Temporal Evaluation of a Farmer Managed Irrigation System by Using Comparative Indicators

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1. Introduction

The occurrence of droughts and their effect on crop production have resulted in increased emphasis on irrigation development. Furthermore, with rain fed agriculture being unreliable and increasing population growth rates demanding more of agriculture production, irrigation is seen as one way of increasing yields and sustaining food production. Sustainable production increase in irrigation can be achieved by development of new irrigation projects or by improving existing projects after evaluating their performance. The performance of irrigated agriculture is influenced by many variables which include; infrastructure design, management, climatic conditions, price and availability of inputs, and the socio economic settings. It is important therefore, that irrigation systems are evaluated from time to time with the aim of assessing their performance. The International Water Management Institute (IWMI) developed a set of comparative indicators that can be used to assess performance of irrigation systems within and across systems. This study applied the comparative performance indicators developed by IWMI to assess the performance of the Bwanje Valley Irrigation scheme by evaluating how land and water resources are being used for agricultural production.

2. Materials and Methods

2.1 The Study Area

The Bwanje Valley Irrigation Scheme is located in Dedza District along the flood plains of Lake Malawi. The scheme has a command area of 800 hectares benefiting 2240 farm families. Namikokwe River is the main water source for the scheme has large monthly fluctuations. The average annual rainfall is 930mm and about 90% of this rain occurs from November to April and it is erratic. The Namikokwe River feeds water to the scheme by gravity system through a main canal which subdivides into three branch canals. Paddy rice is the main crop during the rainfed season and early maturing maize variety and vegetables are usually grown in irrigation season. The scheme is managed by a farmers' cooperative and government also provides technical assistance through extension workers.

2.2 Methodology

IWMI developed a set of comparative indicators which enables cross system comparison, temporal and spatial variation assessment. The indicators make it possible to see how well irrigated agriculture is performing at the system, basin or national scale. Some of the comparative performance indicators developed by IWMI that were used in this study are;

$$\text{Output per water consumed (US\$/m}^3\text{)} = \frac{\text{SGVP}}{\text{Volume of Water Consumed by ET}} \quad \text{(1)}$$

$$\text{Relative Water Supply} = \frac{\text{Total Water Supply}}{\text{Crop Demand}} \quad \text{(2)}$$

$$\text{Financial Self Sufficiency} = \frac{\text{Revenue from Irrigation}}{\text{Total O\&M Expenditure}} \quad \text{(3)}$$

$$\text{Water Delivery Capacity} = \frac{\text{Canal Capacity to Deliver Water at System Head}}{\text{Peak Consumptive Demand}} \quad \text{(4)}$$

where SGVP is the output of the irrigated area in terms of gross value of production measured at local or world prices; 'Volume of Water Consumed by ET' is the actual evapotranspiration of crops and; 'Total Water Supply' is the surface diversions plus net groundwater draft plus rainfall; 'Crop Demand' is potential crop ET or potential ET under well watered conditions; 'Revenue from Irrigation' is income from irrigation activities; 'Total O&M Expenditure' is the cost of carrying out operation and maintenance; 'Canal Capacity to Deliver Water at System Head' is the present discharge of the canal at system head and 'Peak Consumptive Demand' is the peak crop irrigation requirements for a monthly period expressed as a flow rate at the head of the irrigation system.

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3. Results and Discussion

3.1 Output per Water Consumed

Fig.1 presents the output per water consumed which shows amount of water used to meet evapotranspiration demands. The highest value of output per water consumed was 0.11US$/m^3 in rainfed season of 2001-02 and the lowest value was 0.03US$/m^3 in the irrigation seasons of 2007-08 and 2008-09. Generally there is a decline in the trend of the output per water consumed due to a lack of good utilization of rainfall, poor water application to the scheme and reduced area under cultivation.

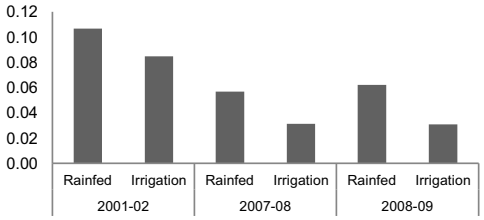

Fig. 1 Output per Water Consumed

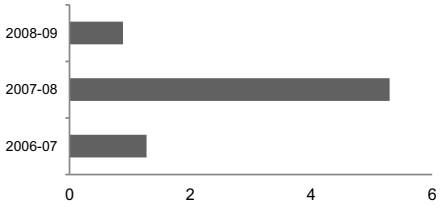

Fig. 2 Financial Self Sufficiency

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Fig.2 presents the Financial Self Sufficiency which indicates the percent of expenditures on operation and maintenance that is generated locally. The financial self sufficiency of BVIS is varying between 0.88 in 2008-09 to 5.29 in 2007-08 with a variation ratio of 1 to 5.29. The highest Financial Self Sufficiency in 2007-08 was due to the fact that government was carrying out a rehabilitation of the scheme which resulted in the farmers spending less money on O&M.

3.3 Relative Water Supply

Relative Water Supply which relates supply of water to demand is presented in **Table 1**. The highest value of Relative Water Supply was 0.97 in 2001-02 rainfed seasons and the lowest value was 0.13 in 2001-02 irrigation season. The Relative Water Supply was higher in the rainfed seasons as compared to the irrigation seasons. This can be attributed to the contribution of rainfall during the rainfed seasons.

Table 1 Relative Water Supply values

Year	Season	Relative Water Supply
2001-02	Rainfed	0.97
	Irrigation	0.13
2007-08	Rainfed	0.95
	Irrigation	0.47
2008-09	Rainfed	0.85
	Irrigation	0.35

3.4 Water Delivery Capacity

Water Delivery Capacity is the ratio of the canal capacity to deliver water at system head to the peak consumptive demand. From **Fig.3**, the Water Delivery Capacity was highest in 2001-02 rainfed seasons with a value of 0.66 and was lowest in 2007-08 irrigation season with a value of 0.35. Generally there is a declining trend of the values of Water Delivery Capacity. This indicates that the system design is constraining the meeting of the peak crop consumptive demands.

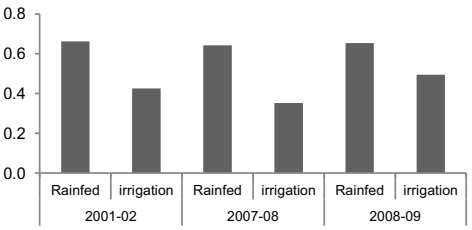

Fig. 3 Water Delivery Capacity

4. Conclusion

Comparative performance indicators developed by IWMI were used to evaluate the performance of Bwanje Valley Irrigation scheme for 2001-02, 2007-08 and 2008-09 growing seasons. Although more water was used during the rainfed seasons in all years, it was not used effectively as the productivity per unit water was relatively low. This was due to poor water management by farmers. Low cropping intensities and inadequate water supply especially during irrigation season also affected the production from the scheme. Generally there is a declining trend of the values of water delivery capacity which indicates that the system design is constraining the meeting of the peak crop water demand especially during the irrigation season.