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Performance Evaluation of a Minor Irrigation Scheme

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Abstract

The study was conducted to assess the performance of Kalwande Minor Irrigation Scheme (KMIS) in Chiplun, Ratnagiri district of Maharashtra using various indicators such as output per unit cropped area and water consumed, related to production with land and water. Relative water supply (RWS), irrigation supply (RIS) and water delivery capacity (WDC), related to water supply from the system with crop water demand and financial self sufficiency (FSS) related with collection of fees from water users in the command area. In this study, the performance indicators in Kalwande Minor Irrigation Scheme were determined for year 2013-14; the results were discussed and evaluated. The analysis of agricultural performance indicators showed that the production value of different crops grown in command area were lower than that of the recommended package of practices. The analysis of water use indicators showed that RWS and RIS were calculated as 2.49 and 1.27 respectively indicating the condition of water abundance. The value RWS and RIS was more than one represents that the total water supply is enough to meet the crop demand. The WDC for whole Kalwande command was calculated as 7.1 represents the canal capacity was sufficient to meet the peak consumptive requirement. The analysis of economic or financial indicators showed that the scheme had a serious problem about the collection of water fees i.e. revenue or irrigation charges collected from scheme were less than that of total operation and maintenance expenditures.

Keywords: Performance indicators, irrigation project, relative water supply, relative irrigation supply, command area.

Introduction

Day by day the world's population is increasing at the alarming rate resulting in increasing demand of food and fiber. On the other hand, per capita land and water resources are decreasing at alarming rate. Water is valuable natural resource, which is used for agriculture, recreation and industrial purpose. Due to industrialization and population growth the demand and utilization of water is increased which increased pressure on the water resources. The major portion of the water resource is used in agriculture sector for irrigation purpose to enhance the crop production. Due to growing demand for household and development purpose the share of the irrigation water is diverted for industries, recreation and drinking purpose. Therefore it is need of the time to utilize the available water resources optimally and judiciously with multipurpose use.

India has made tremendous progress in development of its irrigation potential. However, only about two-third of the created irrigation potential is actually being utilized and overall project irrigation efficiencies are very poor. Applying water to crop through irrigation increases yield and production in agriculture. However, inappropriate management of irrigation schemes might lead to environmental problems such as a high water table and poor drainage and thus salinization and pollution in addition to low quality of water. Assessing the performance of irrigated agriculture is necessary in order to evaluate the impact of agricultural and hydrological interventions. The performance of many agriculture systems is significantly below their potential due to number of shortcomings, such as poor design, construction, operation and maintenance[1].

The system performance, agricultural productivity and financial aspects are the domain provides an idea about performance indicators. The system performance providing facility of water for irrigation and other purposes. The water distribution system is influenced by physical, climatic, economic and other factors. The prevailing climatic condition largely determines both, the available water resources and the crop water requirements in any season. The agricultural productivity shows that, in Maharashtra more than 55 percent population depends on agriculture, thus production per unit area as well as per unit water is vital for State's economy [2]. The financial performance indicated that any system is to be termed as economically sustainable, if the yearly operation and maintenance expenditure incurred on the project is met from its own revenue hence; the existing performance of Kalwande Minor Irrigation Scheme was assessed using performance indicators. The performance of the command area was evaluated on the basis of agricultural indicators, water use indicators and financial indicator.

The study on performance indicators show that evaluation of actual irrigation system performance should rely on an accurate hydrologic water balance over the area considered. They provided equations, procedures and examples for making these calculations and recommended that confidence intervals be included in all reporting of irrigation performance parameters[3].

The compared performance of eighteen irrigation systems located in eleven different countries through various indicators. They used nine indicators and their results showed large differences in performance among the systems[1].

The performance of Kizilirmak basin was evaluated using indicators suggested by IWMI for the years 2003-2005[4].

Material and Methods

Study area: The area selected is the command area of KMIS, located in coastal belt of Maharashtra state and situated in Konkan region. The details of location map and index map of Kalwande Minor Irrigation Scheme is shown in Figure-1.

Details of the project: The dam is earthen type with concrete waste weir. The dam site is located between 17°28'53"N Latitude and 73°29'12.37"E Longitudes at altitude of 108.65 m above mean sea level. The Kalwande Minor Irrigation Scheme has 3.42 km^2 catchment area. The gross capacity of dam is 1.967 Mm^3 with 1.927 Mm^3 of live storage. The Kalwande Minor Irrigation Scheme has gross command area (G.C.A.) of 140 ha out of which 135.7 ha (96.93 percent of G.C.A.) area is under C.C.A. At present only 9.06 ha is being irrigated, amounting to 6.67 percent of culturable command area.

The climate of the command is characterized as humid subtropical having two district cropping season; *kharif* and *rabi.* The *kharif* or rainy season starts from mid-June and ends in September and *rabi* season is spread over October to mid March. The textural classes of soil in command area were determined as sandy to loamy sand. The average annual rainfall in the command area is more than 3500 mm [5]. The 95 percent rainfall occurs during June to September.

Existing cropping pattern: In Kalwande command area in 2013-14 during *kharif* paddy crop was grown while in *rabi* season (October to Jan-Feb) pulses, vegetables, watermelon, groundnut etc. crops were irrigated with canal water. The perennial and horticultural crops like cashew, mango, banana and pineapple were also grown in the command area and irrigated with canal water. Hence at present only 9.06 ha area was irrigated during *rabi* season.

Methodology: In command area in year 2013-14 during *rabi* season only 9.06 ha area was under cultivation. From survey of command area it was observed that the actual area under crops was very less, hence grouping of crops were done into pulses, vegetables, horticultural, oil seeds and watermelon. The main output considered is crop yield and foremost inputs are water and land. Six basic performance indicators namely output per unit irrigated crop area, water consumed, RWS, RIS and WDC were computed. Calculation of these indicators required data on cropped area, command area, evapotranspiration, peak demand, water diverted by canal, rainfall and production value. The data were collected from Sub-Division Office, Irrigation Department, Government of Maharashtra, Chiplun. The evapotranspiration was computed using FAO-56 Penman-Monteith equation. For calculation of production, the yield obtained is collected through field survey using questionnaire.

Output per unit irrigated crop area: It is ratio of yield obtained in terms of gross returns measured at local prices to the ICA [1]. An ICA is the sum of the areas under crops during the time period of analysis.

$$O/P \text{ per ICA (Rs/ha)} = \frac{\text{Production(Rs.)}}{\text{Irrigated crop area}} \quad (1)$$

Output per unit water consumed: This indicator is obtained by taking ratio of production to the volume of water consumed (WC) by crop. The WC by crop is the actual ET of crop [1].

$$O/P \text{ per WC (Rs/mm)} = \frac{\text{Production (Rs.)}}{\text{Water consumed by crop (mm)}} \quad (2)$$

Relative water supply: The RWS is the proportion of total water supplied to the total crop demand[1]. This indicator used both at measurement of adequacy and seasonal timeliness [6]. The value of relative water supply more than one indicates the TWS is enough to meet the demand. Higher value of RWS indicates that there is excess water supply. The RWS is given by equation 3.

$$RWS = \frac{TWS}{CD} \quad (3)$$

Relative Irrigation Supply: It is the fraction of irrigation supply to irrigation demand[1]. It is the inverse of irrigation efficiency[7]. The value of RIS more than one indicates that irrigation supply by the canal is enough to meet crop insist. The RIS is given by equation 4.

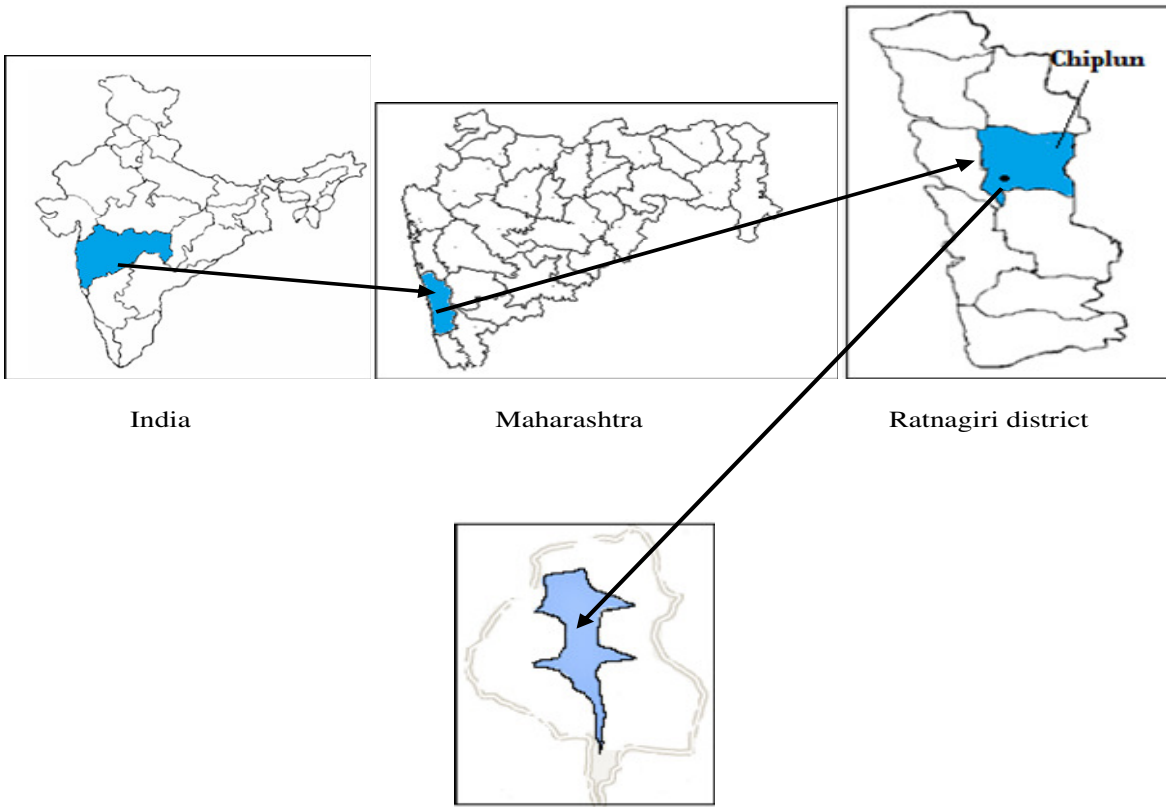
$$RIS = \frac{IS}{ID} \quad (4)$$

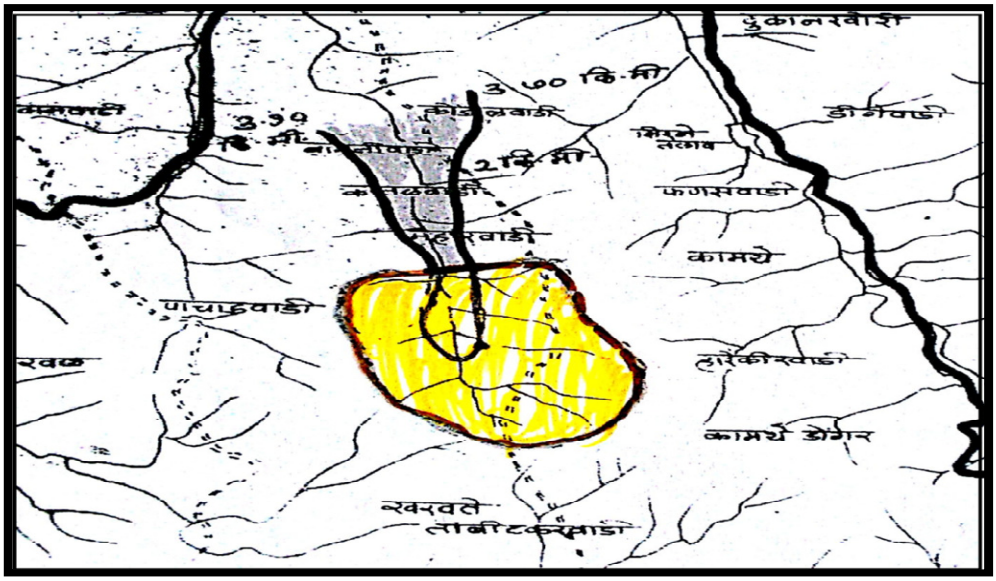
Water delivery capacity: It is obtained by using equation 5. It is an indication of the degree to which irrigation infrastructure is anyway constraint for cropping intensities by comparing the canal conveyance capacity to peak consumptive demand[1].

$$WDC\ (\%) = \frac{\text{Canal capacity to deliver water at system head}}{\text{Peak consumptive demand}} \quad (5)$$

Financial self-sufficiency (FSS): It is determined using equation 6[1]. In the present study the revenue from irrigation service fee was taken as irrigation water charges. The financial self sufficiency represents the collection of fees from water users either sufficient or insufficient for operation maintenance cost[8].

$$FSS\ (\%) = \frac{\text{Revenue from irrigation charges}}{\text{Total opration and maintenance expenditures}} \quad (6)$$





Index map of Kalwande Minor Irrigation Scheme

Figure-1
Location map of Kalwande Minor Irrigation Scheme

Results and Discussion

O/P per ICA: The ICA of KMIS during year 2013-14 is only 9.06 ha; it is observed that total gross returns from existing area was Rs.4,68,235 during *rabi* season. Hence the O/P per unit ICA for whole command area was Rs.51, 682 ha^{-1}.

Output per unit water consumed: It is determined by considering reference crop ET for pulses, vegetables and horticultural crops. The daily ET_o values were estimated using FAO Penman-Monteith method. The ETc values obtained on the basis of 23 years average data. From Figure-3 it is observed that the O/P per WC was varies from Rs.26.88 mm^{-1} for groundnut to Rs.206.35 mm^{-1} for watermelon. It was higher for watermelon due to less water consumed and high gross returns. These results point out that the cropping pattern and intensity, produced differences in O/P per WC. For whole command area the indicator was obtained as Rs. 59.75 per mm of water

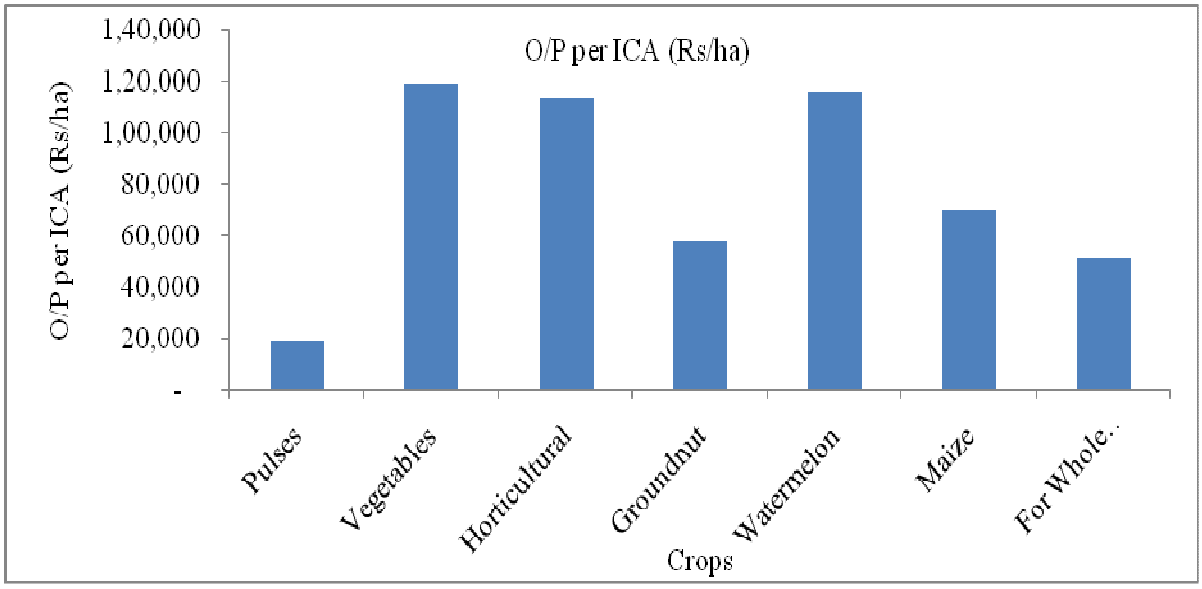


Figure-2
O/P per ICA

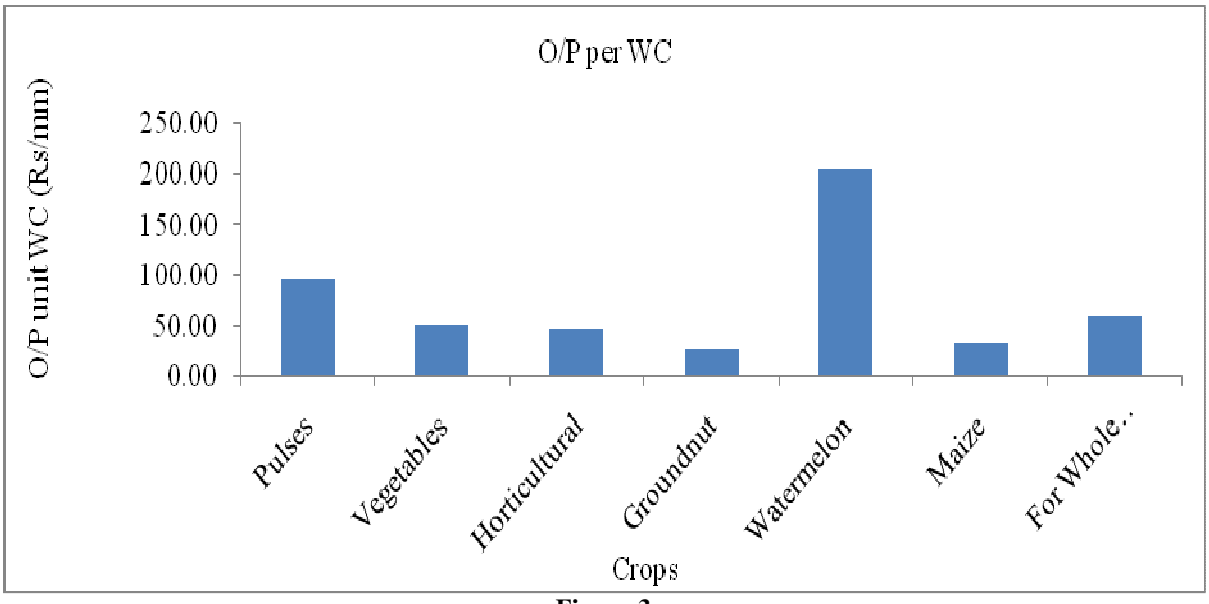


Figure-3
O/P per WC

Relative water supply: The TWS for different crops grown in command area ranged from 189.56 mm to 6243.98 mm, while the crop demand ranged from 79 mm to 854 mm. From Table - 1, it is seen that the relative water supply for whole Kalwande Minor Irrigation Scheme was 2.49 indicates the condition of water abundance. The value of relative water supply was more than one represents the supply is enough to meet the crop insist. The RWS value of 1.91 was observed for Hayrabolu Irrigation Scheme in Turkey[8], 3.13 to 5.96 for Takez basin, Northern Ethiopia for the years 1998 to 2002[9], 1.14 for tail reach of Patna main canal command, Bihar[10]and 1.41 to 4.04 for different irrigation schemes in Turkey for year 2001[11].

Table-1
Water use indicators for Kalwande MIS

Sr. No.	Parameters	Value
1	Irrigation supply (mm)	14,406.34
2	Rainfall (mm)	5,094.00
3	Total water supply (mm)	19,500.34
4	Crop demand (mm)	7,837
5	Irrigation Demand (mm)	11,310.3
6	Canal capacity to deliver water at system head (m^3day^{-1} ha^{-1})	432
7	Peak consumptive demand (m^3day^{-1} ha^{-1})	61.2
8	RWS	2.49
9	RIS	1.27
10	WDC	7.1

Relative irrigation supply: The IS for different crops grown in command area varies between 189.56 mm to 1149.98 mm, while the ID varies between 109.13 mm to 1169.08 mm. From table-1, it is seen that the RIS for Kalwande MIS was 1.27, which was more than one indicates the irrigation provide by the canal system is enough to assemble the crop requirement. The RIS value was found between 0.41 to 4.81for eleven different countries[1], 1.55 for Hayrabolu Irrigation Scheme in Turkey[8], 1.4 and 0.77 for Nura Era and Wonji estate of Ethiopia[12] and 3.33 to 6.68 for Takez basin, Northern Ethiopia for the years 1998 to 2002[9].

Water delivery capacity: The canal capacity to distribute water at system head for daily flow rate of 12 h is 432 m^3 $day^{-1}ha^{-1}$; while the peak consumptive demand for banana is highest among all the crops grown in command area i.e. 61.2 m^3 day^{-1} ha^{-1}. From table-1, it is seen that the water delivery capacity was 7.1 for whole Kalwande MIS, which represents the canal capacity was sufficient to meet the peak consumptive demand. The WDC value was found to be 1.4 and 0.77 for Nura Era and Wonji estate of Ethiopia[12] and 1.31 for tail reach of Patna main canal command, Bihar[8].

Financial self sufficiency: From table- 2, it is seen that the FSS for Kalwande MIS was 0.83. The FSS indicates that the revenue collected from irrigation charges was not sufficient for operation and maintenance of the project. FSS also indicates the sustainability of the project. For sustainability of the project the revenue collection should be strengthen.

Table-2
Financial indicator for Kalwande MIS

Sr. No.	Parameters	Value
1	Revenue from irrigation charges (Rs.)	25,000
2	Total operation and maintenance expenditures (Rs.)	30,000
3	Financial self sufficiency(FSS)	0.83

Based on the above indicators, it is concluded that land and water are not the limitation in the command area. The existing prospective of command area was not fully utilized. The gross returns from the existing area were very less as compared to recommended package of practices. This can be overcome by providing the awareness among the users about recent agricultural practices, nutrient management and water management through extension activities and field trials.

Conclusion

The existing performance of KMIS was determined using some agricultural, water use and financial indicators. The results showed that the output values were lower than recommended package of practices. To increase output, crop pattern should include orchards, industrial crops and vegetables. The O/P per ICA was Rs.51, 682 ha^{-1}. The O/P per WC was Rs.59.75 per mm of water; it was more for short duration crop due to less water extreme. The RWS was 2.49 indicates the condition of water abundance and represents TWS is sufficient to meet the crop demand. The RIS was 1.27 which was more than one indicates the supply is enough to gather the demand. The WDC was 7.1 represent the canal capacity was sufficient to meet the peak consumptive demand. The financial self sufficiency (FSS) was 0.83 indicated that the revenue collected from irrigation charges was not sufficient for operation and maintenance of the project.

The performance indicators showed land and water was not the limitation in the command area. The existing prospective of command area was not fully utilized. This can be overcome by organizing the awareness among the farmers regarding the utilization of available land and water sources by adopting the recommended package of practice

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