Beyond climate change mitigation: the impact of solar irrigation on farmers' poverty, time allocation and equity in accessing groundwater in Bangladesh

IWMI International Water Management Institute

CGIAR

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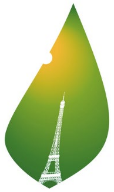
Water Food Energy Climate nexus context in Bangladesh

- 1.6 million pumps, of which approximately 21% are electric-powered and the remainder diesel-powered.

- Diesel pumps irrigate 3.0 million hectares and 2.3 million hectares irrigated from electric pumps
- Water intensive boro paddy essential for food security

- GHG emissions from the agricultural sector in Bangladesh for 2014–15 are 76.79 million tons (Mt) carbon-dioxide equivalent, black carbon emissions
- USD 2.6 billion spent per year on imported diesel
- Black carbon emission causing health hazards due to poor ambient air quality

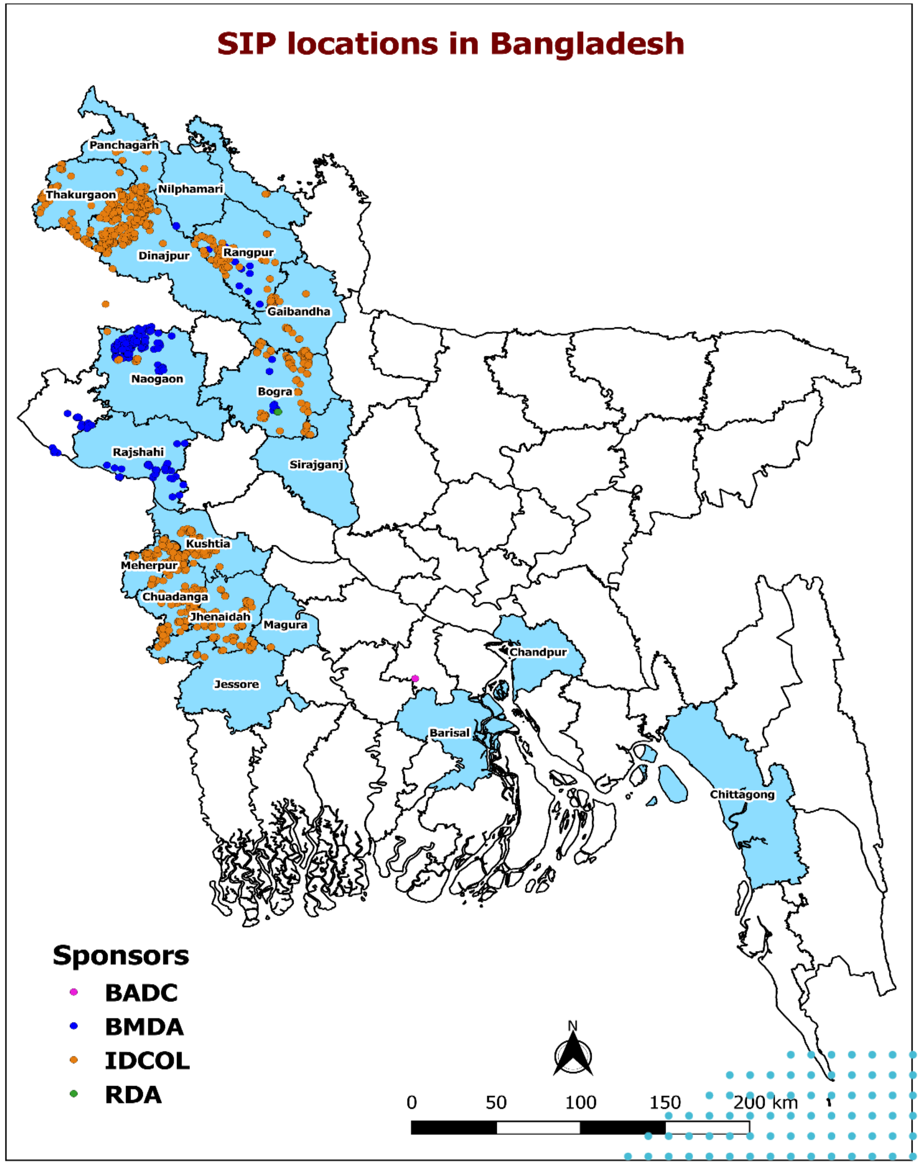


- Pledge to make a 20% reduction of GHG emissions by 2030.
- Renewable Energy Policy of Bangladesh, 2008 has set a target to obtain least 10% of its power needs through renewable sources by 2020.

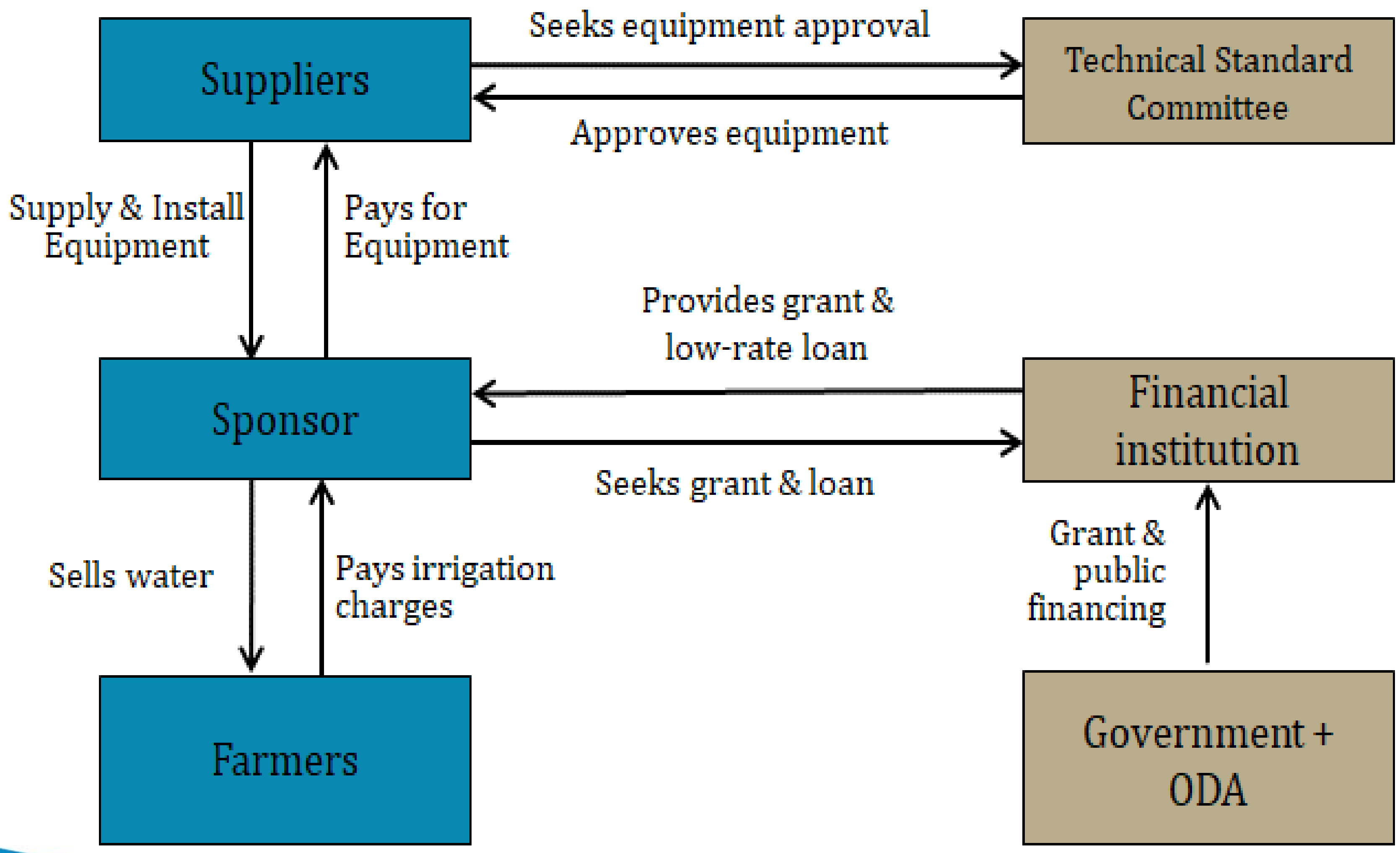
Current scenario of solar irrigation in Bangladesh

2464 Solar Irrigation Pumps (SIP)
49.96 MWp installed capacity

- **Infrastructure Development Company Limited (IDCOL)**
  - So far 1619 operational SIPs, 44.85 MWp
  - Target 10,000 SIPs by 2027
  - Development partners and Government of Bangladesh
  - Fee for service model
- **Bangladesh Rural Electrification Board (BREB)**
  - 60 SIPs intalled
  - ADB funded project for 2000 SIPs
  - Individual ownership model
- **Barind Multipurpose Development Authority (BMDA)**
  - 661 SIPs
  - Surface water pumps
- **Bangladesh Agricultural Development Corporation (BADC)**
  - 48 SIPs
  - Group ownership model
- **Rural Development Authority (RDA)**



Fee-for-Service modalities



SoLAR Impact Assessments of SIPs in South Asia

Mitigation

Adaptation and resilience building

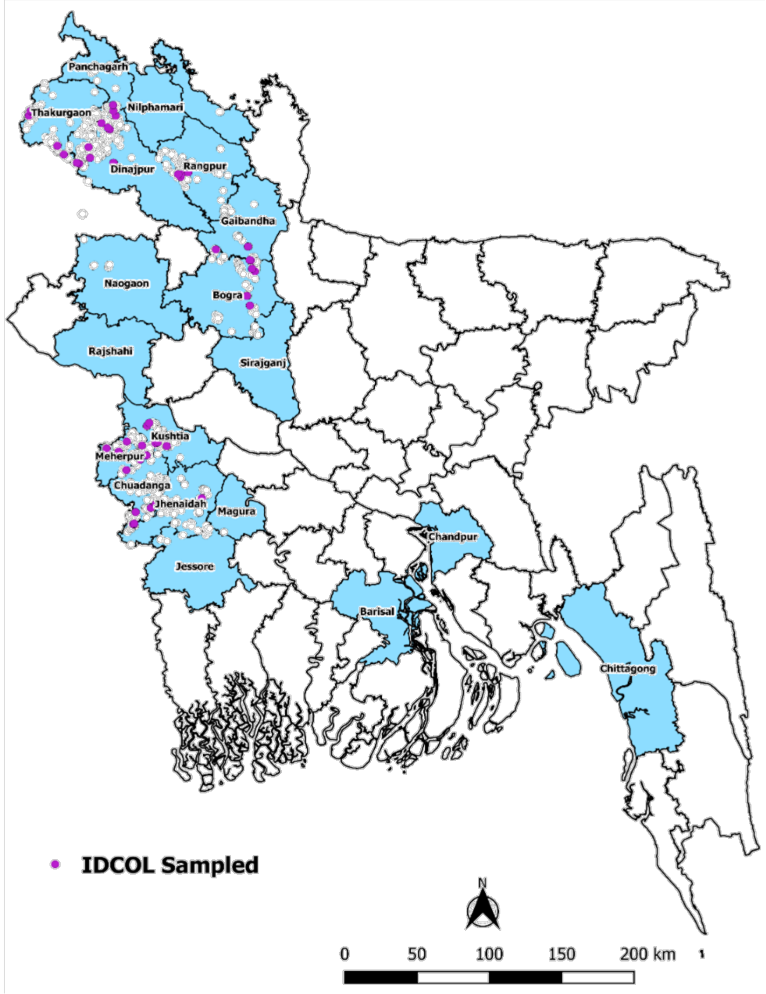
Gender, equity and social inclusion (GESI)

Groundwater sustainability

METHODS | # SIP surveys

- Sample of **83 IDCOL SIPs randomly selected and representative of locations, NGO/private sponsors, years of approval**

- **Phone surveys** with SIP operators
- **4 rounds** collected: *kharif* 2 2020, *rabi* 2020-21, *kharif* 1 2021, *kharif* 2 2021



	Title	Content	Round 1 Kharif 2 2020	Round 2 Rabi 2020-21	Round 3 Kharif 1 2021
Section 1	Introduction and consent		✓	✓	✓
Section 2	Identification		✓	✓	✓
Section 3	SIP characteristics	Technical specification, command area, other agricultural services in the SIP sites, damages	✓	✓	✓
Section 4	Coverage	Plot, farmers, and crops served	✓	✓	✓
Section 5	Fees	Amount collected from the previous season, arrear of payment	✓	✓	✓
Section 6	Operations	Time of operation (days, hours), meter reading if available, complains	✓	✓	✓
Section 7	COVID-19	Disruption by the measures linked to the covid-19 pandemic and potential consequences on SIP operation and SIP farmers	✓		
	Operators	Socio-economic characteristics, benefits, and tasks		✓	
	Training	Training received by the operator and advisory role			✓

METHODS| Household baseline survey

- Sample of **900 households** from 30 villages
- Village selection: Pipeline villages -> Treated villages -> Control villages
- Household selection: Stratified random sampling of 15 household

	Number of villages	Number of households
Group A – Treated SIP	20	300
Group B – Pipeline SIP	20	300
Group C - Control	20	300

- Survey conducted in August-September 2022

	Title
Section 1	Introduction / Identification
Section 2	Demographics
Section 3	Farm and cropping patterns
Section 4	Crop economics
Section 5	Water extraction, practices and perception on irrigation sources
Section 6	Food consumption and food security
Section 7	Shocks and climate change perception making
Section 8	Social network, extension and training
Section 9	Income sources, loans and saving
Section 10	Housing, assets and decision making

13 CLIMATE ACTION

RESULTS | Reduced diesel use for SIP farmers

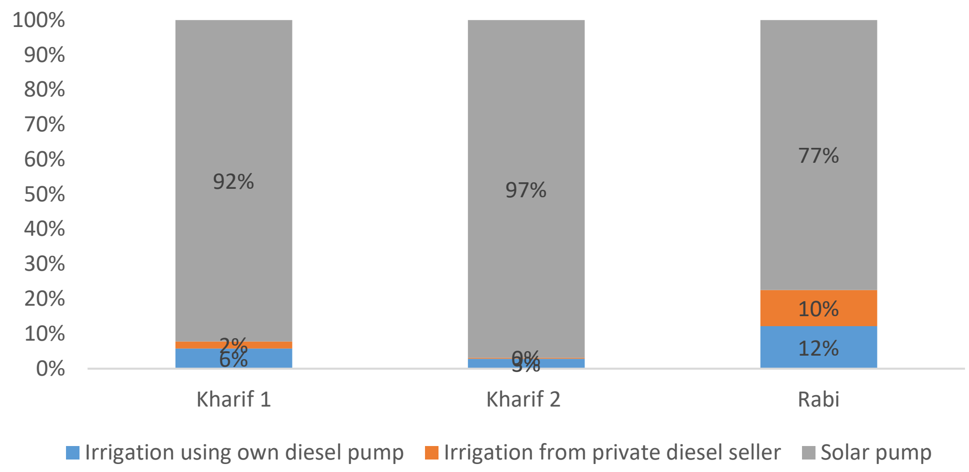


Fig 1 – Source of irrigation within SIP command area

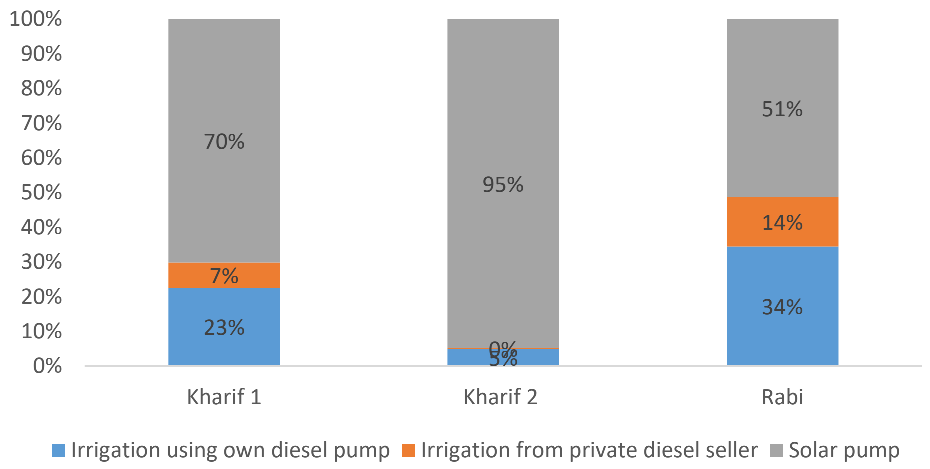


Fig 2 – Source of irrigation (entire irrigated area) for SIP farmers

- Very limited diesel use within the SIP command area

- SIP farmers who were previously irrigating from 100% diesel (from own pump or buying) now have 70% of their total irrigated area from solar sources in kharif 1, 95% in kharif 2 and 51% in rabi.

Source: Data collected from household survey of 900 farmers during Aug-Sept -2021.

RESULTS | Cheaper irrigation and increased incomes

Rising Fuel price

- Diesel : 65 BDT/litre ➔ 80 BDT/litre in 2022
- Subsidised Electricity : 2.3 BDT/unit in 2012 ➔ 4.2 BDT/ unit in 2022 ➔ expected to increase substantially this year

Solar irrigation substantially cheaper

- 20-30% cheaper than diesel, greater saving in highland plots
- 70% SIP farmers in our survey indicates saved irrigation cost

Spending of saved cost

1. Household expense (48.3%)
2. Investment in livestock (38.1%)
3. Investment in agriculture assets (33.7%)

Source: Data collected from household survey of 900 farmers during Oct -2021 + FGDs

RESULTS | Less time spent on irrigation and convenience

Less time spent on irrigation

- 99% farmers in our survey agree
- Time savings if irrigation from service provider than owned pump/ hired machinery (irrespective of diesel/electric)

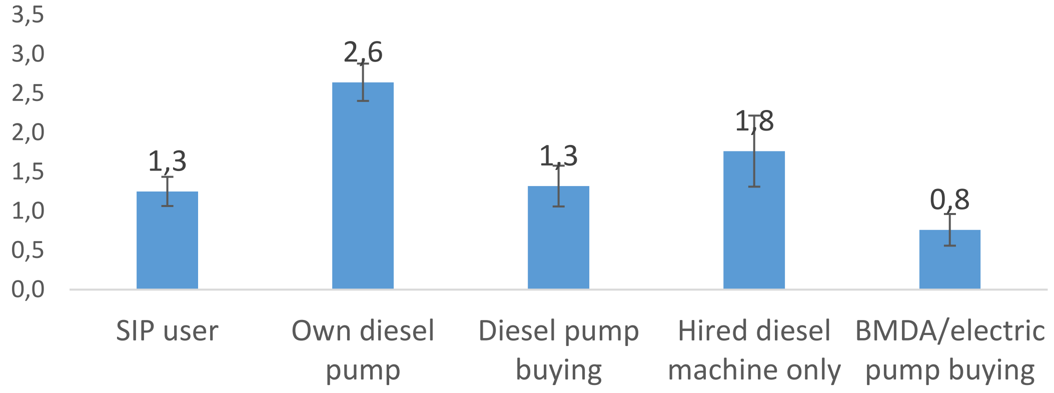


Fig 3 - Hours spent on irrigation per day during Boro

Spending Saved Time

1. Other income activities (59.5%)
2. Personal time (55.3%)
3. Household care work – (30.2%)

Most convenient

- Timely irrigation
- No need to carry engine, buy diesel regularly, set-up system and monitor

Source: Data collected from household survey of 900 farmers during Oct -2021.

RESULTS | SIP beneficiaries: tenant and marginal farmers

- 36% of the farmers' beneficiaries were **not owners of the land** cultivated and irrigated and were either sharecropper (10%) or leaser (26%).
- 10.9% of tenant only farmers in Khulna division, 16.9% in Rajshadi.
- 62% of the farmers served by SIPs in kharif-2 were **tiny farmers** cultivating less than 0.5 acres of land.

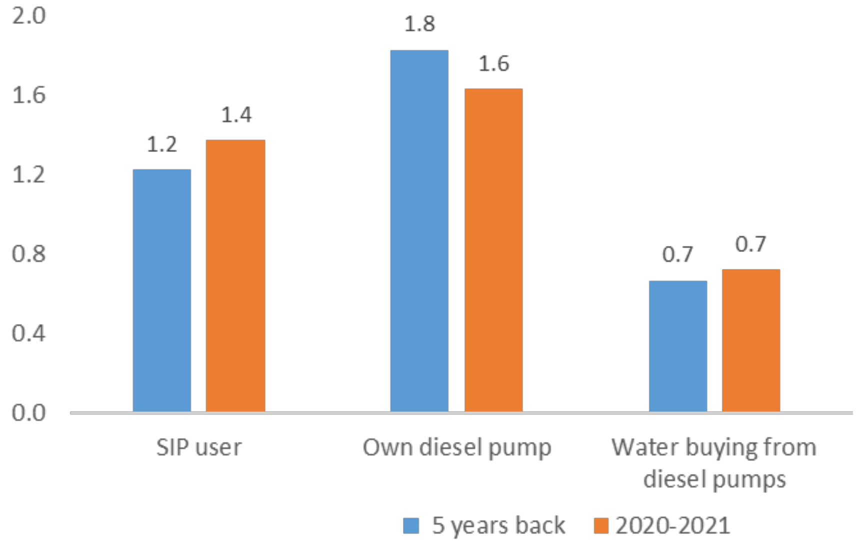


Fig 4 – Total cultivated area (in acres)

- Diesel pump owners tend to be **larger farmers**, followed by SIP users; diesel water buyers cultivate smaller areas on average.
- **SIP users have increased their area cultivated** in the last 5 years, while farmers irrigated from their own diesel pump decreased their areas on average.

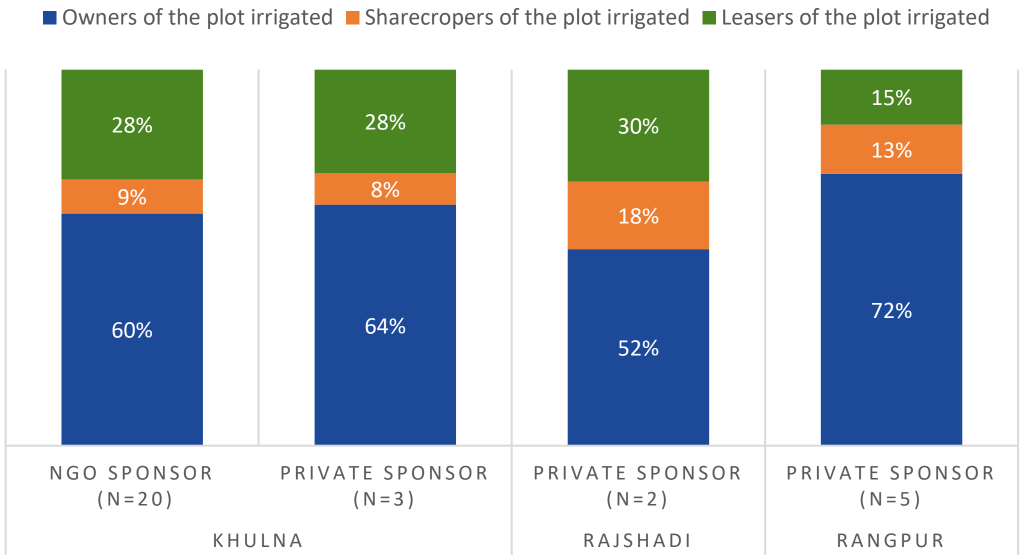
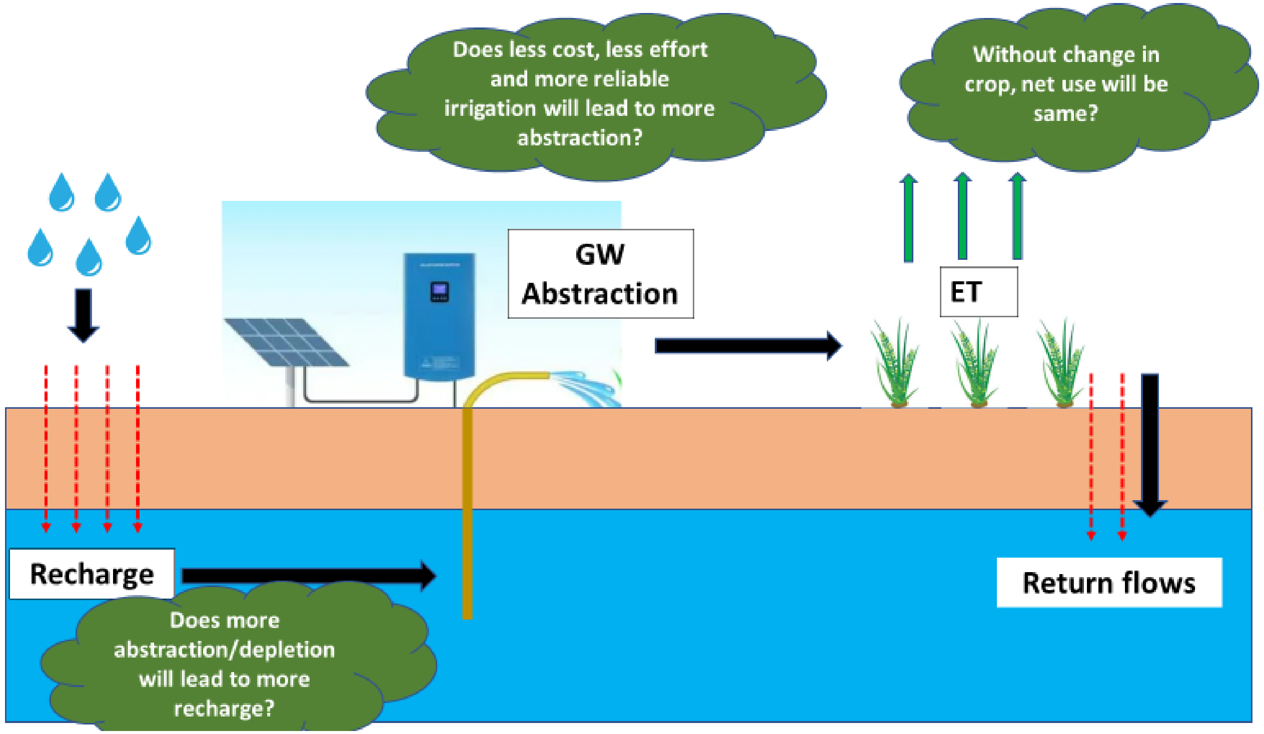


Fig 5 - Land tenure of the SIPs' irrigated plots

Source: Data collected from household survey of 900 farmers during Aug-Sept -2021 and from SIP survey of 83 sites from July 2020 to July 2021.

RESULTS | SIP and groundwater use

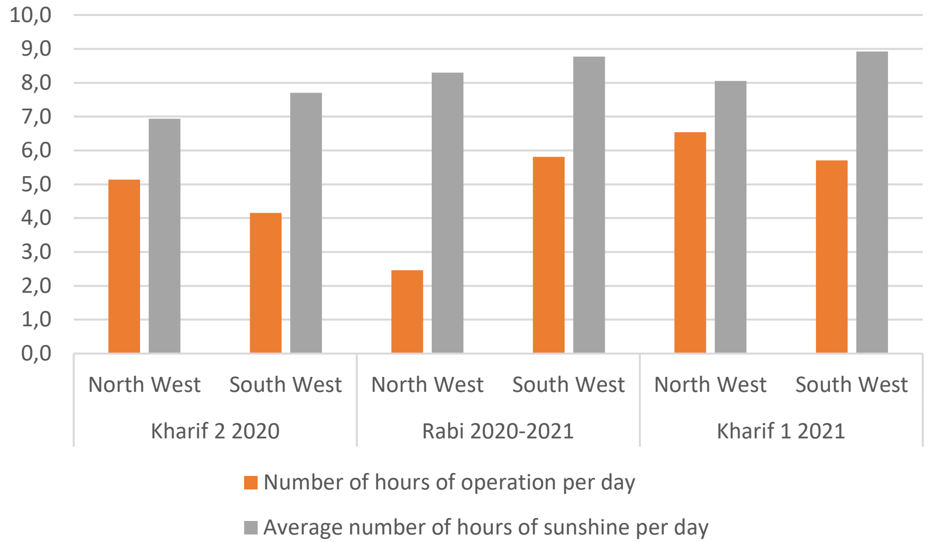


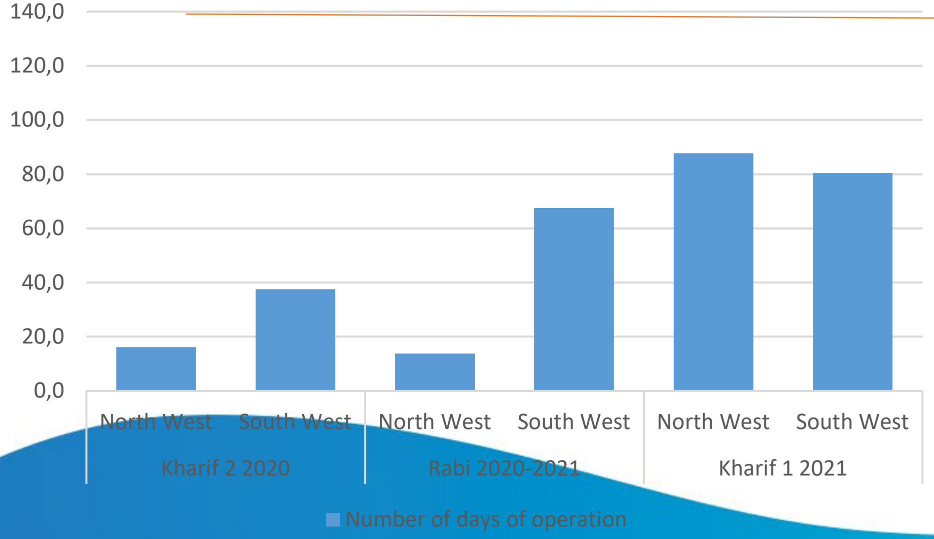
- Lower number of irrigations and shorter duration from SIP as compared to diesel pumps
- But when flow rate is considered, higher application rate in cubic meter per acre of irrigated land
- Confirmation needed based on actual measurements and put into the context of groundwater sustainability analysis and groundwater regional modelling

	Number of irrigations	Hours of irrigation per acre	Estimated water abstraction per acre (cubic meter/acre)
Diesel private seller	19.4	74	1518
Diesel own pump	18.5	63.6	1306
BMDA/Electric private	16.2	39	
Solar pump IDCOL	18.3	53.3	2192

RESULTS | The potential of grid integration

Fig 6 - Number of hours and days of operation





- SIP operation **does not use the full potential of the panels** in terms of number of days and number of hours of operation per day.
- If SIP operation remains stable, the energy produced from 1.5 to 5.8 hours per day can be **evacuated to the grid**.
- Potential income from energy selling could be equivalent or higher than the income from irrigation services.
- Potential slightly higher in South West with higher irradiation.

Source: Data collected from a representative sample of 83 IDCOL SIP from July 2020 to September 2021.

Take away messages and discussion

- SIPs in Bangladesh have a clear mitigation potential, provided rapid upscaling is implemented
- Co-benefits in terms of
  - Poverty reduction
  - Household well-being
  - Job opportunities
  - Equitable access to energy
- Drawbacks?
  - Groundwater abstraction to be assessed and potentially mediated by grid integration
  - Climate change adaptation and crop diversification
  - Financial sustainability and climate justice issue
  - Long term costs, waste and recycling issues

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Thank you.

For more information, questions and comments,
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or visit the SoLAR project website: https://solar.iwmi.org/.

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