Scaling Irrigation for Small-scale Producers: the Role of Private Sector Solutions

Landscape Report – Summary Version

ISF

HYSTRA
hybrid strategies consulting

April 2024

CONTENT OUTLINE

Purpose of this report

This document is a condensed version of the full report summarizing its key findings. For a comprehensive understanding and additional details, please refer to the complete report.

ISF Advisors and Hystra created this report to understand the current state of the small-scale irrigation market in Africa and its future potential, articulate the investment and activities required to scale private sector irrigation technology for small-scale producers, and to identify potential opportunities for stakeholders (e.g., donors, investors) to catalyze further investment in this sector.

This report presents our findings from an extensive desk review of existing research, interviews with 70+ key stakeholders in the sector, and in-depth case studies of 6 private sector solution providers. The intended audience is the broader agricultural development community, including donors, private sector actors, investors, government stakeholders, researchers, and recipients.

This research was made possible by funding from the Bill & Melinda Gates Foundation. The opinions and findings expressed herein are those of the author(s) and do not necessarily reflect the views, strategy, or funding priorities of the Foundation.

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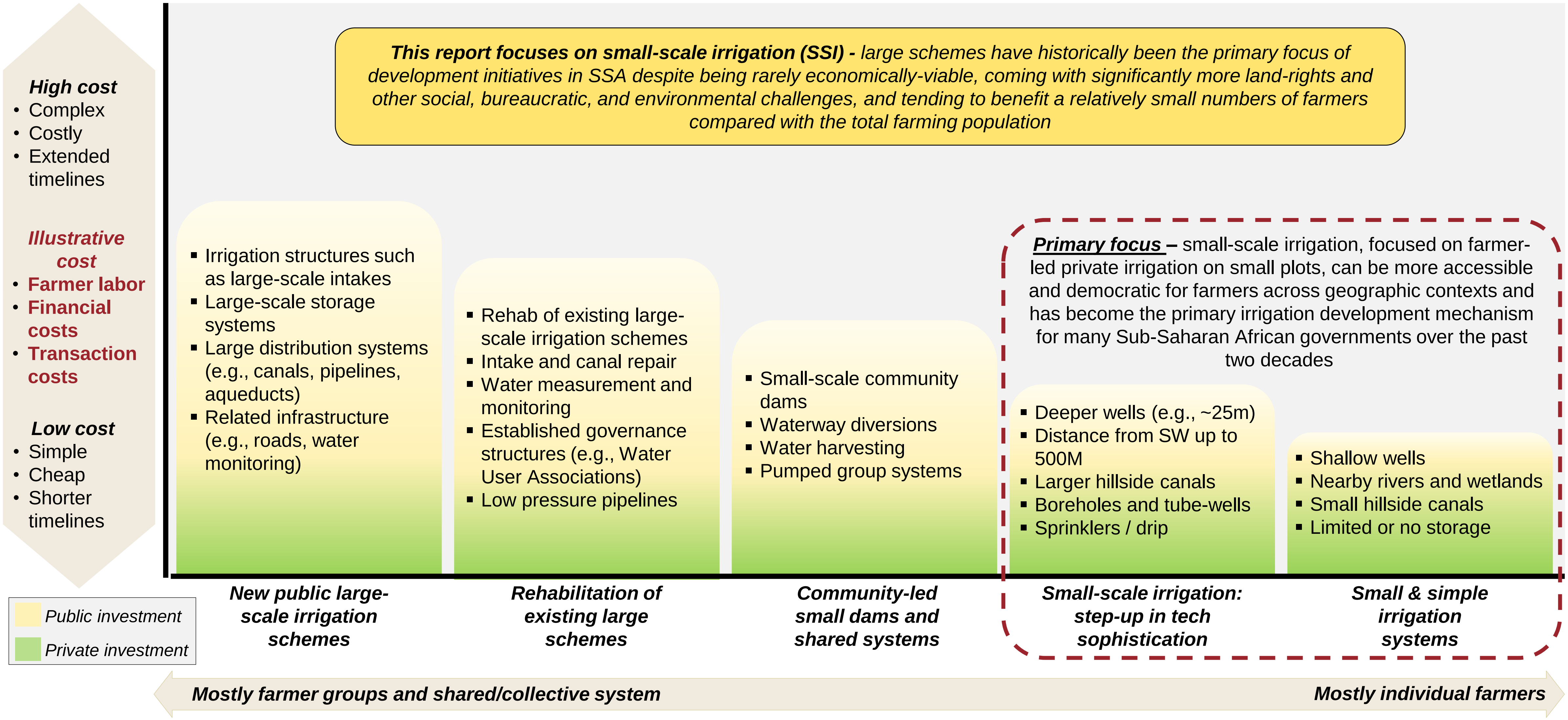
This report focuses on farmer-driven, small-scale irrigation (SSI)



***This report focuses on small-scale irrigation (SSI) -** large schemes have historically been the primary focus of development initiatives in SSA despite being rarely economically-viable, coming with significantly more land-rights and other social, bureaucratic, and environmental challenges, and tending to benefit a relatively small numbers of farmers compared with the total farming population*

High cost
- Complex
- Costly
- Extended timelines

Illustrative cost
- **Farmer labor**
- **Financial costs**
- **Transaction costs**

Low cost
- Simple
- Cheap
- Shorter timelines

New public large-scale irrigation schemes
- Irrigation structures such as large-scale intakes
- Large-scale storage systems
- Large distribution systems (e.g., canals, pipelines, aqueducts)
- Related infrastructure (e.g., roads, water monitoring)

Rehabilitation of existing large schemes
- Rehab of existing large-scale irrigation schemes
- Intake and canal repair
- Water measurement and monitoring
- Established governance structures (e.g., Water User Associations)
- Low pressure pipelines

Community-led small dams and shared systems
- Small-scale community dams
- Waterway diversions
- Water harvesting
- Pumped group systems

Primary focus **–** small-scale irrigation, focused on farmer-led private irrigation on small plots, can be more accessible and democratic for farmers across geographic contexts and has become the primary irrigation development mechanism for many Sub-Saharan African governments over the past two decades

Small-scale irrigation: step-up in tech sophistication
- Deeper wells (e.g., ~25m)
- Distance from SW up to 500M
- Larger hillside canals
- Boreholes and tube-wells
- Sprinklers / drip

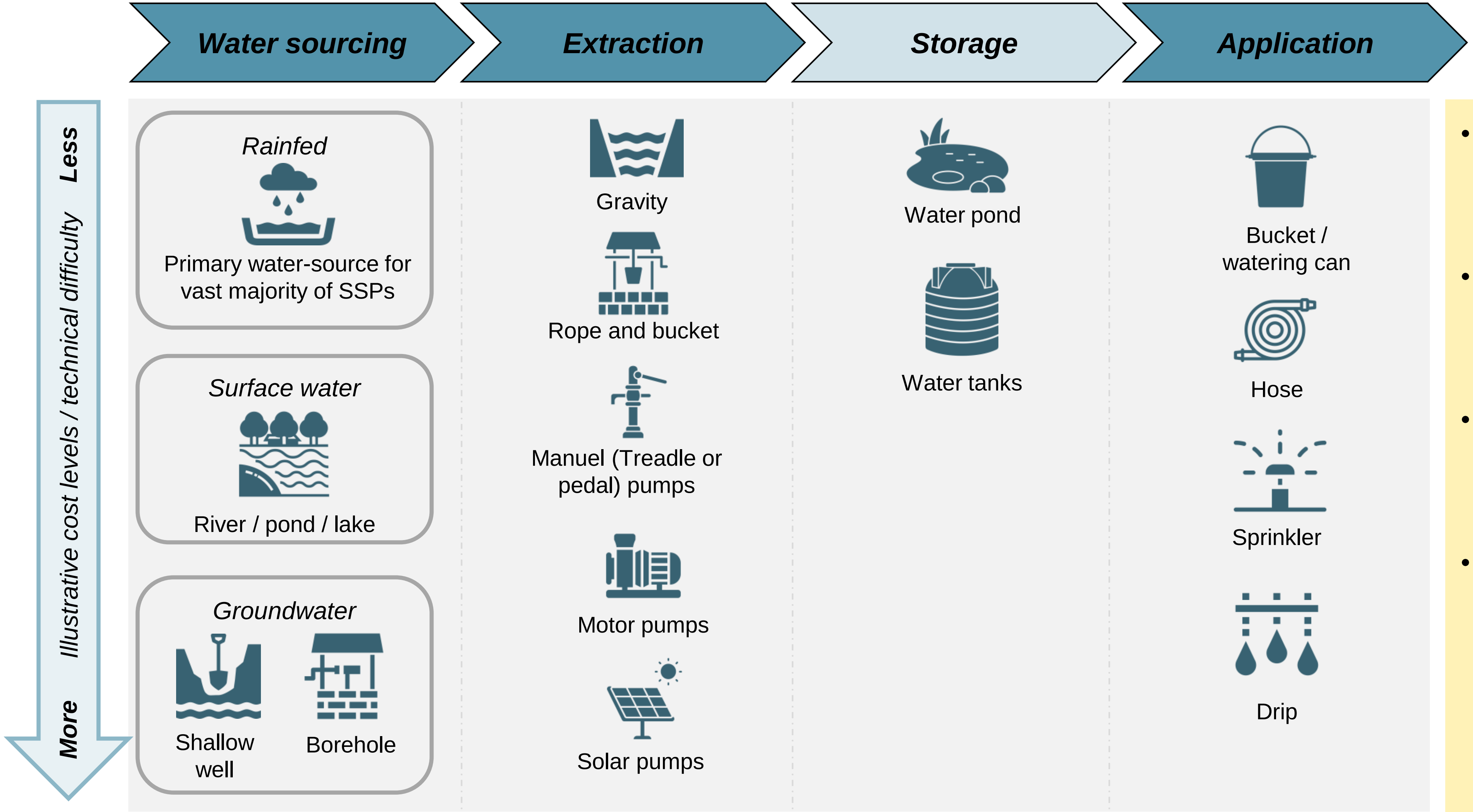
Small & simple irrigation systems
- Shallow wells
- Nearby rivers and wetlands
- Small hillside canals
- Limited or no storage

🟨 *Public investment*
🟩 *Private investment*

Mostly farmer groups and shared/collective system ↔ ***Mostly individual farmers***

Source: Adapted from the World Bank's Farmer led Irrigation Development Guide, 2020

Small-scale irrigation systems typically involve 4 steps: water sourcing, extraction, storage, and distribution or application



Less — *Illustrative cost levels / technical difficulty* — *More*

Water sourcing
- *Rainfed*: Primary water-source for vast majority of SSPs
- *Surface water*: River / pond / lake
- *Groundwater*: Shallow well, Borehole

Extraction
- Gravity
- Rope and bucket
- Manuel (Treadle or pedal) pumps
- Motor pumps
- Solar pumps

Storage
- Water pond
- Water tanks

Application
- Bucket / watering can
- Hose
- Sprinkler
- Drip

- Each component (other than storage) of SSI systems are necessary for a successful SSI system
- Farmers must be able to access and reliably move water and then distribute it to their crops with some degree of efficiency
- They must also be able to grow crops that generate profits high enough to render their overall investment profitable
- Various costs and benefits of each type of SSI systems are explored in more depth in sections 4 and 5 of the full report

Acronyms used throughout this report

BM: Business Model

COGS: Cost Of Good Sales

D&A: Data & Analytics

Fx: Foreign Exchange

GWI: Ground Water Irrigation

LMIC: Low and Middle Income Countries

HH: Household

IaaS: Irrigation as a Service

MFI: Micro-Finance Institutution

MoA: Ministry of Agriculture

MoF: Ministry of Finance

MoW: Ministry of Water

PayGo: Pay as you Go

R&D: Research and Development

ROI: Return On Investment

SACCO: Savings and Credit Co-Operatives

SSA: Sub-Saharan Africa

SSI: Small-Scale Irrigation

SSP: Small-Scale Producers

SWP: Solar Water Pumps

WCR: Working Capital Requirements

WUA: Water Use Association

CONTENT OUTLINE

1. Scope and objectives
2. **Impact case for scaling irrigation and current state of small-scale irrigation**
3. Emerging private sector solutions, barriers to scale and sustainability
4. Recommendations to scale private sector providers

Irrigation can be a key lever for agricultural development and food security in SSA

Sub-Saharan Africa urgently needs to accelerate the pace of agricultural growth to improve livelihoods, ensure food security, and keep droughts from turning into famines

Food security and poverty reduction for rapidly growing population

- ➢ Despite ongoing efforts, **Sub-Saharan Africa is not on track to meet the food security and nutrition targets** of SDG2 on Zero Hunger for 2030
- ➢ SSA **faces the largest projected food gap in the world**, with cereal demand projected to triple by 2050 driven by the highest global population growth
- ➢ Agricultural growth has been found to **be 2-4X more effective in reducing poverty** from economic growth within the sector than other sectors

Farmer productivity and yield gap is a key issue to address

- ➢ **SSA's 76% yield gap** is far above the global average of 50% yield gap for LMICs
- ➢ **75% of additional food in the next decade could come from the world's low-yield farmers**, increasing their production to 80% of the amount achieved by high-yield farmers
- ➢ Enhancing future food security will require a primary **focus on sustainable intensification** of African SSP farming systems

The ongoing impact of climate change will make agri development more difficult

- ➢ Climate change will lead to **increase in variability, temperature** and slightly **reduced average rainfall**
- ➢ **Rainfed farming is highly vulnerable** (longer dry seasons, more off-season, and heavier rains leading to floods)
- ➢ **Yield reduction of 10-20% of major grain crops** across most of Africa

Scaling irrigation can play a crucial role in addressing these needs in Sub-Saharan Africa

- ❖ Irrigation has played a crucial role in the global increase in farm productivity over the past 60 years. Irrigated land provides 40% of the world's food supply on only 20% of agricultural land
- ❖ While rainfall has historically allowed sufficient production of indigenous crops adapted to the climate and soils of the region, climate change has altered this harmonious balance, and patterns of rainfall are changing faster than farmers can adapt
- ❖ Estimates show that, without substantial additional investment in irrigation, the share of people at risk of hunger in Africa could increase by 5% by 2030 and by 12% by 2050 due to climate change
- ❖ The IWMI estimates that 29% more irrigated land will be required by the year 2025 to sustain food production and reduce poverty on the continent
- ❖ Other productivity/resilience enhancing methods such as fertilizers, drought resistant seeds, and weather forecasting all continue to rely on water for production

Note: further detail on the household and macro-level impact case can be found in appendix 1

Sources: FAO, 2023; FAO, 2018; FAO, 2021; IWMI, 2000; World Bank, 2018; IFAD, 2022; African Union, 2020; IFPRI, 2018; IFPRI, 2022

Access to irrigation can accelerate a farmer’s journey towards commercialization and deliver multiple positive outcomes

Illustrative journey from rainfed to irrigated production

ILLUSTRATIVE

Rainfed Production

Identifying opportunity and starting manual irrigation

Experiencing initial impact

Expanding irrigated area with more advanced technology

Experiencing initial commercialization

Expanding irrigated area / intensity

Establishing commercial enterprise

Example impact

Resilience – Farmers able to grow, harvest, and sell crops between rainfed harvests when food is scarce and prices high during dry period

Productivity – yields increase relative to prior year (evidence shows average increase can be ~50-400%) and high value crop production

Food security increased productivity leads to sufficient calories for entire household, on average ~25% more than rainfed

Gender – motor pump irrigation reduces on-farm labor time for women, increase female income, and increase empowerment

Income – harvest surplus allows farmer to sell crops on market and develop additional revenue streams 1-3.5X higher than rainfed on average

Poverty Reduction adapt timing of production to market demand / higher prices and crop mix to higher value crops, which can lead to ~25-50% higher per capita consumption on average

While scaling irrigation can be a technical solution that leads to specific farmer-level impacts, some impact outcomes are reliant on other development areas within the broader system

Furthermore, farmers would need to be further segmented as different farmer segments need different levels of support to scale up irrigation (i.e. gender differences, crop variations, seasonality, level of access to finance)

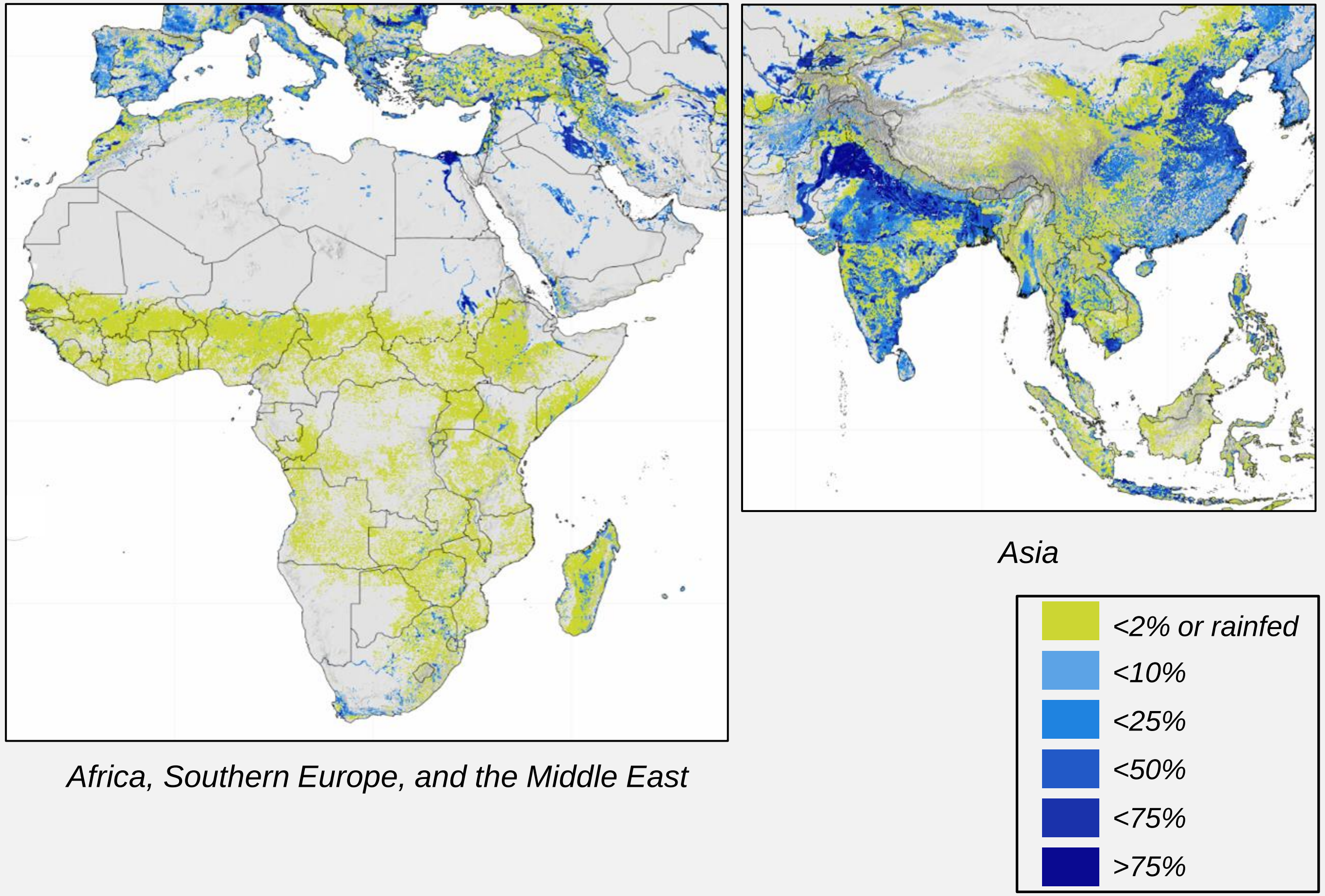
This illustrative journey highlights the role that market access and linkages plays for any farmer seeking to commercialize activities using irrigation. While irrigation cannot address the potential barriers at these steps, it can be an effective way to develop and de-risk the production-component of food systems development

Note: further detail on the household and macro-level impact case can be found in the full report

Sources: FAO, 2018; FAO, 2021; IWMI, 2000; World Bank, 2018; IFAD, 2022; African Union, 2020; IFPRI, 2018; IFPRI, 2022

Only ~2-5% of cropland in SSA is irrigated, far below the global average (~20%), South East and East Asia average (~56%), and South Asia average (~45%)

Percent of area equipped for irrigation (FAO AQUASTAT)



Irrigation in SSA lags far behind global peers

- The cultivated area in Africa is estimated at ~270 Mha, but only ~6-14 Mha of that area is recorded as being irrigated, of which are mostly large scale
- This accounts for ~2-5% of all cultivated land across SSA, far below the global average (~20%), South East and East Asia average (~56%), and South Asia average (~45%)
- Even the low level of existing irrigation across SSA is relatively concentrated in certain geographic areas, primarily Southern Africa and areas of the Sahel (further discussion on country-level differences can be found later in this section)

Key parameters define geographic concentration of irrigation

- Irrigation is concentrated geographically, often in areas that have both physical access to enough water, whether surface or ground, where it can address a water yield gap or allow shoulder/dry season production, and where the economic and enabling conditions support development
- Hence irrigation is common across parts of Asia, the Middle East and North Africa, and Mediterranean countries
- SSA stands out for its relative lack of irrigation given large swathes of land that have physical access to enough water resources and its relative economic reliance on agriculture

The pace of growth of such SSI in Sub-Saharan Africa has remained tepid at about 3% per year

- SSA is estimated to be adding ~60 Kha per year of SSP irrigated land, concentrated in a few countries
- In comparison, South Asia added, on average, 1.5 Mha per year of SSI between 1985 and 2010 in a much smaller geography than SSA

Sources: FAO AQUSTAT (2020); Siebert et al. (2010); Altchenko and K. G. Villholth (2015)

Research indicates that SSA has enough water resources to expand irrigation to 45 to 105M hectares, i.e., 17% to 39% of cropland, without depleting aquifers

44.5-105.3 *million hectares of irrigation potential*

- Sub-Saharan Africa **has enough shallow groundwater to irrigate between 44.5 million ha and 105.3 million ha without depleting aquifers** according to a 2015 study that uses hydrological data, allocating only that fraction of groundwater recharge that is in excess after satisfying other present human needs and environmental requirements (Altchenko and Villholth, 2015)

120x increase *on current groundwater irrigated areas*

- Based on a comprehensive study of 13 SSA countries, Pavelic et al. (2013) has suggested that the known **groundwater resource can easily support 120x their current groundwater-irrigated area**. This study shows that all countries have variable but significant potential for GWI expansion, in total an area of 13 million ha, potentially serving 26 million additional SSP households

~90% of countries *with sufficient water resources*

- Zaki et al. 2018 results show that, except for Zimbabwe, **the current available surface water and groundwater resources could be sufficient to farm all of the potential cultivable areas in 15 selected countries** when both rain-fed and irrigated systems are fully operational

5.5% of renewable water resources *currently being withdrawn*

- Data from FAO's AQUSTAT database indicates that in SSA as a whole, current annual **water withdrawals amount to just 5.5% of total annual internal renewable water resources** (a measure of water generated within a given country, equal to runoff + groundwater recharge from precipitation and seepage from rivers into aquifers)

~90% of countries *with high water storage and recharge levels*

- Macdonald et al. 2012 showed that **African water security is greatly enhanced by the distribution of groundwater storage and recharge**; many countries that feature low recharge, possess substantial groundwater storage, whereas countries with low storage typically have high, regular recharge. Only five countries have both water recharge and storage below median level (Eswatini, Zambia, Lesotho, Zimbabwe and Eritrea)

Focusing on SSI, the expansion potential is 19M hectares i.e. 7% of cropland, considering agroeconomic and social conditions

There is **abundant evidence that the potential for expanding SSI in SSA is immense** (taking into account other variables beyond just resource availability)

However, **these estimates vary significantly at the continental level**. Estimated ranges of potential expansion area include:

- *~3-15 million hectares (You et al., 2011)*
- *~25-29 million hectares (Xie et al., 2014)*
- *~38 million hectares (Malabo Montpellier Panel, 2018)*
- *~10-19 million hectares (Xie et al., 2018)*
- *~47 million hectares (FAO Aquastat, 2020)*

The wide variation in irrigation potential results from different assumptions. While water, in the form of runoff, may easily be quantified and translated into theoretical potential irrigation areas, **assessments do not account equally for a set of practical realities**

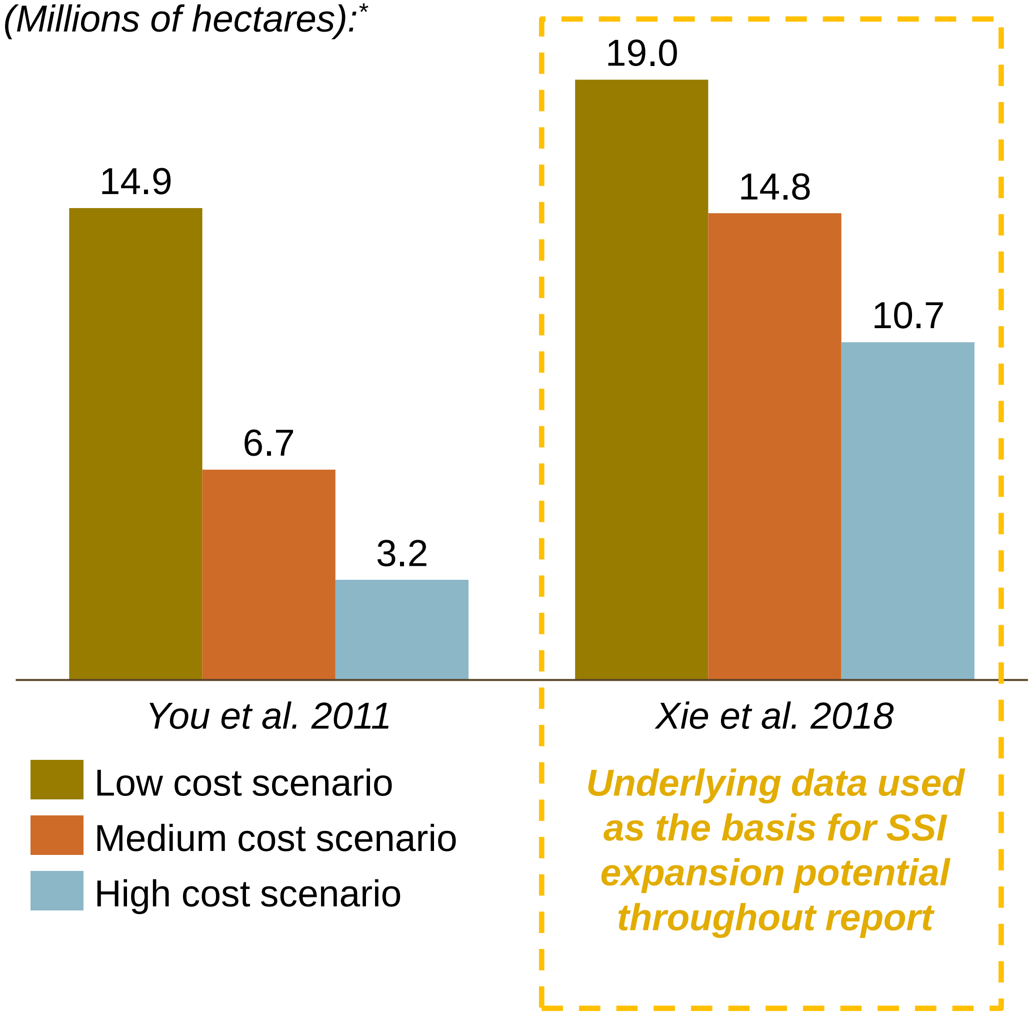
An alliance between the World Bank, IFAD, AfDB, and CGIAR carried out a series of studies to **more accurately assess the potential for SSI expansion that takes economic dimensions further into account**

- This model **identified potential areas for irrigation development**, using distance to market, existing arable farmland, and distance to water resources. An optimization model calculated the potential for small- and large-scale irrigation for each country as well as various impact and ROIs

We use the latest figures from this model, provided by the IFPRI team via personal communication, as a basis for understanding the potential expansion opportunity for SSI at both a continental and country level

Potential Irrigation Expansion, from two leading studies

*(Millions of hectares):**



Underlying data used as the basis for SSI expansion potential throughout report

*Source: You et al. 2011; Xie et al. 2018; *Cost scenarios indicate the assumed cost associated with irrigation investment. Thus, the higher cost scenarios results in lower expansion potentials due to decreased theoretical ROI*

Expansion of SSI in SSA across 19M hectares has the potential to impact 20-30M SSP households across the region

~19.1 million hectares[1]

~20-30 million SSP HHs[2]

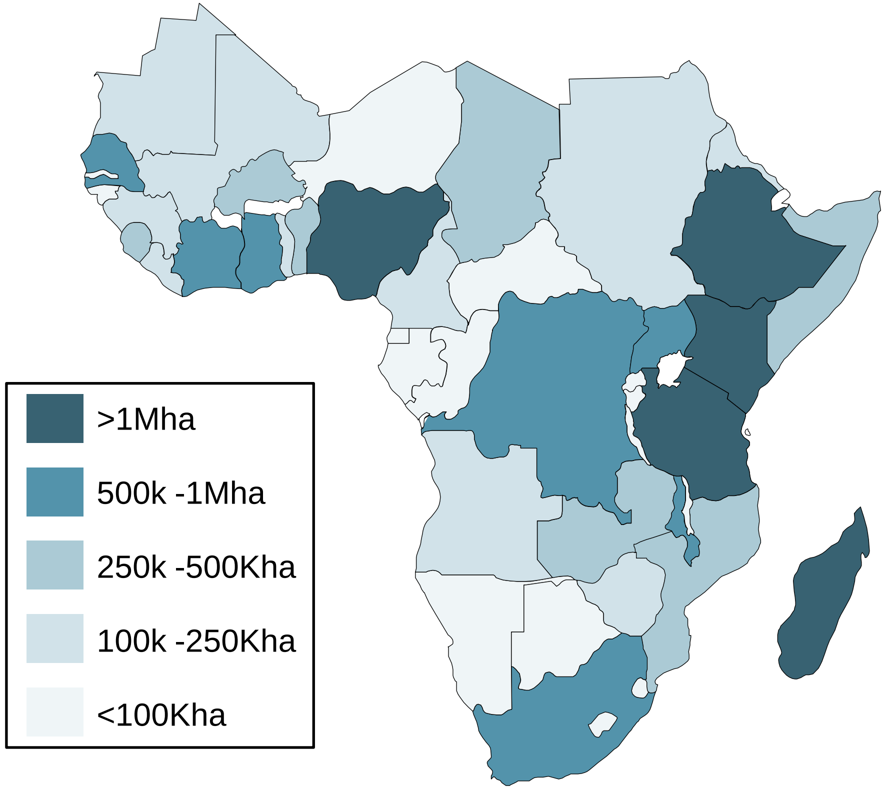
~120-200 million rural population[2]

~28% ROI for SSI in SSA[3]

~5% reduction in food insecure population[4]

~60% reduction in food import dependency[4]

Potential area for SSI expansion in SSA by country



Countries	SSI expansion potential (Kha)[1]	Potential # of SSP HHs with irrigation[2]	Arable Land (Kha)	Current Irrigated Area (Kha)	% of Cultivated Area Currently Irrigated
Nigeria	*2,900*	2.73 mil	35,000	218	0.8%
Tanzania	*1,768*	1.47 mil	13,500	189	2.3%
Kenya	*1,349*	~2 mil	5,800	97	3.2%
Madagascar	*1,344*	1.54 mil	3,000	1,080	23.1%
Ethiopia	*1,095*	2.5-3 mil	16,200	290	4.6%
Côte d'Ivoire	*999*	409k	3,500	67	0.9%
Uganda	*961*	991k	6,900	5.9	0.1%
South Africa	*949*	1.1 mil	12,000	1,500	17.1%
DRC	*923*	616k	13,500	6.8	0.1%
Malawi	*807*	1.7 mil	3,600	54	2.4%
Senegal	*790*	439k	3,200	69	3.7%
Ghana	*598*	363k	2,500	55	0.6%

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1) IFPRI modelling; Xie et al. 2018 "Can Sub-Saharan Africa feed itself? The role of irrigation development in the region's drylands for food security"; 2) ISF Analysis based on SSI land potential from Xie et al, 2018's research divided by the average SSP farm size in each country; 3) You et al. 2011; 4) Potential reduction if potential irrigated land is addressed

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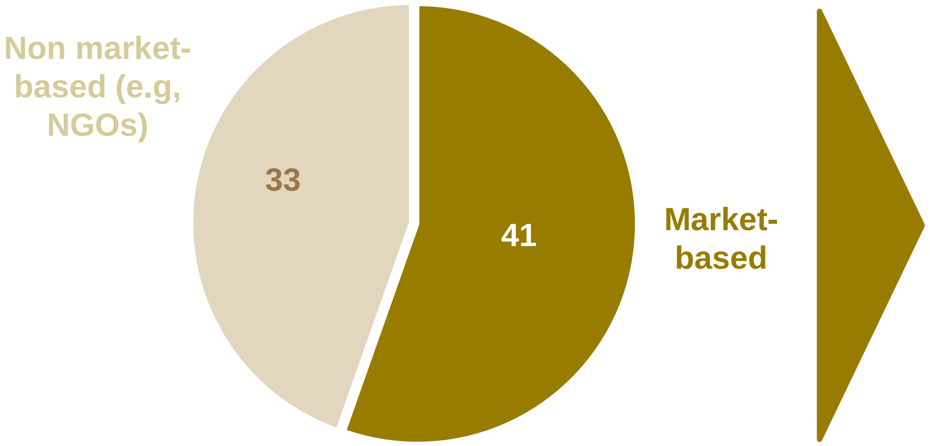
Our analysis focused on 6 private sector providers, representative of the 4 main SSI pumping technologies

Mapping of SSI initiatives in SSA[1]

Over the 74 SSI initiatives mapped, 41 are market-based.



Private sector providers analyzed in-depth and countries visited during the project

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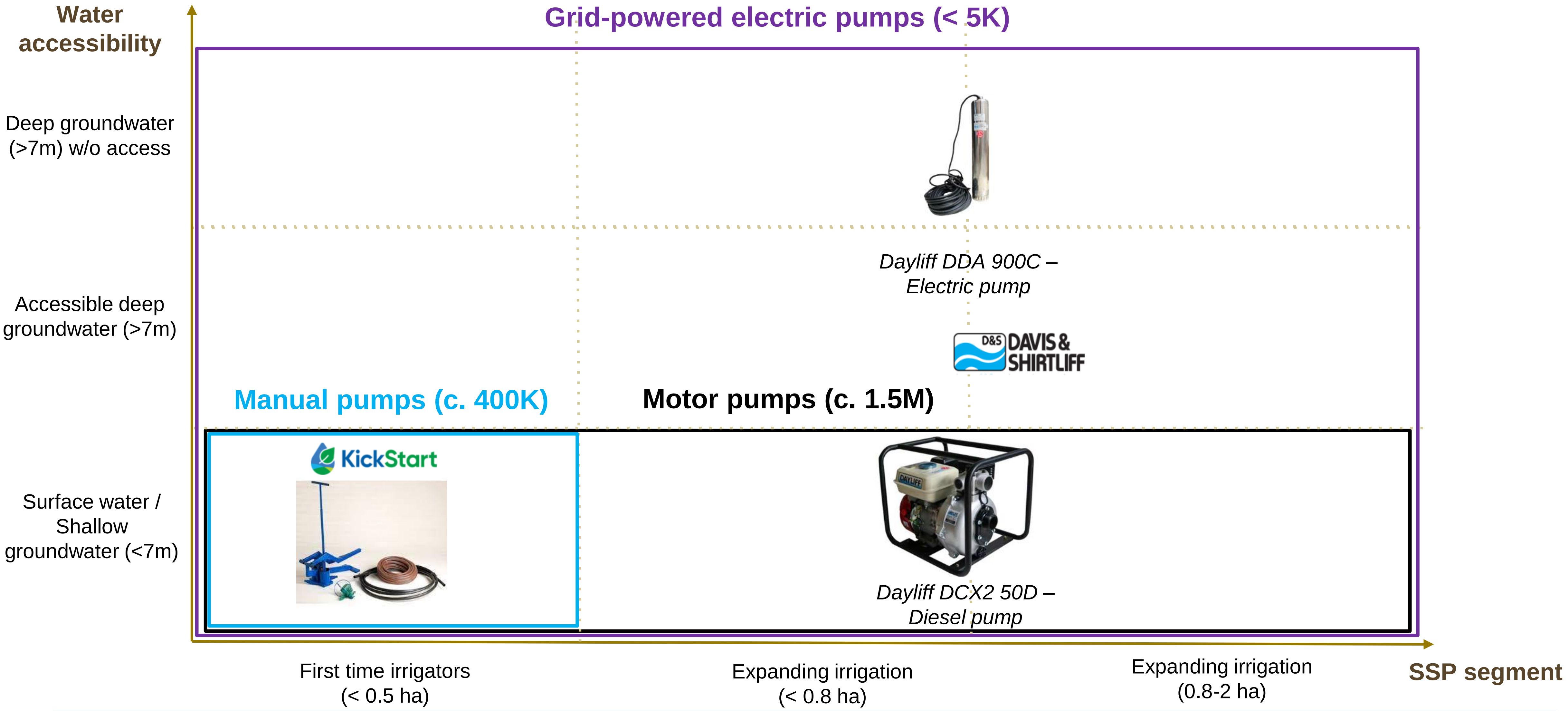
[1] *Hystra's analysis based on scanned initiatives from desk research and expert interviews.*

Historical sales of pumps in SSA have been estimated to less than 2M in total



Water accessibility

Deep groundwater (>7m) w/o access

Accessible deep groundwater (>7m)

Surface water / Shallow groundwater (<7m)

Grid-powered electric pumps (< 5K)

Dayliff DDA 900C – Electric pump

Manual pumps (c. 400K)

Motor pumps (c. 1.5M)

Dayliff DCX2 50D – Diesel pump

First time irrigators (< 0.5 ha)

Expanding irrigation (< 0.8 ha)

Expanding irrigation (0.8-2 ha)

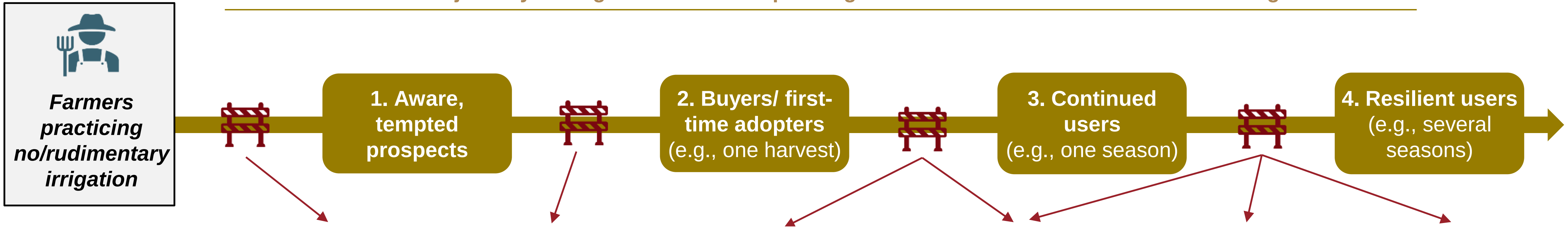
SSP segment

*Estimates from KickStart

Logos represent providers featured in case studies in the full report

Wide-spread adoption of SSI has been mostly limited by the high cost of acquiring and operating irrigation pumps

Customer journey to irrigation and corresponding barriers from awareness to resilient usage



Farmers practicing no/rudimentary irrigation

1. Aware, tempted prospects

2. Buyers/ first-time adopters (e.g., one harvest)

3. Continued users (e.g., one season)

4. Resilient users (e.g., several seasons)

Key barriers		Lack of understanding and risk aversion	Lack of investment capacity	High operating cost (energy/labor)	Need for repairs and maintenance	Unreliable access to market	Unreliable access to water
Irrigation products	Motor pumps	~ Easy-to-use & known but of variable quality	✗ High upfront cost ($200-400)	✗ High fuel and lubricant costs	✗ No support (warantee may be included)	✗	✗ Limited to surface/shallow ground water
	Manual pumps	✓ Easy-to-use, well known and durable	~ Medium cost ($70-200)	✗ Labor-intensive	~ Warantee and spare-parts included		

Reinforced risk perception *and decreased likelihood to purchase*

Affordability and cost over time

Need for support (beyond provision of technology) to reap the full benefits of irrigation

High cost of failure *for farmers given high initial investment*

High risk of failure *for farmers in the absence of support*

Promising innovative business models have emerged to solve this affordability barrier, so far at limited and varied scales

Business Model

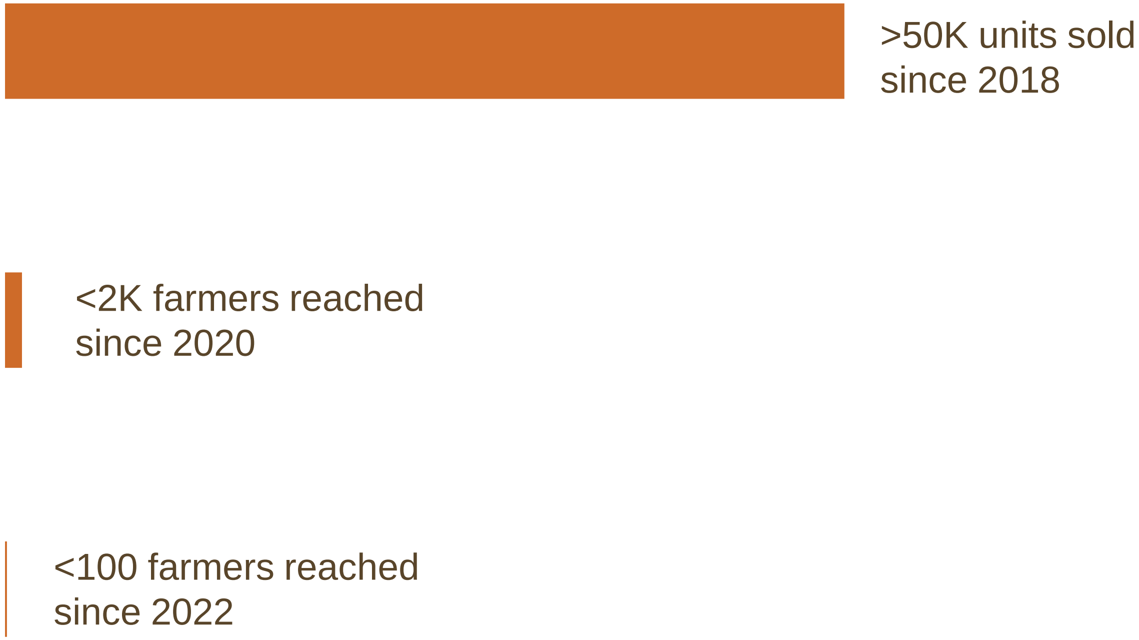
Pay-as-you-Go (PayGo)
offers credit to farmers for solar pumps

SunCulture
D&S DAVIS & SHIRTLIFF
BONERGIE energie pour vos ambitions

Irrigation-as-a-Service (IaaS) makes irrigation a variable cost

- **Mobile IaaS*** — AGRIWORKS
- **Fixed IaaS** — STABLE FOODS

Number of units sold or farmers reached



>50K units sold since 2018

<2K farmers reached since 2020

<100 farmers reached since 2022

**Mobile Irrigation-as-a-Service models has so far been primarily developed with motor pumps*
Logos represent providers featured in case studies (see appendix 5 of the full report)

Solar pumps with PayGo has become the leading improved irrigation solution (>50K units sold), both for first-time users and farmers expanding irrigated areas

SunCulture

BONERGIE
energie pour vos ambitions

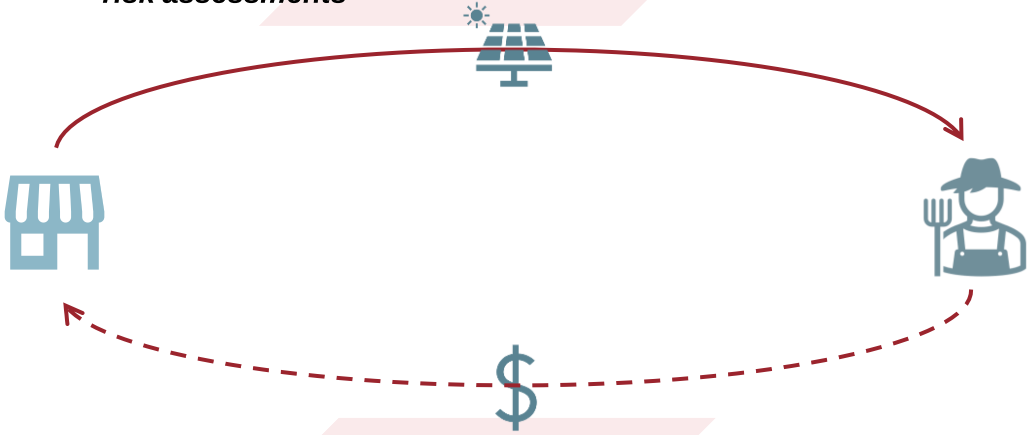
- ✓ In-house financing guarantees a **long-term relationship** with farmers, ensuring high-quality after-sales service…
- ❖ … but creates a working capital burden for the provider

« Access to finance to cover our working capital requirements is our largest barrier to growth at this stage: the demand is there»
Solar PayGo irrigation provider

D&S DAVIS & SHIRTLIFF

1. Irrigation providers sell solar irrigation kits to farmers

*a) Kits including pump, panels, controller, piping and sprinklers are sold starting at **$380 for 1 acre** (drip lines optional at $1k/acre)*
*b) Sales happen mostly via group events with coops or farmer groups initially, and later through **word-of-mouth** and reference from farmers*
*c) Systems are installed by technician after an in-person or remote **site assessment** to check water availability*
*d) When sold on credit (70-85% of sales), providers also carry out **credit risk assessments***



2. Farmers pay back through PayGo

- *A **10-30% downpayment** is required from the farmer*
- ***Monthly repayments** can be fixed or flexible, over 24-36 months, made through **mobile money***
- ***Maintenance** and a 2-year warrantee is typically **included***
- ***Financing cost** for the farmer is **20-40%** of total price paid*
- *In case of non-payment (often in rainy seasons), after a grace period of 2 to 4 weeks, provider can remotely lock and eventually repossess the system*

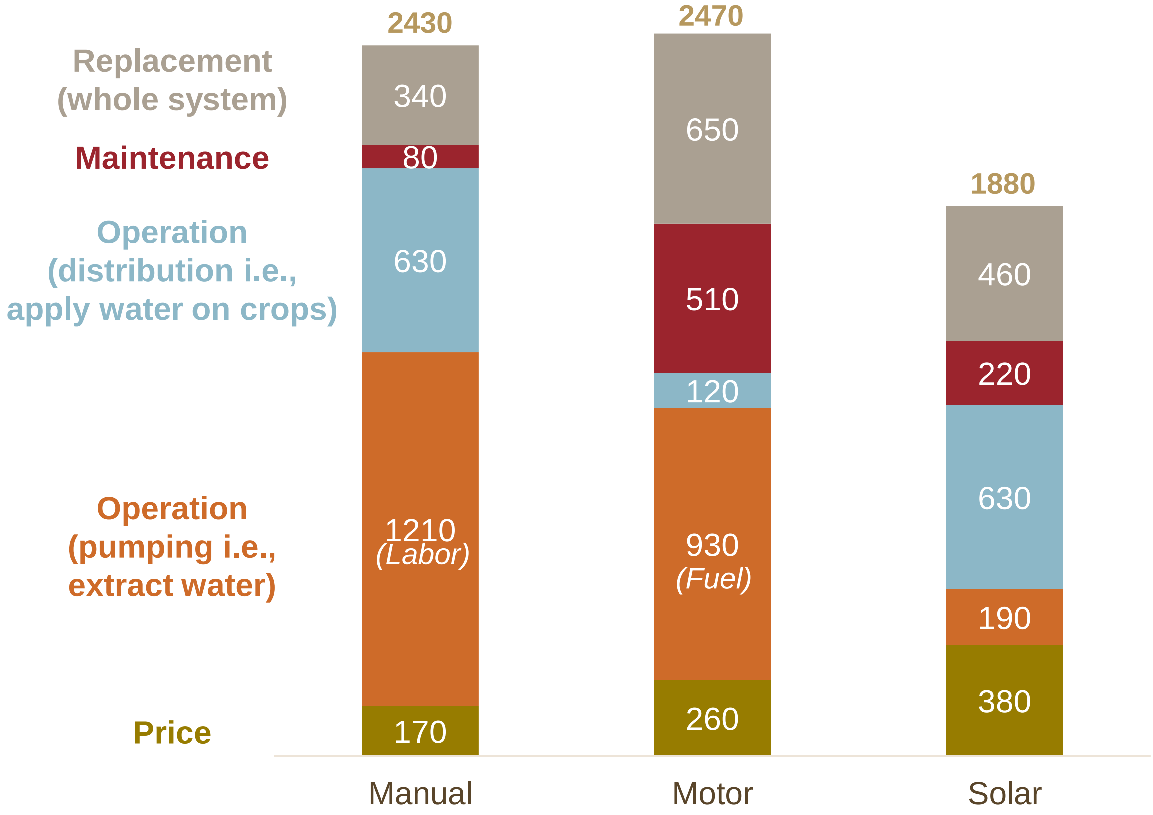
- ✓ For first-time irrigators: PayGo **reduces risk by limiting initial investment** to 10-30%
- ✓ For farmers switching from motor pumps: solar **provides savings** (up to $5/day for 2ha)

« Thanks to my solar pump I made $1K in net profit in just one year by selling tomatoes off season, when the price is at its highest »
SunCulture client in Western Kenya

Source: case studies on SunCulture, Bonergie, and Davis & Shirtliff (see appendix 5 of the full report)

Solar pumps enable farmers to significantly reduce energy or labour costs, making them cheaper over time, and shielding farmers from hikes in energy prices

Cost analysis of 3 main pumping technology over 10 years for a 1-acre farm, assuming c. 1K m^3 of irrigation water per year ($) [1,2,3]



> *"Thanks to solar, I'm saving $2 per day of irrigation and don't have to worry about rising fuel prices anymore"*
>
> *Bonergie customer*

Key hypotheses

- Based on annual water consumption of 1K m^3 (enough to irrigate ½ acre of most vegetable crops, for 2 harvests a year[4]), with resp. flow rates of 2.5; 25 and 0.8 m^3/h at 14m head
- Pumping: resp. operation time of 100% (extract water manually); 5% and 5%
- Distribution: assuming sprinklers for manual and solar, and hose for motor, with resp. distribution time of 1h per irrigation day (to move the sprinklers) and 100% of pumping time.[5]
- Replacement of the whole system: resp. pump lifetimes of 5; 4 and 7 years, with solar panels lasting 15 years and representing c. 30% of system cost
- Other assumptions: fuel consumption = 1.7 L/h; fuel cost = 1.35 $/L; lubricant cost = 10% fuel cost; labor cost = 0.3 $/h

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[1] Hystra's analysis from desk research. [2] World Bank, Solar pumping: The Basics, 2018. [3] Pump models used: SunCulture RainMaker2 ClimateSmart Direct, Dayliff DCX1-50P & KickStart MoneyMakerMax, retail prices in Kenya. [4] Assuming one harvest is 500K m^3 of water applied during 3-4 months. [5] Motor pump pressure is too high for sprinklers on a small farm. Additional cost (c. 40$) and water savings (+10%) of sprinklers compared to hose are not included here.

Mobile IaaS offers complete de-risking for the poorest farmers but has so far only been deployed at small-scale (< 2K farmers)

- ✓ **SSPs show a clear willingness to pay for irrigation services of which the higher limit has not yet been explored:** in 4 seasons, Agriworks has doubled its price per hour from \$1.5 to \$3 and demand has remained high
- ✓ **Leveraging part-time staff and pumps such as bodaboda riders[1] and their bikes helps tackle the issue of seasonality,** and reduces both CAPEX and OPEX

AGRIWORKS

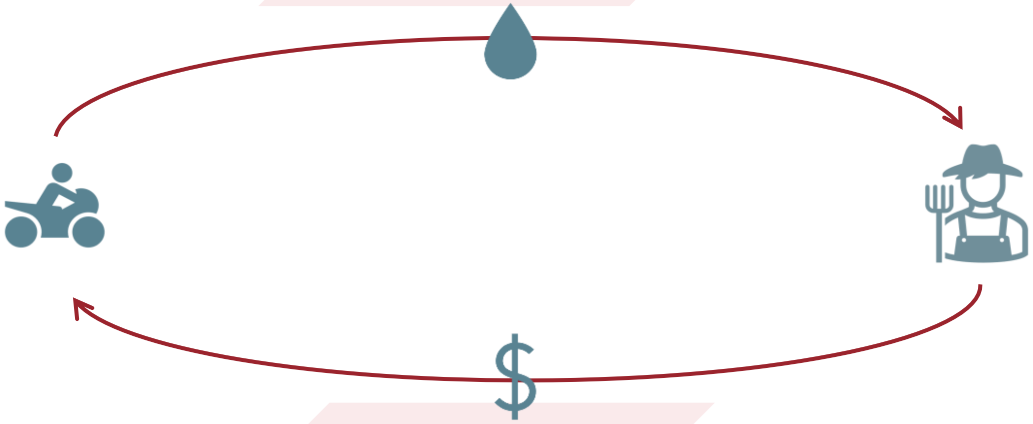
1. Mobile irrigation agents bring pumps to the farmers' fields

*a. Farmers become aware of the service mostly through **word-of-mouth** and call a branch manager to order 1-6 hours of irrigation*

b. Branch manager dispatches an agent to the farmer's field

*c. Agent pumps **accessible surface water** onto the farmer's field (max 250m distance)*

d. Pumps are powered by motorcycle's engine, but could be powered by solar if and when panels become portable enough, or a battery



2. Farmers pay per hour of irrigation

- *Agriworks charges farmers **\$3 per hour** of irrigation i.e., c. 10 m3*
- *Out of the \$3, **Agriworks collects 25%** (\$0.75)*
- *Riders typically use c. \$1.5 for fuel and maintenance expenses, and end up with **net earnings of about \$0.75/hr**.*
- *Farmers can get discounts when ordering many hours of irrigation at a time (i.e., >5h)*

- ✓ For first-time irrigators, **mobile IaaS considerably reduces risk** by making irrigation a variable cost
- ✓ For farmers who have their own pump, mobile IaaS brings **savings on operating costs** as well as convenience
- ✓ Almost 60% of users would not grow any dry season crop if the service was not available, and **average profit is c. \$250 per dry season**

« My petrol pump was very expensive in fuel and maintenance. Agriworks also makes it a lot easier to irrigate my different plots of land in different areas»
Agriworks client in Eastern Uganda

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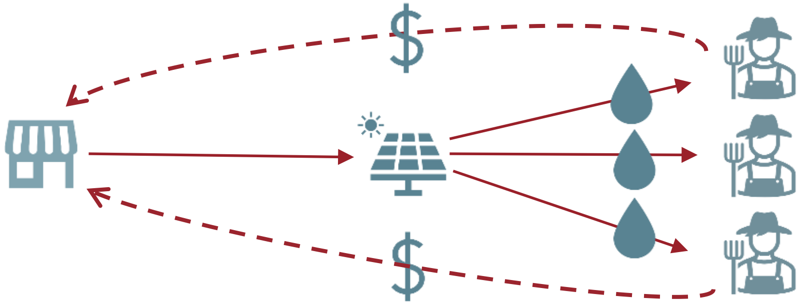
[1] Taxi drivers who are carrying passengers or goods on their motocycles
Source: case study on Agriworks (see appendix 5 of the full report)

Although still at pilot stage (< 100 farmers)**, fixed IaaS** offers complete de-risking for farmers, and is expanding into market access to ensure shared success

1. ***Fixed IaaS installs a fixed solar pump and connects neighbouring farmers***
   a. Stable Foods finds suitable areas for a new site and **convinces enough SSPs to subscribe to the model** (with a minimum of 10 acres in total).
   b. The company then installs a high-capacity solar pump with borehole and equips the farms of SSPs who signed off with **drip lines**

- ✓ Embedding market access can ensure **long-term success** of both farmer and business
- ✓ Model creates **direct incentive to distribute water efficiently** and connect more farmers to the same site
- ✓ **Ensure reliable water access**, with efficient water distribution systems (e.g., drip)



- ✓ No initial investment required, which **strongly reduces the risk for SSPs,** as they can easily go back to their old ways
- ✓ By providing market access, Stable Foods guarantees a high ROI (2-3 times more revenue) and **embeds its success with the farmer's**

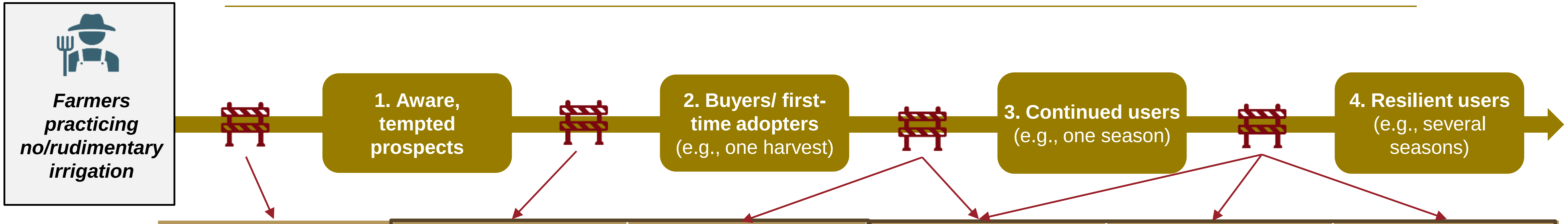
2. Farmers pay Stable Foods under one of 3 models

- ***Irrigation-as-a-Service:*** *SSPs pay for water ($42/acre/month) with at least 6 payments per year. Inputs and market access can be provided on demand.*
- ***Lease & Operate (L&O):*** *Stable Foods* ***leases and cultivates the land*** *for the SSPs. The company can also provide agro-training to the SSPs so they can grow crops by themselves after 2 years*
- ***Jumla model (new):*** *Stable Foods provides irrigation and inputs on credit (20% down-payment) and* ***guarantees crop purchase*** *with a floor price.*

Source: case study on Stable Foods (see appendix 5 of the full report)

Solar pumps with PayGo and **mobile IaaS** can address or avoid the upfront investment barrier, while **fixed IaaS** can also integrate long-term market and water access

Customer journey to irrigation and corresponding barriers from awareness to resilient usage



Farmers practicing no/rudimentary irrigation

1. Aware, tempted prospects

2. Buyers/ first-time adopters (e.g., one harvest)

3. Continued users (e.g., one season)

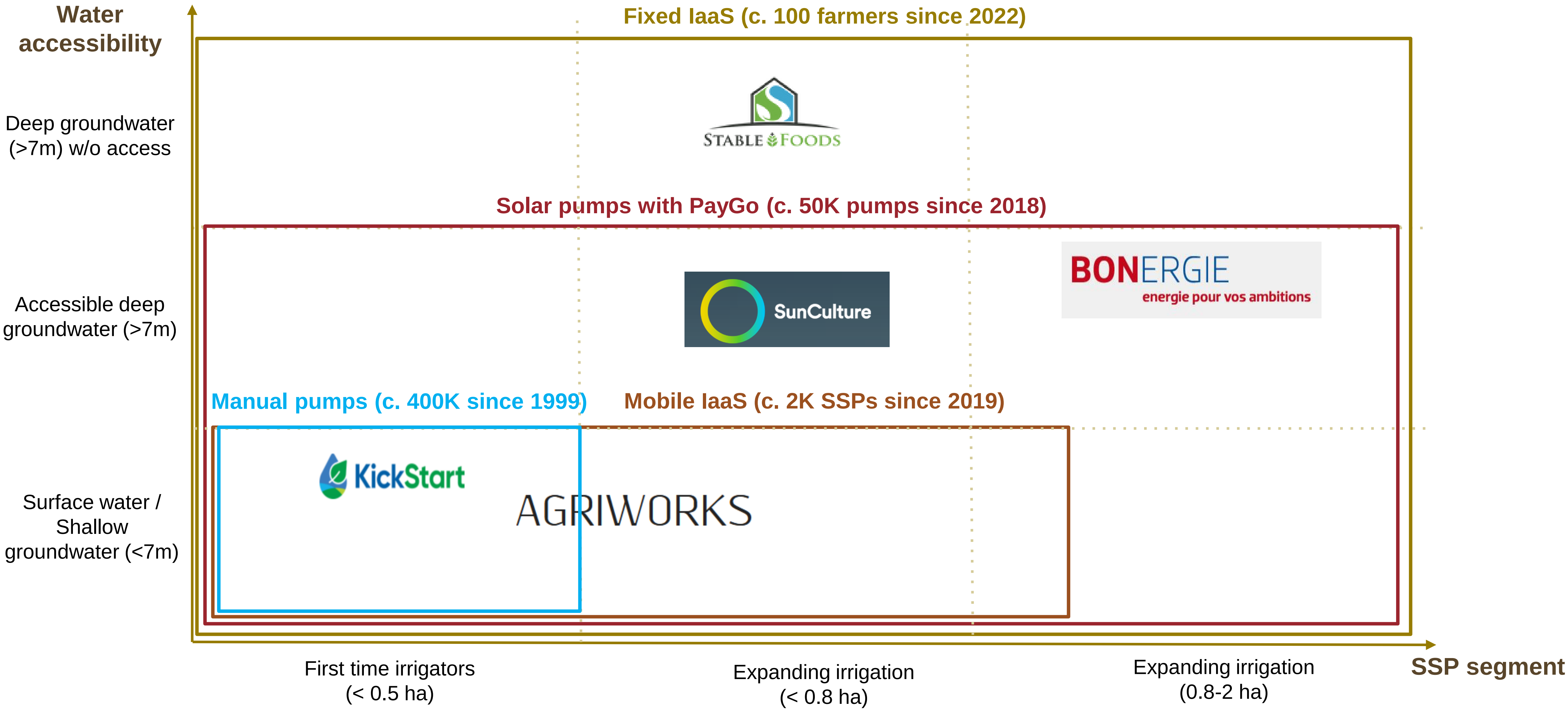
4. Resilient users (e.g., several seasons)

Key barriers		**Lack of understanding and risk aversion**	**Lack of investment capacity**	**High operating cost**	**Need for repairs and maintenance**	**Unreliable access to market**	**Unreliable access to water**
Business models	PayGo	~ Solar as new technology	~ Medium cost of down-payment (10-30% of total cost)	~ PayGo monthly installments	✓ Efficient after-sales (to ensure repayment)	✗	~ Water sources can run dry (due to over-use or poor site assessment)
	Fixed IaaS	~ 1-year commitment	✓ No upfront cost	~ Service cost	✓ Service business model	✓ Purchase contracts	✓ Efficient water distribution systems & proper site assessment
	Mobile IaaS	✓ No commitment				✗	✗ Limited to surface/shallow groundwater
		Reduced risk perception drives adoption	**Affordability and cost over time**		**Need for support (beyond provision of technology) to reap the full benefits of irrigation**		

Reduction/absence of initial and ongoing costs *reduces risk*

After-sales support/service is ***embedded in business models and maximizes chances*** *of farmer success*

These innovative businesses have the potential to cover every farmer segment, with manual pumps remaining a possible stepping-stone for the smallest farmers*



Water accessibility

Deep groundwater (>7m) w/o access

Accessible deep groundwater (>7m)

Surface water / Shallow groundwater (<7m)

Fixed IaaS (c. 100 farmers since 2022)

Solar pumps with PayGo (c. 50K pumps since 2018)

Manual pumps (c. 400K since 1999)

Mobile IaaS (c. 2K SSPs since 2019)

First time irrigators (< 0.5 ha)

Expanding irrigation (< 0.8 ha)

Expanding irrigation (0.8-2 ha)

SSP segment

** Manual pumps can help the poorest SSPs to make enough profit to afford to buy a solar pump, while also being a back-up solution when the sun does not shine.*
Logos represent providers featured in case studies (see appendix)

However, holistically meeting farmer needs creates delivery challenges for **Paygo** irrigation models, which has so far hindered faster growth

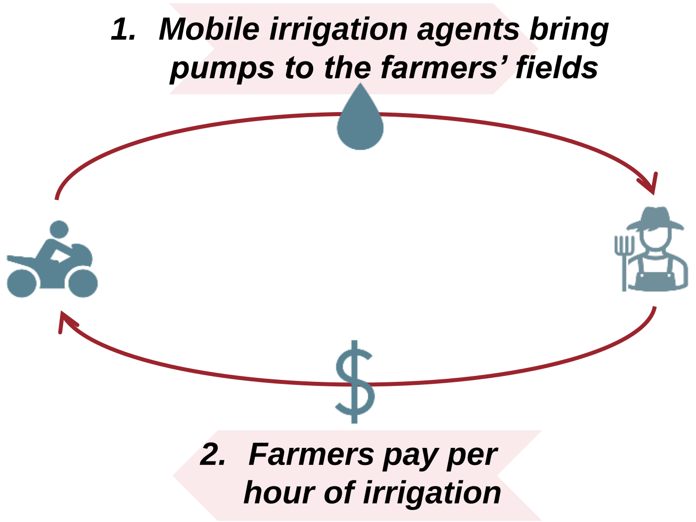
Farmer barriers	Lack of understanding and risk aversion	Lack of investment capacity	High operating cost	Need for repairs and maintenance	Unreliable access to market	Unreliable access to water
Solution from PayGo models	~ Solar as new technology	~ Medium cost of down-payment (10-30% of total cost)	~ PayGo monthly installments	✓ Efficient after-sales (to ensure repayment)	✗	~ Water sources can run dry (due to over-use or poor site assessment)
Remaining challenges for farmers		Even with PayGo, **upfront cost remains a barrier** for small SSPs	Most models have **fixed recurring payments not meeting seasonality** of SSP income		**Market access** remains a key condition for SSP success and is still mostly not provided. For off-season irrigated crops it is not yet a constraint, but it will be a challenge at scale	**Additional cost of drilling a borehole** ($5-10k) can be required to ensure year-round water availability
Challenges for PayGo providers	**Acquisition costs are high** due to need for behaviour change and reassurance; conversion cycles are long	**High WCR of PayGo** is a strong constraint to scale		The **last mile delivery network required** to ensure adequate site assessment and efficient after-sales services is complex to set up and run		Null marginal cost of extraction provides **little incentive to use water efficiently** and in some places, it **will challenge farmers' long term success**

Barriers faced by PayGo (as well as IaaS) providers can be grouped into 4 categories:

- **Investment for SSPs is still a challenge (upfront cost, monthly payments vs. seasonality of income)**
- **Providers lack working capital**
- **Delivery models to provide holistic solutions are still too costly**
- **Incentives to preserve water resources are limited**

Mobile and fixed IaaS have so far only been implemented at a small scale (< 2K farmers), and have not yet reached profitability

Mobile IaaS



1. Mobile irrigation agents bring pumps to the farmers' fields

2. Farmers pay per hour of irrigation

✕ **Farmers willingness to pay** is not yet fully understood
➔ *Pricing can be adapted to encourage first trial, regularity and volume*

✕ **Optimizing logistics** (e.g., minimizing transportation time) is a major challenge and cost driver

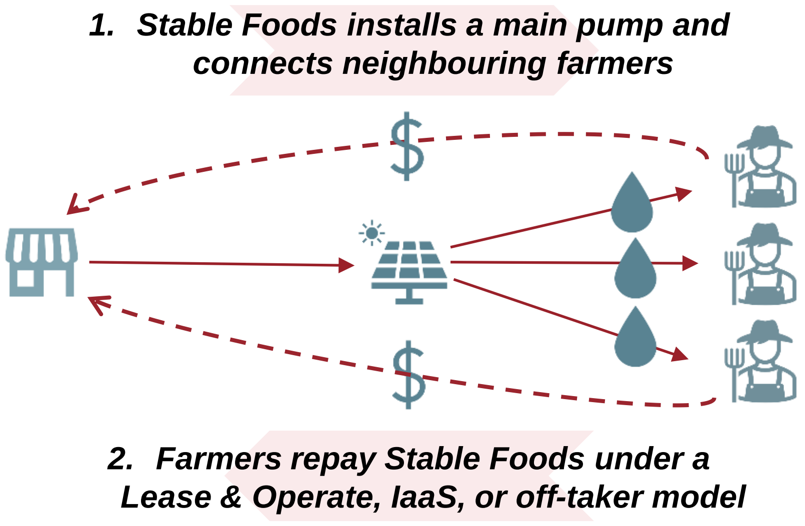
✕ **Access to surface or shallow groundwater** is required

✕ **Water regulation laws** might prevent replication in some countries

✕ **Seasonality of irrigation** endangers overall profitability

✕ **Market access remains a key condition for SSP success** and is not guaranteed

Fixed IaaS



1. Stable Foods installs a main pump and connects neighbouring farmers

2. Farmers repay Stable Foods under a Lease & Operate, IaaS, or off-taker model

✕ **High initial investment required** to find and open a new site, and convince farmers to subscribe

✕ **Economic viability** depends on capacity to ensure market access

Source: case study on Agriworks and Stable Foods (see appendix)

These models (exc. fixed IaaS) rarely use water-efficient distribution systems (like drip irrigation) and have limited incentives to maximize water use efficiency and safeguard long-term resources

Drip irrigation has the potential to save water resources but remains complex to operate and expensive

	Hose	Sprinkler	Drip
			
***Water savings*[1]**	Baseline	-10%	-40%
Lifetime (y)	2-3	7-10	3-5
Price for 1-acre farm ($)	25-75	75-125	500-1000
Operating limitations	High labor costs	Can cope with relatively clean water; limited labor costs	Requires clean water or flushing filter every week and regular checks
Pressure requirement	Low	High	Medium

Only fixed IaaS uses drip irrigation, with a direct incentive to efficiently use water

		Solar PayGo	Mobile IaaS	Fixed IaaS
Distribution	***Hose***	Default usage	Agriworks / KickStart	NA
	Sprinkler	20-40% sales	PayNPump	NA
	Drip	<5% sales	NA	100% of farms with drip
Incentive to save water		❌ **SSPs accessing solar pumps are not incentivized to be water-efficient** • SWPs have virtually no marginal cost of water extraction • Without storage (tank or battery), SWPs are best used with max sunlight[2]	❌ **Mobile IaaS sells water as a service per the hour and not per m3**	✓ **Fixed IaaS creates a direct incentive** to use water efficiently thanks to drip lines, and connect more farmers to same site

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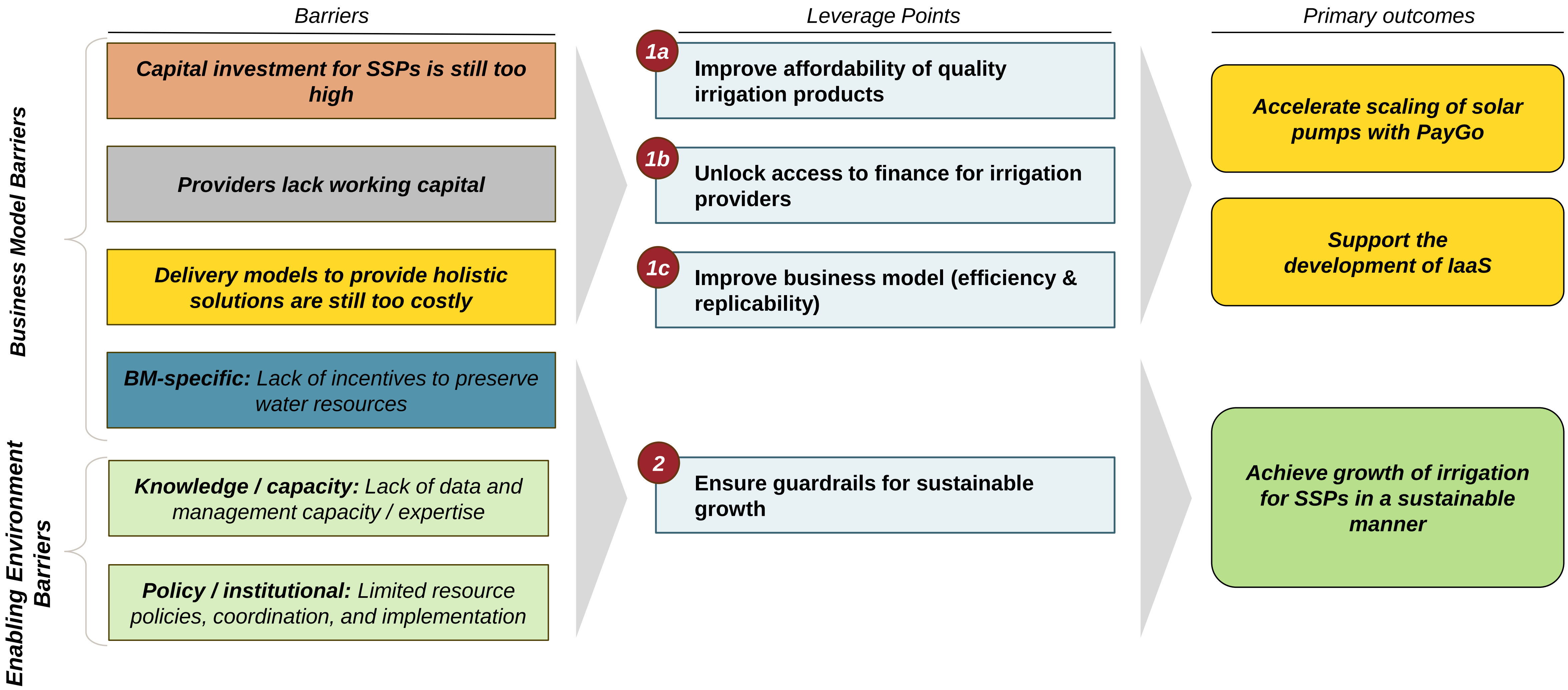
[1] Measured compared to hose, negative values implies less water used. [2] i.e., when evapotranspiration is at its highest

Data comes from Hystra's analysis and: CDurable.info, l'irrigation goutte à goutte en Afrique subsaharienne,2010 and Grekkon Limited, The most efficient way to irrigate your crop, 2022

CONTENT OUTLINE

Barriers to the sustainable uptake of small-scale irrigation can be unlocked by focusing on 4 points of leverage



Barriers

Business Model Barriers

- ***Capital investment for SSPs is still too high***
- ***Providers lack working capital***
- ***Delivery models to provide holistic solutions are still too costly***
- ***BM-specific:*** *Lack of incentives to preserve water resources*

Enabling Environment Barriers

- ***Knowledge / capacity:*** *Lack of data and management capacity / expertise*
- ***Policy / institutional:*** *Limited resource policies, coordination, and implementation*

Leverage Points

- ***1a*** **Improve affordability of quality irrigation products**
- ***1b*** **Unlock access to finance for irrigation providers**
- ***1c*** **Improve business model (efficiency & replicability)**
- ***2*** **Ensure guardrails for sustainable growth**

Primary outcomes

- ***Accelerate scaling of solar pumps with PayGo***
- ***Support the development of IaaS***
- ***Achieve growth of irrigation for SSPs in a sustainable manner***

Donors, public authorities and financial institutions can help unlock each of these leverage points

Barrier	Leverage Point	Recommendations*	Key SH involved
Capital investment for SSPs remains too high	**1a** *Improve affordability of quality irrigation products*	1 Provide targeted and cost-effective price subsidies via tax exemptions	🏛 🤲
		2 Unlock cost reduction in borehole drilling and pumping systems	🤲 🏛
		3 Develop industry standards and guidelines for irrigation equipment	🤲 🏛
		4 Streamline carbon financing of solar water pumps	🤲
Providers lack working capital	**1b** *Unlock access to finance for irrigation providers*	1 Unlock aligned development capital	🤲
		2 Build partnerships between local financial institutions (MFIs/banks) and PayGo providers	🏦
		3 Unlock Fx constraints	🏛 🤲
Delivery models to provide holistic solutions are still too costly	**1c** *Improve BM (efficiency & replicability)*	1 Finance ongoing innovative pilots to optimize their value proposition and delivery model	🤲
		2 De-risk and support the expansion of successful providers into new/adjacent geographies via direct funding as well as policy advocacy	🤲 🏛
		3 Develop irrigation knowledge amongst relevant promoters (e.g., extension workers)	🏛 🤲
Lack of incentives to preserve water resources *Lack of data and management capacity / expertise** *Limited resource policies / coordination / implementation**	**2** *Ensure guardrails for sustainable growth*	1 Develop irrigation management information systems	🏛 🤲
		2 Incentivize water efficient systems	🤲
		3 Fund R&D for optimized distribution systems and remote monitoring systems	🤲
		4 Establish and support organizations or associations governing water use rights	🏛
		5 Create regional coordination platforms by convening key stakeholders	🤲 🏛

🏛 *Public authorities* 🤲 *Donors* 🏦 *Financial institutions*

** See full report for details on each recommendation and their prioritization in different country contexts*