INTERDISCIPLINARY TEAMS FOR ASSESSING THE PERFORMANCE OF IRRIGATED AGRICULTURE SYSTEMS

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ABSTRACT

The Management Improvement Program (MIP) provides a comprehensive methodology for supporting improvement in the profitability and sustainability of irrigated agriculture. Diagnostic Analysis (DA), the MIP's first phase, relies heavily on an interdisciplinary team to assess the performance of irrigated agriculture and provide the foundation for subsequent performance improvements. Small group processes are used to build an effective interdisciplinary team and to frame and concur on understandings that integrate the various disciplinary perspectives. This process compels individuals with diverse technical backgrounds to acquire a holistic understanding of an irrigated agriculture system: farm and district economics, on-farm cultural practices, and water management from source to farm gate to field. Structured, periodic professional facilitation is necessary to build and maintain an effective DA Team. Facilitation also helps to assure that all team members actively engage in developing accurate, complete findings that represent the current performance of irrigated agriculture in the study area. Further, stakeholders must be able to understand the DA Team's description of current performance, so they can identify, plan, and carry out needed improvements. A case study is described in which the DA results were received positively and are being used successfully in the subsequent Management Planning Phase.

INTRODUCTION

In many parts of the world, including much of the western United States, irrigated agriculture depends on large-scale water delivery systems. The performance of these systems influences farm irrigation systems, crop

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water management, crop selection, yields, and ultimately, farm profit. For many irrigation projects, improvements in water management, yields, and profitability are necessary to ensure sustainability and economic viability of irrigated agriculture. To be effective, growers, irrigation districts, and support and regulatory organizations must interact in ways that leverage their own resources to improve overall agricultural profitability, long-term resource management and environmental sustainability, and social well-being. For change in performance to be successful, the problems constraining performance improvement must be understood correctly and the full range of likely causes assessed accurately.

In general, addressing these problems is also complex and rarely as simple as applying generic solutions. For example, if the real problems are related to inappropriate policies, then adopting "off-the-shelf" technology such as canal lining or new gates will not achieve the performance impact sought. Rather, the Management Improvement Program (MIP) incorporates the following concepts: (1) a thorough understanding of the performance of the entire irrigated agriculture system in an area (on-farm, delivery, and the broader context), (2) involvement by key decision makers from all entities involved in irrigated agriculture in joint decision-making processes, and (3) planning and implementation of change by operational managers responsible for performance. The key goal of the MIP is to improve irrigated agriculture's sustainability and profitability. Central to the MIP's methodology is the focus on the realities of growers' individual circumstances and on obtaining their direct input and involvement throughout the process.

The MIP is structured into three phases: Diagnostic Analysis (DA), Management Planning (MP), and Performance Improvement (PI). The DA yields an understanding of the performance of irrigated agriculture in the area and provides insight into the causes of high and low performance. During MP, the growers and organizations involved with irrigated agriculture in the area develop a shared understanding of the current performance and its causes and use that understanding to develop a set of coordinated management plans. During PI, the organizations and growers begin implementing the management plans and continue to monitor results, diagnose problems, and replan improvements. More detailed information on the MIP process can be found in Dedrick et al. (1989, 1992, 1993), Clyma and Lowdermilk (1988), and Jones and Clyma (1988).

In this paper, we describe the DA Phase as it was carried out for a demonstration MIP in Arizona. In particular, we focus on the DA Core Team, on its membership, roles, and responsibilities; the small group processes through which it developed the DA findings; and on how the DA methodology differs from traditional approaches to irrigation system performance assessment.

MSIDD DIAGNOSTIC ANALYSIS

A DA was performed within the Maricopa Stanfield Irrigation and Drainage District (MSIDD) during 1991 (Dedrick et al. 1992). MSIDD is located in hot, arid, central Arizona, receives surface water from the Central Arizona Project (CAP), and pumps groundwater. Water potentially is delivered to 34,000 ha from an open channel distribution system, primarily to surface-irrigated cotton.

The end product of the DA was an interdisciplinary understanding of the current performance of irrigated agriculture in the MSIDD area (DA Report, Dedrick et al. 1992). This performance understanding, as reflected in the DA Report, was used to initiate the MIP's Management Planning (MP) Phase currently underway and is the primary reference for the development of management plans to improve performance.

Though the DA involved a wide range of individuals to provide, clarify, and refine relevant data, the assessment itself was conducted by a DA Core Team consisting of nine members: five representing disciplinary perspectives (on-farm water control, delivery system water control, economics, farm productivity, and social-organizational relationships), two MIP consultants (a Management/Team Planning Specialist and an MIP Specialist), a DA Team Leader, and a program and management assistant. Agencies providing the DA Core Team members included the US Department of Agriculture Soil Conservation Service and Agricultural Research Service, the State of Arizona Cooperative Extension, and the University of Arizona College of Agriculture. A somewhat larger DA Resource Team consulted periodically with the Core Team, assisted in planning the DA, and functioned as an information resource and sounding board during the DA fieldwork and an initial review group for the DA findings. The Resource Team consisted of about 20 individuals representing the MSIDD staff and Board of Directors, growers, outside consultants, and representatives from the above

agencies, the State of Arizona Departments of Water Resources and Environmental Quality, and the US Department of Interior Bureau of Reclamation.

DA planning and preparation (March through June 1991) included selecting the DA Core and Resource Teams, clarifying the DA purpose and approach, clarifying individual and team DA roles, planning data collection, and developing sampling strategies and data collection materials.

Data collection and interim analysis, summary, and synthesis (May through August 1991) included obtaining information from personal interviews, district records, and published background sources. Growers (25), along with some foremen and irrigators; MSIDD staff (30), ranging from all of upper management to a sample of canal operators; and the MSIDD Board of Directors (9) were interviewed by the DA Core Team. Details of the sampling strategy can be found in Dedrick et al. (1992). The DA Core Team periodically summarized, analyzed, and synthesized the data gathered.

Final synthesis, formulation of the DA findings, and development of the DA Report (August 1991 through March 1992) included the DA Core Team's final synthesis of the data and formulation of its findings and review sessions with the DA Resource Team, MSIDD's Board of Directors, MSIDD Management, and the area's growers. These reviews assisted in assuring that the DA findings were accurate and complete, that they were presented clearly and reflected a neutral perspective, and that they did not prescribe solutions. Other DA activities included development and review of the DA Report and establishment of linkages to the MP Phase. Unlike the above presentation of activities, in actuality, the DA dynamically combined ongoing, often simultaneous, data collecting, planning, summarizing, and synthesizing activities. Also, although these activities extended from March 1991 through March 1992, they were periodic and amounted to 3 or 4 months of DA Core Team effort.

DIAGNOSTIC ANALYSIS METHODOLOGY

The management of crop production is a complex task, crossing many technical disciplines. The geographic, economic, and legal context of the agricultural production system increases the complexity. The DA approach addresses actual performance assessment within this broad context. Because virtually no non-trivial performance problems can be solved without addressing multiple subsystems, interactions, and technical

components, the DA approaches performance assessment from an interdisciplinary perspective. This section describes the processes employed to assure that the DA findings painted a complete, accurate picture of the performance of irrigated agriculture in the area and provided a basis for planning appropriate improvements.

DA Planning, Preparation and Data Collection. A meeting between the DA Core and Resource Teams provided the Core Team with initial objectives, performance measures, areas of inquiry, data sources, etc., for various parts of the irrigated agriculture system. The objectives and performance measures were general (e.g., Returns to farming are sufficient to sustain well-managed irrigated agriculture in the district).

The Team Planning Methodology (TPM, Levine 1989) was used to guide the DA activities as the Core Team gathered and synthesized a large amount of data, and shaped it to provide an accurate, comprehensive, and consistent picture. Each of the findings--statements of overall performance as well as identification of specific causes of that performance--were concurred in by all members of the Core Team. Each field interview was carried out by two or more team members using a structured approach, sensitive to both process and content. Interview questionnaires were designed to gather the information required by each DA Core Team member to develop both disciplinary and interdisciplinary understanding of the system. As a result, each team member relied on data collected by others and was responsible for gathering data for others. This blending of disciplinary experience enlarged each member's technical perspective.

As a starting point, the DA team hypothesized a set of performance statements. In the ongoing process of summarizing and synthesizing their understanding, team members replaced the hypotheses with new Performance Statements that more clearly described their observations. For each Performance Statement, the team wrote an Impact Statement, specifying how that performance would affect the profitability and sustainability of the system, and a set of Contributing Factors, identifying the primary causes of the level of performance, including a limited amount of explanatory information or supporting data. The specification of contributing factors (i.e., causes for high or low performance) is a key feature of the DA approach. This identification of causes links directly to identifying important opportunities for performance improvement in the study area. Only Performance Statements considered by the Core Team

to have significant performance impact were included in the final DA findings. Prioritization of Performance Statements would be done during the MP Phase.

Interim Analysis, Summary and Synthesis. The DA Core Team's interim analysis, summary, and synthesis processes were critical parts of their DA work. In essence, the final DA synthesis was simply the last iteration of an activity that began when the first data were collected. The process can be described as re-telling the story of what is going on with irrigated agriculture in the area. The story, however, must accommodate all the data, as well as the various disciplinary interpretations of the individual DA Core Team members. When elements are contradictory or suggest incompatibility, further data gathering and reinterpretation are required; when new data either suggest missing chapters of the story or undercut current aspects, more work and discussion of what has been learned are required. Each reiteration of the story represents a consensus among Core Team members, not just agreement of a majority. Members were urged to apply their disciplinary perspectives rigorously, to clarify for each other any technical matters that might block full understanding and to verify any data that seemingly could not be accommodated.

Early iterations of Performance Statements were challenged and changed, usually because, they oversimplified or overstated a condition, ignored important district history or impacts from the broader context, or had a more negative tone than proved accurate in terms of the larger picture. Also, performance strengths were sometimes omitted or not explicitly stated. An example of the evolution of a particular Performance Statement follows:

Final Performance Statement from Dedrick et al. (1992):

> Soil-building conservation measures such as the use of small grains, alfalfa, cover crops, manure, and reduced tillage systems are inadequately employed to sustain the farming system.

Examples of prior statements are

> Farmers are destroying their soil.

> Farmers are using too many tillage operations on their fields.

Final Synthesis, Formulation of the DA Findings, and Development of the DA Report. The results of the DA were shared with the area's growers, as well as all organizations involved with irrigated agriculture in the area. There were several thrusts to these discussions. One was the clarity and ease of understanding of what was written. Did everyone understand what the team meant to say? A second thrust was correctness. Were the statements accurate, and if not, what corrections were needed? Another aspect was tone. Was it neutral, not negative; neither patronizing nor condescending? A final thrust was comprehensiveness. Were additional statements or contributing factors needed to describe performance fully? And if so, were potential additions substantiated by the DA work completed, or were more data required? These considerations were essential to obtaining the virtually unqualified acceptance of the results by stakeholders who would be planning and implementing improvements.

Throughout these reviews, though most of the performance statements had been reworded or modified in some way, content had not been compromised. That is, the Core Team did not modify its conclusions for political reasons or to avoid controversy. In general, it was able to satisfactorily address issues raised by all parties, including MSIDD management and growers. The widespread concurrence in the DA findings is important confirmation of the ability of the process to yield its intended product. This acceptance has continued throughout the MP Phase, with the findings being used and built upon as plans are developed.

QUESTIONS REGARDING THE DA APPROACH

A number of the more frequently asked questions about the DA process are addressed below, with answers based primarily on the experiences of the MSIDD-Area DA.

Is an interdisciplinary team necessary for a thorough and accurate irrigated agriculture system performance assessment?

The findings of the MSIDD area's DA address multiple system components and are clearly interdisciplinary in both their statement and their supporting data. Even when Contributing Factors (CFs) are single discipline oriented, the set of CFs for a given Performance Statement represents a combination of disciplinary perspectives. Given that actual performance is a result of causes across disciplines and across system components,

an accurate and useful performance assessment should be interdisciplinary. Consider the Performance Statement:

> Though MSIDD's ultrasonic flow meters are effective for water accounting and billing purposes and for operational management if properly used, they are rarely used by growers as management tools, and in general it appears they could be used more effectively by MSIDD personnel.

Such a statement would not have resulted from analysis by any single discipline expert, yet this statement clearly describes the current use of these meters.

How do interdisciplinary DA results improve the likelihood of achieving performance improvement?

First, interdisciplinary Performance Statements are more likely to describe actual performance, since real systems are complex with many interactive components. Second, identifying the causes of problems is as important as identifying the problems themselves. Third, this process continually strives to remain neutral and nonjudgmental, focusing on understanding and description, and neither blames nor attempts to find solutions. Finally, the process involves key stakeholders in an active role from the onset. The "ownership" thus engendered was critical to the acceptance of and confidence in the DA results expressed by all involved with the MSIDD Area DA.

In what ways are this interdisciplinary DA approach to performance assessment new?

Clearly, irrigated agriculture performance assessments and small group processes are not new. The newness lies in the combination of these elements with an interdisciplinary scope and a system/subsystem focus. In our view, this union makes both the approach and the process new.

With an interdisciplinary approach, statements of performance often cross both disciplinary boundaries and subsystem boundaries (e.g., farm and district subsystems, or agronomic and economic subsystems). This is a new kind of product.

How was team-building facilitated?

Team-building was facilitated in several ways. Team members were divided into small groups for various tasks. The Core Team process required confident

individuals with solid disciplinary commitment and understanding. Each team member brought different skills and different communication abilities and styles of interaction. Each also differed in the desire and ability to advocate ideas. To prevent strong personalities from dominating, the role of the facilitator was to focus that strength in positive directions for achieving the Team's goals and to encourage less forceful team members to speak up.

All team members were considered as equals; all opinions were valued. At the same time, all opinions were subject to challenge, and their acceptance resulted from building team-wide understanding. Team members committed themselves to active participation and were discouraged from withdrawing from the work at hand. All were encouraged to contribute, and when one team member disagreed with others, facilitation sought to assist that member in representing his/her perspective, without defensiveness, until the entire team was in agreement. Confrontations were treated as work-based rather than personal--focusing on the issue and not the person.

How did the team function?

The process used in the MSIDD-Area DA combined methods for strategic structuring of development efforts and guiding small group processes (Levine 1989) with the DA approach for assessing the performance of irrigated agriculture (Lowdermilk et al. 1983).

Team members initially agreed on their roles and a set of ground rules to carry them out (e.g., speak up if you have something to contribute, express agreements/ disagreements). Each team member had to accept responsibilities for representing his/her disciplinary perspective and to be accountable for generating certain products (e.g., portions of questionnaires, interviews, Performance Statement Drafts).

Often when team members spoke from their own disciplines, there were questions of clarification or challenges to the particular perspective. After some debate, the team focused on what was correct about the statement, i.e., what they could believe, as opposed to what they could not concur in. In many cases, rephrasing made a statement acceptable. Usually, the disagreement resulted from overstatement of the problem or overgeneralization from insufficient data. At first, members of the team were concerned that the process would "water down" the statements. However,

as work progressed, it was usually evident that the new statements were a clearer, more accurate representation of the actual situation. On the other hand, unimportant issues were discarded since they did not merit the team's time and attention.

How did the team achieve interdisciplinary results?

To achieve interdisciplinary effectiveness, DA Core Team members must solidify their understanding of each other's perspectives and the implications of those perspectives on data to be gathered and conditions to be understood. This knowledge is then used in several ways. First, interview teams ask interview questions pertaining to all disciplines. Also, when a finding is stated by any team member, either preliminarily or as a formal Performance Statement, each team member must understand the statement well enough to enrich it by integrating additional disciplinary perspective as well as to agree, disagree, or request additional verification. Statements or propositions were accepted only if all other members concurred (that is, majority rule was not used). No single discipline was allowed to dominate the results.

Perhaps most importantly the very process of synthesizing information often had synergistic effects. There were many cases during the DA when information from one farm interview appeared to contradict something learned in another farm or MSIDD staff interview. Usually, these apparent contradictions resulted from the Team's incomplete understanding of subtle differences in context. The process of openly grappling with the apparent contradictions usually enhanced the Team's understanding of the real performance and conditions contributing to it.

The DA process is an iterative process of collecting data, synthesizing results, and describing current performance. For each iteration, data are incomplete, analyses are incomplete, and understandings are incomplete. The process also moved from specifics to generalization cyclically. For example, after a group discussion of one or more specific technical points, the team was requested to express its understanding of these points in a general way, with supporting evidence, including an assessment of the impact on production, water use, profitability, etc. By being forced to describe the Team's current understanding, each member was obligated from the beginning to broaden his/her perspectives on issues and to see where and how individual disciplines and understandings fit into the

overall picture. When this occurs, the team member is functioning in a truly interdisciplinary fashion.

What conflicts occurred and how were they resolved?

The team members were eager for more data and more analysis of existing data, while the DA leaders pushed for clarity and closure on identified performance areas or statements. Periodic tension and resistance to the process was to be expected, but pride in the progress and quality of the work continued to grow.

Most of the Core Team members were "borrowed" from their respective agencies and had other jobs. Thus, time was a premium for most, yet the DA is a time-consuming process. However, all members developed a strong commitment to the process, to the team, and to the importance of a high quality result.

What are the drawbacks to this approach?

There is a cost for achieving the interdisciplinary DA understanding. Combining the disciplinary perspectives into a concise performance statement takes time. However, the quality of the results, in our opinion, justifies this cost.

How do you select team members?

Team membership requires individuals who are technically competent in their disciplines, as well as individuals who are intimately familiar with the local area and conditions. Technical strength is needed to make proper inference from causal relations, while local knowledge is needed to provide the proper focus.

Important criteria for team membership are openness and the willingness to discuss issues. Defensiveness is counterproductive. Team members must be capable of both examining technical details and viewing the system in a broad context. Equally important is the ability to move logically from specific technical details to assessing impact on general conditions.

What do team members get out of it?

Team members universally felt they achieved a greater understanding of irrigated agriculture. Those from local agencies also learned how their agencies and impact were perceived by farmers. All team members felt enriched by the experience and had a clear sense of accomplishment. Finally, team members learned to

address problems in a way conducive to change and improvement.

REFERENCES

1. Clyma, W. and M.K. Lowdermilk. 1988. Improving the management of irrigated agriculture: A methodology for diagnostic analysis. D. Fowler, Editor. Water Management Synthesis II Project. WMS Report 95. Colorado State University, Ft. Collins, CO. 88 pp.

2. Dedrick, A.R., et al. 1992. The Demonstration Interagency Management Improvement Program (MIP) for Irrigated Agriculture in the Maricopa-Stanfield Irrigation and Drainage District (MSIDD); Vol. I, The Diagnostic Analysis (DA) Report of the MSIDD Area MIP. USDA-ARS, USWCL IMIP Doc. 5, March. 99 pp., and Vol. II, The DA Findings, Supportive Data, and Supplemental Materials. USDA-ARS, USWCL, IMIP Doc. 6. July. 118 pp.

3. Dedrick, A.R., W. Clyma and J.D. Palmer. 1989. A management improvement process to effectively change irrigated agriculture. P. 45-58 In A.S. Anderson, J. Schaack and D.S. Wilson Jr. (eds.) Planning for water shortages. Proc. of 1989 Meeting USCID, Boise, ID. 24-26 Aug. 1989.

4. Dedrick, A.R., et al. 1993. A demonstration irrigation Management Improvement Program. In: Proceedings of the Fifteenth Congress, ICID, Aug. 30-Sept. 12, The Hague, The Netherlands. (Presented at the Twelfth Technical Conf., USCID, Nov. 1991, San Francisco, CA).

5. Jones, A.L., and W. Clyma. 1988. Improving the management of irrigated agriculture: The management training and planning program for command water management, Pakistan. D. Fowler, Editor. Water Management Synthesis II Project. WMS Professional Paper 3. Colorado State U., Ft. Collins, CO. 14 pp.

6. Levine, D.B. 1989. The team planning methodology: Shaping and strengthening development management. Unpub. Working Paper, OICD, USDA, Wash., DC, 38 pp.

7. Lowdermilk, M.K., et al. 1983. Diagnostic analysis of irrigation systems, Volume 1: Concepts & methodology. D. Fowler, editor. Water Management Synthesis Project, Colorado State U., Ft. Collins, CO.