Promoting Solar Irrigation Service Providers in Ganga Basin: Jobs, Affordable Irrigation and Accelerated Green Revolution

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1. Abstract

It is widely recognized that the provision of irrigation can help millions of smallholder farmers intensively cultivate their small parcels to improve income and better cope with climate induced uncertainties. This is particularly true for Africa and parts of South Asia where the fortunes of millions of poor farmers continue to depend heavily on rain fed agriculture. The challenge is to expand irrigation access to the largest number of poor while keeping its costs affordable, without threatening resource sustainability and minimizing its environmental footprint. The International Water Management Institute (IWMI)'s work in the eastern Gangetic basin in South Asia, home to a quarter of the world's poor, has shown that if promoted well, solar powered irrigation can be a key part of the solution.

Studies suggest that shallow and abundant aquifers of the lower Gangetic basin in Nepal Terai, eastern India and Bangladesh can easily support 2.5 crops/year without any threat of long-term depletion. Yet, cropping intensity in the region continues to range between 1.2 and 1.5 crops/year. This is partly due to extreme land fragmentation – which makes investing in wells difficult for marginal farmers – and to a large extent due to high-energy costs of pumping groundwater. As a result, the poor end up paying a third or more of their irrigated crop output as irrigation fee to diesel pump owners from whom they purchase irrigation service at a premium. Governments are well aware of this inequity but attempts to subsidize diesel for smallholder irrigation have been frustrated by leakages. Delivering subsidized farm power is not only costly but also has a long gestation period. In this context, the falling prices of solar technology in recent years have opened up a new and attractive possibility.

Research carried out by the IWMI Tata Water Policy Program (ITP) shows that promoting small, individual, 1-2 kWp solar pumps is suboptimal. Instead, 5-6 kWp solar pumps should be offered to enterprising young men and women as solar entrepreneurs to catalyze competitive and equitable irrigation service markets. A 1-2 kWp solar pump can operate at full power 3-4 hours daily and pumps little water in the morning and evening, meaning that such pumps are used as standby with the larger diesel or electric pumps remaining as the mainstay for irrigation. As an alternative, ITP and the Aga Khan Rural Support Programme (AKRSP) are piloting a solar irrigation entrepreneurship approach in Chakhaji village, Bihar, India by supporting young entrepreneurial farmers as Solar Irrigation Service Providers in overlapping command areas. While the pilot is still in progress, it is already yielding positive results by: [a] creating competitive

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water markets offering pump-less farmers irrigation service at affordable price; [b] generating full time jobs for solar entrepreneurs; [c] increasing net incomes for farmers and solar entrepreneurs; [d] reducing CO_2 emissions.

2. Context and challenge, including key interactions (range and nature) the case study addresses

The Agrarian Challenge in Ganga-Meghna-Brahmaputra Basin

The plains of the Ganga-Brahmaputra-Meghna (GBM) basin, encompassing Bangladesh, Nepal terai and eastern India, are home to a quarter of the world's rural poor. The basin's copious aquifers are the biggest hope for millions of smallholders locked into unviable agriculture. Studies suggest shallow groundwater wells can support 2.5 crops/year in much of the basin without threat of depletion. Yet, cropping intensities hover around 1.2-1.5 in most parts. Rapid expansion in shallow tubewell irrigation has begun to show productivity improvement for tubewell owners, but the marginal farmers and tenants remain in a disadvantageous position in this tubewell irrigation economy.

Two factors limit benefits to the poor. First, extreme land fragmentation makes it uneconomic for marginal farmers to own tubewells and irrigate all their dispersed plots. Marginal farmers and tenants thus depend on buying irrigation service from diesel tubewell owners. Second, water buyers pay a third or more of their irrigated crop output to diesel pumps owners as irrigation service charges due to the high cost of diesel. GBM's water markets transfer wealth from resource poor water buyers to tubewell owners.

Governments are aware of this inequity but are unfamiliar with the dynamic of water markets and how to make them pro-poor. Attempts to subsidize diesel for irrigation in Bihar and Bangladesh have been frustrated by leakages. Farm electrification is costly and time consuming. The arrival of solar pumps has opened up a new and attractive possibility. But since solar panels are costly (US $ 1500-2000/kWp), most GBM governments are subsidizing small 1-2 kWp solar pumps to reach as many smallholders as limited budgets permit.

Solar Pumps for Pro-poor Irrigation Service Markets

IWMI studies have shown that targeting 1-2 kWp solar pumps to small farmers is sub-optimal. Instead, they should be used to make village-level informal water markets pro-poor. In doing this, small solar pumps are not much help. A 1-2 kWp solar pump can irrigate a plot where panels are laid. It operates at full power 3-4 hours daily and pumps little water in morning and evening. Its yield plummets during summer when water tables recede. Most solar farmers IWMI surveyed used solar pumps as standby but relied on larger diesel or electric pumps as their mainstay for irrigation. Many use electric pumps to lift groundwater into a farm pond and then use solar pump to lift water from the pond. Small solar pumps deliver limited power to push water in pipes to distant fields and are therefore little use for selling irrigation service. In addition, solar pump subsidies are generally captured by large influential farmers. NGO's have tried to resolve some of these issues by experimenting with cart-mounted mobile panels and by promoting group-ownership of solar pumps. But this is patchwork. A more comprehensive strategy is needed to extend the benefits of solar pumps to the poor.

A much larger solar pump initiative than GBM states are pursuing today can rapidly expand pro-poor irrigation provided it is designed to transform monopolistic village water markets into competitive ones. Promoting one or two small solar pumps in every village as presently done is ill-advised. Instead, setting up in every village 6-15 young entrepreneurial farmers as Solar Irrigation Service Providers (S-ISP) in overlapping command areas could help: [a] create a competitive water market offering pump-less farmers irrigation service at affordable price; [b] create 6-15 full time jobs/village; [c] crowd out diesel tubewells; [d] expand irrigated area and promote intensification and diversification of farming systems; [e] improve utilization of solar pump capital; [f] allow small farmers to irrigate their plots by buying water from S-ISP close to each plot; [g] incentivize S-ISP entrepreneurs to contribute to capital investment.

Piloting a solar irrigation entrepreneurship approach in Chakhaji village, Bihar

In 2016, the IWMI-Tata program, with financial support from the CGIAR Research Programs on Climate Change, Agriculture and Food Security (CCAFS) and Water, Land and Ecosystems (WLE), partnered with Aga Khan Rural Support Program (AKRSP) to support 6 young farmers in Chakhaji village of Bihar, India to become service providers by offering 60% capital cost subsidy on 5 kWp solar pumps each with 1000 feet of buried pipe distribution (total cost: USD 49,600). The 40% contribution from the entrepreneurs is recovered through an upfront contribution and 4 annual installments thereafter. The pumps are located so as to have over-lapping command to ensure that buyers could access irrigation from two or more service providers. The solar entrepreneurs benefit from free solar energy but are under pressure to generate cash for repaying installments. This makes them aggressively seek buyers to maximize their water sales; in the process, they offer better irrigation service at lower prices.

The pilot has only completed one winter and one summer season; but evidence is already mounting that 30 kWp solar panels on 6 largish tubewells combined with buried pipe distribution will benefit the poor much more than giving 2 kWp solar pumps to 15 poor farmers. Before the pilot began, 18 diesel pump owners served 1,623 plots belonging to 403 smallholders. These have now been crowded out by new service providers. Before the pilot, diesel pump owners sold water at INR 120/hour; now solar pump suppliers sell water at INR 90/hour and finish watering a field in much shorter time. Earlier, only tubewell owners sowed rice pre-monsoon while buyers waited for rains; tubewell owners grew maize when buyers grew fodder. Now, buyers sow rice pre-monsoon and also grow maize and vegetables. Gross irrigated area in the village has increased by 40%. While service providers are increasing their revenues from larger sales, water buyers are capturing a larger share of the growing pie than they had ever enjoyed. Two interns, who recently completed a study of Chakhaji, noted that buyers have begun investing in improved seeds and fertilizers, and taking to cash crops now that affordable and timely irrigation offers them year-round on-farm water control.

3. How did research efforts deal with the synergies and trade-offs?

Early evidence from the Chakhaji pilot in Bihar suggests that USD 49,600 invested in 6 S-ISPs yielded following economic benefits in the first winter and summer seasons: [a] saving 6,650 liters of diesel consumption valued at USD 6,650; [b] 3325 hours of solar irrigation to provide 498 acre waterings valued at USD 3,836 and resulting in direct increase in net farm income of water buyers of USD 11,500 (not counting irrigation gains to S-ISPs) and [c] reduced CO_2 emission to the tune of 18 mt/year. Assuming average of 6 waterings per crop, Chakhaji pilot created irrigation potential at USD 1,754/hectare, a fraction of the USD 10,000/ha standard for public irrigation systems.

Adaptation Benefits

Solar irrigation promotion as described here can rapidly expand pro-poor irrigation access, secure farming against climate shocks, promote sustainable intensification and diversification, improve utilization factor of solar pump capital, and ensure food and livelihood security. In some locations, increased groundwater use will also ease surface flooding by allowing greater natural recharge.

Co-Benefits

In addition to quickly expanding quality irrigation to the poor at affordable cost, this approach also helps create full-time livelihoods for 6-15 young service providers per village and almost completely eliminates the carbon-footprint of fossil fuel-based groundwater irrigation.

Challenges in implementation

A key barrier to rapid scaling up the proposed approach is the current capital subsidy regime. The current model in India of offering 80-95% capital subsidy on small 1-2 kWp solar pumps imposes restrictions on expansion of the market and removes incentives to continuously improve product quality and lower product costs. With high capital subsidies and unit costs determined through a competitive bidding process, solar pump manufacturers have little or no incentive to innovate on product design. The goal of the profit-maximizing firm shifts from capturing the largest share of the market (by offering superior products at lower costs) to capturing the largest share of the government subsidy. This approach also often results in low consumer awareness, high consumer apathy and poor after sales service. The overall size of the market is determined not by the interplay of demand and supply but by government's provisioning of subsidy. Finally, the design tends to favor large, established players and discourages new entrants. The second key challenge to scaling would be the availability and accessibility of suitable loan products to encourage and facilitate private investments in solar-powered irrigation enterprises.

Monitoring and evaluation

Monitoring the benefits of solar irrigation can help countries report progress against their climate goals in the UNFCCC's global stocktakes. Field-based household level surveys designed to address process indicators will allow to track actual # of beneficiaries accessing solar powered irrigation whereas outcome indicators will enable to assess their adaptation benefits in terms of food security (e.g. measured as households' food diversification and availability over critical periods), production intensification or livelihood security stability and enhanced adaptive capacity (e.g. changes in on-farm income, enhanced ability to buffer against drought, or increase household's saving/investment capacities). An effective measure of the income and livelihood impact would be the gross value of agricultural output – which, in the case of Chakhaji, we expect will more than double within 2 years. Another indication of how well the business model is performing would be private investments by entrepreneurs to extend their buried pipeline networks to capture greater market share. At a more fine-tuned level, adaptation and mitigation co-benefits at the farm level can be evaluated using quantitative indicators to measure improved yields and productivity, increase resource use efficiency/crop intensification and potential GHG emissions reductions.

4. What kinds of partnerships were critical?

Partnering with AKRSP was of critical importance since they already have field presence in Chakhaji area. Moreover, AKRSP was convinced, as IWMI was, that implemented properly, solar pumps can transform the local irrigation scene. Jeevika, Bihar government's World Bank Supported Livelihoods program was keenly watching developments in Chakhaji. IWMI and AKRSP have signed a MoU with Jeevika to replicate Chakhaji pilot in 100 Bihar villages with Jeevika funding. Also crucial were the partnerships with WLE and CCAFS and the flexible financial support which made pilot implementation possible.

5. Lessons learnt, including knowledge gaps and good practices in employing these approaches at scale

Early evidence from the Chakhaji pilot in Bihar suggests that S-ISP driven village water markets can rapidly expand pro-poor irrigation, secure farming against climate shocks, promote sustainable intensification and diversification, improve utilization factor of solar pump capital, reduce carbon footprint of tubewell irrigation and ensure food and livelihood security.

Geographic Suitability

The approach outlined here is specifically tailor made for Ganga-Brahmaputra-Meghana basin states which have abundant groundwater resources, copious aquifers and an agrarian economy that has come to heavily depend on shallow tubewell irrigation. The option is ideal for smallholder fragmented farms which face high risk of crop loss from monsoon flooding and are unable to irrigate in winter and summer due to high energy costs.

Potential for Scale

In our assessment, it is feasible under the present option to add 20 million hectares of high quality, affordable solar pump irrigation in the region within 5 years at costs much lower than through surface irrigation projects and with significantly more contribution from farmers.

Scaling this approach requires the following changes to existing solar irrigation programs in the GMB: [a] diverting funds from current allocation to public irrigation, groundwater irrigation, electricity subsidies to the option proposed; [b] targeting solar pumps to villages instead of farmers; [c] offering 5-7 kWp solar pumps along with 1000-2500 feet of buried pipe distribution system on a 50% subsidy, instead of 1-3 kWp solar pumps at 90 % subsidy; and [d] involving a financial institution to offer a low-interest loan to S-ISPs to repay their share of the capital cost over 5 year installments.

Funding Acknowledgements

CGIAR greatly appreciates the contributions made by all of its funding partners, without which none of our work would be possible. This research was supported by CGIAR Trust Fund contributors.

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