

Solar Didis: Women-led Solar Irrigation in Bihar

Early lessons on the efficiency of off-grid solar irrigation
enterprises

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9th India International Water Week · TF-1 · 23 September 2026



Context-specific solar irrigation models

As solar irrigation scales across India and South Asia, there is a need to imagine models that are context-specific, equitable and efficient.

The **Solar Didi model** in India's water-abundant eastern Gangetic plains is one such attempt: it places women at the centre of irrigation and delivers affordable water across a fragmented, resource-poor and feminised landscape.

1

The model

2

The study

3

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4

Trainings



Solar panels of an SHG irrigation group, Harpur village, Muzaffarpur. Photo: IWMI/Tanmoy Bhaduri

Bihar: abundant water, costly and uneven access

THE CONTEXT



Small, fragmented landholdings

Acute land fragmentation, out-migration and tenancy



Fertile soil, abundant groundwater

Yet expensive diesel irrigation has long been a challenge



A rapid shift to the grid

State subsidies improved water access but brought erratic power supply and a heavy subsidy burden



An increasingly feminised landscape

High labour out-migration, with women engaged in farming

57%

of gross cropped area is irrigated

DES 2023

67%

of irrigation potential created is from tube-wells

6th MIC 2017

20k → 0.4M

electric pumps in Bihar, 2017 to 2022

4%

of the population are pump owners

Where the pilot sits: Bochaha block, Muzaffarpur

1 · THE MODEL



Bochaha block (in red), Muzaffarpur district, north Bihar. Source: SE4RL poster, GCWAS 2026



Fragmented landholdings



Majority smallholders



Diesel dependence

Enterprise model

5 HP

solar pump (5 kWp)

1,500 ft

buried pipe network

~20 acres

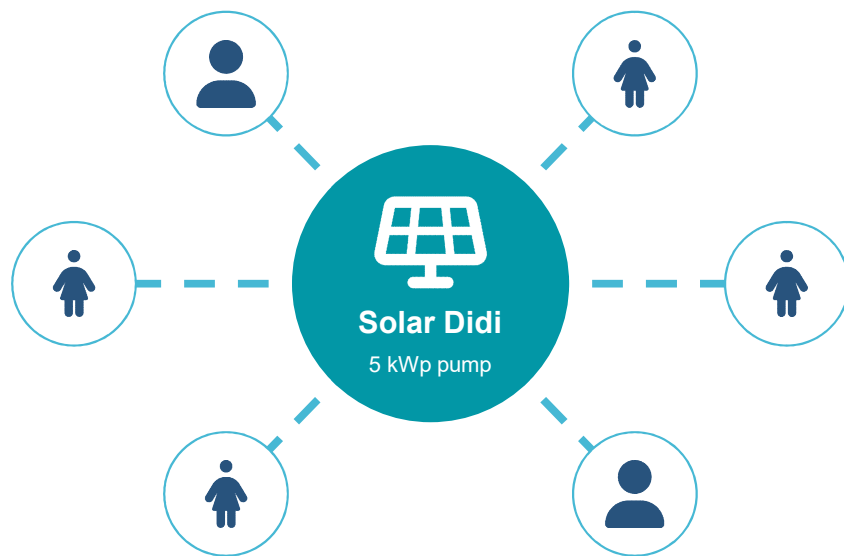
design command area

₹6,00,000

system cost, 50% borne by the entrepreneur through SHG savings and micro-credit

The Solar Didi model: one pump, many farmers

1 · THE MODEL



— buried pipeline to water buyers' plots (many buyers are women)

How it works

- Women from JEEViKA self-help groups own a 5 kWp solar pump with ~1,500 ft of buried pipe
- They sell irrigation, per use, to farmers around them: scheduling, negotiating prices, tracking payments and running the pump
- Medium-term loans at 7% interest; entrepreneurs bear 50% of the cost, a leaner subsidy that builds asset ownership



Irrigation as a women's enterprise

1 · THE MODEL

“

I irrigated for five people and earned 500 rupees. I thought, if I irrigate for six, I earn 600; for seven, 700... That's how I kept going.

Nirmala (name changed)
one of the program's top entrepreneurs

100+

farmers served by Nirmala from a pump at the edge of her 0.4-acre plot

€1,000+

earned by her last year alone

“The men have gone out to work; the woman handles the farming here.”

Kavita Devi (name changed): nearly all of her fifteen customers are women, which is why she wants to extend her buried pipeline

This study: what drives the gap between high and low performers?

2 · THE STUDY



A preliminary look at the efficiency of off-grid solar irrigation enterprises, to identify how to improve ISP performance and design better trainings

Efficiency indicators

Annual operating hours

Revenue billed

Farmers served

Super gross irrigated area

89

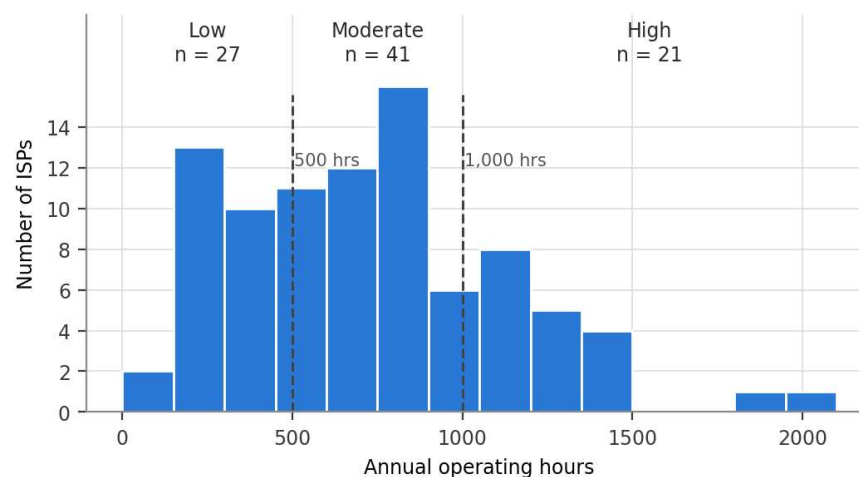
ISPs surveyed, Jun 2025
– May 2026 (of 106 with a full year)

22

in-depth interviews with entrepreneurs

14 + 4

buyer interviews and gender-segregated FGDs

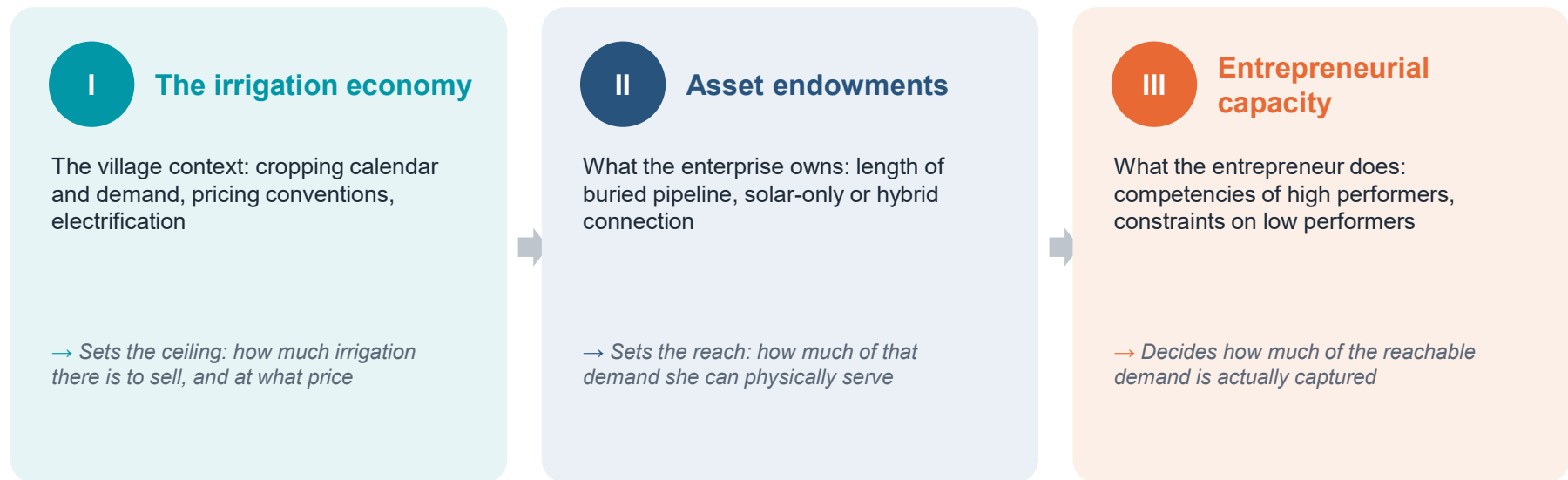


Annual operating hours across 89 ISPs, Bochaha block, Muzaffarpur. Performance bands: low (<500 hrs, n = 27), moderate (n = 41), high (>1,000 hrs, n = 21).

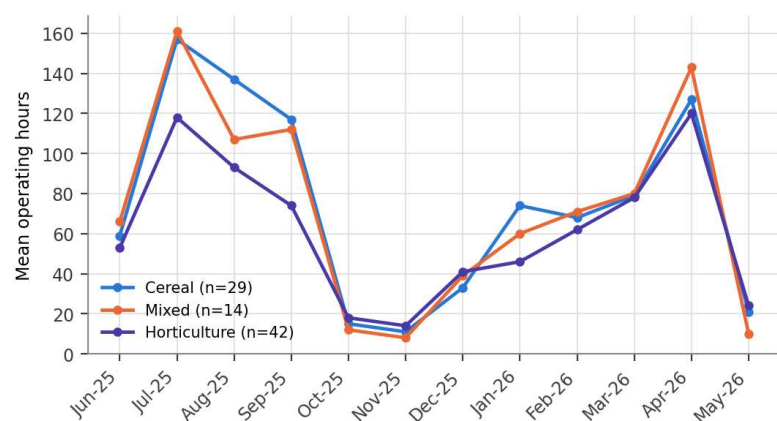
Also drawn on: village profiles for 20 of 27 villages; AKRSP-I MIS records

Reading the performance gap at three levels

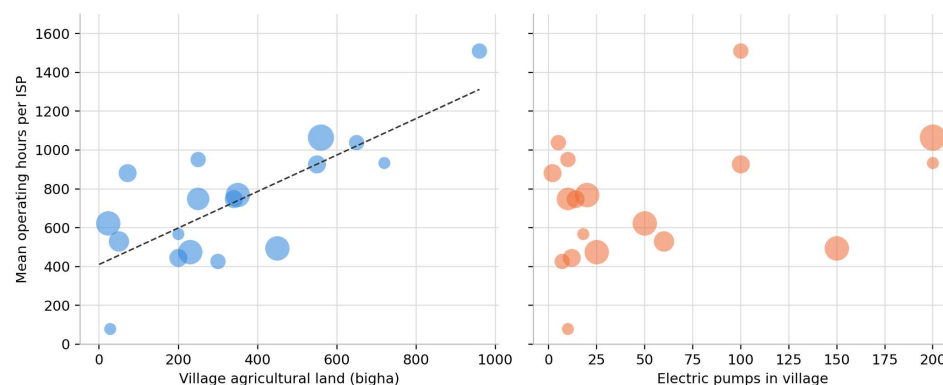
2 · THE STUDY



Farmland drives demand; competing electric pumps matter less



Mean monthly operating hours by cropping belt (n = 85 ISPs)



Village agricultural land (left) and electric pumps (right) vs mean annual operating hours; bubble size = ISPs in village (20 of 27 villages)



Higher pumping hours correlate with more agricultural area in the village

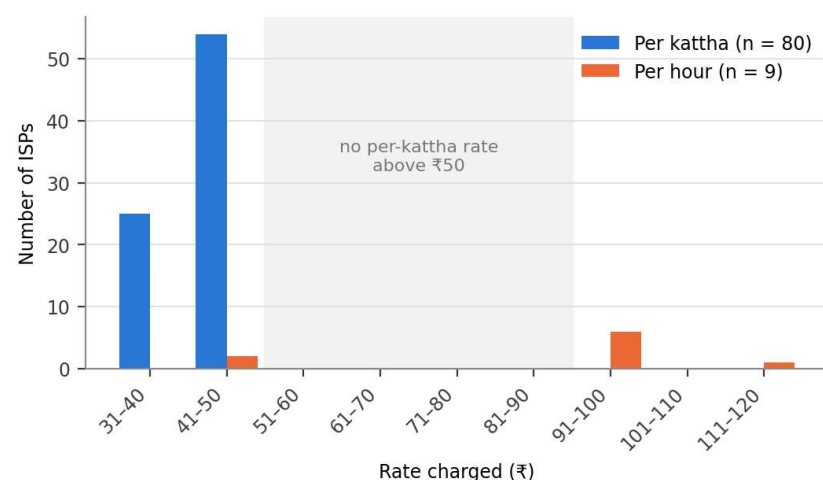


Electric pump density has little bearing on ISP pumping hours

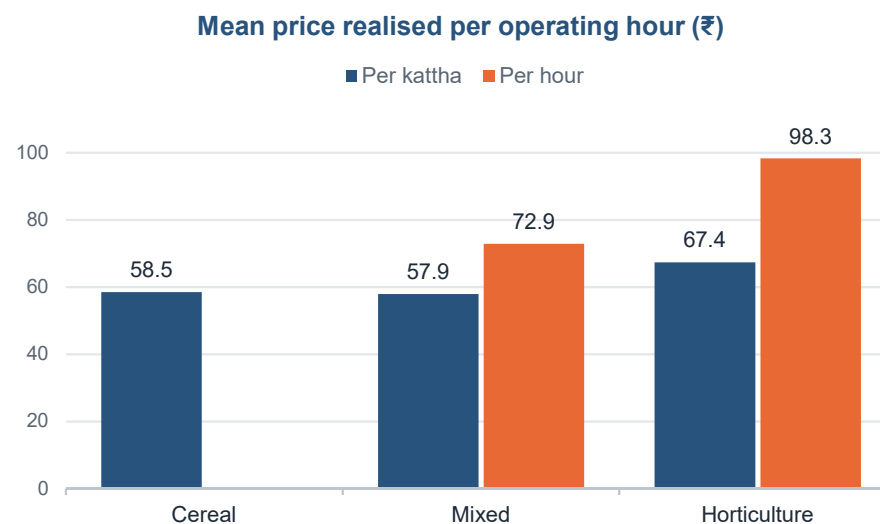


Hours run alike across belts through the year, except a sharp monsoon peak in the cereal belt

Pricing norms are sticky, and those who move past them earn more



Distribution of rates charged, by charging convention (n = 89 ISPs)



80 of 89

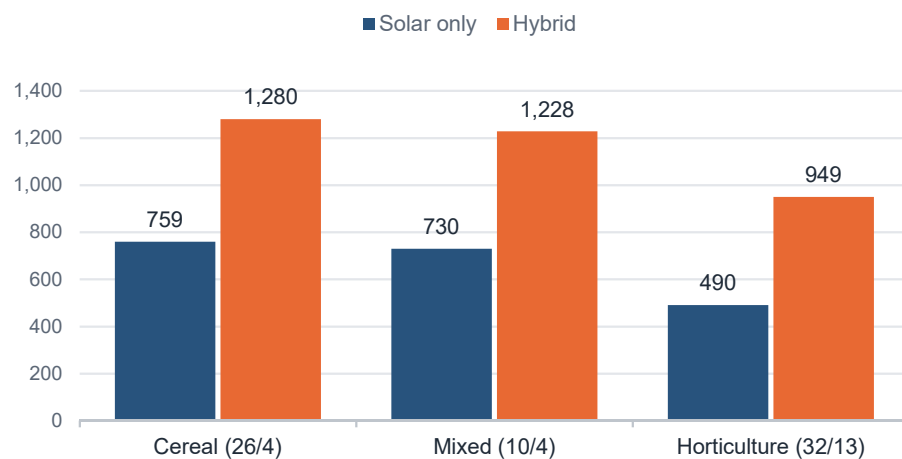
ISPs still charge per kattha, a convention that shifted from per-hour to per-area rates with the move from diesel to grid

₹98 vs ₹67

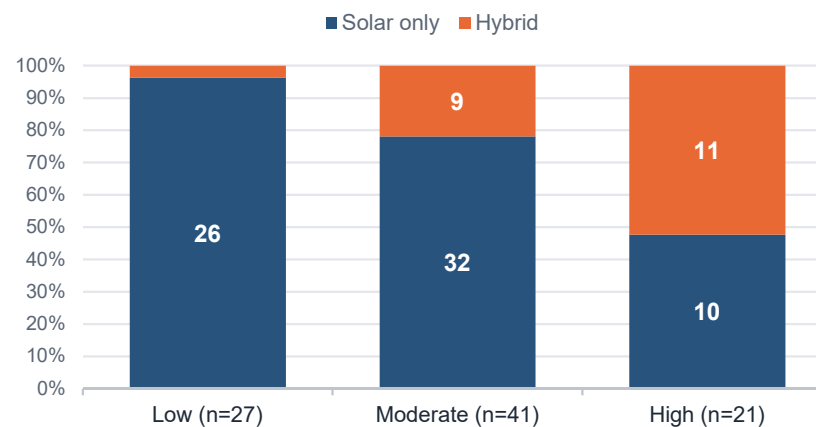
per operating hour in the horticulture belt: per-hour sellers command a much higher return on their pumps

Hybrid connections and pipelines extend an enterprise's reach

Mean annual operating hours, by energy source and belt



Share of ISPs with hybrid connections, by performance band



21 of 89 ISPs have hybrid solar-grid connections: 52% of high performers vs 4% of low performers. Hybrids run longer in every belt.



Buried pipelines reach more area and farmers, but correlate only weakly with revenue ($r = 0.46$), irrigated area ($r = 0.41$) and hours ($r = 0.33$).

The biggest difference is the entrepreneur

III · CAPACITY



What high performers do

Recognising opportunity: actively seek customers; market solar on reliability; extend into flour mills, fish ponds

Building relationships: timely service; help lay delivery pipes; credit for poor farmers and women

Organising delivery: schedule peak demand; supervise running water to prevent losses; keep a ledger

Commercial judgement: recover dues; discounts for prompt payment; hold water until arrears clear

Strategic investment: hybrid connections, longer pipelines, reinvesting earnings



What holds low performers back

No irrigation demand: competing electric pumps; neighbours with their own pumps; unviable pump siting; community or caste issues

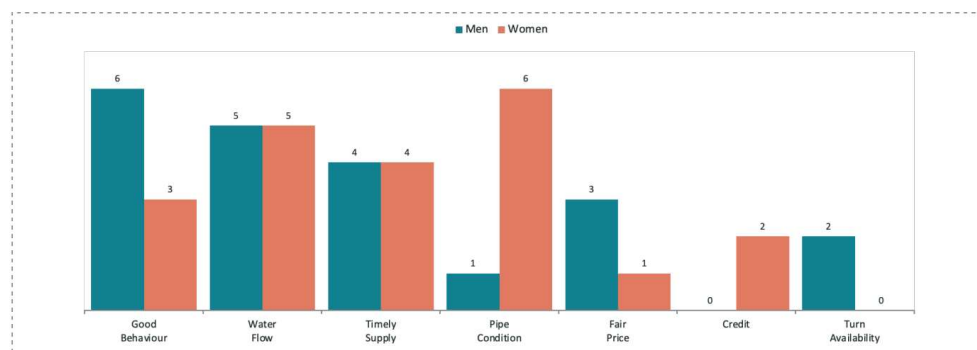
Limited commercial orientation: other income sources; equipment used for other purposes

Financial constraints: binding the growth of the enterprise

Pump downtime: unresolved breakdowns and motor failures

Competencies (after Man, Lau and Chan 2002) and constraints from 22 in-depth interviews with 12 high- and 10 low-performing ISPs, July 2026

What water buyers value in a Solar Didi



Buyer priorities from the bindi-voting exercise, by gender (FGDs, July 2026). Source: IRMA intern report

- Good behaviour and reliability named the most important traits of a water seller
- Solar's stronger flow irrigates the same plot in about half the time
- Hybrid named the best arrangement in vegetable-growing villages
- Women stressed pipe-laying support and credit, as they are paid lower daily wages

“

The water isn't the issue, laying the pipe is.”

A woman water buyer, focus group discussion, July 2026

Where trainings can improve efficiency

-  **Pricing and business:** hourly billing where it fits (horticulture and mixed belts), recovering dues, record-keeping
-  **Operations and water management:** scheduling peak demand, supervising flow to prevent losses
-  **Maintenance:** cutting pump downtime from breakdowns and motor failures
-  **Customer relations:** timely, reliable service; credit; pipe-laying support
-  **Peer exchange:** high performers sharing their best practices



SHG members clean and maintain their solar panels. Photo: IWMI/Tanmoy Bhaduri

Looking ahead



From 10 pumps in 2023 to 159 Solar Didis today, with a target of 500 by 2028



Through JEEViKA and the Government of Bihar, the model could reach thousands of women and millions of hectares of under-irrigated land



It can inform off-grid solar efforts under PM-KUSUM



It holds promise across the Gangetic floodplains of eastern India, Nepal Terai and Bangladesh



Priyanka Devi, a woman farmer in Bochaha block, with her new solar pump.
Photo: IWMI/Tanmoy Bhaduri

