Solar Powered Irrigation to enhance climate resilience in the agricultural sector of Bangladesh

16 March 2022
Latitude: 20°34’ & 26°38’N & Longitude: 88°01’ & 92°41’E

Total Area: 148,460 km²
Population: 167.43 Million
Per Capita Income: $2,227 (FY 2020-21)
GDP Growth Rate: 5.2 % (FY 2020-21)
Agriculture in Bangladesh

- **Total Agricultural Land**: 8.58 million Hectare
- **Intensity of Cropping**: 194%
- **GDP Contribution**: 13.29%
- **Employment Contribution**: 40.60%
- **Major Seasons**: 3 Seasons
- **Major Crops**: Rice, Wheat, Maize, Potato, Jute, Pulses, & Oil seeds
- **Dominant Food Crop**: Rice (covering 75% agricultural land)
- **Achievements**:
  - 3rd Largest Rice Producer
  - 2nd Largest Jute Producer
  - 3rd Largest Vegetable Producer
  - 7th Largest Potato Producer

![Distribution of Agricultural Land](image)
Impact of Climate Change on Agriculture of Bangladesh

- South Asia:
  - Most of the countries are climate vulnerable
  - Climate impacts can reduce GDP by 1.8% annually by 2050 (ADB)
  - Annual temperature increase in the region between 1990 and 2100
    - ~4.8°C – high emissions scenario and
    - ~1.4°C – rapid emission reduction scenario

- Bangladesh:
  - Climate Change Vulnerability Index – most vulnerable country (IFC)
  - Increased risks of floods and droughts due to:
    - changing precipitation patterns and
    - higher temperatures
  - Observed trends – shift in seasonal precipitation patterns and erratic rainy days
  - Temperature rise is impacting crop yield – irrigation requirement increases
Irrigation Scenario of Bangladesh

**Irrigation pumps run by electricity**
- No. of pumps: 340,000
- Area coverage: 2.3 million hectare
- Electricity Consumption: 1,500 MW

**Irrigation pumps run by diesel**
- No. of pumps: 1.24 million
- Area coverage: 3 million hectare
- Diesel Consumption: 1.3 million tons/year

*Source: Bangladesh Agriculture Development Corporation
Energy and Mineral Resource Division, Bangladesh*
Impact of Diesel Pumps: Benefit of SIPs

- Burns diesel – emits CO₂
- Spills fuel – contaminates water
- Uses earthen channel, distance between pumps not maintained
- Farmers need to carry pump and diesel to field
- Requires frequent maintenance, effective life 5 years.
- Difficult for supplementary irrigation - reduces crop yield

• SIP involves zero emission, lower water loss, less O&M expenses, third-party, after-sales services, long equipment life & 20-30% lower irrigation costs.
<table>
<thead>
<tr>
<th>Organization</th>
<th>No. of pumps</th>
<th>Installed Capacity [MWp]</th>
<th>Operation modality</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDCOL</td>
<td>1,515</td>
<td>40.00</td>
<td>Private sector led business model – combination of grant, loan &amp; equity</td>
</tr>
<tr>
<td>BMDA</td>
<td>661</td>
<td>3.44</td>
<td>Subsidized lease arrangement with the community</td>
</tr>
<tr>
<td>BADC</td>
<td>24</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>RDA</td>
<td>2</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>BRRI</td>
<td>7</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>BARD</td>
<td>1</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,210</strong></td>
<td><strong>43.95</strong></td>
<td></td>
</tr>
</tbody>
</table>

In terms of capacity 91% solar pumps have been installed under IDCOL program.

*Source: National Renewable Energy Database-SREDA*
## IDCOL Solar Irrigation Program

<table>
<thead>
<tr>
<th>Installed</th>
<th>Beneficiaries</th>
<th>Coverage/pump</th>
<th>Average Panel Capacity/per pump</th>
<th>Average Pump Capacity</th>
<th>Output/pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,515 pumps (40 MWp)</td>
<td>60,600 farmers</td>
<td>20 Hectare (Boro)</td>
<td>42 kWp</td>
<td>18.5 kW</td>
<td>2 million Litres/day</td>
</tr>
</tbody>
</table>

### Targets to be achieved by 2030:

- **Installation**: 10,000
- **Emission Reduction**: 10 million ton CO₂
- **Supporting**: 400,000 no. farmers

### Targeted SDGs:

- Zero Hunger (2)
- Affordable and Clean Energy (7)
- Climate Action (13)
Development Support

THE WORLD BANK

JICA

KFW

BCRF

GPOBA

USAID

ADB

gf

UNDP
Business Model

Fee-for-Service Model

Suppliers → TSC
Seek system approval
Approves pumps

Sponsor → IDCOL
Provides grant & loan
Seeks grant & loan

Farmers → Development partners
Sells water
Pays irrigation charges
Grant & short term credit

Pay for Equipment
Supply Equipment
Survey on Different Types of Irrigation Pumps – IWMI

- **Quality and Quantity** –
  - SIP preference is highest
  - Dissatisfaction for SIP is low

- **Irrigation Timing** –
  - SIP preference is highest

- **Satisfaction on Tariff** –
  - Satisfaction rate is much higher than diesel

*Source: HH survey of 900 farmers in 2021 by IWMI and NGO Forum.*
Efficient Groundwater Management

Ground Water Management Rule, 2019

Underground pipeline for reduction of water loss

Awareness training on efficient water management

Monitoring static water level

Digital water meter setting training

Demonstration of short-duration crop and water management
SIP Impact on Ground Water (Survey of 1150 pumps)

**Geographical Coverage**
- Rahshahi: 29%
- Rangpur: 10%
- Khulna: 60%
- Chittagong: 1%

**Sound GW replenishment ensured by:**
- SIPs are installed maintaining required distance from nearby irrigation systems
- Efficient and systematic withdrawal of GW compared to diesel pumps
- Field level monitoring mechanism
- Loan-based irrigation service model & operation limited by day hours
- Capacity development of stakeholders

**Static Water Level (ft)**

<table>
<thead>
<tr>
<th>Month</th>
<th>Aug'18</th>
<th>Mar'19</th>
<th>Aug'19</th>
<th>Jan'20</th>
<th>Jul'20</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rangpur</strong></td>
<td>5</td>
<td>15</td>
<td>5</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td><strong>Rajshahi</strong></td>
<td>11</td>
<td>15</td>
<td>15</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td><strong>Khulna</strong></td>
<td>11</td>
<td>16</td>
<td>15</td>
<td>15</td>
<td>9</td>
</tr>
</tbody>
</table>
**Awareness and Capacity Development**

- Training of Farmers: 527 Nos.
- Training of Pump Operators: 68 Nos.
- Training of Pump Supervisors: 29 Nos.
- Technical Training for Suppliers: 2 Nos.

- 15,810 farmers were trained on water management, crop scheduling, fertilizer management, pest control, AWD & seed preservation techniques.
- 2,970 individuals were trained on operation, maintenance & technical aspects of solar irrigation.
Efficient Water Management: AWD

- IDCOL has conducted 124 no. demonstrations since 2018.
- This is now being followed in most of SIP sites.

❖ Alternate wetting and drying (AWD)

- A method of controlled and intermittent irrigation in which the fields are allowed to dry for few days before re-irrigation, without stressing the plants.

- It reduces water demand for irrigation without reducing crop yields.
• Irrigation requirement in treatment plot is **24.5% lower** than the control.
• Yield in treatment plot is **7.5% higher** than in the control plot.
Crop Scheduling

<table>
<thead>
<tr>
<th>Demonstrations</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boro (AWD)</td>
<td>125</td>
</tr>
<tr>
<td>Aus (High Yielding Variety)</td>
<td>105</td>
</tr>
<tr>
<td>Aman (Short-duration)</td>
<td>115</td>
</tr>
<tr>
<td>Rabi</td>
<td>43</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>388</strong></td>
</tr>
</tbody>
</table>

**Major impacts of demonstration activities:**

- Increased land coverage in 1,157 SIP sites
- Farmers now grow Aus (paddy) before heavy rainfall and flood.
- They now can avail irrigation from SIPs, without relying on rainfall.
- Sponsors assist farmers to schedule their crop seedling and transplanting efficiently.
### Categorization of Farmers (Data of 157 SIPs in 2020)

<table>
<thead>
<tr>
<th>Category of farmers</th>
<th>Land ownership(^1)</th>
<th>No. of farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landless</td>
<td>0 to 0.5 acre</td>
<td>7,853</td>
</tr>
<tr>
<td>Marginal</td>
<td>0.51 to 1 acre</td>
<td>2,731</td>
</tr>
<tr>
<td>Small Holder</td>
<td>1.01 to 2.5 acre</td>
<td>840</td>
</tr>
<tr>
<td>Medium</td>
<td>2.51 to 5.0 acre</td>
<td>508</td>
</tr>
<tr>
<td>Large</td>
<td>5.01 acre and above</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>11,932</strong></td>
</tr>
</tbody>
</table>

- 19.6% farmers (2,341 farmers) do not have any land.

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\(^1\) Conversion of Agricultural Land to Non-agricultural Uses in Bangladesh: Extent and Determinants, MD ABUL QUASEM, Bangladesh Development Studies, Vol. XXXIV, March 2011, No. 1, Page 64, section I.3
Financial Benefits to Farmers (157 sites)….1/2

IDCOL recently conducted a survey on 157 SIPs (10.4% pumps under the program).

- In 24% sites a new crop was grown because of water availability.

- Introduction of new crop has increased farmer revenue by 18%.

- Through AWD, paddy yield increased by 7.5%.

- Irrigation tariff is 25% lower in SIP compared to diesel pump.

- Farmer’s net income has increased by 38% due to reduced tariff and higher yield.
## Financial Benefits to Farmers (157 sites)....2/2

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Description</th>
<th>Diesel pump</th>
<th>Solar irrigation</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Paddy yield (kg/ha)</td>
<td>105</td>
<td>113</td>
<td>7.5%</td>
</tr>
<tr>
<td>2</td>
<td>Price of rice (USD/kg)</td>
<td>13</td>
<td>13</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Revenue from rice (USD/ha) (1) x (2)</td>
<td>1,358</td>
<td>1,460</td>
<td>7.5%</td>
</tr>
<tr>
<td>4</td>
<td>Revenue from straw (USD/ha)</td>
<td>37</td>
<td>37</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td><strong>Revenue (USD/ha) (3) + (4)</strong></td>
<td><strong>1,395</strong></td>
<td><strong>1,496</strong></td>
<td><strong>7.3%</strong></td>
</tr>
<tr>
<td>6</td>
<td>Other costs (USD/ha)</td>
<td>631</td>
<td>631</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Irrigation tariff (USD/ha)</td>
<td>297</td>
<td>222</td>
<td>-25%</td>
</tr>
<tr>
<td>8</td>
<td><strong>Net profit (USD/ha) (5)-(6)-(7)</strong></td>
<td><strong>467</strong></td>
<td><strong>643</strong></td>
<td><strong>38%</strong></td>
</tr>
</tbody>
</table>

Net profit per bigha increases by 38%
### Employment Generation under SIP Program

**Direct employment:** 1,858 no.

**Indirect employment:** 320 no.

<table>
<thead>
<tr>
<th>Sponsors</th>
<th>Suppliers</th>
<th>IDCOL</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative employees</td>
<td>55</td>
<td>73</td>
<td>7</td>
</tr>
<tr>
<td>Field supervisor/field engineer/quality inspector</td>
<td>95</td>
<td>90</td>
<td>23</td>
</tr>
<tr>
<td>Pump operator</td>
<td>1,515</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Contractual employee</td>
<td>-</td>
<td>320</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,665</strong></td>
<td><strong>483</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

**Total employment generation: 2,178 no.**

- Direct employment: 1,858 no.
- Indirect employment: 320 no.
Policy Level Interventions of Solar Irrigation

The NDC targets scaling up of SIFs.

Grid integration guideline to utilize excess energy in SIP

- Mujib Climate Prosperity Plan Decade 2030
- Solar Energy Roadmap
- Solar Irrigation Roadmap
### Achievements at a glance

<table>
<thead>
<tr>
<th>Achievements</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence in 5 divisions, 18 districts and 63 upazilas</td>
<td>Developed 29 project sponsors</td>
</tr>
<tr>
<td>Gradually improved business model as per field experience</td>
<td>A pool of 16 equipment suppliers from 8 countries</td>
</tr>
<tr>
<td>System cost reduced by 68% in last 8 years</td>
<td>Irrigation Database of 200 Upazilas</td>
</tr>
<tr>
<td>Irrigation rates reduced by 25% in last 8 years</td>
<td>Set product standard &amp; quality control mechanism</td>
</tr>
<tr>
<td>Multiple crops produced against previous 1/2 crops</td>
<td>Created 2,178 jobs</td>
</tr>
<tr>
<td>System cost reduced by 68% in last 8 years</td>
<td>Successful pilot done on grid integration</td>
</tr>
<tr>
<td>Irrigation rates reduced by 25% in last 8 years</td>
<td>'Grid Integration for Solar Irrigation' guideline drafted by Power Division</td>
</tr>
</tbody>
</table>
Thank You!