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Water Issue Brief - 20
Putting research knowledge into action

Adaptive Innovation Scaling - Pathways from Small-scale Irrigation to Sustainable Development

Scaling solar-based irrigation bundles in Ethiopia: A market linkage pathway

The context

Despite the high potential of and urgent need for wider adoption of agricultural innovations, many scaling ecosystems are ineffective (IWMI 2021) and innovation uptake remains limited (Minh et al. 2021). Successful and sustainable scaling of innovations requires addressing technical, environmental, socioeconomic, institutional and financial aspects to co-identify and co-develop 'best-fit' solutions that are affordable for farmers and other value chain actors (Seifu et al. 2020). Bundling these solutions, such as solar-powered irrigation pumps with pay-as-you-go financing, has been shown to improve the enabling environment for adoption (IWMI 2021). Private sector actors across the technology, agricultural and financial value chains play a key role in farmers' decision to invest in and adopt the innovations. Connecting farmers with these actors and creating market linkages are thus key conditions to reach scale.

Key messages

- Innovations such as solar-based irrigation have immense agricultural potential, but various constraints are holding back their widespread adoption.
- Innovation scaling is successful where one or several core innovations are bundled with complementary innovations and enabling factors that improve the enabling environment for adoption.
- Operationalizing a private sector-led, market linkage scaling pathway can deliver solar-based innovation bundles to larger numbers of farmers in Ethiopia.

Key issues

Scaling agricultural innovations is critical for increasing food and nutrition security, alleviating poverty and helping farmers adapt to climate change (Gebreyes et al. 2021). CGIAR (2020) defined innovation scaling as "a deliberate and planned effort to enable the use of innovations to have positive impact for many people across broad geographies." There are different pathways for scaling agricultural innovations and a range of available innovations that can be scaled. Using an action research approach, the International Water Management Institute (IWMI) co-identified a market linkage pathway for scaling solar-based irrigation technology and service 'bundles' to enhance small-scale fruit and vegetable production in Lemo, Ethiopia.

The pathway builds on earlier IWMI research, which shows that innovation scaling is successful when one or more core innovations (e.g., solar-powered irrigation pumps) are bundled with complementary innovations (e.g., pay-as-you-go financing services and/or digital irrigation scheduling tools) that improve the enabling environment for adoption (IWMI 2021). Private irrigation technology and service providers and agricultural value chain actors play a crucial role in farmers' decision to invest in and adopt the innovations. Connecting farmers with these actors and creating market linkages are thus key conditions to reach scale (Minh et al. 2021).

Solar-based irrigation has great agricultural potential in water-scarce countries like Ethiopia (*photo:* Maheder Haileselassie/IWMI).

Constraints to innovation adoption

The demand for high-value agricultural products such as fruits and vegetables is growing in Ethiopia as a result of rapid urbanization, improved incomes and increased nutritional awareness (Tschirley et al. 2015; FAO 2017). This has positive implications for smallholder farmers' integration into market-oriented agricultural value chains (Ros-Tonen et al. 2019). Irrigated agriculture, in particular, presents opportunities to increase farmers' productivity and build resilience to climate variability. Solar-based irrigation has additional benefits, such as reduced greenhouse gas emissions and lower operating costs, in comparison to fossil fuel-based irrigation systems (Kifle 2015; GIZ 2020).

Ethiopia has immense potential for solar-based, farmer-led irrigation (Schmitter et al. 2018). However, various constraints are hampering expansion (Kafle et al. 2022) (Figure 1). They include underdeveloped supply chains (for both agricultural inputs, such as fertilizers and seeds, and irrigation technologies), and limited access to extension and credit services. The lack of infrastructure (e.g., access to roads) and established output markets for irrigated crops also presents obstacles (Nigussie et al. 2017; Nakawuka et al. 2018; Otoo et al. 2018).

Water access is another major barrier to irrigation. In the middle of the dry season, shallow groundwater levels drop significantly. Carrying water from wells to farms is labor intensive. In some cases, the wells are not deep and/or strong enough to be used. The cost of digging a new well is expensive, around ETB 5,000-10,000 (USD 95-190) depending on the depth. Irrigation-related knowledge and skills of both farmers and professionals (well diggers, development agents) are also limited because irrigation is still a new practice in many areas.

Furthermore, gender inclusion in irrigation development is challenged by women farmers' limited representation and participation in local governance structures as well as restricted access to agricultural land, water and other resources needed to adopt irrigation technologies (Merrey and Lefore 2018; Lefore et al. 2019). Currently, irrigation markets and interventions insufficiently cater to women because they fail to address gender relations and social and technical preferences. Due to these constraints, large-scale adoption of solar-based irrigation technologies is yet to be realized.

Action research approach to scaling

Under the CGIAR Research Program on Water, Land and Ecosystems (WLE), Africa Research in Sustainable

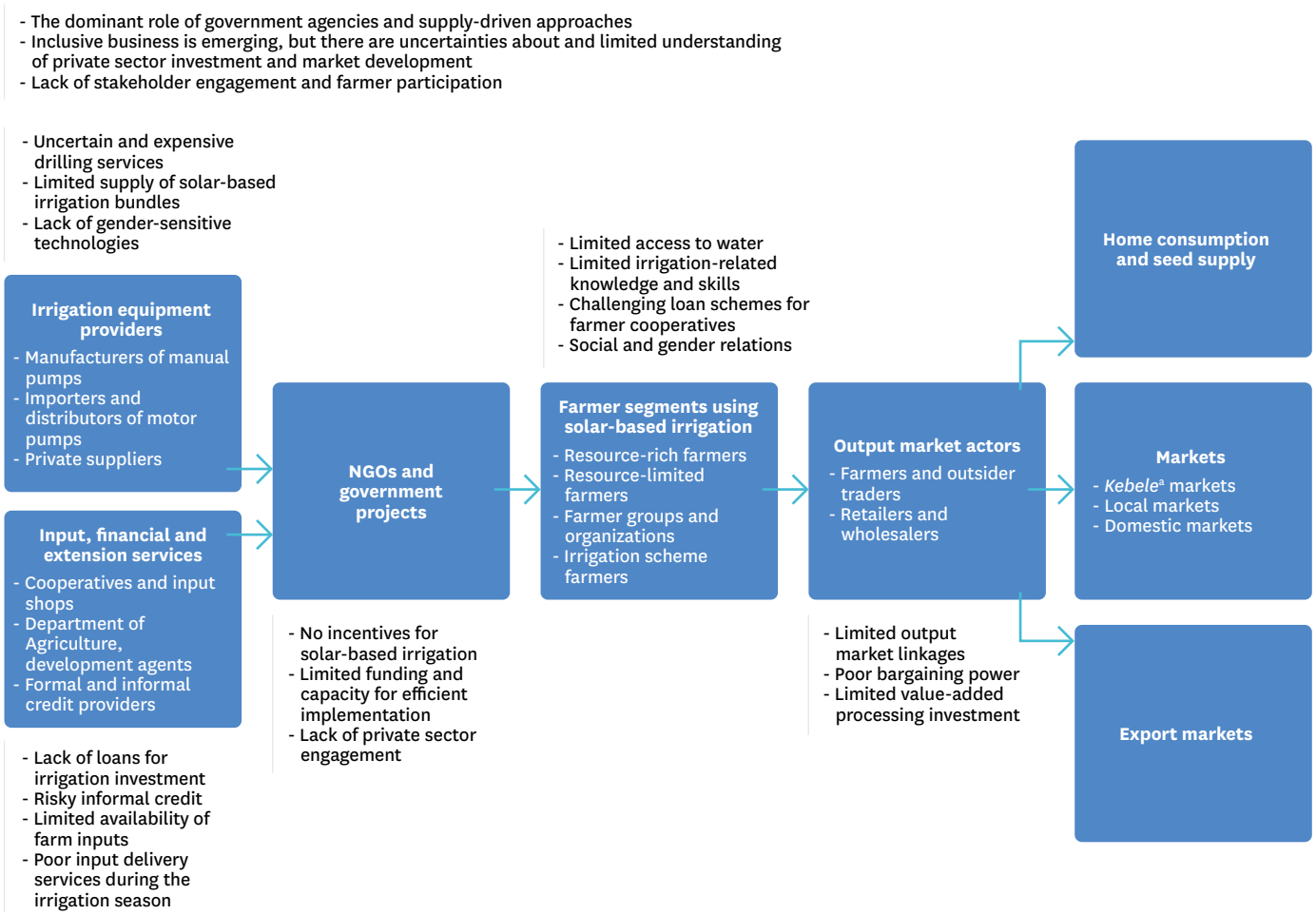

Figure 1. Challenges to scaling solar-based irrigation along irrigated fruit and vegetable value chains.

Note: [a] *Kebele* is the smallest administrative unit of Ethiopia.

Intensification for the Next Generation (Africa RISING) and Innovation Lab for Small-Scale Irrigation (ILSSI) projects, IWMI used an action research approach to co-identify a scaling pathway for solar-based irrigation technologies. The approach has four interrelated steps: analyze, co-develop, engage and reflect (Minh and Schmitter 2020). Together, the steps aim to provide a better understanding of the local context and engage stakeholders in co-developing solutions to the identified challenges. The engage and reflect steps are repeated throughout the process to ensure solutions are relevant and continually improved.

Research was conducted in Lemo, a *woreda*[1] in the Southern Nations, Nationalities, and Peoples' Region (SNNPR) (Melaku et al. 2022). The research initially identified a farmer-driven, private-led scaling pathway for irrigated fruit and vegetable value chains.

The scaling pathway was then operationalized via market linkages for irrigated fruits and vegetables. The focus was on scaling solar-based irrigation bundles targeting small-scale irrigated fruit and vegetable production. Solar-powered irrigation pumps have been piloted in Lemo by government organizations or nongovernmental organizations (NGOs). Farmers who have been introduced to the pumps through these projects have expressed an interest in adopting the technology. However, wider uptake beyond project beneficiaries remains low for the reasons described above.

Scalable solar-based irrigation bundles

The action research approach resulted in the co-identification and co-design of solar-based irrigation bundles (Figure 2). Although specific to Lemo, the bundles are adaptable and scalable to other regions in Ethiopia. The bundles are supplied by Rensys, a private irrigation equipment provider, and comprise solar-powered irrigation pumps and related accessories along with pre- and after-sales services.

Pumps and accessories

Rensys sells three solar-powered irrigation pumps of varying capacity in Lemo. All pumps work for surface (river, pond) or well (shallow or deep) water and are sold with a two-year warranty. Optional accessories include a battery with a Universal Serial Bus (USB) port and light bulbs.

Pay-as-you-go financing

To overcome the financial barrier to pump adoption, Rensys offers farmers pay-as-you-go financing (PayGo). This innovative payment modality allows farmers to use the irrigation equipment while making regular payments until the total cost of the pump is paid off. Payments are made through a mobile money platform and could be on a weekly, monthly or quarterly basis or scheduled around harvest times when cash flow is highest. This will depend on the choice made by farmers and their ability to make payments. In addition, the platform can block the pump remotely in the event of a missed payment. The pump is unblocked once a payment has been received.

Pre-sales services

Assessing the creditworthiness of potential customers is crucial for minimizing Rensys' risk in financing the pumps. Rensys uses a credit assessment tool developed by the ILSSI project in partnership with Bahir Dar Institute of Technology (BiT), Ethiopia. Credit assessment is followed by a product-client fit assessment to ensure that the customer's needs match the pump's technical specifications and performance. The product-client fit assessment considers, among other things, the farmer's water source, plot size, crops and income.

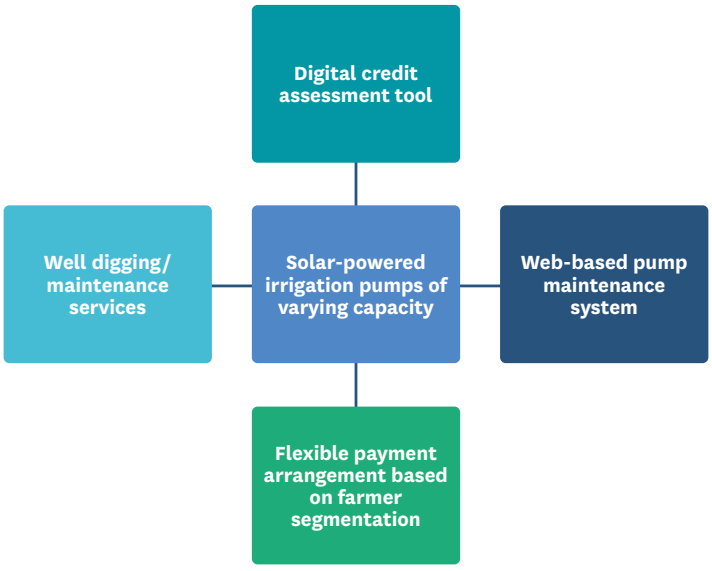

Figure 2. Elements of the solar-based irrigation bundle.

[1] *Woreda* is the third-level administrative division of Ethiopia.

After-sales services and support

After-sales services encompass pump installation, user orientation, maintenance and repair. These are supported by a web-based system that was also developed with BiT. The system has various functionalities such as encoding information on customers, payments, sales agents, commissions, warranties and maintenance. It has greatly enhanced Rensys' business management, and also serves as a feedback and learning mechanism that may help to detect marketing patterns and facilitate systematic tracing of technical challenges.

Farmer segments for irrigation bundles

The credit assessment and product-client fit assessment tools are complemented by market segmentation information. Market analysis identified five customer segments: resource-rich farmers, resource-limited farmers, farmer groups and organizations, irrigation scheme farmers and institutional clients. The solar-based irrigation bundles are aimed at the first four customer segments (Table 1). Each segment is slightly different in terms of the amount of water needed, land and water access, communication channels, pump preferences and capacity to pay for the technology.

Institutional clients include government organizations, NGOs, development partners and projects as well as businesses that introduce solar technologies to farmers and support the use of these technologies. Institutional clients typically engage with farmers through equipment demonstrations, subsidy and cost-sharing schemes, loans or, in some cases, provision of pumps for free to selected model farmers.

IWMI's research shows that this institutional approach would benefit from further nuance in farmer and geographical diversity. For instance, female respondents had a significantly lower education level than male respondents. Therefore, different information campaigns and training materials that target females may be required. Furthermore, differences exist at *kebele* level in terms of farmers' access to credit, their engagement in specific cooperatives, their water sources, irrigation governance structure and where they sell their produce. Considering these local nuances could reveal relevant communication, financing and logistics channels for institutional clients such as input

Table 1. Farmer segments and their characteristics.

Characteristics	Resource-rich farmers	Resource-limited farmers	Farmer groups and organizations	Irrigation scheme farmers
Land and water access	• Own a relatively large plot • Own a shallow or deep groundwater well	• Own land up to 0.5 ha • Access mainly to surface water sources (e.g., ponds or rivers) and some shallow groundwater	• Own land near a reservoir • Collective access to surface water	• Individual ownership to cultivate land in the area near a (small) irrigation scheme • Collective access to surface water
Irrigation technology and irrigation arrangement	• Manual or motorized diesel pumps • Individual irrigation management	• Buckets or manual pumps • Individual irrigation management	• Gravity canals • Individual and/or collective irrigation management	• Gravity canals and/or motorized diesel/petrol pumps • Water users' associations
Agricultural value chain	• (Semi-) commercial vegetable production	• Semi-commercial vegetable production	• Collective marketing of fruits and vegetables	• Individual and/or collective vegetable marketing
Financial capital and potential	• Invest individually • Financial capital to invest or ability to obtain credit	• Invest individually • Limited financial capital and unlikely to obtain credit • Low upfront investment ability with monthly payments (or PayGo)	• Invest collectively	• Invest collectively
Technology preference	High-capacity pump with payment schedule	Low-/medium-capacity pump with PayGo and minimum upfront investment	• Medium-/high-capacity pump for collective use • Low-capacity pump for individual use	• Medium-/high-capacity pump for collective use • Low-capacity, movable pump for individual use

providers and off-takers of agricultural products. Rensys is using this market segmentation information to identify its main customer groups and ensure it is targeting its products and services to the right farmers in the right way.

Enabling the scaling pathway

Further data analysis identified four components that are necessary to scale solar-based irrigation bundles targeting different farmer segments. The market linkage scaling pathway comprises these four components (Figure 3).

Linking demand and supply for solar-based irrigation bundles is the first component of the pathway, whereby local equipment distributors improve their links with suppliers from large cities and other partners to improve the availability of solar-powered irrigation equipment and enhance access to suitable financing arrangements and pre-/after-sales services. At the same time, suppliers further develop the solar-based irrigation market by targeting different farmer segments. This component is operationalized through workshops on demand-supply linkages in four ways.

1. **Engaging value chain actors and creating a space for knowledge and information exchange.** In Lemo, the first workshop, held at Wachemo University, provided a platform to connect solar-powered irrigation technology suppliers and potential users.

2. **Demonstrating solar-based irrigation bundles.** Rensys demonstrated one of the pumps it supplies during the workshop. The demonstration allowed farmers to see the pump in use and to discuss options for investing in the technology. A key insight that emerged was that farmers would be more willing to invest in the technology, if affordable manual drilling services for deeper wells were available.

3. **Setting up sales and service networks.** The workshop and demonstration also provided an opportunity for Rensys to identify local sales agents and set up a group on Telegram (a free, online instant messaging app) for farmers interested in purchasing a pump and discussing related topics, such as pump operation and maintenance.

4. **Tailoring business models to different market segments.** Solar-powered irrigation equipment suppliers segment the market into smaller customer groups and tailor their business models to each group.

Farmers as business partners is the second component of the pathway, where different farmer segments are seen as active business partners rather than passive end users. To increase farmers' entrepreneurial capacity, it is necessary to build their irrigation knowledge and skills, strengthen their collective production and marketing abilities, enhance their access to input markets and services, and develop their links with local irrigation equipment suppliers.

The third component is the **establishment of a local innovation and scaling platform** by local government agencies in collaboration with development organizations. The platform provides a space to (i) connect farmers, technology providers and input suppliers; (ii) promote interactive learning among farmers; and (iii) create opportunities for commerce and collaboration between farmers and other businesses as well as between actors promoting irrigation.

The fourth component, **scaling across locations**, is critical to stabilize and strengthen solar-powered irrigation technology supply and services to farmers. For instance, connecting national importers with local irrigation distribution networks can enhance the mass supply of solar-powered irrigation technologies. Setting up sales and service networks involving different irrigation supply and agricultural value chain

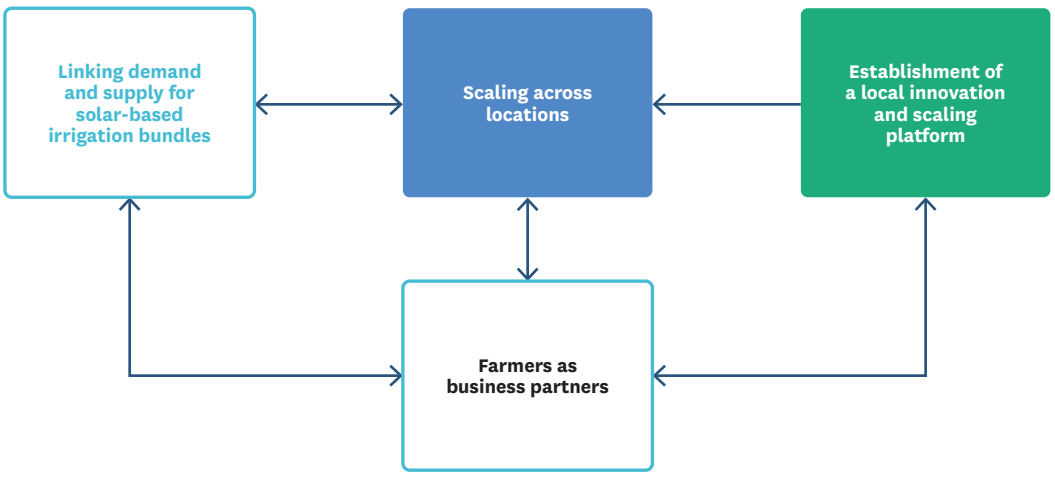

Figure 3. Market linkage scaling pathway for solar-based irrigation bundles.

actors would also increase the geographic reach of these technologies.

The way forward

Solar-based irrigation offers potentially substantial economic and environmental benefits for farmers and their communities in Lemo, Ethiopia. To maximize these benefits, we recommend the following activities to further strengthen the scaling pathway for solar-based irrigation described in this brief.

Understanding customers' realities: Stakeholders in the scaling pathway need to systematically assess the realities that enable or hinder farmers' adoption of the proposed technologies. This involves determining the following:

- Farmers' current **knowledge and experience** that influence their decision to purchase a technology or not. Special attention should be paid to gendered differences in information, knowledge and challenges faced.
- Farmers' **opportunity costs** (loss or gain compared to farmers' current irrigation practices, including investment costs, operational costs, labor requirements and access to high-end markets).
- **Technology requirements** of different customer segments.
- **Main bottlenecks** in farmers' enabling environment, such as the reported unavailability and high cost of manual well drilling services, as a prerequisite for further investments in irrigation infrastructure and equipment. Efforts should also be made to remove these bottlenecks.

Continuous re-evaluation of the innovation bundles: All stakeholders should continuously re-evaluate the suitability of the proposed innovation bundles and identify possible improvements to ensure supply matches demand. For farmers and institutional clients to adopt the technology, the innovation bundles must meet, among others, the following criteria:

- Familiar to, and **tested and recommended** by, farmers or institutional clients.
- **Affordable and useful** to local farmers (matching their water and energy needs), including those who have limited access to resources.
- Accompanied by a **flexible payment schedule** as payment preferences may differ between suppliers and users.
- **Easy to operate, maintain and repair** for long-term use. Ensuring the local availability and reliability of repair services and spare parts is essential to gain trust and increase the number of customers.
- Accompanied by a **monitoring system** to assess, at basin scale, the current state of water resources availability and use as well as the likelihood of causing water shortages.

Strengthening innovation bundle promotion and marketing: For the bundles to be accessed, they must be readily available in local markets. We, therefore, recommend the following:

- Assessing the current and future **availability and accessibility** of solar-powered irrigation pumps for different farmer and institutional segments.
- **Training local sales agents** to provide pre-sales (e.g., supporting preliminary site selection and suitability assessment) and after-sales support (operation and maintenance) in addition to sales and marketing.
- Jointly fostering the tailored approach to **continuously reach out** to more potential users (outside the existing Telegram group) and promote solar-based irrigation technologies. The demand for pumps can be seasonal, peaking around the dry season. Therefore, it would be more effective to align promotional events with these seasons.
- Incentivizing local sales agents through the payment of a **finder's fee** to identify and connect with individuals who may have information about someone wanting to purchase a pump. Extension agents and farmer entrepreneurs in Lemo expressed an interest in connecting potential buyers in their localities to a sales agent – provided there is some arrangement for compensation to farmers that are considered creditworthy.
- Encouraging local agents to continue **communicating and linking** with diverse groups/segments beyond farmers, e.g., promoting pumps to institutional actors in Lemo such as the offices for agriculture, irrigation and energy, and cooperatives and microfinance institutions (MFIs). Communication with irrigation equipment suppliers revealed that institutional clients might be the best entry point to gain the first customer in a new market. In areas where pump stocks are not held locally, sales agents can use this customer to demonstrate the pump to other potential buyers.
- **Exploring further collaboration with MFIs.** During the workshop, Metemamen MFI, which operates in Lemo, expressed an interest in arranging loans for farmers to cover the down payment required to purchase a pump. Rensys and other irrigation equipment providers should further explore this option and propose mechanisms to implement it.

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Farmers at a field demonstration of solar-powered irrigation pumps in Lemo, Ethiopia (*photo*: Thai Thi Minh/IWMI).

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