

## Chapter 1

### PERFORMANCE ASSESSMENT IN THE RAHAD IRRIGATION SCHEME

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#### 1.1 INTRODUCTION

According to Merrey et al. (1993) there are many studies assessing the performance of irrigation systems and diagnosing the causes of the level of performance achieved. But there are few systematic studies of the processes of irrigation system management and little systematic documentation of how system managers presently monitor and assess performance, and what performance indicators they use, if any. The lack of good documentation and understanding of the management process itself - how decisions are made and implemented by whom, what information is available to managers, and how they use it, the formal and informal adjectives of managers, farmers and other stakeholders, how performance is measured, and how the feedback processes from past performance affect future performance - remains a critical gap that must be addressed if performance is to be improved.

Nijman C. (1993) stated that an improved performance of an irrigation agency's services delivery can only be achieved by its managers. Short-term inputs by external actors cannot ensure such improved performance. The levels of performance that private irrigators tend to achieve on smaller, more controllable, decentralized systems, especially with pumping, seem to prove such potential for improvements.

According to IIMI's strategy for the 1990s, performance is the degree to which a system achieves its objectives. IIMI's concern is with absolute standard of performance, consistent definitions, and measurements of the components of performance including productivity, equity, reliability, sustainability, profitability and quality of life.

IIMI initiated a research activity in the Rahad Irrigation Scheme in 1991. The research study entitled as "Forces, Constraints and Interactions of Water Users, the Rahad Agricultural Corporation and the Ministry of Irrigation in the operation and maintenance of the Rahad Irrigation Scheme". The research study aimed to achieve the following objectives:

- a) To document the water indents; deliveries at Minor heads and Abu Ishreen at the head, middle and tail sections of the scheme;

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- b) To document and understand the process by which water indents are determined by the Rahad Agricultural Corporation (RAC), and delivery responses to the indents by the Ministry of Irrigation (MOI);
- c) To evaluate the equity of water delivery among Abu Ishreens in the selected Minors; and
- d) To document and understand water users responses to water delivered.

The above stated objectives are important building blocks of an overall objective, to assist the relevant managing agencies and cultivators to field test practical tools for monitoring and assessing performance of the Rahad Irrigation System.

The research theme was further developed into a comprehensive collaborative research project in irrigation performance. The collaboration brought important contributions from different local agencies including: (a) The Hydraulic Research Station (HRS) of MOI; (b) The Rahad Irrigation Operations of the Ministry of Irrigation (RIO/MOI); (c) The Rahad Agricultural Corporation (RAC); (d) The Agricultural Research Corporation (ARC); and (e) The University of Gezira (U. of G.). The scope of the collaborative research project was formulated to address the issues related to the impact and consequences of the management performance of the scheme. The overall objective is to disseminate a conceptual framework, methodologies and indicators for assessing and improving the performance of irrigation systems. The inception report of the project showed the levels of collaboration, explained the approaches to be followed, and the stages of research activities which included the baseline assessment, the intervention testing stage and finally the synthesis and reporting stage.

As almost all irrigation systems in Sudan are designed after the Gezira Scheme, which aims at delivering adequate, dependable and equitable water supplies, one purpose of the study is to evaluate if the design objectives are being realized. Therefore, the data collection have been targeted first to assess the hydraulic performance of the Rahad Irrigation System.

Like determining the status of water distribution, the yield level performance of the grown crops was also studied. Selected indices for both hydraulic and agricultural performance were tested and parameters for acceptable distribution of water and yields were estimated. To complete the assessment of the overall performance, other aspects like the socioeconomic dimensions of the resources utilized, the organizational setting of the Rahad Agricultural Corporation (RAC) and its financial performance were also examined against a set of performance indicators.

## **1.2 THE RAHAD IRRIGATION SCHEME**

### **1.2.1 Location**

The Rahad Irrigation Scheme, which is approximately 25 km wide and 160 km long, is situated along the eastern bank of the Rahad River which is one of the feeders of the Blue Nile (See map in Figure 1). The scheme lies equally in two different stages, Central and Eastern. The scheme headquarters are

located in El-Fau in the Eastern State. Village settlements are scattered in the scheme area for 13000 tenant families.

### 1.2.2 Land Resources

The first phase of the scheme was completed in 1981. At present the total command area is reported to be 300,000 feddans (approximately 126,000 hectares). When the second phase is developed, the total area will increase up to 720,000 feddans [approximately 344,400 hectares].

### 1.2.3 Soil

The area is a flat alluvial plain with a very negligible slope of 0.5 m per kilometer to the west. The soils are similar to those in the Gezira Scheme (i.e. very deep cracking, self mulching clays with high water holding capacities, but low permeability).

The soils are only workable within a narrow range of moisture content. Salinity is not a significant problem. The quality of irrigation water - which has a negligible salt content - does not pose any future danger of increased salinity.

### 1.2.4 Land Use and Farm-size

The net irrigable area under crops is around 280,000 feddans (approximately 117,600 hectares). The remaining area is under forests, small scale poultry and dairy enterprises, research and seed farming plots, buildings and waste land.

The irrigable area under cropping is divided in plots of 22 feddans under field crops, or 5 feddans under vegetables and fruit gardens. No heritage or any sort of disposal of allotted tenancies is allowed. According to the crop rotations dictated by the management, the location of the plots under field crops will be determined. In the earlier two course rotation, a single tenant is to share with another seven tenants two bigger plots each of 88 feddan size (called **Number**). In the existing four course rotation, he is sharing with another 15 tenants four plots of similar size. In both cases his total allotment is 22 feddans. It is difficult to keep the inter-*number* rotations intact throughout the scheme. There is now evidence of self rotating *numbers* (i.e. more than one crop grown in the same *number*). The typical four course rotation could be illustrated by the following example:

Number <sup>3</sup>	Year	1	2	3	4
1	1	Cotton	Sorghum	Groundnut	Wheat
2	2	Wheat	Cotton	Sorghum	Groundnut
3	3	Groundnut	Wheat	Cotton	Sorghum
4	4	Sorghum	Groundnut	Wheat	Cotton

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<sup>3</sup>A sub-unit of tenancy.

### **1.2.5 Water Resources**

The main source for the irrigation water supply is the Blue Nile. About 200 km downstream of Roseires Dam on the Blue Nile a pumping station is located near the Village of Meina. It includes 11 pumps, each with a capacity of 9.55 m<sup>3</sup>/second, to lift a maximum discharge of 105 m<sup>3</sup>/second into a supply canal. This canal is about 84 km in length.

The Rahad barrage is the terminal point of the supply canal from the Meina Pumping Station. It serves to regulate flow into the main canal for the project area. The barrage also functions to control seasonal discharge from the Rahad River to supplement the irrigation supplies during the flood season. The structure, maintaining the water level about 2 meters above normal river flood level, creates a small reservoir upstream.

### **1.2.6 The Irrigation Network**

The main Rahad canal is 101 km long. The design of the canal is for a capacity of 100 m<sup>3</sup>/sec. which feeds 800 km of major canals, 400 km of minor canals and 4300 km of farm laterals (Abu Ishreen). There is also a network of collector drains to take the surface drainage back to the Rahad River.

The Field Outlet Pipes (FOP) is one of the main structures in the irrigation system and it is designed to deliver water through Abu Ishreen to the field. The FOP is a 122 m long, 0.35 m diameter concrete pipe. It supplies one Abu Ishreen which irrigates 88 feddans, constituting a field called "number". The number is subdivided into 16 tenancies (Hawashas) of 5.5 feddans each. The irrigation water is delivered from the Abu Ishreen to each Hawasha through a small ditch called Abu Sita.

### **1.2.7 Procedures of Water Delivery**

There is a fixed cropping pattern based on a rotation developed by the Agricultural Research Corporation (ARC). Based on the recommendation of ARC on crop water requirements, the total water demand for the area under cropping could easily be calculated.

It is the responsibility of block inspectors to develop water indents. These indents of water are submitted by the block inspectors to the irrigation engineers who control the water delivery up to the head regulators of the minor canals. From thereon, the block inspectors have to arrange their schedules to maintain water supplies to the field.

The main system operations are organized separately as an independent entity attached to the Ministry of Irrigation (MOI). The director of Rahad Irrigation Operations (RIO) supervises two divisional engineers, one for the southern division supervising the operation at the Meina pumping system, The Dinder Syphon and Abu Rakkam Barrage, together with the irrigation operations in two blocks. The irrigations operations for the other seven blocks are under the supervision of the northern divisional engineer. Both are helped by assistant divisional engineers, sub-divisional engineers and water guards at control points.

### **1.3 RAPID APPRAISAL OF IRRIGATION WATER DISTRIBUTION**

Like in any country, the field managers of irrigated agriculture in Sudan need simple, practical and cost-effective daily monitoring efforts. The first Rapid Appraisal was conducted on 2-3 November 1992. The participants were the field managers of the Rahad Agricultural Corporation (RAC).

The second Rapid Appraisal (RA-2) was conducted on 25 February 1993. It was designed for the staff of the Rahad Irrigation Operations of the Ministry of Irrigation (RIO/MOI).

Nine control points of Major 5 (Sub-Main Canal) were selected for this purpose. The main reason for the selection was that these control structures were calibrated by a specialized agency of the Ministry of Irrigation; the Hydraulic Research Station (HRS). After the referred calibration, these control structures are also being used by IIMI as flow measuring devices.

IIMI's data collected on a daily basis during the referred months are to be used to support or suggest caution about the findings of the two rapid appraisals. The main role of IIMI in these exercises was as follows:

- (a) To provide all the necessary support as an international neutral body to bring all the parties together;
- (b) To help in developing consensus about the problems; and
- (c) To present potential management innovations to be tested.

The basic elements of the exercises are the data sets produced under RA-1 and RA-2, compared with IIMI's observations on the respective dates of the exercises. The data analyses will comprise the following sub-headings:

- (a) Data presentation and interpretation;
- (b) Ideas for operating systems for an adequate, dependable and equitable water distribution;
- (c) Comparison of Actual versus Projected Supplies; and
- (d) Status of irrigation performance.

As almost all the irrigation systems in Sudan are designed for adequate, dependable and equitable water supplies, the main aim of the rapid appraisals and IIMI's other related efforts was to evaluate if the design objectives were being realized. The data collected at the control points were transformed to reflect the situation at each reach. The concept of a reach is defined as the stretch of a canal between two control points. As defined, Major 5 has the following reaches:

		Distance	Command Area (ha)	%
R-1	=	K 0.0 to K 1.5	1932	7.8
R-2	=	K 1.5 to K 3.5	4960	20.1
R-3	=	K 3.5 to K 12	1832	7.4
R-4	=	K 12 to K 15	4492	18.6
R-5	=	K 15 to K 18	3956	16.3
R-6	=	K 18 to K 21	2252	9.3
R-7	=	K 21 to K 26	1119	3.7
R-8	=	K 26 to K 38	3990	16.8

The February maximum supplies per unit command area were found in the case of Reach Nos. 1, 3 and 7 having a total command of less than 20%. The supplies in other reaches ranged from half to one-third of the above reaches. Also, November supplies confirm the same results.

When compared to demand (indents), the resulting control-point (CP) based supply-indent ratios (SIR) range from 0.6 to 1.1 with an estimate mean of adequately met or not. In this context, the data on indents from RAC to RIO hardly changed in February, when compared with November.

On the other hand, the water distribution at reach basis gave an average SIR equal to 1.2 in February, while in November the average SIR is 1.39.

In spite of many reservations about the validity of practices related to estimate irrigation water indenting by RAC, and as a consequence the response from the officials of RIO, the fact still remains that the indents are quantities of water demanded at different points and water quantities monitored at these points are the actual water deliveries.

Based on the observations under the exercises of Rapid Appraisals 1 and 2, as verified by the systematic IIMI data collection on daily basis, there are reach-wise erratic water distribution both in November and February. Three main factors are given for this phenomenon:

- (1) Water guards at the control points do contribute to the problem when they respond to complaints from tail sections of different minor canals;
- (2) Changes in the water-levels at the main canal also contribute to this problem; and
- (3) Double-gated Minors also have a potential to receive more water.

The above factors may contribute some inequity or inconsistency, but they definitely do not tell the whole story. The fact remains that the water distribution is not very good. The system needs to be monitored regularly for making and implementing appropriate decisions to deliver adequate, dependable and equitable supplies.

The abnormal water deliveries are almost hidden when the bits of data are arranged at the control points. Information at each control point represents an average rate of all the other points located downstream. Such a lump-summing camouflages many ups and downs to the water distribution that might have happened in individual cases.