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Rajasthan Solar Water Pump Programme–Creating a Better Future for Farmers

Dinesh Kumar Goyal [+]

Principal Secretary to Govt. of Rajasthan, Horticulture Department (PSHR), Jaipur, Rajasthan, India

Abstract. Rajasthan has acute irrigation water shortage, erratic rainfall, recurring droughts, deteriorating ground water, heavy dependence on agriculture for livelihood, inefficient grid/diesel based irrigation methods, long queues for electricity connections; but excellent solar insolation. The author's composite off-grid irrigation package - creating water harvesting structures, drawing water through solar-powered pump, irrigating through drip - is conserving groundwater and conventional energy and creating livelihood for rural folks. Strategy? Converge programs and subsidies; develop regulatory framework; involve Federal and State governments and field functionaries. From 34 installations in year 2010-11, 7000 installed in next two years; the largest solar pump programme implemented in the world.

Keywords: Solar, photovoltaic, Water, Pump, Irrigation, horticulture, Rajasthan.

1. Background of Rajasthan

1.1. Present

Rajasthan has India's 10% land, 5% population and only 1% water sources - a disadvantage by factor of ten for supply of irrigation water vs agriculture area. Acute water shortage, erratic rainfall and recurring droughts have exacerbated the situation. Almost every district in the state has drought in one form or the other for half the time. Over 60 percent population depends for livelihood on agriculture/ horticulture, often marred by low productivity due to unreliable, inadequate or non-available irrigation. About 70 percent irrigation is done through wells/ tube-wells energised mainly with grid-power/ diesel-generators. There is a long queue of farmers seeking grid-based electricity connections for irrigation; approximately 60,000 farmers are waiting. Expansion of electric-grid is not feasible in far-flung areas; almost 70% area in the State is characterised as desert. The ground water has deteriorated rapidly in last two decades. Out of 249 blocks, nearly 200 are in the highly critical zone. Almost 90 percent of groundwater withdrawal in the State is utilised through flood/furrow-irrigation methods with mere 35 to 45 percent water-use-efficiency.

1.2. Potential

Rajasthan is blessed with one of the best solar insolation on earth (6-7 kWh/m2/day) with about 325 sunny days in a year, which makes it one of the most attractive destinations to harness solar energy.

2. The Innovation–Convergence of Federal Schemes and State Support

A large number of Government of India (GoI) schemes are being implemented by the State's Horticulture Department, comprising of National Horticulture Mission (NHM) [1], National Mission on Micro Irrigation (NMMI) [2], National Mission on Medicinal Plants (NMMP) [3], National Bamboo Mission (NBM) [4], Jawahar Lal Nehru National Solar Mission (JNNSM) [5], Rashtriya Krishi Vikas Yojana (RKVY) [6], and State Programmes. All these schemes were studied for amalgamation. Finally, JNNSM's

[+] Corresponding author. Tel.: +91-98290-55522; fax: +91-141-2227107.
E-mail address: dineshkumargoyal@gmail.com.

solar water pump, NHM's water harvesting structures (farm ponds, diggies) and NMMI's drip irrigation were combined. The schema is shown in Fig. 1. Financial resources were arranged - 30% subsidy under JNNSM and 56% from RKVY/ State.

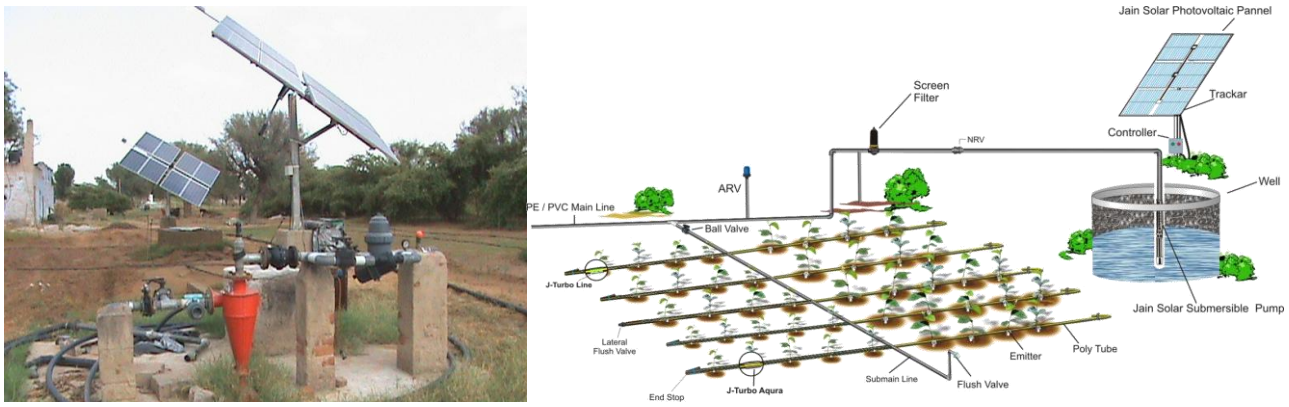

Fig. 1: Solar water pump system–with Drip irrigation

3. Purpose and Priorities of the Programme

- Enhancing irrigated area in the State to increase productivity
- Enabling farmers to diversify into high-value horticulture crops
- Conserving groundwater through efficient irrigation methods
- Narrowing gap between power demand and supply
- Reducing farmers queue for grid electricity
- Replacing polluting diesel pump-sets by harnessing solar-energy
- Providing irrigation in remote locations where electricity grid unavailable
- Saving farmers from drudgeries of night irrigation

4. Strategies Adopted for Transformation

4.1. Exponential Scaling

Unprecedented growth: 34 in 2010-11; 1675 in 2011-12; 4,000 in 2012-13; 10,000 target for 2013-14. Year-wise target, achievement, etc. are depicted in Table 1.

Table 1: Year-Wise Target, Achievement, etc.

Year	Project	No. of District covered	Target	Achieve-ment	Project cost (Rs. Cr.)	MWp	Pump capacity (wp)	sub-sidy	Funding source
1	2	3	4	5	6	7	8	9	10
2008-09	Govt. Farms	7	14	14	0.75	0.025	1800	100%	RKVY
2010-11	Pilot Project	6	50	34	1.83	0.097	2200/ 3000	86%	JNNSM, RKVY
2011-12	First major jump	14	500	1,675	95.86	4.967	2200/ 3000	86%	JNNSM, RKVY
2012-13	Second major jump	33	2,200	4,000	258.29	13.340	2200/ 3000	86%	JNNSM, RKVY
2013-14 (Projected)	Third major jump	33	10,000	10,000	584.69	30.000	2200/ 3000	86%	JNNSM, RKVY, State

4.2. Political-Will Expressed in CM Budget-Announcements

Genuine acceptance enabled focused efforts at all levels in the Government. [7]-[9]

4.3. Decentralization of Implementation Process to District Level

Earlier system of approvals, payment and subsidy release from State Headquarter was dismantled and new decentralised system created under District Collectors, avoiding farmers' visits to State Capital.

4.4. Structural Provisions to Ensure Sustained Support for Beneficiaries

- Supplier: Solar panels cost 75% of total cost of solar pump system. Hence, only Solar Panel manufacturers were qualified to bid. [10]
- Maintenance: Five years Guarantee + additional five years after sales service [11].
- Insurance provided for natural calamities etc.
- Structure: Robust system design withstands wind-load upto 150 Kmph, prevents cattle menace.
- 100w home lighting is made integral.
- Auto tracker introduced for higher solar harvesting.
- Testing of pumps and panels: MNRE's Solar Energy Centre, Gurgaon, was confidentially visited by PSHR himself to understand testing procedures and reporting.
- Computerized MIS Designed.

5. Transparency and Stakeholder Participation

- Bid: Adapting two stage e-bidding [12], pre-bid conferences enabled empanelment of record 12 manufacturers at L-1 price. In the widely dispersed State, large number proved to be a boon.
- Farmer selection: Wide publicity given to scheme, large applications received, selection through open lottery.
- Farmer's decision is final in selecting one of the empanelled suppliers who compete on winning the farmer' trust depicted by technical knowledge, training and prompt after-sale service arrangements.

6. Impact/Benefits Resulting-Qualitative

6.1. Impacts on livelihood and other parameters

The initiative has made far-reaching impacts directly to the lives of farmers and their families, conserved the resources precious to the State (groundwater and energy), and harnessed the clean and free solar energy. It has been effectively contributing towards addressing multiple challenges the State faces.

6.2. Improvement in Service Delivery Time and Beneficiary Feedback

The State catered to only about 50 solar systems in 2010-11, but to about 4,500 units in 2012-13, an escalation 90 times, i.e. about 9000 per cent. The service time per unit has reduced correspondingly. The feedback from the beneficiaries, public representatives, researchers, manufactures, and other stakeholders has been positive owing to the transparent systems developed.

6.3. Procedures Simplified

The programme is implemented and monitored effectively through the essential and simplified procedure depicted in Table 2. An MIS is approved for development in 2013-14 [13].

Table 2: Implementation and Monitoring of Rajasthan Solar Pump Programme

Allocation of targets for the State	Acceptance of quotation
Sanction of 30% subsidy	Administrative sanction and its communication
Sanction of additional 56% subsidy	Letter to farmer for farmer share
Empanelment of Solar panel suppliers	Deposit of Rs.10000 farmer share
Information about various models, their components, costs.	Work order; payment of application money to supplier
Empanelment of Dealers/Agents	Pre-Dispatch-Inspection
Allotment of targets to District Level Officers	Physical verification of material supply
Fund transfer to Districts	36% funds Release to manufacturer
Application from farmer	Physical verification/ Photography
Application short-listing and details	Website updation
Information to farmer to submit quotation of desired brand	Release of funds to manufacturer after successful installation
Quotation from farmer/ supplier	Utilization Certificate

7. Measurable Indicators

7.1. Overall Estimates

The improvements owing to solar initiative are estimated in Table 3.

7.2. Electricity, Water, Diesel, FE, Carbon-Dioxide Savings, and Irrigation Enhancement

The 4,000 solar pumps, most of them of 3000wp each, and installed capacity about 12 MWp during 2012-13, have resulted into replacing the generation of grid-electricity, generated mainly through consuming conventional fuels like coal and gas. Many of the solar water-pumps have been installed in the areas where grid-connected electric power is unavailable or inadequate. An estimated 12,000 Ha of additional land has been brought under irrigation. With at least two crops every year compared with the earlier scenario of having just one monsoon-fed crop in entire year, 24,000 Ha has been irrigated. Many farmers have started having three crops every year and have migrated to far more remunerative horticulture/cash crops including vegetables and fruits. This initiative has started bringing desirable transformations in the lives of the farmers and their families as the incomes have gone up. Migration to mandatory drip irrigation (it has at-least twice the water use efficiency viz-a-viz furrow method) has saved 48 million cubic meter water. Also 2.4 million litre diesel; Rs. 24 million diesel subsidy; Rs. 48 million foreign exchange is saved annually. Estimated emission of 3,480 Kg of CO_2 has been avoided.

Table 3: Measurable Indicators - Rajasthan Solar Pump Programme

SN	***Item***	***Unit***	***Total***
1	Average solar pump capacity	Wp	3,000
2	No. of pumps in 2012-13	No.	4000
3	Equivalent electric power saved (4000x3000 wp)	MWp	12
4	Duration in hours a pump runs/day	hrs.	6
5	No. of units (KWh) saved per day	KWh	18
6	No. of days a pump runs in a year	days	200
7	No. of electric units saved per pump per year 18 x 200	Kwh	3,600
8	Cost per Kwh of electricity	Rs.	5
9	Money saved by solar pump per year 3,600x5	Rs.	18,000
10	Conventional grid, distribution capital cost saved (not considered)	Rs.	-
11	Diesel cost saved per year (diesel generation is twice costly than electric)	Rs.	36,000
12	Diesel saved per pump per day	Litre	3
13	Diesel saved per pump per year	Litre	600
14	Diesel saved total, per year (4000 x 600)	Million Ltr	2.4
15	Foreign exchange saved per year, crude price @ Rs. 20/Litre	Rs. million	48
16	Diesel subsidy saved by Govt. per year (24,00,000 x Rs. 10/Litre)	Rs. million	24
17	Diesel subsidy saved by Govt. in 15 years (Rs 2.4 Cr x 15 years)	Rs. million	360
18	Area Irrigated per pump per crop	Ha	3
19	Area irrigated total, 2 crops a year (4000 pumps x 2x 3)	Ha	24,000
20	Water required for surface irrigation per Ha	Cubic Mtr	5,000
21	Water saved per Ha due to drip irrigation (40% of 500)	Cubic Mtr	2,000
22	Total water saved, 24,000x2,000	MCM	48
23	Additional production value due to irrigation through solar pumps	Rs.	1,00,000
24	Total Addl production value due to irrigation through solar pumps	Rs. million	2,400
25	CO_2 Emission for one 1 kWh electricity produced by Diesel	Kg	0.29
26	Total CO_2 generation avoided, 12,000 KWh x 0.29 kg	Kg	3,480
27	Curtailment in farmers' wait-list for electric connection	Nos.	4,000

8. Sustainability of the Initiative

8.1. Cost-Benefit Analysis, Economies-of-Scale, BOT, Future Replication and Five Year Plan

The overall economic benefits in terms of energy and water saved, emission curtailed, crop production enhanced, etc. need to be captured and quantified through appropriate institutional mechanism. Huge potential exists for reducing costs with economies-of-scale and thereby creating a self-sustaining market with minimal government support. The solar technology is foolproof and replicable on large scale for the farmers across the globe. The manufacturers may commission and operate on BoT basis with government assistance, which will lead to further cost cutting. With the partnership of state energy departments and corporations, and private partners, the technology can be disseminated at large scale. In India, there is a vast scope of replication, with estimated 2,00,000 solar pumps (on surface water bodies or ground water bodies up to 50m depth, connections up to 7.5 HP) in next 5 years. The expected total investment, at Rs. 5,00,000 a system, is Rs. 10,000 crore (Rs. 100 billion, or 1.6 billion US$). In Rajasthan, 1,00,000 solar pumps installed in next 5 years will significantly curtail the long queues of farmers waiting for grid-electricity, will reduce burden on electricity distribution companies and, will extend irrigation facility to additional 3,00,000 Hectare of land resulting into productivity enhanced by manifolds.

8.2. Precedent Created

Now that the administrative, financial, and regulatory systems have been tried and firmed up by Rajasthan, replication elsewhere and up-scaling is limited mainly by the funds and other resources available.

9. MNRE Motivates other States to Follow Rajasthan Initiative

Rajasthan is the lone State which had scaled the programme to such heights and implemented successfully and, therefore, the MNRE on 8th Feb. 2012 asked Principal Secretary Horticulture, Rajasthan (PSHR) to make presentation to MNRE to share Rajasthan experience with other State Secretaries, solar panel manufacturers, motor manufacturers, MNRE officers, etc. Officers from Tamil Nadu visited Rajasthan for extensive discussions with PSHR. PSHR was invited by States like Tamil Nadu and Maharashtra for presentations of Rajasthan case. The Agriculture Department, GoI, asked PSHR to make a presentation in National Conference on NHM on 17.07.2013. A team from ADB had extensive discussions with PSHR for exploring funding the Rajasthan scheme. Queries are being made from other countries like Pakistan. MNRE asked Rajasthan to host a National Conference at Jaipur on 22nd Aug. 2013, to replicate the Rajasthan success story in other States. Planning Commission, GoI, asked PSHR to make presentation on 14th Aug 2013 to concerned secretaries to Govt. of India.

10. Future Benefits, Issues and Challenges

The Rajasthan initiative has identified a number of important challenges and opportunities, for the federal and state governments, manufactures, scientists, and so on, which can drastically change the scenario about use of solar energy in rural areas. A few are mentioned below.

- Storage of unused solar potential
- Other usage like domestic and community lighting, agriculture, and small scale industry.
- Connecting to conventional grid:
- Low cost funding through UN agencies, federal/state governments, CSR
- Carbon credit and flow of sum realized to financing future solar pump projects.
- Mass manufacturing and cost reduction
- Integration of scheme in the country: national and international conferences
- National MIS
- Maintenance, Insurance, control room, BPO service.
- R&D for solar in agriculture/horticulture; MNRE's solar and NHM's drip irrigation together.
- Solar Parks dedicated to use of solar energy in horticulture / agriculture
- Sharing of experiences: The Netherland and Israel efficient use of water and solar energy

11. Acknowledgments

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