Economic Affairs, Vol. 68, No. 01, pp. 533-539, March 2023
DOI: 10.46852/0424-2513.1.2023.22

AESSRA

Research Paper

Economic Viability of Sprinkler Irrigation System in Southern Haryana

Indu Walia[1*], Sanjay Kumar[2] and Janailin S. Papang[1]

[1]Department of Agricultural Economics, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India
[2]District Extension Specialist (Farm Management), Krishi Vigyan Kendra, Kaithal, Haryana, India

*Corresponding author: indu2995@gmail.com (**ORCID ID:** 0000-0002-8722-8061)

Received: 21-11-2022 **Revised:** 28-02-2023 **Accepted:** 07-03-2023

ABSTRACT

In the present paper an attempt has been made to examine the economic viability of sprinkler irrigation system in southern Haryana. The present study was conducted in the southern districts viz., Bhiwani and Rewari, selected on the basis of high rate of adoption of sprinkler irrigation system. For the selection of sample farmers, multistage random sampling technique was used. From each district two blocks were chosen purposively i.e., Tosham and Loharu in Bhiwani district and Khol at Rewari and Nahar in Rewari district. From each block, two villages were selected randomly. Further, 15 farmers were selected randomly from each village. Economic viability of sprinkler irrigation system was examined on the basis of the various indicators viz., NPV, IRR, B:C ratio and Payback period. Information regarding costs and returns of four major rabi crops viz., tomato, onion, wheat, mustard was taken from samples farmers for the year 2021-22. NPV, IRR, B:C ratio and payback period for sprinkler irrigation system was found out to be 384895.22, 57.99, 3.30 and 3 years respectively. This shows that the investment on sprinkler irrigation system was sound and economically viable.

HIGHLIGHTS

- Study was carried out in southern Haryana districts as there is high rate of adoption of sprinkler irrigation system due to scarcity of water availability.
- Economic evaluation was carried out under the assumption that cost and returns remain constant over the entire life of sprinklers.
- The total cost incurred by the farmers in installation of sprinkler irrigation system was found out to be ₹ 148957.83 and ₹ 153811.35 and working cost observed to be ₹ 16491.48 and ₹ 14830.87 in Rewari and Bhiwani district respectively.
- Sprinkler irrigation system was observed to be economically viable in the study area as NPV came out to be positive (₹ 384795.22), IRR was also estimated to be 57.99 per cent, B:C ratio was also found to be greater than one (3.30) with a payback period of 3 years.

Keywords: Economic viability, Sprinkler irrigation, NPV, IRR, B:C ratio, Payback period

Irrigation plays a supreme role in increasing the use of yield increasing inputs and enhancing cropping intensity as well as productivity of crops. Apart from benefiting the farmers, irrigation development also helps to increase the employment opportunities and wage rate of the agricultural landless labourers, both of which are crucial to reduce the poverty among the landless labour households. However, water is becoming increasingly scarce worldwide due to a variety of factors. Despite having the second largest irrigated area in the world, India too has begun to experience severe water scarcity in different regions. Owing to numerous reasons the

How to cite this article: Walia, I., Kumar, S. and Papang, J.S. (2023). Economic Viability of Sprinkler Irrigation System in Southern Haryana. *Econ. Aff.*, **68**(01): 533-539.

Source of Support: None; **Conflict of Interest:** None

demand for water for different purposes has been continuously increasing in India, but the potential water available for future use has been falling at a quicker rate. The agricultural sector, which consumes over 80 per cent of the available water in India, continues to be the major water consuming sector due to the intensification of agriculture. Though India has the second largest irrigated area in the world, the coverage of irrigation is only about 36.2 per cent (71.6 mha) of the gross cropped area (197.3 mha) as of today (MoAFW, 2021- 22). One of the main causes for the low coverage of irrigation is the predominant use of flood (traditional) method of irrigation, where water use efficiency is very low due to various reasons. These includes uneven distribution of water, water loss (seepage and deep percolation), excessive weed growth, water logging and sanitization.

Considering the water availability for future use and the increasing demand for water from various sectors, a number of demand management strategies and programmes (water pricing, warabandhi, waters users' association, etc.) have been introduced since late seventies in India to increase the water use efficiency, particularly in the use of surface irrigation water. One of the demand management strategies introduced recently to control water consumption in Indian agriculture is micro irrigation (MI). Micro irrigation is defined as the frequent application of small amount of water directly above and below the soil surface usually as discrete drops, continuous drops or tiny streams through emitters placed along a water delivery line. Therefore, the conveyance and distribution losses are reduced to minimal under MI resulting in greater water use efficiency. The net utilization of irrigation water in drip system is 90 per cent and through sprinkler system, it is 82 per cent. Drip irrigation and sprinkler irrigation are the two major methods under micro irrigation.

Sprinkler irrigation is a technique of irrigation for efficient use of water in crops. Sprinkler irrigation system enables application of water under high pressure with the help of a motor. Through a small diameter nozzle installed in the pipes, it emits water that is reminiscent of rainfall. Water is dispersed through a network of pipes, sprayed into air and irrigates most of the soil types due to wide range of discharge capacity. The sprinkler method of irrigation saves water by 30-60 per cent and can irrigate much more area than surface irrigation. It also eliminates channels and land levelling and more land is available for crop production. It involves low operating cost due to reduction in labour. The other reasons for adopting sprinkler system in crop cultivation is to increase crop yield, improve crop quality, enhance the fertilizer/ chemical application efficiency, conserve energy, improve pest management, increase feasibility of irrigating in difficult terrains, improve suitability in problem soils, and improve tolerance to salinity.

Over the years, the adoption of sprinkler system penetrated into larger area in states like Karnataka, Maharashtra, Tamil Nadu, Gujarat, Rajasthan, Haryana. The spread of sprinkler irrigation is also not the same across the states. State-wise area under sprinkler irrigation shows that it is primarily concentrated in central and northern part of the country. States with highest area under sprinkler irrigation as in year 2021-22 are: Karnataka (0.33 mha), Maharashtra (0.11 mha), Tamil Nadu (0.10 mha), Gujarat (0.07 mha), Rajasthan (0.07 mha), Madhya Pradesh (0.06 mha), Haryana (0.04 mha). The total area under sprinkler irrigation has been estimated to be about 6.57 lakh hectare of the total area under micro-irrigation i.e., 10.15 lakh hectare of India (PMKSY Report 2021- 22).

In the Haryana state, the topography, soil conditions and the climate that are prevailing in the south western part of the state, especially in districts of Bhiwani, Mahendergarh, Rewari, Rohtak, Sirsa and Hisar, have inspired the adoption of sprinkler irrigation. The Haryana state is mostly arid or semiarid with limited rain fall ranging from 300 millimeter (mm) in the south-west to 1100 mm in the north-east. There are no perennial rivers running through the state and about two-thirds of the area covered with brackish water is facing problems of rising water table and inadequate natural drainage. Micro irrigation in Haryana started under mission mode 2006-07. From the year 2016-17 onwards, the micro irrigation programme is being implemented under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) as per the operational guidelines of "Per Drop More Crop" component of PMKSY. Sprinkler irrigation, which is water efficient, has been introduced in the canal irrigated areas of southern Haryana. Area under sprinkler irrigation has been increased from 1864 hectare in 2006-07 to

10549 hectare in 2018-19 and under drip irrigation it has been increased from 812 hectare in 2006-07 to 2903 hectare in 2018-19 (PMKSY Haryana Report 2019-20).

REVIEW OF LITERATURE

An attempt has been made to review the available research work on Economic Viability of Sprinkler Irrigation System.

Kakhandaki *et al.* (2012) in their study entitled "Study on cost economics of drip and micro sprinkler irrigation for tomato crop" at Raichur (Karnataka), revealed that the installation cost of sprinkler irrigation was less ₹ 94225, B:C ratio was high (3.4) and yield also high (54.2 ton ha^{-1}) as compared to the drip irrigation system which shown very high installation cost ₹ 101891 with lower B:C ratio (3.3) and lower yield (53.6 ton ha^{-1}).

Suceendra *et al.* (2013) conducted a study on "Economic viability of sprinkler irrigation system on onion (*Allium cepa*)" in Vavuniya (a case study in Nedunkerny), Sri lanka. The study showed that the average crop productivity was 4089 kg per acre under basin irrigation whereas it was 5000 kg per acre under sprinkler irrigation. The profit of the onion crop cultivated under sprinkler irrigation was higher by about ₹ 65648 per acre than the corresponding profit earned by basin irrigation. Sprinkler irrigation reduced the cost of irrigation by about 20 per cent, cost of labour by 38 per cent and pesticides cost by 31 per cent. Moreover, compared to basin irrigation, sprinkler irrigation saved 45 per cent in fuel and 23 per cent in fertilizer cost. The NPV, B:C ratio and IRR showed that the investment in sprinkler irrigation was economically viable even without subsidy. Therefore, the area with basin irrigation would be substituted by sprinkler irrigation which would lead to the use of water in an efficient manner.

Razzaq *et al.* (2018) carried out a study on "An economic analysis of high efficiency irrigation systems in Punjab, Pakistan". The results of the study showed that the users of high- efficiency irrigation (HEI) system like sprinkler earned higher gross margin. The NPV were also positive for various discount rates used in the analysis. These values ranged from ₹ 162876 to ₹ 266527. The NPV estimates also confirmed that sprinkler irrigation system on wheat crop is highly profitable and economically viable option. The B:C ratio values for sprinkler irrigation systems on wheat crop were greater than 1 for all discount rates used in the analysis. The values ranged from 1.80 to 1.90. Results proved that high efficiency irrigation systems (sprinklers and drip systems) were economically feasible options.

Nasseri (2019) studied "Energy use and economic analysis for wheat production by conservation tillage along with sprinkler irrigation". The study was conducted to investigate the combination of both sprinkler irrigation and conservation tillage in sustainable agriculture for wheat production. To exploit the advantages of the two systems, conventional tillage along with surface irrigation and conservation tillage along with sprinkler irrigation were compared based on economic analysis and energy indices. The total energy input components of indirect and non-renewable were 65.3 per cent (54.9 %) and 76.0 per cent (62.9 %) for conventional tillage along with surface irrigation (and conventional tillage along with sprinkler irrigation). Energy inputs of nitrogen fertilizer, seeds and diesel were prime energy consuming components. In conventional tillage along with sprinkler irrigation, the sprinkler irrigation was another energy consumption input. The highest net energy gain (109.2 GJ ha^{-1}), energy use efficiency (5.50), energy productivity (382.00 kg GJ^{-1}) and energy profitability (8.50) and the lowest specific energy (3.4 MJ kg^{-1}) were found in conventional tillage along with sprinkler irrigation. As well as the highest net return (1821.0 US$ ha^{-1}), a B:C ratio (4.4) and productivity (9.3 kg $US\$^{-1}$) was obtained in conventional tillage along with sprinkler irrigation. Therefore, application of conservation tillage along with sprinkler irrigation could be recommended as a promising combination for wheat production in a semi-arid environment.

Grewal *et al.* (2021) studied "Micro-irrigation in drought and salinity prone areas of Haryana: Socio-economic Impacts". The study was undertaken in salinity and drought-prone three districts of Haryana namely Bhiwani, Mahendergarh and Nuh and found that financial benefits increased by 60 to 70 per cent upon shift from flood to mini-sprinkler irrigation. The study revealed that is huge saving in labor cost of irrigation. The average cost of flood irrigation is ₹ 2500 per hectare per irrigation while it

is around ₹ 750 in mini-sprinklers. The study proved that the investment in sprinkler irrigation (SI) was quite remunerative. The average B:C ratio (1:1.97), NPV (₹ 7970) and IRR (17 %) indicated that it was worth to invest in sprinkler irrigation.

MATERIALS AND METHODS

Multistage sampling design was adopted in selection of districts, blocks, villages. At the first stage, Bhiwani and Rewari districts of Haryana state were selected purposively for the study, on the basis of high rate of adoption of sprinklers due to scarcity of water. From each district, two blocks with highest number of sprinklers were purposively chosen for study. From the selected blocks in each district, a list of all the villages in a block where sprinkler irrigation system was used by the farmers was prepared separately and two villages from each block was selected randomly for further sampling. Thus, total of 120 farmers were selected for study. For collection of information from farmers, a well-structured interview schedule was prepared after detailed discussion with progressive farmers, development officials and scientists working in various departments of university.

Analytical framework

Standard project worth measures like Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost ratio (BCR) and Payback Period have been computed to work out the economic viability of sprinklers. For returns, net returns from 4 crops (wheat, mustard, tomato, onion) are taken.

Net Present Value (NPV)- NPV is the present value of the cash flow stream. The mathematical form of NPV is given below:

$$NPV = \frac{\sum_{t=0}^{n} B_t}{(1+i)^n} - \frac{\sum_{t=0}^{n} C_t}{(1+i)^n}$$

where, B_t = Benefits streams over a period "t"

C_t = Costs incurred in each year including initial cost of installation

i = Prevailing market rate of interest

t = 0,1, 2,…..n

n = number of years or life span of sprinkler systems

- While using NPV, the decision rule is—
  - » If NPV is positive, the project is economically justifiable or feasible.
  - » If there are different projects, select the one with the highest NPV.

Internal Rate of Return (IRR): IRR is the discount rate which just makes the net present worth of cash flow equal to zero. It is computed by using the following formula:

$$IRR = \frac{\sum_{t=0}^{n} B_t}{(1+i)^n} - \frac{\sum_{t=0}^{n} C_t}{(1+i)^n} = 0$$

where, r = Discount rate at which NPV of the project becomes zero (0)

IRR = Lower discount rate + Difference between discount rates (Present value of cash flows at lower discount rate/ Difference between the present value of two discount rates)

Benefit Cost ratio (B:C ratio): It is the ratio of present value of benefits to the present value of costs incurred.

Mathematically, Benefit cost ratio can be expressed as:

$$B{:}C\ ratio = IRR = \frac{\sum_{t=0}^{n} B_t}{(1+i)^n} \Big/ \frac{\sum_{t=0}^{n} C_t}{(1+i)^n}$$

- While using BC ratio, the decision rule is—
  - » If B:C ratio > 1, then accept the project or policy as an economically feasible option.
  - » If there are different projects or policies, select that one with the highest B:C ratio value.

Payback Period: The payback period is the length of time from the beginning of the project before the net benefits returns the cost of the capital investment. Its mathematical expression is given below:

$$P = \frac{\sum_{t=0}^{n} B_t}{(1+i)^m} = \frac{\sum_{t=0}^{n} C_t}{(1+i)^m}$$

where, P = Payback period of the project

m = Time period in which cumulative benefits will cover the costs

RESULTS AND DISCUSSION

A particular technology does not find favor with its user unless it is economically viable. Therefore, it is deemed necessary to study the economic viability of sprinkler irrigation system. The cost of installation of sprinkler irrigation system and the working cost has been presented in Tables 1 and 2.

In order to determine the economics of an irrigation system, it is essential to first of all estimate its capital investment of installation. Accordingly, information on capital related aspects of sprinkler irrigation system was gathered and has been depicted in table 1. It is evident from the table that in Rewari district, among all the investment cost in installation of sprinkler irrigation system borewell casing pipes, delivery pipes and motor accounts for the highest share i.e., ₹ 69643.58 followed by cost of sprinkler set and other accessories ₹ 41137.17, other cost like electricity connection, cable, starter ₹ 22858.83 and machine charge for borewell ₹ 15318.75. Similar pattern follows in Bhiwani district also. The cost of borewell casing pipes, delivery pipes and motor observed to be highest followed by cost of sprinkler set and other accessories, other cost and machine charge for borewell i.e., ₹ 75453.87, ₹ 42256.65, ₹ 23841.66 and ₹ 12259.17 respectively.

Among working cost, it is evident from table 2 that among fixed cost depreciation on investment and interest estimated to be ₹ 5408.40 and ₹ 6228.85 in Rewari district and it was found to be ₹ 5507.80 and ₹ 3678.33 respectively in Bhiwani district. Among operational cost, repair and maintenance of sprinkler system was found to be high in Bhiwani district i.e., ₹ 3678.33 and ₹ 3240.82 in Rewari district. Electricity charges were observed to be high in Rewari district ₹ 1763.16 as compared to Bhiwani district ₹ 1683.08. Total working cost (including fixed and operational cost) was observed high in Rewari district i.e., ₹ 16941.48 and ₹ 14830.87 in Bhiwani district.

On an average of both the districts operational cost was 34.46 per cent while fixed cost accounted 65.53 per cent of the total working cost of the sprinkler irrigation system. Repair and maintenance of sprinkler system was maximum among operational cost 21.77 per cent followed by electricity charges 10.84 per cent and other expenses 1.83 per cent. Among fixed cost, depreciation on investment

Table 1: Average installation cost of sprinkler irrigation system

Sl. No.	Particulars	Rewari (₹)	Bhiwani (₹)	Overall average (₹)	Per cent
1	Machine charge for borewell	15318.75	12259.17	13788.96	9.10
2	Borewell casing pipes, delivery pipes and motor	69643.58	75453.87	72548.72	47.92
3	Cost of sprinkler set (main pipes, lateral pipes, risers, nozzles) & other accessories (bend, tee, valves etc.)	41137.17	42256.65	41696.91	27.54
4	Other cost (Electricity connection, cable, starter etc.)	22858.33	23841.66	23349.99	15.42
	Total	148957.83	153811.35	151384.59	100

Table 2: Working cost of sprinkler irrigation system

Sl. No.	Particulars	Rewari (₹)	Bhiwani (₹)	Overall average (₹)	Per cent
(A)	**Fixed costs**				
(i)	Depreciation on investment @10%	5408.40	5507.80	5458.10	34.35
(ii)	Interest @ 10%	6228.85	3678.33	4953.59	31.18
	Sub total	11637.25	9186.13	10411.69	65.53
(B)	***Operational costs***				
(i)	Electricity charge	1763.16	1683.08	1723.12	10.84
(ii)	Repair and maintenance of sprinkler system	3240.82	3678.33	3459.57	21.77
(iii)	Other expenses	300.25	283.33	291.79	1.83
	Sub total	5304.23	5644.74	5474.48	34.46
	Total costs (A+B)	16941.48	14830.87	15886.17	100

***Note**: 1. Operational cost was taken for year 2021-22 2. Straight line method was used for calculating depreciation 3. Interest was calculated for fixed capital assets.)*

Table 3: Economic evaluation of sprinkler irrigation system

Year	Investment cost (₹)	Operational cost (₹)	Total cost (₹)	Returns (₹)	Net return (₹)	DF@ 12%	NPV (₹)	DF@ 57%	NPV (₹)	DF@ 58%	NPV (₹)
0	151384.59	15886.17	167270.76	0	-167270.76	1.0000	-167270.76	1.0000	-167270.76	1.0000	-167270.76
1	0	15886.17	15886.17	113915.26	98029.09	0.8929	87530.17	0.6369	62434.72	0.6329	62042.61
2	0	15886.17	15886.17	113915.26	98029.09	0.7972	78148.79	0.4056	39760.59	0.4005	39260.65
3	0	15886.17	15886.17	113915.26	98029.09	0.7118	69777.11	0.2584	25330.71	0.2535	24850.37
4	0	15886.17	15886.17	113915.26	98029.09	0.6355	62297.49	0.1645	16125.78	0.1604	15723.87
5	0	15886.17	15886.17	113915.26	98029.09	0.5674	55621.71	0.1048	10273.44	0.1015	9949.95
6	0	15886.17	15886.17	113915.26	98029.09	0.5066	49661.54	0.0667	6538.54	0.0642	6293.46
7	0	15886.17	15886.17	113915.26	98029.09	0.4523	44338.56	0.0425	4166.23	0.0406	3979.98
8	0	15886.17	15886.17	113915.26	98029.09	0.4039	39593.95	0.0270	2646.78	0.0257	2519.34
9	0	15886.17	15886.17	113915.26	98029.09	0.3606	35349.29	0.0172	1686.10	0.0162	1588.07
10	0	15886.17	15886.17	113915.26	98029.09	0.3219	31565.37	0.0109	1068.51	0.0103	1009.70
Total		174747.87	326132.46	1139152.60			384795.22		2758.64		-52.76

Note: *DF i.e. Discount factor, Returns were taken from rabi crops of the year 2021-22.*

accounted 34.35 per cent followed by 31.18 per cent interest for sprinkler irrigation system. The total average of fixed and operational cost worked out to be ₹ 15886.17.

The economic viability of sprinkler set can be seen from the table 3. Economic evaluation was carried out under the assumption that cost and returns remain static over the entire life of sprinklers. It is evident from the table 3 that total cost during investment year i.e., zeroth year is ₹ 167270.76 while from first to tenth year it found out to be ₹ 15886.17. Net returns were deflated for each year separately at a discount factor of 12 per cent. NPV came out to be ₹ 384795.22. Table 3 shows that returns or positive value for net cash flow is ₹ 552065.98 and cost or negative value is ₹ 167270.76. To reduce them to a lowest minimum, to make them zero, a coefficient 'r' was found out to be 58 per cent. At this rate the sum of streams of positive and negative value is minimum i.e., for cost ₹ 167270.76 and for returns ₹ 167218.00. At this rate, IRR was estimated to be 57.99 per cent. It is clear from the table that total cost for sprinkler is ₹ 167270.76 and sum of deflated benefits is ₹ 552065.98. Benefit cost ratio for sprinkler irrigation system observed to be 3.30. Table 3 also shows that net stream of positive and negative returns is equated in the third year of installation of sprinkler irrigation system. Thus, the payback period for sprinkler set in the study area is 3 years.

CONCLUSION

It is concluded that sprinkler irrigation system was economically viable in the study area as NPV came out to be positive (₹ 384795.22), IRR was also estimated to be 57.99 per cent, B:C ratio was also found to be greater than one (3.30) with a payback period of 3 years. The total cost incurred by the farmers in installation of sprinkler irrigation system was observed to be ₹ 148957.83 and ₹ 153811.35 and working cost found out to be ₹ 16491.48 and ₹ 14830.87 in Rewari and Bhiwani district respectively. It is recommended that farmers can adopt renewable source of energy i.e., solar pumps as a source of irrigation. The cost of installation of sprinkler irrigation system should be brought down by decreasing the price of borewell casing pipes and delivery pipes and motor as it accounted for the highest share in the installation cost.

REFERENCES

Grewal, S.S., Lohan, H.S. and Dagar, J.C. 2021. Micro-irrigation in drought and salinity prone areas of Haryana: Socio-economic Impacts. *J. Soil Salinity and Water Quality,* **13**(1): 94-108.

Kakhandaki, S.H., Padmakumari, O., Madhusudhan, M.S. and Ramappa, K.T. 2012. Study on cost economics of drip and micro sprinkler irrigation for tomato crop. *Int. J. Agric. Sci., Raichur (Karnataka), India,* **5**(1): 95-97.

List of countries by irrigated land area. 2022. Disponible https://en.wikipedia.org/wiki/List_of_countries_by_irrigated_land_area (Last Accessed on 3rd December,2022)

MoAFW. 2021-22. Disponible https://agricoop.nic.in/sites/default/files/Web%20copy_eng.pdf (Last Accessed on 3rd December, 2022).

Nabard Research Study. 2021. Study on efficacy of micro-irrigation system in drought prone parts of Haryana. Department of Economic Analysis and Research, Society for Promotion and Conservation of Environment, Chandigarh.

Narayanamoorthy, A. 2006. Potential for drip and sprinkler irrigation in India. *Draft prepared for the IWMI-CPWF project on 'Strategic Analysis of National River Linking Project of India*.

Nasseri, A. 2019. Energy use and economic analysis for wheat production by conservation tillage along with sprinkler irrigation. *The Science of the Total Environ.*, **648**: 450–459.

PMKSY. 2018-19. Disponible http://minet.hortharyana.gov.in/Final_guidelines2018-19.pdf (Last Accessed 5th December, 2022).

PMKSY. 2021-22. Disponible https://pmksy.gov.in/ (Last Accessed 5th December, 2022).

Razzaq, A., Rehman, A., Qureshi, A.H., Javed, I., Saqib, R. and Iqbal, M.N. 2018. An economic analysis of high efficiency irrigation systems in Punjab, Pakistan. *Sarhad J. Agric.*, **34**(4): 818-826.

Suceendra, T. and Nanthakumaran, A. 2013. Economic viability of sprinkler irrigation system on onion (*Allium cepa*) in Vavuniya (a case study in Nedunkerny), Sri lanka. *Proceedings of the International Symposium on Agriculture and Environment, University of Ruhuna*, pp. 317-321.