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Economic water productivity of paddy in TBP and NRBC command areas of Karnataka

Globally, population growth, rising incomes and urbanization are increasing the demand for water from the household and industrial sectors (Strzepek and Boehlert, 2010). Today's world population of 7,000 million is expected to reach about 8,100 million by 2030. The growing population will result in considerable additional demand for food, water and other necessities. Developing countries are expected to experience an increase in non-agricultural demand for water of 100 per cent between 1995 and 2025 (Turner *et al.,* 2004) and, for the first time, absolute growth in non agricultural water consumption is greater than absolute growth in agricultural water consumption (Rosegrant *et al.,* 2002). Simultaneously, and for the same reasons, there is an increasing demand for food that is resulting in greater demand for water for agriculture. Heightened demand from the household, industrial and agricultural sectors is increasing the competition for water and this increased competition, coupled with concerns about national food security, has led to growing interest in irrigation as a way to increase national production, especially given the increased uncertainty regarding the possible impacts of climate change on water availability (Anon. 2006).

The role of irrigation water in Indian farming as an instrument to economic development hardly needs any emphasis in view of the country's expanding needs of food production. Recognizing this, investment in irrigation projects continued to form a major part of the successive Five Year Plans. However, the investment on irrigation system is in question in recent years due to poor utilization of the created potential (Malhotra *et al.,* 1984).

Similarly, the simultaneous existence of scarcity and inefficient use of irrigation water in the face of sharp increase in the marginal cost of irrigation (Sharma, 1985) in the publicly managed river-basin projects was observed by sixth finance commission. One of the reasons for the poor performance of many canal systems in India is the neglect of main system management (Chamber, 1990).

Canal irrigation has been considered synonymous with the construction of dams and canal network. Therefore, it is important to study the canal water distribution systems at main system mainly to identify operating constraints. The growing world population requires increased food production, while less water resources are available for agriculture. This alarming situation can only be resolved if water is managed more efficiently, so that crop yield per unit of water consumption increases (Anon, 2006). Water crisis is defined by scarcity of water, water-driven ecosystem degradation and malnutrition. In spite of massive water development efforts for food security, the poor are affected the most, because they do not have the resources to obtain or maintain access to reliable and safe water. In the quest for improved access to water and food security, tremendous resources have been invested in developing water for agricultural uses. Yet we know that, with the growing demand for water for industry and municipalities, combined with environmental problems, there will be less water for agriculture in the future. Therefore the solution to the water crisis is to be found in how water is developed and managed. Increasing the productivity of water means, in its broadest sense, getting more value or benefit from each drop of water used for crops, fish, forests and livestock while maintaining or improving ecosystems and the services they provide. Within agriculture, this means obtaining more production or value from every drop. We must increase the productivity of existing water resources and produce more food with less water. Increases in water productivity provide a means both to ease water scarcity and to leave more water for other human and ecosystem use (Jacob *et al.,* 2003).

Water productivity

Economic value of water in agriculture is much lower than that in other sectors (Barker *et al.,* 2003), including manufacturing (Xie *et al.,* 1993). Growing physical shortage of water on the one hand, and scarcity of economically accessible water owing to increasing cost of production and supply of the resource on the other, had preoccupied researchers with increasing productivity of water use in *a*griculture in order to get maximum production or value from every unit of water used (Kijne *et al., 2*003). Raising water productivity is the cornerstone of any demand management strategy. Definition of water productivity is scale dependent. Water productivity can be analyzed at the plant level, field level, farm level, system level and basin level, and its value would change with the changing scale of analysis (Molden *et al.,* 2003). The classical concept of irrigation efficiency used by water engineers omitted economic values and looked at the actual evapo-transpiration (ET) against the total water diverted for crop production (Kijne *et al.,* 2003). Moreover, it does not factor in the "scale effect" (Keller *et al.*, *1*996). At the field level, there is no single parameter to determine the efficiency of water use in crop production. Measures to enhance yield to raise water productivity in biomass per unit of water depleted, might increase the cost of production thereby reducing net return per unit of water depleted. Therefore, crop water productivity needs to be assessed in terms of both kilogram of crop per cubic meter of water diverted or depleted (kg./m^3) and net or gross present value of the crop produced per cubic metre of water (Kijne *et al.,* 2003).

Agricultural water productivity can be expressed either as a physical productivity in terms of yield over unit quantity of water consumed (tones/ha.cm of water or kg/m^3 water consumed) in accordance with the scale of reference that includes or excludes the losses of water or an economic productivity replacing the yield term by the gross or net present value of the crop yield for the same water consumption (₹/volume of water).

The purpose of this study is to analyze water productivity in the command areas. It is widely recognized that the requirements for managing water resources effectively vary geographically and over time. The challenges for farmers, irrigation managers and water-resource policymakers are to identify and implement water policies and practices that are appropriate for the place and time, and to ensure that the institutional climate is such that these can change as the need changes.

The study was conducted in UKP and NRBC command areas of Hyderabad Karnataka region in the year of 2016-17. Multi staged random sampling was adopted in the present study, where at primary level UKP and TBP command areas were selected. From these command areas, one canal was selected from each namely NRBC and TBLLC. From these canals head region, middle region and tail region were selected. From each selected region 20 farmers were selected randomly. Thus, the total sample for the study was 120 farmers and each command area consisted of 60 samples. To assess water productivity primary data were collected from farmers using a structured questionnaire from all the regions, *viz.,* head, middle and tail regions of NRBC and TBLLC. The data collected from farmers included data on crop inputs comprising cost of seeds, labour, fertilizer and pesticides, quantum of irrigation water in m^3 and quantity in Kg and market price in ₹/kg of paddy. In addition, discharge of irrigation wells (litre/sec) was measured using a bucket and stop watch to quantify the volume of water pumped, for which data on number and hours of irrigations for crop and for each season were obtained from the farmers. The analysis was restricted to paddy as their area exceeds 50 per cent of irrigated land in both NRBC and TBLLC.

Similarly, secondary data on collection of water tax, total cropped area, localized cropping pattern of the command area and other general information's about the command areas were collected from the CADA and State Agricultural Department. For the purpose of fulfilling the specific objectives of the study, the data were analyzed by using tabular analysis, percentages.

Water Productivity: It is the ratio of overall output per acre of land to the total volume of water used.

Physical water Productivity (PWP) : It is the ratio of overall physical output per acre of land to the total volume of water used.

PWP = Y /W

Where,

Y -Yield per acre of land (kg)

W- Total volume of water used (m^3)

Unit will be kg/m^3. Accordingly the economic productivity can be obtained.

Economic water Productivity (EWP)

It is the ratio of overall economic returns from the output to the total volume of water used.

EWP = Py /W

Gross economic water Productivity (GEWP)

It is the ratio of Gross economic returns from the output to the total volume of water used.

GEWP = GPy /W

Where,

GPy- Gross returns (Rupees)

W- Total volume of water used (m^3)

Net economic water Productivity (NEWP)

It is the ratio of Net economic returns from the output to the total volume of water used.

NEWP = NPy /W

Where,

NPy- Net returns (Rupees)

W- Total volume of water used (m^3)

Gross economic water productivity and net economic water productivity of paddy in TBLLC and NRBC command areas as presented in the Table 1.

For the calculation of gross and net economic water productivity the gross value of production and net returns from the production in rupees per acre were calculated using crop yield and price of paddy.

Gross economic water productivity and net economic water productivity of paddy are lower in head and middle regions of TBLLC and NRBC command areas, as compared to the tail regions of the same canals.

The canal average gross returns for paddy is ₹ 49,010 and ₹ 44,529 per acre in TBLLC and NRBC respectively. Similarly, the net returns were higher also in head and middle regions compared to tail regions. Average net income of paddy was ₹ 24,718 and ₹ 20,195 in TBLLC and NRBC, respectively. Head and middle region of both canals use the higher volume of

Table 1. Economic water productivity of paddy in TBLLC and NRBC command areas

Canal regions	Avg. gross returns (₹ /acre)		Avg. net returns (₹/acre)		Avg. water applied (m^3/acre)		Gross economic water productivity (₹ /m^3)		Net economic water productivity (₹/m^3)	
	TBLLC	NRBC	TBLLC	NRBC	TBLLC	NRBC	TBLLC	NRBC	TBLLC	NRBC
Head region	52418.33	49155.55	27007.73	22776.15	7434.50	7521.50	7.15	6.57	3.68	3.04
Middle region	49589.92	46632.91	24757.32	21715.91	5858.00	5966.00	8.52	7.93	4.25	3.67
Tail region	45021.58	37797.61	22391.58	16093.20	4017.00	3547.00	11.227	10.66	5.58	4.54
Overall	49009.94	44528.69	24718.88	20195.09	5769.83	5678.16	8.97	8.39	4.50	3.75

water as compared to the tail regions. So, the gross economic water productivity and net economic water productivity were higher in case of tail region than the head and middle regions of TBLLC and NRBC.

The higher physical and economic water productivity in tail regions of canal could be attributed to average yield with limited water supply conditions. Lower water productivity for head and middle region was mainly due to higher volume of water application. This clearly showed that there was a good scope for improvement in water management in head and middle region of both the canals. Mahoo *et al.* (2007) has reported low productivity of water at the head region of Mkoji irrigation canal as compared to high productivity at the tail end of an irrigation canal. At the head of a canal, access to irrigation water was high promoting farmers to use higher volume of water. However, at the tail end of a canal strategy of farmers was to use water carefully and to sometimes produce valuable crops.

Conclusion

This study indicated that individual farmers were more interested in increasing their farm income were less bothered by decreased water productivity. This is probably due to low cost of surface water in NRBC and TBLLC. Therefore, increasing surface water charges by Irrigation Department could be potential option for restricting excessive water use for agriculture. Farmers of NRBC and TBLLC were found to be ignorant of actual crop water requirements and excessively irrigated the lands. Therefore, farmers need to be educated about the actual irrigation requirements for different crops through extension agencies.

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