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Solar Irrigation for Agricultural Resilience

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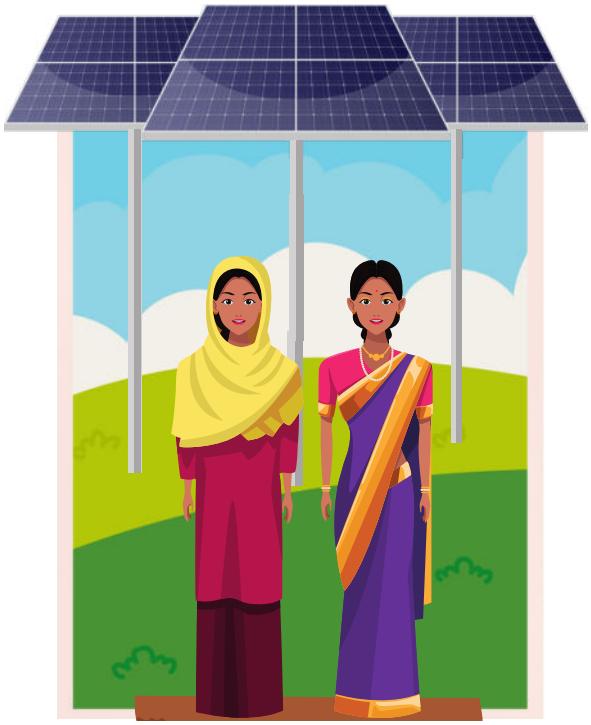

Institutional modalities for decarbonizing irrigation in Bangladesh

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Diesel-based groundwater irrigation has been crucial in expanding dry season boro paddy cultivation in Bangladesh. Boro paddy was, in turn, instrumental in ensuring the country's food security. But high dependence on imported diesel is a financial burden for the government. Transitioning to clean and renewable energy sources, like solar, can alleviate the government's fiscal burden and help decarbonize the agricultural sector. Bangladesh has promoted multiple models for the diffusion of solar irrigation pumps (SIPs), ranging from the conventional subsidy-driven models of SIP ownership to the fee-for-service model that leverages private sector investments for expanding the outreach of irrigation services. The fee-for-service model promoted in Bangladesh by the Infrastructure Development Company Limited (IDCOL) is unique in the South-Asian context for bringing public-private partnership in SIP expansion. This model also offers useful lessons for the provision of affordable irrigation to smallholder farmers in the region.

Bangladesh depends on diesel-based groundwater irrigation for its food security

Diesel-run shallow tube wells (STWs) have been instrumental in increasing boro paddy production in Bangladesh. Boro paddy plays a critical role in the country's food security. Ever since the government liberalized the import of irrigation equipment and removed requirements for tube well permits in 1988, the number of STWs increased exponentially from 0.16 million in 1986-87 to about 1.36 million in 2018-19, with a rapid influx of cheap imported diesel pumps from China and India (Figure 1) (Mukherji et al. 2021). There were 1.24 million diesel irrigation pumps and 0.34 million electric pumps in Bangladesh in 2018-19, with diesel irrigated areas constituting 53.5% of the total irrigated area (BADC 2020). Synchronously, the area under boro paddy increased from 2.5 million hectares in 1990-91 to 4.8 million hectares in 2018-19. Most of the growth in food grains after the 1990s came from boro production. Eighty-eight percent (88%) of total food grain production in Bangladesh is paddy, with boro being the most important one (47% in 2019-20 vis-à-vis 24% in 1984-85)(BBS 2018).

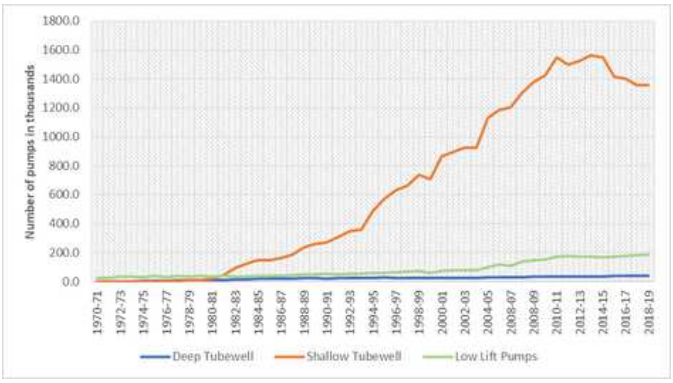

Figure 1. Number of water extraction structures (deep tube wells, shallow tube wells, and low lift pumps) in Bangladesh, 1970-71 to 2018-19
Source: GoB 2020.

Heavy reliance on diesel imposes a financial burden on the country

Bangladesh imported more than 90% of petroleum products (including diesel), and the agriculture sector consumed around 16% of the imported petroleum in 2018-19 (GoB 2020, BPC n.d.). The average import cost of petroleum products between 2009-10 to 2019-20 was USD (US dollar) 3.2 billion (GoB 2020, GoB 2018). High dependency on imported fossil fuels creates financial burdens on the government in two ways: first, through the outflows of foreign exchange reserves, and second, due to escalating government subsidy bills on imports when international oil prices rise. For example, the import subsidy to the Bangladesh Petroleum Corporation (BPC) rose from USD 0.1 billion in 2009-10 to USD 1.6 billion in 2012-13 when the international prices spiked from USD 79 per barrel in 2010 to USD 105 per barrel in 2012 (GoB 2018, World Bank 2022). Conversely, when the government decided not to subsidize imports in the face of the recent global fuel price rise following the Ukraine war, the domestic retail prices of diesel and other petroleum products skyrocketed. In response, the government had to shut down ten diesel power plants, leading to severe power shortages in the country (Paul 2022).

The consequences of energy insecurity and rising diesel prices are dire for Bangladesh's food production. For instance, due to the delayed monsoons in Bangladesh this year (2022), only 25% of the aman area could be planted till early August. Concurrent electricity shortages and high diesel prices meant few could afford to provide necessary supplementary irrigation for timely paddy transplantation (Montu 2022). Climate change is making such droughts and erratic monsoons more likely, and access to affordable energy would be crucial for the country's future food security.

Reducing agricultural emissions can help meet Bangladesh's Nationally Determined Contribution (NDC) targets

Investing in solar pumps can reduce Bangladesh's carbon dioxide (CO_2) emissions. In 2019-20, the agricultural sector used approximately 0.99 million metric tonnes of diesel (BPC n.d.).According to one estimate, 80% of this was used for irrigation (MoEF 2021). Diesel use in the agricultural sector contributed to roughly 3.2 million metric tonnes of CO_2 emission annually, accounting for 3.4% of the total annual production-based CO_2 emissions of 92.8 million tonnes in 2020 (Ritchie and Roser 2020). Bangladesh has revised its NDC targets and pledged to reduce its emissions unconditionally by 6.73% in 2030, and another 15.12% conditional on external financial and technical support (MoEFCC 2021). A rapid transition to renewable energy sources, such as solar power, can help Bangladesh meet its NDC targets.
In 2022, renewable energy contributed only 3.6% of Bangladesh's total installed electricity capacity, with off-grid solar irrigation pumps (SIPs) accounting for about 8% (50.4 megawatts (MW)) of the total solar installed capacity [13]. Till mid-2022, there were 2716 SIPs in the country, primarily in the boro-dominated northwest region (Fig. 2) (SREDA 2020). The SIP sector in Bangladesh is currently at a nascent stage. However, there are ambitious targets for SIPs in Bangladesh. In parity with its revised NDC targets, the government has unconditionally set a target of 176 MW of solar irrigation and an additional 164 MW conditional upon external support as a part of its emission mitigation actions (MoEFCC 2021).

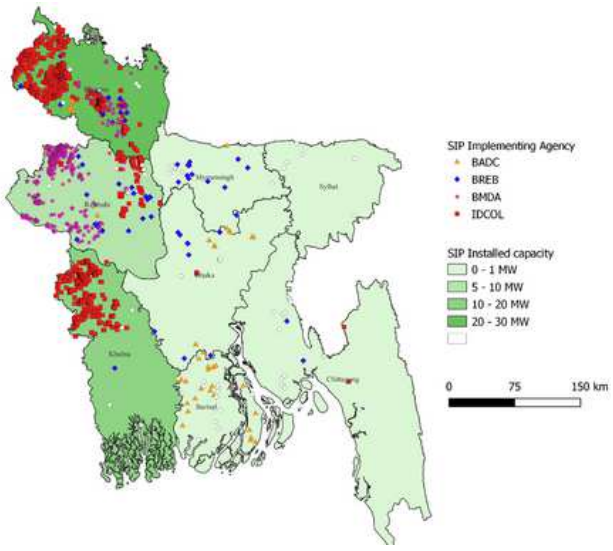

Figure 2. SIP locations in Bangladesh.
Source: SREDA 2020.

Multiple institutional models for the promotion of solar irrigation

The four major implementors of SIPs in Bangladesh are the Infrastructure Development Company Limited (IDCOL), the Barind Multipurpose Development Authority (BMDA), the Bangladesh Agriculture Development Corporation (BADC), and the Bangladesh Rural Electrification Board (BREB). Together, they account for 97% of the total SIPs and 99% of the total installed SIP capacity in Bangladesh as of August 2022 (SREDA 2020).

Fee-for-service model of IDCOL

IDCOL, a non-banking financial institute (NBFI), has installed 1523 SIPs with 42.1 MW total capacity using an innovative fee-for-service financing model. IDCOL channels a 50% grant and 35% credit funding to non-governmental organizations (NGOs) or private investors – called sponsors – who install, own, and operate the SIPs in diesel irrigated off-grid areas. The sponsors pay 15% of the total SIP cost upfront. Farmers pay irrigation fees to the sponsors, and sponsors use the income to pay IDCOL's loan and cover their operational costs. After loan repayment, the revenue accrues as profit to sponsors. The IDCOL SIPs are mostly large systems with an average panel size of 28-kilowatt peak (KWp) (Buisson et al. 2022). The main advantage of the IDCOL model is that it provides better quality and affordable irrigation services to small and marginal farmers who do not have to make upfront investments for SIPs (Buisson et al. 2022; Mitra et al. 2022). But these SIPs depend a lot on boro cultivation in the SIP command areas for their financial sustainability, with a large amount of unutilized capacity in seasons other than boro paddy. Grid integration of IDCOL SIPs will substantially improve the financial sustainability of this model (Mitra and Mukherji 2022).

Grant and subsidy models of BMDA, BADC, and BREB: Group and Individual ownership of SIPs

Government institutions like BMDA, BADC, and BREB have followed the more conventional approach of SIP expansion by financing individual farmers or groups of farmers through grants or a combination of loans and grants.

BMDA and BADC have installed SIPs with farmer groups in off-grid areas through 100% grant financing of the capital expenditure. Under this model, farmer committees operate and maintain these SIPs. The farmers' group decide on the irrigation fees to cover the operation and maintenance costs. This model supports smaller-sized SIPs (4-5 horsepower (HP)) fitted in a dug well (in the case of BMDA) and is suitable for vegetable cultivation, and larger solar low lift pumps (both by BMDA and BADC), which draw water from rivers or canals. These SIPs also provide hassle-free irrigation services to small and marginal farmers and allow a more diversified cropping system than boro paddy. However, given that these are 100% grant-based, their scaling potential is limited (Mitra et al. 2021).

In the individual ownership model implemented by the BREB, individual farmers or groups of a few farmers can apply for a subsidized SIP. Depending on the pump size, farmers get a 62% to 66% grant from BREB, and the rest is a combination of a loan (30% to 35%) and an upfront equity payment by the farmer. The grid-connected SIPs are fitted to deep or shallow tube wells with pump sizes varying between 3-15 HP. Since these are grid-connected, farmers can sell the excess energy into the national grid (Mitra et al. 2021).

The complexity of the agri-food system in Bangladesh, with small and fragmented landholdings, a large number of tenant farmers, diverse cropping patterns, and irrigation sources, requires multiple institutional models for scaling up SIPs in fair and inclusive ways. In this context, the co-existence of these diverse institutional and financial models is an important indicator of the potential scalability and appropriateness of SIPs under different conditions.

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Project

The Solar Irrigation for Agricultural Resilience in South Asia (SoLAR-SA) project aims to sustainably manage the water-energy and climate interlinkages in South Asia through the promotion of SIPs. The main goal of the project is to contribute to climate-resilient, gender-equitable, and socially inclusive agrarian livelihoods in Bangladesh, India, Nepal and Pakistan by supporting government efforts to promote solar irrigation. This project responds to government commitments to transition to clean energy pathways in agriculture. All countries in this project have NDC commitments to reduce GHG emissions and SIPs can play a significant role in reducing emissions in agriculture. https://solar.iwmi.org/

About SDC

The SoLAR -SA project is supported by the Swiss Agency for Development and Cooperation (SDC). SDC is the agency for international cooperation of the Federal Department of Foreign Affairs (FDFA). Swiss Agency for Development and Cooperation, which is an integral part of the Federal Council's foreign policy, aims to contribute to a world without poverty and in peace, for sustainable development. SDC, through its Global Programme Climate Change and Environment (GPCCE), helps find solutions to global challenges linked to climate change. It engages in global political dialogue and manages specific projects in the fields of energy, climate change adaptation, sustainable development of mountainous regions and prevention of natural hazards that are likely to influence regional and international policy.

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The International Water Management Institute (IWMI) is an international, research-for-development organization that works with governments, civil society and the private sector to solve water problems in developing countries and scale up solutions. Through partnership, IWMI combines research on the sustainable use of water and land resources, knowledge services and products with capacity strengthening, dialogue and policy analysis to support implementation of water management solutions for agriculture, ecosystems, climate change and inclusive economic growth. Headquartered in Colombo, Sri Lanka, IWMI is a CGIAR Research Center with offices in 14 countries and a global network of scientists operating in more than 30 countries.

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