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Benchmarking Irrigation

Concepts and Strategies

By
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for
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Setting the Stage

A few performance indicators (e.g., "efficiency") have been included in irrigation jargon for many decades. However, at the Rome meeting we will have a comprehensive discussion on irrigation benchmarking. It will be easy to fall into a discussion of definitions and specifics. Prior to that, it might be helpful to consider the following aspects that will help to set the stage for the details:

A. Who is interested? Although this may sound trivial, the benchmarking indices that are selected and accepted will be different, depending upon the audience. Furthermore, the people who FUND a benchmarking project may not be those who stand to benefit the most from the information. Possible interested parties could include:

1. Farmer groups (large groups such as ANUR in Mexico)
2. Design engineers who must formulate a design
3. Economists who have invested in a project and want to know if the investment was worthwhile.
4. Economists who want to invest in modernization or expansion of an existing project.
5. Project managers
6. International agencies that want to define critical needs
7. Environmental groups
8. Statisticians
9. Educators

If you try to please everyone, no one is satisfied. Focus on a specific audience.

B. What are the broad objectives? Various objectives might include:

1. Develop statistics. FAO, for example, publishes statistics regarding total irrigated acreage.
2. Establish priorities regarding which geographical project (e.g., "Bhakra, in India") should be funded.
3. Establish priorities regarding what specific actions should be funded within a project during modernization.
4. Evaluate various impacts that have occurred as a result of various irrigation projects.
5. Use the benchmarking procedure as a means of educating key individuals within a project, organization, country, etc. This education can occur through participation by those individuals in training and then in field evaluations. This is a main component of the work that FAO sponsored in Thailand in March 2000 and is planning in Vietnam in November 2000.

> It is important to develop local expertise in understanding how to modernize irrigation systems. Benchmarking associated with training is very useful to identify (3) and sometimes (4), while simultaneously developing (1).

C. <u>What are the budget and timeline?</u> It is essential that these items be identified prior to our discussions. For example, if we realistically believe that there will be a budget of $2000 for a project, using local staff without external input or training, and that the benchmarking should be accomplished in the office with existing records, within a 2 week time period……this will immediately eliminate the type of work that IWMI has done on benchmarking. Furthermore, it will eliminate the type of work done by Burt and Styles, as reported in FAO Water Report 19.

> This group should document the full cost (time, budget, expertise) of implementing whatever benchmarking process (including components) it develops. At a minimum, it should assign a time and dollar estimate to develop each performance indicator.

D. <u>How much consistency do we expect between evaluators</u>? It has been my observation that if you find 5 irrigation specialists in the same room, you will get 5 different definitions and 5 different answers, for the same item. This is a serious problem. Even after we develop the definitions, there will always be details in how the data should be obtained and analyzed.

Ideally, we might conduct a test to examine consistency obtained with our procedures. For example, we might have 2 groups of 6 individuals (per group). Using the same irrigation project as a test case, each individual would quantify the various indicators we develop. One group would only have the written information that was developed, without any personal training The second group would have both the information and training. It would be very interesting to examine the differences in results from each individual and group.

> Perhaps we should "benchmark" the benchmarking process, to document the consistency in results.

E. How accurate are the estimates? We do not, and never will, know all values precisely. Each project and indicator will have different quality of data. Just knowing that there is a small, or large, confidence interval is informative. Also, by publishing confidence intervals, we avoid the technical error of appearing to be precise when we really are imprecise. If policy makers believe that an irrigation efficiency (for example) is 50%, a certain decision might be made. The decision may be quite different if the efficiency is expressed as 50%, plus or minus 30%.

> All benchmarking indices should be accompanied by an estimate of their confidence interval (CI).

Of course, there is the logical question of "what confidence do we have in our confidence interval estimate?". Truly, we may not know if it is accurate within plus or minus 10%, or 15%. But just placing a reasonable estimate on CI values is better than treating values as if they are solid and absolute.

F. How accurate do we need to be? Our answer to this question will be pivotal in what we accept as benchmarking tools and techniques. Here are some general observations I have made over the years (which are obviously generalities):

1. Scientists tend to want to get precise numbers on everything.
2. Scientists often worry more about the precision and fine accuracy than about the big picture and the budget and time constraints.
3. Practicing engineers are accustomed to making approximations, since they have no choice - they must apply science in a world of uncertainties.
4. By being precise on some very small details, we are often very inaccurate when it comes to the whole picture. The classic example involves the blind persons examining details of various parts of an elephant's anatomy - each individual comes away with a distorted view of the whole picture.
5. Conversely, a carefully tailored, quick look at many items can sometimes provide a much more accurate picture than the detailed, standard scientific approach to research.
6. Often one can achieve 80% of the results for 20% of the cost of achieving 90% of the results. If we don't even know the general magnitude of the answers at the start, the 80% of the results strategy makes a lot of sense.
7. Often, very detailed, statistically correct, replicated, etc. research concludes that further research is needed to answer the question. The obvious question is: Why was there such a large expenditure on a detailed look at a small part of the problem?

> Large scale benchmarking of irrigation projects will probably best served by developing a comprehensive set of indicators that can be quantified relatively quickly. Then, based on an analysis of the results, new indicators and techniques can be fine tuned. We first need to know approximate answers to big questions.

G. **Is it the Cause or the Effect?** In irrigation projects, causes and effects are intertwined. For example, there is the classic question related to water user organizations - can they exist without good water delivery service, or is good water delivery service only possible if water user organizations exist? As much as possible, we should avoid such discussions and we should instead focus on indicators that might help us to better draw conclusions on arguments such as these. For example, in FAO Water Report 19, Stuart Styles and I note that all 16 projects needed improvements in both hardware and management/operation/software, not just in one or the other.

ITRC Benchmarking Experiences in the U.S.

Cal Poly ITRC has been involved in formal and informal benchmarking of irrigation in the U.S. for over 20 years. Some observations on our experiences are as follows:

A. On-farm irrigation efficiency. Rapidly implemented programs have been attempted using individuals from government agencies, irrigation dealerships, summer students, and electrical utility field services groups. These efforts have largely been unsuccessful. There is just too much to understand, and quick training is insufficient. In general, successful evaluations of on-farm irrigation efficiency require individuals with excellent educational backgrounds in irrigation, plus several years of pertinent professional on-farm irrigation experience.

An exception is the use of the Cal Poly ITRC expert system AGWATER. If a technician sits down with a farmer for about 2.5 hours with the program, it is possible to develop a reasonable estimate of annual field irrigation efficiency. AGWATER cost about $250,000 to develop.

B. Farm irrigation system Distribution Uniformity (DU). ITRC has 3 2-person student teams evaluating farm irrigation systems for DU this summer. The program has been quite successful. It requires that the students have passed at least one entry level irrigation class, participate in 4 day training program, be accompanied by an ITRC specialist during the first 2 field evaluations, and then submit their daily results by FAX to ITRC for review (for at least 2 weeks at the beginning of the summer). To shortcut any one of those steps has resulted in failure.

Students evaluate one irrigation field per day. A "field" in the U.S., of course, if larger than a typical field in many other countries, and the irrigation systems are often more complex in the U.S. Students collect data that they input into ITRC expert system software that computes DU values, the causes of non-uniformity, and also makes recommendations for improvement.

C. Irrigation District Water Balances and Efficiency. Most of the water balances and efficiency estimates that ITRC sees in the U.S. have been developed with flawed techniques, data, and formulas – enough to cause errors of 10-40%. Such errors are unacceptable in California where water supplies are so tight and difficult decisions must be made. Serious disagreements often erupt between experts on definitions and interpretations - something for this group to heed (it is essential that the definitions and procedures for obtaining data for some terms be very closely defined). Good district water balances require good data – data that is historically not available from districts that are accustomed to working in an operational mode. Conjunctive use districts are obviously more difficult to evaluate than those with only surface water supplies. Over the past 10 years, Imperial Irrigation District (200,000 irrigated ha) has probably spent at least $2 - $3 million on obtaining data and computing water balances. The US Bureau of Reclamation requires that irrigation districts perform a rough water balance as part of their Water Conservation Plan completion, but the development of the forms and processes has been unnecessarily long. Most irrigation consultants do not have a good understanding of water balance principles – and the "devil is in the details".

D. Irrigation District Water Delivery Service Performance Indicators. In 1982, I published the results of a study of about 60 irrigation districts. Each district was rated regarding Flexibility of Water Delivery Service to Farms. Each component of Flexibility (Frequency, Rate, and Duration) was given a score of 1-5, and an overall, composite score was assigned to each district. In 1996 ITRC completed a similar report ("Status and Needs 1996"), and another report is presently being written ("Status and Needs 2000"). These two reports categorize other district parameters related to service and statistics, but not related to Efficiency (for about 60 districts, each). Once a rating scale is developed, it is relatively easy to assign scores from districts. Information is obtained by interviewing top personnel at the irrigation districts. In the U.S., those people can generally be relied upon to give accurate answers to the types of questions that were asked.

Three components of water delivery service are typically quoted as being (i) Equity, (ii) Reliability, and (iii) Flexibility. Subcomponents of flexibility are frequency, rate, and duration. In California, Equity and Reliability are typically not major issues, so the focus has been on flexibility. On ITRC evaluation of projects in Less Developed Countries, less emphasis is placed on a complex assessment of flexibility.

<u>Existing Approaches to International Project Benchmarking</u>.

The participants in the Rome meeting have a variety of experiences, and many have developed indicators that they have found to be useful. For example, Bos lists ("Performance indicators for irrigation and drainage", Irrigation and Drainage Systems 11:119-137. 1997) about 40 multipdisciplinary performance indicators. Molden has worked on other indicators (e.g., "Indicators for comparing performance of irrigated agricultural systems", IWMI Research Report 20, 1998). The recent FAO publication (Water Reports 19, Modern Water Control and Management Practices In Irrigation, 1999) lists 31 primary internal indicators, most with 3-4 subindicators, as well as 10 external indicators proposed or modified by myself and Stuart Styles.

I tend to group benchmarking, and performance indicators, into two general categories:

A. External Indicators. These indicators typically only require a "black box" approach that does not examine internal processes. Rather, they examine what goes into and what leaves a project – whether it be money, water, water quality, or other items.

> External Indicators have limited value in comparing one project with another – unless the crops, weather, water supply, soil, etc. are the same. How can one compare the economics of a rice project against a project that supplies vegetables for export? External indicators can be very useful in examining the conditions before and after in a project, as a result of an intervention.

B. Internal Indicators. These indicators sometimes simply examine characteristics of projects, but perhaps the most useful type of internal indicator is that which examines how things function, and what internal factors might affect performance.

> Internal indicators help to show what processes might be changed, and how, to impact the external indicators.

<u>EXTERNAL Indicators</u>

The list of possible external indicators is huge. Furthermore, there are important differences between people in how they define each indicator, and what values should be obtained to compute the final value of an indicator. A possible classification of external indicators is:

A. <u>Water inputs and outputs</u> (referred to as "water balance" indicators by some). Various terms include:
  1. Irrigation efficiency
  2. Relative water supply
     a. During the wet season

b. During the dry season
3. Relative irrigation supply
4. Conveyance efficiency
5. Irrigation sagacity, or

Various "ratios" that are similar to efficiencies have been proposed, such as
1. Field application ratio
2. Tertiary unit ratio, etc.

In all discussions of ratios and efficiencies and other such water balance terms, it is essential to
distinguish the physical or hydraulic level of discussion (field vs. farm vs. lateral vs. secondary canal vs. main canal vs. project, etc.)

Multiple years should be used for such indicators. Many projects have a wide fluctuation of annual irrigation water supply and rainfall.

B. Project Economics.

These indicators generally examine financial self-sustainability, the portion of expenditures going to various directions, the percentage of water fees collected, or perhaps even the adequacy of the O&M expenses.

While some indicators are relatively easy to assess (percentage of water fees collected), other values are very difficult to quantify. For example, an examination of farm family economics is complicated when one tries to define what a "family" consists of, as compared to a "farmer", and outside income, consumed products, and other inputs and expenditures are difficult to identify.

It is also difficult to assess the "cost" of a project, or the level of investment. Often, projects have evolved over many decades, with different levels of investment made in different zones of the project. Some projects include road infrastructure and power lines as part of their responsibility, whereas others do not. It can be difficult to isolate expenditures for maintenance versus construction, and often project authorities do not know the original investments in old projects, much less the equivalent foreign exchange rate for those expenditures, today. Furthermore, it is often difficult to isolate the impact of any single intervention, as one action may merely be an essential component of an infrastructure that was largely intact before final investment.

As an irrigation specialist, I have found most economic rate of return indicators to be difficult to evaluate.

C. Agronomic

Information on project crop yields is often published. Even average crop yields can be confusing to identify accurately – especially when one moves from a single crop such as paddy to a more complex project involving dozens of products. On some projects, one does not know the actual irrigated acreage within 10%.

It is always preferable to publish average yields (averaged over 5-10 years), as yields in any specific year may be high or low due to water availability, insect pressure, or other factors.

D. Social, Institutional.

Indicators may examine topics such as

- Availability of water law
- Availability of enforcing bodies
- Existence of water user associations
- Ability of an agency to hire or fire personnel
- Incentive programs for employees
- Pay scales for persons in different positions
- The number and types of fines a project will levy on users in a year.

E. Environmental

Environmental indicators may address such topics as:

- In-stream flow quantities upstream and downstream of a project
- Salinity before and after in rivers
  - Amounts - loads and concentrations
  - Types
- Salinization of soils
- High water tables

F. Health

Health issues may include:

- Mosquito habitat
- Bilharzia
- Other diseases
- Drinking water availability

G. Uses of a project

Projects can be categorized by usage, such as:

- Irrigation
- Recreation
- Supply of industrial water
- Drinking water
- Restoring the environment, such as in-stream flows

H. Local economics

Most irrigation project studies have some element of local economics, including:

- Average income
- Family size
- Amount of leasing of land vs. ownership

- Operational farm size versus field size
- Price for various commodities
- Price for various irrigation equipment

INTERNAL Indicators

Internal indicators focus on how and why things work inside the irrigation project, and the internal impacts on service. Possible topic areas include:

A. Degree of service offered at all levels in a project.
   - To the individual field
   - To turnouts
   - To the head of a tertiary
   - To the head of a secondary canal
   - By the dam to the main canal

B. Internal indicators that identify constraints to service.
   - Structures
     - Suitability of design
     - Maintenance
     - Operation rules
   - Other physical items (canal capacities, flow measurement, recirculation, etc.)
     - Suitability of Design
     - Maintenance
     - Operation
   - Service philosophy of project authorities
   - Physical constraints (sediment, water supply)
   - Communications
     - Form of communications (radio, phone, etc.)
     - Reliability
     - Frequency
     - Between who or what?
   - Institutional constraints

C. Budgets - how much and where they go.

D. Other internal indicator areas that impact yield, profit, etc.
     - Drainage suitability
     - Land leveling

E. Discrepancy between "stated" and "actual" practices and conditions.

Recommendations

My recommendations are:

A. As irrigation specialists, we should focus on irrigation-specific items. There is ample material to keep us busy, without moving too far into other areas of expertise.

B. A primary objective should be to identify appropriate steps for modernization, in any project that is evaluated.
C. A maximum of 1 person-month should be spent on any one project in collecting data and analyzing that data. This must include time driving down canals, talking with farmers and operators, and examining data in the project office.
D. There should be a combination of internal and external indices.
E. The formulas, and procedures for obtaining data, should be meticulously outlined.
F. Confidence intervals should always be published.
G. Focus on service at all layers within a project, as well as the procedures and hardware that impact those levels of service.