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Research Article

IMPACT ASSESSMENT OF WATER PRODUCTIVITY AND YIELD IN RABI SESSION FOR DIFFERENT WHEAT VARIETIES UNDER DIFFERENT IRRIGATION DEPTH AND IRRIGATION METHODS

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Abstract- Irrigation plays a most important role in crop production from beginning of civilization. The efficient irrigation water management can increase the crop productivity manifolds. A study had been conducted to evaluate the effect of irrigation on yield, water productivity and production which should be consistently evaluated across the area of the entire country in order to meet the needs of increasing population and achieving the food sustainability. The study evaluated 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 on wheat crop. The study results involved measurement of different crop growth parameter, crop yield and eventually water productivity analysis had been performed on different selected parameters. The results indicated that water productivity is significantly impacted by changing crop varieties as well as depth of irrigation. The study suggested that efficient management of crop variety, depth of irrigation water and sowing date can significantly improve the farm income for water scares area.

Keywords- Border irrigation, depth of irrigation, flood irrigation, sprinkler irrigation, water productivity.

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Introduction

Crop water productivity can be defined either as the yield per unit of water depleted in crop production or applied for crop production; or the net return from crop production per unit of depleted water or water applied [7]. Hence, the key drivers of change in water productivity are: amount of water depleted in crop production as it changes denominator of productivity and all crop inputs including crop variety, fertilizer and pesticide dosage and labour as they determine the crop yields and net returns, which change the numerator of part.

The principal objective of this study was to understand farm level wheat-yield differences and to recognize restraints and chances for aggregate yields and overall profitability of wheat production.

Wheat is a very important trade commodity as one fifth of the world its production is traded worldwide [4]. Globally wheat production was estimated to be 715.11 million metric tons from 219.88 million hectares with 3.25 metric tons per hectare productivity during 2013-14. India ranks second in production of wheat (93.51 million metric tons) from 30.0 million ha. and 3.12 metric tons per ha. productivity during 2013-14 [9]. In India, Madhya Pradesh is the third largest wheat producing state with 2.4 metric tons per ha. productivity [2]. Demand of the wheat is increasing gradually due to growing world population and losing the millions of ha. of agriculture land every year [5] along with shifting to temp. regions from winter areas due to changing climatic conditions Therefore several abiotic factors such as drought, high-low temp. And salinity stress significantly causes severe yield loss in wheat [10, 6, 11]. The latest estimated demand for wheat production for the year 2020 is approximately 87.5 million tons, or about 13 million tons more than the record production of 75 million tons harvested in crop season (1999–2000). Since (2000), India has struggled to match that record production figure and thus faces a critical challenge in maintaining food security in the face of its growing population [11].

Wheat has been sown under 50 lakh ha. in the Rabi season (2015-16) in Madhya Pradesh. The wheat production stood at 184.10 lakh tones as against 171.03. lakh tones in 2014-15. a rise of 7.64 per cent. Wheat productivity grew to 3115 kg. per ha. in the state, which was 2850 kg. per ha [1].

Water productivity varies from 1.01 kg/m^3 in Punjab (the highest) to 0.21 kg/m^3 in Orissa (the lowest) among states. These differences are mainly 1 due to varying cropping and land-use patterns, yield levels and CWU. Punjab, Haryana, and Uttar Pradesh in the Indo-Gangetic basin are having the highest water productivity [8]. A major part of area under food grain in these states is irrigated. It is 67, 85 and 97% in Uttar Pradesh, Haryana and Punjab, respectively, and contributing to 48, 72 and 75°/o of the CWU [6].

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 is 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, 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

In this study, improving water productivity of wheat crop be 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.

Soil characteristics analysis: Soil characteristics, which greatly influence the seepage rate such as texture, bulk density and infiltration rate, were determined for the command of Khapa and Magardha minor tank canal.

Soil sample were collected from three locations situated at (head, middle and tail) reach of project area. Mechanical analysis was performed for textural classification. From the U.S.D.A. textural classification of the soil, the surface texture of majority of areas varied from clay to clay loam.

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 (Irrigation applied + Rainfall) 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, 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 and Magardha command area. Factors were considered for selecting an irrigation system whether surface or sprinkler irrigation can be used.

Procedure was to make estimates leading to approximate values for scheduling irrigation comprise of the following steps:

1. Estimate the net and gross irrigation depths (mm).
2. Compute the irrigation water need over the total growing season.
3. Calculate irrigation interval.

The evapotranspiration was computed using Penman-Monteith equation. For calculation of production.

Analysis of variance (ANOVA), There input i.e. (Variety, Irrigation method, Depth of irrigation) had been considered with respect to output, i.e. (yield).

Results and Discussion

Soil characteristics analysis

The analysis showed that the clay content of the soils ranged from 40.42 to 42.45% [Table-2]. The values of bulk density obtained at different reach as presented in [Table-3] was found to be the maximum of 1.21 g/cm^3 at head reach and the minimum of 1.17 g/cm^3 was observed at middle reach.

Table-2 *Soil Texture in command Area.*

SL. No.	Minor	Location	% clay	% silt	% sand	Classification	Bulk density g/cm^3
1	Khapa	Head	40.42	28.52	33.71	Sandy clay	1.20
2		Middle	41.78	36.23	29.75	Silty clay	1.17
3		Tail	42.45	27.41	34.21	Clay loam	1.20
4	Magardha	Head	41.22	27.21	34.21	Sandy clay loam	1.21
5		Middle	41.92	35.21	31.24	Silty clay	1.19
6		Tail	42.35	27.98	34.98	Clay loam	1.20

Existing cropping pattern of production and productivity of wheat crop in village Khapa and Magardha:

The data obtained during farmer's survey in Khapa tank irrigation project were used to determine production per hectare (i.e. productivity) of Wheat crop. Khapa and Magardha minor shows that yield of wheat varies from 17 to 28 q/ha. and 18 to 28 q/ha. The wheat produced per unit of water used varies from 0.51 to 1.42 kg/m^3. and 0.51 to 1.15 kg/m^3. Reasons behind low productivity on existing cropping pattern may be due to use of low quality seeds, improper field preparation (due to stony soil) and limited resources for mechanization, less use of fertilizers. Improved/Demonstrated cropping pattern of production and productivity of wheat crop in village Khapa and Magardha; Khapa and Magardha minor shows that yield of wheat varies from 28 to 34 q/ha. and 31 to 40 q/ha. The wheat produced per unit of water used varies from 0.89 to 1.43 kg/m^3. and 0.91 to 1.47 kg/m^3. Each unit of operation comprise of 0.4 ha. of area, 36 such units were selected with 36 number of farmers in village Khapa and Magardha. 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 40-42 q/ha. The variety normally takes 126 to 134 days to mature. On maturity the plants of the variety attain a height of 90-100 cm.

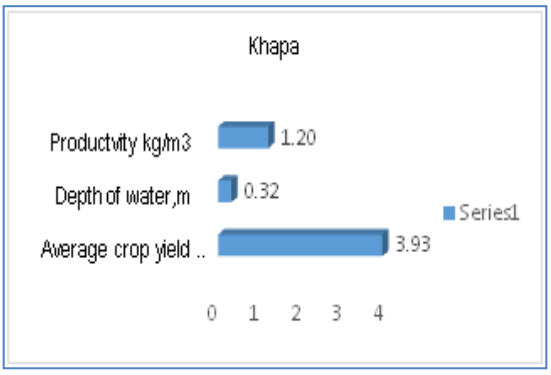
Improved water management practices; Improved water management practices demonstrated to the farmer's field were executed during irrigation season. The source of water is canal and open well. The sprinkler irrigation was applied 4-6 times at different stage of wheat crop.

Table-3 *Apply Sprinkler irrigation in Khapa Village.*

SL .No.	Farmer name	Area ha.	Production Kg.	Yield t/ha.	Total water used, m^3	Water Productivity, Kg/m^3
1.	Binde/Sukali	0.4	1600	40	1280	1.25
2.	Visalsingh/Hari singh	0.4	1520	38	1230	1.24
3.	Pushwa/Briilal	0.4	1600	40	1300	1.23

Table-4 *Apply Sprinkler irrigation in Magardha.*

SL. No.	Farmer name	Area ha.	Production Kg.	Yield t/ha.	Total water used, m^3	Water Productivity, Kg/m^3
1.	Mahendra/Lokman	0.4	1520	38	1267	1.20
2.	Phoolsingh	0.4	1560	39	1270	1.23



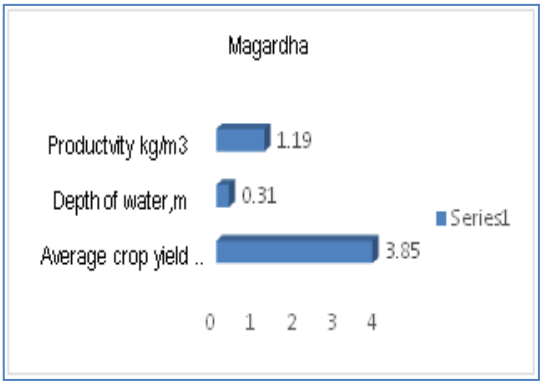


Fig-1 Average crop yield, depth of water and productivity of Khapa and Magardha village.

Table-5 *Save of water among the Flood and Sprinkler.*

SL. No.	Name of Water user Association	Depth of Irrigation in Flood, cm.	Depth of Irrigation in Sprinkler, cm.	Save of Water %
1.	Khapa	47.00	32	32
2.	Magardha	47.00	31	34

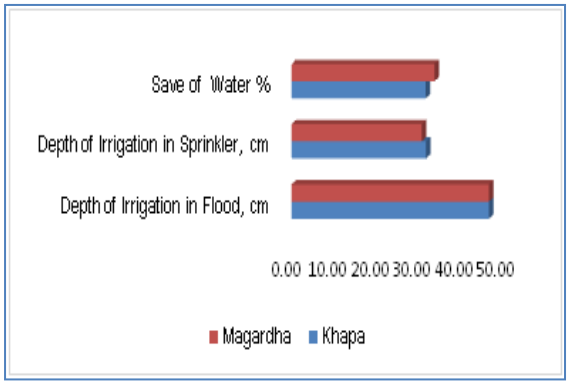


Fig.-2 Apply Sprinkler irrigation in Khapa and Magardha minor

Statistical analysis

Analysis of variance (ANOVA) had been performed considering, three input i.e. (Variety, Irrigation method, Depth of irrigation) with respect to output, i.e. (yield). The analysis of variance shown a very good agreement between input and output and the regression coefficient found at 0.99. The coefficient of input was also determined and presented.

Regression Statistics	
Multiple R	1.00
R Square	0.99
Adjusted R Square	0.99
Standard Error	0.29
Observations	37

	df	SS	MS	F	Significance F
Regression	3	348.09	116.03	1426.58	5.64
Residual	33	2.68	0.08		
Total	36	350.77			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	67.30	1.65	40.73	8.48	63.93	70.66	63.93	70.66
X Variable 1	-1.40	0.09	-14.79	4.00	-1.60	-1.21	-1.60	-1.21
X Variable 2	4.66	0.09	48.70	2.56	4.47	4.8	4.47	4.8
X Variable 3	-1.27	0.05	-22.86	8.23	-1.38	-1.16	-1.3	-1.16

$Y = 67.30 + (-1.40\ X_1 + 4.66\ X_2 - 1.27\ X_3)$

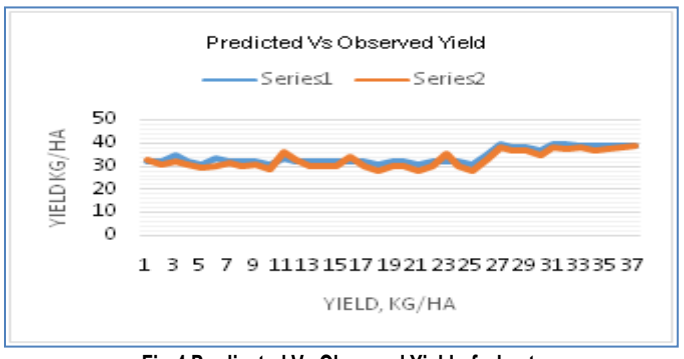


Fig-4 Predicated Vs Observed Yield of wheat.

Conclusion

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 90 to 100%. The study concludes that efficient management of crop variety, depth of irrigation water and sowing date can significantly improve the farm income for water scares area.

Application of research: This research article highlights the importance of water productivity and efficient water planning in water scarcity area.

Research Category: Water productivity, Minor irrigation project

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Abbreviations:

% - Percentage
Cm. - Centimeter
Kg. - Kilogram
Ha. – Hectare
Temp. - Temperature
ANOVA - Analysis of variance
@ - At the rate

Author Contributions: All author equally contributed
Author statement: All authors read, agree and approved the final manuscript

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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