from July to October.

  These conditions favored the capillary rise of groundwater in the flat alluvial plain resulting in the enrichment of surface soil with soluble salts. This was corroborated by regular monitoring of soil conductivity at the nine selected locations. Maximum values of electrical conductivity of the soil-saturated paste were recorded between 18 September and 30 October. The highest values of between 0.87 and 1.26 milli mhos per cm were recorded in the poorly drained locations under the Wirawila Reservoir and the Yoda Wewa. Lower values of between 0.23 and 0.35 were recorded for well-drained locations. There was a sharp decline in these values in November and December consequent to heavy rainfall during November.

- During early maha, irrigation issues from the Ellegala tanks were made exclusively from surface water runoff collected in these tanks at minimum operating levels and not with good quality water from the Lunuganvehera Reservoir. Therefore, needed dilution did not take place during the early phase of the season.

  The measured values of salinity of tank water during October and November indicate high values of electrical conductivity as seen in figure 5. Most of the water came from surface runoff originating in catchment areas rather than from drainage from the new areas. Thus it is apparent that dissolved salts from surface runoff also contribute to enrichment of salts in the Ellegala tanks.

- There was very little surface flushing of salts during the period up to the end of October as only a cumulative rainfall of 370 mm was received from January to the end of October [table 1(b)] as against a cumulative evaporation of nearly 2,000 mm during the same period. In November, there were 390 mm of rainfall and this high rainfall could have flushed out salts from the catchments and brought these into the tanks.

Thus all three circumstances, the absence of irrigation during the previous yala season, the non-mixing with high-quality water from the Lunuganvehera Reservoir because of the decision taken to commence maha irrigation with rainfall and runoff water, and the flushing of salts by the heavy November rains, could have all combined to contribute to increased salinity in the Old Ellegala Irrigation System.

Field inspections during November and December and interviews with farmers in the Tissa Wewa and the Yoda Wewa command areas revealed other reasons for the stunted rice plants in the salinity- affected locations. Most of the salinity-affected areas observed were located in poorly drained grey alluvial soils and less in imperfectly drained brown alluvial soils. However, stunted rice plants were mostly prevalent in locations where farmers had not applied basal phosphates irrespective of soil type, as shown in table 2.

It is well known that rice plants are adversely affected during the early stages of growth when phosphorus is deficient. This is most pronounced in poorly drained soils. In locations of drainage congestion, wherever farmers had applied the recommended dose of basal phosphatic fertilizer, healthy plant growth was observed.

Table 2. Effect of application of basal phosphate fertilizer.

	Soil drainage class	Applied fertilizer	Yield kg/ha
Tissa Wewa	Well drained	Basal	7000
		No Basal	4063
	Imperfectly drained	Basal	5650
		No Basal	4513
	Poorly drained	Basal	5547
		No Basal	3340
Yoda Wewa	Well drained	Basal	4427
		No Basal	3067
	Imperfectly drained	Basal	6930
		No Basal	3000
	Poorly drained	Basal	7067
		No Basal	1147

INFLUENCE OF LANDSCAPE HYDROLOGY AND DRAINAGE DENSITY ON THE OCCURRENCE AND DISTRIBUTION OF SALINITY IN THE OLD ELLEGALA IRRIGATION SYSTEM

A significant feature in the occurrence, severity and distribution of salinity in the Old Ellegala Irrigation System is the influence of the nature of the landscape hydrology and drainage density of the command areas.

Although the Wirawila Reservoir water records the highest level of salinity throughout the year, yet the occurrence, severity and distribution of salinity in its command area are significantly less than in the Tissa Wewa and the Yoda Wewa command areas even though these tank waters show a significantly lower level of salinity than in the Wirawila Reservoir.

This phenomenon can be explained by examining the nature of the landscape hydrology together with the drainage density of the respective command areas. The Wirawila command area is situated in a slightly uplifted and dissected alluvial plain which grades into the main Kirindi Oya in a convex-concave transverse profile with a gradient of 1.5 to 2.5 percent slope.

The morphology of this landscape determines the location of the main canal, distributaries, field channels and drainage ways. A high drainage density is self-evident in this type of landscape. This, together with its drainage basis relative to the bed level of the incised Kirindi Oya, permits a ready outflow of drainage water from the command area. Hence, its tolerance to the comparatively higher salinity levels of Class II water coming from Wirawila Reservoir is greater.

In contrast, the Tissa Wewa and the Yoda Wewa command areas are situated in a very flat alluvial plain with an average 0.5 percent slope. Natural drainage in this type of landscape is comparatively sluggish but it benefits from the incised nature of the main Kirindi Oya around its lower reaches where the bed level is around 5 meters below the land surface. On the other hand, as observed in irrigation and drainage system layout maps, irrigation drainage density in this area is very much lower than in the Wirawila command area. This explains the higher occurrence of salinity within these two systems as compared with the Wirawila Irrigation System.

Monitoring of the quality of the drainage waters at four basnawas located within the command areas of the Tissa Wewa and the Yoda Wewa commenced in May 1993 and its results are shown in Table 3. A clear trend of increasing salinity of drainage waters from the upper to the lower reaches of the command area was observed. The highest concentration of salts was recorded in the lowermost outfall near the sea, the Magama outfall which registered an EC of 1.78 milli mhos per cm by late August. The uppermost outfall at Yoda Ela registered an EC of 0.63 milli mhos per cm for the same period in August 1993. There was a decline in EC values after November because of maha rains and irrigation, except at the maha basnawa, as seen in table 3.

Table 3. The EC of drainage waters at the respective basnawas (in milli mhos/cm), 1993.

Date	Yoda Ela basnawa	Moda Ela basnawa	Maha basnawa	Magama basnawa
23 May	–	–	1.72	0.92
16 June	0.71	0.77	1.72	0.90
30 June	0.56	0.73	1.48	0.89
16 July	0.67	0.73	1.48	1.26
4 August	0.63	0.67	1.70	1.46
24 August	0.63	–	1.64	1.78
9 September	0.75	0.73	1.63	–
21 September	0.74	no flow	no flow	no flow
26 November	0.58	0.67	1.64	0.71
27 December	0.54	0.67	1.77	0.72

PROPOSED SOLUTIONS TO THE SALINITY PROBLEMS OF ELLEGALA

1. The quality of water used for irrigation during the critical crop growth period, namely seedling establishment and flowering should be between Class II and Class I categories. Arrangements should therefore be made to release a sufficient quantity of the Class I quality Lunuganvehera Reservoir water to the Old Ellegala tanks during these periods.

2. Although the main emphasis up to now has been to restrict the water supply to Old Ellegala based on the quantity of water, events that occurred during maha 1992–1993 suggest that water scheduling to Old Ellegala must take into consideration the quality of the water in addition to the quantity in order to overcome the incipient salinity problems.

3. An inexpensive water quality monitoring of the five reservoirs should be sustained with a view to releasing the required amount of Class I quality water from the Lunuganvehera Reservoir in order to effect the necessary dilution.

4. One should take cognisance of the differences in the landscape hydrology and drainage density between the Wirawila Irrigation System and the Tissa - Yoda Wewa systems in regulating the quality of tank waters. The Wirawila Irrigation System can tolerate waters of Class II quality, while the Tissa - Yoda Wewa systems should be kept within the Class I quality.

5. Although farmers' perception that the construction of the Lunuganvehera Reservoir has contributed to the increased salinity problems of Old Ellegala is correct to a certain extent, farmers should be advised that salinity can still become a problem even without receiving the drainage water from the New Irrigation System (NIS) as happened in the maha season of 1992–1993.

6. There are two major contributory factors to the salinity problems of Ellegala. The first is the increased salinity contribution of tank water which can, in the future, be

modified by sufficient dilution from the Lunuganvehera water by proper monitoring of water quality. The second is the drainage congestion in the Tissa and Yoda Wewa command areas and the poor drainage in micro-depressions and lower topographical locations which have poorly drained soils.

7. Early action should be taken to clear the drainage congestion and keep the drainage ways free from blockage and ensure that they are connected to the main arterial drains and eventually to the outfalls to the sea.

8. Farmers should be advised and trained on the provision and maintenance of the drainage facilities around their fields, and also in the use of adequate dressing of basal phosphate fertilizer in locations with poorly drained soils.

9. As mentioned earlier (para 3), it is extremely important that the fortnightly monitoring of water qualities of all reservoirs and the four basnawas be continued over the next five years. This would help keep track of the trends in salinity over this period and it would thus form the basis for the appropriate corrective actions that need to be taken.

10. Special note should be taken of the salinity levels of waters during extraordinary dry years such as 1992, so that the necessary levels of dilution in the Old Ellegala could be maintained at the critical threshold levels.

RELEVANCE OF KIRINDI OYA RESULTS TO NIRP SCHEMES

It should, at the outset, be borne in mind that the salinity problems encountered in the Old Ellegala Irrigation System are quite distinctive and arise from the very specific landscape hydrology conditions that exist within it. It is very unlikely that these would be replicated in the same total manner among the rest of the NIRP schemes, except similar schemes located within the DL5 agro-ecological region.

However, some components of the total complex are likely to be present in the drier northwest regions of the dry zone, namely in the DL3 and DL4 agro-eccological regions. Yet there is no similar situation where salts leached out from a new area enter into an old area. Salinity problems, at most, in other schemes will essentially arise from the quality of irrigation water.

Monitoring of the quality of irrigation water in the NIRP schemes should therefore be carried out on a regular basis, i.e., at least monthly, specially during the yala season. The determination of the electrical conductivity of irrigation water alone would be sufficient, and this is very cheap and inexpensive. As long as the quality of the irrigation water is between Class I and Class II, i.e., between 100 and 750 micro mhos/cm there will be no long-term hazard. But when it exceeds Class II level then the standard precautionary measures should be taken. Chief among these are a cleaning-up, the widening of the natural surface drainage network, and ensuring adequate provision for a ready outflow of the drainage water together with the dissolved salts in it. A minimum gradient in the main drainage outflow should also be ensured.

Efficient Use of Scarce Water by Crop Diversification

C.R. Panabokke[12]

BACKGROUND

RECOGNIZING THE OVERALL water-short character of the Kirindi Oya Irrigation and Settlement Project, the Ministry of Lands and Irrigation planned to allocate the limited inflow from the Lunuganvehera Reservoir for the cultivation—as far as possible—of Other Field Crops (OFCs) on well-drained lands in the New Irrigation System (NIS). The cultivation of rice was to be confined to the poorly drained soils in the NIS and to the alluvial soils of the Old Ellegala Irrigation System. Optimum utilization of the land and water resource base through the adoption of appropriate non-rice and rice cropping systems for the respective seasons was thereby envisaged.

Various scenarios were proposed by the Salzgitter Consultants (1987) based mainly on theoretical considerations of crop water requirement, irrigation efficiencies, delivery performance, seepage and percolation losses. Many of the parameters, especially seepage and percolation losses (S&P) and irrigation efficiencies, were grossly underestimated leading to underestimation of reservoir water releases. There was also no appreciation of the profitability of crops, market potential or availability of labor and it was soon realized that none of the scenarios proposed by the Consultants could be realized.

Initial attempts by the Department of Agriculture, the Irrigation Department, the Irrigation Management Division and the Land Commissioner's Department to introduce OFCs to farmers proved difficult. Farmers preferred to grow rice by the conventional method of puddling on both well-drained and poorly drained lands. The first demonstration conducted by the Department of Agriculture, the Irrigation Department and the Irrigation Management Division during maha 1988/89 showed the profitability of cultivating OFCs on both well-drained and imperfectly drained soils and was well received by the farmers.

Although crop diversification was addressed during the Phase I Study, only a limited number of issues which mainly focused on the economic performance of non-rice crops were researched. The close involvement of IIMI staff in the planning and guiding of the 1990 yala action plan and the maha 1990/91 action plan for promoting OFCs in Tracts 6 and 7 of the Right Bank provided meaningful answers to some of the issues raised and helped to diagnose relevant problems pertaining to irrigated agriculture in the project. During the Phase II Study, action research was undertaken to assist in implementing the Phase I recommendations and to address research issues not considered during the Phase I Study.

The experience gained during maha 1991/92 brought two new approaches: promoting non-rice crops during both seasons on appropriate soils in the command area of all tracts in the NIS by making maximum use of seasonal rainfall (with or without supplementary irrigation) and cultivation of non-rice crops with both residual soil moisture and limited rainfall during the yala season in the Old Ellegala Irrigation System.

12 Senior Associate, IIMI/Sri Lanka Field Operations. Colombo, Sri Lanka.

The scope of the study was expanded beyond that outlined in the Inception Report to include the following additional subactivities starting yala 1990:

1. Study the possibility of cultivating OFCs in the Old Ellegala Irrigation System during the yala season.
2. Study on growing OFCs in the New Irrigation System using water from dug-wells.

A COMPARATIVE ANALYSIS OF OFC CULTIVATION IN KIRINDI OYA

The following outputs were to be realized at the end of the Phase II Study:

a. The feasibility of growing only OFCs during both the maha and yala seasons in the NIS,

b. Harmonizing irrigation management inputs and crop production inputs would be better understood,

c. Improved strategies for proper water delivery at turnouts and methods of sharing water equitably below the turnout with respect to irrigated diversified cropping would be worked out,

d. Farmer incomes which could be derived from two acres of irrigated lands where only irrigated OFCs are grown would be ascertained, and

e. Recommendations would be made for cultivating irrigated OFCs.

Except for c, significant results were obtained in respect of the other four and conclusions can be drawn from the results reported earlier.

Feasibility of Growing OFCs during both Maha and Yala Seasons in the NIS

The seasonal planning procedure which is now well integrated into the main system management component ensures a rational allocation of the available seasonal supply to the three proposed zones: Zone 1 - Tracts 1 and 2 of the Right Bank, Zone 2 - Tracts 5, 6 and 7 of the Right Bank and Zone 3-Tracts 1 and 2 of the Left Bank. This zoning is based on probable inflow into the main reservoir and entails a certain proportion of the command area of the NIS (those areas which do not receive water for rice) cultivating OFCs during the maha season by maximizing the use of rainfall with supplementary irrigation whenever necessary.

Cultivation of OFCs during Maha Season. The extent of OFCs cultivated in the different tracts during the three maha seasons of 1991/92, 1992/93 and 1993/94 is given in table 1.

Taking into consideration the fact that prior to maha 1991/92, land in the command areas of all the tracts listed in table 1 had remained fallow during the maha season, the emerging trend of making use of rainfall and supplementary irrigation during the maha season can be considered a positive development.

Increase in OFC extent since the 1992/93 maha is mainly due to the introduction of the seasonal water allocation plan. However, much of the OFCs cultivated in LB Tracts 1 and 2 during the 1992/93 maha season was destroyed due to the early issue of water for rice. During the 1993/94 maha season, the farmers of LB Tracts 1 and 2 had to grow OFCs according to the seasonal water allocation plan. However, many farmers did not want to grow OFCs expecting water for rice cultivation as during the maha 1992/93 season.

Table 1. Extent of OFCs (in ha) cultivated in different tracts during maha 1991/92, maha 1992/93.

	Maha 1991/92	Maha 1992/93	Maha 1993/94
Right Bank			
Tract 1		90.5	6.4
Tract 2	1.4	0.2	
Tract 5		1.1	1.7
Tracts 6 and 7		55.5	4.5
Left Bank			
Tract 1		64.2	69.0
Tract 2	20.0	256.9	112.3
Tract 3	77.9	92.2	68.8
Total	142.0	561.8	262.9

Cultivation of OFCs during Yala Season. Extents of OFCs cultivated in corresponding tracts over yala 1990, 1991, 1992 and 1993 are given in table 2.

Unlike during the maha season, there is a severe constraint of irrigation supply during the dry yala season. The data in table 2 should therefore be viewed against the high variability in irrigation supply during yala seasons. Moreover, yala 1992 and 1993 faced severe water shortage making it impossible to plan cultivation of OFCs in any part of the NIS. The small extents of OFCs cultivated during the yala seasons were done with supplementary irrigation from dug-wells.

In the long term, cropping intensity in the NIS during maha, made up of both irrigated rice and rain-fed OFC cultivation with supplementary irrigation, could be 85 to 90 percent. This cropping intensity could be achieved through full cultivation of rice in tracts which receive irrigation during maha and the extents of well-drained soils in the remaining tracts which would receive the normal maha rainfall plus supplementary irrigation for OFCs.

Table 2. Extent of OFCs (in ha) cultivated during yala 1990, 1991, 1992 and 1993.

	Yala 1990	Yala 1991	Yala 1992	Yala 1993
Right Bank				
Tract 1	–	–	45.8	18.3
Tract 2	–	–	29.0	19.2
Tract 5	NA	–	2.4	6.1
Tract 6 and 7	NA	–	2.9	90.5
Left Bank				
Tract 1	NA	NA	17.5	33.6
Tract 2	NA	NA	20.6	34.8
Tract 3	–	–	1.2	14.4
Total	249.8	239.8	118.3	216.2

The cropping intensity during yala seasons would however be determined by the amount of water available. Whenever there is a significant supply available in the Lunuganvehera Reservoir by late January, the tendency has been for tracts which did not receive irrigation during maha to do a *meda* rice from late February to June. The present cropping patterns are expected to change with the introduction of the seasonal water allocation plan which would allocate 20 percent of yala inflow from the main reservoir to the NIS for a yala cultivation. This water is expected to provide supplementary irrigation for OFC cultivation. Supplementary irrigation and water from dug-wells should be sufficient to bring the cropping intensity to at least 25 percent. This could be further improved by bringing more lands under semipermanent crops, such as banana, which need few irrigations between June and August. Banana cultivation should however be limited to upper tracts like Tracts 1 and 2 of the Right Bank and Tracts 1 and 2 of the Left Bank.

Use of Rainfall. Figure 1 gives the monthly 75 percent rainfall probability based on 96 years of unbroken records for Tissamaharama. As the figure shows and as indicated in table 3, only the months of October, November and December have rainfall values nearer to evaporation values and in all other months, evaporation outstrips rainfall values, thus indicating the importance of irrigation for these months.

Figure 2 gives the 1:1 confidence limits of rainfall based on 3-weekly moving totals indicating weeks where we have a large range of confidence limits. As one could see, it is only in maha that a considerable amount of rainfall can be made use of for growing OFCs, while in yala we need to supplement rainfall with irrigation or else the soil must have sufficient residual soil-moisture left over from maha for making use of during yala in conjunction with the yala rainfall.

Apart from lack of water during yala, many farmers face problems protecting their OFCs from stray cattle. By bringing more farmers into yala cultivation, this problem could be limited to some extent. However, a permanent solution to the cattle problem is expected in the near future.

Figure 1. Monthly 75 percent rainfall probability (1872-1967), Tissamaharama.

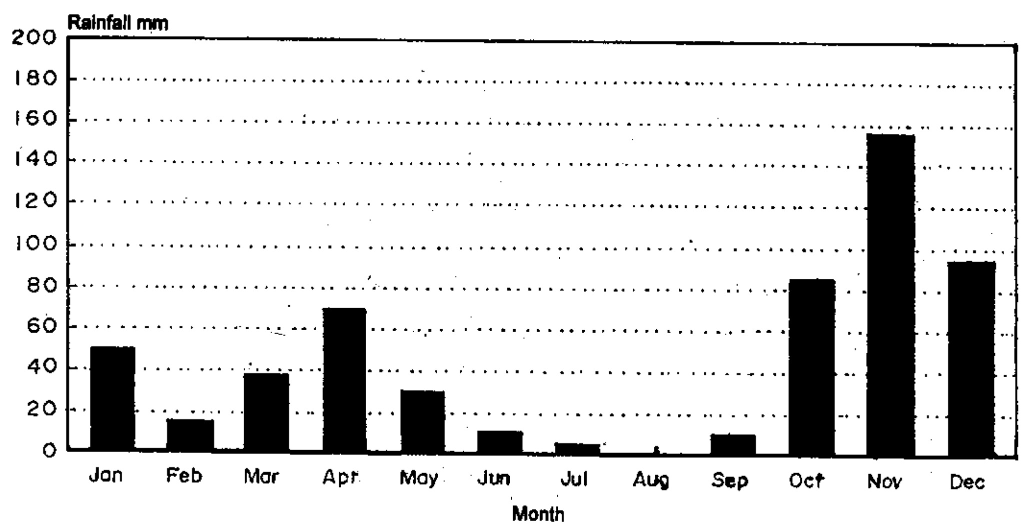


Figure 2. Confidence limits of rainfall, 3-weeks moving totals (1872-1967), Tissamaharama.

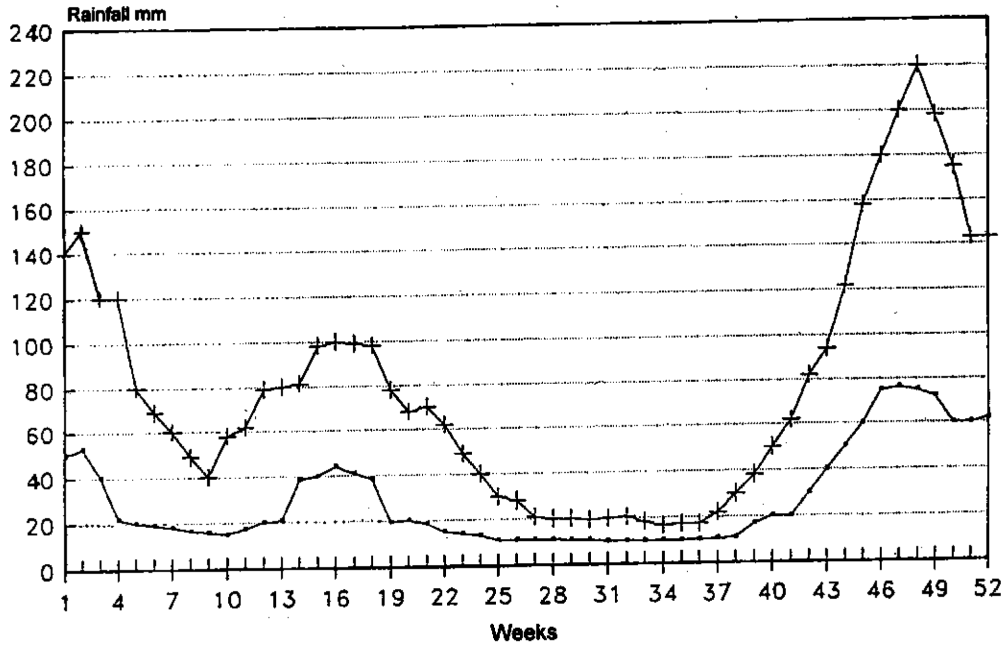


Table 3. Climatic data, Tissamaharama.

Month	Rainfall (1872-1987) mean monthly mm	75% probability mm	Evaporation (Penman) - 20 years average mm
January	101	51	132
February	36	15	157
March	75	38	171
April	93	69	153
March	61	31	165
June	23	10	185
July	15	5	201
August	12	0	215
September	34	10	210
October	141	84	167
November	223	155	121
December	154	94	120
Total	968	562	1997

Pilot Testing of OFCs in Tracts in the Left Bank

To maximize the use of the limited inflow, every attempt should be made to optimize the use of the seasonal rainfall. Bearing in mind the high variability in rainfall both during the season and between seasons, maximum use should be made of weekly probability values of past seasonal rainfall. This has been done with the weekly rainfall data for Tissamaharama available for the period 1872 to 1967.

Based on rainfall probability, it was proposed that cultivation of *low performance crops* like groundnut and green gram should commence with the onset of seasonal rains during the first and second weeks of October. To avoid moisture stress during the crop growth period, irrigation issues should be made during the latter weeks of December or early January, depending on rainfall. Commencement of cultivation of low performance crops after receiving 70 mm of cumulative rainfall is most appropriate. Most of the rainfall during November and December should be used for the crop growth period and only a few (two to three) irrigation supplies should be allocated. Only two irrigations were issued in November and December during maha 1991/92. No irrigation supply was made in November and December during maha 1992/93. Low performance crops can be raised without irrigations during November and December, but chili would need at least two irrigation supplies during November and December. Three to four irrigations should be made in January because rainfall during this month is negligible.

For *high performance crops,* it would be necessary to supply adequate irrigation during land preparation in early October in order to prepare proper quality seed beds. Further irrigations are needed beyond January and February for longer-duration crops like chili. Assured regular irrigation supply is necessary for better performance of high value crops to increase fertilizer application and for the use of improved high-yielding and short-duration varieties. However, irrigation supply could be limited to three irrigations in November and December since rainfall is high during this period. These crops need irrigation for a longer period compared to low performance crops. Irrigation supply should continue up to the end of March in the case of improved varieties of chili.

An innovation developed by farmers was extending the maha cropping season beyond the conventional date of termination. These innovative farmers made use of water issues in March to establish a second crop. These crops matured with residual soil moisture and rainfall received in April and May—150 mm during yala 1993. However, cultivation was limited to the middle and lower reaches of field channels.

Shallow dug-wells were used only to irrigate vegetables and onions. Most of the wells were located in the middle and lower reaches of field channels. Further studies should be made to examine the availability of groundwater in order to expand dug-wells into other areas. Also, this innovation should be further improved by supplying a few irrigations during dry periods of the yala season and cultivation should be expanded into the upper section of field channels as well.

It has been clearly demonstrated that cultivation of OFCs during the maha season should be confined to well-drained soils. Crops such as soybean and groundnut can be grown on imperfectly drained soils if proper surface drainage is provided. It has also been demonstrated that crop establishment should be completed well in advance of the November rainfall.

Although it was not possible to confirm through studies on economic returns, the present practice of raised-bed cultivation for chili and onions and of row seeding for groundnut and green gram on graded terraces is recommended. Further studies should be done to establish the economic advantage of furrowed basins.

The economic analysis of OFC cultivation in Tract 3 of the Left Bank during maha 1991/92 and maha 1992/93 shows that economic performance of both low performance and high performance crops was low due to low yields. Yields from OFCs obtained during the two seasons were far below potential yields. Among the low performance crops, groundnut performed well during both maha seasons. Compared to green gram, it gave a much higher return with lower risk. Since there is no market, soybean is not recommended. High performance crops like chili need higher input application, crop care and regular irrigation to obtain a higher yield and give a much higher return compared to rice. Low performance crops give a little higher or similar returns as rice and need less inputs.

Crop combinations depend on the farmers' resource base. However, irrigation supply should be planned to include 25 percent high performance crops like chili which will increase total farmer incomes.

One of the constraints for OFC cultivation during the maha seasons is the soil factor. Farmers who have farm lots in the lower reaches of field channels face a higher risk in growing OFCs due to drainage problems. Cultivation of high performance crops is not possible without construction of drainage canals and farm drainage. This would increase the cost of cultivation and hence reduce incomes. One other disadvantage is the limited number of crops which can be cultivated on these lands.

OFC Cultivation in the Old Ellegala Irrigation System by Using Residual Soil Moisture and Yala Rainfall

Although farmers in the Old Ellegala Irrigation System claim 100 percent rice cultivation during maha and 100 percent in yala, past cropping intensity data show 100 percent cropping intensity during maha for rice and only 40 percent cropping intensity for rice during yala. Wirawila has a large storage capacity and a larger catchment compared to Tissa Wewa and Yoda Wewa. Therefore, cropping intensity in the Wirawila command area is higher during yala compared to the other tanks.

The overall strategy should be to give the same amount of water to the Old Ellegala Irrigation System as in the past to irrigate 100 percent rice during maha and a certain proportion during yala. Experience in Pihille Yaya during yala 1992 and in other Ellegala areas during yala 1993 shows the possibility of OFC cultivation on brown alluvial soils during the yala season. The major crops cultivated during these seasons were green gram and groundnut which can do with minimum land preparation and other inputs. However, the time of planting is most important in obtaining higher yields from green gram. The performance of green gram in Pihille Yaya during both yala seasons was better than in the command area of other tanks since farmers established the crop before the end of April and the crop was not affected by the yellow mosaic virus. Also, the Pihille Yaya is located where no seepage water affects crops. Therefore, advance yala seasonal planning is essential to identify areas with brown alluvial soils and to set dates for commencement of the season.

However, if the proposed seasonal water allocation plan is implemented, the Old Ellegala Irrigation System would receive 80 percent of the yala inflow from the main reservoir. The total allocation would be divided among to the five tanks based on the command area. This water should be sufficient for rice cultivation in 60 percent of the total command. With cultivation of OFCs in 20 percent of the balance extent, a total of 80 percent cropping intensity could be obtained during yala.

However, other institutional arrangements should be made to settle land tenure arrangements for OFC cultivation and to make landowners agree to the crop diversification program during yala. Other kinds of major institutional support necessary to promote OFC are agricultural extension and marketing services.

LESSONS LEARNED

1. To maximize the use of limited inflow to the Lunuganvehera Reservoir, seasonal rainfall had to be effectively utilized in raising OFCs. Because of the high variability in rainfall both during the season and between seasons, weekly probability values of past seasonal rainfall based on long-term records were made use of in planning and implementing the OFC Program in the pilot project area.

2. Based on economic returns, crops other than rice grown in the Kirindi Oya System can be grouped into high performance crops and low performance crops. Chili and big onion come under high performance crops while green gram, cowpea, vegetables, soybean and groundnut come under low performance crops.

   Cultivation of low value crops like groundnut and green gram should commence with the onset of seasonal rains during the first and second weeks of October. Commencement of cultivation of low value crops after receiving 70 mm of cumulative rainfall is found to be appropriate. To avoid moisture stress during the crop growth period, irrigation issues should be made during the latter weeks of December or early January, depending on rainfall. Only two irrigations were issued in November and December during maha 1991/92. No irrigation supply was made in November and December during maha 1992/93.

3. For high value crops, at least 2 irrigations are necessary during land preparation in early October in order to prepare proper quality seed beds and establish crops. Assured regular irrigation supply is necessary during crop growth period for better performance of high value crops to increase fertilizer application and the use of improved high-yielding and shorter-duration varieties. However, irrigation supply could be limited to 3 irrigations in November and December since rainfall is high during this period. Further irrigations are needed beyond December and upto March for crops like chili. It is found that a minimum of 10 waterings should be planned for chili, 2 during crop establishment, 3 during the rainfall period of November and December and 5 waterings beyond December.

4. The present practice of raised-bed cultivation for chili and onions and of row seeding for groundnut and green gram with graded terraces is found suitable.

5. A water-sharing practice of 1 cusec by two farmers at a time is found to be appropriate and is adopted by the farmers. However, allotting a fixed and uniform time for each of the farmers under a turnout did not work due to soil type and geographical location of the plot in the turnout.

6. There is a high variation in the economic performance of OFCs within seasons and between seasons. In-seasonal variations are mainly due to variations in soil and drainage conditions while seasonal yield variation is mainly due to variations in weather conditions and occurrence of diseases. Also, poor crop management practices and inadequate land preparation methods, and low application of fertilizer, particularly for chili, resulted in low yield performance.

7. During the maha season, chili and green gram performed well on well-drained soils. Farmer incomes from chili and green gram cultivated on well-drained soils gave a 50 percent higher return than when these crops were cultivated on imperfectly drained soils. Soybean performed better on imperfectly drained soils. Other Field Crops planted on poorly drained soils were completely destroyed by excess seepage, drainage water and rainfall.

8. Among the crops tested, chili gave the highest average gross value added and average farmer income. All other crops tested gave an average income similar to that of rice. In the case of chili, the input cost in terms of labor, fertilizer and chemicals ranges 2 to 3 times that for other OFCs. Capital required for green gram and groundnut was comparable with that for rice.

9. Extending the maha cultivation into the yala season is a new innovation introduced by the farmers of Tract 3. Most of these innovations took place in the middle reaches of FCs where groundwater is available closer to the surface. Crops were established with rain received during March and/or with one or two waterings received for the maha crop. These crops effectively utilized the rainfall received during March and April for crop growth. Water from dug-wells was used only to water vegetables like onion and bean. Although the area cultivated is small under this innovation, it demonstrates the potential for farmers to earn additional income by extending the maha cultivation into yala.

10. In the Old Ellegala Irrigation System, the study demonstrated that OFCs can be grown in the brown alluvial soils utilizing residual moisture left over from the maha season coupled with April and May yala rains. The crops grown are: green gram, cowpea, groundnut and vegetables. In order to get better yields and be free from pest attacks and diseases, cultivation, especially that of green gram, should start early, preferably in April.

11. The on-farm distribution system in EIS is not conducive to better flow controls. In many turnouts, irrigation is from field to field and several fields utilize water from drainage canals for raising the rice crop. Under these conditions, raising high profitable crops such as chili, onion, etc., is risky and farmers are not willing to venture raising these crops.

12. Cultivation of OFCs in the newly developed area is possible using dug-wells. However, yala cultivation can be carried out only in those places where groundwater is available in sufficient quantity for a considerable length of time such as riverine alluvial deposits, valley axes and areas adjoining main irrigation canals. Since the groundwater table improves during maha, especially in areas adjoining main canals, farmers in the newly developed area who do not cultivate rice could cultivate OFCs using dug-wells.

13. In the NIS, during a wet maha, farmers prefer to grow rice with very little area used for OFCs. On the other hand, in a dry maha, farmers make use of rainfall and supplementary irrigation to grow OFCs. This is a positive development. In maha 1992/93, 562 ha of OFCs were grown with rainfall and irrigation. This area can be increased to about 1,000 ha.

14. During yala, the NIS farmers are reluctant to grow OFCs due to high variability in irrigation supply. The seasonal allocation planning procedure which is now well integrated into the main system management component ensures a rational allocation of the available seasonal supply to the NIS. With this assured canal supply in conjunction with rainfall and dug-well supplies, it would be possible to increase the OFC cultivation from 250 ha, now being cultivated, to about 1,000 ha. This area could be further improved by bringing more lands especially from Tracts 1 and 2 of RB and LB under semipermanent crops, such as banana, which need few irrigations between June and August.

15. The results of diversification of crops in Kirindi Oya show that even with poor yields, farmers can earn a profitable income from OFCs, if they can avoid problems such as late cultivation and stray cattle menace and can acquire sufficient knowledge on how to cultivate OFCs on irrigated lands. The two major economic constraints observed in this system were fluctuations in output price and yield variation within and between seasons.

CONCLUSION AND RECOMMENDATIONS

Kirindi Oya System comprised three distinct environmental situations:

1. Newly developed command area of KOISP, namely LB Tracts 1 and 2 and RB Tracts 1, 2, 5, 6 and 7 made up of lands with undulating relief and residual soils occurring in a drainage topo-sequence
2. Old command area of the Ellegala Subsystem located in a flat alluvial plain with an incised drainage and mainly alluvial soils
3. Pilot research site in LB Tract 3, made up of gently undulating relief and residual soils

Recommendations for NIS

1. In a wet maha season, a 100 percent cropping intensity of rice can be achieved. In a dry maha season 85 to 90 percent of cropping intensity could be achieved through cultivation of OFCs in the third zone which would not receive water for rice cultivation. OFCs should be confined only to the well-drained area. Groundnut and soybean can be grown on imperfectly drained soils with a high level of drainage facilities.
2. It is recommended that only low performance crops such as groundnut, green gram, cowpea and vegetables should be grown. Cultivation of recommended crops should commence with the onset of seasonal rainfall during the first and second weeks of October. Two or three irrigations are recommended for the period from December to January. Other short-term OFCs such as vegetables and pulses could be grown with water from shallow wells only where groundwater could be tapped.
3. Measures should be taken to protect the crop from stray cattle and wild elephants.
4. Provision of irrigation for raising OFCs during the yala season is not possible now. However, with 20 percent of yala inflow allocated to NIS it would be possible to grow low value OFCs to the extent of 25 percent of the new area. This can be achieved by effective and integrated use of canal water with rainfall and well water.

Recommendations for the Old Ellegala Irrigation System

1. OFC cultivation is possible on brown alluvial soils during the yala season. This constitutes about 20 percent of the Old Ellegala Irrigation System area.

2. Time of planting is most important to obtain a higher yield and to utilize residual soil moisture and yala rainfall. It is recommended that the crops should be established before the end of April.

3. Only low performance crops such as green gram, groundnut, cowpea and vegetables are recommended for the Old Ellegala Irrigation System, in view of inadequate flow control at the on-farm level.

LESSONS FOR THE NATIONAL IRRIGATION REHABILITATION PROJECT

Although the Kirindi Oya Project is located wholly within the DL5 agro-ecological region, some lessons with suitable adaptation could be applied effectively to the NIRP schemes. These could be listed as follows:

1. Because of the high variability in rainfall both within and between seasons in the DL1 agro-ecological region within which most NIRP projects are located, weekly probability values (75 percent probability) of past rainfall records should be estimated with a view to fixing the cropping seasons, maha and yala, with more precision and reliability.

2. Promote the use of shallow open dug-wells to tap the seasonal water table within the comma area, for use of lift irrigation for short-duration high-productivity crops such as onion and vegetables.

3. Establish the chili crop on well-drained land during the latter part of the maha season after the heavy rains are over, and close to locations where water from shallow dug-wells will be available up to the end of May.

4. Recognize the difference between high-performance OFCs such as chili and onion, versus the low-performance OFC crops such as green gram, groundnut and soybean based on economic returns, and also the need for higher irrigation frequency intervals for the high performance OFC crops.

Comments on the Development of the Seasonal Plan

C.M. Wijayaratna[13]

I THINK IT is too early to make concluding remarks as we have another session. However, I would like to summarize the proceedings of the morning session and make some comments. At the beginning of the session, Dr. Sakthivadivel discussed the need for understanding the system, especially the hydrological characteristics, water balance and socioeconomic aspects including farmer organizations, when this kind of Participatory Action Research is started. He started with the diagnostic phase and elaborated on how the Irrigation Department (ID), the Department of Agriculture, the Irrigation Management Division (IMD), the Land Commissioner's Department, and all the other actors with farmers as a team analyzed and began to understand system characteristics. They have identified the factors that can be expected during inter- and intra-seasonal periods under different probability levels of inflow.

Seasonal planning means not only the hydrological characteristics or hydrology but also matching the hydrological aspects or water availability with the crop scheduling, most importantly arranging for various mechanisms including institutional aspects to achieve the planned objectives. This is also included in the planning business. It is, therefore, a challenge to match different supply conditions and to manipulate the demand. This is one of the major lessons learned from the Kirindi Oya experience: how a multidisciplinary group can be put together including farmers to manipulate/change/ adjust the demand to match with the supply characteristics which at times are beyond control. Dr.Sakthivadivel and Mr. Karunasena dealt with cumulative inflows, storage, the need for maintaining storage of various tanks at minimum operating level, and also the analysis of evaporation and other factors in order to get a better understanding of the balance storage at various tanks of the system.

Mr. Karunasena in his presentation stressed the need for organizational rearrangement; the need for various committees and participation of various actors in these committees like the Study Advisory Committee and the Study Coordinating Committee. He warned that research should not be for the sake of research and it should be for development and should go as a collaborative effort. This has been demonstrated especially in Phase II. It must be accepted that not only Phase I but even pre-phase activities by the ID and others had helped a great deal in this regard.

As for the impact of research, the following were mentioned as "reasons for success:"

- the openness in the environment within which the team worked
- the interdisciplinary nature of the team, and the proper orientation and cooperation the team received
- the transparency and credibility of the events

For this type of work the need for Participatory Action Research has been emphasized for improving performance. Research must aim at specific targets as in the case of Kirindi Oya. This kind of work is more appropriate for an environment of a turbulent nature.

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13 Head, IIMI/SLFO and Chairperson of the Session. Colombo, Sri Lanka.

Dr. Jeff Brewer in his presentation, stressed the need for public acceptance of the plan. Also, the project management committee system was helpful, because earlier the old system was separated from the new system in project management. But under the unified system it was made easier to test this kind of approach. The approach was in accordance with the participatory management policy of the government, being implemented by INMAS, MANIS and even Mahaweli and the farmers were involved in the decision-making process. Also, the importance of the aspects such as details of rules, water rights and priorities, especially between old and new systems which were not clarified at the beginning but clarified during the process was stressed. A very important aspect, that is, political interference was mentioned. How the system could avoid or minimize the political interferences was discussed. However, of late it has been found that even at this stage, there are political interferences. As for the achievements, Dr.Sakthivadivel's paper clearly provided the evidence: the way the relative water supply has been increasing; duty for the seasons during the test and after the test; area irrigated and implementing water use efficiencies in the whole system. As for the principal lessons learnt, understanding the system behavior; introduction of new knowledge and tools which are relevant to the environment and integrated and coördinated efforts were mentioned.

Dr. C.R. Panabokke clearly mentioned that water cannot be saved just by introducing OFCs, unless the delivery system is properly managed. Introduction of OFCs should not be taken simply as a solution to water-short systems. At this point, I may add that water can be saved only by changing irrigation intervals and duration of irrigation and by modifying the use during land preparation without changing the crops. Practically any crop consumes the same amount of water per day. The more important factors in selecting crops and designing schedules are duration and interval of irrigation. It is proposed that in the future instead of thinking of highly diversified cropping patterns based on small farms, specialization be emphasized. It is important to note that no country in the developed world has succeeded on irrigated agriculture just by diversification within small farms. There is a need for specialization at least at turnout level if not at distributary command level. The IRMU can test these options. Dr. Panabokke distinguished between less labor-intensive, less capital-intensive, less-risk crops versus high- risk crops. The Mahaweli OFC cultivation was distinguished from the crop diversification in a water-short system like Kirindi Oya. The need for a continuous cropping sequence (starting from September/October going upto June) where two crops can be cultivated and change in the traditional recommendations were mentioned. The labor productivity and water productivity, not necessarily the land productivity in certain circumstances, have to be considered. Dr. Panabokke and the team have demonstrated that salinity problems can be managed by mixing different classes of water and applying correct fertilizer at correct times.

Finally, the major lessons learnt from this research are the need for combining technology/technical solutions with management solutions. As for the technical solutions, as the Director of Irrigation pointed out, it is not only irrigation structures that are important but also management technology for managing irrigation and different allocation patterns. New technologies in allocation and distribution were tested. And this was combined with organizational and institutional changes viz. changes in organizational structures, changes in institutional structures as well as changes in the management of systems jointly by farmers and various actors including the Irrigation Department, the Irrigation Management Division, the Department of Agriculture and the Land Commissioner's Department. The second point is the need for team work and the need for committees aimed at specific targets. In many other systems, if not in all systems, there is an urgent need for the Irrigation Department to join with the Department of Agriculture, the Irrigation Management Division and others to form subcommittees and work together to achieve targets.

One more point is to be stressed here. In Kirindi Oya, the team has taken risks to some degree. There were some failures. It is, however, very important not to be pessimistic. To go for new management approaches one should be prepared to face some challenges. Finally, I thank all of you for attending the workshop.

Next >>

Kirindi Oya Experience in Main System Management

U.S. Wijesekera[14]

INTRODUCTION

THE KIRINDI OYA Right Bank Main Canal is a 22-mile long canal starting from the right bank sluice of the Lunuganvehera Reservoir and ending at the Badagiriya Tank. It has 19 gated cross regulators and 42 takeoff canals. The canal carries a discharge of 350 cusecs and the capacities of takeoff canals vary from 1 cusec to 50 cusecs. The last regulator and takeoff point is about 17 miles away from the sluice. And after that the canal flows to a small intermediate tank called Karambagaswewa which has a storage capacity of 60 ac-ft. Beyond Karambagaswewa, the canal continues as a feeder canal to augment the Badagiriya Tank and its main canal whenever necessary. The direct command area under the RB Main Canal is about 8,400 acres (excluding the Badagiriya Scheme which has a command area of 2,100 acres).

The command area has been divided into 4 tracts with an approximate area of 2,000 acres each and each of them is managed by a Technical Assistant (TA) with the help of a Work Supervisor (WS). There are 17 Gate Operators in these 4 tracts and their services are extended up to the head of the field channel (FC). There are 4 unit offices located approximately at the middle of each tract and a WS is stationed in each unit office.

All the main canal offtakes are gated with galvanized cast iron gates and metric gauges are fixed at upstream and downstream of each offtake turnout. All the cross regulators are fitted with wooden lifting gates and a check wall is constructed to maintain the normal water level of the main canal. Also metric gauges have been fixed to read the upstream and downstream water levels.

The management of the whole RB irrigation system is under the responsibility of the Resident Engineer (Right Bank) whose office is centrally located along the RBMC. The head sluice operations are executed as per the instructions of the Chief Resident Engineer (CRE) who is the superintendent manager of the entire irrigation system of the Kirindi Oya Project. Another engineer is stationed at the headworks for all the headwork operations and he carries out instructions of the CRE.

MANAGEMENT OF THE MAIN CANAL SYSTEM

The responsibility of the main canal management is to ensure target discharges at each offtake and control station, taking into consideration water requirement based on the cropped area, crop growth stage and climatic conditions.

This involves the management of appropriate water levels in the ponds between the gated cross regulators by setting the Gated Regulator (GR) gates and controlling of offtake gate settings in order to deliver the target discharges.

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14 Resident Engineer (RB), Kirindi Oya Irrigation and Settlement Project. Sri Lanka.

Pond water levels at GRs are maintained by trial and error. Adjustments in the GR gate settings are done until the main canal reaches the check wall level. In this process the excess water is released to the downstream section of the canal. Once the main canal water level is maintained up to the check wall, the offtake gates are operated to deliver the target discharge. Calibration curves for the Broad Crested Weirs (BCW), are used to ascertain the quantity of water released. These structures are equipped with metric gauges. Since the offtake discharges are directly proportional to upstream water levels, variations in the discharge to the offtake influence the water level in the canal and vice versa. Therefore, quite a number of gate settings need to be carried out to achieve the desired water conditions and this process demands a fair amount of time and energy.

When the main canal discharge varies frequently the operators have to try out different gate settings to balance the canal with appropriate water levels. In performing this task, if these operators set the gate settings in an ad-hoc manner then it creates more variations in the downstream resulting in wastage of water in some places and also water shortage elsewhere. This implies that solving a problem in one tract or turnout area will certainly create problems in other tracts. Therefore, the whole main canal has to be taken as one hydrological unit in canal operation. Hence, this task needs comprehensive analysis of the whole system using computerized simulation.

MAJOR PROBLEMS IN MAIN SYSTEM MANAGEMENT

The following are the major management problems related to operation of a main canal system (assuming the manager knows the physical system properly).

1. Difficulty in determining the present gate settings at each gated structure along the main canal.
2. Difficulty in determining the present water levels at each control point of the main canal and also at the head of the offtake canal.
3. Difficulty in sending timely operational instructions to the operators.
4. Difficulty in assessment of the magnitude and the time variations of water levels due to gate operations. This problem may arise even after solving problems 1, 2 and 3.
5. Even after settling all the above, there is the difficulty in proposing a new set of gate settings for each structure with the time of operation in order to maintain the main canal water levels up to a satisfactory level with a minimum number of operations.

The first three problems can be solved by introducing a systematic data collection, transmission and feedback system. The 4th problem can only be resolved by using a properly calibrated simulation model. The issues related to the last problem can only be managed by improving the same model to accommodate different operational scenarios within a manageable time period which can be afforded by the system manager. It was experienced that even without solving the last two problems, the management could be significantly improved by providing possible solutions to the first three problems.

An assessment of the current situation of the canal at any particular time may be achieved by improving the mobility of operators and by introducing an electronic communication network between the manager and the operational staff. This may be very costly due to its capital and maintenance costs. However, a simple method of collection of data and hand-delivery to the manager on the same day, provides him a better opportunity to obtain a holistic view of the canal which facilitates the managers in suggesting an engineering solution rather than resorting to complicated ad-hoc operations in isolation.

DATA COLLECTION, TRANSMISSION AND FEEDBACK

Design and implementation of the data collection network were done jointly by IIMI and the ID. IIMI provided the facilities such as necessary tools and equipment, training of personnel, formulation of data collection forms, provision of incentives for data transmission, provision of continuous coordination and motivation of field staff, etc. But the whole program was implemented completely through the ID staff as an integral part of their job. This was a very important decision which helped in natural internalization. Hence, the withdrawal strategies were not required separately because it is an in-built item in the main work plan.

1. Simple but comprehensive data collection forms were developed for gate operators and Work Supervisors.

   Each gate operator has been given a booklet of forms to collect and record data in the field, twice a day, at each gate under his responsibility (upstream and downstream water levels and spindle height). He has to report the water levels and spindle heights of the canals under his jurisdiction to the Work Supervisor who prepares a summary of water levels and gate settings in a message form to be delivered to the manager. This message form which includes data on the evening positions and the following morning positions is hand-delivered to the manager through a messenger everyday before noon.

   Regular training was given to the operators to read the gauges, and to record the data properly.

2. An incentive of Rs.1,000 per month was paid to the Work Supervisor of the tract for recording and transmission of data to the RE's office through a messenger. The same messenger was used to send back the operational instructions back to the field.

   This incentive played a major role in motivating the transmission of the messages in time. In future, the provision of some type of similar or other incentives will have to be continued.

3. Display boards were provided at each unit office and also at the RE's office. The unit office display board can display the last seven days' downstream water levels of each turnout of the tract with the target levels. The display board in the RE's office can display the last eight days' discharges at each offtake along the main canal with the target discharges.

4. A file is maintained to keep the records of daily (twice a day) water levels at each offtake and GR with a comparison of the target water levels. The water delivery duty at the sluice as well as at the tract level is monitored continuously.

MAJOR BENEFITS OF THE DATA COLLECTION NETWORK

There are many direct and indirect benefits that could be derived from the main system management program implemented.

1. Satisfactory low cost solutions have been provided to the first two problems. The manager of the system can visualize the water levels of the main canal, the offtakes and the gate settings of all the gated regulators. This is of great help to the manager to assess the performance of his canal management and it helps identify the trouble areas which require more attention. This approach facilitates better decision making by analyzing the situation in a holistic manner which results in a reasonable equity. If there is a shortage of water in one section, a better judgement may be made to extract water from another section which has drawn a sufficient or a greater quantity of water during the same week.

2. Since the members of the field staff are more aware of the operations and their scientific approach the performance of the operations has become more efficient and effective. This is because of the predetermined operation strategies rather than because of resorting to ad hoc operations. Since there is a daily monitoring program they also try to improve their operations by making accurate readings and operating the system in order to minimize canal fluctuations. A mere recording of imaginary values is not possible due to mismatching with the information at other adjacent structures.

3. Since there is a proper maintenance of past records, field personnel can handle similar situations confidently with less effort and this will create more interest towards their work. If there is any illegal operation by an outsider, such changes could be quickly detected and remedied. These past records could help the new staff to start work with minimal delays and wastage of resources, especially when there is a change of work site or a new placement in the field staff.

4. The third problem also could be solved to some extent by sending the operational instructions or feedback to the field at least once a day.

5. Members of the operational staff are sensitive to both upstream and downstream water conditions which have created an inert tract coordination. Members of the upstream staff have become more sensitive to downstream water conditions and therefore they act in a more responsible manner even though the water condition does not affect their area of responsibility. This has improved the working relationship among the members of the operational staff.

RECOMMENDATIONS

1. Collection of flow data twice a day, transmission of data to the manager's office, provision of necessary tools to process and keeping a long-term database are very useful in main system management. These have to be continued.

2. Payment of an allowance to the Work Supervisors of tracts to cover the cost of traveling for data transmission is highly recommended.

3. To study 6 operational scenarios where the tertiaries as well as the main system can be operated. This can be done by scrutinizing the past records of operations under steady or near-steady condition, for the following conditions:

1.	Very high flow condition:	Peak land preparation issue period with dry soil conditions.
2.	High flow condition:	Peak land preparation issue period with average conditions.
3.	Normal flow condition:	Average irrigation issue period with dry soil conditions.
4.	Low flow condition:	Irrigation issue period with a slight rainfall.
5.	Very low flow condition:	Irrigation issue period with rainfall.
6.	No flow condition:	Tertiary system is closed.

Testing of canal steadiness and recording the spindle heights of all the gates on the days when the canal is operated under the above conditions have to be studied from this season onwards.

Maintenance Management under Resource-Deficit Conditions

H.A. Karunasena[15]

INTRODUCTION

MAINTENANCE IS THE management response to the deterioration of the physical condition of an irrigation system that threatens to make it impossible to achieve operational targets. Maintenance is also the process of keeping the irrigation, drainage and other infrastructural facilities in good repair and working order, enabling managers to meet system objectives (Pereira and McCready 1987). It is also stated that the intention of maintenance is the upkeep of physical facilities with the goals of efficient operations, minimum breakdown and good appearance. Despite these definitions, however, there is frequently no direct relationship between maintenance and operations: sometimes different staff and different budgets are involved, and maintenance inputs are often uncoordinated with operational goals.

In many industrial engineering enterprises, maintenance programs have been developed that support operation of the enterprise in a cost-effective manner. There is little evidence, however, that in irrigation systems, maintenance programs have been evaluated in terms of their impact on irrigation system performance, or that the cost-effectiveness of the procedures has been evaluated. A recent study of maintenance management on five major Sri Lankan irrigation schemes demonstrates that (a) funding levels are inadequate to achieve technically and socially desirable maintenance levels, and more important (b) the present system for maintenance management does not use existing resources effectively, and is not performance-oriented (TEAMS 1991).

One of the primary factors that will determine the success or failure of an operational plan is the physical condition of the conveyance infrastructure. Operational targets are based on assumptions about hydraulic conditions such as slope, roughness and cross section, all of which affect the velocity of water in the canals and therefore head-discharge relationships. Adverse changes in the physical condition of the canal will eventually make it impossible to achieve operational targets.

For maintenance to be effective, there has to be a good system of monitoring, evaluation and feedback on key parameters of system performance that identify when and where maintenance inputs are required. Typical parameters are likely to include conveyance losses, time taken to reestablish correct water levels following closure, and flow velocity. As a pilot exercise the research work on maintenance in Phase II will focus on the Wirawila Tank System in Tissamaharama Division because the canal design and conditions are more typical of those in Sri Lanka than the newer designs incorporated into the Right Bank Main Canal of KOISP.

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15 Chief Resident Engineer, Kirindi Oya Irrigation and Settlement Project. Sri Lanka.

OBJECTIVES

Initially, the overall objectives of the research component have been identified that help to more closely link maintenance inputs to operational targets:

- identification of an acceptable level of physical conditions of the canal system and control infrastructure that permit implementation of operational plans
- improved system performance through more effective water-delivery-oriented maintenance procedures

In addition to the above objectives, during the progress of work, more emphasis was given to the development of a strategy to overcome the resource deficits in maintenance investments through financial management, physical work management and farmer participation. The reorientation was made within the original objectives because of the vital importance of the issues related to management of maintenance funds and implementation strategies at the field level.

INTERVENTION ACTIVITIES

1. Assess whether current procedures for maintenance require modification to maintain or improve the level of performance of the canal system, and where required, make recommendations as to alternative maintenance procedures that will be more cost-effective within the likely availability of resources.
2. Financial analysis of maintenance investments and overhead cost of irrigation divisions with a view to improve the maintenance investment to minimize the system deterioration.
3. Development of a long-term program for maintenance that is based not on annual financial resource availability, but is needs-based in relation to the performance of the conveyance system.

Consequently, the main focus of this research was in the areas of financial and physical management of maintenance programs. Therefore, more technical aspects could not be implemented due to the low priority attached to it by the system managers and later the researchers also felt that more tangible results could be realized by conducting interventions in managerial aspects. In fact, this may be a proper approach, because, some of the financial procedural changes can be implemented with rather limited resources. Some of the technical aspects that were proposed at the inception require highly sensitive measuring equipment and training. Because of using the available limited resources and accommodating the requests of the irrigation managers the research activities were limited to the above-mentioned activities.

APPROACH AND METHODOLOGIES

From the inception of the program, all activities were carried out with the participation of the agency officials and the farmers. Despite the busy schedules of the research partners, it was possible to motivate and activate them in implementing the research components. At the start, the participation was rather limited to meetings and formal and informal discussions. Nevertheless, at later stages, they felt that this work could generate tangible results and smoothen their day-to-day work. Such consideration made them participate in the research activities in a productive manner. On the other hand, carrying out their day-to-day work in a methodical manner could certainly lead to better results. Certainly, these achievements have built confidence between agency officials and beneficiary farmers which encouraged them to participate in these innovations. As in the case of other research components, from the preparation of the inception report up to the final report, maintenance management research activities were carried out with the participation not only of the officials of the ID and the IMD but also of the farmer representatives and the farmers.

The financial management activity was carried out using past records of the ID using the ID staff since these documents are confidential. A few years' data were selected to be used in the analysis for understanding the behavior under different investment intensities. In this analysis, efforts were made to separate the administrative costs and physical maintenance costs to ensure that maintenance funds were used for maintenance rather than diverting them to cover administrative costs. Once the completion of categorization (subsystem-wise and subject-wise) of the expenditures, a comparison of investments was made to examine the equity of investments.

Using worldwide experience, several procedures, formats and methodologies were developed to improve the performance of maintenance in the areas of identification, prioritization, decision making and monitoring. Most of these activities were done using a technique termed "diagnostic walk-through." This walk-through and follow-up ratification meetings were conducted with the participation of the farmers and the farmer representatives. As part of improving the efficient use of limited resources, a few work studies were carried out to establish realistic norms for weeding under different working conditions.

ACTIVITIES IMPLEMENTED

Financial Management

Financial management was implemented to understand the financial management related to maintenance management and to identify important issues that undermine the effectiveness of the physical work program. First, a fact-finding survey was conducted to explore the existing financial regulations and policies in maintenance investments with a view to suggesting future directions. Second, serious attempts were made to establish a maintenance expenditure database to develop allocation principles among different categories of work and subsystems. Finally, work was carried out to develop guidelines to minimize wastage of financial resources through re-demarkation of irrigation administrative boundaries. The following sections discuss the details of activities implemented under three main headings: review of maintenance funding, financially viable size of irrigation divisions and assessment of overhead cost of divisions concerned.

Review of Maintenance Funding. The main objective of this review is to understand the funding policies and regulations and to discover the areas where interventions related to financial management could be implemented.

Analysis of Maintenance Expenditure. This work was done using the financial records such as measurement books, votes ledgers, cash books, checkroll registers, etc., provided by the Irrigation Engineer, Tissa Division. Expenditures under each subitem were separated according to the items given in the IMD circular. The salaries of Work Supervisors and maintenance laborers were tabulated separately. The expenditures under each subitem were further classified according to the subsystems of the division.

In 1990, the administrative expenditure, as a ratio of the physical maintenance expenditure, was 1.42 against the allocation ratio of 0.30. The expenditure ratio of administration cost to maintenance in 1980 was 0.22. According to IMD calculation, the administrative cost of Tissa Division should be Rs 42/acre based on 1985 rates (today's cost is Rs 42 x 1.771 = Rs 74.00). As at the 1985 rate the calculated cost is Rs 500,000.00 which was about Rs 881,000.00 in 1991 (compounded value at 10% inflation).

The 1991 compounded value seemed to be high and the actual expenditure was very close to the calculated figure as per the IMD formula. The allocation values under each subsystem were the values obtained on the basis of the command area. However, the administrative cost was 1.99 times the allocation, whereas maintenance expenditures were 0.41 of the allocation. This indicates the inappropriate use of maintenance funds to cover overhead costs.

Assessment of Overhead Cost. Analysis of the costs of maintenance has two parts: reviewing past expenditure records and assessing overhead costs. In this analysis, expenditures on O&M were separated among administrative, operations and maintenance costs. In doing so, it was necessary to go into the details of each paid document to verify the nature of the spending. It is very clear that administrative expenditures were incurred at the expense of maintenance work. For instance, in 1991, the ratio of the administrative expenditure to the allocation provided for the same is as high as 4.21 compared to 0.85 and 2.10 in the two previous years. There is a trend to spend a greater portion of the available funds on administration. This has certainly had a detrimental effect on the maintenance of the system.

Table 1 indicates that administrative costs for Tissa Division should be Rs 511,200 per year. This is more than the 30 percent of funding for physical work recommended by Sheladia Associates for Irrigation Systems Management Project (ISMP) and more than the 40 percent recommended by the IMD. A large portion of the administrative cost (49%) goes as the salaries of the casual staff. The best possibility of reducing the costs therefore lies in cutting down the number of staff. The other areas where reductions can be effected are traveling expenses (13%) and maintenance of vehicles (17%). If the IMD overhead standards are used, it appears that maintaining a separate division for EIS is not economically justifiable.

Attention is required to determine the appropriate size of a maintenance division. At current funding rates, these figures suggest that an economically viable division should serve at least 24,000 acres [(Rs 511,200)/(Rs 55 per acre)/0.40 = 23,236 acres]. However, the calculation of the administrative cost of the division shown in table 1 was made considering the minimal possible staff and other facilities. It is quite possible that more area can be managed with these staff and facilities. Therefore, the actual requirements need to be properly estimated. Another possible conclusion is that the norm for divisions below 24,000 acres is rather low. A detailed analysis of these figures is required.

Table 1. Quantity sheet for administration of Tissa Division.

S-i	Description	Unit (Rs)	Qty.	Rate (Rs)	Fraction of overhead (Rs)	Amount	Sub-total	Percen-tage
1.	Salaries							
1.1	Watchers (3*22 days)	Days	66	88.95	1	5,870.70		
1.2	Drivers (2*30)	Days	60	83.00	1	4,980.00		
1.3	Operators (20 days)	Days	20	93.85	1	1,877.00		
1.4	Casual Typist (2*23 days)	46, 88.95	1	4,091.70				
1.5	Casual Draughtman (23 days)	Days	23	88.95	1	2,045.85		
1.6	Storeman and Peon (2)	Month	2	2,040.00	0.5	2,040.00	2,090.25	49.07
2	Subsistence for Field Staff							
2.1	Irrigation Engineer	Days	5	200.00	0.3	300.00		
2.2	Divisional Assistant	Days	4	200.00	0.3	240.00		
2.3	Technical Assistants (4*4 days)	Days	16	150.00	0.3	720.00		
2.4	Work Supervisors (4*4 days)	Days	16	150.00	0.3	720.00		
2.5	Drivers (2*10 days)	Days	20	150.00	0.3	900.00		
2.6	Operators	5	150.00	0.3	225.00	3,105.00	7.29	
3	Travelling for Field Staff							
3.1	Irrigation Engineer	Miles	200	10.00	0.5	1,000.00		
3.2	Divisional Assistant	Miles	150	10.00	0.5	750.00		
3.3	Technical Assistants (3*150 Mls.)	Miles	450	10.00	0.5	2,250.00		
3.4	Technical Assistant	Miles	300	1.25	0.5	187.50		
3.5	Work Supervisors (4*300 Mls.)	Miles	1,200	1.25	1	1,500.00	5,687.50	13.35
4.	Overtime for Office Staff							
4.1	Clerks (4*40 hrs.)	Hours	160	7.50	0.5	600.00		
4.2	Draughtman (2*40 hrs.)	Hours	80	7.50	0.5	300.00		
4.3	Storekeeper	Hours	40	7.50	0.5	150.00		
4.4	Typist	Hours	40	7.50	0.5	150.00		
4.5	Peons (2*40 hrs.)	Hours	80	7.50	0.5	300.00	1,500.00	3.52
5	Vehicals							
5.1	Tyres-Nissan (3 sets/year)	Sets	3	9,400.00	0.6	1,410.00		
5.2	Tyres-Daihatsu (3 sets/year)	Sets	3	8,000.00	0.6	1,200.00		
5.3	Fuel and Lubricants	Item	1	7,500.00	0.6	4,500.00	7,110.00	16.69
6	Telephone Bills	Item	1	4,000.00	0.5	2,000.00	2,000.00	4.69
7	Electricity Bills	Item	1	2,500.00	0.5	1,250.00	2.93	
8	Stationery	Item	1	2,000.00	0.5	1,000.00	1,000.00	2.35
9	Rounding off					42.25	42.25	
	Total per month					42,600.00	42,600.00	
	Total for year					511,200.00		

Notes: S-i = Sub-item; Qty. = Quantity.

Financially Viable Size of Irrigation Divisions

As discussed in the above section, the administrative cost of irrigation divisions is not totally provided for in the budget and, most often, when capital works are rather limited the irrigation managers are compelled to consume maintenance allocations to cover up their inevitable administrative cost. Part of the administrative cost is a fixed amount; it does not depend on the work load and, therefore, it can be designated as fixed administrative cost. The balance is strongly related to the work load, command area of the division and other characteristics such as nature of the irrigation system, spatial distribution of subsystems, etc. Expending the maintenance funds under such situations leads to severe underinvestment in physical maintenance work. Repetition of this type of financial management certainly demands frequent rehabilitations. Almost all the rehabilitation programs, in the recent past, have advocated for well-defined maintenance programs to sustain the performance of irrigation systems. It is also noteworthy that such programs have invested large sums of financial resources to streamline the maintenance procedures. Therefore, this research component has very clearly identified the felt need for improving the maintenance process in the area of financial management.

Using the information generated in the analysis of maintenance expenditure during a few seasons, several strategies were tried out to overcome the misuse of maintenance allocations. This analysis was ultimately used to develop a method for checking the financial viability of an irrigation division. The fixed costs of irrigation agencies should be based on the requirements of staff, maintenance of vehicles, salaries, allowances and other office needs like the telephone and electrical bills, etc. According to the cost analysis, the size of a financially viable irrigation division can be calculated by using the following equation:

$$C = (A - I - P) / (M * F)$$

where,

C =Financially viable size of the division in acres
A =Estimated administrative cost
I =Total overhead cost allowed in works other than maintenance
P =Administrative cost provided
M=Maintenance allocation per acre
F =Factor allowed for administrative cost

Using local figures and when $I = 0$ and $P = 0$, the size of an irrigation division will work out to about 25,000 acres. If the administrative cost provided is not adequate and the size of the division is not financially viable, then there is a great tendency to use the maintenance funds for administrative purposes which creates underinvestments in maintenance. This equation needs to be field-tested in several irrigation divisions so as to validate the different cost components and the factor of administrative cost allowed. The administrative cost does not totally depend on the irrigable extent but it is directly related to the spatial distribution and the type of irrigation schemes. Therefore, it is recommended to test this equation in a wide range of irrigation systems in different parts of the country.

Management of Physical Work

Planning of Maintenance Work. This section of the report intends to explain the process followed in planning maintenance activities. As stated before, the method of diagnostic walk-through was used to identify the needs and farmer participation was considered as the driving force in the implementation of a successful work program.

Identification. The planning of maintenance activities for the forthcoming year needs sufficient time since it is required to go through several stages of refining. This process needs to be started at least four months before the start of the new financial year. This period always coincides with the close season between dry and wet seasons. Since water is not being issued, the irrigation staff and the farmers can afford to spend more time. The other advantage is that the maintenance requirements can clearly be inspected and necessary surveys and leveling can be done under dry conditions. Unlike in the past, the identification of maintenance activities was carried out in a more participatory manner and the Identification Team (Panel 1) comprised: the Technical Assistant, ID (Leader); the Work Supervisor, ID; the Institutional Development Officer, IMD (for main canals); the Institutional Organizer, IMD (for tertiary system); the Farmer Representatives; and the Turnout Attendants, ID.

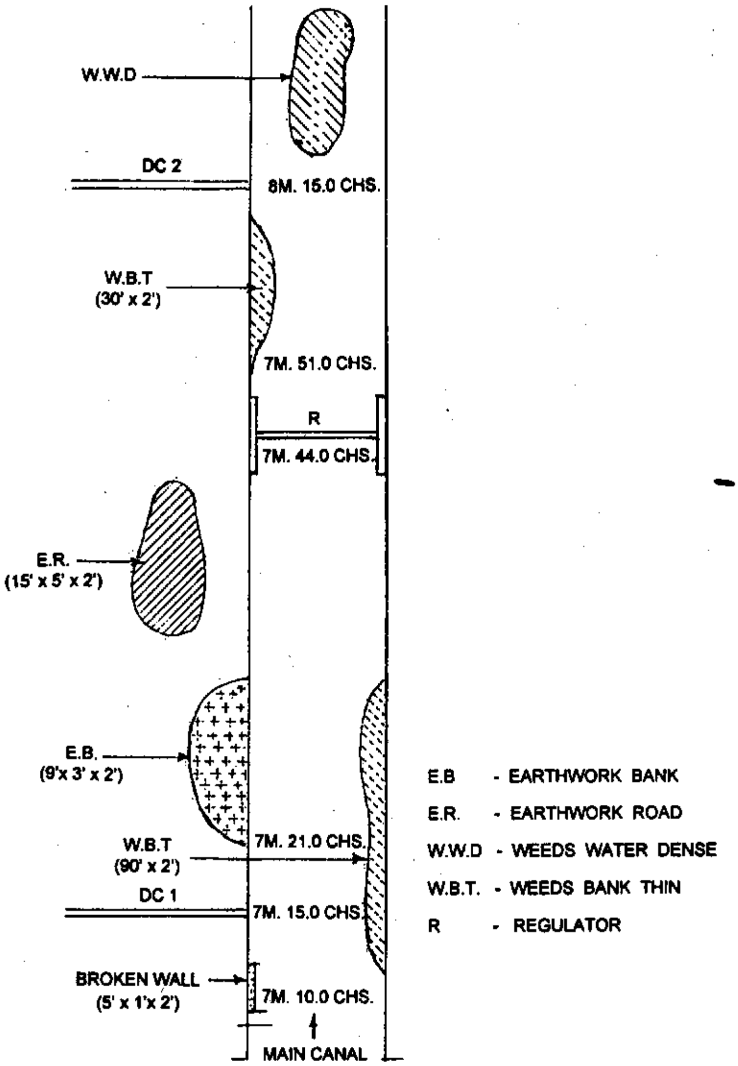
This Team has conducted the diagnostic walk-through along the canals and has inspected the maintenance requirement in canal sections, structures and service roads. The walk-throughs are used to stimulate discussions with the Farmer Representatives (FRs) to extract firsthand information on the operations of the particular facility of the system. It was observed that a large mass of useful information could be gathered because it was discussed at the site with FRs from both the upstream and the downstream. In addition, the field-level system operators had considerable opportunities to discuss their operational difficulties that resulted from deficiencies in irrigation facilities. While doing the walk-through survey the TA had sketched the maintenance requirement on a predesigned format with actual quantities of work to be done (figure 1). The use of these formats and the abbreviations speeded up the process and finally it has resulted in quite neat drawings of maintenance work.

Prioritization. Once the Panel 1 completed its identification, the maintenance requirements submitted by the TA were carefully studied by the Irrigation Engineer before his walk-through. In case the area to be covered by the IE is large, then he will have the option to visit the most important locations. The purposes of this visit are to: verify the quantities of work and their technical viability, overcome technical deficiencies of the facilities, solve problem within the financial resources, monitor the ongoing program of work and check the work done in the past.

The prioritization panel (Panel 2) comprised the following personnel: the Irrigation Engineer (leader), the Technical Assistant, the Work Supervisor, the Institutional Development Officer, the Institutional Organizer and the Farmer Representatives. In the case of the tertiary system, the routine type of work need not be inspected by the IE. Nevertheless, the IE should personally inspect the improvement works and large repairs before the implementation of the maintenance activities.

Decision Making. After the Panel 2 inspection and with the amended list of items, the Panel 3 conducted the walk-through. In case where the extent to be inspected is large the team could ride along the canals to inspect selected items of work to verify the quantum of work and the technical validity of the proposal. The decision-making team comprised the following personnel: the Deputy Director of Irrigation (DDI), the leader; the Irrigation Engineer; the Technical Assistant; the Institutional Development Officer (for the main system) and the Institutional Organizer (for the tertiary system). In the case of tertiary system maintenance work the DDI can delegate his function to the IE. As mentioned in the above section this procedure has enhanced the performance of maintenance work as a result of the DDI's attention and supervision which may not occur under normal circumstances.

Figure 1. Sketch of maintenance work.



Preparation of Estimates for the Wirawila Main Canal. As explained before, the identification of maintenance work was done by the walk-through method. A trial walk-through was done in May 1991 using newly developed formats. The detailed estimate with the priorities was discussed with the Farmer Representatives and their priority was to invest money on desilting (table 2). Most of the irrigation officials believed that desilting could not be done partially and that it should be done completely. On the other hand, discussions with farmers disclosed that desilting in two locations would certainly improve the conveyance of water to the tail-end sections of the system. In fact, this decision of the farmers matched with the financial constraints faced by the agency. Accordingly, two items of work in removing silt at the entrances of Warapitiya and Uduwila tanks were successfully completed. This program has introduced a number of ID officers to the needs-based maintenance. The ID officers also used the diagnostic walk-through and farmer consultation to determine maintenance needs in subsystems outside the pilot area. It is clear that this method is replicable and there is a positive response from the system operators.

Table 2. Maintenance estimate for Weerawila main canal.

S-i	Quantity	Unit	Description	Rate Rs Cts.	Total Rs Cts.	PTY
1	149.80	sqs.	Water weeding (WBD) in M/C. (2/Year)	8.00	1,198.40	1
2	435.70	sqs.	Water weeding (WB) in M/C. (2/Year)	5.35	2,331.00	1
3	294.40	sqs.	Water weeding (WBD) in M/C. bund. (2/Year)	8.00	2,355.20	1
4	1,442.35	sqs.	Water weeding (WBD) in M/C. bund. (2/Year)	5.35	7,716.57	1
5	189.00	sqs.	Water weeding (WBD) in M/C. road. (2/Year)	4.00	756.00	1
6	1,090.20	sqs.	Water weeding (WBD) in M/C. road. (2/Year)	3.20	3,488.64	1
7	38.33	sqs.	0.5' thick cement plastering 1:3 cement motar	517.00	19,816.61	2
8	32.09	cu.	E/E from borrow and back filling around structure	337.25	10,822.35	2
9	32.09	cu.	Placing and compacting fill material	45.00	1,460.10	2
10	1.78	cu.	R/R masonry in 1:5 cement motar	4,085.00	7,271.30	2
11	0.40	sqs.	g" thick rubble pitching in 1:5 cement motar	3,028.00	1,211.20	2
12	0.88	cu.	1:3:6 (1.5") cement concrete with form work	7,082.00	6,232.16	2
13	1,833.44	cu.	Desilting along the main canal	106.75	195,719.72	4
14	54.91	cu.	E/E from borrow and back filling washaways	337.25	18,518.40	3
15	54,91	cu.	Placing and compacting fill material	45.50	2,498.40	3
16			Contingencies		3,603.95	
					285,000.00	

Notes: S-i = Sub-item; PTY = Priority; sqs. = 100ft^2; cu. = 100ft^3; E/E = earth excavation

Use of Turnout Attendants (TOAs) for Maintenance Work. In this exercise the TOAs were employed to carry out certain selected items of work which needed unskilled labor. Generally, the norms for these items are given as daily outputs, information that is very useful in the implementation and progress control. Details such as the location and the length of the canal to be attended daily were given in the work plan which was also very useful for inspection by the supervisory staff. The continuous monitoring of the maintenance work done by the TOAs has improved their performance. The other reasons for the improved performance are the special attention given by the higher officials, appreciation expressed and the recognition given by the officers and the farmers. At the beginning, very few TOAs performed well; however, as time passed, quite a number of them took interest in their work and performed well. This improvement trend, due also to higher output and improved attendance, can be seen in figures 2, 3 and 4. With this activity, the maintenance laborers were given record books to write down the details of their own daily work. The supervising and inspecting officers are advised to read these notes and to make remarks in their inspection notes.

The departmental norm for weeding the irrigation reservation is 25 squares per man-day. This study suggests a higher norm of around 35 squares outside the canal section and a lower norm of around 15 squares inside the conveyance section. These figures are site-specific and cannot be directly used in other systems. However, this method can be used to establish norms in those locations where simple work studies of this nature can be carried out. This study revealed that an average monthly output of 200 and 600 squares of weeding can be expected from a TOA in canal sections and embankment sections, respectively (figures 2, 3, and 4).

Training for Farmers and Officers

The subject matter for the training was as follows and all the resource persons were from the ID and the IMD and the IIMI field-level staff.

For Officers. The sources of resource allocation and their limitations; maintenance process and prioritization; the norms for maintenance work and importance of farmer participation in the maintenance process.

For Farmer Representatives. Maintenance process; responsibilities of farmers in maintenance work; small-scale contract management and responsibilities of each party and strategies to overcome resource deficits.

The objectives of the program were: to make field-level officers and farmers aware of the concept of needs-based maintenance; to motivate farmer participation in maintenance work and to mobilize and make effective use of resources.

IMPACTS

This program had direct results and impacts over the entire project area. In this exercise, it was intended to develop and field-test the maintenance procedures and also to prepare a maintenance manual. The progress of this component is satisfactory and results are encouraging. The following can be identified as the results and achievements.

Figure 2. Progress of maintenance work.

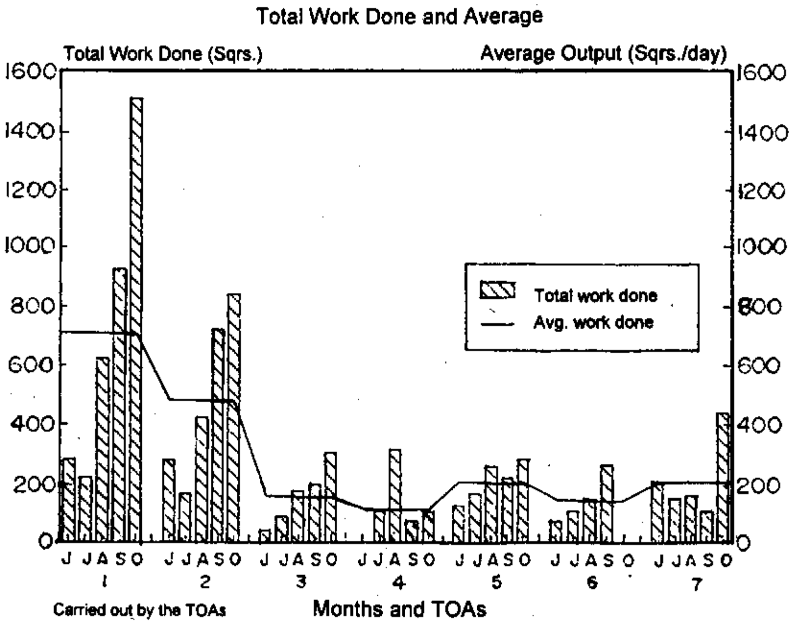


Figure 3. Progress of maintenance work.

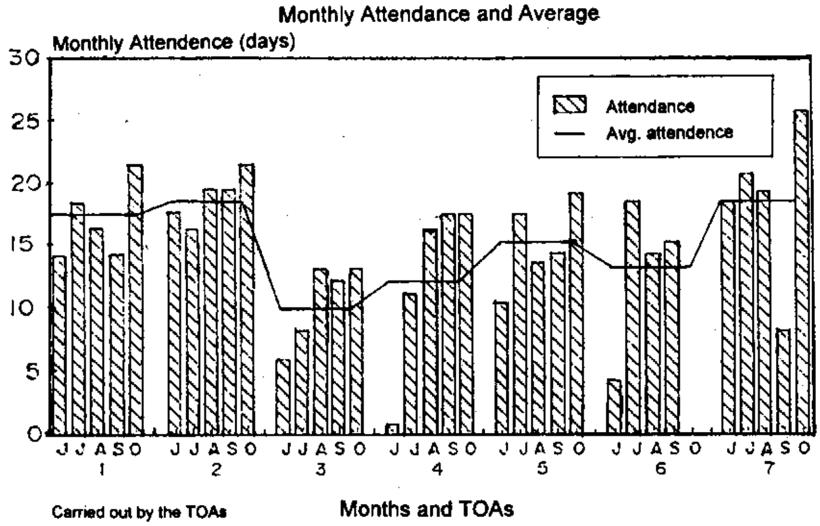
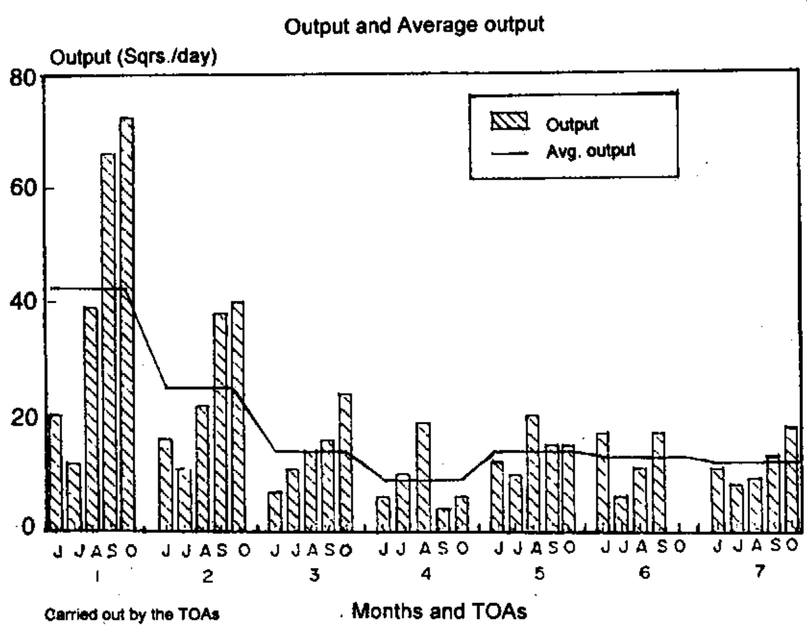


Figure 4. Progress of maintenance work.



- The internalization of the concept of "diagnostic walk-throughs" is one of the key impacts in this program. This term has become quite common among the field-level staff and even among the farmers. In fact, most engineers are using this method to ascertain their maintenance requirements. More importantly, the recently implemented Rectification of Irrigation Deficiencies (RID) Program in the EIS followed this method to inventorize the rehabilitation requirements in all subsystems.

- The maintenance program of the Right Bank Subsystem was prepared at the beginning of the year and the Resident Engineer published this information; this document contained information such as total allocation, allocation for tertiary systems, estimated value of work in tertiaries, and the difference in tertiary funding.

  This resource deficit between the allocation and the value of total work was overcome by mobilizing farmers' free labor contributions through self-help work. This was the first time that an ID officer made this information transparent to the farmers with details of actual work to be done under each canal and the availability of financial resources. This can be taken as a useful step towards the physical system sustenance and strengthening the farmers' organizations. This report further suggests that the engineers could follow this procedure so that financial resources for maintenance will be allocated and work will be carried out on the basis of needs-based maintenance. Furthermore, this procedure has strengthened the officer-farmer and officer-officer relationships.

- The employment of the maintenance laborers in carrying out maintenance in a planned manner with established norms was found to be very effective. The outputs of the gang were very good and this can be recommended for replication. On the other hand, some of the laborers are interested in improving their performance because of the recognition they get from their superiors. Also, it was observed that the performance of the laborers as a whole has shown some visible improvements.

- A complete analysis of the maintenance data generated a clear picture about the trend of expenditure and this could be used in financial planning in the future. In fact, when construction activities are at a state of diminishing status the overhead cost of irrigation divisions should be readjusted to suit the work load in hand. This is rather a difficult task because certain fixed costs such as salaries of office and supporting staff, vehicle maintenance, electricity charges, etc., are essential, irrespective of the value of work in hand. This cost can be reduced to a certain limit. To overcome this situation and to minimize fixed cost resources this report suggests changing the norm for area of authority of such irrigation divisions.

MAJOR CONCLUSIONS

1. The fixed administrative costs of irrigation agencies should be ascertained considering the staff requirements, stationary vehicle maintenance requirements, salaries and other allowances, etc. Accordingly, this cost analysis size of a financially viable irrigation division can be calculated using the following equation:

$$C = (A - I - P) / (M * F)$$

where,
- C = Financially viable size of the division
- A = Estimated administrative cost
- M = Maintenance allocation/acre
- F = Factor allowed for administrative cost
- P = Administration cost provided
- I = Total overhead cost allowed in works other than maintenance

Using the local figures and when I and P = O, then the viable size of an irrigation division will work out to 25,000 acres. If the administrative cost is not adequate and the size of the division is not viable the tendency to use the maintenance funds for administrative purposes is great, creating underinvestment in maintenance.

2. Resources for maintenance work should be allocated based on their actual requirement obtained through physical verification. However, it is advisable to set apart money for different categories of works like main canals, headwork, distributary channels, roads, etc., to minimize deterioration due to inequity in investments.

3. The identification, prioritization and decision-making walk-throughs are found to be very effective and they make farmer participation more productive. Farmers felt that their ideas and suggestions were entertained by the irrigation bureaucracy and they were, in fact, encouraged to participate in self-help work. This environment further strengthened the relations between the users and the operators.

4. New formats were designed with consultation of the irrigation staff based on the existing formats and these were used in the identification, quantification and preparation of cost estimates and they were found to be very effective, efficient and useful for needs-based maintenance.

5. These procedural changes encouraged the higher-level irrigation managers to participate in and supervise the maintenance work. Thus the quality of the maintenance work improved and lower-level field staff were also motivated and encouraged to perform better because of appreciation and commendation of the supervisors and the water users.

6. The preparation of the work plans for the works directly executed by the ID is a great step forward in the direction of the sustainability of the irrigation system. This work program helps the ID to utilize the limited resources and the maintenance laborers in a more effective manner.

7. The departmental norm for weeding in the irrigation reservation is 25 squares/day and this is a general figure for all the cases. The results obtained suggest that a higher norm of around 35 squares outside canal sections and 15 squares inside the canal conveyance sections, can be covered. These figures are site-specific and cannot be directly used in other systems. This study revealed that an average monthly output of 200 squares of weeding can be expected from a TOA in the canal sections and the other figure will be around 600 squares (figures 1 to 3).

8. With the training and the awareness provided by the IMD under their participatory mode of management it was quite easy to implement this research program. Nevertheless, it was necessary to provide extensive training for the farmer representatives on the needs-based maintenance management. It was expected that the farmer representatives and the field-level staff of the ID and the IMD would perform this

task at the DCO and FCG levels, but it was not successful. However, it was possible to motivate and mobilize farmers to contribute to this felt need.

RELEVANCE TO NIRP SCHEMES

1. The concept of diagnostic walk-throughs is one of the key concepts used in the maintenance management under resource deficit conditions in the Kirindi Oya Irrigation and Settlement Project. This concept can be readily adapted and extended to small- as well as medium/large-scale projects undertaken for rehabilitation under NIRP.
2. The process adopted to overcome deficit maintenance resources by mobilizing farmers and free labor contributions through self-help work and to employ the maintenance laborers in carrying out maintenance in a planned manner with established norms is readily applicable to those NIRP schemes where management exists.
3. Training of farmers in maintenance management is a prerequisite for successful implementation of maintenance activities and this is directly applicable to all NIRP schemes.

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Comments at the Plenary Session

D.W.R.M. Weerakoon[16]

KIRINDI OYA IS a new project whereas the NIRP covers old schemes. Kirindi Oya consists of a large number of settler farmers, but in most of the NIRPs, schemes consist of traditional farmers. The conditions (physical, institutional, etc.) in Kirindi Oya, therefore, are different from those in NIRPs. Combination of cropping patterns and cropping times should also be considered when attempts are made to transfer technology/management practices from one scheme to another.

A regular monitoring system is also very important. The NIRP would be able to develop a better communication system. (Collection of data and information, processing them and giving the feedback as most of these are minor schemes.)

Several trials were done to implement a seasonal plan. These seasonal plans, however, failed because farmers did not work according to the agreed plan.

Political interference is increasingly becoming a serious problem. Educating politicians too is not easy because different politicians have to be dealt with in different seasons. In yala 1992, politicians learnt some lessons. However, again in maha 1992/1993 a different set of politicians intervened. Also in present-day politics, many politicians belonging to different levels, such as the Pradeshiya Sabha, the Provincial Councils and the Parliament, are involved.

Taking management decisions by the PMC is the method that the ID needs to adopt. The ID is an operator. Legal support for taking decisions by the PMC is given through the newly amended Irrigation Ordinance.

16 Senior Deputy Director (O&M), Irrigation Department, Colombo, Sri Lanka.

Comments

G.O. Uittenbogaard[17]

OPERATION AND MAINTENANCE IN THE KIRINDI OYA SCHEME

THE NEED OF operation planning was emphasized during the workshop. As one speaker remarked, without a plan there cannot be management. It became clear during the workshop that an operation plan evolves over time. It needs continuous monitoring and what is very important is that all operations during the season will be based upon the agreed plan. The workshop revealed the various difficulties in developing an operation plan for the Kirindi Oya Irrigation and Settlement Project (KOISP). Problems were both of a technical nature, e.g., assessment and agreement of the amount of water available for irrigation and of a socioeconomic nature, e.g., defining the important people who should agree on the seasonal operations. It was shown that the development of an operation plan needs considerable skills in various disciplines. Economists, agronomists, irrigation engineers, hydrologists, farmers all will have an input in the development of an operation plan. The day-to-day management of the plan is the responsibility of the scheme management in close consultation with the water users.

The workshop focused on the participatory management in the development of the plan. It seems, however, that further work has to be done on the development of the operation plan with a clear set of operation rules. Important rules relate to the operation under variable water availability, and operation rules in response to rainfall. It should be mentioned that the development of a set of operation rules can avoid "ad-hoc" decisions during the season and above all, with the rules, the management will become transparent.

Operations in the KOISP are relatively new and the operation plan as based on the original design concept, is being fine-tuned, as shown in the ID/IIMI research, and made specific to the needs of the scheme. Through the present research valuable lessons have been learnt, in particular, on the process of evolving operations and the importance of data collection through day-to-day monitoring. Without doubt the lessons learnt in the KOISP are useful for any new irrigation project like the NIRP.

Although KOISP is a large irrigation scheme with its own characteristics, processes learnt in the scheme can be utilized in other projects. Although NIRP schemes are smaller, varying from 20 to 1,000 ha, operations will be planned systematically and operation plans are the basis of the rehabilitation of each scheme. The concept of preparation of operation plans and their implementation in the NIRP schemes are discussed below:

17 Co-Project Director/Team Leader, NIRP, DHV Consultants BV. Colombo, Sri Lanka.

FRAMEWORK FOR OPERATION PLANNING—THE CASE OF NIRP

Operations in the NIRP can follow either a supply-based or "crop-to-water" system, distributing water according to predetermined schedules, with the farmers choosing their cropping pattern accordingly, or demand-based or "water-to-crop"-oriented, attempting to meet the crop needs. The operations will consider the design concept of the schemes. Most irrigation schemes in Sri Lanka have been designed for a fully regulated demand system with gated regulators up to the field offtake.

Framework for Improved Operations

The NIRP recommends a framework for operations which emphasizes the development of an operation plan at the start of the rehabilitation. The Plan of Operation and Maintenance forms the basis of the rehabilitation and it considers the following aspects:

Operation Policies—Objectives and Rules

An irrigation rehabilitation project aims at the improvement of the operation of existing schemes. Improved operation strategies normally include a review of the present operation strategy (often demand-based) and, where feasible, the introduction of supply-based strategy. Another important aspect of the operation framework under NIRP is the formulation of a more detailed operation plan consisting of water delivery schedules and operation rules and regulations.

Water delivery schedules will be based on average cropping plans, and indicate flows, timing and duration of irrigation.

Rules and regulations should be transparent and dynamic, which means that they are scheme-specific, unambiguous, and evolve over time. Operation instructions (rules and regulations for daily operations) are prepared for all operating staff. These instructions are based on the operation plan and the responsibility of the operator concerned.

Operation Planning

The operation planning should follow a systematic process:

- First an assessment of past operation procedures will be made. The assessment gives information on the shortcomings of the scheme and the improvements which are required.
- A second step is the determination of the water allowance (m^3/ha). This can either be volume-based, flow-based or proportional-shared-based. At this stage, it is important to assess, as accurately as possible, the water availability.
- Once the water allowance has been fixed, operation rules will be determined, often by simulation, to ensure that the water allowances match the water availability. The most important rules concern operations in response to rainfall; operations with variable water availabilities; and operations in response to emergencies.
- Subsequently, with the rules established, irrigation release schedules will be prepared.

In principle, operation plans remain valid for a number of years. They will be changed only when major revisions in operation strategy are needed. For instance, changes are needed because of the introduction of new technology in irrigation design, when new cropping plans emerge, or with major changes in the water availability. However, the development of operation plans is a gradual process as seen from the experience in the Kirindi Oya Irrigation and Settlement Project. Fine-tuning of the plan, on the basis of seasonal monitoring results is very often necessary.

Implementation of an Operation Plan

An operation plan to be effective should fix clear operation targets, e.g., timing and flow of irrigation. Operation instructions are given to achieve the operation targets. In-season monitoring of operations should ensure that the water deliveries are carried out according to the plan. Monitoring of water availability at the sources (rainfall position, river flows or reservoir storage) and in the irrigation system is of particular importance. When the actual water availability differs from the anticipated availability operations will have to be adjusted accordingly, taking into account the specific rules and regulations for operation. An end-of-the-season monitoring and evaluation should result in proposals for improved operation planning for the next irrigation season.

Expectations from an Improved Operation Plan

Of this improved operation strategy one may expect that:

- Actual operations are in tune with planned operations. That is, irrigation water is delivered on time, and equally distributed over the command area.
- Changes in the cropping pattern occur. For instance, in the tail reaches, the better water distribution may result in an increase in OFCs.
- Operational problems are less (less complaints), which means that farmers are content with the improved (transparent) plan.

SPECIAL ASPECTS FOR NIRP

Operation planning in the major/medium schemes will follow the above scenario. The preparation of an O&M manual which contains the Plan of Operation and Maintenance is an element in this. During the after-care period, operations will be monitored and changes in the plan, if any, will be proposed. The plan will be endorsed by the Scheme Management Committee.

In minor schemes, a Plan of Operation and Maintenance will also be prepared. However, as schemes have a limited number of farmers and a "simple" irrigation infrastructure has been traditionally operated and maintained by the farmers, these plans are more flexible. The Plan of Operation and Maintenance should, for instance, at least indicate the area that can be irrigated with different storage or flow available. Detailed water delivery schedules are perhaps not required for the small schemes.

To implement an improved operation strategy is not easy; for NIRP, it requires the consideration of several operation management issues such as strengthening of staff capabilities, participatory management and improvements to the irrigation system.

Strengthening of Staff Capabilities

Irrigation in Sri Lanka still has a strong focus on rehabilitation. Planning and design based on scheme-specific operation requirements, especially in rehabilitation programs, are a relatively new activity. As few or no planners/economists/agronomists are employed in the Irrigation Department, it will be difficult to prepare operation plans. In this situation, training in operation planning should be given high priority. Other implementing agencies in the NIRP, in particular, the provincial irrigation units, have insufficient experience in this respect.

Participatory Management

Operation plans for major/medium schemes are prepared by the Irrigation Department, normally through the Project Manager, in consultation with other relevant agencies in the Scheme Irrigation Management Committee. An operation plan to be effective requires the approval of the farmers, represented in the Scheme Irrigation Management Committee. For minor schemes, operation plans for the season are entirely prepared by the farmers' organizations.

Improvements to the Irrigation System

As mentioned before, in the NIRP the Plan of Operation and Maintenance forms the basis of the rehabilitation of the irrigation system. To successfully implement an operation plan continuous adjustments to the irrigation system may be required. Usual adjustments are related to gate operations, flow monitoring and flow sizes. Monitoring of the implementation of an operation plan may result in such adjustments.

Workshop on Seasonal Planning Procedures to Improve Irrigation Management Performance: How Kirindi Oya Experience of IIMI/ID Can Be Transferred to NIRP Schemes

Date	:	Monday
Place	:	Head Office

PROGRAM

Morning Session

8.30 – 9.30 a.m. Inaugural Session

Chairperson : Mr. L.U. Weerakoon, State Secretary Irrigation

- Registration
- Lighting of the Oil Lamp
- Welcome Address by Mr. B.M.S. Samarasekera, DD, IRMU
- Introduction of the Workshop by Mr. K.S.R. de Silva, Project Director, NIRP
- Address by the Chief Guest, Mr. L.U. Weerakoon, State Secretary, Ministry of Irrigation
- Address by the Special Guest, Mr. Nanda Abeywickrema, Director, International Cooperation, IIMI
- Address by Mr. K. Yoganathan, Director, Irrigation Department

9.30 - 10.00 a.m. Tea Break

DEVELOPMENT OF THE SEASONAL PLAN

Chairperson: Dr. C.M. Wijayaratna, Head, IIMI/SLFO

Rapporteurs: Mr. T.P. Alwis, IE (Planning), ID

Mr. J. Upasena, RO, IIMI/SLFO

10.00 - 11.00 a.m. *An Overview of the Findings of Kirindi Oya Study* by Dr. R. Sakthivadivel, Senior Irrigation Specialist, IIMI and Mr. H.A. Karunasena, Chief Resident Engineer, Kirindi Oya Irrigation System

11.00 - 11.30 a.m. Development of the Seasonal Plan

- *Technical Aspects* by Dr. R. Sakthivadivel, Senior Irrigation Specialist, IIMI
- *Participatory Approach and Political Process* by Dr. Jeff Brewer, Social Scientist, IIMI

11.30 - 12.00 a.m. Discussion

12.00 - 12.30 a.m.

1. *Efficient Use of Scarce Water by Crop Diversification*
2. *Mitigating Salinity Problems in the Old Ellegala Irrigation System* by Dr. C.R. Panabokke, Senior Associate, IIMI

12.30 - 1.00 p.m. Discussion

1.00 - 2.00 p.m. Lunch Break

Afternoon Session

Chairperson: Mr. D.W.R.M. Weerakoon, Senior Deputy Director (O&M), ID

Rapporteurs: Mr. N.A. Sisirakumara, IE (RW), ID
Ms. S. Malini, IE, IRMU, ID

IMPLEMENTATION OF THE SEASONAL PLAN

2.00 - 2.30 p.m.	*Main System Management* by Mr. Sarath Wijesekara, Resident Engineer, R.B., Kirindi Oya Irrigation System
2.30 - 3.00 p.m.	Discussion
3.00 - 3.30 p.m.	*Maintenance Management* by Mr. H.A. Karunasena, Chief Resident Engineer, Kirindi Oya Irrigation System
3.30 - 4.00 p.m.	Discussion

Plenary Session

Chairperson: Mr. L.T. Wijesuriya, Senior Deputy Director (Rehabilitation), ID

Rapporteurs: Mr. C. Withana, IE, ID

Mr. K.A.S. Susantha, IE, IRMU, ID

Comments by Mr. D.W.R.M. Weerakoon, Senior DD, O&M

- Comments by Mr. G.O. Uttenbogaard, Team Leader NIRP
- Comments by Other Participants

4.45 p.m.	Concluding Remarks by the Chairperson
	Vote of Thanks by Mr. B.M.S. Samarasekera, DD, IRMU
5.00 p.m.	Closure

List of Participants

Resource Personnel

Mr. H.A. Karunasena
Chief Resident Engineer, Kirindi Oya Irrigation System

Mr. U.S. Wijesekera
Resident Engineer, Kirindi Oya Irrigation System

Dr. R. Sakthivadivel
Senior Irrigation Specialist, IIMI

Dr. Jeff Brewer
Social Scientist, IIMI

Dr. C.R. Panabokke
Senior Associate, IIMI

Irrigation Department

Mr. L.U. Weerakoon
State Secretary, Ministry of Irrigation

Mr. K. Yoganathan
Director

Mr. L.T. Wijesuriya
Senior Deputy Director (Rehabilitation)

Mr. D.W.R.M. Weerakoon
Senior Deputy Director (O & M)

Mr. N.T. Atukorale
Deputy Director (O&M)

Mr. S.A.P. Samarasinghe
Deputy Director (RW)

Mrs. P.A.S.M. Samarasekaera
Deputy Director (NIRP)

Mr. N. Indrasenan
Chief Irrigation Engineer (NIRP)

Mr. W.A.D.M. Amarasekera
Chief Irrigation Engineer (NIRP)

Mr. T.G. Somaweera
Irrigation Engineer (O&M)

Mr. J.W.M.R.T. Seeman
Irrigation Engineer (Major Construction)

Mr. R. Karunaratne
Chief Irrigation Engineer (Plan Implementation)

Mr. S. Sivapalan
Irrigation Engineer (Major Construction)

Mr. T.P. Alwis
Irrigation Engineer (Planning)

Mr. N.A. Sisirakumara
Irrigation Engineer (Regional Works)

Mrs. W.L.D.P.De S. Silva
Chief Irrigation Engineer
Colombo

Mr. A.K.S. Sisiranatha
Irrigation Engineer
Weeraketiya

Mr. B.K. Jayasundara
Deputy Director, Irrigation Department
Galle

Mr. G.V. Ratnasara
Deputy Director, Irrigation Department
Hambantota

Mr. W.A.R. Parakrama
Irrigation Engineer
Ratnapura

Mr. N.A.I.U.K. Nissanka
Additional Irrigation Engineer
Matara

Mr.H.P.S. Somasiri
Deputy Director, Irrigation Department
Kurunegala

Mr. K.W.I.de Silva
Deputy Director, Irrigation Department
Polonnaruwa

Mr. W. Gamage
Deputy Director, Irrigation Department
Ampara

Mr. S. Mohanarajah
Irrigation Engineer
Office of Deputy Director Irrigation
Batticaloa

Mr. M.W. Chandrawansa
Irrigation Engineer
Anuradhapura

Mr. N.U. Hemakumara
Irrigation Engineer
Huruluwewa

Mr. P.C. Senaratna
Deputy Director (Planning & Computer)

Mr. H.M. Jayatilleke
DDI
Irrigation Training Institute
Galgamuwa

Mr. G.T. Dharmasena
Deputy Director
Hydrology Division

Mr. Nimal Rohana
Irrigation Engineer

Mr. V. Regunathan
Senior Deputy Director (Plan Implementation, Works General and Training)

Mr. W. P. Jinadasa
Senior Deputy Director (RW)

Mr. R.A. Nandasena
Deputy Director, Training

Mr. S. Senthinathan
Deputy Director (Major Construction and Machinery)

Mr. C. Withana
Irrigation Engineer

Mr. U. Delpachitra
Deputy Director, Irrigation Department
Colombo Range

Mr. U.K. Chandrasinghe
Technical Assistant (Construction)

Mr. K.M.P.S. Bandara
Irrigation Engineer (Planning)

Mr. D. Kaluvitharana
Irrigation Engineer
Colombo Range

Mr. S. Jegatheeswaran
Irrigation Engineer, NIRP

Mr. D.C.D. Wickremaratne
Chief Irrigation Engineer

Ms. R.A.D. Jayanthi
Irrigation Engineer (Design)

Mr. K.R.P.M. Mullegangoda
Irrigation Engineer
Monaragala

Mr. G. Sarawanabawan
Irrigation Engineer (Design)

NIRP

Mr. K.S.R. de Silva
Project Director

Mr. G.O. Uttenbogaard
Co-Project Director

Mrs. P.I.L. Imbulana
Chielf Irrigation Engineer

Mr. S.S.L. Weerasinghe
Chielf Irrigation Engineer

Mr. M. Balakumar
Irrigation Engineer

Mr. S.S. Ranatunge
O&M Specialist

Department of Agriculture

Dr. G.A.C. de Silva
Deputy Director (SEPC)

Mr. W.J.K.V. Ranjith
Assistant Director

PGIA

Dr. E.N.R. Gunawardena
Head, Department of Agricultural Engineering
Faculty of Agriculture
University of Peradeniya
Peradeniya

Dr. W.A. J. M. de Costa, Senior Lecturer
Department of Crop Science
Faculty of Agriculture
University of Peradeniya
Peradeniya

Provincial Councils

Mr. D. Mangalagama
Irrigation Engineer
Central Engineering Department
Central Provincial Council
Building Department Complex
Kandy

Mr. Upali Amarasinghe
Divisional Irrigation Engineer
Galle

Mr. D. Mallikarachchi
Deputy Director, Irrigation Department
Sabaragamuwa Province
Bandaranayake Mawatha
Ratnapura

Mr. M.A.M.S. Munasinghe,
Director, Engineering
Provincial Engineering Department
North Western Province
Kurunegala

Mr. P.H. Jayawardena, Director Engineering
Provincial Engineering Department
Western Province
Colombo

Faculty of Engineering, University of Peradeniya

Dr. G.E. Amirthanathan
Senior Lecturer
Department of Civil Engineering

Dr. N. Wickramanayake
Senior Lecturer
Department of Civil Engineering

Dr. S.B. Weerakoon,
Senior Lecturer
Department of Civil Engineering

University of Moratuwa

Dr. Sohan Wijesekara
Senior Lecturer
Department of Civil Engineering

Faculty of Engineering
University of Moratuwa
Moratuwa

MEA

Mr. H.A. Wickremaratne
Chief Irrigation Engineer
Mahaweli Economic Agency

Jawatte Road
Colombo 7

DAS

Mrs. D. Dharmawardene
Deputy Commissioner
Department of Agrarian Services

North Western Province
Agrarian Services Office
Kurunegala

IIMI

Mr. Nanda Abeywickrema
Director, International Cooperation

Dr. C.M. Wijayaratna
Head, IIMI Sri Lanka Field Operations

Dr. Douglas J. Merry
Program Leader, Sector Level Management and Public Irrigation Organizations

Dr. D.F. Marikkar, Consultant
IIMI/SLFO

IMD

Mr. G.T. Jayawardena
Additional Director

Mr. W.H.E. Premaratne
Additional Director

Mr. S. Danansuriya
Deputy Director

NGO (FFHC)

Mr. A. Mahadevan
Engineer
FFHC Board

17, Malalasekera Mawatha
Colombo 7

IRMU

Mr. B.M.S. Samrasekera
Deputy Director

Dr. K. Azharul Haq
Technical Advisor

Mr. P. Muthukumarana
Research Associate

Mr. K. Hemakeerthi
Research Officer

Mr. J.J. Upasena
Research Officer

Mr. K.A.S. Susantha
Irrigation Engineer

Ms. S. Malini
Irrigation Engineer