Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

International Water Management Institute

Solar Irrigation for Agricultural Resilience (SoLAR)

Solarisation of Indian agriculture: Challenges and Prospects

Summary Report of Webinar 2

2 February 2021

Table of Contents

List of Tables

List of Abbreviations

IWMI	International Water Management Institute
SIP	Solar Irrigation Pumps
PM-KUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan
CEEW	Council on Energy, Environment and Water
DISCOM	Distribution Companies
EBI	Evacuation Based Incentive
FiT	Feed-in-Tariff
BLDC	Brush Less Direct Current
SWP	Solar Water Purifier
PV	Photo Voltaic
RPOS	Renewable Purchase Obligations
RBI	Reserve Bank of India

Webinar 2- Solarisation of Indian Agriculture: Challenges and Prospects

The region in focus for webinar 2 was India. Agriculture is the largest consumer of water in India, and the challenges and prospects associated with solarisation are intriguing. The topic was: 'Solarisation of Indian agriculture: Challenges and prospects' and was held on 2nd Feb 2, 2021. The session was moderated by Shilp Verma of IWMI and was divided into two sections of presentation and panel discussion, followed by a Q&A session.

Table 1: Schedule for Webinar 2

Webinar	**Date & time**	**Presenters/Speakers**	**Panellist**
Webinar 2	2nd Feb 2021 (3:00-5:00 PM IST)	Neha Durga Ashwin Gambhir Manjunatha AV Siddharth Goel Ayan Deb Anas Rahman Mandvi Singh	Tushaar Shah Priya Jadhav Ganesh Neelam Nilanjan Ghose Divya Kashyap Mohinder Gulati

Recording of webinar 2: https://www.youtube.com/watch?v=MJ5PZkJN_7k

I. Presentations

a) Evolution of Solar Irrigation in India: How did we get here? (Gujarat and Bihar)

A presentation by Neha Durga, IWMI, India

Solar irrigation has been evolving over the last decade. However, the policies framed, issues flagged, and the political economy aspects have mainly been energy-centric. Solar irrigation had remained financially unviable until 2014, when the Government of India announced the introduction of 100,000 solar pumps on the field. This was followed by the launch of a bouquet of policies in different states. NGOs and private organisations have strengthened the SIP space by providing the resources to launch pilots, innovative design models, and experiments to save water, increase farmer incomes, protect against climate change, and increase inclusivity.

With the establishment of the PM-KUSUM scheme, states introduced their schemes which were highly subsidised. This resulted in higher levels of uptake among farmers, but overall participation remained low. The problem remains that the discourse on SIPs and the execution of SIP expansion policies are still

focused on energy due to its high costs. More pilots, experiments, and research are required for the future development of solar irrigation in India. This must compulsorily incorporate ways to address groundwater concerns. Against the backdrop of declining costs of solar technologies, India has tremendous potential to frame policies that revolve around equity, efficiency, and sustainability. The need of the hour is to creatively design schemes considering different needs, pump systems, and objectives.

Table 2: Q&A with Neha Durga

Sl no	Question	Answer
1.	Can we get the link for the study done on the Surya Raitha scheme?	The paper will be soon published.
2.	Any update on further scaling up of Surya Raitha to other feeders or places?	KUSUM has now taken over.
3.	Is there any guideline/norm adopted by any of these states or even the KUSUM scheme to look at water resources, especially groundwater, while planning/identifying/prioritising feeder plans/pump infrastructures?	Off-grid, pumps are not to be promoted in the dark zone regions.

b) Solar Irrigation Pilots and Experiments: Experience from States

This section included presentations by the following people:

1. **Ashwin Gambhir**, Prayas Energy Group, Mukhyamantri Saur Krushi Vahini Yojana (Maharashtra)
2. **Manjunatha** A.V., ISEC, Surya Raitha (Karnataka)
3. **Neha Durga**, IWMI, Dhundi Saur Urja Utpadak Sahakari Mandali and Catalysing Irrigation Service Markets in Bihar
4. **Siddharth Goel**, IISD, Solar BLDC Pumpsets Scheme (Andhra Pradesh)
5. **Ayan Deb**, Cini, Solar Irrigation in tribal Jharkhand
6. **Anas Rahman**, CEEW, Solar Irrigation Pumps in Chhattisgarh
7. **Mandvi Singh**, GIZ, Asset Utilization of Solar Pumps (Five States)

The presentation provided a rich overview of various solar irrigation schemes in the Indian States, including the challenges in implementation, unique features, and outcomes of various innovative

interventions. The speakers also linked this with the possibility of the respective schemes being integrated with PM KUSUM.

Ashwin Gambhir covered the Saur Krushi Vahni Yojana in Maharashtra, which is a solar feeder scheme with an announced target of 5 GW. The success of the Saur Krushi Vahni Yojana scheme in high scalability and deployment can be attributed to the absence of upfront capital subsidy and Maharashtra's position as a pioneer in the solar feeder space. He concluded that the scheme could potentially be incorporated under component A of the PM KUSUM scheme.

Manjunatha spoke about the Surya Raitha scheme in Karnataka, which powered 310 pumps in 2018. It adopted the net metering concept to encourage the export of excess energy to the grid. A study revealed that the scheme effectively ensured an uninterrupted daytime power supply and benefitted farmers' livelihoods that shifted towards profitable mulberry and silk. Sharing the feeder benefits with non-scheme farmers resulted in a bit of reduction in groundwater abstraction, which was supposed to have fallen due to the limited number of pumping hours. This is a concern for many schemes in other states as it increases subsidy outlay. There must be some strategy to separate the supply to non-beneficiaries of the system.

Neha Durga presented on the solar irrigation experiments in Gujarat and Bihar. An innovative model was introduced in Dhundi (Dhundhi Saur Urja Utpadak Sahakari Mandali), under which a cooperative of 9 farmers gave up electrical pump connections and switched to SIPs. The pilot positively impacted farmers' incomes, allowing them to earn from agriculture and the sale of excess power to the local DISCOM. This paved the way for introducing the SKY scheme, which was designed to provide an Evacuation Based Incentive (EBI) and a Feed-in Tariff (FiT). 50% of farmers earn a net positive income from the sale of electricity even after repayment of the SKY loan, which is an early indicator of its success. The case of Bihar highlights the formation of irrigation service markets (Chakhaji Experiment). The financial model (flat rate-rigging) encouraged farmers to sell irrigation through pipelines. This resulted in the cultivation of the Chakhaji vegetable and a new crop due to the reduced cost of irrigation, increase in the total cultivated area, and Gross Value Addition. Thus, rigorously designed financial models can create schemes that reduce burdens on DISCOMs while making farmers better off.

Siddarth Goel provided insights from the Solar BDLC (Brush Less Direct Current) pump-sets Scheme in Andhra Pradesh. It is a grid-connected scheme formed to reduce electricity load for DISCOMs. He mentioned that the primary challenge was the absence of grid power as the pumps solely ran on solar energy, the solution for which involves off-grid pump use. However, the scheme was not scaled up as the government focused on centralising solar plants under Component A of PM-KUSUM. Secondly, the concern regarding the willingness of farmers to financially contribute to Component C has increased the preference for Component A**.** Nevertheless, this is a shining example for other states to derive learnings as net metering incentives and FiT worked and boosted farmers' earnings.

Ayan Deb illustrated the case of 'Sustain Plus' in Jharkhand and Orissa. SIPs accelerated the increase in income as the scheme reduced recurring costs and increased command area. Inclusivity, combining precision farming with SIPs, and utilising the local capabilities of vendor partners (who helped gain access to government subsidies) have been instrumental in the success of this intervention. The PM KUSUM scheme has set a target of installing 10,000 SWP under Component B. Farmers received handholding support to apply for the scheme and were trained in Operation and Maintenance. However, the delay in installation caused by agencies from outside the state and poor inter-departmental convergence to implement SIPs and precision farming are the issues that must be tackled.

Anas Rahman gave a snapshot of the Saur Sujala Scheme. It installed off-grid solar pumps and is now a permanent scheme that will continue despite PM KUSUM's advent. The reasons behind the scheme emerging as the most successful in the country are solid political support, targeting of tribal districts, and channelling CREDA's extensive solar experience**.** A barrier to the implementation of PM KUSUM Component B is centralised tendering, which Saur Sujala Yojana has overcome in the form of decentralised execution at the district level. However, the common concern which echoes in all solar irrigation schemes, to which this one is no exception, is neglecting groundwater sustainability. This is putting Chhattisgarh on the same path as scarce groundwater states in the north and west and is another challenge that PM KUSUM must deal with while ensuring equity and efficiency.

Mandvi presented the preliminary results of a study to determine learnings from state solar water pump schemes in the context of asset status and maintenance. It captured the experiences of Uttar Pradesh, Rajasthan, Tamil Nadu, and Odisha. The interim survey data analysis, which covered 360 SWPs, shows very little farmer awareness regarding basic maintenance practices as solar panels are rarely cleaned. Almost half of the pumps have broken down since installation, and there are massive delays in repair, especially in Rajasthan, where such instances are the highest. Farmers are also unaware of the free 5-year maintenance contract. Although SWPs have reduced diesel pump use by 75% in Orissa and 25% in Uttar Pradesh, more concrete feedback will be collected from farmers, vendors, and nodal agencies to derive the complete picture. This suggests that there are significant gaps in farmer knowledge and delivery of after-sales and repair services. In terms of asset utilisation, farmers can efficiently operate SWPs but can be limited by inadequate pump size and fragmented landholdings.

Table 3: Q&A with experts

Sl no	Question	Answer
1.	Do you think there is merit in combining a scheme like Punjab's *'Paani Bachao Paisa Kamao'* Scheme with the solar feeder program to incentivise efficient use of	**Ashwin Gambhir:** In Maharashtra, the average cost of supply is Rs 4.5-5/kWh while solar at the same 11/33 kV level is Rs 3.1-3.3. Thus, a saving of 1.4-1.6 Rs/kWh; this actual

	groundwater?	savings (no additional budget subsidies) can be used at the discretion of State Government/DISCOM to share with farmers and incentivise them for drip irrigation/metering/efficient motors or just a direct financial transfer.
2.	Under the feeder level solarisation, how does the DISCOM or other implementing agency ensure that farmers will not opt for Off-grid solar pumps under the Component-B that are connected to the same feeder?	**Ashwin Gambhir:** Off-grid pumps will only be in areas where there is no grid.
3.	Ashwin, what was the impact on consumptive water use of crops after the solar feeder program?	**Ashwin Gambhir:** It won't be any different from the earlier baseline since the hours of supply are the same 8 hours, though much more reliable and in the daytime with reduced costs for the DISCOM/State. DISCOMs have mentioned that once-reliable supply is given, water use goes down.
4.	How are the energy efficiency measures of pump-sets considered in view during the feeder solarisation?	This is not explicitly considered right now but can easily be considered part of sharing benefits/incentives for more efficient pumps.
5.	Will oversizing pumps under Surya Raitha not dissuade the DISCOMs from implementing this on a large scale?	Not at all, as this will not affect their irrigation water use/demand. Incremental improvement in energy use will be there compared to the earlier situation about Surya Raitha.
6.	What is the plan for Surya Raitha vis-a-vis the KUSUM scheme? Has the efficiency of the solar IP sets under the Surya Raitha Scheme been studied?	The pump efficiency increased from 0.25 to 0.50. The state plans to replicate the Surya Raitha business model in other parts of Karnataka under central and state support to

		reduce the farm subsidy burden and promote water/energy use efficiency.
7.	How is water selling changed after solarisation? How about the scaling up?	**Manjunatha:** Water selling has increased due to continuous power, promoting equity and efficiency. Karnataka is promoting the Surya Raitha model. Only individual farmers are adopting but not on a big scale like Surya Raitha.
8.	What is the capacity design for the PV panel under the BLDC scheme? Surprisingly, in 2 years, DISCOMs have recovered the subsidy.	**Siddharth Goel:** DISCOM has made this statement based on an internal calculation. They accounted for these using different kinds of estimations, reduced TDC losses, lower supply costs due to early injection of power into the grid and reduced subsidy outflows. An external agency may not have evaluated the analysis. We would need to reach out to DISCOM and acquire further information on this.
9.	In AP, in the case of the BLDC scheme, were the AC pumps owned by farmers, retained by the farmers, or did they have to give them away?	**Siddharth Goel:** 3 or 5 HP pumps were replaced by the exact size of BLDC pumps. Estimations and field visits were informally conducted, and 90% of farmers were happy with the pumps. No survey was done on retention rates of pumps by farmers. The main challenge is honouring maintenance contracts by developers, so some pumps remain unutilised as components have not been replaced.
10.	Who are these system integrators, and how were they trained themselves? Are they farmers themselves or private	**Anas Rahman:** System Integrators are private companies, primarily local entrepreneurs. Their function is to get pumps, controllers and

	companies?	panels and offer one whole package. Usually, they get the basic technical details from various sources like electrical engineers, other integrators etc.
11.	What do we call a 'micro solar pump'? Is it about power, flow rate or other criteria?	Solar micro pumps are those categorised as 1 HP or less. Many innovations are happening in this space. They are quite suitable for small land plots, horticulture crops etc.
12.	Noting how shallow agro-well success in Sri Lanka has led to significant deforestation (thus undermining other ecosystem services), should policy messages consider broader agroecological conditions where significant trade-offs in land use may exist?	Very pertinent point. The state I work in, Chhattisgarh, is a heavily forested area. The solar pumps have taken irrigation into forest villages. Whether this is resulting in deforestation, I can't say for sure. On the other hand, the use of pumps is being diversified now. Here, the forest department has used it for recharging waterholes and plantation works.
13.	Punjab was not a dark zone when free/subsidised electrification started in the 70s. Solar irrigation seems to be technically 'free'- for the user. What arguments are being put forth to suggest this will not/does not go the NW India way, especially as we see states like Chattisgarh taking a surge?	**Anas Rahman:** This discussion is not happening currently. CREDA is only focused on installing the pumps, and the policymakers at the state level are not attentive to the water Energy Food nexus concerns. At present, the groundwater levels are good, but there are no measures to control water usage. Hence, if this rate of heavily subsidised solar pumps continues, then Chhattisgarh may also go down the same path as Punjab and Haryana.
14.	Is there any documentation on the Solar BLDC Pump sets scheme?	**Siddarth Goel:** TERI and IISD are currently working to document a case study on Andhra Pradesh's implementation of solar pumps,

		including the BLDC pump-sets scheme. The case studies are likely to be available in March.
15.	Is there any documentation on the Scheme in Chhattisgarh?	**Anas Rahman:** No, there hasn't been documentation yet. There is an impact assessment report by NABCONS consultancy. But it is not available for public consumption.
16.	Can you please share the complete asset condition and utilisation report?	**Mandvi Singh:** So far, we have surveyed around 450 farmers, and the target is 935 farmers, so only by April we can share interim results, but the entire project will take some more time.
17.	Yes, the assessment of carbon footprint is essential. But then it has to be done for the entire life cycle, including during the production of solar panels. For the latter, it is the highest among all energy sources.	**Aditi Mukherji:** Can you share your source that solar has the highest life cycle carbon emissions? Would you please email at a.mukherji@cgiar.org

c) Solarizing India's Irrigation: Can PM-KUSUM live up to its promise?

A presentation by Abhishek Jain, CEEW

Components A and C of PM KUSUM were discussed in detail from the angle of challenges in implementation and what we must be paying attention to here forth.

Component A

Poor interdepartmental coordination within the state can be resolved by allocating the responsibility of the implementation to state renewable energy agencies as is being done in Punjab and Rajasthan.

As many states have already contracted sufficient power and have fulfilled their Renewable Purchase Obligations (RPOs), Component A is no longer attractive.

On the other hand, farmers face difficulties in sourcing equity, as banks refuse to accept agricultural land as collateral for non-agricultural purposes for which RBI needs to intervene.

Component C

In states with low power costs and reliable power supply, farmers do not opt for the scheme as they want to put in zero investment and receive a solar pump, which will be owned by the DISCOMs who need to give additional incentives to save water. Alternatively, this will result in water selling and not electricity selling, which is economically unviable.

DISCOMs weak financial capacity prevents them from acquiring loans to segregate feeders and renders them unable to implement KUSUM C.

The top three takeaways are:

Takeaway 1: Demand-driven measures such as FiT to remunerate farmers will encourage their participation in the scheme.

Takeaway 2: A thorough understanding of incentives from the perspectives of farmers, DISCOMs and developers are required for scaling up. Iteration is the key to getting it right. Pump size, targeting, utilisation of the asset and water-saving must be adequately addressed before introducing a scheme.

Take away 3: With Component C now solarising at the feeder level and having better incentives for DISCOMs to increase their returns, Component A must adopt timely measures to remain competitive.

Table 4:Q&A with Abhishek Jain

Sl no	Question	Answer
1.	Thanks for sharing your views. Under PM-KUSUM, substantial scaling-up of SIP at the individual farmer level might never happen as they share about 40% of the cost. Even the pilot-scale adoption has happened because of full government subsidy; an example is South Gujarat. So, the programme design itself has flaws.	I do agree. This had been highlighted even when the scheme had come out. Now, on-ground experiences are only confirming the same.
2.	Do you think component A would be a better business model for scaling up than Component C?	It's the other way around, as I said. The feeder solarisation part of KUSUM C is more attractive for the DISCOMs than component A.

II. Panel Discussion: Key Policy Lessons for PM-KUSUM and Way Forward

1. Comparison of Electricity Supply for Irrigation Pumps – Grid-Based and Solar Photovoltaic

Priya Jadhav from CTARA was a distinguished panellist for this session.

Priya drew a comparison of the economic and environmental costs between off-grid pumps and grid-connected agricultural feeders. This helped answer the question on the determinants of these costs, which are the following:

Seasonality of Irrigation /Pumping Hours: The results of the study by CTARA in Maharashtra show that there is a threshold point for pumping hours that determines whether the cost associated with different pump sizes is economically viable or not. On average, solar PV pumps are more economical for users with longer pump hours.

Infrastructure conditions, the locational value of the pump and energy consumption patterns matter. This depends on the amount of energy transmission back to the grid, land costs to situate feeders near agricultural areas and economy of scale in solar PV plants.

The monetary value of energy-saving must be set high enough to incentivise water saving. Farmers are shifting from one irrigation practice to the other changes the operational head of the pump, which is highly expensive for solar PV pumps. Additional costs are incurred when investing in the irrigation system. Net-metering should therefore incentivise water savings**.**

Table 5:Q&A with Priya Jadhav

Sl no	Question	Answer
1.	Nice comparison. However, I would like to highlight that the lifetime of the cheap solar pumps (basically the solar panels) available these days cannot be more than ten years, in fact even lesser. Further, installing them in Marathwada and Vidarbha that experience groundwater scarcity during the Rabi (winter) season, is a waste of public money. Your data on pumping hours confirm the same.	Net-zero carbon emissions in all sectors is a worthy goal by itself; the question is net-zero also harmful in terms of water? RE is the future, all said and done, the climate change imperative is way too urgent. Very interesting about the solar pumps lifetime. Aditi, do you mean solar PV pumps result in more water extraction?

2. What are the lessons that PM KUSUM can draw from all experiences and experiments of different states? What are the significant gaps that must be addressed for effective delivery of PM KUSUM?

This session included the following panellists:
Tushaar Shah from IWMI, Priya Jadhav from CTARA, Ganesh Neelam from TATA Trusts/Cini, Nilanjan Ghose from GIZ India, Divya Kashyap from SDC India and Mohinder Gulati from World Bank.

Tushaar Shah: The pressing issue that India continues to face is the difficulty in metering powering supply. Flat tariffs, zero costs and subsidies are the roots of the Indian groundwater crisis. It is essential to revisit the experiences of all the states, especially Chhattisgarh, to understand farmers' responses to good quality daytime supply in terms of evacuation, energy consumption and water use.

Mohinder Gulati: He agreed with the points that Tushaar Shah raised and stressed that the Water-Energy-Food nexus is a political economy issue. A deep understanding of the role of local agencies is necessary to design suitable schemes that will work. The electricity price must encourage farmers to shift to electricity selling from water selling. KUSUM must introduce financial instruments such as collateralising solar pumping systems and protecting farmers against the risk of non-payment by DISCOMs. KUSUM C particularly has the potential to reduce political and commercial risk of power supply. Therefore, the conversion of farmers from consumers/beneficiaries of subsidies to producers of power is the cog in the engine of the WEF nexus.

Ganesh Neelam: A renewable energy shift in agriculture is vital. During this transition, it is essential to consider the well-being of small and marginal farmers. KUSUM C should focus on community or collective targeting and not just on individual pump systems.

Divya Kashyap: KUSUM should aim to transition to renewable energy and function as water and agricultural scheme, which is social and gender-inclusive. Given that subsidies are not sustainable in the long term, KUSUM must explore financial models to price energy and water optimally.

Nilanjan Ghose: Convergence of different schemes from the central and state governments is vital for the smooth implementation of all components of KUSUM.

Overall, the panellists found the discussions incredibly insightful, rich and stimulating. It enabled them to understand the innovative interventions in different states and how each state can draw from each other's experiences. The dissemination and learnings from across India at a common venue was highly appreciated. Institutional arrangements, local capacity, design alternatives and farmer responses will be the key factors to be incorporated as a way forward for the effective implementation of KUSUM.

Top three takeaways from the webinar, and how and whether SoLAR future work can address them?

Takeaway 1: Understanding the behaviour and responses of farmers are vital for designing solar irrigation policies. Introducing positive incentives for farmers to reduce groundwater abstraction and make financial contributions to the scheme can go a long way.

Takeaway 2: Digital continuous monitoring of the KUSUM scheme is necessary to track energy requirements, consumption, generation, grievance redressal of farmers and root causes of technical, operational and maintenance problems.

Takeaway 3: As farmers landholdings are highly fragmented, it becomes difficult to use the pump even if eligible for the policy by pump load. Hence, this discrepancy between the technology provided and the policy eligibility criteria of the scheme must be resolved by KUSUM.