Interdisciplinary Approach to Improving On-Farm Irrigation Systems

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I. Introduction

The basic purpose of an irrigation project is to improve the well-being of mankind through increased food production. To achieve this purpose it is necessary that an irrigation project fulfill the following objectives (Clyma, 1982):

1. A water control system that is:
   a. Predictable — quantity and time;
   b. Equitable — distribution to turn-outs along a canal reach;
   c. Adequate — in amount of water delivered to each turn-out
2. Increased productivity
3. Farmers' involvement in system management
4. Resource conservation
5. Return on investment.

The reason an irrigation project often fails to satisfy the basic purpose is because one or more of these objectives are not achieved or need significant improvement in some respect. In many cases improvement plans are made without knowledge of the system's present condition. This creates more problems while not solving the real problem, or (more likely) the symptoms are treated but the real problem remains unsolved. For example, one of the important practices of canal maintenance is desiltation of canals. Desiltation is a solution to a symptom, and should be done at least once a year. However, the real problem is the source of sediment, such as canal bank and bottom erosion and sediment carried from catchment area erosion; this problem should be solved before desilting the canal bottom. Salinity and a high water table are other significant problems in irrigated land. Salinity is caused by salts present in irrigation water and high water table. Both waterlogging and salinity are symptoms of over-irrigation. Because of a low water use efficiency, quite often well-drained soils become poorly drained saline soils after the water table is built up by over-irrigation.

There are many other problems which constrain food production from irrigated agricultural land. These problems may not be identified and solved by a single discipline. The discussion in this paper is based on the experience and knowledge*

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gathered from a workshop entitled "Diagnostic Analysis of On-Farm Irrigation Systems", held 2 July to 6 August, 1982, in Sri Lanka. This paper will present the concept and procedures used in the workshop.

II. Concept of Interdisciplinary Approach

On-farm irrigation water management is not well understood or managed by a single discipline. It is such a complex system (Figure 1) that an effective interdisciplinary team is a necessity for understanding and solving problems. The concept of an interdisciplinary approach is that it includes the essential disciplines necessary to adequately understand and manage the components of a system as a total system (Clyma et al., 1977). The members of the team should respect the contributions from other disciplines and desire to establish effective communication among them.

An interdisciplinary team of five specialists was considered to identify problems and constraints to system efficiency and food production of an irrigated agricultural area. These specialists included (but are not limited to):

1. On-farm engineer
2. Irrigation engineer
3. Agronomist
4. Extension person or sociologist
5. Economist.

There should be no order of importance to the activity of each specialist; each acts as a member of the interdisciplinary team. No single discipline can expect to gain an

![Figure 1: A farm irrigation system and its management components](https://example.com/figure1.png)

*Figure 1* A farm irrigation system and its management components
adequate understanding of a farm irrigation system. Quite often a specialist thinks that he or she is the final authority and the most important person in solving problems and improving an irrigation system. As we see from the objectives to be achieved in an irrigation project, this is not true.

A model was developed to improve on-farm water management systems through an interdisciplinary approach (Skogerboe et al., 1980). The model was directed towards increasing the productivity of existing irrigated lands, improving the equity of income distribution, and conserving resources. The model was composed of three phases (Figure 2):

1. Diagnostic analysis to identify values and constraints of system operation;
2. Development and assessment of improvement alternatives that remove key constraints;
3. Implementation of key improvement alternatives as a development program for an irrigated agricultural area.

![Figure 2 Development model of farm irrigation system improvement (after Skogerboe et al., 1980)](image)

As shown in Figure 2, each phase interacts with the others to achieve the best result. Among these three phases, Phase I is the most important, yet it is most likely to be ignored in development planning of an irrigation system improvement. The unique feature of Phase I and its process is the interdisciplinary approach with farmer participation to achieve knowledgeable operation and management of an irrigation system. Systematic problem identification is necessary in order to understand an area’s traditional farming system and to isolate the major constraints to improved on-farm water management and better agricultural production. A diagnostic analysis of an on-farm irrigation system is a method of identifying problems using the interdisciplinary approach with farmer participation to achieve an understanding of system operation.

The purpose of diagnostic analysis is to understand, through an interdisciplinary approach, how and why a system operates in its present condition, with an assump-
tion that the system has potential for improvement. The results obtained with this approach provide the best basis for system improvement and design for rehabilitation. As mentioned above, without a knowledge of present system operation, a solution to irrigation system problems may create more problems while not solving the real problem.

Role of interdisciplinary team

In diagnostic analysis, judgments about the adequacy of the operation of the system are based on the ability of the system to achieve project objectives. As discussed earlier, an interdisciplinary team approach is useful to adequately evaluate and understand the present operation of an irrigation project. The objectives of an irrigation project listed above should be jointly evaluated by the interdisciplinary team.

Productivity is evaluated by agronomists and economists. For example, there may be adequate levels of production, but the economic returns may be inadequate. The agronomist needs to identify the actual yield compared to the potential yield. In many cases farmers cannot prepare their fields in the experimental conditions under which greatest potential yields are achieved. Farmers' involvement in a project is evaluated by the sociologist or extension person. The farmers' role in the diagnostic analysis should not be ignored, since they are real interdisciplinary decision makers with field experience.

Resource conservation requires both engineers and agronomists or the assistance of other specialists. Return on the investment is evaluated under the leadership of the economist, but the actual evaluation requires the knowledge of the entire team. In general, any measures which are necessary to improve an irrigation system require all or part of each specialist's knowledge and should not be determined from the viewpoint of a single discipline.

III. Diagnostic Analysis Study

A workshop in diagnostic analysis was held to provide training interdisciplinary teams in a diagnostic analysis of on-farm irrigation systems. The workshop was held 2 July to 6 August, 1982, in Sri Lanka. The workshop was presented by the Water Management Synthesis Project of Colorado State University (U.S.A.) in collaboration with the Ministry of Lands and Land Development of Sri Lanka and the U.S. Agency for International Development.

The first week of the workshop took place at the Agricultural Research and Training Institute in Colombo, and the last four weeks were spent at the In-Service Training Center at Mahalluppallama. Two irrigation systems of the Mahaweli Development Project were studied during the workshop to identify the problems and constraints. The objectives of the workshop were to teach the following subject areas to the host country professionals who were engaged in an irrigated agriculture:
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1. Discipline knowledge and skills by field activity and experience.
2. Concepts, principles, procedures, and experience of diagnostic analysis.
3. Interdisciplinary principles and team experience in diagnostic analysis.
4. Understanding the operation of an irrigation system in its present condition and identifying problems and constraints.

A team of trainers in the five discipline areas mentioned above and their counterparts from the host country conducted the workshop. There were four interdisciplinary teams of participants. Each team was composed of five participants in the discipline areas and one observer from Bangladesh. The workshop was conducted as the following sequence:

1. Introduction of a study area and selected irrigation system(s) by guest lecturers who have knowledge of the area.
2. Reconnaissance of a selected irrigation system as a preview of the system to prepare for detailed studies and priority problems subjected to analysis later.
3. Detailed studies of the system to collect information and detailed observation of the system's physical, sociological and economical aspects.
4. Report preparation—disciplinary and interdisciplinary reports of observations and findings.
5. Repeat steps 2 through 4 for different study site(s).
6. Final report of the diagnostic analysis of the study area to prepare for a comprehensive interdisciplinary report and to itemize give priority to problems and constraints for input to Phases II and III shown in Figure 2.

The interdisciplinary team combines knowledge and experience with systematic observation of a system to develop solutions which farmers can use to give priority order to problems and constraints.

Two final reports were published by the Water Management Synthesis Project from the results of the workshop in Sri Lanka (Alwis et al., 1983a, Alwis et al., 1983b). More details of the workshop and related information can be obtained from the Water Management Synthesis Project, Colorado State University, Fort Collins, Colorado (U.S.A.). Similar workshops were held in several developing countries around the world.

Role of irrigation engineers

Among the participating disciplines, the role of irrigation engineers will be further discussed and the roles of other disciplines will be briefly mentioned. The irrigation engineer's role in the diagnostic analysis was to evaluate irrigation conveyance systems (from irrigation water supply to field turn-out) in order to identify problems.
and constraints on system efficiency and crop production. The engineer's detailed tasks were:

1. Review and specify the original design and operational plan of an irrigation systems.
2. Observe and measure the operation of the system in its present condition.
3. Evaluate the status of the present system relative to the original design and actual operation.

The first was done by reviewing documents and interviewing officials operating the system. The last two processes were conducted under actual operating conditions. The system was viewed as a continuous flow process from a supply point to field turn-out with discrete control points as shown in Figure 3. At each control point,

![Figure 3](Image)

**Figure 3**  Schematics of an irrigation conveyance system and its control points

variables of water control to satisfy the objectives of an irrigation system (predictable, equitable and adequate) were evaluated. These variables include:

1. discharge rate,
2. supply time,
3. total volume of water supplied,
4. frequency of supply, and
5. water surface elevation in canal.

If values of the variables at each control point listed above are satisfactory for the objectives of the irrigation project, then operation of the system is appropriate. Frequently, the original design and operational plan are contradictory to the actual operation and operational plan. In an example, the actual operational plan, which contradicts both the original design and the operational plan, is to supply a constant and equitable but inadequate amount of water to a large number of farm fields (Alwis et al., 1983a and Alwis et al., 1983b); however, the actual operation supplies an unlimited amount of water in an unreliable and inequitable amounts in time and location to a small number of fields only in the upper part of the system. Therefore, the lower part of the system suffers shortage of supply in an unpredictable and unreliable manner. The design of a farm turn-out assumes a relatively constant flow, but the actual operation attempts to distribute a fixed fraction of a varying total flow which requires variable flow at the turn-out.

In many cases the original operational plan cannot be implemented due to the existing delivery systems. As shown in Figure 4, the system had badly deteriorated under poor or no maintenance, and widely abused by human and animal
Figure 4  Poor condition and abuse of irrigation conveyance systems are some of the constraints to system efficiency and food production. Examples: damaged drop structure of a canal (top), animal watering and bathing in canal (center), and canal bank damaged by human activities (bottom)

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activities. These symptoms were traced to not only engineering problems but also to social, economic and agronomic problems.

At each control point the following questions were raised in order to obtain information under present operating conditions:

1. What are the criteria for establishing the value of each variable at a control point?
2. Is each variable measurable and controllable?
3. What are the criteria for changing each variable in time and space?
4. What are the operational criteria used by canal operators at each control point and the methods of communication between operational personnel and farmers?

These questions could not be answered by an irrigation engineer alone. Instead, it required an inter-disciplinary team to find appropriate and meaningful recommendations for a solution.

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References


