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Performance Benchmarking In Irrigation and Drainage Systems

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ABSTRACT

Due to the rapid growth in world population, increasing numbers of people especially those who are living in arid and semi-arid regions are suffering from shortage of water and food, and this is the driving force for improving irrigation and drainage systems' efficiency. As irrigated agriculture is a consumer for over 75% of world fresh water supplies, using the water allocated to the agricultural sector more efficient and then releasing the surplus of water for other sectors' use seems to be the only solution for coping with water scarcity. Irrigation and drainage infrastructure is the indispensable element of irrigated agriculture. The level of irrigation and drainage services maintained in the irrigation area is directly affecting the quantity of crop production. Improving irrigation system efficiency / performance in aspects of Management - Operation - Maintenance (MOM) tasks has become a major concern for stakeholders and system managers, but monitoring and evaluating the performance of irrigation systems by using performance indicators have been a major concern for the researchers in this area. The term "Irrigation system performance evaluation" refers to what extent the targets and objectives have been achieved. Benchmarking implies comparison either internally with previous performance and desired future targets, or externally against similar organizations, or organizations performing similar functions. The overall aim of benchmarking is to improve the performance of an organization as measured against its mission and objectives. This paper emphasizes on the concept of benchmarking and its applications in irrigation and drainage systems.

Keywords: Benchmarking, performance evaluation, irrigation and drainage systems

INTRODUCTION

Main destination for developing new areas for irrigated agriculture worldwide or introducing irrigation to dry agricultural lands is to meet the food needs of increasing population. Securing food and water should be the main challenge of mankind in order to sustain himself. "Getting more crop per drop" is the goal of modern irrigated agriculture in the world struggling with global climate change and diminishing water resources.

Due to declining per capita production of food grains and increasing numbers of people living in poverty and hunger, there is a growing need worldwide to identify and develop new lands with adequate agricultural potential (Hargreaves and Olsen, 1999).

The question is whether there will be enough freshwater to satisfy the growing needs of agricultural and non-agricultural users. FAO expects that the withdrawal of irrigation water in the 93 countries of its study will grow during the period 1998–2030 by only about 14%, a small increase compared to the projected increase in the irrigated area. Crop water consumption per unit of area is expected to decrease by 3%, and gross crop water use by 16%. FAO explains most of this difference by an expected improvement in irrigation efficiency, that should result in a reduction in the water withdrawals per unit of irrigated area. The FAO model is based on the assumption that 2.5% of the existing irrigated area is rehabilitated or substituted by new irrigation systems each year, an activity that would commit a considerable investment in irrigation hardware and technology (Playán and Mateos, 2006).

Concerns and problems over water scarcity will certainly affect irrigated agriculture. The rate of increase in irrigation withdrawals will not be the same as over the last 25-year period. From 1995 to 2025, FAO forecasts a growth in irrigation withdrawals of 14%, while IWMI sees a 17% growth in withdrawals for irrigation. But food production from irrigated lands during the same period should grow by at least 40% to meet the needs of a 33% increase in population, and to satisfy trends for improved nutrition. There is increasing competition for water. Water is increasingly being transferred from irrigated agriculture to higher valued industrial and urban uses, and irrigated land is going out of production from urban sprawl. Water quality problems increase with rising industrialization and inefficient irrigation water use, leading to pollution and salinization. There is a call for more water to be reserved for environmental uses. It is not clear how much land is going out of production due to salinization, but it is clearly a threat to irrigated food production systems (Bos et al., 2005).

Performance Assessment in Irrigation and Drainage Systems

The concept of benchmarking in irrigation and drainage systems has emerged from the previous performance evaluation studies which constitute a basis and a background for the researchers in this area. Clemmens (2006), stated that without a clear understanding of the link between irrigation system operations and the resulting system performance, one cannot develop a rational plan for implementing needed changes, nor where to start.

Irrigation water, once applied, becomes part of the hydrologic system and is difficult to trace. When determining irrigation performance, it is usually necessary to make assumptions about what happened to all the applied water (Clemmens, 1999).

Many irrigation systems, particularly in developing countries, perform below their potential. Head-tail problems, leaky canals, and malfunctioning structures because of delayed maintenance, leading to low water use efficiency and low yields, are some of the commonly expressed problems. A large part of low performance may be due to inadequate water management at system and field level (Çakmak et al, 2004).

Performance of a system is represented by its measured levels of achievements in terms of one or several parameters, which are considered as indicators of system's goals (Mondal and Saleh, 2003). Performance assessment enables verification of the degree to which targets and objectives are being realized. It also provides different stakeholders (system managers, farmers and policy makers) with a better understanding of how a system operates. It can help determine problems and identify ways and means of improving system performance (Çakmak et al, 2004).

The need for higher levels of performance in the irrigation and drainage sector is driven by several factors:

- Increasing population leading to a need for greater agricultural production

- Growing water scarcity within river basins leading to a need for irrigated agriculture to produce ''more crop per drop''

- Higher expectations from farmers and their families in terms of their livelihoods

- Higher expectations by farmers in relation to the level of service required from the irrigation and drainage agency

- Changing perceptions, attitudes and practices within government on provision of public services (Malano et al., 2004).

Irrigation performance assessment had been focused on internal evaluation of each individual irrigation system and the methods were given in detail in Rao (1993). Malano et al., (2004), mentioned that the work on the comparative performance of irrigation schemes, which lies at the heart of benchmarking came primarily from International Irrigation Management Institute (Perry, 1996; Molden et al., 1998; Kloezen and Garces-Restrepo, 1998; Sakthivadivel et al., 1999).

The process of performance assessment hinges around the capacity of the managers of an organization to answer two simple questions:

- "Am I doing things right?", which asks whether the intended level of service (that has been set and agreed upon) is being achieved. This is the basis for good operational performance.
- "Am I doing the right thing?", a question that aims at finding out whether the wider objectives are being fulfilled, and fulfilled efficiently. The latter is part of the process of assessment of strategic performance (Bos, 1997).

The organizations responsible for irrigation and drainage systems can be very helpful in providing information about system performance, assuming they have a well-established monitoring and evaluation program and an efficient management information system. In this respect it is also useful to clarify who are the actors in the field of agricultural water management (Figure 1) (Schultz and de Wrachien, 2002).

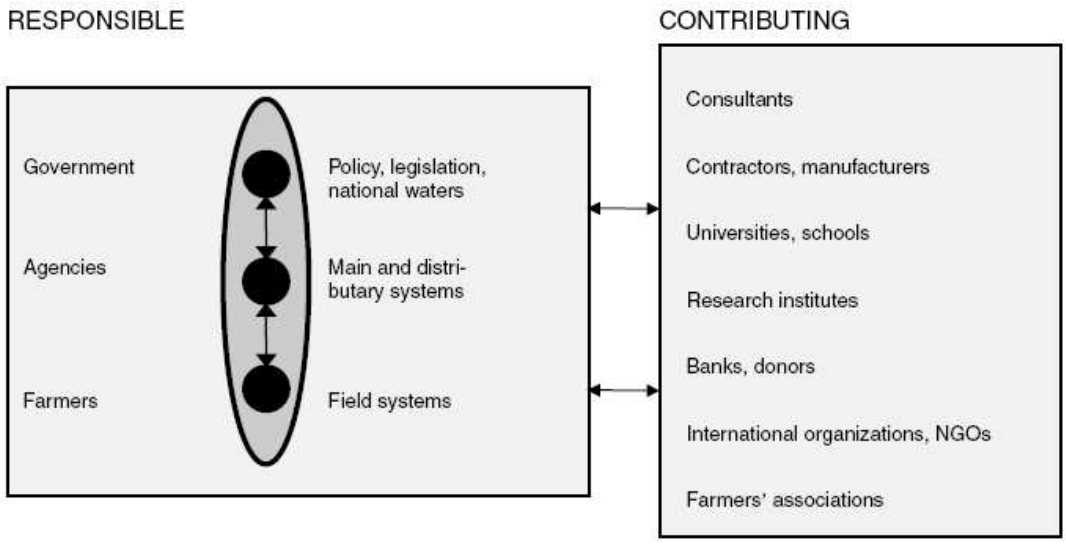

Figure 1. Indicative schematization of actors in agricultural water management (Schultz, 2001)

The Concept of Benchmarking

Benchmarking is a fundamental business skill that supports quality and excellence and since the early 1990s has become widely regarded as a skill that should be communicated and utilized in day-to-day private and public business operations. Recent developments are utilizing the technique for government operations in municipal and state services for example. Benchmarking has also broad applications in problem solving, planning, goal setting, process improvement, innovation, reengineering, strategy setting, and in various other contexts (Gonzalez, 2000).

Benchmarking is a process whereby organizations pursue enhanced performance by learning about their own organisation through comparison with their own historical performance and with the practices and outcomes of others (Alexander, 2002).

Benchmarking and performance assessment are related but different in several ways. Benchmarking is essentially an externally focused activity. In benchmarking the specific aim is to identify key competitors/comparable organisations, and find best management practices for that organisation. These then become standards and/or norms against which to assess an organisation's own performance. Performance indicators are specifically identified to enable the comparison, and to monitor progress towards closing the identified performance gap (Malano and Burton, 2001).

Benchmarking is a management tool based on indicators that enable managers to know the relative position of an organization with respect to others (external benchmarking) or to compare different sections

within an organization for their performance over time (internal benchmarking) (Rodríguez-Díaz et al., 2004).

Benchmarking in Irrigation and Drainage Sector

As defined in preliminary IPTRID (International Program for Technology and Research in Irrigation and Drainage) documents, benchmarking is a systematic process for securing continual improvement through comparison with relevant and achievable internal or external norms and standards. The overall aim of benchmarking is to improve the performance of an organization as measured against its mission and objectives. Benchmarking implies comparison either internally with previous performance and desired future targets, or externally against similar organizations, or organizations performing similar functions. Benchmarking is in use in both the public and private sector (Burt and Styles, 2004).

The first evidence of benchmarking in the irrigation and drainage sector, rather than performance assessment, being applied as a management process in the irrigation and drainage sector was its use by the Australian National Committee of the International Commission on Irrigation and Drainage (ANCID). Upon the request of the World Bank to the Consultative Group of the International Programme for Technology and Research in Irrigation and Drainage (IPTRID) in December 1999, a research study to develop guidelines for benchmarking in the irrigation and drainage sector was launched by IPTRID. The study was carried out as a joint initiative of the IPTRID partner institutions, namely, World Bank (WB), Food and Agriculture Organization of the United Nations (FAO), International Water Management Institute (IWMI) and the International Commission on Irrigation and Drainage (ICID) and coordinated by the IPTRID Secretariat. The IWMI (International Water Management Institute) has developed an on-line programme called the On-line Irrigation Benchmarking System (OIBS), in which users can introduce data and establish a benchmarking procedure using existing data (Malano, 2002; Cornish, 2005; Malano and Burton, 2001).

Performance indicators are a powerful tool for identifying deficiencies in irrigation district management and determining which measures should be taken to improve them. This process is known as benchmarking. Until now, analysis has been based on direct comparisons of performance indicators from different irrigation districts. However, this procedure does not provide an overall view of the actual performance of each district in relation to others. Furthermore, on some occasions irrigation districts are compared with very different ones and best practices cannot be adapted to organisations having lower performance (Rodríguez-Díaz et al., 2008).

Benchmarking is a continuous process that involves (a) internal assessment of the organisation, (b) comparing it with the best practices of more successful similar businesses in the market, (c) determining performance gap between current practice and best practice, and (d) selecting best practices, tailoring them to fit the organisation and implementing them (Figure 2). The cycle of improvement continues.

Benchmarking does not substitute other diagnostic and appraisal analyses, but rather complements them (Malano and Burton, 2001).

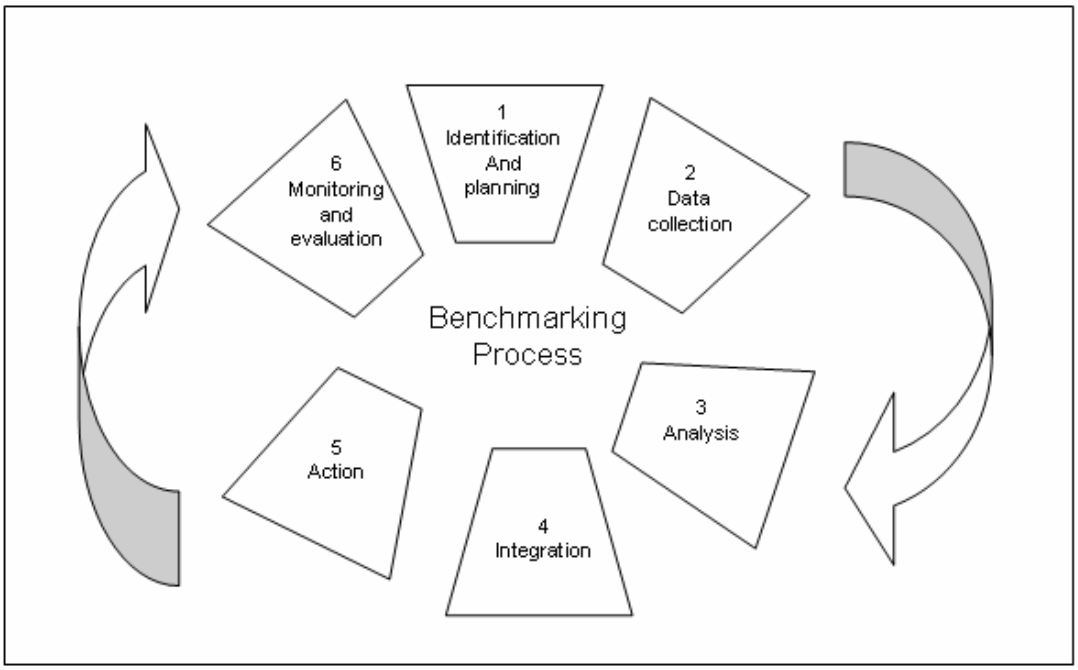

Figure 2. Stages of the benchmarking process (Malano and Burton, 2001)

In approaching benchmarking for the irrigation and drainage sector there are three characteristics that need to be borne in mind:

- Irrigation and drainage service providers operate in a natural monopoly environment
- Irrigation and drainage entails complex and interacting physical, social, economic, political, technical and environmental processes
- Performance of irrigation and drainage schemes is site specific (Malano and Burton, 2001).

A significant problem with benchmarking and performance assessment of irrigation and drainage schemes is the complexity and thus variety of types of scheme. Some schemes are farmer-managed, some are private estates with shareholders, some are gravity fed, some fed via pressurized pipe systems, etc. There is as yet no definitive methodology for categorizing irrigation and drainage schemes, therefore there will always be discussion as to whether one is comparing like with like (Burton et.al, 2000.)

A distinctive feature of irrigation and drainage schemes is their site or region specified nature. In order to allow comparisons between irrigation and drainage schemes they need to be categorised into similar types. There are a variety of ways this can be done. Following are the categorization headings that will be used for benchmarking:

- type of control (fixed proportional division, manual control, automatic control);

- type of management (government agency, private agency, farmer managed);
- method of allocation and distribution (supply, arranged-demand, demand);
- climate (humid, arid)
- predominate crop type (rice, non-rice, subsistence/cash cropping);
- water availability (abundant, scarce)
- water source (surface water, groundwater);
- socio-economic setting (gross domestic product, degree of industrialization, developing / developed nation);
- size (large, small)
- location (Asia, Africa, Americas) (Malano and Burton, 2001).

The extent of the benchmarking exercise needs to be identified and the boundaries defined. The extent/boundaries can be categorized into five key dimensions, such as; spatial (numbers of schemes to be considered), temporal (duration of the exercise and temporal extent of the data), system(s) to be assessed, processes to be assessed, level (primary, secondary, tertiary, field; village, district, national) (Burton et al., 2000).

Benchmarking can be carried out by a variety of organisations, including private companies, government organizations, regulatory/supervisory organizations, management consultants, independent agencies (Table 1). In all cases the benchmarking exercise will be initiated within the organisation and may be executed in the main by personnel within the organisation (Malano and Burton, 2001).

Table 1. Examples of for whom, from who's viewpoint and by whom benchmarking and performance assessment might be carried out? (Burton et al., 2000)

For whom?	**From whose viewpoint?**	**By whom?**
Government regulatory body	Water users Irrigation service provider Society (use of resources)	Government regulatory body Irrigation service provider (data provision)
Irrigation service provider	Irrigation service provider Water users	Irrigation service provider Consultant (possibly)
Water users	Water users	Consultant
Academic community	Irrigation service provider	Research institute University

The application of benchmarking techniques to improve irrigation district performance is a relatively recent phenomenon. The main objective of this technique is to enhance the performance of a given irrigation district by comparing its current performance with that of other districts. In this way, it is

possible to determine which practices lead to better performance in a district and subsequently adapt these practices to irrigation districts that perform less efficiently. Similarly, irrigation districts that perform more poorly will be able to determine which aspects are in need of improvement and take the necessary steps to achieve better performance. Performance indicators are the main tool in a benchmarking process. A performance indicator is a ratio that relates variables (i.e. irrigated area, volume of irrigation water applied or productivity) in such a way that a large amount of information can be reduced to a single number. By comparing performance indicators it is possible to determine when an irrigation district is more or less efficient than another and take the necessary measures to correct any existing deficiencies (Rodríguez-Díaz et al., 2008).

In the water sector benchmarking has an important potential to contribute to improve the services and the efficiency of the operations. It has successfully been applied in the water supply and sanitation in different conditions. The objective is to compile, analyze and compare a core database of irrigation projects, which are or should be available in the files of well managed irrigation agencies. The data will not fulfill the needs of all involved in irrigation, the idea is to identify the most important processes and cost centers and to start with simple indicators that could describe the improvement of a system in time and the comparison of similar systems (Gonzalez, 2000).

The simple comparison of indicators involves subjective judgment-making which provides little information about the global position of an organization with respect to others. In order to address this problem, data envelopment analysis (DEA) techniques were applied. DEA is a nonparametric frontier method for the study of production functions. The use of DEA analysis based on inputs and outputs of an irrigation system enables us to determine the relative efficiency of an organization or a productive function within an organization and to determine its position in relation to the optimal situation by providing a numerical quantification of the direction in which the organization must direct its efforts in the future (Rodríguez-Díaz et al., 2004).

In order to facilitate the use of performance indicators, a computer application called IGRA, (Application of Irrigation Performance Indicators), is developed. This application facilitates the calculation of indicators and defines them using a wide range of zone descriptors and irrigation year variables, allowing comparisons to be established between different zones and irrigation years. IGRA also takes into account certain phases of the benchmarking procedure. The programme is used in this study to calculate and compare performance indicators for several irrigation zones in Andalusia-Spain (Pérez et al., 2004).

The rapid appraisal process (RAP) of irrigation projects as a key part of benchmarking was introduced in a joint FAO/IPTRID/World Bank publication Water Reports-19 (Burt and Styles, 1999). The Rapid Appraisal Process (RAP) for irrigation projects is a 2 week process of collection and analysis

of data both in the office and in the field. The process examines external inputs such as water supplies, and outputs such as water destinations. It provides a systematic examination of the hardware and processes used to convey and distribute water internally to all levels within the project (from the source to the fields). External indicators and internal indicators are developed to provide (i) a baseline of information for comparison against future performance after modernization, (ii) benchmarking for comparison against other irrigation projects, and (iii) a basis for making specific recommendations for modernization and improvement of water delivery service (Burt and Styles, 2004).

CONCLUSION

Irrigated agriculture makes an important contribution meet the food demand of the world population and irrigation and drainage infrastructure is the indispensable element of this system. The benefits expected to obtain from irrigation is subject to the productivity, efficiency and sustainability of irrigated agriculture. Implementation of performance evaluation techniques and benchmarking in irrigation and drainage systems help system managers and policy makers in diagnosing the deficiencies of the system and improving its efficiency.

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