Report | June 2022

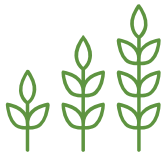
Mainstreaming Micro Solar Pumps to Improve Incomes of Marginal Farmers

Wase Khalid, Abhishek Jain, Shruti Jindal, and Arpan Thacker

Highlights

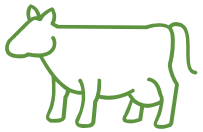
The high dependence of marginal farmers on electric and diesel/kerosene pumps for irrigation, in addition to low cropping season and cycle, are causing low yields, lesser profits, and higher debt.

The total available market (TAM) for irrigation applications involving sub-HP solar pumps (SHSPs) is **USD 6.4 billion (INR 47,805 crore)**, with the potential to impact 7.5 million marginal farmers; for animal husbandry applications the TAM of SHSPs is **USD 1.3 billion (INR 9,689 crore)**, with the potential to impact 1.5 million households.



The serviceable available market (SAM) for irrigation applications is **USD 2.6 billion (INR 19,279 crore)**. More than 3 million sub-HP solar pumps can be deployed across India, impacting lives of as many marginal farmers. The SAM for irrigation applications has two parts:

- **A USD 862.1 million (INR 6,466 crore)** market for more than 1 million SHSPs with the potential to **reduce costs, debt, emissions and improve incomes.**
- **A USD 1.7 billion (INR 12,813 crore)** market for more than 2 million SHSPs with the potential to **improve irrigation accesses, yields, cropping cycles, and incomes.**



The serviceable available market (SAM) for animal husbandry is **USD 352.1 million (INR 2,641 crore)**. More than 400,000 sub-HP solar pumps can be deployed across India, impacting the lives of as many households.

Sources for datapoints are discussed on slide 13 and 19

Highlights

West Bengal, Kerala, Bihar, Andhra Pradesh, and Assam account for 74% of the SAM for irrigation application; whereas **Uttar Pradesh, West Bengal, Maharashtra, Gujarat, Bihar, Madhya Pradesh, Rajasthan** account for 90% of the SAM for animal husbandry application.

Conducting pilot demonstrations of SHSPs to generate success stories and evidence is key in improving awareness, knowledge, and confidence about SHSPs among stakeholders.

The inclusion of SHSPs in existing schemes, or an explicit focus on this category, is required to promote the market penetration of these pumps.

The role of financiers, end-user financing schemes, and support from other private players in providing loans for SHSPs is crucial for catalysing large-scale deployment. This is because it is difficult to subsidise solar pumps for the large farmer base in the country.

Entrepreneurs can deploy SHSPs either through equipment sales or the service (shared usage) model. After initial stage, when subsidised/ grant-based sales have been tapered off, sales through distributors and retailers (DAR) & asset financing partnerships are critical to scaling up equipment sales.

Sources for datapoints are discussed on slide 15 and 22

Image: Wase Khalid, CEEW

Powering Livelihoods

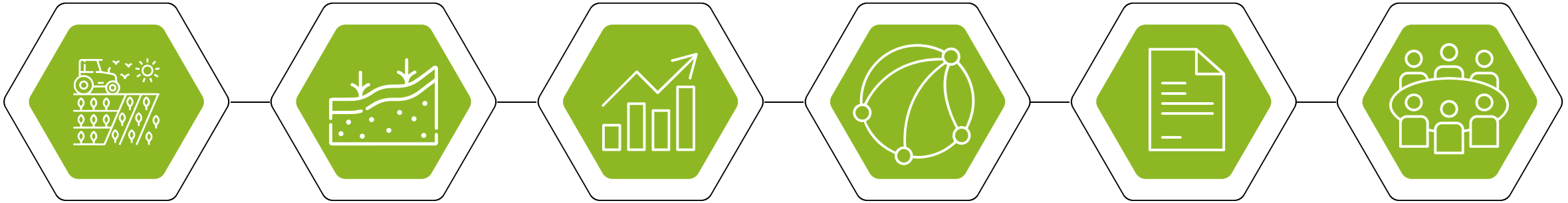
Powering Livelihoods – a USD 3 million (INR 21 crore) initiative by CEEW and Villgro – is mainstreaming clean energy-based solutions in the rural economy. It provides capital, technical, and sectoral growth support to help social enterprises deploy a large number of clean energy–based livelihood solutions in a gender-inclusive manner.

The agriculture and allied services industry is India's largest employer. At Powering Livelihoods, we focus on enterprises developing or deploying innovative appliances to improve productivity, reduce drudgery and raise incomes. Examples include sub-HP solar pumps (SHSPs), micro food processing appliances, hydroponics-based fodder grow units, cold storage units, dryers, etc.

About this report

Through an insightful analysis of the value chain, market segmentation, and policy associated with micro solar pumps, this market research report by Powering Livelihoods aims to boost sectoral growth by providing insights to entrepreneurs, investors, and policymakers targeting micro solar pumps category.

Research questions



What are the **irrigation needs of marginal farmers** in India?

Can SHSPs efficiently meet the irrigation needs of marginal farmers?

What is the **potential market size for SHSPs**?

What major **market segments and geographies can entrepreneurs target** to promote SHSPs?

Which government **policies are relevant for such entrepreneurs**? Which ones are **gender-inclusive**?

Who are **the relevant stakeholders to engage** with & what business strategies can SHSP manufacturers/entrepreneurs adopt?

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Irrigation needs of Indian marginal farmers

At 85.4 million, 68% of agricultural holdings in India are marginal in size (< 1 hectare) with an average holding size of 0.94 acres.[1] However, their share of land area is only 24% of agricultural land.[1]

83%* **70.7 million**[1] marginal holdings are owned by males. Among total agricultural landholdings owned by males in India, **67% are marginal.**[1]

17%* **14.7 million**[1] marginal holdings are owned by females. Among total agricultural landholdings owned by females in India, **72% are marginal.**[1]

Decreasing incomes, increasing debt, and low farm output

The income of marginal agricultural households from crop production has reduced to **29%***[2], and from animal farming has reduced to **5%**.*[2]

55% [3] of marginal and small farmers are in debt, limiting their ability to seek fresh loans for making high investments.[3,4]

Rain-fed farms have **significantly lower (< 50%)** crop yields than irrigated farms.[5]

Irrigated holdings

60% [1] of cultivating marginal holdings have irrigation access, covering **54%**** of net sown area under marginal holdings.[1]

Non-irrigated holdings

40% [1] of cultivating marginal holdings are dependent on rainfall for agriculture, comprising **46%**** of net sown area under marginal holdings.[1]

The high dependence on diesel/kerosene pumps for irrigation or low cropping intensity and yields

2/3rd of marginal farmers with pumps rely on **diesel/ kerosene** pumps.[6]

Fuel/energy costs account for **20–40%** of the total production cost.[3]

Rain-fed farms are highly vulnerable, as erratic rainfall **adversely impacts crop production.**[7]

Dependence on rainfall constraints the farmer **typically to one cropping cycle.**[7]

Thereby, it is critical to reducing the risks involved in agricultural production by reducing famers' dependence on diesel/kerosene-based irrigation and improving irrigation access in rainfed regions. This could enhance yields, cropping cycles, and profitability for farmers while reducing their debt burden and vulnerabilities.[7]

*Between 2013-2019; **For the year 2016

1 Department of Agriculture and Farmers Welfare (2016). 2 NSSO 77th Round (2019). 3 Koan Advisory (2019). 4 NABARD (2018). 5 Ministry of Agriculture and farmers welfare (2017). 6 Department of Agriculture and Farmers Welfare (2012).
7 Stakeholder consultation; Authors' Analysis

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Image: iStock

Addressing irrigation needs of marginal farmers efficiently

- Are SHSPs an effective solution to meet the needs of marginal farmers?
- What are the different types of SHSPs suitable for irrigation?
- What are the water pump applications beyond irrigation?

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SHSPs could meet the needs of marginal farmers effectively

	Rainfed[8]	Electric pumps[9, 10]	Diesel/Kerosene pumps[10, 11,12]	Higher-HP solar pumps[13, 14]	SHSPs[14,15]
Capacity	Not applicable	0.5 HP and higher	2 HP and higher	1 HP and above	0.25–0.75
Capital cost	Nil	Low INR 2,500 and above (grid connect cost is additional)	Low INR 10,000 and above	High (without subsidy) INR 100,000 and above	Moderate INR 30,000–60,000
Recurring cost	Nil	Moderate ~INR 0-4 per unit of electricity consumed + maintenance cost	High Fuel cost of ~INR 80–95 per litre + maintenance cost	Low Maintenance cost	Low Maintenance cost
Portability	Not applicable	Low	Low	Low	High
Daily water output	Erratic	High	High	High	Moderate
Water flow rate/speed*	Unreliable	Moderate	High	High	Moderate
Water wastage likelihood	Not Applicable	Moderate	Moderate	High	Low
On-demand water availability	Low (monsoon dependent)	High	High	High	High
Fossil-fuel dependence	Nil	High (as of now)	High	Nil	Nil

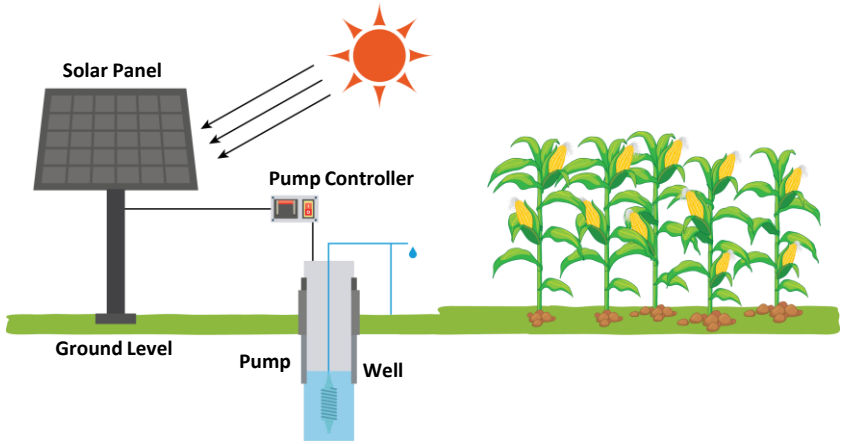
Source: Authors' compilation

Shifting from conventional to solar pumps results in significant reductions in emission & input costs for farmers. Further, the table highlights that SHSPs are an effective solution for many marginal farmers to meet their irrigation requirements.
But the absence of subsidies for SHSPs hinders large-scale adoption.
Hence, **access to end-user financing, preferably long-duration loans of 2-3 years, is key to deploying SHSPs at scale.**

8 Authors' Analysis; Stakeholder consultation. 9 Authors' Analysis; https://mechanicalboost.com/tullu-pump/. 10 https://web.ttpowergroup.com/blog/comparing-electric-diesel-water-pump 11 Authors' Analysis; Indiamart; 12 https://www.kisankraft.com/agriculture-water-pump/. 13 Authors' Analysis; https://futurepump.com/advantages-and-disadvantages-of-solar-water-pumps/. 14 Solar PV pumping system for irrigation purpose and its economic comparison with grid-connected electricity and diesel operated pumps. 15 Authors' Analysis; https://wri-india.org/content/portable-solar-powered-solution-irrigate-fields
*High water flow rate/speed (WFR) can damage the crops of marginal farmers engaged in horticulture. For such farmers, moderate WFR is sufficient to satisfy their need and is considered desirable.

Types of sub-HP solar pumps (SHSPs) suitable for irrigation

Submersible solar pumps[16]

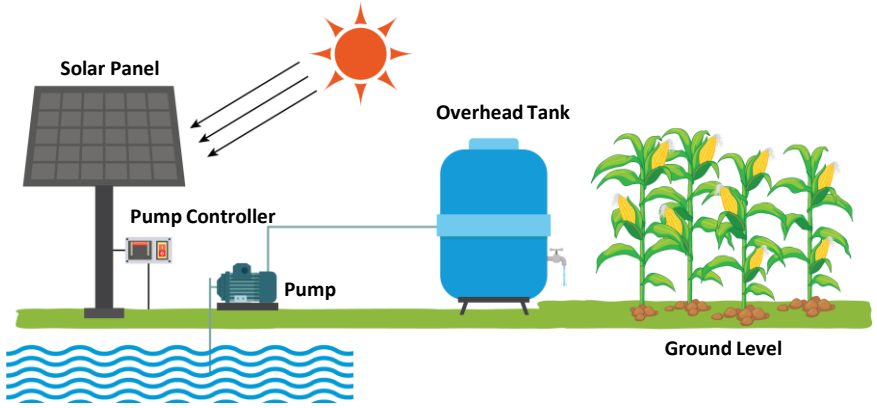


Low head: 15 m; low flow: 1 litre per 2 seconds; output: up to 15,000 litres per day (LPD)

Low head: 10 m; moderate flow: 1 litre per second; output: up to 30,000 LPD

High head: 20–80 m; low flow: 1 litre per 2 seconds; output: up to 15,000 LPD

Surface solar pumps[16]



Low head: 10 m; moderate flow: 1 litre per second; output: up to 30,000 LPD

High head: 20 m; low flow: 1 litre per 3 seconds; output: up to 10,000 LPD

Source: Recreated from "Global Leap Awards - Buyer's Guide for Solar Water Pumps."

Our focus is on low head and moderate flow SHSPs with an output of up to 30,000 LPD, which is sufficient to effectively support sustainable irrigation for many marginal farmers engaged in horticulture and multi-cropping.

Moreover, given the relevance, majority of existing SHSP manufacturers focus on low head and moderate flow irrigation pumps.[17]

16 Global Leap Awards (2019). 17 Authors' Analysis; Stakeholder consultation

Pumping water for use cases beyond irrigation

Application	Assumptions used	Applicability of different pump types Sub-HP (< 1 HP) Optimal head: 10 m Water output: ~30,000 LPD	1–5 HP Optimal head: 30m Water output: ~150,000 LPD	> 5 HP Optimal head: >30m Water output: >150,000 LPD	Can sub-HP pumps be used?
Irrigation [18,19,20]	• The optimal head is used instead of the max head to understand the application of different pump types	Up to 1 acre of land can be irrigated	Around 5 acres of land can be irrigated	More than 5 acres of land can be irrigated	Yes
Domestic use (tap water/ drinking)[21]	• Some suction head is required for lifting water. • The average height of a floor is ~4.3 m (12 feet)	Up to 2-storied buildings	Up to 9-storied buildings	More than 9-storied buildings	Yes
Fisheries/ aquaculture [22]	• Water needs to be filled in 2 days • Height of pond: 1m	Can be used for small ponds (up to 0.15 acres)	Can be used for pond size up to 0.45 acres	Can be used for pond sizes of more than 0.45 acres	Yes
Salt farming [23,24]	• Brine (found at least 12 m below the ground level)	Not feasible (cannot pump brine present below 12 m)	2–3 HP pumps used	Not economically feasible (the pumps need to be replaced every 2–3 years)	No
Animal husbandry [25]	• Average water needs of 50 litres per animal per day	Up to 600 animals	Up to 2,000 animals	More than 2,000 animals	Yes
Price range (INR)		**30,000–60,000**	**100,000–300,000**	**300,000– 750,000**	

Source: Authors' compilation

18 Authors' Analysis; Stakeholder consultation. 19 Ministry of New and Renewable Energy (2019). 20 India Water Portal. 21 Authors' Analysis. 22 Stakeholder consultation; Vikaspedia. 23 The Better India (2016). 24 IJATES (2016). 25 IWMI (2006)

Pumping water for use cases beyond irrigation

Beyond irrigation, SHSPs can effectively support other livelihoods activities such as **fisheries, aquaculture, and animal husbandry** (such as dairy and poultry). As the application of water pumps in fisheries and aquaculture is currently in the nascent stage, we consider estimating only the market for use of pumps in irrigation and animal husbandry.

Given the capacity of SHSPs, it is an ideal solution for **horticultural crops**, as other crops like paddy require more water of up to 50,000 LPD.

As the average ownership of cattle is ~two per household and ruminant livestock is ~four per household, most SHSPs can effectively **meet the water requirements of households** engaged in animal husbandry across the country.

Image: iStock

Market Segmentation

Irrigation

- What is the total and serviceable available market for sub-HP solar pumps (SHSPs) for irrigation applications?
- Which Indian districts are a priority market for SHSPs?
- Which districts are a priority market for targeting diesel pump set users and non-irrigating marginal holdings?

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Total & serviceable available market for SHSPs for irrigation 1/2

Approach

The amount of water pumped through SHSPs is adequate to meet the irrigation needs of marginal farmers growing horticultural crops or practising multi-cropping, as the water requirement for crops such as paddy is significantly higher. Thereby**, marginal holdings practising horticulture are considered the primary target group for market size estimation.**

SHSPs can pump groundwater or surface **water at a depth of up to 10 m.** SHSPs can also **be used in irrigation canals** to improve last-mile delivery.

A groundwater index (GWI) is used **to identify and exclude districts prone to highly depleting groundwater tables**. The GWI is estimated based on annual water extraction and recharge levels.

We aggregate the district-level estimates for TAM and SAM to project the all-India market size. We use district-level data for:

- Number of marginal holdings[28]
- Area of marginal holdings under horticulture[29]
- Sources of irrigation for marginal holdings[30]
- Number of irrigating marginal holdings using diesel pumps[31]
- Number of non-irrigating marginal holdings cropping once[32]
- Groundwater level depth[33]
- Groundwater index[34]

To identify the SAM, we estimated:

- Irrigating marginal holdings using diesel pumpsets – **with the opportunity to reduce costs, debt, and emissions and improve incomes**
- Non-irrigating marginal holdings – **with the opportunity to improve irrigation access, yields, cropping cycles, and incomes**

Total Addressable Market [26] (TAM) — **7.5 million*** SHSPs — **USD 6.4 billion**** (INR 47,805 crore)

A	Number of marginal holdings with horticultural cover using groundwater (GW) for irrigation	X	Share of monitored GW wells with water levels up to 10 m
+			
B	Number of marginal holdings under horticultural cover using canal and other sources for irrigation		
+			
C	Number of non-irrigating marginal holdings pursuing horticulture	X	Share of monitored GW wells with water levels up to 10 m

Serviceable Addressable Market [27] (SAM) — **3 million*** SHSPs — **USD 2.6 billion**** (INR 19,279 crore)

TAM (A) and (B)	X	Percentage of irrigating marginal holdings using diesel pump-sets	**Filtered to number of marginal holdings in districts with groundwater index >= 0.60**
+			
TAM (C)	X	Percentage of non-irrigating marginal holdings cropping once	**Filtered to number of marginal holdings in districts with groundwater index >= 0.60**

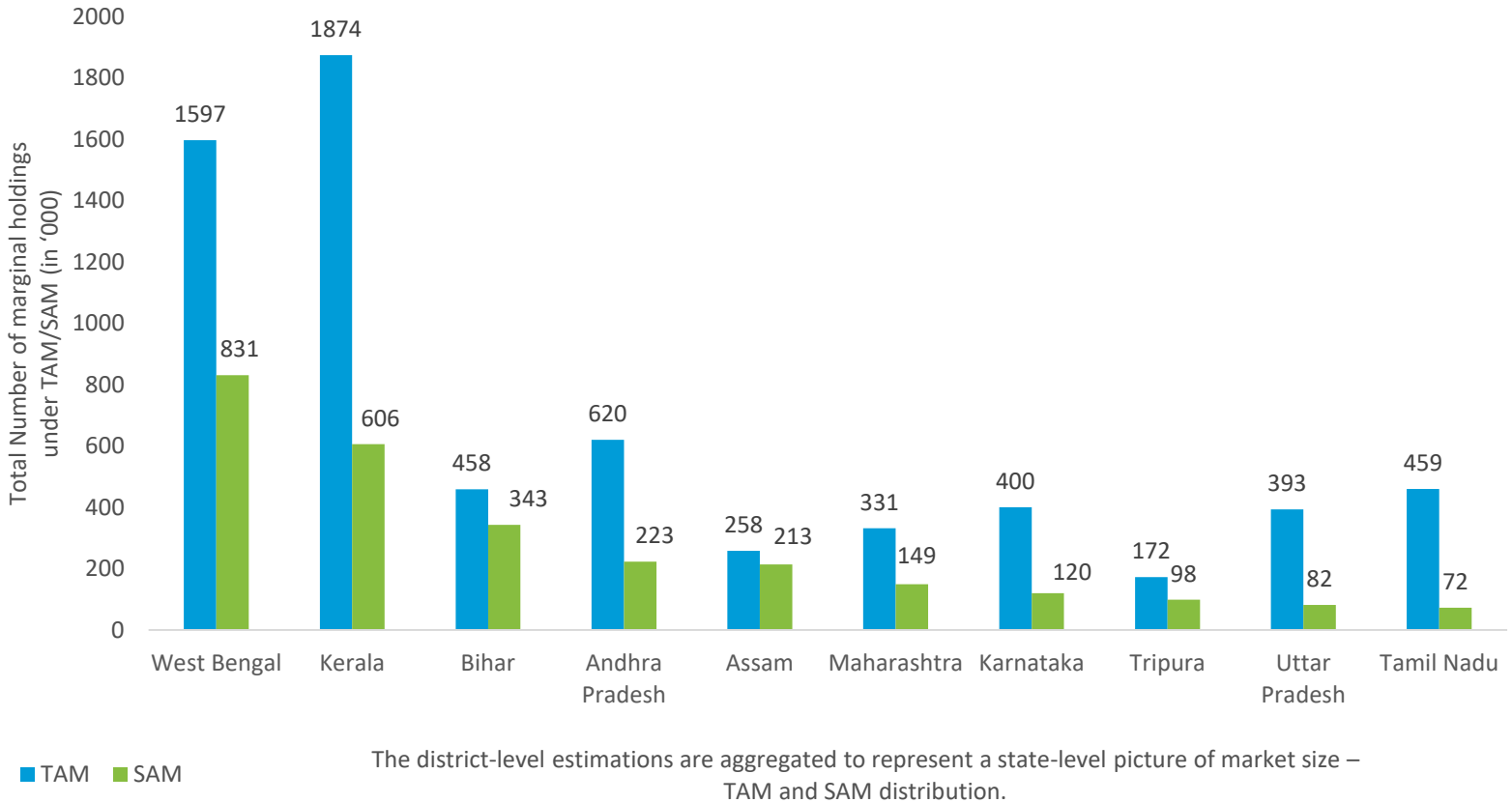
The numbers estimated as part of SAM have been further disaggregated to identify key market segments for solar-powered micro-pumps for irrigation.

*One SHSPs per marginal holding estimated under TAM/SAM; **Cost of one pump is assumed at INR 64,000

26 Authors' Analysis. 27 Authors' Analysis. 28 Marginal holding table (2015-16). 29 Cropping Pattern table (2015-16). 30 Sources of Irrigation table (2010-11). 31 Holdings using Machinery (2011-12). 32 Area cropped once and more than once (2010-11). 33 Central Ground Water Board (2019). 34 Dynamic Water Resources (2017).

Total & serviceable available market for SHSPs for irrigation 2/2

The top 10 states represented below capture 91% of the overall serviceable market for SHSPs, of which West Bengal, Kerala, Bihar, and Andhra Pradesh account for two-thirds of the overall market size, amounting to a cumulative sales potential of more than 2 million SHSPs.[35]



The district-level estimations are aggregated to represent a state-level picture of market size – TAM and SAM distribution.

Source: Authors' Analysis

Assumptions

- We have included dataset of the data following crops as representative of horticultural crops for calculations – all fruits, all vegetables, all spices and condiments; all floricultural, aromatic, and medicinal plants.
- Only districts with a groundwater index (GWI) of 0.60 and higher are considered in our market estimation, as districts with a GWI lower than 0.60 are more vulnerable to depleting water tables.

Limitations

- No datasets present an exact number of marginal farmers/holdings involved in horticulture at the district level. Hence, agricultural census data on the percentage of area under horticulture (2015–16) are used to estimate marginal holdings engaged in horticulture.
- Since the data on location or geographical spread of the marginal holdings is not available, we assume that marginal holdings are homogeneously spread across districts.
- To estimate the number of marginal holdings using diesel pumps, the last available estimates from Agriculture Input Survey 2011–12 are used. Further, the data only talks about diesel pump users, electric pump users, and non-users. There is no mention of kerosene pump users.

35 Authors' Analysis

Priority markets for SHSPs to meet irrigation needs of marginal holdings

Serviceable Addressable Market (SAM)

The top 10 districts account for around 26% of the SAM – 0.8 million SHSPs. These are four districts from West Bengal, four from Kerala, and two from Bihar.[36]

As a market strategy, an enterprise can target regions where clusters of districts are emerging. It will ease processes such as partnerships, after-sales support, and other logistical concerns. Such clusters can be observed in eastern, north-eastern, south-eastern, and south-western states.

Top 10 districts for SHSP deployment

State	District	No. of target marginal holdings	% share of SAM
West Bengal	Nadia	114,204	3.8%
	24 Parganas North	92,449	3.1%
Bihar	Samastipur	86,223	2.9%
Kerala	Kozhikode	83,781	2.8%
	Ernakulam	71,814	2.4%
West Bengal	Murshidabad	70,180	2.3%
Kerala	Malappuram	68,659	2.3%
	Idukki	68,433	2.3%
Bihar	Kishanganj	64,048	2.1%
West Bengal	Hoogly	60,380	2.0%

Source: Authors' Analysis

A complete list of districts with market potential estimates is available here[36]

District-wise distribution of serviceable available market

Potential market[36]

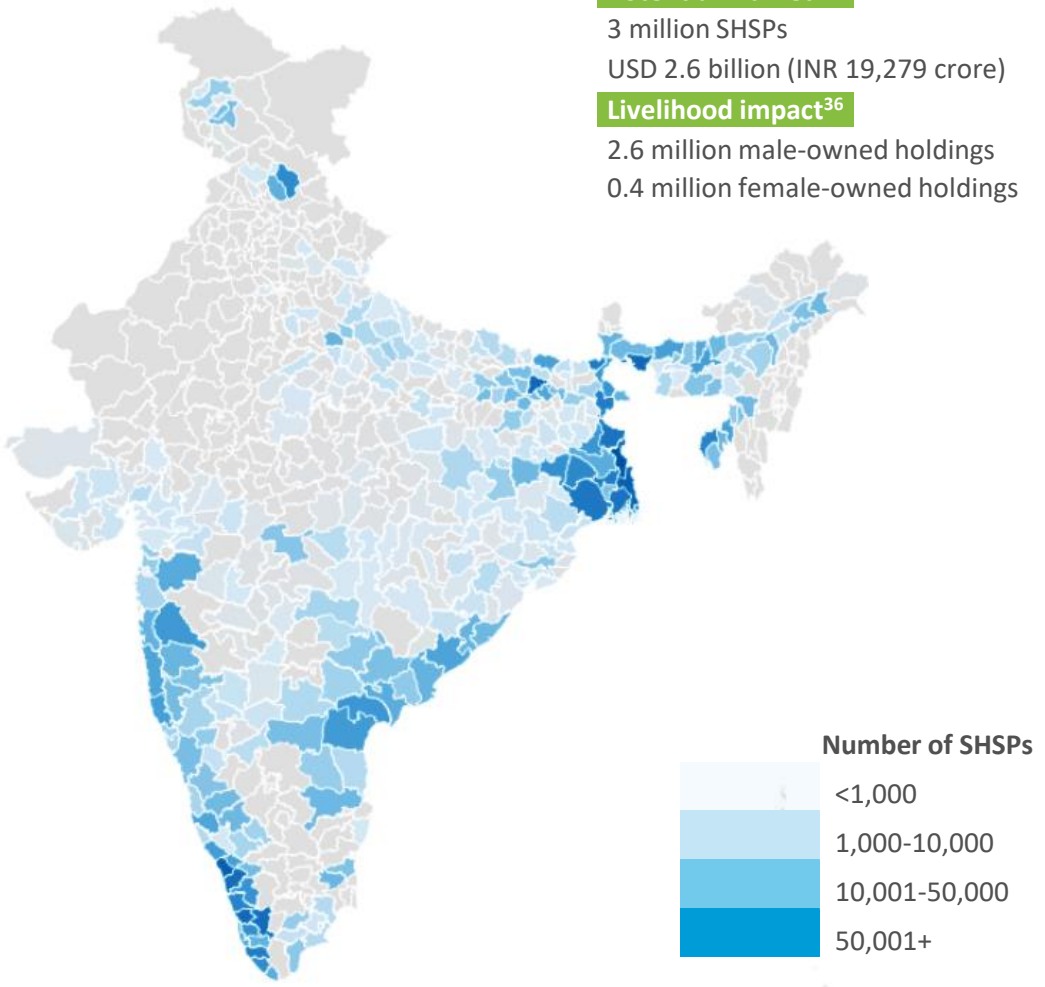
3 million SHSPs

USD 2.6 billion (INR 19,279 crore)

Livelihood impact[36]

2.6 million male-owned holdings

0.4 million female-owned holdings



Source: Authors' Analysis

36 Authors' Analysis

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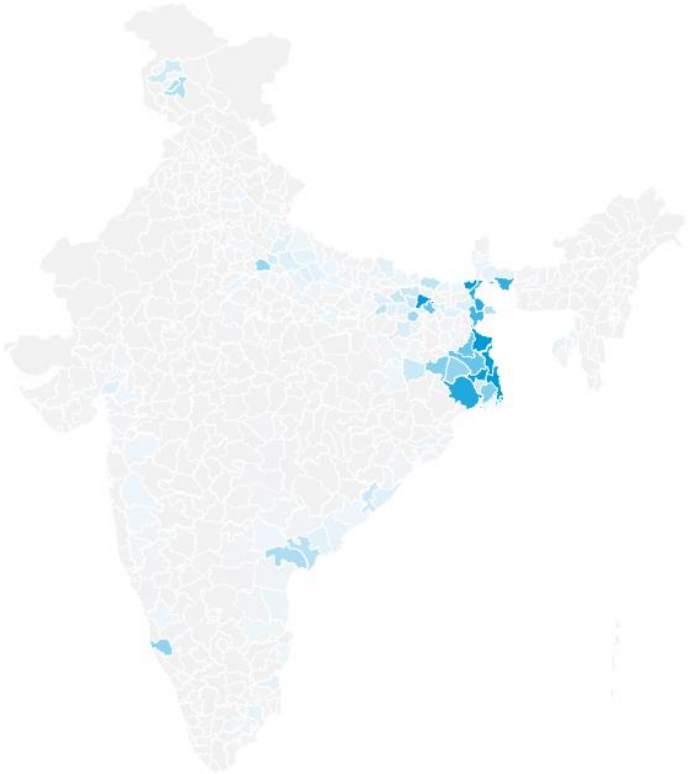
Priority markets for targeting diesel pump set users

District-wise distribution of the serviceable available market for irrigating marginal holdings using diesel pumps



Source: Authors' Analysis

Segment opportunity

1 million SHSPs

USD 862.1 million | INR 6,466 crore

Livelihood impact[37]

920,000
male-owned holdings

90,000
female-owned holdings

Number of SHSPs

- <1,000
- 1,000-10,000
- 10,001-20,000
- 20,001+

Top 10 districts for SHSP deployment

State	District	No. of marginal holdings	% share
West Bengal	Nadia	110,170	10.9%
Bihar	Samastipur	64,213	6.4%
	Kishanganj	64,081	6.3%
West Bengal	24 Parganas North	57,747	5.7%
	Murshidabad	57,309	5.7%
	Hooghly	47,936	4.7%
	North Dinajpur	39,354	3.9%
	Coochbehar	37,219	3.7%
	Malda	32,342	3.2%
	Paschim Meddinipur	27,949	2.8%

A complete list of districts with market potential estimates is available here[37]

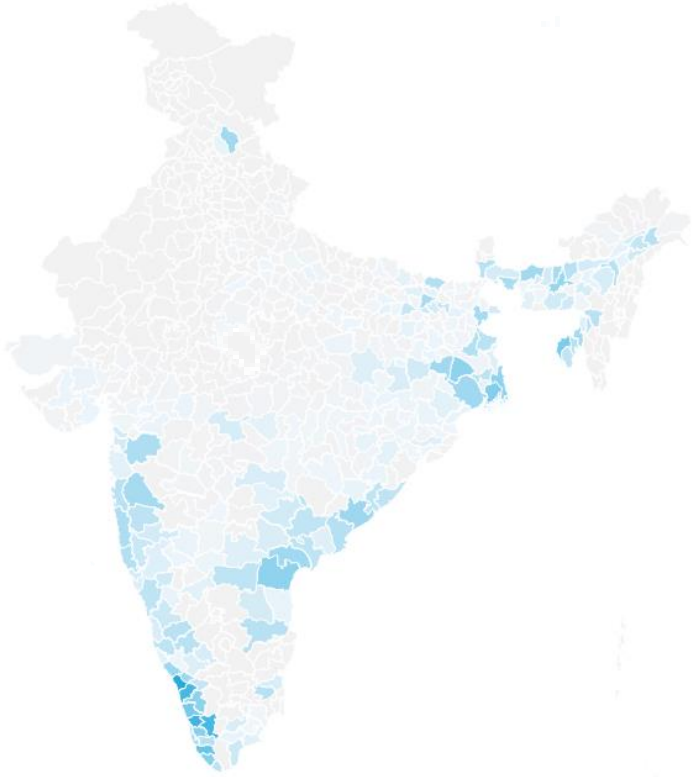
The top 10 districts account for around 53% of the market for targeting diesel pump set users - 540 thousand SHSPs.[37]
West Bengal (54%) and Bihar (25%) are states the maximum share of market for targeting diesel pump set users - 793 thousand SHSPs.[37]

SHSP manufacturers could consider irrigating marginal holdings as a priority market segment target, as these groups of farmers are already accustomed to the use of diesel pumps for irrigation. SHSPs are highly economically viable given the rising fuel cost of diesel/kerosene pumps.

37 Authors' Analysis

Priority markets for targeting unirrigated holdings

District wise distribution of serviceable available market for non- irrigating marginal holdings



Source: Authors' Analysis

Segment opportunity
2 million SHSPs
USD 1.7 billion | INR 12,813 crores

Livelihood impact[38]

1.7 million
male-owned holdings

0.3 million
female-owned holdings

Number of SHSPs
- <1,000
- 1,000-10,000
- 10,001-20,000
- 20,001+

Top 10 districts for SHSP deployment

State	District	No. of marginal holdings	% share
Kerala	Kozhikode	83,461	4.2%
	Ernakulam	71,814	3.6%
	Malappuram	68,659	3.4%
	Idukki	68,019	3.4%
	Kollam	53,551	2.7%
	Thrissur	47,359	2.4%
West Bengal	24 Parganas (South)	40,885	2.0%
Kerala	Thiruvananthapuram	40,372	2.0%
	Kottayam	39,232	2.0%
	Palakkad	36,056	1.8%

A complete list of districts with market potential estimates is available here[38]

The top 10 districts account for around 27% of market for targeting unirrigated holdings - 549 thousand SHSPs.[38]
Kerala (30%) and West Bengal (14%) are states with the maximum share of market for targeting unirrigated holdings – 892 thousand SHSPs.[38]

A thorough field survey is required before entering this market segment, as the majority of unirrigated marginal holdings are dependent on rainfall for irrigation. This market may require clubbing SHSPs with promoting rainwater harvesting structures. This will not only increase the adoption of SHSPs but will also help reduce dependency on groundwater.

38 Authors' Analysis

Image: iStock

Market segmentation - animal husbandry

- What is the total and serviceable available market of SHSPs for animal husbandry applications?
- Which districts are priority markets for SHSPs to meet animal husbandry water requirements?

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Total & serviceable available market for SHSPs for animal husbandry

Globally, India has the largest livestock population. However, India is far behind in livestock milk and meat yields. In India, the majority of livestock is dependent on common sources of water (lakes, rivers, canals, ponds, and others), which do not provide clean and freshwater. Along with several other factors, access to clean/freshwater is crucial for the productivity of livestock.[25] Hence, using SHSPs to pump water from wells and tube wells can help improve access to clean/fresh water for livestock.

1.5 million SHSPs*

USD1.3 billion** (INR 9,689 crore)

Total Addressable Market (TAM)[39]

0.4 million SHSPs*

USD352.1 million** (INR 2,641 crore)

Serviceable Addressable Market (SAM)[39]

District-wise number of households **reporting major land use as animal farming** → **Filtered to households that have livestock water requirements of more than 200 litres per day** → Share of monitored GW wells with water levels up to 10 m = **TAM**

TAM → **Filtered to the number of households dependent on diesel pumps for wells and tube wells and are in districts with a groundwater index (GWI) >= 0.60** = **SAM**

*One SHSPs per household (reporting major land use as animal farming) estimated under TAM/SAM; **Cost of one pump is assumed at INR 64,000

25 IWMI (2016). 39 Authors' Analysis.

Total & serviceable available market for SHSPs for animal husbandry

Approach

- As the previous section has already covered pumps for irrigation purposes, only households reporting **major land use – animal farming/fisheries** – were considered to be the primary target group for market estimation.
- Household **level ownership of livestock** is used to estimate the household level water requirement.
- Given SHSP capacity, **district with water levels up to 10 m depth** are considered.
- The GWI is used to **identify and exclude districts prone to highly depleting groundwater tables**. GWI is estimated based on annual water extraction and recharge levels.

We aggregate the district-level estimates for TAM and SAM to project the all-India market size. We use district-level data for:

- Households reporting ownership of livestock – cattle, buffalo, poultry, horses, pigs, camels, and others[40]
- Major land usage of households[41]
- Groundwater depth[32]
- Wells and tube wells running on diesel pump sets[42]
- Groundwater index[34]

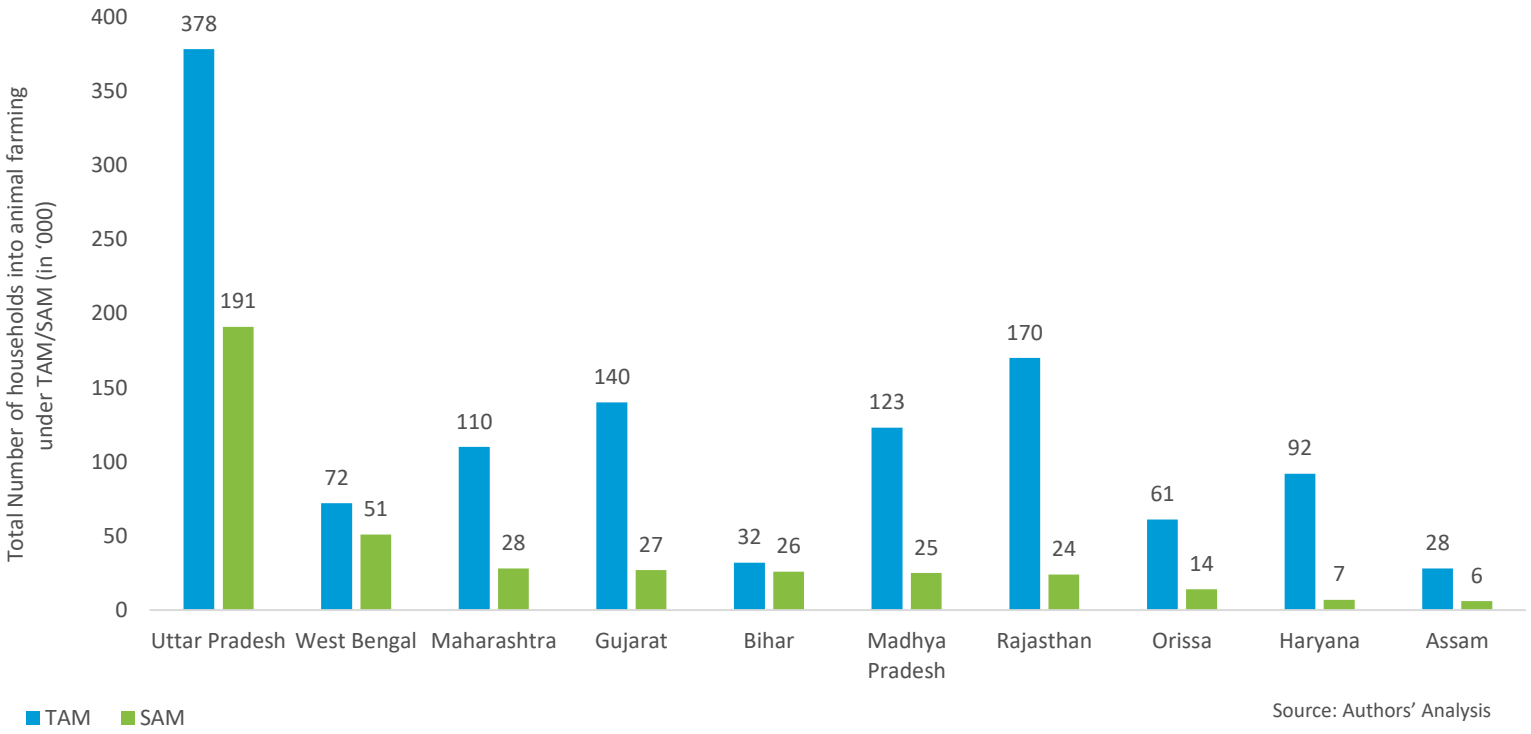
Assumptions

- Households requiring water **less than 200 litres per day can collect/pump water manually.**
- Only districts with a GWI of 0.60 and higher are considered in the market estimation as districts with a **GWI lower than 0.60 are more vulnerable to depleting water tables.**

33 Central Ground Water Board (2019). 34 Dynamic Water Resources (2017). 40 NSSO (2013). 41 NSSO (2013). 42 Agricultural Census (2010-11).

Total & serviceable available market for SHSPs for animal husbandry 1/2

The table below represents the state-wise distribution of TAM and SAM. The top 10 states represent 97% of the SAM.[43]



Source: Authors' Analysis

Limitations

- Data on access to water up to 10 m of depth are available at the district level. We assume that there are no significant water table variations within a district.
- To estimate the number of wells and tube wells running on diesel, the last available estimates from Agricultural Census 2011–12 was used. Further, the data only talks about diesel and electric pump powered wells and tube wells. There is no mention of kerosene pump users.
- Non-marginal farmers – not accounted for in the irrigation use case – practicing animal husbandry (as a secondary practice) might not have access to pumps at home. These farmers are not accounted for in the present estimation.

States such as Uttar Pradesh, West Bengal, Bihar, Maharashtra, Madhya Pradesh, and Gujarat have the highest number of households falling under SAM for deploying SHSPs. There are a few districts in the northern and western parts of the country as well, but these have a relatively lower concentration of farmers.
A detailed geographical distribution is presented below

43 Authors' Analysis

Total & serviceable available market for SHSPs for animal husbandry 2/2

Serviceable Addressable Market (SAM)

The top 10 districts account for around 31% of the SAM – 128,000 SHSPs. These are five districts in Uttar Pradesh, two districts in West Bengal, and one each in Rajasthan, Madhya Pradesh, and Maharashtra, respectively.[44]

Enterprises can target clusters observed in states like Uttar Pradesh, West Bengal, Gujarat, Bihar, Bihar, and Madhya Pradesh for ease of market penetration and serviceability.

Top 10 districts for SHSP deployment

State	District	No. of target households	% share of SAM
Rajasthan	Ganganagar	16,369	4.0%
Uttar Pradesh	Sitapur	15,147	3.7%
	Kheri	14,412	3.5%
	Hardoi	14,260	3.5%
	Aligarh	13,620	3.3%
	Barabanki	12,977	3.1%
Madhya Pradesh	Shivpuri	11,311	2.7%
West Bengal	Uttar Dinajpur	11,050	2.7%
	Maldah	10,432	2.5%
Maharashtra	Chandrapur	8,682	2.1%

A complete list of districts with market potential estimates is available here.[44]

District-wise distribution of serviceable available market

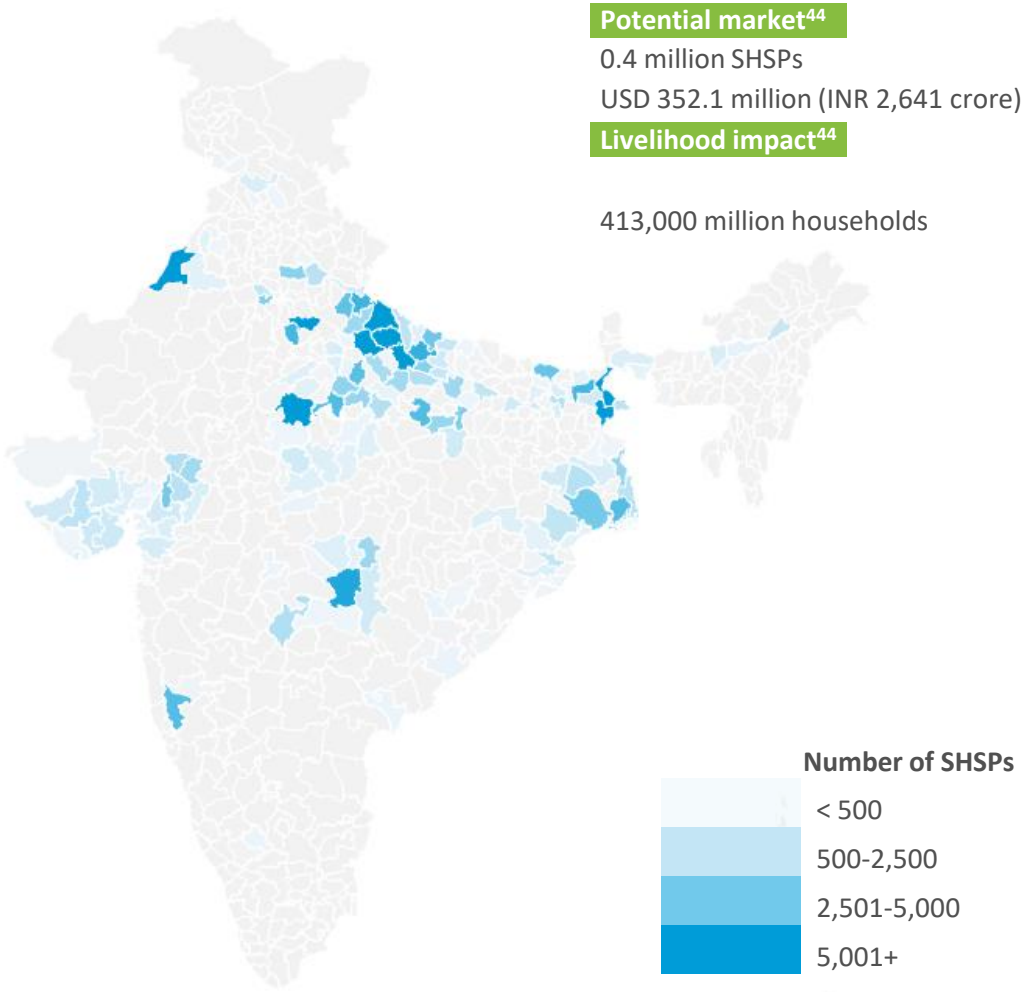
Potential market[44]

0.4 million SHSPs

USD 352.1 million (INR 2,641 crore)

Livelihood impact[44]

413,000 million households



Source: Authors' Analysis

44 Authors' Analysis

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Image: CEEW

Policy landscape

- What are the relevant policies for farmers and entrepreneurs?
- What policy measures and support are required?

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Relevant policies for farmers and entrepreneurs regarding SHSPs

Schemes	Beneficiaries	Objective	How to avail	Scheme value
Subsidy schemes for farmers				
Kisan Urja Suraksha evam Utthaan Mahabhiyan (KUSUM) by MoAFW [45] (Gender targeted)	All farmers (special focus on marginal and small farmers)	• To reduce farmers' dependence on conventional pumps and promote the adoption of solar pumps. • To solarise existing grid-connected electric pumps. • To enhance farmer incomes. • To promote decentralised renewable power generation. • To promote innovative and cost-effective solar pumps.	**Farmers:** They are required to register on the scheme website. Post this, a state-level implementation agency will screen the application. **Manufacturers (1HP and above)*:** Centralised tendering through central PSUs. **Manufacturers (SHSPs):** Manufacturers developing pumps with a better performance than specified by the Ministry of New and Renewable Energy (MNRE) can submit a proposal to the MNRE for empanelment. If shortlisted, their pumps will be deployed for pilot/testing.[46]	INR 34,422 crore
Financial and marketing support for pump manufacturers				
Credit Guarantee Trust Fund by Ministry of Micro, Small and Medium Enterprises (M/o MSME) and SIDBI [47] (Gender agnostic)	All MSMEs	• To implement the Credit Guarantee Scheme for micro and small enterprises. • To provide collateral and third-party guarantee–free credit for MSMEs.	MSMEs can directly approach the lending institutes registered with the trust to avail the scheme. The list of member lending institutes can be accessed here.	Credit facilities of up to INR 200 Lakh per eligible borrower
Marketing Assistance Scheme, M/o MSME [48] (Gender agnostic)	All MSMEs	• To enhance the skills, capabilities, and competitiveness of MSMEs. • To provide a platform for MSMEs to interact with large institutional buyers. • To disseminate/propagate various government programmes.	The National Small Industries Corporation (NSIC) publishes updates about forthcoming events on its website at least three months in advance so that target beneficiaries can decide whether they would like to participate well in advance. The applications/proposals for seeking assistance under the scheme are to be submitted directly to NSIC, with full details and justification.	Information not available

Source: Authors' compilation

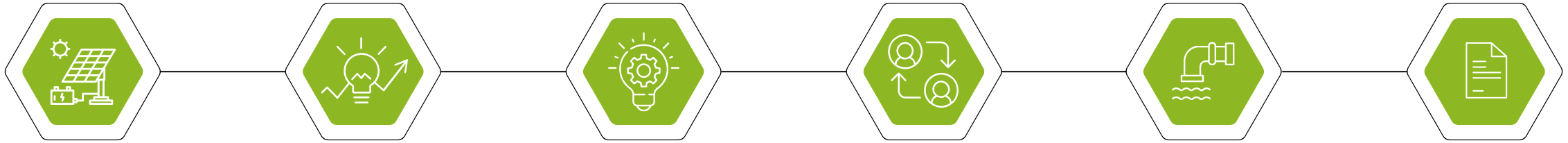
*Currently, SHSPs are not availed under the scheme [49]

45 https://mnre.gov.in/img/documents/uploads/8065c8f7b9614c5ab2e8a7e30dfc29d5.pdf. 46 https://mnre.gov.in/img/documents/uploads/file_f-1617858634315.pdf. 47 https://www.cgtmse.in/Home/VS/3.
48 https://msme.gov.in/sites/default/files/MASCHEME-New-18112014.pdf. 49 Stakeholder consultation

Policy measures and support required

Currently, SHSPs are not covered under subsidy schemes, making their penetration into the market difficult.

Promotion of larger solar pumps in water-stressed areas can further deplete groundwater tables. The government should consider benchmarking pump capacity according to land size and crop type along with emphasising water conservation practices through awareness schemes such as the Atal Bhujal Yojna.[50]



Inclusion of SHSPs in existing schemes or creating an explicit scheme: The majority of government schemes (central and state) focus on high-capacity solar pumps, excluding SHSPs. It creates an uneven playing field, where SHSPs compete on market prices against heavily subsidised (60–90% subsidy) larger capacity pumps.

Flexible approach to pump performance standards: Performance standards for SHSPs should be based on a capacity-agnostic performance benchmark (such as per W basis) rather than for fixed specific capacity. At present, the MNRE has only given performance standards of 250 W and 500 W pumps, whereas many pumps in the market also fall beyond this capacity size.

Rewarding efficiency through innovative tendering: The current system of tendering based on pump capacity does not incentivise pump efficiency. For example, if a tender for SHSPs is limited to 500 W pumps, any pump that has a lower capacity but produces output equivalent to 500 W (thus more efficient) cannot participate in the tender. On the other hand, a water output–based comparison would not constrain participants in terms of pump capacities and thus would promote efficiency.

Interdepartmental coordination: SHSP promotion at the state level should be in close coordination with horticulture departments and state rural livelihood missions. In most states, it is the agriculture department that selects beneficiaries. These departments are mostly unaware of the developments in the SHSP sector. A steering committee with participation from all these departments at the union and state level could help promote SHSPs in their respective schemes.

Pilot demonstrations: A critical concern for SHSPs is low confidence about their water output capacity and water flow. It is important to support pilot demonstrations in different parts of the country for relevant use cases to improve confidence about the product category.

End-user financing scheme for SHSPs: There are around 100 million marginal holdings and around 30 million conventional pump set users in India. Hence, it is difficult to provide solar pumps to all through subsidies. Here, the role of financiers, end-user financing schemes, and support from other private players is crucial for providing accessible financing infrastructure for farmers in India. As the majority of SHSPs cost about INR 30,000–50,000, end-user financing could unlock greater adoption of SHSPs.

50 http://mowr.gov.in/schemes/atal-bhujal-yojana

Image: iStock

Key business strategies and stakeholders

- What business models can be used to scale up the adoption of SHSPs?
- Who are the key stakeholders for the SHSP value chain?

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Business models to scale up the adoption of SHSPs[51]

Model	Description	Benefits	Challenges	Primary research insights
Equipment sales* Individual units sale to end-users 	**Direct sales –** manufacturers themselves are engaged in sales of the product	The manufacturer gets first-hand information on the needs and experiences of customers.	Customer identification and sales conversions are capital and resource-intensive for manufacturers.	In the absence of capital and resources, it is a difficult model to adopt in the early stages of scale-up. However, manufacturers can get the maximum profit margin with this model.
	Sales through business channels – distributors/retailers (DARs) and other business partners.	Opportunity to leverage existing DAR networks for large-scale deployment.	SHSPs might not be the focus for DARs due to limited product knowledge and the availability of conventional alternatives.	As high sales are the primary objective, DARs focus on cheaper conventional pumps – diesel, kerosene, and electric. However, in the presence of customer financing support, DARs are willing to shift focus to selling SHSPs.
	Sales through organization – subsidised adoption through government, NGO, and Civil Society Organisations (CSOs) partnerships.	The deployment of pumps at subsidised rates or on a grant basis will help in building ground-level evidence in the early stages.	The availability of pumps for free or at low rates sets false benchmark prices and might cause hesitancy to purchase at market prices later.	Subsidised or grant-based deployment can support initial deployment by manufacturers. However, given the huge farmer base in India, it is not a fiscally viable strategy in the longer run.
	Sales through financing partners – deployment at scale through Micro Finance Institutions (MFIs) and Small Finance Banks (SFBs).	Access to financing could trigger and catalyse large-scale deployment.	Lack of availability of collateral and secondary market for SHSPs.	Given the huge base of marginal farmers and conventional pump set users, having a product financing option is a sustainable strategy in the long run for large-scale deployment.
Service model* (shared usage) Providing either water or pumps as a service 	**Renting –** a provider owns, maintains, and rents the pumps to interested farmers. **Pumping-as-a-service –** an on-demand pumping service for a fee.	Irrigation access to very poor farmers who cannot afford to purchase SHSPs or where pumping needs are limited to a very few days a year. No upfront capital investment is required for the farmers.	Farmers may face the occasional unavailability of pumps/water.	Mobility of pumps is key to shared usage. As SHSPs are highly portable and easy to relocate, if irrigating days are planned efficiently, these are ideal for shared usage among marginal farmers.

Pump manufacturers can consider adopting a multi-prong phased strategy to drive scale. For initial traction and evidence generation, they should prioritise sales through organisations (subsidised/grant-based), followed by a focus on sales through DARs and financing partners.

Source: Authors' compilation

51 Authors' Analysis; *Ownership can be both individual or group (pump supplier, any private entity or farmers association)

Key stakeholders for the SHSP value chain[52] (1/2)

Understanding the role, importance, contribution, interest, and influence of different stakeholders

Solar pump manufacturers (SPM)

Given the limited ecosystem support, few SPMs are interested in manufacturing SHSPs.

Policy support from the government and active consideration by investors and financiers will enhance the confidence of SPMs and other stakeholders to shift focus to the SHSP category.

Government

There is, at present, a limited focus on developing policies, technical specifications, and pricing benchmarks for SHSPs.

Schemes with an explicit focus on SHSPs are required, from MNRE and other relevant ministries, to enable and catalyse large-scale deployment.

Components manufacturers (CM)

SPMs import various components due to a lack of preferred configuration and quality.

Tax rebates for manufacturing solar products' components will encourage CMs to consider domestic manufacturing; this will also further the vision of 'Atmanirbhar Bharat'.

52 Authors' Analysis

Key stakeholders for the SHSP value chain[52] (2/2)

Understanding the role, importance, contribution, interest, and influence of different stakeholders

Farmers

Small and marginal farmers are the intended consumers of the product. However, they have low interest in the product due to the lack of knowledge about this product and the availability of cheaper subsidised alternatives.

CSOs, NGOs and market enabling organisations with last-mile presence can play a crucial role in creating awareness through product demonstration activities, pilot deployments and other outreach activities.

Financiers

Enterprise and end-user financing are crucial to scale-up SHSPs. However, financiers have shown low confidence due to limited evidence of the product's potential.

Innovative tools like the first loss default guarantee (FLDG) with the support of philanthropies and buyback guarantee by SPMs are needed to mitigate risk and enhance the confidence of financiers in the early stages.

Distributors and retailers (DAR)

DARs make SHSPs accessible locally. However, due to higher demand for cheaper diesel/electric alternatives, there is a limited focus and interest in the sale of SHSPs.

SPMs must engage with DAR in the long run as farmers prefer purchasing locally-available pumps. Supporting DAR with product demonstrations and demo units will also build their confidence in this product category.

SPMs need to onboard end-user financing partners to attract DAR to this product category.

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