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A study on constraints faced by irrigation users in renewable energy and non-renewable energy shallow tube-well sources of irrigation in Cooch Behar districts of West Bengal

[1]Nityananda Layek, [2]Anmol Giri, [1]Gobinda Mula and [1]Satyendra Ch. Sarker

[1]Department of Agricultural Economics, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India

[2]Department of Agricultural Economics, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

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Corresponding Author: Nityananda Layek

Abstract

Agriculture is a multifaceted enterprise that employs millions of small and marginal farmers in India. The majority of Indian farmers are resource-poor and illiterate, with limited or no access to modern technologies. Agriculture and rural development success is determined by the availability of information, knowledge, technologies, and a proper irrigation system for millions of rural families. Cooch Behar district has an agrarian economy that is supported by a variety of irrigation systems. The shallow tube wells (STW) have a direct impact on the cropping intensity of the Cooch Behar District. In this context, a study was conducted in the Cooch Behar district of West Bengal to reveal constraints faced by farmers in renewable and non-renewable energy shallow tube-well sources of irrigation.

Keywords: Renewable energy, irrigation, solar energy, economy, technology

Introduction

The Earth's environment, societal well-being, and means of subsistence—particularly through water—are all significantly impacted by climate change. Freshwater makes up the remaining 2.50% of the water on Earth, whereas saltwater makes up the majority (97.5%). The freshwater supply is made up of only 0.26% lakes, reservoirs, and rivers. Just 5% of freshwater is useful and accessible (Mittermeier *et al*., 2010) [1]. Water, like religion and philosophy, can have a profound impact on millions. Water is necessary for human survival. All living creatures, including humans, depend on water to survive. Water scarcity is a major obstacle to increasing agricultural output (Newson, 2008) [2].

Irrigation is essential for raising crop intensity, yield utilization, productivity, and input efficiency. Producing crops requires a lot of water. All the countries of the world are looking for new source of energy such as renewable (Solar, wind, geo thermal and wave energies) and nuclear due to the scarcity of conventional energy (Rana *et al*., 2021) [3]. According to Dain and Pawar (1987), groundwater irrigation may account for 70-80% of the value of irrigated production in India. This indicates a significant increase in India's agricultural production. The production relies on groundwater. Agriculture's poor performance can be attributed to limited access to irrigation, production inputs, credit, markets, and advanced technology.

According to Yang *et al.* (2006) [9], water scarcity directly affects food production, which is the largest user of water. Water scarcity is a major barrier to increasing food production for a growing population (Playan and Mateos, 2006) [10}. In India, agriculture accounts for 84% of water resources, with farm efficiency ranging from 20-50%. Rivers, tanks, canals, and ponds are the primary sources of water for surface irrigation. Surface water irrigation canals are the primary means of releasing water from the main dam into major canals and distributaries leading to farmers' land, ensuring adequate irrigation in command areas (Saha *et al*., 2023) [7]. While the initial capital cost of solar pump may be far greater than a generator but because of low maintenance and zero fuel costs, solar power system can be cheaper option at a long run. On the other hand, solar power irrigation system can greatly reduce the water wastage and human intervention in irrigation system (Rana *et al*., 2021) [3].

Methodology

To achieve the study's objectives, the investigation was conducted using data collected from field surveys in the study locations. A multistage sampling technique was used to select sample units for the various irrigation systems used by farmers. Irrigation techniques in the Cooch Behar district include open-dug wells, deep tube wells, shallow tube wells, river lift irrigation, and tanks. The study investigated at the Cooch Behar district, specifically two of its 12 blocks, Cooch Behar I and Cooch Behar II. In each block, 50 respondents were selected randomly.

Tools of analysis

To meet the numerous aims stated earlier, the tabular method of analysis is aggressively adopted. The tabulated data have been subjected to statistical analysis by utilizing MS-Excel.

Garret ranking technique

To capture comprehensively the constraints faced by the farmers during installation and maintenance of drip systems in coconut orchards, Garret ranking technique was used. Some major prevailing constraints were highlighted during preliminary survey and the order of the merit given in ascending order was converted into ranks by using the formula. Accordingly, these ranks were converted to scores by referring to Garrets table. Garrett's formula for converting ranks into percent was given by

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

Where,

R_{ij}= Rank given for ith item by j^{th} farmer

Nj = Number of items ranked by ^{jth} farmer

The percent position of each rank was converted to scores by referring to tables given by Garret and Woodworth (1969) [13]. Then for each factor, the scores of individual respondents were summed up and divided by the total number of respondents for whom scores were gathered. The mean scores for all the factors were ranked, following the decision criterion that higher the value, the more important is that constraint.

Mean score

Mean score was obtained by total scores of each statement divided by total number of respondents.

$$\text{Mean score} = \frac{\text{Total Score of a Practice}}{\text{Total no,of respondents}} \times 100$$

Results and Discussion

Diesel shallow tube-well

The examination of 50 respondents' shallow tube-well irrigation systems revealed the presence of restrictions that are unrelated to renewable energy sources. The significant upfront cost emerged as the primary limitation, achieving the highest average score of 61.68 and ranking first. Furthermore, the increased cost of diesel fuel appeared as the second most significant financial obstacle, with an average score of 58.74. The reasons for the lower ranking of shallow tube-wells are as follows: higher maintenance costs, difficulty in finding spare parts locally, low income from farming, damage caused by rodents and animals, a lack of knowledge about the precise water requirements of crops, and problems with water leakages in the system. We ranked these factors 3rd, 4th, 5th, 6th, 7th, and 8th, with mean scores of 58.12, 54.58, 54.00, 51.68, 50.62, and 49.48, respectively. In addition, the limited quantity of land holdings and the absence of technical expertise were identified as important limitations, ranking 9th and 10th with mean scores of 48.40 and 48.38, respectively.

Table 1: Farmers' constraints when it comes to non-renewable energy irrigation from shallow tube-well sources (N=50)

Sl. No	Constraints	Total score	Mean Score	Agree (%)	Somewhat Agree (%)	Disagree (%)	Rank
1	High initial investment	3084	61.68	90	6	4	I
2	Low farm income	2700	54.00	76	12	12	V
3	Higher Maintenance Cost of shallow tube-well	2906	58.12	80	12	8	III
4	Diesel is more expensive	2937	58.74	84	12	4	II
5	Lack of technical knowledge	2419	48.38	78	16	6	X
6	Lack of availability of spare parts at local level	2729	54.58	68	24	8	IV
7	Problems of water leakages in the system	2474	49.48	74	18	8	VIII
8	No knowledge about precise water requirement of crops	2531	50.62	82	14	4	VII
9	Damage by rodent and animals	2584	51.68	64	30	6	VI
10	Small size of land holdings	2420	48.40	68	26	6	IX

Solar shallow tube-well

An examination of restrictions associated with solar shallow tube-wells for renewable energy was conducted based on feedback from 50 participants. The analysis identified a range of constraints, including financial, technological, and natural factors. The data from the table indicates that the respondents considered the higher maintenance cost of Solar Shallow tube-well to be the most significant financial limitation, with a mean score of 61.48. This constraint obtained the top position in the ranking. The second highest mean score of 59.82 was obtained by low farm income of solar shallow tube-wells. This was followed by limited area water supply, weather dependence, lack of availability of spare parts at the local level, lack of technical knowledge, no knowledge about precise water requirements of crops, skill to repair irrigation equipment, and problems of water leakages in the system. These factors were ranked 3rd, 4th, 5th, 6th, 7th, 8th, and 9th, with mean scores of 59.28, 57.54, 55.78, 55.52, 54.58, 53.96, and 53.46, respectively. In addition, the restrictions of damage by rodent and animals and small size of land holdings were identified as significant, ranking 10th and 11th with mean scores of 53.02 and 52.88 respectively. This discovery bears resemblance to the unofficial, non-formalized water markets in the Kathmandu Valley (Raina *et al*., 2020) [12].

Table 2: Farmers' constraints when it comes to renewable energy irrigation from shallow tube-well sources (N=50)

Sl. No	Constraints	Total score	Mean Score	Agree (%)	Somewhat Agree (%)	Disagree (%)	Rank
1	Low farm income	2991	59.82	84	10	6	II
2	Higher Maintenance Cost of Solar Shallow tube-well	3074	61.48	70	26	4	I
3	Limited area water supply	2964	59.28	74	20	6	III
4	Skill to repair irrigation equipment	2698	53.96	60	32	8	VIII
5	Lack of technical knowledge	2776	55.52	64	26	10	VI
6	Lack of availability of spare parts at local level	2789	55.78	68	28	4	V
7	Problems of water leakages in the system	2673	53.46	64	24	12	IX
8	No knowledge about precise water requirement of crops	2729	54.58	82	12	6	VII
9	Damage by rodent and animals	2651	53.02	78	14	8	X
10	Small size of land holdings	2644	52.88	80	14	6	XI
11	Weather Dependence	2877	57.54	78	18	2	IV

Conclusion

The results of the current investigation highlight the notable economic limitations faced by farmers, with multiple crucial variables contributing to their difficulties. One of the main obstacles is the substantial upfront investment that is necessary, which presents a big challenge for several farmers looking to enter or expand their operations. Moreover, the financial strain on farmers intensifies due to the elevated price of diesel and the elevated maintenance costs associated with shallow tube wells. In addition, the scarcity of spare parts at the local level presents logistical challenges and may prolong the period of inactivity for crucial equipment, exacerbating financial difficulties. Furthermore, insufficient agricultural revenue exacerbates these difficulties, resulting in a recurring cycle of financial hardship for farmers. Rodents and animals increase the costs, while the dependence on non-renewable energy sources raises both financial and environmental issues. Overall, the study emphasizes the complex and diverse range of financial limitations that farmers have. These constraints include the need for initial capital, ongoing expenses, income levels, and external concerns such as insect damage and dependence on non-renewable energy sources. We need a comprehensive strategy that integrates financial assistance mechanisms, technical advancements, and governmental interventions to tackle these difficulties. This would help reduce the challenges faced by farmers and promote the adoption of sustainable farming methods.

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