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Economic dimensions and resource use efficiency of wheat crop under sprinkler irrigation in Southern Haryana

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Abstract
The paper examines the economic dimensions, resource use efficiency and constraints in wheat crop under sprinkler irrigation in Southern Haryana using the primary data from 60 randomly selected farmers using sprinkler irrigation under wheat crop from two selected districts namely Mahendergarh and Bhiwani. Multistage random sampling technique was used for the selection of sample farmers. The overall variable and total cost incurred for cultivation of wheat accounted for Rs. 38394.50 and Rs. 68436, respectively. The B:C ratio over total cost in Mahendregarh, Bhiwani and overall were 1.50, 1.43 and 1.47, respectively. The results of Cobb-Douglas production function indicated that MVP of inputs whose regression coefficients were found statistically significant in wheat production function was compared with their respective unit price. Erratic supply of electricity in the area ranked the most important constraint in sprinkler irrigation system by the farmers with total weighted score of 264. Heavy initial investment, less efficiency of the sprinkler due to high wind velocity and declining water table were the II, III and IV ranks of the constraints, respectively.

Keywords: Economic dimensions, wheat crop, sprinkler irrigation

Introduction
Wheat is one of the principal cereal crop grown worldwide and one of the important staples of nearly 2.5 billion of world population. India, second largest producer of wheat after China. The crop has been under cultivation in 30 million hectares (14% of global area) with production 99.70 million tonnes of wheat (13.64% of global production) with a record average productivity of 3371 kg/ha. Having a significant share in consumption of food basket with 9.36 per cent share in the total food grains produced from India, ensuring not only food security but also nutrition security. India which covers an area of 329 mha, with its population of 1.25 billion accounting for one sixth of the world population, its renewable water resources are only four per cent of global availability. Per capita availability of land and fresh water in India is 0.2 ha and 220 m^3 against the world average of 0.27 ha and 7400 m^3 respectively. Irrigation is most critical input for enhancing crop intensity as well as productivity of crops (vaidyanathan *et al.*, 1994) [7] and therefore expansion of irrigation has been key strategy in the development of agriculture in the country.

At present out of 139.9 mha of net sown area, about 48.89 per cent (68.4 mha) is irrigated and remaining 10 per cent area sown under rain-fed condition (Anonymous, 2019) [1]. One of the main reasons for the low coverage irrigation is the predominant use of surface method of irrigation where water use efficiency is only about 35-40 per cent. The surface method of irrigation causes uneven distribution of water, water loss in the seepage and deep percolation, promotes excessive weed growth besides creating salinity, water logging thus, effect the land and crop productivity (INCID, 1994).

The agriculture sector (irrigation), currently consumes over 80 per cent of available water in India, continues to be the major water consuming sector due to the intensification of agriculture and poor irrigation system. The increasing demands on water resources by India's burgeoning population and diminishing quality of existing water resources because of population and the additional requirements of serving India's spiraling industrial and agricultural growth have led to a situation where the consumption of water is rapidly increasing while the supply of water remains more or less constant. Surveys conducted by the Tata institute of social sciences (TISS) showed most of urban cities are water deficient. Nearly 40 per cent of water demand in urban India is met by ground water. As a result ground water table in most cities are falling at alarming rates of 2-3 meters per year.

Owing to poor water resource management system and climate change India faces a persistent water shortage. As per OECD environment outlook 2050, India would face severe water constraints by 2050. (http://www.yourarticlelibrary.com/essay/essay-on-water.in-India-1113-worlds/20871).

Keeping in view the importance of efficient irrigation method (sprinkler) and farmers were not using the resources as per the recommendation this leads to increased in over head cost (Fare *et al.,* 1994). Inefficient use of resources is also reason for declined growth of agriculture sector. Since the study was undertaken to analyze the economic dimensions and resource use efficiency in cultivation of wheat under sprinkler irrigation in Mahendragarh and Bhiwani districts of Haryana.

Methods and Materials

The study was conducted in two districts (Mahendergarh and Bhiwani) from southern zone of Haryana. Two blocks from each district were selected i.e. Mahendergarh and Kanina blocks from district Mahendergarh, and Kairu and Bahal blocks were selected from Bhiwani. From each block, one village was selected randomly. Further, 15 cultivators were selected randomly from each selected village from the list of wheat growers incentivized by State Department of Agriculture & Farmers Welfare and Krishi Vigyan Kendras (KVKs) of CCS Haryana Agricultural University. The relevant information pertaining to various resources like seed, farm machinery, human labour, farm operations etc was extracted from wheat cultivators under sprinkler irrigation through personal interaction. Simple budgeting techniques and descriptive analysis were employed to draw valid inferences from the collected information. The Cobb-Douglas function/log linear production was fitted with six independent variables namely Human labour (X_1), machine labour (X_2), seed cost (X_3) fertilizer cost (X_4), plant protection chemicals (X_5) and irrigation (X_6) The model adopted was as follows.

$$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + \ln \mu$$

Y = Returns per hectare in rupees
a = Intercept
X_1 = Human labour charges in rupees
X_2 = Machine labour charges in rupees
X_3 = Seed cost in rupees
X_4 = Fertilizers charges in rupees
X_5 = Plant protection chemicals in rupees
X_6 = Irrigation charge in rupees
b_1 to b_6 = Respective elasticity co-efficients

For testing the regression co-efficients or production elasticities 't' value was calculated using the formula.

$$t = \frac{bi}{S.E \text{ of } bi}$$

Where
bi=Regression co-efficient or production elasticity of input xi
S.E of bi = Standard error of bi

Returns to scale was calculated by summing production elasticity of all the inputs (∑bi).

If, ∑ bi: = 1, ∑bi : > 1 and ∑bi : < 1 it indicates constant, increasing and decreasing returns to scale

Marginal value productivity indicates the expected increase in gross returns forthcoming from the use of an additional unit of relevant input, while the level of other inputs remaining unchanged.

A resource or input factor is considered to be used most efficiently if its marginal value product is just sufficient to affect its cost. Equality of marginal value product to factor cost is the basic condition that must be satisfied to obtain efficient resource use. In Cobb Douglas production function, marginal value product (MVP) of Xi, the i^{th} input factor is given by the following formula.

$$\text{MVP of Yi} = \bar{Y} / \bar{X}i * bi$$

Where,
$\bar{Y}$ = Geometric mean of output Y
$\bar{X}$ = Geometric mean of output X
Bi=Regression co-efficient of Xj

After computation of marginal value product of a variable, it is to be compared with its acquisition cost or opportunity cost. If the variable in the production function is taken in rupee terms, then the acquisition cost of unit of that input will be one rupee. When the input is expressed in physical units, then the marginal value product must be compared with the actual acquisition cost of one physical unit of that input.

Resource-use efficiency is worked out by computing the difference of marginal value product to opportunity cost. If the difference is less than one, it indicates that too much of the particular resource is being used under the existing price conditions and vice versa.

Results and Discussion

The cost of cultivation of wheat under sprinkler irrigation is presented in Table 1. The overall variable and total cost incurred for cultivation of wheat accounted for Rs. 38394.50 and Rs. 68436, respectively. Overall operational cost of wheat cultivation under sprinkler irrigation reveals that harvesting and field preparation accounted for 19.54 and 10.15 per cent of the total cost, respectively. Both operations accounted for about one-fourth of total cost incurred in raising wheat crop under sprinkler irrigation. The other variable items of total cost of wheat cultivation were irrigation (11.05%), fertilizer investment (7.86%) and hoeing/weeding (1.91%) while in case of fixed expenses, rental value of land accounted 30.90 per cent followed by management and risk charges (11.22%) and transportation charges (1.77%), respectively. Similar findings were also observed by Sahu, *et al.,* 2018.

Table 1: Cost of cultivation of Wheat under sprinkler irrigation in Haryana (₹/ha)

Sr. No.	Particulars	Mahendergarh	Bhiwani	Overall
1.	Field preparation	6810 (9.81)	7085 (10.50)	6947.50 (10.15)
2.	Seed cost	2590 (3.73)	2535 (3.76)	2562.50 (3.74)
3.	Fertilizer Investment	5465 (7.88)	5290 (7.84)	5377.50 (7.86)
4.	Irrigation	7720 (11.13)	7410 (10.98)	7565.00 (11.05)
5.	Hoeing/weeding	892 (1.29)	735 (1.09)	813.50 (1.91)
6.	Plant protection	-	-	-
7.	Harvesting & Threshing	13980 (20.15)	12760 (18.91)	13370.00 (19.54)
8.	Misc.	1905 (2.75)	1612 (2.39)	1758.50 (2.57)

9.	Variable cost	39362 (56.73)	37427 (55.46)	38394.50 (56.10)
10.	Mgt and risk charges	7872 (11.34)	7486 (11.09)	7679.00 (11.22)
11.	Rental value of land	20875 (30.08)	21425 (31.75)	21150.00 (30.90)
12.	Transportation	1280 (1.84)	1145 (1.70)	1212.50 (1.77)
13.	Total Cost	69389 (100.00)	67483 (100.00)	68436.00 (100.00)

Figure in parentheses indicate the percentage of total costAs regards to the returns structure from wheat cultivation under sprinkler irrigation was concerned in the study area it is observed from the table 2 that the gross and net return for Mahendergarh, Bhiwani and overall was Rs. 104410, 96835 and 100622.50 and Rs. 35021, 29352 and Rs. 32186.50 respectively. The B:C ratio over total cost in Mahendregarh, bhiwani and overall were 1.50, 1.43 and 1.47, respectively. Similar findings were also observed by Verma, *et al.,* 2015 [8].

Table 2: Returns from cultivation of wheat under sprinkler irrigation in Haryana (₹/ha)

S. No.	Particulars	Mahendergarh	Bhiwani	Overall
1.	Production (main)	87860	83720	85790.00
2.	By-product	16550	13115	14832.50
3.	Gross Return	104410	96835	100622.50
4.	Cost of Production (Rs./qtl.)	1453	1483	1468
5.	Return over variable cost	65048	59408	62228.00
6.	Net Return	35021	29352	32186.50
7.	B:C over variable cost	2.65	2.59	2.62
8.	B:C over total cost	1.50	1.43	1.47

Marginal value of productivities (MVPs)

Resource use efficiency: In order to examine the resource use efficiency in wheat production, the marginal value productivity (MVP) of inputs whose regression coefficients were found statistically significant in wheat production function were compared with their respective unit price.To test the significance of deviation of MVP of an input from its unit price, t-statistics was used. A significant higher MVP of an input from its unit price implies that more of that input can be used to increase the wheat productivity, while a significant lower MVP of an input from its unit price implies that the input is used in excess and needs curtailment.

The study revealed that the difference between MVP of fertilizer cost and its unit was found to positive and significant in Mahendergarh, Bhiwani as well as in overall result of both the districts. While, human labour found to be negatively significant in Mahendergarh, Bhiwani as well as in overall result of both the districts (Table 3). Result agrees with the findings of Dhakal *et al.,* 2015 [3].

Table 3: Resource use efficiency of wheat crop under sprinkler irrigation in Haryana

Mahendergarh (N=30)					
Resources	**GM**	**B**	**MVP**	**MFC**	**Difference**
Human labour	14657.89	-0.14	-0.83	1.00	-1.83**
Machine labour	7729.86	0.20	2.25	1.00	1.25
Seed cost	2652.02	-0.01	-0.27	1.00	-1.27
Fertilizer cost	2712.09	0.10	3.32	1.00	2.32**
Plant protection	481.18	0.01	2.19	1.00	1.19
Irrigation	4513.21	0.11	2.14	1.00	1.14
Bhiwani (N=30)					
Human labour	13975.17	0.05	0.35	1.00	-0.65
Machine labour	7222.48	0.23	3.07	1.00	2.07**
Seed cost	2438.42	-0.01	-0.24	1.00	-1.24
Fertilizer cost	4262.30	0.14	3.14	1.00	2.14**
Plant protection	501.01	0.01	2.27	1.00	1.27
Irrigation	3973.26	0.09	2.16	1.00	1.16
Overall of both the districts (N=60)					
Human labour	14312.46	-0.12	-0.74	1.00	-1.74**
Machine labour	7471.87	0.17	2.13	1.00	1.13
Seed cost	2542.98	-0.01	-0.25	1.00	-1.25
Fertilizer cost	3399.96	0.12	3.23	1.00	2.23**
Plant protection	490.82	0.01	2.06	1.00	1.06
Irrigation	4234.64	0.11	2.38	1.00	1.38***

*Significance at 1% level, **Significance at 5% level, ***Significance at 10% level

Constraints faced by respondents

Ranking of constraints based on total score as per their relative importance in adoption of sprinkler irrigation as per farmers perception is given in Table 4. Erratic supply of electricity in the area ranked the most important constraint in sprinkler irrigation system by the farmers with total weighted score of 264. Heavy initial investment, less efficiency of the sprinkler due to high wind velocity and declining water table were the II, III and IV ranks of the constraints, respectively. Due to high temperature more water loss in irrigation system, Presence of salty water, Unavailability of spare parts at proper time in the village market and fewer subsidies as compared to investment were the constraints with total weighted score 231, 224, 224 and 203, respectively. Bahire *et al.* (2015) [2] the

major problems expressed by the farmers of Maharashtra were higher initial cost of investment, high cost of drip repairing and higher cost of liquid fertilizers as compared to other fertilizer.

Table 4: Constraints faced by the respondents (N =60)

S. No.	Particulars	Total Weighted Score	Weighted Mean Score	Rank Order
1	Erratic supply of electricity in the area	**264**	**4.40**	**I**
2	Heavy initial investment.	245	4.08	II
3	Less efficiency of the sprinkler due to high wind velocity.	243	4.05	III
4	Declining water table	242	4.03	IV
5	Due to high temperature more water loss in irrigation system.	231	3.85	V
6	Presence of salty water.	224	3.73	VI
7	Unavailability of spare parts at proper time in the village market.	224	3.73	VI
8	Fewer subsidies as compared to investment.	203	3.38	VII

Conclusion and Policy Implication

The study has revealed that sprinkler irrigation was found efficient irrigation system as increased the irrigation efficiency, cover higher area as compared to surface irrigation. The per hectare return over variable cost and net returns from wheat crop was found Rs. 62228.00 and Rs. 32187.00 respectively with B: C ratio over variable cost and total cost is 2.62 and 1.47, respectively. Analysis revealed that the difference between MVP of fertilizer cost and its unit price was found to positive and significant which indicates that these inputs were under utilized in Mahendergarh, Bhiwani as well as in overall result of both the districts. While human labour found to be negatively significant in both the districts. This indicates that human labour was over utilized. The major constraints reported by the farmers were erratic supply of electricity, Heavy initial investment, less efficiency due to high temperature and high wind velocity and salty water.

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