Current Journal of Applied Science and Technology

39(48): 183-188, 2020; Article no.CJAST.64474
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Impact of Sprinkler Irrigation System on Production and Profitability of Wheat in Sagar District of Madhya Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. Author RSB performed the statistical analysis and wrote the first draft of the manuscript. Author SST managed the literature of searches. Author DR wrote the protocol, designed the study and managed the analyses of the study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2020/v39i4831218
Editor(s):
(1) Dr. Michael Ignatius Ferreira, Western Cape Department of Agriculture, South Africa.
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(2) Alexander N. Sadovski, Bulgarian Science Center of the IEAS, Bulgaria.
Complete Peer review History: http://www.sdiarticle4.com/review-history/64474

Original Research Article

Received 25 October 2020
Accepted 30 December 2020
Published 31 December 2020

ABSTRACT

In India, the area irrigated by the sprinkler system is 3.59 million ha, which is less than 2.5 % of the total area under irrigation. Madhya Pradesh has been covered 35195 ha area under micro irrigation (2017-18) Share of Sagar district in micro irrigation area 895.20 ha. Sagar has major wheat growing district under micro irrigation system (MPKSY). An intensive survey was made to collect the relevant data from adopters (48) and non adopters (12) of sprinkler irrigation system in cultivation of wheat. An overall the total cost of cultivation of wheat nominal increase by only 1.66 percent in cultivation of wheat in sprinkler (Rs. 17271.47/ acre) an against without sprinkler (Rs. 16989.87/ acre) irrigation system. The net farm income, family labour income and return per rupee investment were found to be increased by 21.75, 17.73 and 9.81 percent, respectively after the introduction of sprinkler irrigation in cultivation of wheat in the area of the study.

Keywords: Sprinkler; micro irrigation; profitability.

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1. INTRODUCTION

Irrigation is the process of applying controlled amounts of water to plants at needed intervals. Irrigation helps to grow agricultural crops, maintain landscapes and revegetate disturbed soils in dry areas and during periods of less than average rainfall. Different irrigation systems are suited to different soils, climates, crops and resources. There are three main types of irrigation systems: Surface, Sprinkler and Drip/trickle irrigation [1, 2].

Surface irrigation stands for a large group of irrigation methods in which water is distributed by gravity over the surface of the field. The three most common methods are basin irrigation, border irrigation and furrow irrigation. It is normally used when conditions are favorable: Mild and regular slopes, soil type with medium to low infiltration rate, and a sufficient supply of surface or groundwater. Surface irrigation is widely utilized and therefore a well-known system which can be operated without any high-tech applications. Whereas in surface irrigation methods only 30-45 per cent water reaches the crops. That is 55-70% water losses by traditional methods of irrigation [3].

The modern methods of irrigation also known as micro irrigation methods include sprinkler systems, drip systems, etc. In the sprinkler system, water is sprinkled on the crop by using a pipe and nozzle system. It resembles raining. In the drip system, waterfalls drop by drop just at the position of the root.

Drip irrigation is the most efficient and appropriate irrigation system. Instead of wetting the whole field surface, water is applied only to the plant root zone. The primary goal of drip irrigation is to apply water at the time when plants need it most and in rates needed for proper plant growth. Drip irrigation is a highly efficient way to water. A well designed drip system can use up to 30%-50% less water than other methods of watering. Properly installed Drip irrigation method saves 30 to 70 per cent water and it is possible to irrigate three times more area with the same amount of water. Crop production is higher by 20 to 40 per cent in drip irrigation method, because plants can get air and water in required quantities, resulting in regular growth of crops. Drip irrigation requires little water compared to other irrigation methods. About 40-80 liters per day are needed per 100-200 plants. The small amount of water reduces weed growth and limits the leaching of plant nutrients down in the soil.

Sprinkler irrigation method is an easy and simple method of irrigation in present times. Sprinkler irrigation is a method of applying irrigation water which is similar to natural rainfall. The Government of India has been implementing Centrally Sponsored Scheme on micro-irrigation with the objective to extent water use efficiency in agriculture sector by promoting drip and sprinkler irrigation system during 2015-16. Sprinkler irrigation system not only save water over the traditional method but also increases yield and profitability of different crops and agro climatic conditions.

According to 2001/2002 Agriculture census, only 581.3 lakh hectares of land was actually irrigated in India. At the all-India level, 43.71 lakh hectares of lands (7.52%) were brought under micro irrigation in the last five years. Madhya Pradesh has been covered of 11385.09 '000'ha area under irrigation whereas Sagar district have been 394.01 '000' hectare area under irrigation (3.5%) in year 2017-18.

In India, the area irrigated by the sprinkler system is 3.59 million ha, which is less than 2.5 % of the total area under irrigation (https://www.google.co.in). Madhya Pradesh has been 0.29 '000' hectare (0.075%) area under micro irrigation in the year 2018-19.

Wheat (*Triticum aestivum*) is one of the most important staple food grains of human race. India produced 94.88 million tons of wheat during the year 2011-12 which is about 13.53 percent of world production. The second largest producer of wheat in the world. India is also the second largest in wheat consumption after China.

In the year 2017-18 India's wheat production level 99.70 million tone. In Madhya Pradesh area 5.32 million ha, Production is 15.91 million tone which area 17.97 percent to total wheat production of India that same year [4].

Sagar has major wheat grooving district under micro irrigation system (MPKSY). Micro Irrigation (MI) is one of the demand management strategies introduced recently to control water consumption in Indian agriculture which includes mainly drip and sprinkler irrigation method of irrigation.

Irrigation frequency is one of the most important factors in pressurized irrigation scheduling. Due to the differences in soil moisture and wetting pattern, crop yields may be different when the same quantity of water is applied under different irrigation frequencies. Therefore, proper management of inputs particularly irrigation water using modern technology is essential for maximizing production and for providing high returns to farmers [7].

After the Green Revolution, wheat production in India has been on the rise. After rice, wheat is the most consumed crop by the Indian population. Not just that, our country is also one of the largest exporters of all varieties of wheat, making us the second largest producer of the crop worldwide. However, the fact that cannot be ignored is that 900 litres of water is required to produce 1kg of wheat. In India, this crop's production is mainly in the northern region – Uttar Pradesh, Punjab, Madhya Pradesh, Haryana, Rajasthan, Bihar, Gujarat, Maharashtra, West Bengal and Uttarakhand are the major producers of this crop. (source:https://claroenergy.in/). An intensive survey was made to collect the relevant data from adopters (48) and non adopters (12) of sprinkler irrigation system in cultivation of wheat.

2. DATA AND METHODOLOGY

The research work was conducted in the sagar district of Madhya Pradesh. The data of research work based on beneficiaries of sprinkler irrigation system adopted under Pradhan Mantra Krishi Sichai Yojana (PMKSY) Per Drop More Crops (PDMC). The multistage random sampling technique was followed in the selection of districts, Taluka, villages and respondents. At the first stage, Sagar district were selected purposively from Madhya Pradesh as district has highest area under wheat cultivation under sprinkler irrigation system. At the second stage, Deori and Khurai blocks was selected from Sagar district. At the third stage, seventeen (17) villages were selected randomly from two blocks. At the fourth stage, an intensive survey was made to collect the relevant data from adopters (48) and non adopters (12) of sprinkler irrigation system in cultivation of wheat [8]. The primary data were collected for agricultural year 2018-19 using survey method through a personal interview.

The cost of cultivation of wheat was estimated under various cost concepts. Cost A1 = Value of hired human labour, hired bullock labour, owned bullock labour, hired machine labour, owned machine labour, value of seed (both farm produced and purchase), value of insecticide and pesticides, value of manure (owned and purchased), value of fertilizer, depreciation on implements and farm buildings, irrigation charges, land revenue and other taxes, interest of working capital and miscellaneous expenses (artisans etc.).

Cost A2 = Cost A1 + rent paid for leased in land
Cost B1 = Cost A1 + interest on value of owned fixed capital assets (excluding land).
Cost B2 = Cost B1 + rental value of owned land and rent paid for leased- in land.
Cost C1 = Cost B1 + imputed value of family labour.
Cost C2 = Cost B2 + imputed value of family labour.

Cost C3 =Cost C2 + value of management input at 10% of cost C2 (http://eands.dacnet.nic.in). The cost concepts were used for estimation of wheat cultivation, which are adopted by the Commission for Agricultural Cost and Price, Ministry of Agriculture, GOI. The profitability may be calculated by using various economic formulas:

Gross Income = (Main Product X Price per unit) + (By Product X Price)
Net Income = Gross income - Cost C3
Farm Business Income = Gross Income – Cost A1
Family Labour Income = Gross Income – Cost B2
Farm Investment Income = Net Income + Rental value of owned land + Interest on fixed capital
Benefit Cost Ratio = Gross Income/ Cost C3

3. RESULTS AND DISCUSSION

The present study has been conducted to examine the impact of Sprinklers irrigation system on production and profitability of cultivation of wheat in Sagar district of Madhya Pradesh. Vize family labour (-9.68%), hired human labour (-11.11%), machine power(-4.0%) among different components of operational cost all the cost were found to be decreased in wheat. among different components of material cost the expenses on seed (-6.67%), irrigation (-25.00%) was found to be decreased while expenses on manure and fertilizers (98.63%), herbicide (90.00%) was found to be increased with

the introduction of sprinkler in cultivated of wheat. Impact of micro irrigation presented in the Table 1.

The study revealed that an average wheat grower spent less expenditure on operation (-7.23%) and variable (-7.77%) cost, while more on fixed cost (15.27%). while adopting sprinkler system in his farm. An overall the total cost of cultivation of wheat nominal increase by only 1.66 percent in cultivation of wheat in sprinkler (Rs. 17271.47/ acre) an against without sprinkler (Rs. 16989.87/ acre) irrigation system. With the introduction of sprinkler irrigation system in cultivation of wheat, the production of wheat (18.5 q/acre) was found to be increased by 12.12 per cent over non adopter (16.5q/acre). The cost of production per quintal of wheat (Rs. 933.89 q/acre) found to be decrease by 9.33 percent over non adopter (Rs.1029.68 q/acre).

Table 1. Cost of cultivation of wheat (rs/acre)

Particulars		Sprinkler Irrigation	Without Sprinklers	Value Change	% Change
1.Operational Cost					
A. Human Labour	Family	1400	1550	-150.0	-9.68
		32.11	32.98	-0.9	
	Hired	800	900	-100.0	-11.11
		18.35	19.15	-0.8	
B. Machinery Power		2160	2250	-90.0	-4.00
		49.54	47.87	1.7	
C. Owned Bullock labour		0	0	0.0	0
		0.00	0.00	0.0	
Total Operational Cost		4360.00	4700.00	-340.0	-7.23
		100.00	100.00	100.00	0.0
2.Material Cost					
A. Seed		1260	1350	-90.00	-6.67
		31.07	30.51	0.56	
B. Seed Treatment		0	0	0.00	0
		0.00	0.00	0.00	
C. Manure & Fertilizers		1650	1650	0.00	98.63
		40.68	37.29	3.39	
D. Herbicide		180	200	-20.00	90.00
		4.44	4.52	-0.08	
E. Irrigation		750	1000	-250.00	-25.00
		18.49	22.60	-4.11	
F. Depreciation		216	225	-9.00	-4.00
		5.33	5.08	0.24	
Total Material cost		4056	4425	-369.00	-8.34
		100.00	100.00	0.00	
Total Variable cost		8416.00	9125.00	-709.00	-7.77
3. Fixed Cost					
A. Rental Value of own land		7023.33	6133.33	890.00	14.51
		96.40	97.04	-0.64	
B. Revenue /tax		12	12	0.00	0.00
		0.16	0.19	-0.03	
C. Interest on Fixed capital		250	175	75.00	42.86
		3.43	2.77	0.66	
Total Fixed Cost		7285.33	6320.33	965.00	15.27
		100.00	100.00	0.00	
Total cost (Cost C2)		15701.33	15445.33	256.00	256.00
Managerial Cost		1570.13	1544.53	25.60	1.66
Cost of Cultivation (Cost C3)		17271.47	16989.87	281.60	1.66

Table 2. Production and profitability of wheat (per acre)

Particulars	Sprinkler	Non-Sprinkler	Change Value	% Change
Yield (q/acre)	18.5	16.5	2	12.12
Rate/quintal (Rs.)	1840	1840	0	0.00
Main Product Value(Rs./acre)	34040	30360	3680	12.12
By Product Value(Rs/acre)	3600	3360	240	7.14
Gross income	37640	33720	3920	11.63
Net Farm income	20368.53	16730.13	3638.40	21.75
Family Labour income	23338.67	19824.67	3514.00	17.73
Farm business income	30612.00	26133.00	4479.00	17.14
B:C Ratio	2.18	1.98	0.19	9.81

3.1 Production and Profitability of Wheat

A positive impact was to be observed of sprinkler irrigation of an wheat production, yield(q/acre) of main product & by product, gross income, net farm income, family labour income, farm business income and benefit cost ratio/B:C ratio are presented in Table 2.

4. CONCLUSION

The income of adopter farmers was also found to increase due to adoption of sprinkler system in the area under study. A 21.75, 17.73, 17.14 and 11.63 percent charge was observed in net farm income, family labour income, farm business income and gross income respectively as adopter farmer as compared to non adopter farmers, A 9.81 percent charge also observed in benefit cost ratio in adopter farmers (1: 2.18)as compared to non adopter farm (1:1.98).

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/64474