Dhundi, Gujarat, India // South Asia

Solar Power as a Remunerative Crop (SPaRC)

UNIVERSITY OF NOTRE DAME

Country Information

Population

1.4 Billion
(World Population Review, 2023)

UNFCCC National Adaptation Plan

No

Intervention Information

>$120 Million (Gujarat)
Cost

2016-Present
Timeline

GINI

(Scale of 0-100)

(World Population Review, 2018)

ND-GAIN Vulnerability Score

(Scale of 0-1)

(ND-GAIN, 2023)

Rationale for Selection

Cases were selected for review based on general screening criteria, including timeframe of intervention, location of implementation, and evidence-based outcomes, as available. This effort was highlighted for its progress on effective policy to implementation interventions at the energy-water-agriculture nexus.

Outcome Area(s)

Water Security, Energy Security, Income/Livelihoods, and Food Security

Funding Partner(s)

CGIAR Research Program on Water, Land and Ecosystems (WLE), Tata Trusts, International Water Management Institute (IWMI), Consultative Group on International Agricultural Research (CGIAR), the Swiss Agency for Development and Cooperation (SDC) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Implementation Partner(s)

International Water Management Institute (IWMI) and Tata Trusts, CGIAR Research Program on Water, Land and Ecosystems (WLE) and CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Context of Intervention

India struggles with energy demands, poor air quality and water scarcity. It ranks third highest in planet-warming gas emissions in the world, with 70% of the country's energy comes from fossil fuels such as coal. Approximately 60% of India's cities have air quality levels that are seven times higher than the World Health Organization (WHO) guidelines. India's Central Electricity Authority (CEA), an advisory body to the federal power ministry, expects annual electricity demand in the country to grow at an average of 7.2% through March of 2027.[1] This is almost twice the growth rate over the preceding five years. India also suffers from extreme water stress. India's agriculture accounts for 90% of water demand, which includes roughly two million groundwater wells across the country.[2]

Rural farmers face several challenges related to unsustainable energy use and climate change. Many agricultural areas are remote, with limited access to grid electricity. As such, typical irrigation systems often rely on fossil fuels to power pumps, leading to high greenhouse gas emissions, air pollution, and increased operating costs.[3] For those connected to the grid, electricity is unreliable and the cost of running irrigation pumps is a significant burden for farmers. Overpumping can also pose risks to water security, in a time when water is scarce in select regions in India. All of these factors hamper sustainable agricultural productivity, hurting local farmers' incomes and exacerbating rural poverty.

Description of Intervention

The Solar Power as a Remunerative Crop (SpaRC) initiative empowers farmers to utilize solar irrigation pumps on their farms while receiving a reduced feed-in tariff for any excess solar power they feed into the grid. In the past, conventional off-grid solar irrigation pumps had a binary function: they either generated energy solely for water pumping or wasted any surplus energy. This scenario had the risk of encouraging unsustainable water pumping practices in an attempt to utilize all generated energy.[4] SPaRC presents an innovative, context-sensitive model that leads to less energy waste and encourages sustainable irrigation practices. While solar pumps in India are not new, organized efforts to irrigate using solar power are necessary to respond to the challenges of the energy-water-agriculture nexus. This approach applies an economically sustainable and politically practical solution for providing highly subsidized electricity while preventing over extraction of groundwater and supporting livelihoods.

The beginnings of the intervention came from the village of Dhundi in Gujarat forming the world's first farmers' solar cooperative: Solar Pump Irrigators' Cooperative Enterprise (SPICE). This initiative brought twofold benefits to farmers: 1) it ensured a more reliable energy supply compared to the intermittently provided government-subsidized grid electricity; and 2) it reduced their reliance on expensive diesel pumps for irrigation. The regional grid power faced numerous challenges, including 8-hour power interruptions, voltage fluctuations, and unreliable nighttime supply. To promote the adoption of solar power as an alternative, members of Dhundi SPICE contributed to the initial capital costs of the solar pumps, while the International Water Management Institute (IWMI) and the Research Program on Climate Change, Agriculture, and Food Security (CCAFS) provided additional financial support through a research grant. Under a 25-year agreement, farmers now collectively sell their surplus solar energy to the local power distribution company.

Following the widespread success of this pilot initiative, various funding entities collaborated with the Gujarat state government to launch the Suryashakti Kisan Yojana (SKY) initiative in 2018, with a budget of $120 million USD. This program, which translates to "Solar Power for All Farmers," replicates the model for all interested farmers in the state. Similar to the pilot, participating farmers receive subsidies for the solar pumps and, in turn, use the income from selling excess solar power to the local power distribution company to repay any loans for the remaining pump costs.

The approach has been taken up at the national level of the Indian government. The Union Ministry of New and Renewable Energy (MNRE) scheme, called Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan (PM-KUSUM), is intended to help India to pursue sustainable solarization.[5] The PM-KUSUM program comprises three key components: 1) the establishment of solar and alternative renewable energy facilities integrated into the grid (KUSUM-A); 2) offering assistance to agricultural laborers in installing solar-driven pumps in areas without grid access (KUSUM-B); and 3) enabling the transition to solar power for small-scale farmers' grid-connected pumps (KUSUM-C). The SPaRC initiative supports the KUSUM-C component of the program.

Intervention Funding

The Dhundi pilot program received financial support from various sources, including the CGIAR research program on Climate Change, Agriculture, and Food Security (CCAFS) and the IWMI-TATA Water Policy Research Program (ITP). These funds covered expenses related to program operations, events, fieldwork, and data collection, in collaboration with Dhundi SPICE and the local government. The ITP initiative represents a partnership between the International Water Management Institute (IWMI) and the Sir Ratan TATA Trust. As part of programmatic costs, the CCAFS agreed to subsidize the difference between the market price and the feed-in tariff price to reduce the risk of initial investment by the Dhundi SPICE; ITP similarly provided income bonuses to SPaRC pilot farmers. Beginning in 2019, the Swiss Agency for Development and Cooperation (SDC) acted as essential capital for IWMI's solar irrigation initiative, the Solar Irrigation for Agricultural Resilience in South Asia (SoLAR-SA). The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), however, invested in the Solar Irrigation Expansion in India Partnership to develop tools and case studies for solar irrigation promotion at scale, particularly for SPaRC. Finally, the CGIAR Research Program on Water, Land and Ecosystems (WLE) was funded to engage in analysis and dissemination of the findings, such as through articles, conferences, white papers and policy events.

Outcomes from the Intervention and Dissemination

The Solar Power as a Remunerative Crop (SPaRC) initiative addresses a variety of challenges at the energy-water-agriculture nexus, contributing to progress on four key United Nations Sustainable Development Goals (SDGs) – no poverty (1), zero hunger (2), affordable and clean energy (7), and climate action (13).[6] Critical for this initiative was the integrative approach to issues in clean energy and food production, as well as the vertical and horizontal coordination for effective development of the intervention at a local scale and expansion to national scale and beyond.

Strengthened Collaborative Policy Infrastructure

Beginning with the pilot intervention at the state level and moving to the SPaRC scaling nationally, this initiative both leveraged and strengthened research and policy implementation networks for solutions in the energy-water-agriculture nexus.[7] The statewide pilot intervention required partnerships with local farmers, the local power distribution company, state government, and national and international researchers and funders. National scaling required similar collaborations and funding partners, as well as India's Ministry of New and Renewable Energy (MNRE).

ITP and CGIAR worked to communicate the benefits and co-benefits of SPaRC at a much faster rate than academic evaluations, allowing policymakers and researchers doing parallel work to augment programs where needed. The formation of the IWMI-TATA Water Policy Research Program (ITP) was also key to the success of the program. ITP was staffed with many managers, as opposed to only researchers, and focused on policy engagement and establishing an enabling environment by sustained partnership and communication regarding SPaRC. This ultimately led to the uptake of Dhundi SPICE by the Gujarat state government and the national government's energy transition initiatives. As an action-oriented partnership, ITP is considered a "bridging organization" that translates research into policy action and focuses its efforts on political engagement and policy recommendations rather than academic platforms.[8]

Livelihoods

Through this intervention and the ability to sell back excess energy, solar pumps are now considered both as an irrigation asset and income-generating asset that provides an additional income stream. The concept of a 'solar crop' offers farmers a better income insurance option compared to other crops. With this ability to produce revenue from the production of energy as well as from agriculture, producers have more flexibility with their livelihoods, which is critical to increasing resilience in rural areas.

Enhanced Energy, Food, and Water Resilience

The estimation of the impact of the SPaRC model draws from the insights and results observed in the Gujarat State's Power Sector SKY initiative. For example, in Gujarat, renewable sources of energy grew from 9% to close to 30% from 2017 to 2023.[9] The relationship between poor irrigation and lower agricultural yield is well documented[10], and the impact of irrigation changes for the Solar Pump Irrigators' Cooperative Enterprise (SPICE) farmers in the Village of Dhundi in Gujarat was exponential. According to an outcome evaluation, the proportion of women owning SIPs are projected to be 5%-10% while smallholder farmers are projected to own 10%-30% in four years.[11] In the case of replication, it is anticipated that the combination of KUSUM-A and KUSUM-C will yield similar benefits, including the reduction of agricultural power subsidies, enhancement of farmers' incomes, and the promotion of more efficient water and energy usage in crop production. A combination of both is also projected to result in a substantial reduction in greenhouse gas (GHG) emissions.

Scaling and Replicability
The success of the SPaRC – from pilot to replication – created widespread recognition about the viability of clean energy transition in agriculture. The adoption SPaRC's design (i.e., facilitating the solarization of small-scale farmers' grid-connected pumps) into the Government of India's $50 billion USD KUSUM program is testament to its scalability and replicability.

Since the success of the intervention, IWMI created a new initiative called the Solar Irrigation for Agricultural Resilience in South Asia (SoLAR-SA). The project not only disseminates current research on solar irrigation pumps (SIPs), but it commits to support implementation of national clean energy transitions and "contribute to climate-resilient, gender-equitable, and socially inclusive agrarian livelihoods.[12]" SoLAR-SA is now the largest program using this intervention. With its strong emphasis on gender equality and social inclusion (GESI), it has led to GESI being a focal point in other solar irrigation projects.

Considerations

Capital Investment Costs and Asset-Building
Solar panels have a high capital investment, which serves as a major deterrent. Two challenges exist with high investment – one is the cost itself and the other is the perceived value of the investment. In the pilot program, it was clear that the capital costs were a substantial barrier, especially for low-income farmers. The initial grant for the research pilot was used to significantly fund the costs of the solar pump, and this subsidy allowed for proof-of-concept. For sustainability, there are two streams of funding that are available for energy that could be used to incentivize solar pump adoption in India: 1) state and national government funding specific to solar pumps; and 2) the grid-power subsidy. The latter has not been explored as much, but it is identified as one of the key approaches to renewable energy transition.[13] The outcomes from the initial pilot were important, as they led to substantial expansion and uptake solar irrigation pump use in India. Now, solar pumps are considered both an irrigation asset and a form of income-generation – a 'solar crop.' Convinced of the benefits of SPaRC, many farmers with the means are now willing to invest more in solar pumps.[11] Farmer buy-in is important, because slower transition to renewable energy is due in part to local resistance.[9]

Translation: Moving Knowledge to Practice
Translating research-based understanding of a complex issue into context-specific policy implementation strategies is both challenging and crucial. The approach to achieving this goal varies depending on the nature of the problem and the intervention in question. Nevertheless, for interventions that encompass multiple scales and desired outcomes, organizations capable of bridging the gap between research, policy, program implementation, and the affected communities play a vital role in achieving successful outcomes. In the context of this project, the collaboration between the International Water Management Institute (IWMI) and the Sir Ratan Tata Trust to establish the IWMI-TATA Water Policy Research Program (ITP) appears particularly pivotal. The ITP model, which facilitates the connection between research and practical application, is widely regarded as highly effective in the research community.[11]

Citations

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