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Economic Impact Of Solar-Pump Irrigation On Farmers Of Haryana

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ABSTRACT
This study represents the results of a field survey undertaken in the Jind district of Haryana, India, to assess the impact of solar irrigation pumps on farmers' income, crop production, and other socio-economic aspects of solar irrigation pumps. More than half of the rural population of Haryana is dependent upon agriculture for their livelihood, and the recent energy crisis, which includes rising fuel oil prices and electricity rates, has negatively impacted farmers. Due to this, farmers' reliance on fossil fuels for irrigation has increased exponentially, increasing the cost of agricultural production. This study is mainly based on Primary data on farmers, agriculture, and irrigation activities collected through a well-structured questionnaire. Subsequently, qualitative and statistical analyses were conducted. The results of this study show that the installation of solar pumps has resulted in a significant increase in farmers' income and savings, led to an increase in crop production, and reduced the cost of irrigation.

Keywords: solar irrigation pumps, farmers' income, crop production, energy crisis, agriculture.

HIGHLIGHTS

- The use of solar pumps in rural areas has been beneficial for the economic upliftment of the farmers in Haryana.
- The irrigated area has increased due to the solar pumps.
- The crop production increased significantly in the case of wheat, mustard, and sugarcane.
- The production cost of these crops is reduced significantly due to the installation of solar pumps.
- The farmers' income also increased significantly after the installation of solar pumps.

Indian economy is an agro-based economy in which the agriculture sector plays an important role, and the agriculture sector has more than 18.3% share in GVA and more than 45.5% share in employment (NSSO, 2022). The state of Haryana is also an agro-based economy, where agriculture plays a crucial role in sustaining rural livelihood. The Agriculture and Allied Sectors has

always been an important contributor to the Gross State Domestic Product (GSDP) of Haryana (Government of Haryana, 2023). Indian agriculture is entangled with various problems even in modern times, mainly due to weather, lack of financial facilities, lack of awareness among farmers, lack of advanced agricultural techniques, inadequate irrigation facilities etc. Indian agriculture is mainly monsoon-based agriculture, but whenever the monsoon rainy season is not good then the farmers have to suffer a lot as their income decreases and their overall development gets hampered (Goyal et al., 2016).

India and the Haryana state governments have the vision of doubling the farmers' income (Bihari et al., 2019). To fulfill this goal, many schemes have been started by the government which is directly and indirectly benefiting the farmers. One of them is PM-KUSUM, an irrigation-related scheme. The Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) Yojana is a significant initiative by the Indian government to support farmers and promote the use of solar energy in the agriculture sector. The scheme aims to provide financial and water security to farmers by installing solar pumps and grid-connected solar power plants. Under PM-KUSUM, farmers are encouraged to set up solar power projects on barren or cultivable lands (MNRE, 2023). This helps generate a stable income for farmers by selling the surplus energy to the grid. Additionally, solar pumps are provided to farmers for irrigation purposes, reducing their dependence on traditional grid electricity or diesel generators (Hossain et al., 2014).

There are generally two approaches for increasing farmers' income. The first is to diversify a farmer's income sources to include other activities besides agriculture. The second is to reduce the cost of agricultural production. Solar energy has emerged as a promising renewable source for meeting energy demand in Indian agriculture applications (Kumar et. al., 2023). It can play an important role in increasing the farmers' income and reducing agricultural costs. Solar water pumps have significant impact on the consumption of water, electricity and diesel as well as the profits of farmers (Gupta, 2019). Because solar energy is cheaper as compared to other energy options, if farmers use solar energy-based irrigation pumps for irrigation, then agricultural costs can be reduced because energy is a part of agricultural costs. On the other hand, a farmer using energy-based irrigation pump can sell water for irrigation to other farmers, and the additional electricity generated from solar panels can also be sold to others, from which he can get additional income. The electricity subsidy will also be reduced by using Solar Pump / Solar Energy so that the economic burden on the national or state economy will be less, while the use of Solar Pump is likely to increase the irrigated area, which also likely increase in agricultural production.

Solar-powered irrigation pumps are a way of raising the income of Indian farmers and uplifting their status by improving their standard of living. It is also helpful in improving irrigation facilities to marginal and small farmers. It will also help promote clean energy for the nation and saving the environment. It will also help achieve the national goal of doubling farmers' income. This study will be helpful for policymakers at national and international levels who are concerned with solar energy and irrigation.

RESEARCH METHODOLOGY

This study is aimed at describing and comparing the impact of solar pumps on farmers' income, crop production, and cost of crop production, as well as the socio-economic status of farmers. To achieve this, a "before and after" scenario was used to compare the situation before and after the installation of solar pumps. The study was conducted in the Jind district of Haryana and involved a sample of 30 farmers randomly selected from 8 different villages. A well-structured questionnaire-based survey was conducted through face-to-face interviews in March 2022. Face-to-face

interviews were chosen as the best technique for collecting household-level data from rural areas of district Jind. The selection of district Jind was purposive, while the villages were selected randomly.

ANALYTICAL TOOLS

Hypotheses were formulated to assess the impact of solar pumps on farmers' income, crop production, and cost of crop production. The paired samples t-test was used to test the hypotheses and measure the impact of solar pumps. Five indicators were used to analyze the impact of solar pumps on farmers, including the economic benefits, satisfaction in savings, improvements in living standards, satisfaction with water performance, and recommendations to other farmers to adopt the technology. The responses were based on farmers' perceptions, which were evaluated using a five-point Likert scale ranging from 1 (strongly dissatisfied) to 5 (strongly satisfied). An average score for each impact indicator was calculated and interpreted as belonging to the corresponding category.

Hypotheses:

H01: There is no significant impact of solar pumps on the production of wheat.
HA1: There is a significant impact of solar pumps on the production of wheat.
H02: There is no significant impact of solar pumps on the cost of wheat production.
HA2: There is a significant impact of solar pumps on the cost of wheat production.
H03: There is no significant impact of solar pumps on the production of cotton.
HA3: There is a significant impact of solar pumps on the production of cotton.
H04: There is no significant impact of solar pumps on the cost of cotton production.
HA4: There is a significant impact of solar pumps on the cost of cotton production.
H05: There is no significant impact of solar pumps on farmers' income.
HA5: There is a significant impact of solar pumps on farmers' income.

RESULTS AND DISCUSSION

This section presents the empirical results. Under this section we discuss some descriptive statistics on various aspects of solar irrigation pump and employ paired samples t-test to assess the impact of solar irrigation.

In Table 1, on the basis of before-solar pump and after-solar pump installation scenarios, different variables have been taken for the impact evaluation of the solar pump on farmers' income, wheat production, cotton production, cost of wheat production, and cost of cotton production. The descriptive statistical results show that farmers' income after the installation of solar pumps is more average than before the installation of solar pumps. In the case of wheat production, the mean score of 1.94 after installation is more than the mean score before installation of the solar pump, which is 1.73. In the case of cotton production, the mean score of 6.22 after installation is more than the mean score before installation of the solar pump, which is 5.25. In case of production cost of wheat and cotton the mean score of after installation of solar pump is respectively Rs. 11077.92 and 12333.33 less than to mean score of before installation of solar pump is respectively Rs. 14923.08 and 15666.67 which means that there is a significant impact of Solar pump on farmers' income, wheat production, cost of wheat production, cotton production and cost of cotton production.

Table: 1 Descriptive Statistics

		N	*Mean*	*Std. Deviation*	*Std. Error Mean*
Income	Before	30	402066.67	502263.355	91700.323
	After	30	461600.00	584716.471	106754.134
Wheat production	Before	27	1.7333	.17974	.03459
	After	27	1.9407	.18451	.03551
Production cost of Wheat	Before	27	14923.08	3451.644	676.923
	After	27	11076.92	2813.156	551.705
Cotton production	Before	18	5.250	1.0326	.2434
	After	18	6.22	1.353	.319
Production cost of Cotton	Before	18	15666.67	3412.779	804.400
	After	18	12333.33	3029.269	714.006

Source: Authors' own calculations based on primary data.

Table 2, For farmers' income, wheat production, cost of wheat production, cotton production, and cost of cotton production, the p-value is less than .05 ($p<.05$) which shows that the Null Hypothesizes H01, H02, H03, H04, and H05 are rejected and the Alternative Hypothesizes HA1, HA2, HA3, HA4 and HA5 are accepted which means there is a significant impact of Solar pump on farmers' income, wheat production, cost of wheat production, cotton production and cost of cotton production.

Table: 2 T-Test

		Paired Differences					T	df	Sig. (2-tailed) p-value
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Income	before - after	-59533.33	89944.708	16421.582	-93119.239	-25947.427	-3.625	29	.001
Wheat production	before - after	-.20741	.06752	.01299	-.23412	-.18070	-15.962	26	.000
Production cost of Wheat	before - after	3846.154	1461.296	286.584	3255.924	4436.384	13.421	26	.000
Cotton production	before - after	-0.9722	.5550	0.1308	-1.2482	-0.6962	-7.432	17	.000
Production cost of cotton	before - after	3333.333	1137.593	268.133	2767.622	3899.045	12.432	17	.000

Source: Authors' own calculations based on primary data.

Table: 3 Cost and Production of Other Crops

Name of Crop	*No. of Respondents*	*Average Production of Crops(tons)*		*Average Cost of Production (Rs.)*	
		Before Solar Pump	*After Solar Pump*	*Before Solar Pump*	*After Solar Pump*
Mustards	3	0.6	0.73	7333.33	5666.67
Millet	7	0.6	0.73	7714.28	5571.42
Vegetables	3	1.05	1.2	173333.3	156666.7
Sugarcane	2	26	30	41000	33000

Source: Authors' own calculations based on primary data.

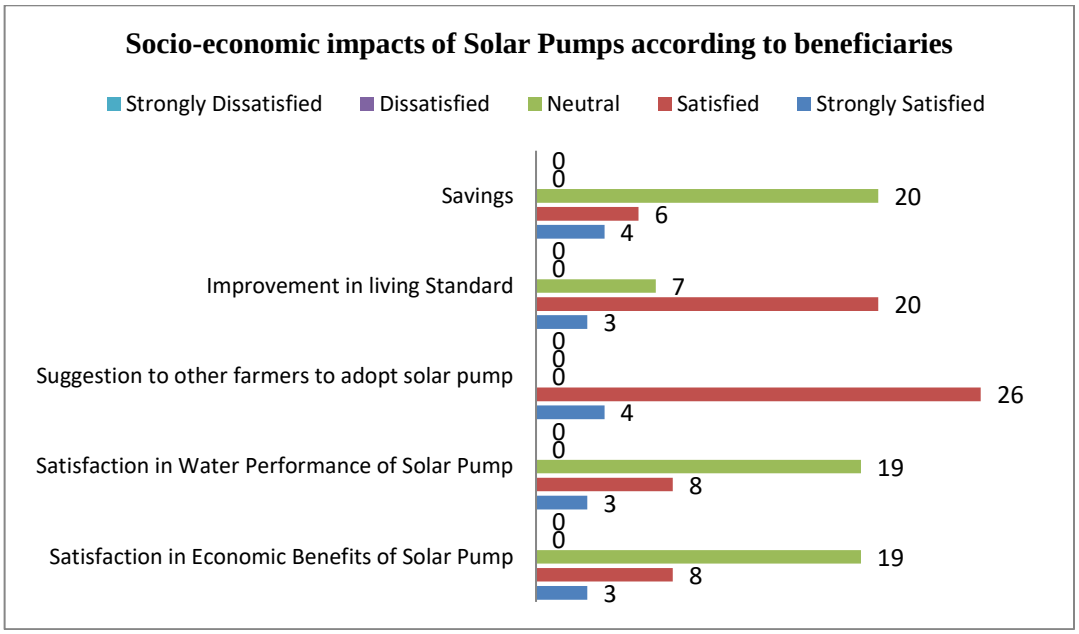
In Table 3, the descriptive statistical results show that the mean score of mustards, millet, vegetables and sugarcane are respectively as 0.73, 0.73, 1.2 and 30 after the installation of the

solar pump which is more than the mean score of these crops of 0.6, 0.6, 1.05 and 26 before the installation of solar pump which shows a positive impact of solar pump on production of these crops. In the case of cost of crop production, the mean scores of these crops after installation of the solar pump are less than the mean scores of these crops before the installation of the solar pump. The results show a positive impact of solar pumps on the cost of production of these crops, i.e., the production cost of these crops is reduced due to the installation of solar pumps.

Economic Impacts Based on Farmers' Perception

Farmers' perception-based economic impacts were analyzed according to solar pump beneficiaries' responses in five indicators: satisfaction with the economic benefits of solar pump, Satisfaction with Savings, Improvements in living standards, Satisfaction with water performance of the solar pump, and Suggestions to other farmers to adopt solar pumps. Figure 3 and Table 5 illustrate the overall results.

Figure: 1 Socio-economic impacts of Solar Pumps according to beneficiaries



Source: Authors' own calculations based on primary data.

Table: 4 Farmers Perception of Benefits received due to Solar-Pump Installation

Indicators	Average scale	Category
Satisfaction in Savings	4.4	Moderate
Improvement in Living Standard	3.8	Significant
Suggestion to other farmers to adopt solar pump	4.1	Significant
Satisfaction in Water Performance of Solar Pump	3.4	Moderate
Satisfaction in Economic Benefits of Solar Pump	4.2	Significant

Source: Authors' own calculations based on primary data.

Post-installation assessments of the socio-economic impacts of the solar pump revealed that improvement in living standards, willingness of suggestion to other farmers to adopt solar pump, and satisfaction with economic benefits of the solar pump were perceived as the most significant

impacts. Meanwhile, satisfaction in savings and satisfaction with the water performance of solar pumps were moderately significant. Each indicator is further explained in the following subsection.

Satisfaction in Savings

In terms of satisfaction with savings, respondents reported a satisfactory capability to save money. The majority of the respondents (66%) said the saving was significant and a further 10% stated that it was very significant (a total of 76%). The solar pump provides a fuel cost-free option for irrigation. On average, each respondent spent approximately Rs. 13000 annually on irrigation before the solar pump, the majority of which was the marginal or small farmers. Since the solar pump is installed, there is no fuel cost for irrigation; therefore, from the solar pump, there is a saving in terms of fuel cost. However, those who benefited from saving money were unable to buy an asset in terms of a house or open a new business. Rather, the saved money was spent on child education (80% of respondents), renovating the house (20%), and spent on health services (70%), and daily necessities (90%).

Improvement in Living Standard

To analyze changes in lifestyle, the respondents were assessed in terms of changes in activities and changes in irrigation timing. Before solar pumps, farmers had to wait for electricity (100% of respondents). Due to this, their time was wasted as well as there was also the problem of power cuts. However, after the installation of solar pumps, the farmers got rid of all these problems. Before the solar pump, the farmer had to irrigate fields mostly during the night, but after the solar pump, the problem of irrigation at night has been solved. The farmer's sleep quality has significantly improved. This positive development not only benefits the farmer's health and well-being but also enhances their productivity and performance.

Suggestion to other farmers to adopt Solar Pump

Inspired by the benefits of solar pumps, all farmers have said that they recommend that other farmers install solar pumps as well. By installing solar pumps, other farmers can also eliminate irrigation-related problems.

Satisfaction in Water Performance of Solar Pump

In terms of satisfaction with the water performance of the solar pump in the case of draining groundwater, respondents reported a less satisfactory water performance of the solar pump. The majority of respondents (65% of respondents) said that the water performance of solar pumps was not significant, and a further 35% stated that it was very significant. According to 65% of respondents, the working hours of solar pumps is less due to the unavailability of sufficient sunlight and the deep groundwater level.

Satisfaction in Economic Benefits of Solar Pump

In terms of satisfaction with the economic benefits of solar pumps, respondents reported a satisfactory response. The other economic benefits excluded the benefit of savings (fuel cost) obtained from the reduction in maintenance cost (40% of the respondents) and water sold to other farmers for irrigation purposes (50%).

Findings from the survey

1. The use of solar pumps in rural areas has been beneficial for the economic upliftment of the farmers in Haryana.
2. The irrigated area has increased due to the solar pumps.
3. The crop production increased significantly in the case of wheat, mustard, and sugarcane.
4. The production cost of these crops is reduced significantly due to the installation of solar pumps.
5. The farmers' income also increased significantly after the installation of solar pumps.
6. Inspired by the benefits of solar pumps, all farmers have said that they recommend that other farmers install solar pumps as well. This way, other farmers can also eliminate irrigation-related problems.
7. Before the solar pump, the farmer had to irrigate fields mostly during the night, but after the solar pump, the problem of irrigation at night has been solved. The benefit of this is that the sleep problem of the farmer has come down.
8. The solar pump provides a fuel-cost-free option for irrigation. On average, each respondent spent approximately Rs. 13000 annually on irrigation before the solar pump, the majority of which was the marginal or small farmers. Since the solar pump is installed, there is no fuel cost for irrigation; therefore, from the solar pump, there is a saving in terms of fuel cost.

CONCLUSION

The primary contribution of this study was to demonstrate the influence of Solar Irrigation Pumps on the economic status of farmers in the Jind district of Haryana. Solar pumps offer direct advantages to farmers by providing an affordable irrigation facility. Increased economic benefits, savings, and improved living standards are regarded as the most significant impacts of solar pumps, contributing to farmers' satisfaction. Solar pumps enable farmers to irrigate their fields during the day, as opposed to at night. The results indicate that farmers express contentment with the utilization of solar pumps.

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