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Cutting Edge Advantage of Solar over the Conventional Electric Powered Groundwater Irrigation in Villupuram District of Tamil Nadu, India

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ABSTRACT

Solar energy is the major renewable energy source in the world. In the is energy use scenario, solar energy has occupied second position and it's share in renewable energy has 27.5 per cent. In India, solar energy is in first position in renewable energy capacity and it's share in renewable energy has 33.5 per cent. Solar is photovoltaic is conversion of solar energy into electricity which can be used for solar water pumping. With the above background, the present study is attempted to focus on the impact of solar and electric operated tubewell irrigation in the sample farms. A quota sampling selection procedure and snow ball sampling technique were used for this study. A sample size of 45 each of solar and electric operated sample farmers altogether 90 sample respondents were contacted for the conduct of this research study. Garrett's ranking technique was used for assessing the merits and demerits of solar and electric operated tubewell irrigation as opined by the sample respondents. It was observed that free electricity for motor pumping was the prime most important attribute which influenced the farmers preference for electric energy followed by efficiency in lifting water from higher depths with good discharge rates. The foremost bothering issue in electric energy use was the limited hours of 3 phase electric power availability and frequent voltage fluctuations. The availability of huge subsidy component in the initial investment and reduction in the energy bill were the foremost important reasons for the adoption of solar power motor pumps in irrigation. The foremost bothering issue in solar energy use for irrigation was unavailability of battery for power store which was expressed as the major drawback in solar energy irrigation pumping. To promote the large scale adoption of this important renewable energy all the merits of this energy source expressed by the farmers should be widely propagated among the farming community. The demerits in the use of existing devices of this energy source such as battery for storage, efficiency improvements with higher horse power's should be addressed by gearing up the Research and Development wing to focus on these issues expressed by the farmer stakeholders.

Key words: *Solar energy, Renewable energy, Solar operated, Electric operated, Irrigation, Logistic regression*

Introduction

Solar energy is the world's common renewable energy which is a flow resources with public good nature. It is free gift from nature to all living things in the world. India comes under the tropic of cancer, so it experiences different kinds of climatic conditions and it receives lot of solar radiation from the sun directly. Irrigation is the important factor for agriculture. Among the different sources of irrigation

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groundwater has become predominant owing to some of its advantages features. Ground water irrigation is done by pumping out of water from open well or bore well or dug cum bore well to crops through some energy which may be renewable non renewable energy. There are different types of renewable energy in India, viz., wind, hydro, solar, biomass, bagasses and others. Solar energy of which has an edge over the other sources in tropical climatic countries like India.

In end of the 2021, the total renewable energy capacity (TREC) has installed 3063.926 GW (Giga Watt) in world. During 2021, renewable energy capacity growth is 9.1 per cent compared with 2020. India's share in the TREC has 4.80 per cent (147.122 GW). India has in second position in renewable energy capacity installation. In 2021, solar energy has installed 849473 MW (Mega Watt) of the TREC in world. India's share in the total solar energy capacity has 5.85 per cent (IRENA, 2022).

In the world, solar energy has second position in renewable energy use and it's share has 27.5 per cent. In India, Solar energy has first position in renewable energy capacity and it's share in renewable energy has 33.5 per cent (IRENA, 2022).

Solar energy is the basis for all the forms of energy. It can be obtained from different ways, one way is thermal energy from the temperature and another one way is solar photovoltaic (SPV) from solar light. Thermal energy is used for solar drying, solar water heating, solar cooking, solar steam cooking, solar cooling. SPV is conversion of solar energy into electricity which can be used for solar lighting, solar water pumping, solar water purification system, solar fencing, solar refrigeration, running electrical equipment, devices or appliances.

With the above background on the importance and scope of solar energy solar pumps for irrigation an economic study is attempted to focus on the advantages accruing to the solar irrigation pump operating farms over the existing electric energy operating farms so as to address the impact issues that stumbles the widespread adoption of this energy source for irrigation.

Objective

1. To elicit and examine the farmer's opinion regarding the merits and demerits of electrical and solar energy use in the operation of irrigation pumps

Data and Methodology

Villupuram district has the huge number of solar pump installations for agriculture during 2015 to 2019 (Agricultural Engineering Extension Centre, Villupuram district). There are 24 blocks in Villupuram district. Out of which, solar pumps for irrigation were installed in 19 blocks. Purposive sampling procedure was used to select the solar irrigated farmers. The solar samples were identified with the help of institutional information and adopting snow ball sampling technique. From the same location same number of randomly, elected electric operated farmers were also contacted for making comparative analysis. A sample of 30 technical people were who contacted from the four divisions of agricultural engineering department in Villupuram district so as to get better clarity and elicit technical detail pertaining to solar irrigation system.

A quota of 45 each of solar and electric operated sample farmers and 30 technical experts altogether 120 sample respondents were contacted for the conduct of this research study.

Collection of Data

Primary and secondary data were collected and used in this study. Primary data were collected from the sample farm households with the help of well-structured, pre-tested interview schedule, bearing questions in relation to the objectives of the study. The information was related to merits and demerits regarding solar and electric operated tubewell irrigation system, factors influencing the installation of solar and electric operated tube well irrigation of the farm household such as education level of farmer, size of holding, initial investment, availability of subsidy and opinion regarding solar pump operation by technical experts were collected from the samples. Secondary data were collected the Agricultural Engineering Extension Center and Agricultural Engineering Department. The information was related to contact details of the solar farmers.

Tools of Analysis

Garrett's Ranking Technique

The Garret's ranking technique was used for the analysis of merits and demerits of solar and electric operated tubewell irrigation of sample farms (Thulasiyammal *et al.,* 2019). The respondents were asked to rank their merits, demerits of solar oper-

ated and electric operated wells in crop irrigation. In Garrett's ranking technique, these ranks were converted into per cent position by using the formula,

$$\text{Percent position} = \frac{100 \times (R_{ij} - 0.5)}{N_j}$$

Where,

R_{ij} - Ranking given to the i^{th} attribute by the j^{th} individual

N_j - Number of attributes ranked by the j^{th} individual.

By referring to the Garrett's table, the per cent positions estimated were converted into scores. Then for each factor the scores of various respondents were added and the mean values were estimated. The mean values thus obtained for each of the attributes were arranged in descending order. The attributes with the highest mean value was considered as the most important one and the others followed in that order.

Results and Discussion

Farmer's Opinion on the Merits and Demerits of Electrical and Solar Energy Adoption in the Operation of Irrigation Pumps

Merits of Electric Energy Motor Pumping in Irrigation

Out of the exhaustive literature review six attributes were identified and the respondents were asked to rank them. This Garret ranking analysis revealed that the farmer's opinion regarding the merits in the adoption of electric energy use in irrigation pumping.

It could be observed from the table 2 that the free electricity bill for motor pumping was the prime most important attribute which influenced the farmer's preference for electric energy followed by efficiency of lifting water from higher depth with good discharge rates using motor power of more than 15 horse power (HP). Hence water lifting from higher depths and high volume of water obtained during pumping were ranked second and third reasons for electric energy preference. The other factors such as comparatively lesser investment cost, 24 hours power supply and no seasonal variations did not fetch which attention of those farmers.

Demerits of Electric Energy Motor Pumping for Irrigation

The demerits of electric energy motor pumping were discussed with the identified six attributes which were elicited from the electric energy using sample farmers. The ranking preference given by the electric energy using farmers on these factors were analysed using garret ranking technique. It could be observed from the Table 2 that limited hours of electricity 3 phase power supply was opined as the foremost bothering issue in electric energy use and it was ranked first followed by quality of the electric energy provided, which had low voltage problem with frequent fluctuations leading

Table 1. Merits of Electric Energy Motor in Irrigation Pumping

S. No.	Particulars	Mean Score	Rank
1.	Water can be lifted from higher depth using higher HP motors	360.48	2
2.	No electricity bill for motor running	386.85	1
3.	Initial investment is low for getting of new connection	262.57	4
4.	Availability of electricity in day and night time for irrigation	206	5
5.	No seasonal variations in supply	105.85	6
6.	High volume of water obtained during pumping/ High pump efficiency	309.71	3

Table 2. Demerits of Electric Energy Motor Pumping in Irrigation

S. No.	Particulars	Mean score	Rank
1.	Getting of new connection very difficult	299.75	4
2.	Electricity rationing for limited hours	710.00	1
3.	Frequent Power cuts during Summer	405.00	3
4.	Some time suddenly motor struck and stops during irrigation	164.20	6
5.	Voltage Fluctuation and Coil Burning	586.75	2
6.	Inconvenience of Night time power supply	254.80	5

to coil burning. The high frequency of power cut interruptions in summer season power supply was opined as the third important demerit of the electric energy use for irrigation. The procedural delay for providing of free connection service and inconveniences in night time irrigation operations were ranked as 4th and 5th disadvantageous features of electric power irrigated farms.

Merits of Solar Energy Motor Pumping in Irrigation

The analysis on farmer's opinion regarding the merits in the adoption of SPV pumps is presented in Table 3 which revealed that the availability of huge subsidy component in the initial investment and reduction in the energy bill (if suppose the electric power subsidy is withdrawn) were the foremost important reasons for the adoption of solar power motor pumps in irrigation. The ranking preference given by SPV using farmers also revealed many other features of solar energy use which were all expressed as demerits in the electric power use. They felt the command over the irrigation supply at their disposal on any day any time as the most important advantageous feature of this solar energy use and ranked it at 3rd position in their preference attributes. Low repair and maintenance cost, prolonged guarantee period and other eco-friendly nature of this renewable resource were also expressed as the reasons for the adoption of solar motor power pumping for irrigation.

Demerits of Solar Energy Motor Pumping for Irrigation

The analysis on farmer's opinion regarding the demerits in the adoption of SPV pumps is presented in table 4 that the most of the farmers opined unavailability or inefficient battery for power store as the major drawback in solar energy irrigation pumping. Voltage fluctuations while operating at higher depths received second rank. Solar energy production is subject to seasonal sunshine variations and so it is more efficient during summer and less efficient or not active in rainy season which received rank three with a mean score of 170.91. Inefficiency with higher HPs, reduced water output during cloudy times, requirement of lot of space for installation in the farm area were opined as the 4th, 5th and 6th major constraints of this energy use system. Low per-

Table 3. Merits of Solar Energy Motor Pumping in Irrigation

S. No.	Particulars	Mean score	Rank
1.	Low repair and maintenance cost	187.6	4
2.	Irrigation supply is at their command	189.5	3
3.	Eco-friendly in nature	135.6	7
4.	Renewable energy	142.5	6
5.	Reduction in energy bill (if electric power subsidy is withdrawn)	207.1	2
6.	20 years guarantee	159.6	5
7.	Innovative technology	99.5	8
8.	Infinite source of energy	63.9	10
9.	Availability of subsidy	238.8	1
10.	No grid connection	97.8	9

Table 4. Demerits of Solar Energy Motor Pumping in Irrigation

S. No.	Particulars	Mean score	Rank
1.	Water output low during cloudy season	149.91	5
2.	Seasonal energy	170.91	3
3.	High Initial Investment Cost	106	8
4.	Delay in Processing Subsidies	71.33	9
5.	Inefficiency with higher HPs	155.33	4
6.	Low water output	47.5	10
7.	Requirement of Lot of space for installation in the farm area	125.75	6
8.	Voltage fluctuations	171.58	2
9.	Low performance in higher depth	110.5	7
10.	Unavailability of battery for power store	190.33	1

formance in higher depth received rank seven. High initial investment cost, delay in processing subsidies and low water output were also expressed by some of the sample farmers as the demerits of solar powered irrigation system.

Conclusion and Policy making

To promote the large scale adoption of this important renewable energy, all the merits of this energy source expressed by the farmers should be propagated among the farming community. This should be carried out through conducting awareness creation campaigns, workshops, seminars etc., by the institutions and technical experts for which liberal funding support from the government is the key.

The demerits in the use of existing devices of this energy source such as battery for storage, efficiency improvements with higher HPs should be addressed by a strong Research and Development wing's support to focus on these issues expressed by the farmer stakeholders.

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Conflict of Interest

All the co-authors have seen and agree with the contents of manuscript and there is no financial interest to report.

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