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Water Productivity Concept, Importance and Measurement in the Khapa Minor Irrigation Project

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Abstract
In this study Irrigation water productivity is stated that as ratio of the crop output to the irrigation water applied by the farmer through irrigation system surface canals, tank, pond or the well and during the wheat crop growth. Thus irrigation is an economic activity and the farmer has to incur certain expenditure to apply the water (kg/m^3). Studies were carried out to evaluate the wheat yield and water productivity for different varieties, irrigation method and depth of irrigation in Khapa and Magardha command area, which is located in Mandla district of Madhya Pradesh (India). In this study, Different irrigation application methods i.e. (sprinkler irrigation system, Border irrigation and flood irrigation) and different sowing methods were applied in wheat crop. These practices may reduce on-farm irrigation water applications and improve crop yields. Water management technologies like sprinkler irrigation is used in these command area, of conserving the available water resources and thereby sustainably improving the productivity as well as profitability.

Keywords: Border irrigation, depth of irrigation, flood irrigation, sprinkler irrigation, water productivity

Introduction

It is widely recognised that the world is facing an unprecedented water crisis and among the key factors influencing this situation are water management issues in the agricultural sector. Two basic factors are critical- first, the agricultural sector is by far the largest user of freshwater (Molden, 2007) [4]; and second, water use in agriculture tends to have lower net returns as compared to other competing uses (Scheierling *et al*., 2014) [8].

It is reported that in the next three decades, the global food systems will need 40-50 per cent more freshwater than today. Municipal and industrial demand for water will increase by 50-70 per cent during this period, while demand for energy sector will increase by 85 per cent. India faces high water stress and the country is amongst those with the most fragile and uncertain water resources in the world. Irrigation sector with almost 78 per cent share dominates the present and future water use scenario in India. One of the main concern to these emerging challenges is to focus on improving water productivity in agriculture, as even small improvements could have large implications for local and national water budgets and allocation policies. This view is shared by Global Water Partnership (2000) [3], UNESCO which consider demand management as an important option to cope with water scarcity, with improving agricultural water productivity as the single most important avenue for managing water demand in agriculture. Land, labour and water are the critical resources in agricultural production. However, unlike land and labour productivity, the concept of Water Productivity (WP) though existent from a long time, became prominent only recently especially in the developing countries (Barker *et. al*., 2003) [2]. The famous slogan of 'More Crop per Drop' (Molden, 1997) [5] or 'Per Drop More Crop' as rechristened by the Indian Prime Minister featured throughout the past decade in analyses of WP of crops, cropping systems and agricultural production systems (Kijne *et. al*., 2003; Amarasinghe *et al*., 2007) [12, 1] Improving WP at scales of fields, farms, irrigation systems and river basins (Zwart and Bastiaanssen, 2004; and across sectors of agriculture, domestic, industry and environment has been the central argument in discourses on averting water crisis and ensuring water security to vulnerable populations and regions of the world. Many countries in the world (Rosegrant *et. al*., 2002) [6] and large intensive water-use regions within the countries (Rodell *et al*., 2009) are breaching the thresholds of physical and economic water scarcities. Originally, crop physiologists defined water use efficiency as the amount of biomass or marketable yield per unit of transpiration or evapotranspiration (Viets, 1962) [9]. Irrigation scientists and engineers used the term water (or irrigation) use efficiency as “the ratio of irrigation water transpired by the crops of an irrigation farm or project during their growth period to the water delivered from a river or other natural source into the farm or project canals during the same period of time (Israelsen, 1932) [10]. In spite of some improvements, this concept of water use efficiency provides only a partial view because it does not indicate the total benefits produced, nor does it specify that water lost by irrigation is often used by other users downstream (Seckler *et al*., 2003) [12]. The current focus of water productivity has evolved to include the benefits and costs of water used for agriculture in terrestrial and aquatic ecosystems (Molden *et al*., 2007) [4]. In its broadest sense, it reflects the objectives of producing more food, income, livelihoods and ecological benefits at less social and environmental cost per unit of water consumed (Sharma, Molden and Cook, 2015) [13]. Physical water productivity is defined as the ratio of agricultural output to the amount of water consumed (from all available source of water like rainfall, irrigation, etc.).

Irrigation water productivity is defined as ratio of the crop output to the irrigation water applied by the farmer/ irrigation system either through surface canals, tank, pond or the well and tubewell during the crop growth. Thus irrigation is an economic activity and the farmer has to incur certain expenditure to apply the water (kg/m^3).

Material and Methods

Details of Study area: The experiments of wheat crop were conducted at the Farmer’s fields (2016-2017), in the Khapa, Dhudhwa and Magardha villages which are situated in Bijadandi Block of Mandla district in Madhya Pradesh. The Khapa tank is a major irrigation source for these areas. The study area has maximum rainfall (yearly) 208.07 cm. Minimum rainfall (yearly) 89.94 cm. Average rainfall (yearly) (for fourteen years) 148.33 cm. Dependable rainfall at 75% and dependability (yearly)120.39. The climate of the locality is characterized as typically semi-humid and tropical which is featured by hot dry summer and cool dry winter. In order to study existing cropping pattern in command area the land revenue record of last ten years was studied. The present cropping pattern found in the study area includes Wheat, Gram, Pea, Masoor and Mustard in Rabi season. Paddy, Maize, Kondo and Arahar in Kharif season.

Methodology

Water productivity of wheat crop is improved either by reducing the water losses that occur in various ways during water conveyance and irrigation practices or increasing the economic produce of the crop through efficient water management techniques. A sample results was included for suggesting improvement.

Water productivity is defined as the crop production per unit amount of water used. Concept of water productivity in agricultural production system in focused on producing more food with the same water resources or producing the same amount of food with less water resources. It is the ratio of crop yield to the amount of water applied to produce it and express as kg/m^3.

$$\text{Water productivity (WP)} = \frac{\text{Yield (kg/ha)}}{\text{Total depth of water (cm)}}$$

The traditional practice of cultivation includes old variety, high seed rate, no seed treatments, low fertilizer dose, poor weeding, and excess irrigation depth with inefficient irrigation method and irrigation as per supply not as per demand of the crop. These practices were tested in farmer’s fields in the Khapa command area. Factors were considered for selecting an irrigation system whether surface or sprinkler irrigation can be used.

Results and Discussion

Improved Water Productivity of Wheat Crop in Khapa Command Area

The data collected during farmer’s survey in Khapa tank irrigation project to determine yield and water productivity of Wheat crop. Khapa minor yield of wheat varies from 15 to 22 q/ha. The wheat produced per unit of water used varies from 0.42 to 0.78 kg/m^3. The causes of fewer yields on existing Wheat crop in the Khapa command were use of indigenous seed variety, indecent field preparation and limited resources for mechanization, less use of fertilizers. Improved/ Demonstrated cropping pattern of production and productivity of wheat crop in minor shows that yield of wheat varies from 30 to 42 q/ha. The wheat produced per unit of water used varies from 0.58 to 1.46 kg/m^3. Each unit of operation comprise of 0.4 ha. of area, 18 such units of farmers were selected in Khapa minor. Seed of improved variety of wheat GW-273 and HD-2851 (HYV) was provided along with the recommended dose of 80:40:20 (N: P: K), The tractor mounted seed drill was made available for timely sowing and in irrigated conditions. Its gives an average yield in range of 30-42 q/ha. The variety normally takes 120 to 136 days to mature. On maturity the plants of the variety attain a height of 80-110 cm.

Conclusion

Interestingly, the Khapa minor showed considerable improvement of Wheat yield in response to irrigation. As such sincere and concerted efforts need to be made to improve the spread of canal irrigation to improve the low wheat yields in the Khapa command, recommended improved seed varieties and crop irrigation management. The Improved water management practices demonstrated to the farmer’s field, along with improved seed variety and recommended dose, of seeds & fertilizer can increase the yield up to 95 to 100%. The research concludes that efficient management of crop variety, depth of irrigation water and sowing date can significantly improve the farm income for water scares area.

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