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Performance of Small Capacity Solar Pump in Eastern Region of India

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ABSTRACT

Solar energy use for groundwater abstraction is one of the most viable options for small holders' irrigation in current scenario of increasing fuel prices. Therefore, the dissemination and adoption of solar pumps of low capacities among these farmers is in demand. This paper presents the performance of a 3.0 horsepower solar pump, as this capacity solar pump are being promoted by many state governments among small farmers at subsidised rates. As performance of solar pump depends upon the solar radiation availability and groundwater regime, therefore assessment and quantification of water abstraction per day round the year is of immense importance for cropping pattern and cropping intensity. Study showed that in Eastern region of India where groundwater depth is ranged from 5-10 m bgl with annual fluctuation of ±2 to ±4 m, solar radiation is ranged from 6.4 to 3.4 kWh/m^2/day ; a 3.0 horsepower solar pump can abstract groundwater between 102-173 m^3/day, depending on the months and brightness of the day. This capacity pump also offers a delivery pressure head of 1.1- 1.5 kg/cm^2, and therefore it facilitates pressured irrigation coupling for improved water use efficiency.

KEYWORDS

Solar pumps, small holders, groundwater, energy resources, climate change

INTRODUCTION

Indian is dominated by small farm. Typically, the smallholders' staple food production is risky and of low due to long dry spells and erratic rainfall—the two problems to further exacerbate under climate change (Lobell *et al.*, 2008; Held *et al.*, 2005). These smallholders could play a major role in increasing food production if they had the access of key ingredient, i.e., the irrigation water (Lipton, 2006). The secured water supply provides opportunity to grow higher valued crops and crop diversification. Further, the India's energy requirements are constrained by country's energy resources and import possibilities. India is not well endowed with natural energy resources, as oil reserves, natural gases and uranium ores are meagre. Though coal is abundant but it is regionally concentrated and is of low calorific value and having high ash content with limited extraction technology. Hydro potential is significant but small compared to India's needs. Further, the need to mitigate environmental and social impacts of storage, schemes often delays hydro development thereby causing huge cost overruns. Therefore, providing energy access and energy security to the rural for agricultural use in terms of electricity and fossil fuels at affordable cost would continue to be a major issue. Solutions to this have to be found but it no longer appear possible from conventional sources.

Renewable energy, the solar energy could therefore be a key part of the solutions and is likely to play an increasingly important role in energy access for groundwater abstraction and irrigation and also in pursuing low carbon pathway. Keeping these facts in view many state governments are promoting solar pumps at subsidized rates. For example, in eastern region, particularly in Bihar, there are about 1850 solar pumps of which about 1500 pumps are of 2.0 horsepower capacity with induction motor rating of 1.5kW. Under the prevailing solar radiation condition in Eastern region, which rangesbetween6.4-3.4 kWh/m^2/day, the required operating solar panel size is 1.8 kWp when module efficiencyis14 to15 percent. These 2.0 horsepower solar pumps are useful for ground water abstraction if groundwater depth is less than 7.0 m, bgl, as its working principle is based on vacuum creation which permits water abstraction from a maximum depth of 8.0 m.

In Eastern region, in general, the groundwater regime is ranging 5-10 m, bgl, with annual fluctuation of ±2 to ±4 m; however, in some pockets it goes below 20 m, bgl. Therefore, many a time's 2.0 horsepower pump fails during summer season. Therefore, this makes imperative to think alternative to2.0 horsepower solar pump. Keeping these facts in view state governments are now focusing to promote3.0 horse power submersible pumps instead of 2.0 horsepower solar pump. The 3.0 horsepower solar submersible pump is based on induction motor of rating 2.2 kW and required operating solar panel size, under prevailing solar energy radiation condition, is 3.0kWp. In Bihar alone now there are more than 350 solar pumps of this capacity and their numbers are increasing over the time. In view of popularity of 3.0 horsepower solar pumps, performance assessment and quantification water abstraction under the prevailing solar radiation condition are to be worked out for daily water output to facilitate the farmers to prepare plan for their crops and cropping pattern. Keeping these facts in view performance assessment of a 3.0 horsepower solar pump was undertaken to generate necessary data.

MATERIAL AND METHODS

To assess a 3.0 horsepower pump pup in Eastern region, a solar pump of this

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capacity was selected and operated by recommended solar panel size of 3.0kWp **(Fig. 1)** at Main campus of ICAR-Research Complex for Eastern Region, Patna (Bihar) India.

Fig. 1: 3.0 horsepower solar pump at ICAR RCER Patna India (Testing sight)

The specification of solar pump and the solar panel is reported in **Table 1**. Solar panel was mounted on a dual axis manually operated sun tracking structure to rotate the panel 3 times in a day such that the solar array is tilted 45°E from horizontal in the morning, then flat horizontal between 9.30 - 14.30 hours and finally 45°W tilt. From month of March to mid-November no tilt was done in N-S, and only rotation was performed in E-W direction. However, from mid-November to January, solar panel is tilted permanently by 35° in South from horizontal and E-W rotation was performed as usual. These arrangements maximise the power harnessing and therefore more abstraction of groundwater per day was observed. Solar panel was cleaned weekly by water for removing dust particles for solar plate.

Table 1: Specifications of solar system component

Electrical Parameters of solar module		Electrical characteristics of pump and Controller	
Type of Module	C-Si	Pump	DC Submersible Pump
Array size	3060Wp±3%	Shutoff Head	35 m
No f modules	18	Motor Capacity	3 HP/ 2.2 kW
Power (P_{max})	170Wp±3%	Delivery Pipe Size	2.5"
Open circuit voltage (V_{oc})	43.66V	Pump Controller Rating	3 horsepower/ 2.2 kW
Short Circuit Current (I_{sc})	5.21A	MPPT Tracking	Automatic
Current at Maximum Power (I_{pm})	4.82A	Driver efficiency	97%
Voltage at Maximum Power (V_{pm})	36V		
Nominal Opt. Cell Temperature	46 ± 2 °C		
Temperature coefficient of Power	1.036W/^{0}C		
Module efficiency	14.5%		

Results and Discussion

The discharge of the pump was measured over a day for different months and mean monthly daily discharge over different time on a bright day was worked out. The outcomes of the observations are reported in **Table 2.**

Table 2: Mean monthly daily discharge over different time on a bright day

Day time	Jan	Mar	Apr	Jun	Jul	Oct	Dec	Day time	Jan	Mar	Apr	Jun	Jul	Oct	Dec
07:00								12:15	5.3	5.6	6.0	5.7	5.4	5.4	4.9
07:15								12:30	5.3	5.5	6.0	5.5	5.4	5.5	4.9
07:30								12:45	5.3	5.5	6.0	5.5	5.2	5.3	4.9
07:45		1.9		3.5	2.9	2.1		13:00	5.3	5.3	6.0	5.3	5.1	5.2	4.8
08:00		3.9	3.8	4.0	3.5	2.9		13:15	5.3	5.2	5.8	5.4	5.0	5.3	4.7
08:15		4.1	4.0	4.5	4.0	3.5		13:30	5.2	5.0	5.8	5.3	4.9	5.2	4.6
08:30		4.6	4.3	4.6	4.3	3.8		13:45	5.0	5.2	5.7	5.2	4.9	5.1	4.4
08:45	2.5	4.9	4.9	5.0	4.4	3.9		14:00	4.7	5.0	5.6	5.2	4.6	5.0	4.4
09:00	3.5	5.3	5.0	5.1	4.5	4.0		14:15	4.6	5.1	5.6	5.3	4.3	4.7	4.4
09:15	3.9	5.4	5.4	5.4	4.9	4.6	3.2	14:30	4.5	5.0	5.6	4.8	4.4	4.6	4.3
09:30	4.2	5.7	5.7	5.5	4.9	4.6	3.5	14:45	4.1	4.8	5.4	4.8	4.3	4.6	4.0
09:45	4.4	5.7	5.7	5.6	4.9	4.8	3.8	15:00	3.7	4.9	5.1	4.6	4.2	4.3	3.5
10:00	4.6	5.7	5.9	5.5	4.9	4.9	4.0	15:15	3.3	4.6	4.9	4.3	4.0	4.3	3.2
10:15	4.9	5.8	6.0	5.6	5.0	4.9	4.3	15:30	3.0	4.4	4.6	4.0	3.9	4.2	2.9
10:30	4.9	5.8	6.1	5.4	5.1	5.2	4.5	15:45	2.6	4.2	4.3	3.8	3.6	4.0	1.9
10:45	5.0	5.6	6.0	5.5	5.1	5.2	4.6	16:00	2.2	4.0	4.0	3.5	3.5	3.8	1.3
11:00	5.1	5.5	6.1	5.5	5.2	5.4	4.7	16:15		2.9	3.2	2.7	3.3	3.5	

Day time	Jan	Mar	Apr	Jun	Jul	Oct	Dec	Day time	Jan	Mar	Apr	Jun	Jul	Oct	Dec
11:15	5.3	5.5	6.1	5.4	5.2	5.4	4.9	16:30		1.9	2.9	2.4	2.7		
11:30	5.1	5.6	6.0	5.5	5.3	5.4	4.9	16:45		1.0	2.4	2.3	2.1		
11:45	5.2	5.5	6.0	5.5	5.3	5.5	5.0	17:00							
12:00	5.3	5.6	6.1	5.5	5.3	5.4	4.9								

The cumulative groundwater abstracted over a day was worked out for mean monthly daily water output and is plotted as Fig. 2. These parameters were worked out underground water regime, ranged from 5-14 m, bgl. Interpretation of data shows that the discharge and therefore the water output per day for different month on a bright sunshine day was ranged from 102-173 m^3. The maximum water output was found to be in the month of April and lowest in December, as solar radiation was highest in April and lowest in December. The average irrigation water depth for crops was about 7.0 cm, and therefore on an average cropped area of 1450 – 2450m^2 was irrigated per day by flood method of irrigation

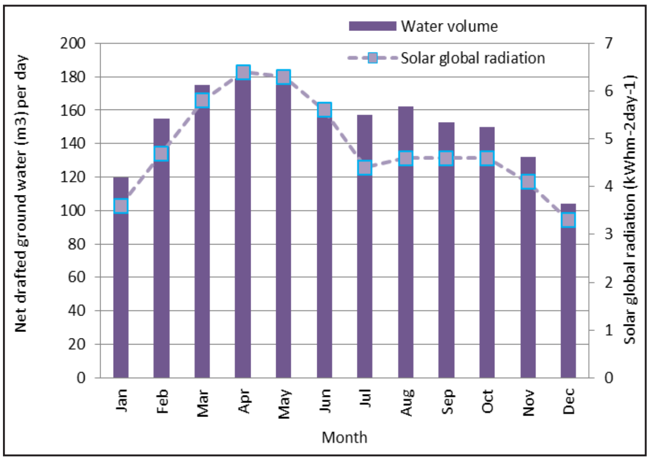

Fig. 2: Mean monthly daily water output for different month

Further, the groundwater pumping increases stress on ground water, however for groundwater sustainability its management on scientific lines is vital. Past studies have showed that the solution to the problem of growing groundwater scarcity and persistent groundwater resource degradation can be made through the demand management by efficient use of the available water both in the short-run and long-run perspectives. The demand management mechanism is the adoption of micro irrigation such as drip and sprinkler methods of irrigation. Evidences show that around 50 per cent of the increase in demand for water can be met by increasing the effectiveness of irrigation (Seckler *et al.*,1998) and the water-use efficiency increases up to 100 per cent in a properly designed and managed drip irrigation system (INCID, 1994). Drip method of irrigation helps to reduce the over-exploitation of groundwater that partly occurs because of inefficient use of water under surface method of irrigation. Environmental problems associated with the surface method of irrigation like waterlogging and salinity are also completely absent under drip method of irrigation (Narayanamoorthy, 1997). Drip method also increases water-use efficiency, decreases tillage requirement and increases crop yields (Namara *et al.*, 2005). It is evidenced that the drip irrigation technology is technically feasible, particularly when the farmers depend on groundwater sources (Dhawan, 2000). In view of these facts it is also observed that this pump facilitates drip and micro sprinkler irrigation, as it offers pressure head ranging from 1.0-1.5 kg /cm^2 during mid-day in most of the month.

CONCLUSION

The solar powered groundwater pumping data for 3.0 horsepower soar pump generated and presented in this paper could be useful for performing assured irrigation to planed cropping by surface and pressurised irrigation, as farmers will have advance information about the availability of water at different point of time round the year.

REFERENCES

Narayanamoorthy A. 1997. Drip irrigation: A viable option for future irrigation development. *Productivity* **38** (3):504-511.

Dhawan BD. 2000. Drip irrigation: Evaluating returns. *Economic and Political Weekly* **35**(42): 3775-3780.

Gandhi, Vasant P and Namboodiri NV. 2002. Investment and institutions for water management in India's agriculture: Profile and behaviour', in D. Brennan (ed) Water Policy Reform: Lessons from Asia and Australia, Australian Centre for International Agricultural Research (ACIAR), Canberra.

Held IM, Delworth TL, Lu J, Findell KL and Knutson TR. 2005. Simulation of Sahel droughtin the 20th and 21st centuries. *Proc Natl Acad Sci USA*. **102**:17891–17896.

INCID (Indian National Committee on Irrigation and Drainage).1994. *Drip Irrigation in India*, New Delhi.

Sivanappan RK.1994. Prospects of micro-irrigation in India, *Irrigation and Drainage Systems* **8** (1):49-58.

Lipton M. 2006. Can Small Farmers Survive, Prosper, or be the Key Channel to cut Mass Poverty. *Journal of Agricultural and Development Economics* **3***(1):58-85.*

Lobell DB. 2008. Prioritizing climate change adaptation needs for food security in 2030. *Science* 319:607.

Namara Regassa E, Upadhyay, Bhawana and Nagar RK. 2005. *Adoption and Impacts of Microirrigation Technologies: Empirical Results from Selected Localities of Maharashtra and Gujarat States of India*, Research Report 93, International Water Management Institute, Colombo, Sri Lanka.

Seckler David, Amarasinghe, Upali, Molden, David, de Silva, Radhika and Barker, Randolph .1998. *World Water Demand and Supply, 1990 to 2025: Scenarios and Issues*, Research Report 19, International Water Management Institute (IWMI), Colombo, Sri Lanka

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