REIMAGINING IRRIGATION

DRIVING RESILIENT FUTURES THROUGH SOLAR

Strategic Insights from IWMI's Experience in India's Water-Energy-Food Nexus

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CGIAR

India’s Water-related Challenges

4%
Of the world's freshwater resources are in India

2%
Of the world's land area

18%
Of global human population

15%
Of global livestock populations

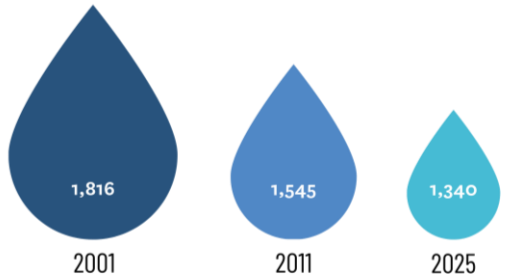
142 million
Hectares of net cultivated area, only 68 M Ha is irrigated, with about 50% being rainfed

Climate change is impacting hydrology and increasing water demand

6-25%
yield reduction is expected by 2100

Land degradation, declining water quality, drying mountain springs, and shrinking wetlands

82%
Of total water withdrawn is used in agriculture, in future more will be diverted to other competing uses due to rapid urbanization, industrialization



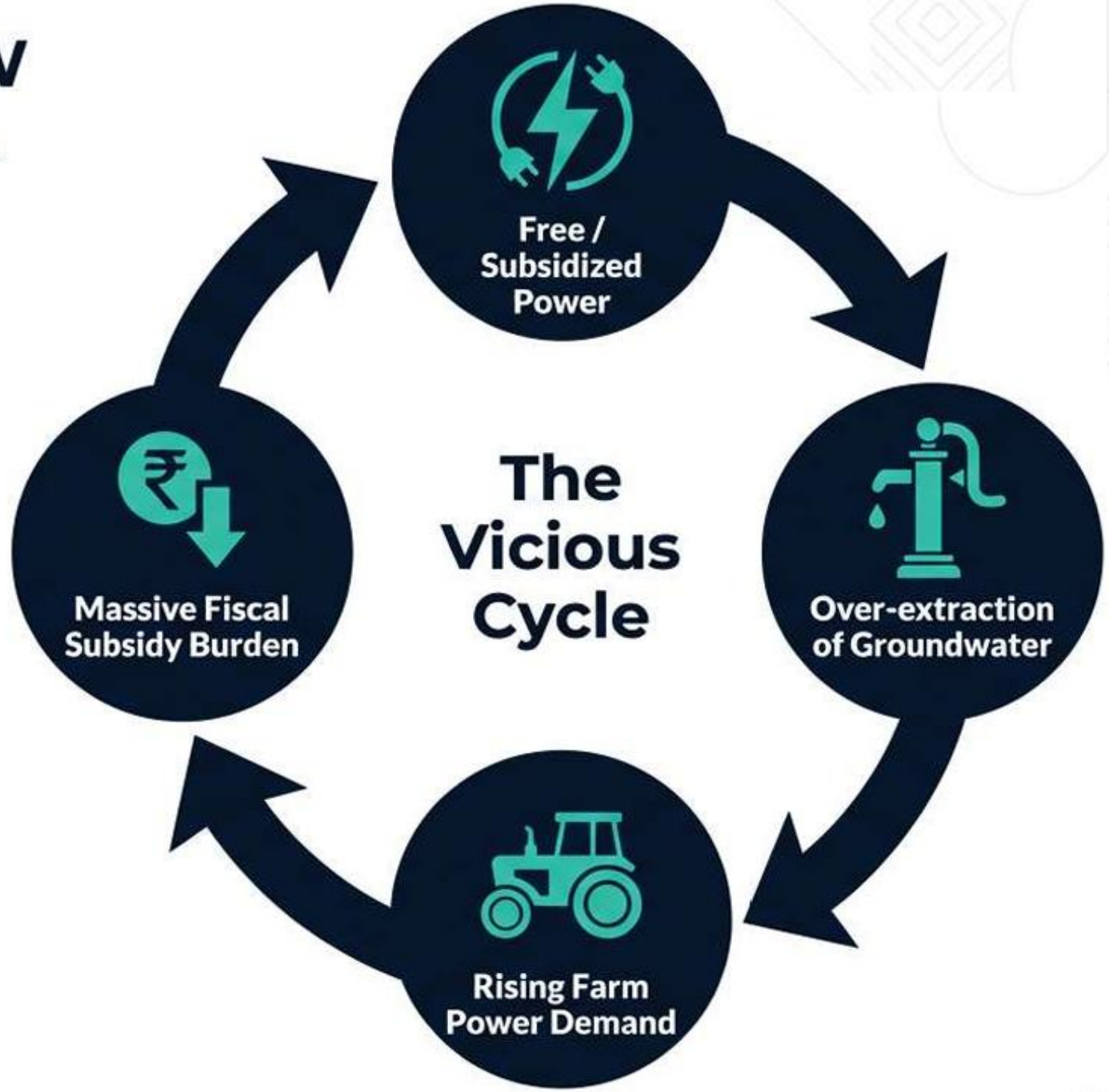
Declining per capita water availability (cubic meters)

70 million
Hectares of farmland effected due to floods and droughts, increasing water risks due to climate change

THE NEXUS TRAP: HOW SUBSIDIES CREATED A CYCLE OF DEPLETION

India's food security gains were historically built on groundwater irrigation powered by subsidized electricity.
This created a tightly coupled system under stress.

Agriculture now accounts for >20% of India's electricity consumption.



A STRATEGIC INFLECTION POINT

Moving from Fossil Dependency to Decentralized Resilience

The Convergence Opportunity

Decarbonization
Shifting away from ~9 million diesel pumps and coal-heavy grid power.

Water-Use Efficiency
Incentivizing conservation through smart financial models.

Farmer Resilience
Reducing operational costs and providing climate-proof energy.

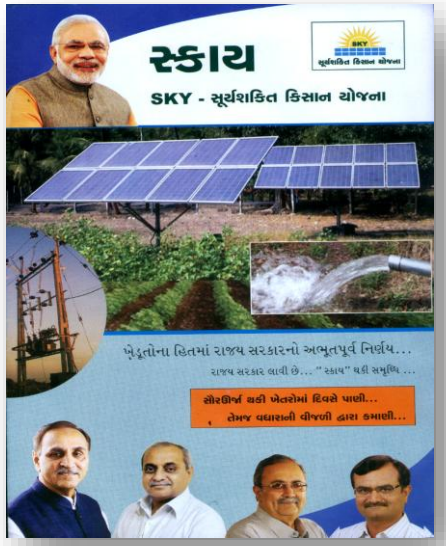
"Solar irrigation enables simultaneous progress on decarbonisation, water-use efficiency, and farmer resilience."

Innovation 1 : Grid-Connected SIPs (Example from Gujarat)

Small Field Experiment
'Proof-of-Concept'

Demonstration Pilot
'Learning-by-Doing'

Replication Pilot
'Learning-by-Doing'



Policy Pilot: SKY
'Scale Experiment'

PM-KUSUM
World's Largest Agri. Solarization Campaign
'Scale Implementation'

2014 2015 2017 2018 2019

IWMI-TATA Water Policy Program
CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems
CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security
CCAFS
german cooperation giz
Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra
Swiss Agency for Development and Cooperation SDC
ISA INTERNATIONAL SOLAR ALLIANCE
SE4RL Solar Energy for Rural Livelihoods
AKRSP Aga Khan Rural Support Programme
THE WORLD BANK
ADB
ICAR
IWMI International Water Management Institute
IKEA Foundation
SUSTAIN+
SoLAR Solar Irrigation for Agricultural Resilience
CInI

Grid-Connected SIPs under Surya Shakti Kisan Yojana (SKY, Gujarat)

THE FINANCIAL ENGINEERING OF SKY

A Shared-Risk Model for Sustainable Adoption

Farmer Upfront Cost + Central Subsidy + State Loan (Govt of Gujarat) = Total Solar Installation

Payback Mechanism

- Loan Repayment: 7 Years
- Incentive: Feed-in Tariff (Rs 3.50/kWh) + Evacuation Bonus (Rs 3.50/kWh)

Farmers sell power instead of over-extracting water.

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Adoption Dynamics & Economic Impact

Drivers vs. Barriers

Barriers

- Risk aversion
- Capital constraints
- Intra-household decisions

Drivers

- Education levels
- Pump size (HP)

Economic Impact

Income: +₹21,900 / year
from electricity sales, ~43% of crop income

ROI: 25-28%
investment recovery in 2 years

Payback: ~8 Years
Full loan repayment achieved

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Sustainable Water & Carbon Mitigation

The Green Trade-off: Sustainable Water & Carbon Mitigation

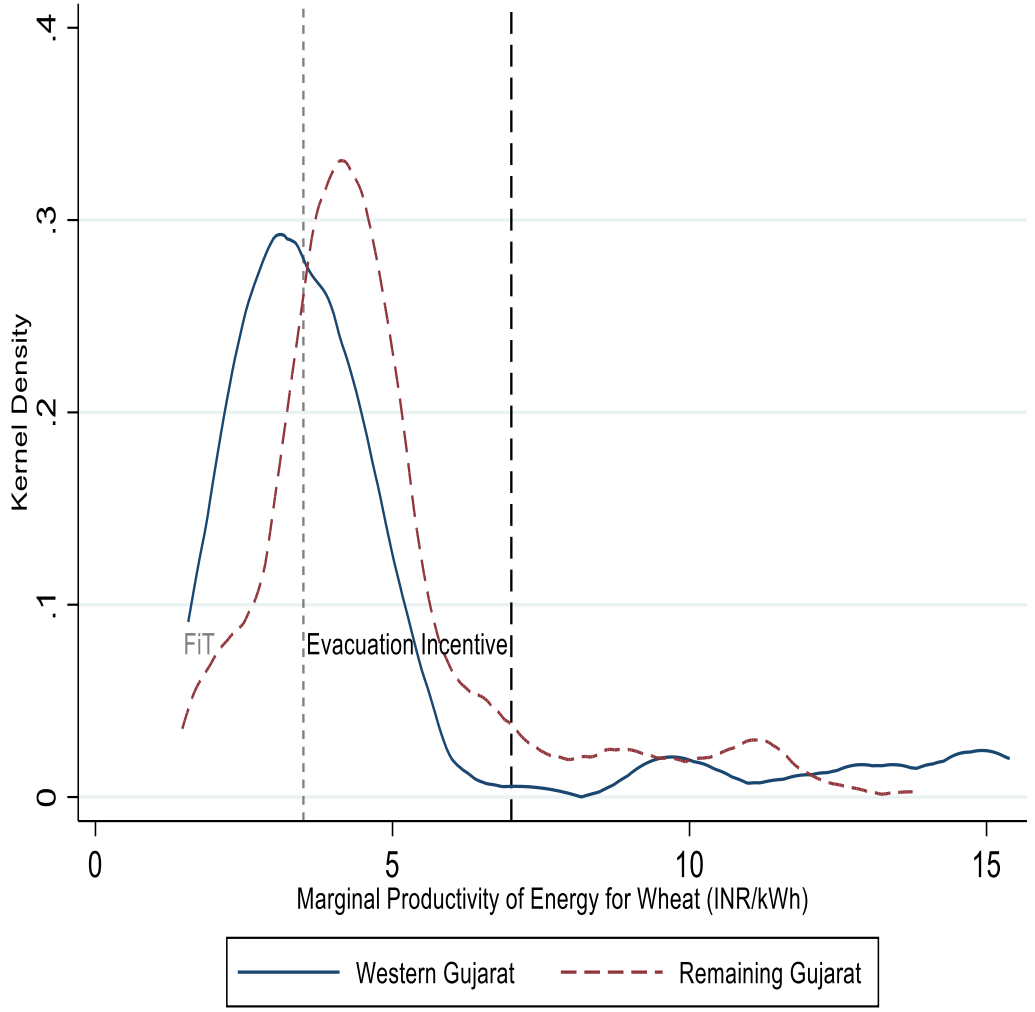
Farmers sell power instead of over-extracting water.

Green Impact

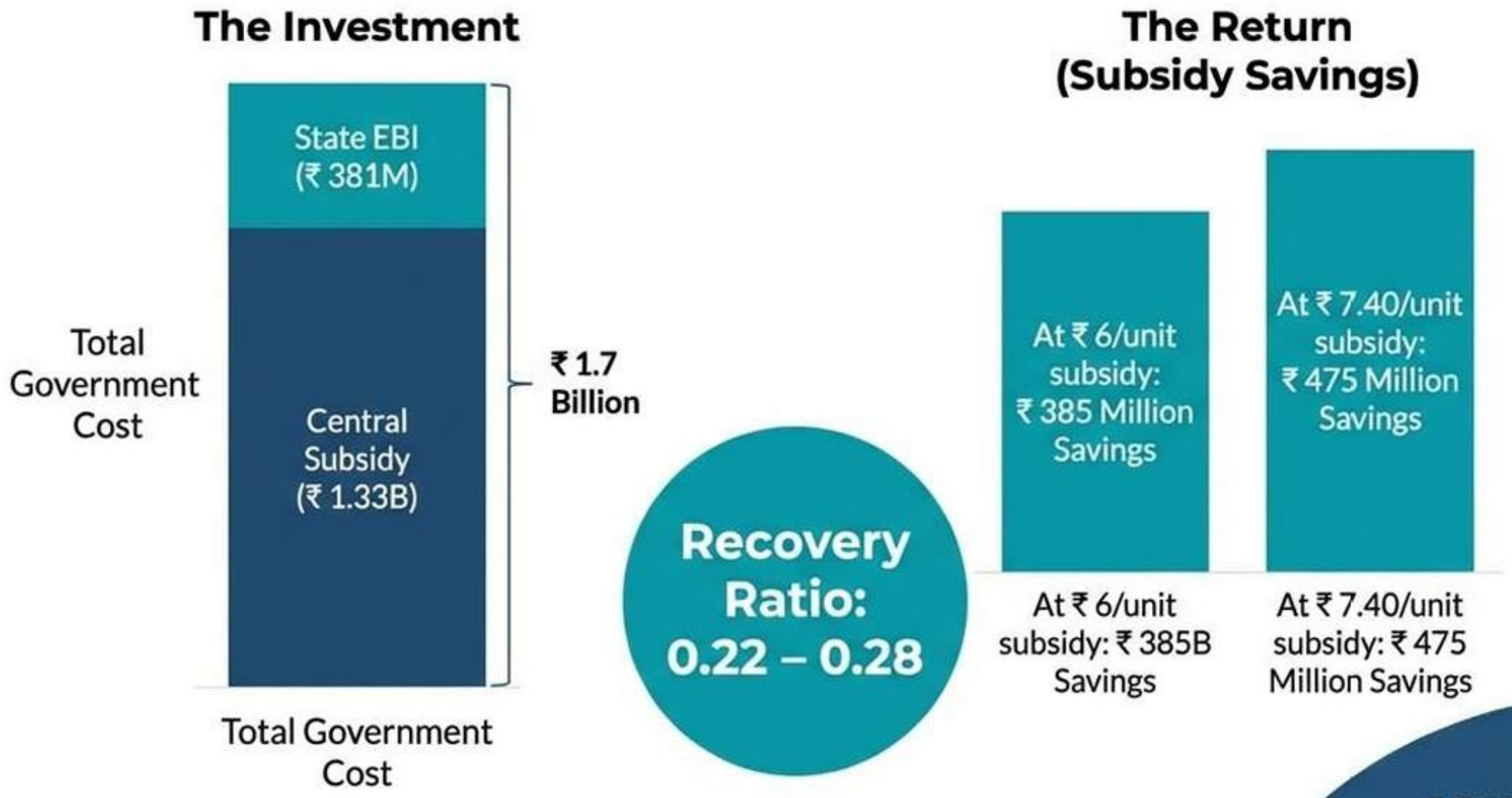
10.86 Metric Tons of CO2
Offset per farmer annually.

2x Impact
Compared to off-grid solar pumps.

47,610 Tons
Total annual abatement across pilot.



The Economic Argument: Analyzing the SKY Data



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Way Forward for Kerala: Solarizing for Resilient & Inclusive Growth

Establish a Multi-Stakeholder Proof of Concept (PoC)

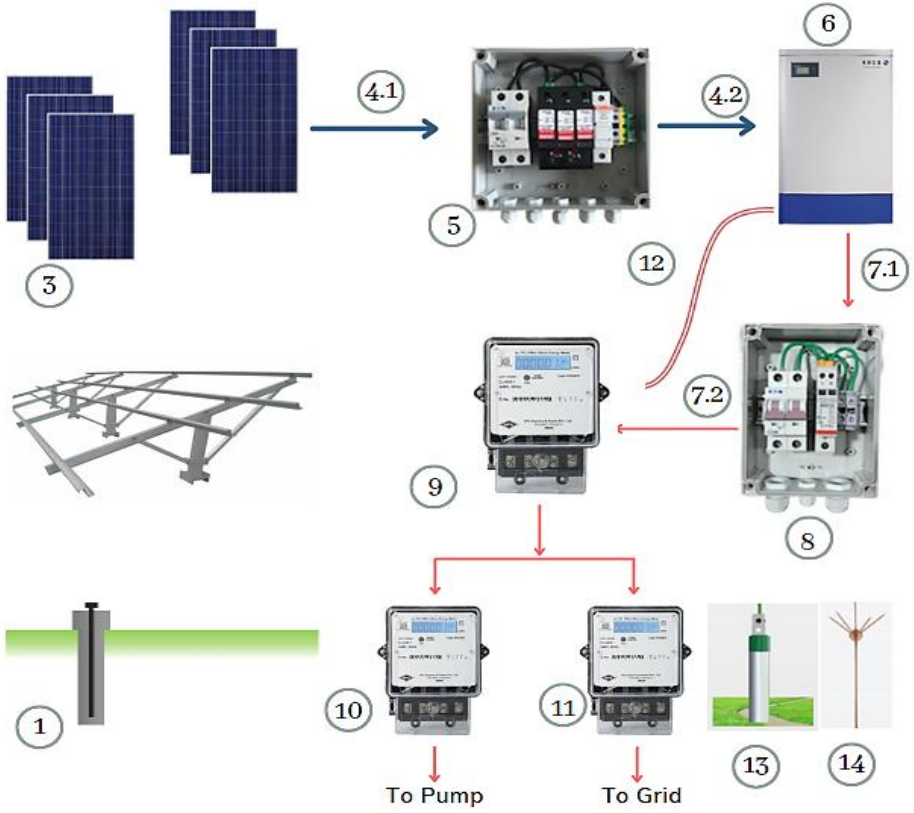
- ❑ Initiate a PoC based on the experiment to policy pilot. Conduct a rigorous assessment of stakeholder costs and benefits, utilizing analytics from existing on-grid models.

Feasibility of a 100% Subsidy Model for Inclusive Development

- ❑ Reach the most vulnerable groups (marginal farmers and women-led SHGs) to ensure no one is left behind.
- ❑ Evaluate the feasibility of a "Zero Upfront" model.
- ❑ Leverage NABARD for institutional financing to manage the initial cost of SIPs.
- ❑ Loan repayment through stakeholder benefits.

Phase 1: The 5-Feeder Pilot Program

- ❑ Launch pilots in 5 selected feeders to test practical feasibility and document challenges.
- ❑ These pilots will serve as a "Policy Pilot" to generate ground-level insights on energy-use efficiency and grid integration before a statewide scale-up.



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Innovation 2 : A Community-Based Adoption of SIPs (Example from Madhya Pradesh)

Beyond Power: Two Community Models in Madhya Pradesh

Model A: Chimkatola

Capital Heavy

- **10%** Upfront Farmer Share
- **90%** Donor Funded
- Managed by Women's WUA (13 members)

Model B: Kevlari

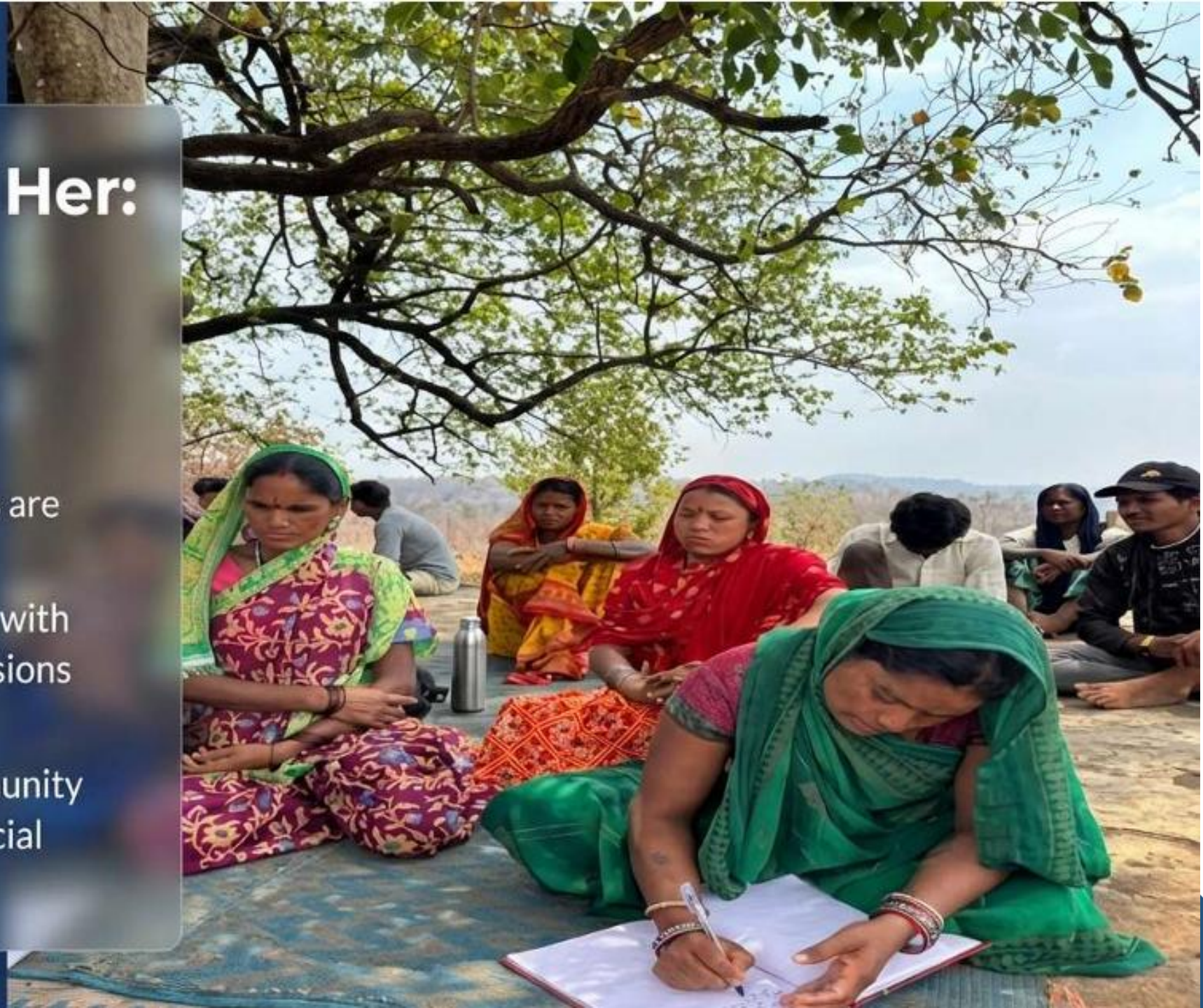
Inclusive Financing

- **Zero** Upfront Cost (Earn First, Pay Later)
- Institutional Financing
- Reduces entry barriers for poorest farmers

Both models utilize surplus energy for income generation, but financing structures define accessibility.

The Power of Her: Women as Managers of Energy

- Women-led WUAs & SHGs are central to management.
- Success driven by linkages with State Rural Livelihood Missions (SRLM).
- Outcomes: Stronger community buy-in and improved financial discipline.



Using the Unused: Livelihood Diversification

Surplus Solar Energy

↓

Post-Harvest Processing (Rice Milling)

↓

Off-Season Income

Farmers in Kevlari reinvested SIP savings to establish this mill, creating value beyond irrigation.

Changing Crop Choices and Profit Margins

Crop Diversification

Shift towards Wheat during Rabi-2024.

Expansion

Increased area under irrigation in summer season.

Profit & Revenue

Lower irrigation costs + New revenue from selling water.

Shaping Policy Pathways : Summarizing Our learnings from the ground

Policy & Institutional Learnings

I. SIPs remain subsidy-driven; targeted innovations in subsidy design are essential.
II. Stronger alignment needed between agriculture and SIP-governing institutions for scaling.
III. The way forward for grid-connected solar irrigation lies in getting pricing right—aligning incentives for farmers, utilities, and sustainability.

Ground-level Insights & Use-Cases

I. SIPs reduce fossil fuel use and irrigation costs—e.g.,.
II. Expanding beyond irrigation (e.g., post-harvest, solar mills) diversifies farmer benefits.
III. Effective models bundle SIPs with efficient irrigation (in water-scarce zones) and market access (in water-abundant zones)
IV. Community-based solar solutions unlock scale by pooling demand, finance, and management.

Gender & Financial Inclusion

I. GESI-focused design, training, and financing crucial for inclusive impact.
II. Women-led SIP models (via SHGs, SRLM linkages) show potential for enterprise creation.
III. Community-based, grid-connected models improve energy use efficiency and economic returns.

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