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Financial Feasibility of Solar Irrigation System in Sri Ganganagar District of Rajasthan

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ABSTRACT

Agriculture is primary sector of the Indian economy. And it remains major challenge to achieve overall water, energy and food security in India. Solar energy is the most abundant source of energy in the world. Solar power is not only an answer to today's energy crisis but also an environmentally friendly form of energy. The present study was undertaken for financial feasibility of solar irrigation system in Rajasthan. Sri Ganganagar district of Rajasthan was selected purposively because it secures second rank in terms of installation of solar irrigation system. The 80 sample farmer comprises of 40 solar irrigation systems and 40 diesel irrigation systems were randomly selected from the Sri Ganganagar district. The study was conducted with the objective to study the status of solar irrigation system in Rajasthan. Financial feasibility of solar irrigation system with and without subsidy and suggest the policy implementation for adoption of solar irrigation system. The collective data shows that the installation number of solar irrigation system in Rajasthan in 2020-21 is 33064. In financial feasibility we are calculated the Payback Period and B:C Ratio with and without subsidy. The Payback Period is 1.30, 1.80, 2.58 with subsidy and 3.26, 4.51, and 6.46 without subsidy for 3, 5, and 7.5 HP solar irrigation system. The B:C Ratio is 7.06, 5.49, and 4.09 with subsidy and 3.35, 2.51, or 1.80 without subsidy for 3, 5, and 7.5 HP solar irrigation system.

Keywords: solar irrigation system, status, financial feasibility, B:C Ratio

Agriculture remains a major challenge to achieve overall water, energy, and food security in India. In order to address the need to increase water access for growing populations, produce renewable and clean energy, and feed the planet, solar-based groundwater pumping for irrigation (referred to SGPI) has been put forward as part of a sustainable energy portfolio for both developed and developing countries. The use of solar technology is expanding worldwide and since 2010 the world has seen more solar energy system capacity installed than during the previous four decades (IEA, 2014). In the Middle East and North Africa (MENA) region alone, solar photovoltaic energy production increased with 112 per cent between 2008 and 2011 (REN21, 2013).

Solar energy is the most abundant source of energy in the world. Solar power is not only an answer to today's energy crisis but also an environmental friendly form of energy. Photo voltaic generation is an efficient approach for using the solar energy. Solar panels (an array of photovoltaic cells) are nowadays extensively used for running street lights, for powering water heaters and to meet domestic loads. The cost of solar-panels has been constantly decreasing which encourages its usage in various sectors. One of the applications of this technology is

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used in irrigation systems for farming. Solar powered irrigation system can be a suitable alternative for farmers in the present state of energy crisis in India. This is a green way for energy production which provides free energy once an initial investment is made (Harishanker *et al.* 2014).A financial feasibility study is a very important tool for decision-makers in the analysis of whether or not to implement a particular project or program. We conduct feasibility study based on extensive research on both the current practices and the proposed project.

India has around 26 million irrigation pumps (Shim, 2017). Around 8 million of which are diesel pumps, and 18 million of which are electric pumps. For agricultural use by December 2020, 2,72,700 solar water pumps had been installed (MNRE-REPORT2020-21) throughout the country. Chhattisgarh had the highest number of 61970 solar-pump installations followed by Rajasthan, a distant second, with 53,423 installations in India. These pumps were largely constructed by State renewable development agencies with capital subsidy assistance from the New & Renewable Energy Ministry (MNRE).

METHODOLOGY

For the purpose of study multistage sampling design was used to select district, tehsils, villages and farmers. In this procedure, Sri Ganganagar district of Rajasthan was selected purposively at first step because it secure second rank in Rajasthan in terms of installation of solar irrigation system with 4088 installation number in year 2020-2021. Then Suartgarh and Padampur tehsils were selected purposively from selected district on the basis of their first and second rank in solar irrigation system in the District. In the third stage 40 solar irrigation system farmers and 40 diesel irrigation system farmers were randomly selected from the selected thesils. Thus total sample size for the present study was 80 farmers with similar cropping pattern and geography. Primary and secondary data were used to accomplish the objective of the study. Pre structured Interview schedule method was attempted to collect primary data. The secondary data pertaining to objectives of the study was collected from Department of Horticulture Sri Ganganagar, Jaipur and various published sources.

Analytical Procedure

Gross Return for solar irrigation system was taken as diesel cost savings by a irrigation system per farm in one year. For calculating payback period and benefit-cost ratio of solar irrigation system with and without subsidy, following economic criteria have been employed :

(a) Payback period

$$P = \frac{\text{Initial Investment}}{\text{Annual cash Inflow}}$$

(b) B-C ratio

$$B-C \text{ ratio} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^n}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^n}}$$

Where,

B_t = Present worth of cash flow

C_t = Present worth of cost

r = rate of interest

n = number of year

RESULTS AND DISCUSSION

Status of solar irrigation system in Rajasthan

This table (1) shows that Jaipur district secured the first rank in Rajasthan in terms of the installation of solar irrigation systems, with 4174 installation numbers in the year 2020–2021 followed by Sri Ganganagar district with the installation of solar irrigation systems with 4088 installation numbers in the year 2020–2021. The total number of installations of solar irrigation systems in Rajasthan was 33064 in the year 2020–21.

In the year 2010-11, the total number of solar irrigation systems installed in Rajasthan was 31, and by the end of 2020-21, the number of solar irrigation systems had highly increased and reached 33,064. The growth trend in the installation of solar irrigation systems suggests that it was augmenting with a compound annual growth rate of 55.1 per cent per annum during the period of study (Table 2). This was discovered to be comparable to the compound annual growth rate investigated by Gautam *et al*. 2020.

Table 1: Status of solar irrigation system in Rajasthan (In Number)

Sl. No.	District	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total
1	Jaipur	3	80	436	1490	513	383	798	1149	1500	3414	4174	**13940**
2	Sri Ganganagar	11	621	643	1032	473	436	480	631	783	1901	4088	**11099**
3	Bikaner	0	392	543	1362	656	657	714	648	583	2345	1467	**9367**
4	Churu	0	0	31	100	96	147	371	528	685	2448	3790	**8196**
5	Jalore	0	0	51	147	92	141	470	874	1278	1239	1965	**6257**
6	Others	17	585	2528	5869	2232	1722	3319	4526	5746	12537	17580	**56669**
	Total	**31**	**1678**	**4240**	**10000**	**4062**	**3486**	**6152**	**8356**	**10575**	**23884**	**33064**	**105528**

Table 2: Compound annual growth rate of solar irrigation system in Rajasthan

Particulars	CAGR (2010-11 to 2020-21)
CAGR	55.1*

*Indicate significant at 1 per cent level of significance.

Table 3: Cost of installation of irrigation system in Sri Ganganagar District of Rajasthan

Sl. No.	Solar irrigation system				Diesel irrigation system	
	HP	Farmer's Share (₹)	Subsidy (₹)	Total cost (₹)	HP	Total Cost (₹)
1	3	74653 (40)	111979 (60)	186632	7.0	26500
2	5	103330 (40)	154996 (60)	258326	14	45000
3	7.5	147940 (40)	221910 (60)	369850	NA	NA

Figures in parentheses are the percentage to the respective total; NA: Not applicable.

The total cost of a 3 HP solar irrigation system was ₹ 1,86,632, out of which the farmer's share was 40.00 per cent and the remaining cost of the irrigation system was paid by the government in the form of a subsidy, i.e., 60.00 per cent (Table 3). Similarly, for a 5 HP solar irrigation system, the total cost of installation was ₹ 2,58,326 and the farmer's share was 40.00 per cent; and the remaining amount (60.00 per cent) was contributed by the government in the form of a subsidy. The total cost of the installation of a 7.5 HP pump solar irrigation system in the study area was found to be ₹ 3,69,850. Out of the total cost, the farmer's share and government subsidy worked out to be 40.00 and 60.00 per cent, respectively.

The price of the solar irrigation pump included the installation cost along with the cost of the solar panel, Solar inverter, Solar battery, Junction box, DC cable, AC cable, MC4 connector, Fasteners, Cable tie, Crimping tool, Earthing kit, and lighting arrestor. The Rajasthan Govt. provides 60 per cent subsidy for the installation of all types of solar irrigation systems, so farmers pay only 40 per cent of the total cost, which is ₹ 74,653 in the case of 3 HP, ₹ 1,03,330 for 5 HP, and ₹ 1,47,940 for 7.5 HP.

In a diesel irrigation system, the cost was inclusive of accessories like a starting handle, an exhaust silencer, a cleaner, a fuel tank, a set of spanners and a screwdriver, and installation charges. The average cost of installing a diesel irrigation system of 7 HP in the study area was found to be ₹ 26500 (Table 3). Similarly, the average cost of installation of a 14 HP irrigation system was calculated at ₹ 45,000. In the study area major adoption was found for 7 HP system because water level is high in Sri Ganganagar district and it is cheaper than the 14 HP.

Crop-wise diesel consumption, cost & saving were calculated per farm for 7 HP diesel irrigation system and it is presented in Table 4. The average area allocated by the sample farmers under cotton

Table 4: Diesel saving, consumption and diesel cost by a diesel irrigation system per farm

Sl. No.	Crop	Area per Farm (Ha)	Number of irrigation	Time required per irrigation (Hrs/ha)	Diesel consumption per hectare (Litres/Ha)	Diesel consumption per farm (Litres)	Value of diesel savings ₹ 95.00/ litre
1	Cotton	1.95	**6**	8	120	234	22230
2	Guar	1.32	**3**	8	60	79.2	7524
3	Wheat	1.56	**6**	8	120	187.2	17784
4	Mustard	1.71	**3**	8	60	102.6	9747
	Total				**360**	**603**	**57285**

Table 5: Payback period of solar irrigation system in Sri Ganganagar district of Rajasthan

Financial ratio	Sl. No.	Capacity of irrigation system (HP)	With subsidy	Without subsidy
Payback period	1	3	1.30 Year	3.26 Year
	2	5	1.80 Year	4.51 Year
	3	7.5	2.58 Year	6.46 Year
Benefit Cost Ratio	1	3	7.06	3.35
	2	5	5.49	2.51

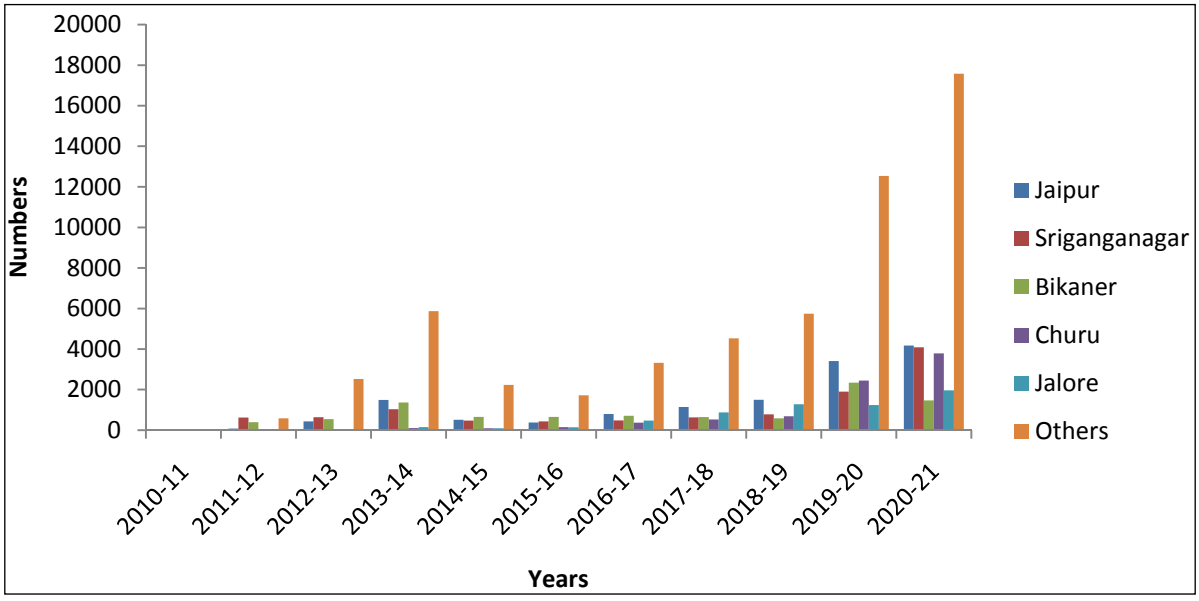

Fig. 1: Status of solar irrigation system in Rajasthan

cultivation was 1.95 hectares in the study area. The total diesel requirement for irrigating cotton using a 7 HP diesel pump was calculated at 234 litres. The total cost for purchasing diesel was calculated at ₹ 22,230 if farmer use the diesel price of ₹ 95.00.

The table reveals that in the Cotton and Wheat crops, diesel consumption per hectare was the same (120 lit/ha), and in the case of Guar and mustard, it was 60 lit/ha. The value of diesel savings was different for each crop. Because the savings were calculated on a per farm basis. The average land size under crop was 1.95 ha for Cotton, 1.32 ha for Guar, 1.56 ha for wheat, and 1.71 ha for Mustard. The value of diesel savings was Maximum for Cotton crops (₹ 22,230/farm) and minimum for Guar. The table also shows that the total savings were ₹ 57,285 for one agriculture season. This was found to be comparable to the investigated by (Gautam *et al*. 2021).

Payback period and benefit Cost Ratio (B:C Ratio) of solar irrigation system with and without subsidy

Table 5 shows the payback period associated with solar irrigation systems of 3 HP, 5 HP, and 7.5 HP capacity with or without subsidy. The cost of installing a solar irrigation system with a subsidy of 3 HP, 5 HP, and 7.5 HP was ₹ 74653, ₹ 103330, and ₹ 147940, respectively and without subsidy, the costs of 3 HP, 5 HP, and 7.5 HP were ₹ 186632, ₹ 258326, and ₹ 3,69,850. It was calculated that the investment made on a 3 HP solar irrigation system with subsidy was recovered in 1.30 years, and without subsidy, it was recovered in 3.26 years. For a 5 HP solar irrigation system, it would take 1.80 years with subsidy, and without subsidy, it was 4.5 years. The highest payback periods were observed in a 7.5 HP solar irrigation system (2.58 years with subsidy and 6.46 years without subsidy).

It was observed that investments made in 3 HP solar irrigation systems were more attractive for farmers because of their low initial cost and less payback period, whereas it was less economical for a farmer to install a 7.5 HP solar irrigation system due to its high installation cost. Gautam *et al*. (2020) has also shown similar results.

The B-C ratio was found to be 7.06 in Sri Ganganagar district of Rajasthan for a 3 HP solar irrigation system with subsidy, which was the highest. For a 5 HP solar irrigation system with subsidy, it was 5.49, and in the case of a 7.5 HP solar irrigation system with subsidy, the B-C ratio was 4.09 and the B-C ratio was found to be 3.35 for a 3 HP solar irrigation system without subsidy, which was the highest. For a 5 HP solar irrigation system without subsidy, it was 2.51, and in the case of a 7.5 HP solar irrigation system without subsidy, the B-C ratio was 1.80. Since the ratio was greater than unity in all the cases, with or without subsidy, all investments were economically feasible. However, because of the highest B-C ratio, a 3 HP solar irrigation system was economically more feasible, followed by 5 HP and 7.5 HP solar irrigation systems with or without subsidy.

CONCLUSION

The above study concluded that the average cost of installation of a 14 HP and 7 HP irrigation system was calculated to be ₹ 45,000 and ₹ 26500, respectively. In the study area major adoption was found for 7.5 HP systems because water level is high in Sri Ganganagar district and it is cheaper than the 14 HP. The CAGR of solar irrigation system showed that it installation was augmenting with a compound annual growth rate of 55.1 per cent per annum during the period of 2010 – 2021. The investment made on a 3 HP solar irrigation system with and without subsidy was recovered in less year in comparison to 5 HP and 7.5 HP in respective classes. Benefit cost ratio of solar irrigation system with or without subsidy showed that 3 HP system was more financial feasible in respective category because installation of it required less investment in comparison to 5 HP and 7.5 HP.

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