Farmer Raman Parmar uses solar power pumps to irrigate his farm in Anand. (Prashanth Vishwanathan/IWMI)

Sunshine: India's new cash crop

In India, solar pump plan gains traction

On a recent hot day, water gushed onto Ramanbhai Parmar's lush, green field in Anand, a district in semi-arid western India. The scene was typical of many farms in the developing world, with this exception: An array of solar panels dominated the view.

"For almost my entire lifetime, I had been using electric pumps to draw groundwater and irrigate my fields," he told a film crew. Then researchers with the International Water Management Institute, which leads the CGIAR Research Program on Water, Land and Ecosystems (WLE), came along and asked if he would consider using solar-powered water pumps.

"I had never heard anything like this or anyone irrigating like this," Parmar said. "But since I have always been open to new techniques for farming, I thought I should give this a try."

He did, and six months later, he likes the results. He now has access to electricity during the day, while before he had to wake up at night to irrigate his farm. "Secondly, there is a 50 percent cut in my electricity bills," he said.

Parmar's experience reflects the groundswell of change occurring in one of the world's most populated countries. The sun increasingly is powering irrigation pumps on farms in India. Solar power is being embraced by Indian Prime Minister Narendra Modi as a way to help meet the country's massive power needs, while being a "green" solution to a growing carbon emission problem.

A 'SPaRC' to keep aquifers healthy, put cash in farmers' hands

However, in a country where groundwater has emerged as the main source of irrigation for smallholder farmers, scientists worry that solar-powered irrigation pumps could threaten aquifers just as much as electric pumps powered by free or subsidized grid electricity have. Many areas of western and southern India- – where farm power supply is either free or heavily subsidized – already experience groundwater over-pumping. Solar pumps, which offer 2,300-2,500 hours a year of uninterrupted, daytime free energy, could just exacerbate the problem by, in essence, encouraging farmers to use water at will.

In the past 18 months, IWMI researchers have come up with what they believe is a practical solution to potential groundwater exploitation by solar pumps: Lower the electricity subsidies to a modest rate and enable farmers to sell back surplus solar power to the utility grid. In other words, WLE would like to position solar power as a crop that farmers can 'grow.' The plan has been dubbed "SPaRC" (Solar Power as a Remunerative Crop).

"By allowing farmers to in effect grow solar power as a 'cash crop,' they will be motivated to use such energy efficiently, thereby minimizing the pumping of scarce water," said Tushaar Shah, a senior fellow at IWMI. That, in turn, could propel smallholder farmers onto a path of prosperity.

Solar-powered pumps are used to irrigate fields.
(Prashanth Vishwanathan/IWMI)

In places like Anand, in the westernmost area of India, SPaRC could also be the recipe to managing water resources amid the effects of climate change, including extended hot, dry spells and unpredictable rainfall.

"This project exemplifies WLE's aim to deliver innovative science into practice that unlocks potential value and results in 'triple wins' – environmental sustainability, agricultural productivity and equitable social benefits – for more resilient smallholder farming communities," said Meredith Giordano, co-leader of WLE's Land and Water Productivity research theme.

Government starting to embrace the concept of solar buyback

Getting things done in India often comes down to politics, and IWMI's progress with SPaRC exemplifies WLE's goal of nurturing close working relationships with governments to help them weigh the trade-offs inherent in major natural resource investment decisions.

Shah, named a CGIAR Outstanding Scientist in 2002, has a background in economics and public policy, is politically well-connected and has often been called on to advise the government on irrigation policy. He presented the solar power buyback idea to India's finance ministers in 2013 and 2014 and to power secretaries in Gujarat and Maharashtra states in 2015. He also has promoted the approach at conferences and in opinion pieces in major newspapers in India.

The Indian government's 2014 budget provided USD 67 million for solar pump promotion. But the National Solar Pump Program is aimed at large-scale deployment of solar pumps, which could hurt aquifer health in certain regions of India.

India is a big country, with varied climate conditions, so the goals of the solar buyback program vary depending on the region.

In dry areas such as Gujarat state, officials want to wean farmers from using powerful electric pumps, which strain power and groundwater resources.

In eastern India, where aquifer resources are generally plentiful, the hope is to stimulate agricultural production in an area where, until recently, production had stagnated because of soaring diesel prices.

In September 2014, the Karnataka state government in southwestern India introduced a policy in line with IWMI's SPaRC concept, establishing Surya Raitha, a program that encourages farmers to buy solar pumps and sell back excess power to the utility at a guaranteed price. A farmer with a typical 10kwp solar power system (10 kilowatts at peak performance or full sun) is expected to earn about USD 800 a year selling back surplus power, according to state documents promoting the policy.

Andrew Noble, former WLE director, said solar buyback provisions have tremendous potential to support aquifer health and address the 'energy-water nexus' in the developing world.

"I feel this is potentially a 'game changer' in addressing the challenge of over-extraction of groundwater, a challenge that not only India is facing, but one that certainly could emerge in sub-Saharan Africa," Noble said.

"This approach offers to farmers a choice that I believe will result in behavior change without the implementation of full-scale policy reforms. I would expect farmers to be more judicious in the way they pump and use water for their crops in order to benefit from the sale of excess electricity into the national grid."

Farmer Raman Parmar operating the switch to supply energy generated by solar panels. (Prashanth Vishwanathan/IWMI)

IWMI has worked through resource problems before

Both IWMI Fellow Shah and Indian Prime Minister Modi have experience working through difficult energy-water resource challenges.

A decade ago in Gujarat, heavily subsidized electricity for irrigation resulted in over-pumping, huge financial losses for utilities and political chaos. IWMI researchers led by Shah recommended a tamper-proof rationing of farm power supply with improved quality of service and monitoring of groundwater depletion. Taking these recommendations, Gujarat separated the agricultural electricity feeder line, improved the quality and reliability of service and provided farmers with an eight-hour-per-day power ration on fixed schedules. Gujarat state officials put the scheme in place in 2006.

The solution was expensive – USD 250 million – but aquifers and the utilities are recovering, and the state economy has been on a roll. Gujarat recovered the investment in less than three years through reduced farm power subsidies. The Stockholm International Water Institute, a non-profit think tank, said that this electricity rationing scheme sparked new non-farm enterprises and improved rural livelihoods. (Not everyone agrees; some say poor farmers have suffered, which perhaps explains why the government of Gujarat has issued half a million new electric connections, especially targeted at poor and marginalized farmers).

Future challenges; proposed solutions

WLE's solar pump proposal, or SPaRC, has a way to go before being fully embraced. Solar buyback is just one aspect of the plan. Another is to reduce solar panel subsidies. Currently, many Indian states still offer subsidies of 80 to 90 percent for farmers to buy solar panels.

IWMI's research shows that the heavy subsidies have created unintended adverse incentives. The subsidies have made it too easy to buy and use solar pumps and have led to potential groundwater over-extraction. They have also enabled the solar industry to raise solar panel prices – increasing their profits and locking some poor farmers out of the market. Elites have captured a lion's share of the subsidies.

IWMI recommends lowering solar panel subsidies to a modest amount, but helping poor farmers buy pumps by making bank financing more readily available. Researchers also emphasize the need for solutions to be tailored to local conditions.

SPaRC faces an institutional challenge as well. A utility faces high transactional costs if it is required to buy back power from individual farmers. That's because the utility would need to monitor and measure each farm's power surplus.

"We need to find a solution to that challenge, and we believe the best way is by forming solar farmers' cooperative enterprises," Shah said. A cooperative could set up one connection on the grid where the utility would monitor, measure and buy back surplus solar power. The co-op then would absorb the costs of monitoring and measuring individual farms and compensating the farmers fairly.

Earlier this year, the IWMI-Tata program, with financial support from the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), launched a joint pilot project in Gujarat state to explore climate-smart agriculture with solar farmers' cooperatives. The group is in the process of forming perhaps the world's first Solar Pump Irrigator's Cooperative Enterprise (SPICE) in the village of Dhundi.

The cooperative will evacuate surplus solar power generated by its members at a single point in the utility grid. The utility will meter the power being put back on the grid and pay the cooperative a set price, likely between 3.5 and 6 Indian rupees per kilowatt hour. Gujarat recently included the option of the utilities buying back surplus power in its new solar policy. Tata Trusts is interested in supporting a larger, similar co-op with 40 to 50 solar pump farmers in another village.

Potential for replication

IWMI researchers believe the SPaRC proposal has application to other parts of South Asia, which still depend heavily on diesel power.

Noble said it might be more difficult to enact a solar buyback plan in sub-Saharan Africa.

“While this program may have significant positive outcomes in India where you have the infrastructure to support the sale of electricity into the grid, this may not be appropriate for parts of sub-Saharan Africa where the basic infrastructure to move electricity still has to be built in rural areas,” Noble said.

However, he added, that even in areas where the infrastructure is lacking, excess energy produced by solar panels could be used to help meet household needs by powering lights, radios, TVs and recharging cell phones. “So at the end of the day, I do feel this is a replicable approach that needs to be tailored to fit the context.”

In the past year, Shah has distilled his research to development process to four main points for replication:

- Strive for policy change rather than research only for the sake of science
- Adopt a broad, cross-disciplinary approach
- Focus on problem solving more than hypothesis testing
- Generate practical, doable research projects with a quick turnaround

India’s first sunshine farmer

In June of this year, Parmar, the wheat and banana farmer in Anand district, became the first farmer in IWMI’s pilot program to sell energy back to the power grid. He received 7,500 Indian rupees (about USD 120) for the surplus power, generated over a four-month period.

At that pace, he would receive about USD 360 a year, equivalent to more than 20 percent of Gujarat’s average per capita income. Over time, IWMI researchers believe that farmers, as they weigh the trade-offs between irrigation pumping and selling excess power, will be able to earn close to USD 1,000 a year.

The CGIAR Research Program on Water, Land and Ecosystems (WLE) combines the resources of 11 CGIAR centers, the Food and Agriculture Organization of the United Nations (FAO) and numerous national, regional and international partners to provide an integrated approach to natural resource management research. WLE promotes a new approach to sustainable intensification in which a healthy functioning ecosystem is seen as a prerequisite to agricultural development, resilience of food systems and human well-being. This program is led by the International Water Management Institute (IWMI), a member of the CGIAR Consortium, and is supported by CGIAR, a global research partnership for a food-secure future. **wle.cgiar.org**

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