

**EFFICIENT UTILIZATION OF IRRIGATION WATER
IN SMALL TANKS**

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ABSTRACT

During the last two decades, more emphasis has been paid on small schemes rehabilitation and vast investments have been made in this context. Hence it is imperative to review the performance of the past projects. Their impact on irrigation and agricultural developments should be ascertained. The lessons learnt and experience gained in implementing those projects should be incorporated in future projects. As such, the strategies, concepts and activities developed under NIRP for improving the water utilization efficiency in planning, construction and sustainability aspects are discussed in this paper.

Planning Aspects

- ◆ Any irrigation rehabilitation package should consist of Institutional, Technical and Agricultural components. These components are inter linked by three performance activities (i) effective implementation of O & M (ii) supply of irrigation water required for the crops and (iii) appropriate cultivation practices. The overall success of the rehabilitation program depends on the extent of the concentration of the three main components and the success of the performance activities.
- ◆ For sequential and smooth (trouble free) implementation of a project, flowcharts (work plans) for pre construction, construction and post construction phases should be prepared. Common such flowcharts with relevant items/ activities which can be used for any rehabilitation program are illustrated.

Construction Aspects

- ◆ The conceptual changes are necessary in physical construction aspects. The approaches developed and lessons learnt under NIRP on FO contract works and 10% of the farmers' voluntary contribution are discussed herein.
- ◆ Deviating from traditional rehabilitation packages, two special application research programs conducted on small tank deepening and low cost channel lining. The methods and the results are discussed.

Sustainability Aspects

- ◆ More emphasis should be paid on the sustainability of the schemes after rehabilitation. Under this two actions were taken - (i) appointment of a water master cum caretaker for water management (ii) development of scheme level Maintenance Fund. These activities are implemented in nearly 300 schemes.
- ◆ Performance Assessment Survey was conducted in all NIRP (953-nos.) schemes. The indicators developed and the categorization method according to the marks are discussed. Similar on going annual performance evaluations are recommended for all the irrigation rehabilitation projects.

1. INTRODUCTION

Irrigation can be defined as the process of artificially supplying of water to soil for growing crops. Since the demand for irrigation is gradually increasing, more and more attention has been paid for the planning and designing of efficient and economical irrigation systems. Especially in Sri Lanka, since the land and water resources are very limited the efficient utilization of available water resources for improving agriculture is of paramount importance.

Mainly there are two types of irrigation systems in the country - tanks (reservoirs) and anicuts (weirs). The tanks are mostly located in the dry zone to store water during the rainy period and distribute it during the dry period. From the anicuts the water level of a stream is elevated and diverted to the irrigated area, as such they are mainly located in the wet zone. For the convenience of control and management those irrigation systems are grouped into three categories based on the command area; Major schemes (command area above 600 ha), Medium (80 to 600 ha) and Minor (Small) schemes (below 80 ha). Construction of new schemes are very limited due to their high cost involvement and limited water resources and therefor more attention is paid on rehabilitation of the existing schemes.

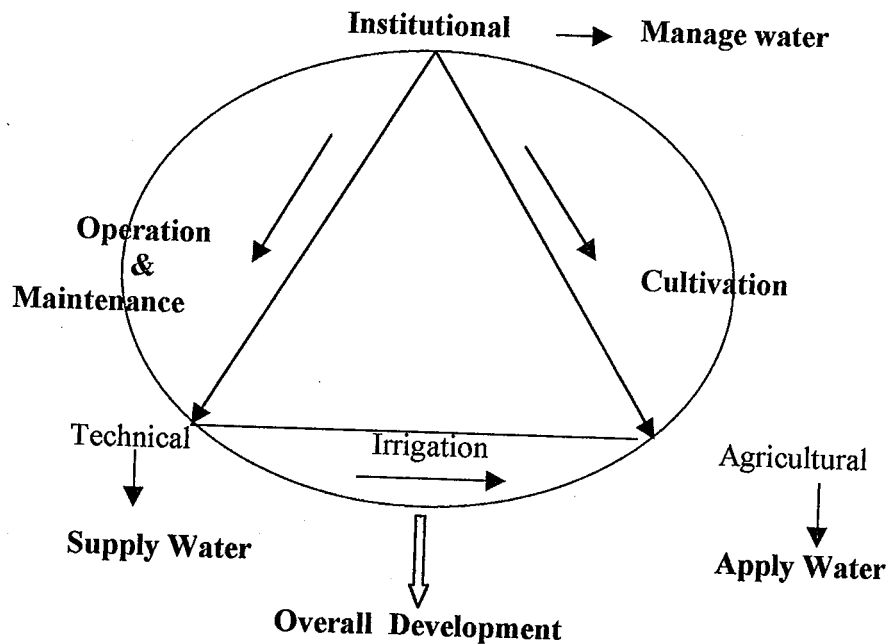
The experience gained under the recently completed National Irrigation Rehabilitation Project (NIRP) and the proposals to apply some of those experiences for any irrigation rehabilitation project (including major schemes) are discussed in this paper.

2. STRATEGY FOR IRRIGATION DEVELOPMENT IN PLANNING PHASE

2.1 The Development Approach

What is the best development approach in an irrigation rehabilitation program? Is it the prevailing system of formation of Farmer Organization (FO) first and commencement of constructions next or do we need to go further backward?

Since the irrigation rehabilitation is multi-disciplinary it should encompass the Technical (T) (Irrigation Rehabilitation), Institutional (I) (Organizational) and Agricultural (A) components.



Those three main components (TIA) are inter-linked with functional & performance activities. The success of the overall rehabilitation program depends on the success of all the three individual components and the functional activities. Hence equal priority should be given for all the three TIA components from the project planning stage. The functional activities are the keys to the success and those are the measurable indicators to review the success of the project. For example, after rehabilitation the required irrigation water should be supplied to the crop. At the same time, the farmers should make arrangements for systematic water distribution and maintenance program. The success in agriculture depends on the proper and timely cultivation practices followed by the farmers.

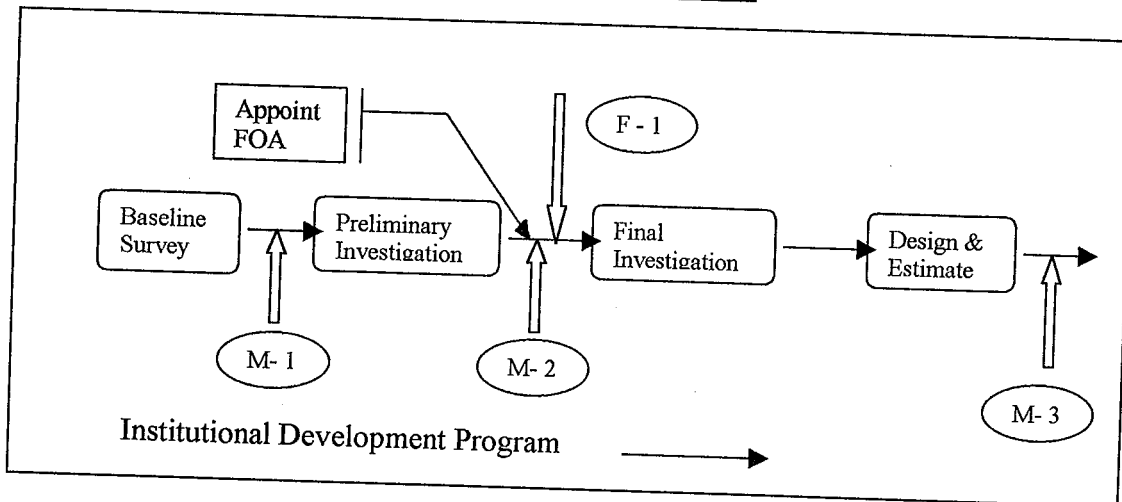
Since these components as well as the activities are inter connected it rotates in a circle. The best results can be achieved if the circle is rotated anti-clockwise commencing from the Agriculture. The rehabilitation needs should be determined taking into consideration the constraints/ difficulties faced by the farmers during the previous cultivation seasons. The farmers in organizational mode, should identify their problems in cultivation and ensure that the constraints are overcome in the rehabilitation program

In some of the NIRP schemes, the FOs complain that their rehabilitation needs are not properly attended. In some, even after the rehabilitation the main irrigation problems have not been solved. Hence, from field to water source (tank) approach is more appropriate than the water source to the field approach.

2.2 The Work Plan for a Rehabilitation Program

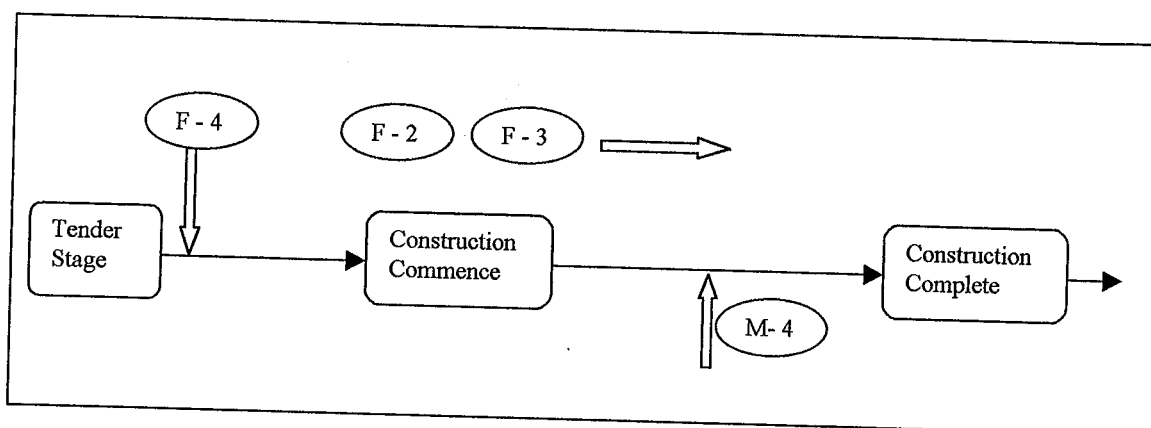
An overall work plan from the initial stage to the final stage is essential for uniform and successful implementation. Based on NIRP experience the following work plan is recommended at each of the three stages namely Pre-Construction, Construction and Post Construction - Operation & Maintenance (O & M) phases. In small schemes this program can be implemented at scheme level and in the large systems in D (Distributory) channel level.

1. Work Plan – Pre Construction Phase – (6 months)



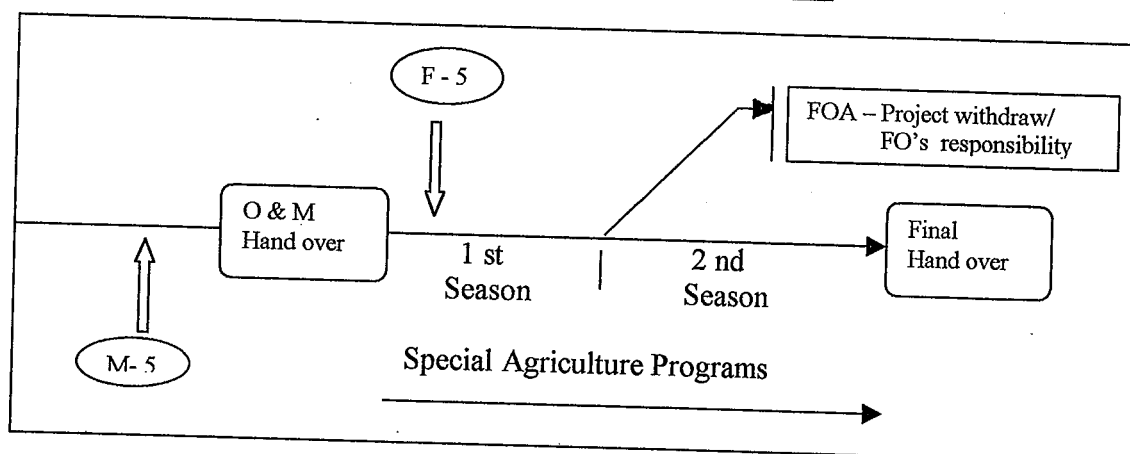
- ◆ **Baseline Survey –** To assess the present status (pre-project situation) of FO, system performance on water distribution and maintenance, agriculture activities and other prevailing problems. This helps to address the prevailing problems in the system and to assess the impact after the project.
- ◆ **M-1 Preliminary Farmer Meeting –** General discussion on project activities How, When, Why and What about the project.
- ◆ **Preliminary Investigation** P R A Approach – Take farmers' views on rehabilitation, field visit (walk through) & Prioritize rehabilitation needs.
- ◆ **Appoint FOA -** Select and appoint a FO Assistant (Middle age Farmer) to assist the FO on Institutional, Rehabilitation and Operation and Maintenance aspects. He/ She will be given training (3days *3 programs) during the 2 year period.
- ◆ **M-2 Secondary Farmer Meeting** Meeting with farmer leaders on surveying – clearing and other labor assistance for surveying works
- ◆ **F-1 Awareness – Training** Project components/activities, farmer participation and FO contracts and their involvement in rehabilitation package.
- ◆ **Final Investigation –** Surveying & Leveling (Field Works)
- ◆ **M-3 Ratification Meeting** to discuss the 10% contribution, FO contract and other activities and confirm the rehabilitation proposals.

2. Work Plan - Construction Phase (12 Months)



- ◆ F-2 Institutional Development Program (2 days) for farmer leaders
- ◆ F-3 Financial Management Training for farmer leaders (2 days)
- ◆ F-4 Construction Training – (2days) Class room & Field Practical
- ◆ M-4 Construction Review Farmer Meeting (when 50% work completed)

3. Work Plan Post Construction (O & M) Phase (6 months)



- ◆ M-5 O & M Handing Over Farmer Meeting
- ◆ F-5 O & M Training (2days)
- ◆ FOA – Farmer Organization Assistant. All the assistance given to FOA by The project is terminated at this stage and an allowance should be paid by the FO for his service.

In general, the water management programs should be implemented during first two cultivation seasons after rehabilitation. During the first season the improved operation and maintenance (O & M) and new agricultural practices have to be introduced. During the second season the farmers themselves should implement O & M program with the required guidance from the officers. After the season the scheme is completely handed over to the FO.

3. CONCEPTUAL CHANGES NECESSARY AT THE CONSTRUCTION PHASE

3.1 More Farmers Participation in Construction Activities

Irrigation rehabilitation is a joint effort. Its success depends on the extent of beneficiary involvement and close collaboration between officers and beneficiaries. The irrigation development strategy adopted before 1991, focused mainly on the construction of the physical irrigation system and the farmers' participation was only sought upon completion of construction. The NIRP approach in contrast, is to have the whole development process combined with beneficiary participation from the stage of selection of the scheme up to handing over. For this purpose Institutional Organizers (IOs) were appointed (one person for two schemes) and they are expected to work in close liaison with the officers concerned to ensure farmers' active involvement. The weakness observed in this concept was, that the IO's perform their duties at pre-construction & construction phases but failed to do so in O & M phase. It indicates the capability in official functions rather than the farming (agricultural) functions. As such the whole development effort made so far may be gradually erode. Therefore, it is proposed to appoint a farmer representative (middle age person who has a commanding authority) in future development projects.

3.2 FO Contracts-

Awarding the contracts of rehabilitation to the FOs was made compulsory firstly under NIRP. The aim was to get their active involvement in the construction activities. The FOs are encouraged to take either part or full contract mainly because it (i) creates awareness on quality & standards which facilitates O & M. (ii) reduces conflicts and complaints and (iii) helps to develop FO's fund. The FO has the option to take over the full or part of the contract depending on their resources and capacities.

As a study, in 10 schemes in Badulla District instead of awarding the full contract to FO, each was divided into packages and awarded to small farmer groups (5 to 10 members) within the FO. The observed benefits are (i) all members actively participate in construction. (ii) quality upgraded due to self monitoring (iii) speedy construction with less capital (iv) team work, cohesiveness and leadership are developed (v) 5% deposit from each group's payments build-up the FOs' fund. Some difficulties/constraints experienced are (i) skill labor shortage due to parallel constructions (ii) need for continuous supervision from officers' (iii) payments at short intervals. Since this program has been highly successful, it is extended to all Integrated Rural Development Project's schemes in the district.

3.3 Farmers Contribution

Ten percent (10%) farmer's contribution is a new concept introduced under the NIRP. The objective of this compulsory participation is to create a sense of ownership of the scheme and create competence in construction activities, which is useful for effective O & M program. In NIRP 953 schemes, 10% contribution works were satisfactorily done in 736 schemes. In Mahawali System "H", the FO assistance for survey labor works, reservation demarcation and protective measures considered as a part of the 10% is an appropriate approach. The difficulties in getting farmers contribution under NIRP are only due to main construction delays or defects. Some of NIRP farmer contribution works are commendable. About 30 year old "Wetakaya" (Spiky plant) cleaning in main stream to about 2 km, in Halpanbissa anicut in Galle and 1.5 Km long 3 m wide service road formation in anicut in Badulla are two good examples. They expressed the view that they didn't consider much on compulsory contribution, but the concept was utilized to meet a long felt necessity.

3.4 Appropriate Technology for Construction

The normal irrigation rehabilitation package consists of earthwork and some concrete structures. By this traditional approach the tank may get rehabilitated but the performance improvements are less. That is because, here more attention is paid on physical structures but not on the irrigation applications. The Department of Agrarian Services (DAS) conducted a number of action research programs on these aspects of which two are discussed here.

(a) Small tanks deepening program

The tank water losses are directly related to water spread area and consequently to water depth. Mathematical computations and water balance simulation models show that when the tank water is at the optimum height (between half and three quarter of the maximum water height of the tank) the percentage of water losses is minimal and thereby irrigation potential is maximized. Hence, the increase of the water holding capacity at the optimum water height is considered the best remedial approach to increase tank irrigation efficiency.

To achieve this, three following categories of physical and geometrical (shape) changes in small tanks were identified. Two programs in each category was conducted in Kurunegala and Anuradhapura district.

1. **De-silting** – Most of the small tanks built centuries ago have silted up considerably reducing their capacity. Hence the removal of the silt mainly at the optimum water heights was done to increase the effective water holding capacity.
2. **Enlarging** – Excavation and removal of the new soil at the optimum heights and increasing the capacity. The removed earth was evenly spread above the full supply level without disturbing the water inflow.
3. **Deepening** – In most of the tanks water spread area at upper contours were very high and caused high losses. In this process the water-spread area at the highest contours was reduced at suitable places. This is done by deepening the tank at optimum height interval and forming a platform (cut and fill) at high water spread places.

The observations and some of the recommendations are;

- the De-silting (category 1) is an uneconomical process. This has to be implemented when there is no other option to increase the capacity (e.g. raising the spill). The increase of dead storage is an additional benefit to the villagers.
- Proper soil investigations should be carried out before Enlarging and Deepening. The excavation should be limited to a minimum 450 mm above the gravel layer. The earth removing area and the volume should be pre identified and in placing the water courses kept well open. By compacting the removed soil and turfing and tree planting re-erosion can be prevented. The assumption that tank desilting will disturb the hard pan resulting in drastic increase in S & P losses is not tenable.
- In general the term desilting is used for all the three categories. The argument that – instead of high cost desilting the capacity can be increased immensely by a slight raising of the spill level is not acceptable. The intrinsic advantage is that, the water value at the optimum level is higher than that at the spill level.
- Though the increased capacity is comparatively small (1.5 to 3 ham) it is adequate to provide two water issues in January, the most critical month. Hence the increased capacity is for the “life saving” of the crop.

- The Enlarging is more suitable for smaller tanks (10 to 20 ha) and Deepening is for comparatively larger tanks.

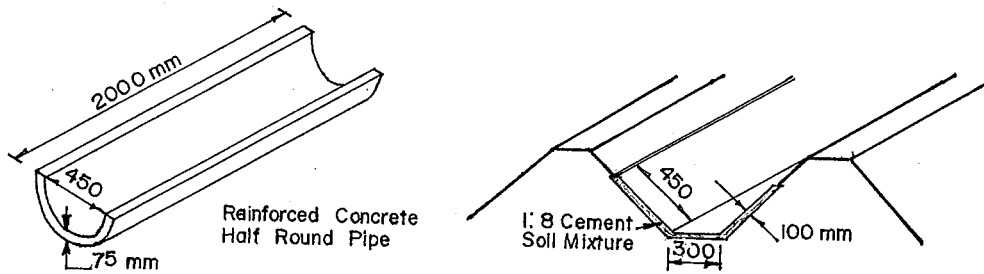
This program was highly successful and extended to implement in 100 schemes in Kurunegala District with the financial assistance from the Agricultural Ministry.

(b) Improve the irrigation efficiency in the conveyance system

In the Dry zone tanks the water conveyance losses are very high (20%) and water distribution is highly time consuming. The major causes are (i) high S & P losses in sandy clay earth channels (ii) rapid weed growth in the earth channels thereby reducing the velocity and increasing the losses and (iii) damages to the earth channels by stray cattle during the off season and consequent increase in water wastage. To overcome these problems two studies were conducted.

(i) **Half round pre cast concrete channels** were introduced and tested.

(ii) **Soil cement lining** – Cement: soil 1:8 mixture was used and for 8 to 10 cm thickness the trapezoidal channel section was formed.



Both methods are low cost very simple technologies capable of minimizing most of the above constraints.

- ◆ The half-pipes can be cast by FO groups or local pipe casting yard easily at a cost of Rs 750 per linear meter (Lm). Transport of pipes within the site and laying are done by the farmers voluntarily. This method is cheaper and quicker than normal concrete lining (approximate cost is Rs 1450) and high quality can be maintained. Easy repair and maintenance is an added advantage. Since the land required for concrete pipes is 50% less than the earthen channels small land holding farmers prefer this system.
- ◆ The cement soil lining is also a very cheap method since the cost incurred on cement and skill labor only. At first, the FO needs to form well compacted, proper channel section. Then the cement & sand at 1:8 thoroughly mixed dry and water is added to the optimum moisture content. Soil used should not contain more than 35% fine fraction passing 200 sieve. The mixture is placed on the subgrade to 8-10 cm thickness and properly compacted. Then the section is covered with wet straw for 10 days for curing. From one cement bag (50 kg) average 3 m long channel section can be formed and average cost is Rs 200 per Lm.

This technique paves the way for an efficient and effective water management program and thereby improves the irrigation efficiency significantly. The half round is more appropriate for loose sandy or highly clay type places where proper channel sections cannot be formed by earth. The cement soil mix is suitable for hard grounds where proper earth channel section can be formed before lining.

4. REMEDIAL MEASURES FOR EFFECTIVE O & M

Even after proper rehabilitation, sustainability of the system for effective and long run O & M is a problem. Due to inefficient management and inadequate maintenance of irrigation structures the entire system is bound to deteriorate. In NIRP schemes following two steps were taken to maximize the sustainability on water management aspects.

4.1 Water Management – Appointment of Water Master cum Care-Taker

Though the scheme level FOs are developed it was found that the Water Master cum Caretaker for water management activities was a necessity. He is nominated by the FO and appointed by the Commissioner of Agrarian Services. That is merely for bestowing some legal authority and to making the appointment more formal. He is responsible for implementing water management programs and an allowance is paid after collecting a fee (Rs 100 per acre) from the farmers after harvesting. The protection and preservation of the components (such as anicut planks, sluice gates) of the scheme is one of his main responsibilities. So he acts as a caretaker of the scheme. The extension of his services or replacement is a responsibility of the FO.

4.2 Maintenance – Maintenance Fund Development

Building-up Maintenance Fund at scheme level is a long felt need. Farmers naturally tend to attend to the labor-involved maintenance works (clearing, earthwork etc.) but not minor repairs or works that need money. (replace or repair the gates etc.). As a result, the whole system is bound to deteriorate and lead to re- rehabilitation. To avoid such circumstances a program has been launched to form a maintenance fund in most of the NIRP schemes. The target at the first phase is to collect an average of Rs.500 per acre to raise Rs.25, 000 – Rs.50, 000 per scheme depending on the cultivated extent. The FO deposits this money in a bank for a period of 10 years. Before commencing the cultivation season (once in 6 months) the deposit interest (about Rs.2500) can be spent on repairs on the decision of the cultivation meeting. This is a very effective approach and nearly in 300 schemes the program has been launched successfully.

5. PERFORMANCE EVALUATION (PA) OF NIRP SMALL SCHEMES

Need for Performance Assessment Study

Normally the performance assessments of irrigation schemes are done by outside agencies at the end of the project (generally one year after the project). By that time it may be too late to rectify any mistakes. It may also be rather difficult to get firsthand information since most of the officers involved may not be available or interested.

The Objectives of the Study

The main objective of the study is to assess and grade all the NIRP schemes based on performance indicators and make recommendation for improving project activities to achieve the set targets.

The Specific Objectives are;

- (1) to identify the percentage of the success of the schemes on FO Development, Rehabilitation and Agricultural Activities and rectify any possible mistakes early.
- (2) to make recommendations based on the performance- establish and strengthen the high graded (A & B) schemes; assist and promote the medium (C & D) schemes which have potential for development and exclude the lower grade (E & F) from further investments.

The Key Areas and Main Indicators – The 7 indicators under each key area are as follows;

Key Area	Performance Indicators
A. Institutional Activities	A-1 Membership
	A-2 Farmers Meeting & attendance
	A-3 Books & Records Maintenance
	A-4 Membership Fee Collection Rate*
	A-5 Fund available in FO's account*
	A-6 Assets per Member*
	A-7 Auditing & Transparency
B. Rehabilitation Activities	B-1 Ratification Meeting
	B-2 10% Contribution*
	B-3 FO's Contracts
	B-4 Private Contracts
	B-5 Farmers' Involvement in Construction
	B-6 IDCL Success (I-Identification, D- Design C- Construction Quality & L-Liaison between the FO & the Construction Agency*
	B-7 Overall Rehabilitation Success*
C. Agriculture Planning & Implementation.	C-1 Cultivation Meeting
	C-2 Performance of Water Master
	C-3 Improvements in Irrigation efficiency
	C-4 Maintenance Fund Development*
	C-5 Maintenance Plan & Implementation
	C-6 Increase in cultivation extent & Cropping Intensity*
	C-7 Overall Agricultural Success*

This survey was conducted in 2 phases in September 1997. Firstly the data were collected from IOs by using a questionnaire. Secondly it was cross-checked with farmers' representatives and Divisional Officers. Marking system was introduced on the % of success. Maximum marks given for each indicator is 10 but for important indicators shown in * is 20. The total marks for each key area is 100. (e.g. If the % of success in A-1 & A-4 indicators is 70% the given marks are 7 & 14 respectively).

On the basis of marks obtained under each indicator, the total marks received for each key area is given in Table. On an average, above 60 marks (A & B) can be considered as successful schemes and between 45 to 60 (C & D) are schemes potential for improvements. The schemes below 30 (E & F) are of low performance and after investigation, the non-suitable schemes can be dropped to avoid further investments.

Hence Successful Number of Schemes	(Marks above 60)	= 337 (40 %)
Potential for Success	(Marks 45 ~ 60)	= 402 (42 %)
Unsuccessful Schemes	(Marks below 45)	= 174 (18 %)

Grading of schemes (Total 953) and % according to the marks.

Key Area	A Above 75 Marks	B 60 ~ 75	C 45 ~ 60	D 30 ~ 45	E 15 ~ 30	F Less 15
1. FO Developm.	55 (6%)	285 (30%)	351 (37%)	203 (21%)	56 (6%)	2 (0%)
2. Rehab. Activities	337 (35%)	332 (35%)	181 (19%)	77 (8%)	17 (2%)	9 (1%)
3. Agri. Activities	40 (4%)	184 (19%)	347 (37%)	228 (24%)	114 (12%)	40 (4%)
Overall Average	40 (4%)	337 (35%)	402 (42%)	146 (16%)	25 (3%)	3 (0%)

The factors contributory to high performances are;

1. Leadership of FOs' and the activism and dedication of IOs.
2. Success of IDCL (Indicator B-6). Especially the coordination between officers and FO's has direct impact on success.
3. Farmers' interest evinced for rehabilitation and their adherence to project activities.

The reasons observed for low performances are

1. Low rainfall and the consequent unsuccessful cultivation during the past 5 years. As a result, farmers have lost interest on FO activities and system maintenance.
2. Conflicts among members due to political intervention and or mis-management of the FO leaders. In about 16 schemes the FOs are inactive due to these reasons.
3. Location of schemes (10 Nos.) closer to the civil disturbance area. So cultivation and FO activities are at a standstill.
4. Low performance in IDCL – Wrong identification & selection (12 schemes) e.g. land ownership problems, non-adherence to selection criteria etc.
Design defects –(4 schemes) due to improper investigation & designs the new irrigation facilities cannot be obtained.
Construction defects – prevails in 50% of the schemes at various levels.
Liaison inadequacy – delay in payments and in technical assistance to FOs affected the overall performance.
5. Low priority of some farmers. In some of the schemes farmers pay low attention since they have lands under other tanks, or other income sources. So the others are also discouraged or reluctant to make their contributions.

This type of ongoing annual evaluation is recommended for all the rehabilitation programs in future because it helps to identify and rectify the mistakes during the project period itself. The "Postmortem" type evaluations conducted after the project does not have any impact.