Original Research Article

Constraints in adoption of solar photovoltaic water pump sets in Haryana

Abstract

The investigation aimed to find the constraints faced by adopters and non-adopters of solar photovoltaic water pump set. The study was conducted purposely in Jhajjar district of Haryana on the basis of highest number of solar photovoltaic water pump sets installed. 50 beneficiaries and 50 non-beneficiaries were taken for the study and interviewed through a well-defined questionaire. Garret ranking methodology was used to know the ranks of constraints given by farmers in adoption of solar water pump set. More than 50 per cent adopters reported major constraints like poor after sale service by the service providers, delay in installation of solar pump set, small land holdings and availability of less number of solar photovoltaic water pump set (SPWPS). Similarly, the constraints which the non-adopters highlighted in adoption of this technology for irrigation purpose were less availability of subsidized solar water pump set, high initial cost, small landholdings and lack of knowledge about the profitability of solar pump technology. Suggestions for proper implementation of this technology were also incorporated in the study.

Keywords: constraints, solar pump technology, garret ranking, suggestions

1. Introduction

India is on the road to prosperity, but in order to maintain a high rate of progress, continuous electricity supply is required. Manufacturing, education, agriculture, and healthcare are all heavily reliant on electricity and fuel. There are various roadblocks in the way of fully realising India's electricity sector's potential. Fuel availability is a crucial issue in every industry. Due to the increased reliance on outsourced coal, Coal India ltd restricted the supply of coal to coal-based thermal power plants. As a result, the cost of electricity generation rises. The agricultural sector in India consumes around 20 per cent of overall energy consumption, with 85 million tonnes of coal and nearly 4 billion litres of diesel being used as fuel for fuel-operated water pumps (Kumar *et al*. 2020). Farmers' face a difficult scenario due to poor energy supply and expensive electricity costs, which results in coarse irrigation. If a sufficient amount of water for irrigation is available when it is needed, crop yields can boost by 10 per cent(Upadhyay *et al*. 2014). The disparity between demand and supply for electricity is likely to widen in the future. The primary goal of a solar-powered pump is to increase agricultural production by providing farmers with safe access to groundwater resources. In India's rural areas, there is a huge untapped market for solar off-grid energy, which offers a lot of potential for power generation and the possibility to replace fossil fuel supplies (AlvarClosas& Edwin Rap, 2017).

Purohit and Michaelowa (2008) studied the potential of solar photovoltaic pumps in India. A renewed impetus for developing and disseminating renewable energy-pump sets was an erratic availability of traditional sources of energy and environmental and sustainable development but high initial investment in adoption of solar water pumps was found to be the main hindrance in the adoption of this technology. Khan *et al.* (2013) and Zohu*et al.* (2017) in their respective research also reported higher internal rate of return of SPWPS.Tayde*et al.* (2010) observed that the major constraint faced by the beneficiaries of the sprinkler irrigation scheme were less contact with extension workers, very poor availability of spare parts and repair service, and lack of technical knowledge about sprinkler irrigation scheme. Kumar *et al.* (2017) did research in Hisar and Rohtak districts of Haryana state. Less working hours in winter season and technology only works in shallow (less than 8 meters) water table, were considered as major technical constraints respectively. While in Rohtak district, less availability of spare parts and feasibility of technology in shallow water table were observed major constraints in adoption of PWPS. The high cost of PWPS was considered to be the most severe financial restriction encountered by the Hisar District respondents. Less subsidy on PWPS was the most serious financial constraint and it was ranked 1st by non-adopters of Rohtak District.Narale et al. (2014) in their research 'Techno economic assessment of solar photovoltaic water pumping system' also reported lower operational cost of solar pump sets. Bansal*et al.* (2013) and Hossain *et al.* (2015) also found higher cost of diesel and electronic motor operated pump set in comparison to SPWPS in their respective studies.

Jain, A., & Agarwal, S. (2018) in their study noted that the main barrier to loans, including for solar pumps, was farmers' inability to provide adequate collateral. For short-term (crop) loans, the majority of farmers in India have already mortgaged their properties. In such circumstances, a new lender would be reluctant to provide already indebted farmers with high-value, long-term credit without any kind of collateral.Ali et al. (2016) investigated the elements that affect farmers' decisions regarding water pumps (such as electric, diesel, solar photovoltaic (PV), or biogas pumps) and to evaluate the effects of these water pumps on crop yield, household income, and poverty. To accomplish these goals, the multivariate probit model and propensity score matching strategy are used in the paper. According to the empirical findings, farmers with higher education, who are younger, and who are wealthier are more likely to use water pumps powered by alternative energies. A farmer may choose to use alternative energy-based water pumps rather than relying on electricity if they have access to credit facilities and experience frequent load shedding. The production of wheat, rice, and maize crops as well as household income are positively and significantly impacted by alternative energy sources. Poverty has decreased by 11–20% as a result of the usage of alternate energy sources for water pumping.

In a related study, Namara et al. identified the adoption trends and barriers for water lifting technology in Ghana and proposed actions to promote wider implementation. These technologies are currently primarily available to wealthier farmers. Poorly developed supply chains, limited financial access, high operational and maintenance expenses, high output price risks, and a lack of institutional backing are the key barriers preventing wider adoption. The entire value chain of lift irrigation systems needs to be improved in order to fully utilise the potential of water lifting technology.

The main barrier to the broad use of renewable energy technologies, notably solar, is the high cost of their deployment. The fact that almost all of the parts are expensively imported from abroad,is not the only factor contributing to the high price. Additionally, the majority of the employees and technologies are imported.Another barrier, besides cost, is the lack of knowledge about the technologies' utility, effectiveness, or dependability. There is a lot of fear of the unknown, therefore many industrial enterprises would prefer to continue with the tried-and-true traditional power production methods rather than take the chance of investing in novel solar schemes. For systems to perform sustainably over their claimed lifetimes, there is a dearth of sufficient and properly qualified technical expertise. (Ogunleye&Awogbemi, 2011).

Solar energy has become increasingly important in minimizing the usage of fossil fuels. Solar-powered irrigation water pumps have been promoted as an important part of every country's reliable energy portfolio. Solar technology is now being used in every country, and since 2010, the world has seen an increase in solar energy systems and capacity as compared to the previous four decades. Despite some shortcomings in use of this technology, it is going to be the ultimate solution in place of our non-renewable sources.

2. Materials and Methodology

2.1 Geography of Haryana state:

Haryana is a landlocked state in Northern India. It lies between 27°39' and 30°35' N latitude, and 74°28' and 77°36' E longitude. The total geographical area of state is 4.42 million hectares, or 1.4 percent of the country's total. The cultivable area is 3.809 million hectares (86.2 percent of the total geographical area), with a net area sown of 3.508 million hectares (93.6 percent of cultivable area). The total cropped area is 6.549 million hectares, with 2.938 million hectares area sown more than once and a cropping intensity of 182.39 percent. The net irrigated area is 2.93 million hectares (with canals accounting for 45.3 percent, tube wells for 54.2 percent, and others accounting for 0.5 percent). The gross irrigated area is 5.446 million hectares, with an 82.3 percent net irrigated sown area. The total number of land holdings is 16.17 lakh, with marginal farmers accounting for 7.34 lakh (46.1%). The average land holding is 2.25 hectare. The major cropping patterns are- rice-wheat, cotton-wheat and bajra-wheat. Haryana is located in Agro Climatic Zone VI, also known as the "Trans-Gangetic Plains Area. The state's four major geographical features are "Shivalik Hills, Ghaggar Yamuna Plain, Semi-desert sandy plain, and Aravali Hills. Haryana is often named the country's "Food Mine".

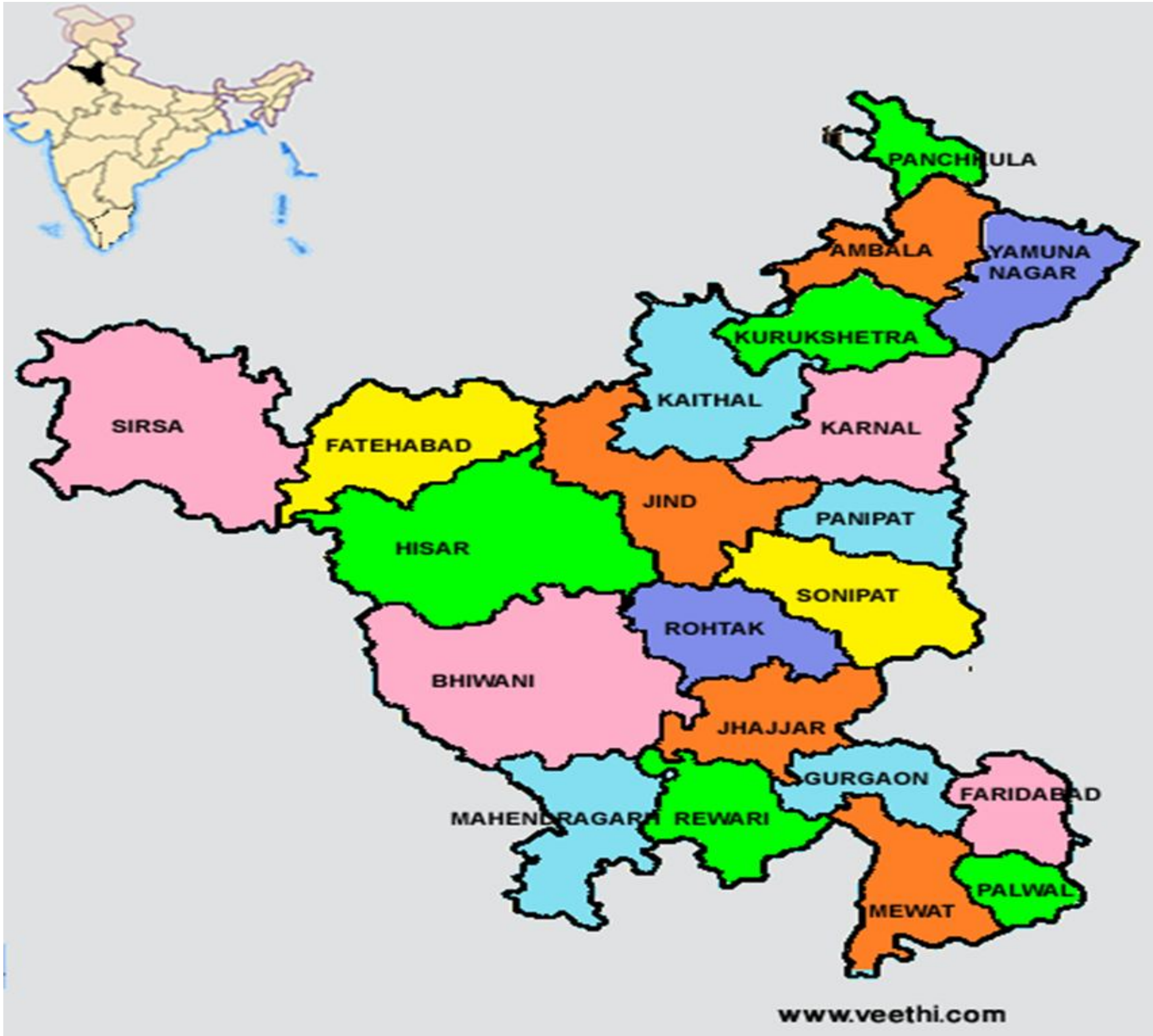

Fig 2.1: Geographical map of Haryana

2.2 Selection of study area:

The study was conducted in Jhajjar district of Haryana. The district was selected purposely on the basis of highest number of solar water pump sets installed. Multistage sampling method was used for selection of adopters and non-adopters. At first stage, two blocks were selected from the district randomly. Five villages from each block were selected randomly at second stage of sampling. At the final stage of sampling, 10 adopters and 10 non-adopters were chosen from each village randomly. Hence a total of 100 farmers (50 adopters and 50 non-adopters) were interviewed through a well designed questionnaire.

A comprehensive list of constraints in using the solar water pump set was identified after studying the review of literature and in consultation with the major advisor and other experts. Relevant constraints were selected after proper addition and deletion. The **Garret ranking** methodology was used to determine the major constraints that affect the respondents. Respondents were asked to rank all constraints using this process, and the results were then translated into a score value using the formula below:

Percent position = $100*(Rij-0.5)/N_{ij}$

Where R_{ij} stands for rank given for i^{th} (i=1,2,3,……10) constraint given by j^{th}(j=1,2,3,…………100) individual

Nij stands for number of i^{th} constraint given by j^{th} individual.

Following the discovery of the percent positions, the percent positions of each rank were translated to scores using the table provided by **Garret and Woodsworth (1969)**. The scores for each constraint were then averaged over the number of sample farmers who ranked them. Total scores for each constraint were calculated in this manner, and mean scores were calculated by dividing the total score by the number of respondents who provided ranks. Finally, the constraints were ranked overall by assigning a rank in descending order of the mean scores.

3. Result

A list of constraints faced by adopter farmers in the study area is presented in Table 1. More than 50 per cent of the respondents were stated that poor after sale service by solar panel service providers, delay in installation of solar water pump set, small landholding, less number of PWPS are available on subsidy, lack of credit facilityand low farm income were the major constraints in adoption of SPWPS. Similarly, lack of knowledge about solar system, high cost of PWPS, fear of theft, maintenance and operational problems and others were also identified as major constraints in wider adoption of SPWPS in the study area.

Table 1: Constraints faced by adopters of SPWPS in Jhajjar district of Haryana (n = 50)

Sr. No.	**Constraints**	**Percent position P.P= 100* (Rij-0.5)/N_{ij}**	**Garret Score**	**Mean Score**	**Rank**
1.	Fear of theft	4.5	83	44.9	9
2.	High cost of PWPS	13.6	72	46.02	8
3.	Low farm income	22.7	65	51.58	6
4.	Lack of knowledge about solar system	31.8	60	47.68	7
5.	Lack of credit facilities	40.9	55	52.5	**5**
6.	Small landholding	50.0	50	61.86	**3**
7.	Delay in installation of solar water pump set	59.1	46	61.94	**2**
8.	Maintenance and operational problems	68.2	41	35.42	10

9.	Poor after sale service by solar panel service providers	77.3	36	75.76	**1**
10.	Less number of PWPS are available on subsidy	86.4	29	53.16	**4**
11.	Others	95.5	18	21.5	11

Constraints faced by non-adopters in the study area

The constraints faced by non-adopters in the study area are shown in the Table 2. The results showed that majority of the farmers (about 60 per cent) found less availability of solar photovoltaic water pump sets on subsidyfollowed by high cost of SPWPs, maintenance and operational problems of diesel engine and small landholding were the major constraints faced in the study area.

Similarly, small landholdings, lack of information regarding profitability of SPWPS and low farm income were identified major constraints in wider adoption of SPWPS in the study area. Despite above stated constraints, some of the problems viz; lack of credit facilities, poor quality of ground water, long waiting list in getting connections, and lack of extension services were also identified which were faced by non-adopters of SPWPS in the study area.

Table 2: Constraints faced by non-adopters of SPWPS in Jhajjar district of Haryana (n = 50)

Sr. No.	Constraints	Percent position P.P= 100* (Rij-0.5)/N_{ij}	Garret Score	Mean score	Rank
1.	Lack of information regarding profitability of SPWPS	4.5	83	53.02	**5**
2.	Poor quality of ground water	13.6	72	38.7	8
3.	High water table depth	22.7	65	36.84	9
4.	Low farm income	31.8	60	51.32	**6**
5.	Lack of credit facilities	40.9	55	47.26	7
6.	Small landholding	50.0	50	55.18	**4**
7.	Maintenance and operational problems of diesel engine	59.1	46	68.22	**3**
8.	Long waiting list in getting connection	68.2	41	36.28	10
9.	Less number of PWPS are available on subsidy	77.3	36	75.78	**1**

10.	High cost of SPWPS	86.4	29	70.54	**2**
11.	Others	95.5	18	22.14	11

4. Discussion

The previous section results showed that poor after sale service by solar panel service providers, delay in installation of solar water pump set, small land holdings, less number of SPWPS available on subsidy, lack of credit facilities and low farm income were identified some of the major problems faced by adopter farmers of SPWPS in the study area.

Despite, the above stated constraints, some other problems experienced by adopter farmers of SPWPS *i.e.* lack of knowledge about solar system, high cost of SPWPS, less working hours during winter season, fear of robbery and inadequate subsidy.

Similarperceptionsof farmersregarding constraints of SPWPS were reported by Kumar *et al.* (2017), Tayde*et al.* (2010),Upadhay and Chaudhary (2014), Kumar *etal*., (2019) Singh (2017) Ali, A., &Behera, B. (2016)in their respective studies.

Similarly, in case of non-adopters of SPWPS, study concluded that availability of very less number of SPWPS on subsidy, high cost of SPWPS, maintenance and operational problems of diesel engine, small landholdings, lack of information regarding profitability of SPWPS and low farm income were observed major constraints in adoption of SPWPS in the study area.

Similar study regarding constraints in adopting solar photovoltaic water pump was presented by Ali, A., &Behera, B. (2016), Namara et al. , (2011)

In spite of, above stated constraints in adoption of SPWPS, lack of credit facilities, poor quality of ground water and lack of extension services were identified major problems. Similar findings were reported by Purohit and Michaelowa (2008), Patel *et al.* (2018) Singh*et al.* (2017) Jain, A., & Agarwal, S. (2018)in their respective studies.

5. Suggestions and policy implications

In the study area, some suggestions were given by the majority of the farmers for improvement in the solar photovoltaic pump technology. These are given below:

1. In order to improve the after-sale service of solar photovoltaic pump set, necessary guidelines need to be given to the concerned companies so that after sale service can be improved.
2. There should be a timely installment of solar photovoltaic water pump set as many farmers reported that there is a huge gap between filing the application form and installment of solar pump set.
3. Availability of more number of subsidized solar photovoltaic water pump set should be ensured to enhance the uses of eco-friendly green energy.
4. High rate of solar pump cost remains a challenge especially for small-scale farmers hence more credit with lower interest rate should be promoted to encourage the purchase and wider adoption towards this technology especially among the marginal and small farmers.

5. The Indian government ought to encourage private investors to fund the installation of solar panels and other solar PV system components.
6. In order to boost the efficiency of the solar panels, which is now 40% for imported solar panels, the government should provide appropriate funding to our universities, polytechnics, and research centres to produce a solar PV that will be adapted to our environment.
7. To dissuade people from using generators, the government should increase public knowledge of the benefits associated with Renewable Energy Technologies (RET) like solar. Because generator importation has a negative impact on the environment, the government may also consider prohibiting or restricting it.
8. Appropriate steps should be taken to connect solar tube wells to the grid with a provision for buy back of surplus power to discourage over-exploitation of groundwater and realization of extra income by the farmers. training and extension services on efficient water management have the potential to shape farmers' behavior and prevent over-extraction.
9. Solar pump fitted with inbuilt trolly system should be promoted so that along with reducing the dangers of theft as well as its potential can also be fully utilized.

5. Conclusion

In India, solar electricity is a great way to boost power production. This is also beneficial to our economic development and environmental conservation. Solar power is an infinite source of energy, and our country has a climate that is conducive to its use, but we need a better idea to improve efficiency and lower production costs. Poor after sale service by solar panel service providers, delay in installation of solar water pump set, small land holdings, less number of SPWPS available on subsidy, lack of credit facilities and low farm income were identified some of the major problems faced by farmers of SPWPS in the study area.Proper implementation of policies and suggestions has the full potential to replace the non-renewable source of energy. Hence mitigating the above limitations and full utilization of renewable resources can lead to tremendous growth in the economy.

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