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Solar Irrigation for Agricultural Resilience

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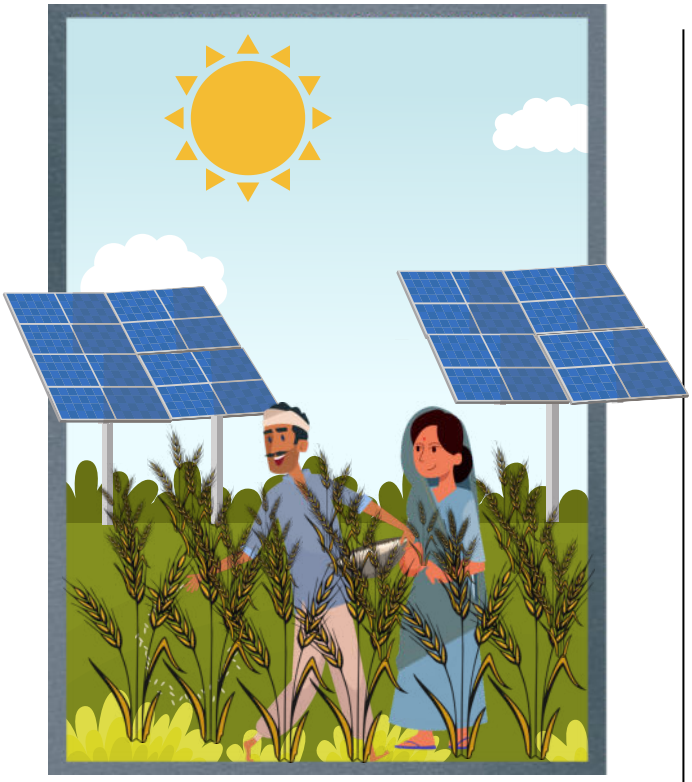

Mitigation and beyond: Multiple co-benefits of solar irrigation in Bangladesh

ISSUE BRIEF SERIES
No. 02

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Irrigation in Bangladesh depends primarily on imported diesel. The Government of Bangladesh (GoB) has started investing in solar irrigation pumps (SIPs) to replace diesel pumps in off-grid areas. The objective is to achieve energy security and reduce agriculture's greenhouse gas (GHG) emissions. Results from a representative survey of farmers in the command areas of the SIPs installed by the Infrastructure Development Company Limited (IDCOL) show that beyond effectively achieving the primary objective of reducing the use of diesel (mitigation), these pumps also provide other significant benefits to the farmers. The study found that these SIPs reduce farmers' cost of irrigation by 20% to 30% compared to diesel irrigation pumps, offer them access to less labor-intensive, time-saving irrigation services, and support their needs for supplementary irrigation in case of delayed monsoons.

Introduction

As per its revised Nationally Determined Contribution (NDC), Bangladesh plans to reduce greenhouse gas (GHG) emissions unconditionally by 6.73% below business-as-usual (BAU) in 2030 and another 15.12% conditional on external financial and technical support. As a part of the mitigation actions, the government has set a target of 176 megawatts (MW) of solar irrigation unconditionally and an additional 164 MW provided it gets external support (MoEFCC 2021).

Bangladesh relies heavily on imported diesel for irrigation, making the country's food sector susceptible to global fuel price shocks. Domestic farmers bear the brunt of increasing diesel prices if the Government of Bangladesh (GoB) decides not to subsidize diesel in the event of global price rises. The consequences are dire for diesel irrigation-dependent boro cultivation, which is crucial for Bangladesh's food security. Dependence on imported diesel also puts a heavy burden on the government's foreign exchange reserves. Substituting diesel pumps with solar irrigation pumps (SIPs) can help achieve energy security while sustaining food security (Mitra et al. 2021, Mitra et al. 2022).

Until mid-2022, Bangladesh has installed 2716 SIPs, with a total capacity of 50.4 megawatts (MW) (SREDA 2020). The Infrastructure Development Company Limited (IDCOL), a nodal agency for renewable energy financing in Bangladesh, has financed around 84% of the installed capacity in solar pumps (1523 SIPs with 42.1 MW capacity). IDCOL uses a unique fee-for-service business model, where a private company or a non-governmental organization (NGO) undertakes the installation, operation, and maintenance of the SIPs, and farmers purchase irrigation services from the operators for a fee (Mitra et al. 2022, Buisson et al. 2022).

The International Water Management Institute's (IWMI) Solar Irrigation for Agricultural Resilience (SoLAR) project in Bangladesh conducted a survey covering 900 farmers (both IDCOL SIP farmers and non-SIP farmers) from 60 villages in Rangpur and Rajshahi divisions in north-west Bangladesh for the agricultural year 2020-21. These two divisions cover 70% of IDCOL SIPs installed so far. The study found that transitioning to solar-based irrigation provides various benefits to farmers, besides mitigating diesel-driven carbon emissions in agriculture (Buisson et al. 2022).

Mitigation benefit: SIPs reduce diesel use

Farmers who receive irrigation services from IDCOL SIPs have substantially reduced diesel use for irrigation. The use of diesel within the SIP command area is just 8% during the boro season (Kharif 1), 3% during the aman season (Kharif 2), and 22% during the Rabi season. The slightly higher use of diesel during the Rabi season is attributable to vegetable cultivation. For vegetables requiring more controlled water application, some farmers prefer to use smaller diesel pumps.

Using a bottom-up approach for estimating carbon dioxide (CO) emissions, diesel use in irrigation is calculated from the number of diesel pumps, the number of irrigation hours, the area under diesel irrigation, and the average hourly diesel consumption of a typical diesel pump. Results from the IWMI survey show that, on average, irrigating one acre for three seasons (Kharif 1, Kharif 2, and Rabi) in a year requires ~ 65 liters of diesel (Buisson et al. 2022). But the average diesel use is reduced to just seven liters for an acre of land that comes under IDCOL SIP irrigation, leading to a savings of 58 liters per acre. This reduction in diesel use translates to an avoided CO emissions of 2.8 metric tonnes of CO per SIP (EPA n.d.), or 4293 metric tonnes of CO from the 1523 IDCOL SIPs per year.

The average command area of a diesel pump is approximately 5.9 acres compared to 18 acres served by an IDCOL SIP (Buisson et al. 2022). If the GoB replaced all 1.24 million diesel pumps irrigating 2.99 million hectares (Buisson et al. 2022, BADC 2020) with about 400,000 IDCOL-type SIPs, that could translate to reduced emissions of 1.2 million metric tonnes of CO per year. Since this data pertains to areas where IDCOL SIPs are located, extrapolating the numbers for entire Bangladesh has some limitations as irrigation water requirements may differ elsewhere. In addition to clear mitigation benefits, several other benefits of SIPs can potentially lead to better adaptation outcomes for the farmers.

Adaptation co-benefit 1: SIPs reduce farmers' out-of-pocket expenses for buying irrigation water

The plot-level cost of buying irrigation water from IDCOL SIPs is 20% to 30% lower than the cost of purchasing water from diesel pump owners. The savings are higher for irrigation-intensive crops like boro paddy (Fig. 1). Also, in terms of the quantity and quality of water received from the seller, the percentage of water-buyers who disagreed that they were satisfied is comparatively lower when buying from solar pumps (9% for quantity and 2% for quality) vis-à-vis diesel pumps (15% for quantity and 14% for quality). Similarly, in terms of whether irrigation was received at adequate timing, dissatisfaction is substantially higher amongst water buyers from diesel pumps (36%) as compared to solar pumps (only 19%) (Buisson et al. 2022).

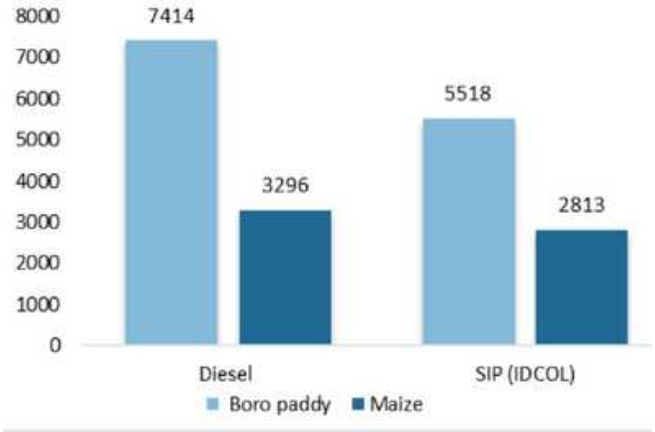

Figure 1. Cost of irrigation across different irrigation sources for boro and maize
Source: Buisson et al. 2022.

Adaptation co-benefit 2: Irrigation from IDCOL SIPs saves time and labor costs

Time spent for irrigation is significantly lower when irrigation is bought from a fee-for-service IDCOL SIP (1.3 hours/day) as compared to irrigation using own diesel pump (2.6 hours/day) or hired diesel machines (1.8 hours/day) (Fig. 2).

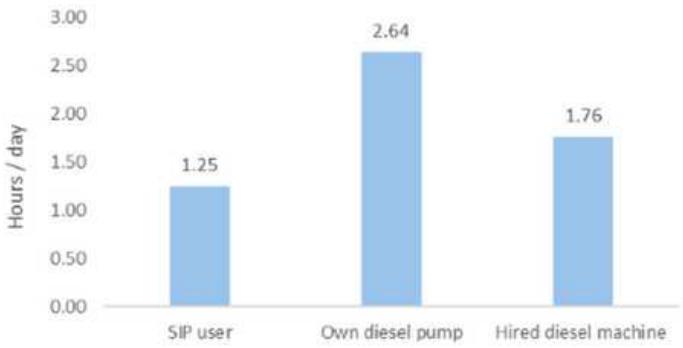

Figure 2. Average hours spent on irrigation on a typical day during the boro season
Source: Buisson et al. 2022.

Fee-for-service model of IDCOL

Diesel irrigation is a labor-intensive activity. Tasks include carrying the pump from home to the field and back, installing it on tubewell, and executing the entire process of irrigation manually to ensure there is no wastage of the expensive diesel. Farmers often hire laborers to carry out these activities, and they can incur approximately BDT 500 – BDT 1000 per season. While in the case of fee-for-service solar irrigation, the operator does a lot of the work – like operating the pump, controlling the irrigation delivery, and monitoring the plots till irrigation demand is met, which frees up the farmer to engage in other productive activities.

Adaptation co-benefit 3: SIPs enable supplementary irrigation during late monsoons

Climate change is making rainfall patterns increasingly erratic in South Asia. In the event of delayed monsoons (as in 2022) or long gaps between two rainfall episodes, SIPs are used for supplementary irrigation in Bangladesh. The share of plots (22%) using SIP irrigation in the rainy Kharif 2 season (primarily for aman paddy) is relatively higher than those using purchased diesel irrigation (18%) (Fig. 3). These numbers are likely to be higher in a drought year.

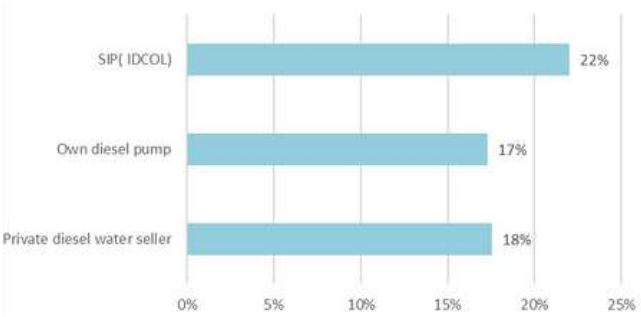

Figure 3. Share of plots using different sources of supplementary irrigation during Kharif 2 (aman) season
Source: Buisson et al. 2022.

Most agricultural mitigation strategies, such as those deployed for reducing emissions from paddy fields, livestock, or fertilizer use, entail at least short-term production losses. However, replacing diesel pumps with SIPs has no such productivity trade-offs. Instead, there are many adaptation and mitigation benefits. Recognizing these co-benefits is essential in prioritizing solar irrigation as a mitigation option in Bangladesh's path to clean energy transition.

A farmer carrying a diesel pump to his field (*photo*: Waresul Haque, NGO-Forum)

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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.

Acknowledgements

The support provided by Sunipa Das Gupta (Communication Consultant, IWMI) for editing the document and Aariz Raza (Communication Consultant, IWMI) for designing it is greatly acknowledged.
Data and technical support provided by the Infrastructure Development Company Limited (IDCOL), the project partner in Bangladesh, is also greatly acknowledged.

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This publication has been prepared with care by the authors. Responsibility for editing, proofreading and design/layout of the document, and for any remaining errors and opinions expressed lies with the authors and not the institutions involved.

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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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Published: December 2022