

Advancing Solar Irrigation in India: A Science Policy Forum

National Forum by IWMI- SDC-SoLAR project

Date: 12th March 2024; Location: Jaypee Siddharth Hotel/Online



Alok Sikka delivering the Welcome remarks from IWMI at the workshop in Delhi Photo Credit: Tanmoy Bhaduri/IWMI

BACKGROUND

The surge in carbon emissions in India, driven largely by the agriculture sector's escalating energy demands and reliance on fossil fuels, poses significant environmental challenges. Groundwater irrigation, which accounts for a substantial portion of India's carbon emissions, is heavily subsidized, with electricity provided to farmers at significantly lower rates than domestic users. This subsidy, coupled with policies promoting irrigation and high-yielding crop varieties, has led to widespread groundwater exploitation and depletion. The adoption of solar irrigation pumps (SIPs) presents a promising solution to mitigate these challenges. SIPs offer environmental benefits by reducing CO₂ emissions and decreasing reliance on power subsidies. While off-grid SIPs provide energy access in

remote areas, grid-connected SIPs offer the additional advantage of stabilizing groundwater withdrawals by allowing farmers to sell surplus electricity back to the grid, thereby augmenting their income. India's abundant solar potential and government schemes like PM KUSUM further underscore the importance of solar irrigation in achieving sustainability goals. However, the adoption of SIPs remains limited, highlighting the need for scaling to realize the full potential of solar irrigation in India's agricultural landscape.

The primary aim of this forum is to present and discuss recent insights into i) challenges associated with the adoption of SIPs by smallholder and women farmers, ii) their impact on livelihoods and groundwater, and iii) the need for capacity building interventions to improve the implementation effectiveness of SIP programs. Additionally, the forum will engage in an in-depth discussion about scaling strategies and policy interventions.

WORKSHOP PARTNERS

To understand these issues, the International Water Management Institute (IWMI), under the “Solar Irrigation for Agricultural Resilience” (SoLAR)-SA project, funded by the Swiss Agency for Development and Cooperation (SDC), organized a national stakeholder workshop in New Delhi.

The SoLAR project is a South Asia (SA) regional initiative involving Bangladesh, India, Nepal, and Pakistan, implemented by IWMI, and funded by the Global Programme of SDC. The project aims to support the climate-compatible development of energy and water systems in rural South Asia for resilient livelihoods. IWMI is partnering with IDCOL to mainstream solar irrigation in Bangladesh.

PARTICIPANTS AND MODALITY

The workshop was conducted in a hybrid mode (virtual + onsite) and in two sessions – i) Adoption and Impact of SIPs: Inclusive Scaling Strategies and Policy Lessons and ii) Solar Empowerment: Unleashing Full Potential through Knowledge and Skills. Panel discussions brought together different stakeholder groups including government, policymakers, research and academics, international and grassroots civil society, etc.

DISCUSSION

Welcome remarks by Dr Alok Sikka (Country Representative India, IWMI)

Dr Sikka welcomed all dignitaries as they convened to discuss the collaborative endeavour of the SKY Gujarat program. The discourse delved into the imperative of impact assessment and underscored the discourse surrounding the push for solarization deemed as the lynchpin for future sustainability. He highlighted that India stands at the forefront of solar programs globally, further reinforced by collaborative efforts such as the South-South collaboration seen at COP-28. The discourse focused on the exchange of business models, drawing examples from African contexts and Bangladesh context. He also pointed out that in the middle of this programmatic landscape, the criticality of capacity building was paramount. For example, in Gujarat alone, over 2000 farmers received training and various parameters were monitored including billing, water usage, etc. The discussion emphasized the necessity to consider groundwater sustainability concomitantly while scaling up and formulating policies, particularly in the context of both on-grid and off-grid scenarios.

Welcome remarks by Darshini Ravindranath, Project Leader, SoLAR-SA, IWMI

She extended a cordial welcome to all dignitaries present, setting the stage for a discussion on the pivotal SOLAR project. She highlighted the importance of leveraging research to drive policy impact, emphasizing its crucial role in addressing climate change and enhancing access to vital resources such as energy security. Highlighting India's robust leadership in solar initiatives, evident through endeavours like the SKY and PM KUSUM programs, she pointed to the notable increase in solar irrigation pumps as a tangible indicator of progress. She also emphasized the necessity of rigorous impact assessment studies and groundwater analyses, noting a consistency in water pumping behaviors irrespective of the energy source. Proposing policy interventions, she suggested extending loan repayment periods and prioritizing capacity-building initiatives. She also underscored the significance of forging partnerships with entities such as DISCOM (GUVNL) to bolster program efficacy. Looking forward, she outlined forthcoming activities including the deployment of solar energy extension agents and the establishment of community models, signifying a proactive stance towards sustainable energy solutions.

Welcome remarks by Divya Sharma, Deputy Head of Cooperation, SDC

She initiated a discussion on the importance of solarization in bridging science and policy. She emphasized the significance of establishing a policy forum conducive to critical discourse, specifically about the interplay between solarization initiatives and underground water resources. Miss Sharma underscored the pivotal role of agriculture in the developmental trajectory of countries, with a specific emphasis on India. She highlighted the shifting energy dynamics within the nation, citing the PM KUSUM national scheme as tangible evidence of the agenda for solar-backed agricultural endeavours. She also articulated a nuanced understanding of the intersection between scientific advancement, policy formulation, and the imperative of sustainable agricultural practices.

Opening remarks by Suman Chandra, IAS, Deputy Secretary, MNRE

She extended warm greetings to all attendees and emphasized the critical need for integrating gender perspectives into the discourse surrounding energy policy. She underscored the strategic challenge posed by India's burgeoning population leading to an increase in energy demands. She highlighted the nation's goals and domestic targets about energy security and climate change and acknowledged India's acceptance of anthropogenic climate change while highlighting the underreporting of emissions from land. She hailed the solarization of agriculture as a promising avenue in irrigation, citing the introduction of the PM KUSUM scheme as a significant step towards this end. At the same time, she highlighted the challenges facing the scheme, including disruptions caused by the COVID-19 pandemic and hurdles in capitalizing feeder-level solarization. She underscored the need to free up capital from subsidies to boost farmer welfare and addressed concerns regarding low uptake, while citing instances of success such as capacity-building initiatives in Maharashtra. Chandra also highlighted the intricate interplay between water, energy, and food resources, stressing the need for innovative solutions within the WEF nexus framework. Discussing the stress on aquifers and the butterfly effect of solar energy on groundwater sustainability, she called for efforts to extend the benefits of solar beyond irrigation, necessitating affordable finance and enhanced capacity-building endeavours. In her concluding remarks, she advocated for the continued support to boost India's renewable energy endeavours, in order to maintain its position as a global leader with 75 GW of installed renewable energy capacity.

Opening remarks by Geetu Joshi, Advisor, Ministry of Finance

She underscored the intricate nexus between agriculture, food security, energy, and water resources, representing approximately 15% of the GDP. Highlighting the challenge of power supply in agriculture, she advocated for solar pumps as a viable alternative to conventional energy sources. She mentioned that upfront finance remains a significant hurdle in the adoption of solar technologies, challenging for farmers due to the limited availability of funds. In addressing this challenge, she emphasized the importance of traditional financing solutions alongside the imperative for sustainable innovation finance, such as social bonds, green bonds, and SDG bonds. Drawing from India's experience during its G20 presidency, she underscored the importance of adopting a people-centric approach, with a focus on sustainable development. She highlighted the expansion of the G20 sustainable finance working group's scope beyond climate finance to include SDG finance, aiming to channel climate finance towards technology investments. Additionally, she advocated for the identification and assessment of capacity-building needs through forums such as the G20 action plan, presenting an opportunity for prioritizing sustainable development on a global scale.

Opening remarks by Mr. R.K. Singh, ADG, (Agriculture Extension), ICAR

He underscored the need for translating scientific advancements into practical applications. With 731 Krishi Vigyan Kendras (KVKs) playing a pivotal role, he emphasized their significance in scaling up technological interventions for farmers. He delineated two broad approaches: the top-down approach, emphasizing hierarchical dissemination, and the co-production process that integrates stakeholders, community mobilization, and policy and science frameworks for the adoption of Sustainable Intensification Practices (SIPs). He stressed the importance of convergence with relevant departments and highlighted the intricate dynamics of social-ecological systems. Recognizing the need for effective communication channels, he advocated for leveraging KVKs as vehicles for disseminating scientific knowledge to society, thus fostering a symbiotic relationship between science and its practical applications.

Opening remarks by Dr Sunil Kumar Ambast, Chairman, Central Groundwater Board

He highlighted the impact of solar irrigation pumps on groundwater resources. Highlighting the current groundwater scenario in India, he mentioned that 74 percent of blocks register groundwater levels at or below the critical threshold, with 3.17 percent classified as critically overexploited. He highlighted the concerted efforts initiated since 2017 by both the state and central governments, exemplified by initiatives like Mission Kakatiya in Telangana and the Atal Bhujal Yojana, resulting in a notable improvement from 67 to 74 percent within sage blocks. Emphasizing the necessity of regulating groundwater extraction, he expressed concern over the unregulated utilization of groundwater in agriculture, accounting for 82 percent of total consumption. He drew attention to the alarming groundwater conditions in Chennai and Bangalore, where water levels have plummeted to depths of 500 to 600 feet, necessitating innovative measures such as replenishing dried-up sources with treated water. He underscored the importance of low-cost, low-carbon emission technologies while advocating for a comprehensive study on groundwater projections to inform future strategies.

SESSION 1: ADOPTION AND IMPACT OF SIPS: INCLUSIVE SCALING STRATEGIES AND POLICY LESSONS

Presentation 1: Empowering Farmers with Grid-Connected Solar Irrigation Pumps: Evidence from Gujarat, India: Dr Deepak Varshney

- The study outlined three overarching objectives: capacity-building impacts, evidence from groundwater studies, and the evaluation of the SKY program.
- Evaluation of the SKY program reveals its significance amidst a backdrop of 26 million pumps in operation and the economic dynamics of India's power sector, highlighting the implications of overreliance on fossil fuels.
- The study proposes Sustainable Intensification Practices (SIPs) as a solution, focusing on stabilizing groundwater withdrawals by leveraging excess electricity sales to the grid.
- It traces the evolution of SIPs in India from initiatives like the Jawaharlal Nehru National Solar Mission (JNNSM) in 2010 to the PM-KUSUM scheme in 2019, culminating in the establishment of solar cooperatives like DSUUM in 2015 and subsequent state schemes like SKY.
- Analyses of SKY's technical and financial models reveal key differences from PM-KUSUM, emphasizing factors such as upfront costs, loan guarantees, and feed-in tariffs, while addressing adoption issues, drivers of solar energy generation, and the correlation between financial and technical assessments.



Deepak Varshney presenting on Empowering Farmers with Grid-Connected Solar Irrigation Pumps: Evidence from Gujarat, India at the workshop in New Delhi Photo Credit: Tanmoy Bhaduri/IWMI

Dr Manohara Khadka: Solar irrigation and GESI: Some Insights from Nepal

- Solar irrigation initiatives in Nepal, established since 2016, have seen notable growth, with over 300 solar irrigation pumps (SIPs) deployed by 2023, albeit facing a significant demand-supply gap, with only 5% of demand being met.
- Gender Equality and Social Inclusion (GESI) integration in solar irrigation programs aims to enhance food security and livelihoods, with over 60% of beneficiaries contributing to agriculture, and specific efforts to include women farmers and professionals in decision-making processes within households and policy forums.
- GESI integration targets within solar irrigation programs aim for over 30% women participation in knowledge forums, with dedicated roles for women scientists and researchers.
- A comprehensive review of Water-Energy-Food (WEF) policies across Bangladesh, India, Nepal, and Pakistan highlights varying degrees of GESI awareness and responsiveness, with Nepal's SIP subsidy policy demonstrating inclusivity but limited access for smallholder farmers.
- Practical outcomes of SIPs include improved water access, reduced labor intensity, and enhanced access to land and livelihoods, while strategic outcomes focus on mitigating physical risks and enhancing inclusivity, with lessons emphasizing the importance of research uptake, policy adaptation, and innovative financing solutions.



Manohara Khadka presenting on Solar irrigation and GESI: Some insights from Nepal at the workshop in New Delhi Photo Credit: Tanmoy Bhaduri/IWMI

Panel Discussion 1: Inclusive Scaling Strategies and Policy Lessons for Solar Irrigation in India

Panelist: J.V. Meenakshi (IIIT), Santosh Rai (AEPC), Nilanjan Ghose (GIZ), Tushaar Shah (IWMI), Sumedh Agarwal (USAID)

Moderator: Veena Srinivasan (WELL Labs)

The key takeaways of the panel discussion are:

- **J.V. Meenakshi:** Dr. Meenakshi emphasized the pivotal role of cost-benefit analysis in driving adoption stressing the importance of understanding the economic dynamics for both small and marginal farmers. Future studies should consider factors such as water and cropping demand changes to gauge the scalability of Solar Irrigation Pumps (SIPs) and their potential impact on farmer welfare.
- **Tushar Shah:** Dr. Shah highlighted upfront contribution as a major barrier to adoption, suggesting a redesign of financial models to incentivize farmers. Proposed adjustments include payment based on generation rather than evacuation and providing farmers with the entire cost of generation upfront, coupled with telescoping tariffs based on evacuation levels.
- **Sumedh Agarwal:** The USAID VENEXA project, as presented by Sumedh Agarwal, outlined challenges faced in shifting agricultural loads to solar in Karnataka, emphasizing the need for innovative financing mechanisms and the adoption of an annuity-based model to alleviate constraints such as pump capacity and margin money.
- **Santosh Rai:** Mr. Rai from AEPC discussed the similarities in climatic conditions between India and Nepal, underlining the challenges in making SIP technology accessible to women farmers due to constrained resources. This necessitates sustainable financing mechanisms and a shift in mindset through capacity building efforts to overcome initial hesitance.
- **Nilanjan Ghose:** Mr. Ghose highlighted GIZ's experience with PM-KUSUM emphasizing the challenge of ensuring equitable access and effective utilization of assets. He stressed the need for standardized delivery models that support policy design without compromising customization, emphasizing the importance of capacity building in this process.



Panellists at the session Photo Credit: Tanmoy Bhaduri/IWMI

Presentation: Impact of Grid Connected SIPs on Groundwater Withdrawals. Speaker: Faiz Alam



Faiz Alam presenting on Impact of Grid Connected SIPs on Groundwater Withdrawals Photo Credit: Tanmoy Bhaduri/IWMI

The key takeaways of the presentation:

- Adopting Solar Irrigation Pumps (SIPs) leads to expanded agricultural areas, increased irrigation among previously low-irrigation farmers, and higher cropping intensities, indicating enhanced agricultural productivity.
 - Large-scale adoption of SIPs demonstrates varied impacts on groundwater (GW) abstraction across regions like India and Bangladesh. In India, comparisons between SKY and non-SKY areas reveal no significant differences in water pumping or cropping patterns. Similarly, in Bangladesh, SIP adoption results in 20-30% cheaper irrigation and minor shifts in cropping patterns without significant changes in water use. Importantly, farmers do not exhibit inefficiency in water usage after transitioning to solar irrigation.
 - Shilp Verma (IWMI) suggests further investigation into off-grid solar systems to verify the observed insignificance in water pumping results, highlighting the need for comprehensive research on the impacts of solar technology on agricultural practices and groundwater sustainability.
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Panel Discussion 2: Potential of Grid- Connected SIPs for Sustainable Groundwater Solutions

Panellists: Ratan Jain (GWRDCL), Saumava Dey (IIT), Adlul Islam (ICAR), DK Singh (ICAR)
Moderator: Alok Sikka (IWMI)

Ratan Jain: Dr. Jain emphasized the necessity for comprehensive policy and regulatory measures to facilitate widespread adoption of SIPs while ensuring groundwater sustainability. He highlighted two crucial aspects: the importance of energy subsidies in demand management, exemplified by initiatives like the Atal Bhujal Yojana, and the promotion of crop diversification to mitigate groundwater dependence, as demonstrated by the Government of Haryana's shift from rice to millets.

Dr. D.K. Singh: Dr. Singh proposed optimizing pump sizes for groundwater sustainability and advocated for transitioning from electric to solar energy, emphasizing the need for meticulous management to monitor groundwater impacts. He recommended utilizing graphical representations to illustrate farmers' crop types, soil conditions, and irrigation requirements, underscoring the significance of demand management strategies.



Panellists at the session Photo Credit: Tanmoy Bhaduri/IWMI

Dr. Saumava Dey: Dr. Dey underscored the potential risk of increased energy consumption with reduced energy costs and stressed the importance of raising awareness among farmers regarding sustainable groundwater usage practices. He emphasized the significance of understanding the hydrogeology of regions and emphasized aquifer recharge as a means of achieving balance.

Dr. Adul Islam: Dr. Islam highlighted the role of groundwater modeling in conducting scenario-based analyses, emphasizing its importance in developing effective groundwater management strategies.

SESSION 2: SOLAR EMPOWERMENT: UNLEASHING FULL POTENTIAL THROUGH KNOWLEDGE AND SKILLS

Presentation: Design and Implementation of Capacity building intervention for the grid-connected solar farmers: Nikunj Usdadia

The presentation centred on delineating the factors influencing farmers' income disparities and bill management within the solar energy framework, notably showcasing an Ideal Capacity Utilization Factor (CUF) of 25, while the prevalent SKY condition CUF lingered at a challenging 18%. His presentation underscored the widespread struggle among farmers to adhere to maintenance standards, leading to bill recovery issues for DISCOMs. Field insights revealed alarming practices such as drying clothes on panels and theft of cables, adding to the operational challenges.



Nikunj Usdadia presenting on Design and Implementation of Capacity Building intervention for the grid-connected solar farmers Photo Credit: Aariz Raza/IWMI

To address these issues, a comprehensive Capacity Building Program was initiated, encompassing content development, pilot and main training sessions, and pre-training surveys aimed at gauging existing knowledge gaps. The findings highlighted a lack of prior training, misconceptions regarding bill charges, and unresponsiveness from private installers, exacerbating power theft issues. The qualitative impact of training was evident in improved module cleaning, clarity on financial and technical models, and rectification of operational inefficiencies. He wrapped up the presentation with

a series of recommendations ranging from establishing local EPC agency stores to mitigating power theft and enhancing SKY app compatibility, underscoring the need for continued training across remaining feeders and streamlining maintenance processes to ensure sustainable solar energy utilization.

Presentation: Impact of capacity building intervention designed for solar farmers on solar energy generation: Evidence from the Randomized Control Trial (RCT): Dr Deepak Varshney

Dr Varshney's presentation focused on unlocking the full potential of solar energy through knowledge and skill development. The presentation began with a comprehensive survey analysis revealing critical insights: a mere 30% accurately understood the panel size-to-contracted load ratio, while awareness of the SKY app stood at a meagre 21%, hampered further by login difficulties. Moreover, only 15% were proficient in identifying the financial model, and only 45% adhered to regular solar panel maintenance.



Deepak Varshney presenting on Impact of capacity building intervention designed for solar farmers on solar energy generation: Evidence from the Randomized Control Trial (RCT) Photo Credit: Aariz Raza/IWMI

He elaborated on the approach, employing a Randomized Control Trial (RCT) methodology to ensure impartiality and rigor, with a focus on minimizing biases. The main training program evidenced significant attendance, with 81% of the treatment group participating physically, underscoring the evident demand for training. Pre-intervention, disparities in solar energy generation and consumption were negligible, yet post-intervention, a noteworthy 6.7% increase in generation and a significant 10% decrease in consumption were observed. Particularly striking were the results indicating a 20% growth in solar generation among underperforming DISCOMs, advocating for strategic investment prioritization in such entities.

Presentation: Capacity building intervention for grid connected SIP farmers: Understanding Farmers' Perspectives: Farmers – Manubhai, Kanabha, Bhikhubhai and Deputy Engineer Hiran H. Ganatra

The farmers shared their experiences about the transformative impact of solar energy adoption in Haripur village, Rajkot district. With 66 consumers, including 43 net earners, diligent maintenance of solar panels has become integral, ensuring consistent performance. Notably, the transition to solar power has facilitated significant agricultural advancements, including round-the-clock water provision leading to improved crop diversity and enhanced yields across three crops – cotton, wheat, and groundnut.

This agricultural transformation reflects the fulfilment of promises and satisfaction among SKY farmers. Also, the extension of power availability to 12 hours, a notable increase from the previous 8-hour supply, coupled with prudent water and electricity management, underscores the substantial savings and economic empowerment realized within the community.



Panellists at the session Photo Credit: Aariz Raza/IWMI

The transition has mitigated issues such as unreliable night-time power, facilitated by the support of empanelled agencies and DISCOM (PGVCL), fostering sustainable practices and resource conservation. Additionally, financial resilience is evident, with individuals like the cited example, despite loan repayment, they were experiencing significant net income gains, further affirming the socio-economic benefits of solar energy integration. Notably, the transition has curbed wasteful practices like nocturnal water flooding, emphasizing the holistic environmental and economic dividends realized through solarization.

Panel Discussion: Necessity of Awareness and Knowledge for Accessing and Optimizing Solar Irrigation Pump Usage

Panellists: RJ Vala (PGVCL); Akash Davda (GERMI); Manohara Khadka (IWMI); Shilp Verma (IWMI); Atul Dhir (USAID)

Moderator: Darshini Ravindranath (IWMI)

RJ Vala underscored the need for augmenting farmers' benefits, advocating for an elevation from 70% to 80% through cap building efforts. He highlighted the successful integration of 90% of farmers into the grid, accentuating the necessity of comprehensive training for the remaining cohort.

Dr Akash Davda articulated the pivotal role of digital platforms in modern agricultural practices. He elaborated on leveraging mobile phones and diverse digital avenues for disseminating training modules, thereby transcending traditional print-based mediums. Emphasizing the inclusivity afforded by digital content, he underscored its efficacy in reaching all members of farming households.



Panellists at the session Photo Credit: Aariz Raza/IWMI

Dr Khadka pointed out the critical areas necessitating attention, notably the underrepresentation of women in agricultural training programs. She advocated for sensitizing trainers and technicians to this disparity while expanding training opportunities for women through governmental and grassroots initiatives. Stressing the significance of linguistic and temporal considerations, she advocated for training dissemination in vernacular languages. She also highlighted the need of gender-inclusive subsidy mechanisms and policies, prioritizing marginalized farmers with less than 0.5 hectares of land.

Atul Dhir highlighted the foundational elements essential for widescale technological mobilization: reliability, affordability, and accessibility. He underscored the dual objectives of cap building and their pivotal role in informing policy decisions. Additionally, he identified key challenges including the

evaluation of asset importance, vendor rating mechanisms, and the assessment of diverse solar systems deployed in Gujarat.

Shilp Verma underscored the significance of identifying proficient technical partners, particularly within the context of rural and agricultural initiatives. He advocated for the formation of cooperatives to serve as intermediaries between governmental entities and farmers, thereby facilitating seamless collaboration.

CLOSING REMARKS

Darshini Ravindranath thanked everyone for their contributions and spoke about the need for engaging policymakers as paramount for the advancement of agricultural initiatives.



Participants at the National Forum Photo Credit: Tanmoy Bhaduri/IWMI