

Performance Evaluation of Irrigation Systems under Different Hydro Meteorological Conditions

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ABSTRACT: Water is the limiting factor in most of the world. Increasing yields and sustaining food production depend mainly on irrigation. The main objective in the performance evaluation is to decide the performance indicators. The study area was Tamil Nadu and Kerala which are different in hydro-meteorological parameters for the comparison. The six indicators selected were output per cropped area, per unit command, per unit irrigation supply, per unit water consumed, relative water supply and relative irrigation supply. The evaluation revealed that the production values were varying for both the irrigation systems with land as well as water as constraints. From the results obtained, it is concluded that a better performance of the irrigation system can be improved by changing the cropping pattern, cropping intensities and choosing the right variety of crops. In both the systems, it is advised to do strict and active water management system to control the wastage of water and use the available water judiciously.

KEYWORDS: Performance indicators, SGVP, Irrigation systems, Hydrometeorology, Evapotranspiration
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I. INTRODUCTION

Water is a valuable resource for agricultural production. Scarcity and misuse of water pose a serious and growing threat to life and sustainable development. As water is the limiting factor in most of the world, increasing yields and sustaining food production depend mainly on irrigation. Therefore, protection and development of water resources are crucial for irrigation facilities. The increase of food production with the limited water resource is the main challenge for the irrigated agricultural sector in the 21st century and therefore it is necessary to monitor the performance of the irrigation systems. Studies of performance assessment that provide a periodic flow of data regarding the key indicators in an irrigation project are an efficient management tool to monitor irrigation systems. Some of the hydro-meteorological parameters are Rainfall, Temperature, Relative humidity, Evaporation or evapotranspiration and sunlight hours. Each of these parameters are described below using a comparison of two states- Kerala and Tamil Nadu which are under different hydro meteorological conditions. Two irrigation systems from Kerala and Tamil Nadu were taken for the study. Annappa Naicken Kuppam anicut system feeding 20 tanks is situated in Gummidipoondi taluk of Thiruvallur district, Tamil Nadu. The area covered by one of the tank, namely, Panabakkam tank of A. N. Kuppam anicut was one of the irrigation system selected for the study. Kallada Irrigation system, Kerala is one of the largest irrigation systems in Kerala. There are several tributaries and distributaries for this system which originates from Kallada River. Konni distributory is one among them. The region fed by this distributory selected was the second study area

II. PERFORMANCE INDICATORS AND ITS FUNCTION

Performance indicators are classified as external indicators and internal indicators. The internal indicators are used only for the performance assessment within a system and they are data intensive. But external indicators relate output to the input and they are not too data intensive. A total of six external indicators are used for the cross system comparison. The various indicators used in this thesis are: Output per cropped area, Output per unit command, Output per unit irrigation supply, Output per unit water consumed, Relative water supply, Relative irrigation supply. The various indicators can be found out using the following Equations:

- i. Output per cropped area = Production/Irrigated cropped area
- ii. Output per unit command = Production / Command area
- iii. Output per unit irrigation supply = Production/Diverted irrigation supply
- iv. Output per unit water consumed = Production/ Volume of water consumed by ET
- v. Relative water supply = Total water supply/ Crop demand
- vi. Relative irrigation supply = Irrigation supply/ Irrigation demand

The Standard Gross Value of Production (SGVP)

The Standardized Gross Value of Production (SGVP) was developed for cross system comparison as there is difference in local prices between the two areas. They help in the comparison of the irrigation systems irrespective of the kind of crops grown. The SGVP considers both local as well as the international preferences and this will be the summation of area, yield, and local price of crops compared with the local price of base crop and multiplied with value of base crop at world. To obtain SGVP, equivalent yield is calculated based on local prices of crops grown, compared to the local prices of predominantly grown base crop. SGVP is calculated using the equation:

$$SGVP = \left(\sum_{crops} A_i Y_i \frac{P_i}{P_b} \right) P_{world} \quad (1)$$

Where Y_i is the yield of crop i , P_i is the local price of crop i , P_{world} is the value of base crop traded, A_i is the area cropped with crop i , P_b is the local price of base crop

The various data required regarding the production, area cultivated for each crops and the price rates of crops for the year 2010-2011 was collected to find out the productivity at both the study area. The results obtained was analyzed and found out that the productivity of Paddy was higher in A.N. Kuppam anicut system. The following tables show the productivity and rates of crops in both the study areas. Table 1 show the Details of productivity and price rates of crops grown at A. N. Kuppam anicut system for the year 2010-2011. Table 2 show the Details of productivity and price rates of crops grown at Kallada Irrigation System for the year 2010-2011.

Table. 1 Details of productivity and price rates of crops at A. N. Kuppam anicut system for the year 2010-2011.

Sl. No.	CROPS	AREA (ha)	PRODUCTION (tones)	PRODUCTION (kg)	PRODUCTIVITY (kg/ha)	PRICE (Rs/kg)
1	Paddy	390.96	1958.7	1958700	5780	9.61
2	Groundnut	25	19.5	19500	780	35

Table. 2 Details of productivity and price rates of Kallada Irrigation System for the year 2010-2011.

Sl. No.	CROPS	AREA (ha)	PRODUCTION (tones)	PRODUCTION (kg)	PRODUCTIVITY (kg/ha)	PRICE (Rs/kg)
1	Paddy	172	440.62	440624	2562.51	9.9
2	Sugarcane	0.38	2.25	2250	5921.20	5.18
3	Pepper	120	96.41	96410	803.44	114.95
4	Banana	249	1652.85	1652850	6637.5	19.5

The following table shows the Standard Gross Value of Production calculated for various crops grown in both the study area. The Standard Gross Value of Production of A. N. Kuppam anicut system was found to be US\$ 1256358 and that of Kallada Irrigation System is US\$ 1785374. The production was found to increase for increase in the cultivated area. Comparing paddy crop alone, it was found that the SGVP is higher in A. N. Kuppam anicut system. This is because

the cropped area for paddy is higher here. In A. N. Kuppam anicut system, the farmers mainly depend on irrigated agriculture than depending too much on the rainfall. Thus, the production of paddy depends on the amount of water diverted to the fields which is higher in A. N. Kuppam anicut system.

Table.3 Net crop demand and Net irrigation demand calculated for Kallada Irrigation System.

Sl. no	Crops	Area (ha)	Net crop water requirement (mm/season)	Net irrigation requirement (mm/season)	Total net crop demand (mm/season)	Total net irrigation demand (mm/season)	SGVP (US\$)
1	Paddy	172	539	256.6	728.33	318.26	407857
2	Sugarcane	0.38	1607.2	382.7			370.49
3	Pepper	120	498.5	73.5			350847
4	Banana	249	1054.9	478.7			1026300
	TOTAL	541.3					1785374

Table. 4 Net crop demand and Net irrigation demand calculated for A. N. Kuppam anicut system.

Sl. no	Crops	Area (ha)	Net crop water requirement (mm/season)	Net irrigation requirement (mm/season)	Total net crop demand (mm/season)	Total net irrigation demand (mm/season)	SGVP (US\$)
1	Paddy	391	518.9	262	518.27	269.65	1233987
2	Groundnut	25	508.4	389.3			22371.2
	TOTAL	416					1256358

The six performance indicators for both the study area were calculated and the results were tabulated. Table 5 shows the results of the six performance indicators calculated for both the study area.

Table. 5 Results of the six performance indicators calculated for both the study area.

Study area	SGVP per cultivated area (US\$/ha)	SGVP per command area (US\$/ha)	SGVP per unit irrigation supply (US\$/m ³)	SGVP per unit water consumed (US\$/m ³)	Relative water supply	Relative irrigation supply
A. N. Kuppam anicut system	3020.38	2745.80	0.313	0.58	3.014	0.835
Kallada Irrigation System	3298.13	3025.80	1.16	0.45	5.63	2.5

SGVP per cropped area

SGVP per cropped area is found to be higher in Kallada Irrigation System where most of the area is occupied by banana cultivation. Whole area cannot be cultivated due to fallow land and certain socio economic factors in the irrigation system. The irrigated area and the cropping pattern can be changed from year to year. If the un-irrigated area is irrigated, the SGVP per cropped area can be increased to a limit of US\$ 3200 to 3700 per ha. Precautions should be taken to decrease fallow land and farmers should be given training for this. SGVP per cropped area can be improved through increase in production, reduction in cost of cultivation and inputs and providing proper support price for the produce. Figure 6 below shows the variation of SGVP per unit cultivated area (US\$/ha) for both the study area considering all the crops grown in the area.

It was found that the SGVP per cropped area for the crop paddy alone in A. N. Kuppam anicut system was US\$ 3156.3/ha and that in Kallada Irrigation System was US\$ 2371.95/ha. It is seen that considering the paddy crop alone, SGVP per cropped area is higher for A. N. Kuppam anicut system. Figure 7 below shows the variation of SGVP per unit cultivated area for both the study area considering paddy crop alone.

SGVP per unit command area

The value of SGVP per unit command area usually ranges from approximately US\$679 to US\$ 2,888 per ha. In A. N. Kuppam anicut system, the value is 2745.80 US\$/ha whereas the value of SGVP per unit command of Kallada Irrigation system is US\$3025.80 per ha. It is noted that the value changes with the cropping intensity of rice and the type of crops grown. Figure 8 shows the graph showing the variation of SGVP per unit command area for both the study area.

SGVP per unit water consumed

The SGVP per unit water consumed is computed considering the Evapotranspiration of the crops. The value of this indicator was found to be US\$ 0.58 /m³ for A. N .Kuppam anicut system and US\$ 0.45 /m³ for Kallada irrigation system. The total net crop demand for Kallada Irrigation system was obtained as 728.33mm/season and that of A.N.Kuppam anicut system was obtained as 518.27mm/season. This reveals that the production value per unit of water consumed is little better in A. N .Kuppam anicut system than Kallada Irrigation System. Figure 9 shows the graph showing the variation of SGVP per unit water consumed (US\$/m³) for both the study area.

But considering the SGVP per unit water consumed for the paddy crop alone, it is seen that the value ranges from US\$ 6.47/m³ in A. N .Kuppam anicut system to a value of US\$ 15.74/ m³ in Kallada Irrigation System. This values obtained reveals that the production value of paddy obtained per unit of water consumed in Kallada Irrigation system is better than A. N .Kuppam anicut system. Figure 10 shows the variation of SGVP per unit water consumed for the paddy crop alone.

SGVP per unit irrigation supply

This indicator specifies production value per unit of irrigation supply. The value of this indicator was found to be US\$ 0.313/m³ for A.N.Kuppam anicut system and US\$ 1.16/m³ for Kallada Irrigation System. Higher value of this indicator in Kallada Irrigation System indicates lower irrigation supply. In Kallada Irrigation system, the amount of water diverted is lower compared to A. N. Kuppam anicut system. This is because the farmers in this system are depending on the rainfall for the crop production and irrigation supply is done only when the rainfall is insufficient to meet the needs of crops.

Relative water supply and Relative irrigation supply

Relative water supply ratio relates water supply to demand and indicates the condition of water abundance or scarcity and how tightly supply and demand is matched. The relative water supply which measures the compensation of water demand was obtained as 4.5 for A. N. Kuppam anicut system and 5.63 for Kallada Irrigation System. The value more than 1 indicates that the water supply is enough to meet the crop demand. The results relate the value of water per unit diverted and the value per unit of water needed and it shows that the excessive irrigation water was used. Relative irrigation supply relates irrigation supply to demand. The value of this indicator computed was obtained as 3.8 for A. N .Kuppam anicut system and 2.5 for Kallada Irrigation System. The value more than 1 indicates that the irrigation supply is enough to meet the crop demand. Figure 12 shows the variation of relative water supply and relative irrigation supply for both the study area.

III. CONCLUSIONS

From the study, it has been seen that the cropping pattern should be revised and more crops should be grown to increase the overall production of the irrigation system. Production per unit of water and production per unit of land are quite diverse. From the cropping systems, cropping pattern and the cropping intensities are the major factors affecting the gross value of production. In A. N Kuppam anicut system, the amount of water delivered to field is mostly wasted as seepage losses, canal losses etc. so it is recommended to do lining of canals in order to increase the water delivered to the fields by reducing the losses in the canal. Productivity of land is higher in Kallada Irrigation System and the productivity of water is higher in A. N Kuppam anicut system. Productivity in Kallada Irrigation Systems can be increased by increasing the cropped area but to a maximum limit of 370 ha. Strict and active water management is required in A. N Kuppam anicut system to achieve maximum cultivated area without water shortages affecting production. The water should be supplied when the crop is in need and not according to water availability. So necessary measures should be taken to provide an alternate water supply when needed. In both the irrigation systems, it should be advised to the water user associations to judiciously use the water without causing the wastage of irrigation water. If the canal is opened when the water requirement for the crops is too low such as the nursery period, some secondary storage structures can be made which is maintained as required to store this extra water without wastage to be used when required by the crops. In A. N. Kuppam anicut system, where the capacity of canals is higher, the cultivated areas should be enlarged otherwise irrigation water in canals is drained out of command area, without being used. The Irrigation or Water department can prepare a canal water schedule along with the water users association according to crop water requirement. Output from both the irrigation systems can be improved by selecting high value crops that will fetch good prices in the market. The system performance could be improved by suitably altering the cropping pattern with less water requiring crops coupled with better groundwater utilization plans to augment the irrigation water supply during water deficit periods.

REFERENCES

- [1] CagatayTanriverdi., HasanDegirmenci., SertanSesveren., (2011), ' Assessment of irrigation schemes in Turkey based on management types', *African Journal of Biotechnology*, Vol. 10 (11), pp 1997-2004.
- [2] Cakmak.B. Kendirli.B., Ucar.Y. (2007), 'Evaluation of Agricultural water use: A case study of Kizilirmark', *Journal of Tekirdag agricultural faculty*, Vol. 4 (2), pp 175-185.
- [3] FongsamuthPhengphaengsy., Hiroshi Okudaira., (2008), 'Assessment of irrigation efficiencies and water productivity in Paddy fields in the lower Mekong River Basin'; *Paddy Water Environ (2008)*, Vol 6, pp 105-114.
- [4] Gorantiwar S.D., Smout I.K., (2005), 'Performance assessment of irrigation water management of heterogeneous irrigation schemes: a framework for evaluation', *Irrigation and Drainage Systems*, Vol 19, pp 1-36
- [5] HasanDeurmencu., HakanKcangaz B.Y., Hayrettin Kupcu., (2003), 'Assessment of Irrigation Schemes with Comparative Indicators in the Southeastern Anatolia Project', *Turk Journal for Agriculture*, Vol. 27, pp.293-303.
- [6] Molden., David J., Sakthivadivel R., Christopher J. Perry., Charlotte de Fraiture., Wim H. Kloezen., (1998), Indicators for comparing performance of irrigated agricultural systems, Research Report 20. Colombo, Sri Lanka: *International Water Management Institute*, pp 1-26.