A MANAGEMENT IMPROVEMENT PROCESS TO EFFECTIVELY CHANGE IRRIGATED AGRICULTURE

A. R. Dedrick[1] Wayne Clyma[2]
J. D. Palmer[3]

ABSTRACT

A management improvement program to improve the performance of irrigated agriculture is described. The improvement process entails three general phases. Diagnostic analysis is an interdisciplinary field study to thoroughly understand the actual performance of an irrigation system. Areas of high and low performance are identified. Management planning is a process for organizational change. The process uses the information and understanding obtained from the diagnostic analysis to make important changes in physical structures and/or management procedures for improving irrigation system performance. Management performance is carrying out the management plan. Monitoring and evaluation is included to assist in management decision making and to measure the impact of the changes on system performance. The management planning is done by the key managers in an irrigated area, farmer representatives, and representatives from other involved organizations. Conscious, deliberate applications of the processes offer important advantages to the farming community and to water management professionals. The results are effective, appropriate solutions to many relevant problems in irrigation.

INTRODUCTION

In many parts of the world, and in much of the western United States, irrigated agriculture depends on large water delivery systems. In many instances these systems need to be rehabilitated and improved. But simply rebuilding an existing physical infrastructure may not achieve the high performance delivery service needed to improve on-farm irrigation. Improvements which are appropriate to a given delivery system must help meet the farmer's objectives in using water. If performance of an irrigation system is to be improved, then goals of productivity, economic feasibility, and environmental sustainability must be achieved on a project-wide scale, down to the farm level. As

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[1]Agricultural Engineer, U.S. Water Conservation Laboratory, USDA-ARS, Phoenix, Arizona

[2]Professor, Agricultural and Chemical Engineering Department, Colorado State University, Fort Collins, Colorado

[3]Hydraulic Engineer, U.S. Water Conservation Laboratory, USDA-ARS, Phoenix, Arizona

Replogle and Merriam (1981) noted "The project and the farmers must be considered as a single integrated unit. The farm produces all of the wealth. All costs occurring on the project and on the farm are either paid for by the farmer or must be subsidized, which absorbs wealth from other sources."

But addressing change many times results in a dilemma for an irrigation project manager, as the following hypothetical narrative suggests:

> I am the manager of an irrigation project in an arid climate where we must irrigate to grow crops. Farmers pay little for the use of water, less that 5% of their production costs. The cost is a small fraction of its value. The water supply has always been adequate, even in years of drought. I know the cost of water does not reflect its value as perceived by farmers. Farmers attempt to manage their water carefully - not because of the cost - but because the value of good water management is high in terms of improving production.
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> Farmers continue to install improved field irrigation systems. I know farmers have various criteria for scheduling irrigations. Some use a service that is commercially available, some use the extension service information in the newspaper, and some use their own scheduling process. Other farmers want to order water differently because they have changed their crops. Some water delivery problems have developed when farmers order water in ways that violate at least the spirit of our rules. I know this is caused in part by the district not making rule changes to accommodate needed on-farm changes.
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> Some engineers and some of the farmers have been suggesting improvements in the district. We should be using new or better structures. We should change our rules. We should be measuring water. We should be scheduling district deliveries of water from the farmers' projected schedule. We should be managing our district according to an updated plan. We should be training our staff regularly. We should be providing training to farmers.
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> In the past few decades industry at large has experienced tremendous changes, resulting in improved manufacturing, communications, and services to consumers. Agriculture as an industry has also changed greatly, with unprecedented improvements in production and productivity. But have we changed as a water district? Not much!

> We use different equipment now, but to accomplish functions that were defined many years ago. The basic rules, roles, responsibilities and actions to provide water to farmers remain about the same as when we started. Why haven't our operations improved more? Why hasn't the way farmers order, access and manage their water been improved? Is the modern world leaving us behind?
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> My district manages water according to habits formed over the years. My employees deliver water according to tradition, not necessarily because it's the right way to do things, but because it's the way things have always been done.
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> We cannot improve what we do without involving farmers since what we do affects them. Certain farmers keep suggesting we should change because they say there are better ways to do things now. In many instances the farmer cannot change unless we change.
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> Where should I start? How can I decide what is "right" and what is "wrong" to change? Who should decide? If I decide to change and I am wrong, some farmers may go bankrupt and I would probably lose my job! It seems like there is a lot of risk. What should I do?

The observations and questions of this hypothetical irrigation district manager reflect our perceptions of the conditions, problems and issues that irrigated agriculture faces. For change to be successful, the problems constraining performance improvement must be considered carefully. Addressing these problems is complex and rarely as easy as simply continuing tradition. Adopting "off-the-shelf" technology such as canal lining, new gates or other solutions may not address the key problems and issues or accomplish the needed change.

Effective improvement requires a) a thorough understanding of the existing overall system, b) involvement by several key decision makers in a joint decision process, and c) responsible decision makers carrying out the planned changes. A management improvement process can accomplish these three key goals. The objectives of this paper are to describe and discuss such a management improvement approach for changing the performance of irrigated agriculture and to present an example of applying the first step, diagnostic analysis, to an irrigation district.

MANAGEMENT IMPROVEMENT PROCESS

<u>Diagnostic analysis</u> (DA) is a process which leads to thorough understanding of system performance. <u>Management planning</u> builds

on the understanding from the DA: changes which are necessary to sustain and improve performance are planned. Management performance is the process of carrying out the management plan and monitoring and evaluating the impact of changes made in an irrigation project or organization. These three processes represent a management improvement approach to improving the performance of irrigated agriculture.

The purpose of a management improvement program is to improve the performance of an irrigated area. The program involves farmer representatives and individuals from the relevant organizations (the team) in a field study of the irrigated area to identify opportunities for improving performance. The team decides how system and management changes can improve performance. Some key objectives of the effort are to:

--reach a common understanding of the general process of management improvement including its purpose, outcomes and approach to meet specific project needs;

--develop a common understanding of the most important aspects of system performance, including areas of high and low performance and the causes of each performance level;

--develop a management plan for improved performance that includes system improvements and improved management for low performance areas;

--carry out the management plan with monitoring and evaluation to improve management decision making, and periodic replanning to continue improving performance.

The general approach to the management improvement process is illustrated in Fig. 1. The process is cyclic in that once commitments and plans are made to improve performance, the management and field performance of the irrigation unit is assessed (DA). A management plan is then developed to improve the performance using the understanding gained from the DA. The management plan is then implemented and evaluated to assess the impact of changes made within the irrigation unit, and replanning is done on this basis to adjust the management plan (path B, Fig. 1). Another diagnostic analysis is completed if needed (path A, Fig. 1), and the cycle is repeated.

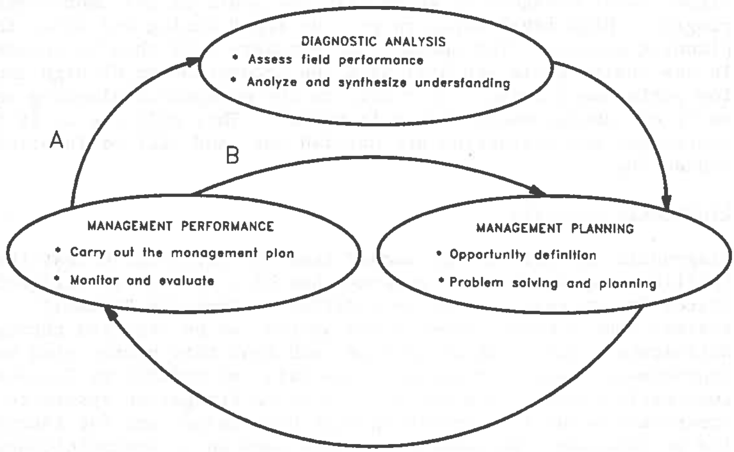

Figure 1. Management improvement process phases for improving performance of irrigated agriculture.

The decision to improve the management of an irrigation project can be made at any level. Farmers, irrigation districts, or other agricultural or irrigation related agencies may make the decision to initiate a management improvement program. The next step is to get managers in the key organizations to commit to an improvement program.

The management improvement steps are conducted by teams of individuals, with each individual filling a defined role. A team leader provides overall leadership to the program to assure that stated purposes and outcomes are accomplished. A management planning specialist provides management knowledge and skills needed to effectively carry out the program. The management planning specialist also serves as a facilitator to the entire management improvement program. In most cases, the team will be learning to plan organizational change while planning organizational change during the management improvement process. A facilitator can greatly improve this learning process.

The key to successful management improvement of an irrigation unit lies in involving the leaders of all concerned groups (e.g. farmers, project upper and middle [operational] level managers,

managers of government assistance and regulatory agencies, etc.) in the entire management improvement process. The personnel involved must be in decision making positions. The exact role of a project manager is defined for each improvement effort and is flexible. Middle level operational managers should be mandated by higher level managers to accomplish the goals of the improvement program. High level managers provide input during and after the planning process. The operational managers will then be involved in the entire cycle and will have the understanding of high and low performance areas. They will do the management planning and carry out change where change is needed. They will see to it that monitoring and evaluation are carried out, and will be involved in replanning.

Diagnostic analysis

Diagnostic analysis is approached from the perspective that the familiar, day-to-day view a person has of a system, an irrigation system in our case, may be very different from the "actual" system; that a better view of the system can be realized through a deliberate sequence of activities; and that this better view makes improvement easier. Diagnostic analysis, as defined by Clyma and Lowdermilk (1988), is a field study of an irrigation system to understand needs for sustaining high performance and for improving low performance. Diagnostic analysis uses an interdisciplinary team for examining interrelated components of an operating irrigation system (Lowdermilk, et al., 1983).

The main objective of diagnostic analysis is to collect information that can provide a basis for understanding management performance. Both the management and field performance of the important management units within an irrigation project are assessed. The management units, in the case of an irrigation district, include the entire delivery system as well as on-farm water control systems. Important areas of high and low performance are determined and causes of this performance are identified. The diagnostic analysis phase can be broken into the following steps:

--A detailed plan for completing the diagnostic analysis is developed.

--A rapid diagnosis is completed in which project personnel at all levels and farmers, farm managers and irrigators are interviewed to establish how the irrigation project is being operated/managed. Background data and additional data on the physical system are used as needed to define the actual performance of the system.

--A detailed diagnosis is organized which includes analyzing data and synthesizing an understanding of the performance of the irrigated area. The result of this step is a report which defines the performance of the key management units of the related organizations, including farmer operations, the areas of high and low performance, and the causes of high or low performance.

--The report is presented to key managers and farmers and initial plans are developed for the management planning phase.

Team members for planning the diagnostic analysis include key design and management personnel from the irrigation project being studied, plus other outside specialists as needed. A planning workshop, facilitated by a management specialist, establishes the context and needs for the irrigated area, the purpose and objectives for the effort, the roles and responsibilities for the team, and the plans for the overall process. Team members for the interviews and data collection step include key district representatives and in some instances farmers.

Management planning

Management planning is the process of determining opportunities for sustaining and improving performance and detailing the plans to make improvements (Jones and Clyma, 1988). The purpose of this phase is to reach a common understanding of the performance of the irrigation project including the causes of high and low performance, based upon the results of the diagnostic analysis and from the knowledge and experience of the participants. The management planning process generally involves the following steps:

--A detailed plan for completing the management planning phase is developed.

--A workshop is organized to define opportunities for improvement. Team members reach a common understanding of the performance of the district and the causes of high and low performance. The outcomes of this phase are to determine which low (and high) performance areas have most significant impact, determine what conditions are causing this level of performance, assign priorities to the performance areas with high impact which can feasibly be improved, and develop general strategies for accomplishing the improvements.

--Problem solving and planning, accomplished through another workshop, focuses on setting goals for improvement, defining objectives, and planning activities necessary for improved performance of the system. This will result in a plan to improve facilities and management procedures, to provide a monitoring and evaluation program to objectively evaluate system performance, and to assist in decision making.

--Finalization of the management planning process involves review, additional input, and approval of the management plan written during the problem solving and planning step.

The management planning process should be facilitated by a management specialist. The management planning team will include the operational managers of the irrigation project, key farmer representatives and individuals from other involved organizations. The team establishes time frames and responsibilities for activities to carry out the management plan.

Management performance

The management performance process involves carrying out the management plan. The monitoring and evaluation parts of the management plan assist the managers' decision making process and help to assess system performance. Monitoring and evaluation provide a basis for objectively judging the effectiveness and impact of the management plan. Experience with the improved system, along with the monitoring and evaluation information, provide the basis for periodic replanning, path B in Fig. 1. When alternative, potential improvements are not sufficiently understood the cycle should be restarted with a diagnostic analysis, path A in Fig. 1. The main steps in the management performance process include:

--Carry out the management plan to improve facilities and management procedures within the irrigation project.

--Initiate the monitoring and evaluation parts of the management plan. Monitoring and evaluation of the changes initiated for both the management practices and facilities are included.

--Assess the performance of the management plan on a regular basis using the monitoring and evaluation results. Revise plans as needed and report changes in performance to key managers.

--After a period of time, generally six to nine months, initiate replanning to assess the management performance and accomplishment. Review progress under the management plan. For those improvements and management changes not performing adequately develop a new or revised improvement process. Include additional important improvements when identified.

Replanning can often be accomplished on the basis of understanding gained from carrying out the initial management plan, from the results of the monitoring and evaluation phases, and/or by reassessing the information gained from the original diagnostic analysis. In other instances, another diagnostic analysis may be required if certain performance areas are inadequately understood.

The replanning is accomplished by the original planning team with assistance from the various involved agencies and appropriate outside consultants.

A new or modified management plan is the result of the replanning process and is developed either by the diagnostic analysis and management planning route (Path A) or by the management planning route only (Path B), Fig. 1. Hence, the cycle of management improvement is completed. Conscientious management replanning can be repeated and potentially institutionalized. The entire management improvement process can be applied recursively to irrigated agriculture within a project area to eventually achieve improvements in many aspects of performance.

DIAGNOSTIC ANALYSIS OF AN IRRIGATION DISTRICT

The authors and others at the U.S. Water Conservation Laboratory (USWCL) conducted a diagnostic analysis of a southwestern U.S. irrigation district to a) learn how to use the diagnostic analysis concepts and procedures, and b) increase the understanding of district operations both to determine needed improvements and to develop an appropriate research agenda for our research program. The DA could be considered incomplete in that an interdisciplinary team was not used; hence, items like crop production performance and economics were not considered, and no one responsible for implementing and evaluating change was involved. The DA did, however, serve to facilitate our understanding of the management improvement processes. Simultaneously, while learning about the processes, certain understandings of the district's operation and on-farm performance were developed. These understandings, though limited, would be shared with district personnel and other interested parties.

The team members from the USWCL had conducted research in the district for a number of years and were familiar with the irrigation process in the area. Most of the research studies had focused on-farm and concerned application systems, water management, automation and water measurement. In 1985 we began to intensively monitor the operations of several district canals to study interactions at the district-farm interface.

The canal monitoring project showed a large amount of fluctuation in flow rates at farm turnouts (Palmer, et al., 1989), which could be traced to actions by ditchriders, physical or hydraulic constraints, and the type and sequence of actions taken to adjust canal structures. It was shown (Palmer, et al., 1987) that such fluctuations could limit the farm irrigator's ability to make accurate judgments about when to change irrigation sets or when to end an irrigation.

The monitoring data helped quantify certain aspects of district delivery service, but many questions were yet unanswered: How do the delivery personnel actually schedule deliveries? How do they decide when and how to adjust structures? How do farmers and farm irrigators communicate with one another and with the district to negotiate flow rates and durations? What if changes have to be made during an irrigation? Does the farmer have the management capability to make use of an improved delivery system? Are the fluctuating flows really a problem? How do district and farm personnel know if they are doing a good job or a poor job?

Background information about the district was assembled and discussed by the team. The team tried to determine the objectives for the water delivery system, and to describe the necessary functions of such systems. Various hypotheses were formed about the performance of the irrigation district in meeting these objectives, and best estimates were made of the causes for that performance.

From a water delivery standpoint the canal monitoring study in the district had produced quantitative data about delivery operations. Additional data needs were seen to mostly concern management decision-making, the behavior of canal operators, and interactions between the district and farmers: information that could be largely obtained through interviews. The team therefore planned for three days of interviews with district management and staff, farmers and farm irrigators.

From an on-farm standpoint, additional information was needed on how farmers were actually making management decisions regarding <u>when</u>, <u>how much</u> and <u>how</u> to irrigate. Two of the team members planned four additional days for interviewing farmers and farm irrigators.

An initial meeting was held with district managers to briefly explain the purpose, objectives and methodology of the DA. A series of interviews was then conducted with the chief engineer, the district manager, the watermaster, the dispatcher, a main canal operator, several lateral canal operators, several farmers, and several irrigators. Interviews were generally from one to two hours long. They were designed to capture the interviewee's understanding about what the system should be doing (examples would be how a canal lateral should operate or how a farmer decides when to irrigate), about the problems and needs of the system, and about the causes of low and high performance. Leading questions were avoided.

<u>Examples of Diagnostic Analysis Results</u>

<u>Delivery System Related</u>: The performance of the delivery system was separated into physical and managerial processes. From a physical process standpoint a number of items were identified that could lead to inadequate water delivery service. Examples were: a) operators had not been trained in hydraulics or canal

operations; b) the written procedures for controlling structures were not applicable under many circumstances and had largely been discarded by operators in favor of highly individualized, experience-driven rules; and c) canals were operated at higher than necessary levels for administrative reasons.

Managerial processes, both district and on-farm, that generally act to over-supply water to the farms included: a) the delivery of extra volumes of water was considered by district personnel to be an additional benefit of delivery service to the farmer, b) at any given time there was 15-25% more water in the system than had been ordered for delivery, available for unscheduled demand, c) farmers have no incentive to order accurate durations of flow, and d) ditchriders usually try to deliver a higher rate than is ordered.

Farm Related: The on-farm decisions regarding when, how much, and how to irrigate were generally not based on adequate or sufficient quantitative information. Level-basin irrigation is the primary irrigation technique used in the irrigation district. The basic criteria for irrigating level basins is to apply the required volume of water to the basin at each irrigation. Factors to consider are contained in the familiar relationship:

$$Q\,t = \frac{a\,d}{DU}$$

where

Q = flow rate, cfs
t = set time per basin, hours
a = basin area, acres
d = net application depth, inches
DU = distribution uniformity, decimal form

An expected operational statement, which is based on the basic criteria of how to irrigate level basins, was "Farmers apply water to the level basins volumetrically." That is, a is measured at the time of design or construction, d is determined by measurement (scheduling process), DU is known from the design and/or is field verified, and Q is measured at the time of delivery. The set time for irrigating each basin (t), can then be calculated once these variables are quantified.

Findings from the diagnostic analysis indicated that essentially none of the farmers interviewed applied water according to time, or volumetrically, to the level basins being irrigated. In nearly all cases, the farmer or irrigator used a point in the field to determine when to stop an irrigation. Hence, how the fields were being irrigated was at odds with the systems' design.

More reasons for not irrigating as originally intended were identified from additional DA findings. For example, an expected operational statement, based on the criteria that d be determined by measurement, was "Irrigations are scheduled using widely recognized approaches of determining when to irrigate and how much water to apply." We found that the farmers were using indicators such as plant temperature, plant appearance, crop harvesting schedule, or historical guidelines to determine when to irrigate. They were, however, generally not using definitive soil, plant or climatic measurements to define how much water to apply. Hence, d in the equation was not being adequately defined which leaves the irrigator in a position of trying to apply an unknown amount of water.

Another expected operational statement, related to Q in the basic design, was "Water is delivered to the farm at the flow rate ordered and remains constant throughout the delivery." In this case we found that the flow rate (Q in the equation) at the delivery point to the farm tends to be different from what the farmer ordered (generally higher). Further, as we had found in the monitoring program, the flow rates fluctuate during the delivery period. Both conditions prevent the irrigator from determining set times (t) before irrigating, even if d were known.

These findings from the DA helped to identify reasons why volumetric control of the level basin systems in the irrigation district becomes essentially unmanageable.

Research Identification

A number of research items can be developed from these preliminary findings. The obvious, and historically traditional items, would be engineering solutions such as new structures, hydraulic modeling, automation and remote control. But, as can be seen from the sampling of results, it is apparent that the irrigation system is a complex mix of engineering works and human elements, that the objectives and operations of such systems evolve over time, and that they are not operated by trained personnel. Further, there is a widening gap between the state-of-the-art and field-level applied technology both in canal operations and on-farm. Research is needed to develop strategies for transferring existing knowledge into effective, appropriate improvements. It is obvious from the items noted in the DA that there is a relative urgency to improve the management of level basins, to develop procedures for transferring management skills to farmers and irrigators, and to develop strategies for widespread adoption of irrigation scheduling procedures.

Presentation of Results to District Management

Since the district personnel were not part of the DA team, two meetings were held to brief the project manager, project engineer, and other key project officers. The discussions illustrated the value of direct district involvement in that it was apparent in some instances that the USWCL's understanding of the water delivery operations was lacking and would have been enhanced with earlier input by the district. Nevertheless, the meetings stimulated fruitful discussions and potentially may result in cooperative studies in which performance improvement opportunities are considered.

SUMMARIZING THOUGHTS

The management improvement processes involving diagnostic analysis, management planning and management performance could help our hypothetical irrigation project manager address some of the concerns noted in the introduction. The diagnostic analysis process gives the manager a place to start. The manager's concern about "how do I decide what is 'right'?" need not be a concern since farmers will be involved in the processes and the decisions that result. "Who should decide?" is inherent to the processes. The concerns regarding incorrect decisions and the financial problems that could develop would be tempered by involvement of all parties, starting with the farmers. The underlying theme for the entire management improvement program is that the farm must benefit. The systematic approach used in the management improvement processes removes much of the risk associated with change. Before changes are made all parties will have agreed on what must and will be done.

The diagnostic analysis that we performed provided new insight and understanding about an irrigation project's performance, both from the water delivery and on-farm standpoints. The process helped illustrate how such a systematic performance improvement program might be used in irrigation projects. Approaches for institutionalizing such programs need to be identified and assessed.

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