

Solar-based irrigation bundle profile and scaling in Ghana



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Summary

There are solutions to sustainable intensification, irrigation technologies, and water management under changing weather and climate conditions; they are just not available to smallholder farmers and vulnerable groups on a large scale. Scaling these solutions, therefore, needs to develop bundles of best-fit solutions to diversify farming and farmer conditions and adapt them to the context of irrigated farming. Throughout the action research process, **solar-based irrigation bundle** (SBIB) has been scaled in Upper East, Upper West, Northern, Northeast, and Savannah region, Ghana since January 2020. SBIB offers solar-powered irrigation pumps and pay-as-you-go and pay-as-you-own (PAYGO/PAYOWN) financing services to smallholder farmers in combination with tailoring their business models to different client segments (ability to pay, frequency, amount) to lower the barrier for upfront investment cost, enabling solar irrigation adoption and enhancing productivity and income throughout the year. This SBIB profile consists of three components: 1) bundle components and characteristics, 2) assessing the scalability and scaling potential of the bundle, and 3) developing scaling strategies

This bundle includes various innovations, services, and scaling actions:

- **Core innovations:** solar-powered irrigation pumps (SPIPs); PAYGO/PAYOWN financial services to lower the initial cost of the pump; And tailored business models to different client segments
- **Services:** Sale and service networks for market linkages; Digital financial payment (MoMo MTN); De-risk investment from development partners (e.g., GIZ with 40% for male farmers and 50% for female farmers) subsidy for the PAYGO/PAYOWN SPIPs investment; and Internship with and for filling in the private sector partners' knowledge and human resource gaps
- **Scaling actions:** Market segmentation for the PAYGO/PAYOWN SPIPs; demand-supply linkage workshop and services; and multi-stakeholder dialogues on scaling small scale irrigation (SSI) to leverage the private sector engagement and multi-sector investment

To scale this bundle, a demand-supply linkage pathway was co-developed with actors in the irrigated vegetable value chain. The pathway consists of four components: 1) establish sales and service networks, 2) increase the private sector's visibility and outreach in the regions, 3) capitalize on the sale of PAY-OWN PS2 solar-powered pumps, and 4) facilitate environmental and social sustainability and inclusivity of scaling solar-based irrigation in the region. A multi-actor partnership was established between private sector partners (Pumptech Ghana, Tech2 Ghana), research partners (International Water Management Institute – IWMI), Government Partners (Ministry of Food and Agriculture, Regional Agricultural Department – MOFA; Rural Development Bank); and Development partners (Green Energy Project and Green People's Energy Project - GIZ).

The **scaling readiness of SBIB** is at level 9—Proven innovation bundle—because the bundle and its bundling process have proven certain impact indicators in Ghana and scaled to Ethiopia and Mali. One private sector partner in Ghana increased their sale of solar-powered irrigation pumps up to 80% in 2021. The estimated annual investment in 2022 from the private sector partners is US\$500,000 of which to the smallholder farmer segment is US\$250,000. Based on the outcome of the partnership, one million US\$ for impact investment into smallholder solar-based irrigation has been mobilized jointly by the Shell and Lorentz foundations to target Lorentz's distributors in Sub-Saharan Africa.

Scaling of SBIB contributes to different **development outcomes** such as SDG 1 (e.g., eradicate extreme poverty); SDG 2 (e.g., end hunger and all forms of malnutrition, double agricultural productivity, and incomes of small-scale food producers, ensure sustainable food production systems and producer support); SDG 5 (e.g., give women equal rights to economic resources, enhance the use of ICTs to empower women); SDG8 (e.g., higher productivity through upgrading and innovation and higher value-added, support decent job creation and entrepreneurship, and enhance youth employment opportunities); SDG 10 (e.g., reduce inequality); SDG12 (e.g., reduce food loss and waste); and SDG (e.g., take urgent action to combat climate change).

Solar-based irrigation bundles – SBIBs profile

COMPONENT 1: Bundle components and characteristics		
1.1. Innovation bundle description		
1.1.1	The ID is composed of the country code and the unique number you assign to it	GH_01
1.1.2	Please assign a short name to the bundle	Solar-based irrigation (Ghana)
1.1.3	The description could mention the subject, core innovation(s), and possibly the target group	Solar-based irrigation equipment and service providers in Ghana offer solar-powered irrigation pumps and pay-as-you-go and pay-as-you-own financing services to smallholder farmers in combination with tailoring their business models to different client segments (ability to pay, frequency, amount) to lower the barrier for upfront investment cost, enabling solar irrigation adoption and enhancing productivity and income throughout the year
1.1.4	Please indicate whether this innovation/ innovation bundle has been or if you would like it to be published as CGIAR IPSR Innovation Profile PDF.	
1.1.5	Please provide URLs to 3-5 key images, photos, or pictures that best visualize or illustrate the innovation.	
1.1.6	The country in which the innovation bundle was developed	Ghana, Ethiopia, and Mali
1.1.7	If applicable, please indicate the CGIAR initiative that will lead the further (co-)development of the innovation (bundle)	IWMI
1.1.8	If applicable, please indicate the CGIAR initiative and non-pool/bilateral projects that will	1. The Innovation Lab for Small Scale Irrigation (ILSSI) 2. The Africa Research in Sustainable Intensification for the Next Generation programmes (Africa RISING).

	tangibly contribute to the further (co-)development of the innovation (bundle)	3. Sustainable and intensification of Mixed Farming System (SI-MFS)
1.1.9	Please mention the value chain and market system the innovation bundle is relevant to (e.g., fruits and vegetables (Nigeria), dairy (Uganda), farmed fish (Bangladesh), and grains and pulses (Central America).	In the Up North Ghana, the common vegetables cultivated in the dry season are onion, pepper, eggplant, tomato, watermelon, okra, cabbage, and green leafy vegetables such as amaranth, bitter leaf, bambara bean leaf, and hibiscus. Depending on the income generated from marketing these crops, farmers see them as high- and low-value vegetables. Lower-value vegetables are mainly leafy greens such as amaranth, bitter leaf, bambara bean leaf, and hibiscus. Women see these vegetables as 'their crops', including young woman farmers and women's farmer groups. High-value vegetables include pepper, eggplant, and onion which are considered cash crops in the dry season. Men grow these high-value vegetables as cultivating these crops requires a significant investment throughout the cropping season, such as the application of complicated techniques and the high cost of irrigation and inputs, and labor. They grow and irrigate small areas in home gardens for home consumption and sell the surplus at local markets.
1.1.10	Please mention the functions in the value chain and market system that the innovation bundle aims to strengthen and how. The five main value chain functions are 1) pre-production, 2) production, 3) collection and trading, 4) processing and distribution, and 5) consumption.	1 and 2
1.1.11	Please mention the gaps/issues that the innovation bundle aims to address/strengthen within the systems.	<ul style="list-style-type: none"> - Not many smallholder farmers use irrigation, but those who do mostly use diesel-fueled pumps, which are expensive and polluting. However ample water resources and strong input and output markets have created a demand to increase irrigation. Drilling services, though expensive, are easily available to those who can afford them. - Farmers with current or potential access to a water source, farmers who are deepening investment in agricultural production in the dry season (instead of drawing from off-farm employment), and farmers who are currently using some form of irrigation equipment may be willing to take up the bundle. Those desiring to save time or labor (by switching from manual to solar-powered) or energy costs (by switching from diesel-powered to solar-powered) would see value in the innovation bundle.

		<ul style="list-style-type: none"> - However, since solar-powered technology is relatively new to farmers, there is little experience in how reliable the technology and specific providers really are. The trust component is a major risk factor for farmers, hampering their investment. Agricultural extension workers could play a role here. - Competitors are manufacturers and retail space/partners of other (less sustainable but more established) pump technologies, such as diesel-powered pumps. - The bundle of solar-powered pumps and payment modality was not already being used. Some farmers use solar-powered pumps, although other equipment such as buckets and watering cans, treadle pumps, petrol or diesel pumps, open gravity systems, and drip irrigation systems are more common. Formal credit is provided by the banking system and individual farmers and farmer groups can access it if they meet the requirement. Informal credit is commonly found with village savings and loans or 'Susus' by which farmers save money as part of a self-organized group scheme. These forms of credit are used to buy irrigation technologies, although solar-powered pumps are rare in the market. Agricultural extension agents rarely cover farmer-led irrigation. In the dry season, AEAs conduct mainly monitoring and backstopping activities.
1.1.12	Please indicate how mature the innovation bundle is (New, ≤ 1 year, 1-2 years, 2-4 years, ≥ 4 years)	2-4 years
1.1.13	Please mention the type of bundled innovations in terms of 1) their nature; 2) their novelty; and (3) the change they imply i.e., incremental, radical, or disruptive change.	Technological, business, and financial innovation bundle
1.1.14	Please mention the core innovations in the bundle	Core innovations: <ol style="list-style-type: none"> 1. Solar-powered irrigation pumps (SPIPs) 2. PAYGO/PAYOWN financial services to lower the initial cost of the pump 3. Tailored business models (including different payment schemes, pre and after-sale services of pump suitability, warranty, spare parts, and repair)
1.1.15	Please mention additional elements (complementary innovations, solutions, services)	Complementary elements: <ol style="list-style-type: none"> 4. Market segmentation for the solar-powered pumps and pay-go/pay-own 5. Demand-supply linkage workshops and services

	that are needed to scale the initial innovation	6. Sale and service networks for market linkages 7. De-risk investment from development partners (e.g., GIZ with 40% (for male farmers) and 50% (for female farmers) subsidy for pay-own solar irrigation investment 8. Digital payment (MoMo MTN) 9. Internship with and for filling in the private sector's knowledge and human resource gaps 10. Multi-stakeholder dialogues on scaling small scale irrigation (SSI) to leverage the private sector engagement and multi-sector investment
1.1.16	Please indicate the current scaling readiness of each innovation component and the bundle as a whole: 0 - idea 1 - basic research 2- formulation 3- proof of concept 4- controlled testing 5- model /early prototype 6- semi-controlled testing 7- prototype 8- uncontrolled testing 9- proven innovation	9 - Proven innovation bundle We chose readiness level 9 - proven innovation bundle - because the SBIB and the bundling process have proven certain impact indicators in Ghana and scaled to Ethiopia and Mali. In Ghana since January 2020, a multi-actor partnership has been established, involving Pumptech and Tech2 (two Ghanaian irrigation supply companies), the International Water Management Institute (IWMI), the Ministry of Food and Agriculture (MOFA), and development partners (E.g., GIZ). One private sector partner in Ghana increased their sale of solar-powered irrigation pumps up to 80% in 2021. The estimated annual investment in 2022 from the private sector partners is US\$500,000 of which to the smallholder farmer segment is US\$250,000. Based on the outcome of the partnership, one million US\$ for impact investment into smallholder solar-based irrigation has been mobilized jointly by the Shell and Lorentz foundations to target Lorentz's (A German solar pump manufacturer) distributors in Sub-Sahara Africa.
1.1.17	Please indicate the geography (e.g., village, community, district, province, national) at which there has been a demand for the innovation bundle	National wide
1.1.18	Please describe by whom (e.g., farmers, SMEs, government institutions) has there been a demand for the innovation bundle.	Farmers with current or potential access to a water source, farmers who are deepening investment in agricultural production in the dry season (instead of drawing from off-farm employment), and farmers who are currently using some form of irrigation equipment may be willing to take up the bundle. Those desiring to save time or labor (by switching from manual to solar-powered) or energy costs (by switching from diesel-powered to solar-powered) would see value in the innovation bundle.

1.1.19	Please indicate the users as specific customer segments the innovation bundle caters to. Please describe the different segments based on value chain, natural, human, physical, social, and financial capitals.	<p>There are five farmer segments invested in the SBIB:</p> <ul style="list-style-type: none"> - Resource-rich farmers - Resource-limited farmers - Resource-poor farmers - Mobile farmers - Out-grower farmer scheme - Farmer groups/cooperatives.
1.1.20	Please describe whether the innovation bundle addresses any potential risks (floods, droughts, land infertility) and other shocks (political instability, market price fluctuations) to farming systems and livelihoods. (y/n) if yes how?	<p>Since solar-powered technology is relatively new to farmers, there is little experience in how reliable the technology and specific providers really are. The trust component is a major risk factor for farmers, hampering their investment. Agricultural extension workers could play a role here. Competitors are manufacturers and retail space/partners of other (less sustainable but more established) pump technologies, such as diesel-powered pumps.</p> <p>Another risk is groundwater access. Unknow about the groundwater availability coupled with the uncertain quality of the borehole drilling services has risked farmers' investment loss. Finally, the tradeoff when the scaling SBIB reaches the large scale can be the over-exploitation of the groundwater that would be negatively influenced environmental sustainability.</p>
1.1.21	Please describe whether the functioning or success of the innovation bundle is impacted by any of the following risks (floods, droughts, land infertility) or other shocks (political instability, market price fluctuations). (y/n) if yes how?	<p>The volume and quality of vegetables produced in the region are not stable, which negatively influences the supply to meet the high market demand. Due to water shortages from February to May, there are not enough locally produced vegetables for the markets. The quality of locally produced vegetables is negatively affected by the overuse of chemicals that farmers use to prevent insect infestations and diseases. To save costs, farmers use cheap pesticides and chemical fertilizers. Coupled with inappropriate application and inadequate irrigation, vegetables can change color, mature too quickly, or rot. Another risk is that there is strong competition with the supply of vegetables produced in neighboring Burkina Faso. Also, national traders are unreliable, often pushing down prices by letting farmers wait for the last moment i.e., if they don't sell, their products will spoil. These risks/shocks affect the quality and quantity of vegetables that farmers can sell at a good price.</p> <p>Children's and women's malnutrition risk can be managed with more vegetables produced in the dry season as an additional nutrition source. Finally, jobless, and migration-related risks, especially for youths, can be managed with the increase of irrigated farming.</p>

1.1.22	Please describe whether there are periods in the year where there could be a higher/lower uptake of or demand for the innovation bundle. (y/n) if yes which period and why?	Farmers use different water sources to cultivate irrigated vegetables including dams, small reservoirs, and wells or boreholes. Farmers begin cultivation by raising seedlings in nurseries for one to two months usually towards the end of the rainy season in September/October before transplanting in October/November. However, during the dry season, some of these water sources dry out or are no longer accessible. Therefore, having greater access to water sources during the dry season through solar-powered pumps could be a major motivator for farmers to adopt the innovation bundle. People must use fertilizer to ensure crop production, too, so the ability to use the water also depends on the affordability of other inputs and on access to land during the dry season. So far, many men rent out their fields for the dry season since most concentrate on farming in the rainy season.
1.1.23	Please provide URLs to any reference materials on CG-space and other sources that describe the innovation or innovation bundle or its use	https://cgspace.cgiar.org/handle/10568/113924 https://cgspace.cgiar.org/handle/10568/119935 https://ilssi.tamu.edu/files/2021/08/20210816-MSD-Ghana-Report-Submitted-Revised-AK.pdf https://ilssi.tamu.edu/2021/06/18/supporting-solar-irrigation-companies-to-break-down-markets-and-lift-up-smallholder-farmers-in-ghana/ https://www.iwmi.cgiar.org/2021/06/how-market-knowledge-is-powering-africas-solar-irrigation-sector/ https://agrilinks.org/post/building-better-solar-irrigation-market-ghana https://agrilinks.org/post/new-market-research-captures-potential-malis-solar-powered-irrigation-sector https://www.agrilinks.org/post/closing-demand-supply-gap-malis-solar-powered-irrigation-value-chains https://www.km4djournal.org/index.php/km4dj/article/view/489/608
1.2. Bundling		
1.2.1	Please specify the partnership needed for the innovation bundles and scaling	A multi-actor partnership was established between private sector partners (Pumptech Ghana, Tech2 Ghana), research partners, Government Partners (Ministry of Food and Agriculture - Regional Agricultural Department; Rural Development Bank); and Development partners (Green Energy Project and Green People's Energy Project (GIZ)
1.2.2	Please specify the resources needed for the partnership	<ol style="list-style-type: none"> 1. Private sector partners: Technical and market-related knowledge; marketing, and financial investment in SPIPs make them available at stock, staff and time, technologies 2. Research partner: market and resource-related knowledge, resource and data-driven tools, staff, funding for market linkage activities, and another operational budget 3. Government partners: Grassroots networks, staff, and time 4. Development partners and impact investors: funding to de-risking private sector partners' investment

1.2.3	Specify the innovation bundles and scaling for each innovation component in the bundle, the partner/institution/company that is responsible for the innovation, and their responsibility and/or activity.	<ol style="list-style-type: none"> 1. Private sector partners (Pumptech Ghana, Tech2 Ghana): providing/selling solar-powered irrigation pumps and accessories; water convergence and application equipment; tailoring their business models and services to different farmer segments; Investing in smallholder irrigation segments; Providing Pay-go/Pay-own services; establish sales and service networks to expand SPIP markets 2. Research partners (International Water Management Institute): provides knowledge, expertise, tools, and services to de-risk investment for the private sector partner and develop inclusive business models for solar-based irrigation to target marginalized market segments at the bottom of the pyramid and boost the sustainable market development for solar-based irrigation. 3. Government Partners (Ministry of Food and Agriculture - Regional Agricultural Department; Rural Development Bank): providing market linkage services by mobilizing agricultural extension agents and other actors in the irrigated vegetable value chains and facilitating the private sector partners' visibility in the regions 4. Development partners (Green Energy Project and Green People's Energy Project (GIZ)): de-risking investment to the private sector's Pay-own financial investment (40-50% subsidy for male/female farmers' investment in solar-based irrigation) 5. Impact investors (e.g., Shell and Lorentz foundation): providing investment to inclusive market for smallholder irrigation 6. Collaborations between research for development actors, farmers, input suppliers, and local, national, and international off-takers were key to actualizing the joint development of irrigated agricultural value chains.
1.2.4	Describe how stakeholders were consulted/included throughout the bundling process to support the refinement of the bundle, minimize blind spots, and make it as relevant as possible to those who ask for the bundle and would benefit from it.	<p>Stakeholder consultation and engagement have been organized through:</p> <ul style="list-style-type: none"> - Stakeholder consultation workshops during the value chain analysis process to co-select and reflect on the core and scalable innovations - Participatory market segmentation with farmers and their communities which included SPIPs demonstrations to access the actual interests and demands - Demand-supply linkage workshops to establish the digital sale and service networks for SBIBs. In this format, farmers and other value chain actors also identified potential clients for SBIBs and SBIB potential client database has been developed and continuously updated - Field demonstration brings SPIPs directly to the potential farmer clients and their communities - Workshop to strengthen sales and service networks engages more members joining - Bundling innovation engages farmers, input suppliers, local, national, and international off-takers, NGOs, and development partners in co-developing and contextualizing SBIBs.

		<ul style="list-style-type: none"> - Multi-stakeholder dialogues engage a wide range of actors and stakeholders across levels and sectors, fostering cross-sector learning, leveraging on the private and public sector investment, and influencing policies and investments in SBIBs. The multi-stakeholder meetings often included representatives from local government bureaus and provided visibility and outreach to policymakers. The establishment of a platform to link demands with the available bundles for solar-based irrigation and identified client segments can enable policymaking targeted toward intended beneficiaries.
1.2.5	Mention whether the innovation bundle has been piloted to date in its current form. Y/n, if Yes what has been the learning i.e. what worked well, and what are some of the challenges?	<ul style="list-style-type: none"> - The SBIB in Ghana has been bundled and scaled since late 2019. The scaling however has been building on lessons learned during the action-research process that helped establish the most promising scaling pathway for the innovation bundle. - The intervention co-developed the demand-supply linkage scaling pathway using action research for the development approach to ensure contextually relevant and evidence-based knowledge and innovation bundles about the potential for irrigation market development. The action research process involved four steps: analyze, co-design, actualize and reflect. The analysis step investigated potential pathways to scaling and the best-fit bundles of irrigation technologies and services along irrigated agricultural value chains. The co-design step co-identified value chain pathways to scaling best-fit bundles and link farmers with input and output markets. The actualize step jointly implemented the demand-supply linkages pathway in the Upper East Region and beyond. The reflect step assessed the scaling pathway and identified the follow-up actions to adapt the pathways and incorporate lessons learned into new scaling pathways.
1.2.6	Describe potential challenges and tradeoffs in bundling that could happen for the different actors involved in the bundling process and within the wider bundling environment. Please also describe how these challenges can be mitigated.	<ol style="list-style-type: none"> 1. Limited reach to resource-limited and resource-poor farmers. Business model tailored for these segments emphasizes pay-go financing service and incentivize farmers' investment either through support from other organizations or rewards. 2. As one of the major water sources for SBIBs is groundwater, the availability and affordability of high-quality borehole drilling services are high-risk factors for farmers and SPIP suppliers. Solar irrigation suitability mapping at the regional and national levels that tailors to the SPIP suppliers' products and business can mitigate the risk to water access for farmers. 3. When SBIBs reach a large scale, over-exploration of water resources is a trade-off. Improving/strengthening water abstraction data is critical to mitigating the trade-off. This can be done by upgrading technology (e.g., SPIPs, water application systems), and farmers changing irrigation behaviors toward water use efficiency. 4. Access to finance is the biggest challenge for both farmers and SBIB suppliers, especially during the current financial crisis (2022). Blended finance, impact investment, and innovative financial organizations and services can be the ways to address the challenges.

		5. Social and gender inequal access to irrigation can be wider. Tailoring business models and financial services to these segments of the market can work to mitigate this challenge.
1.2.7	Please indicate what is the envisioned time frame for the bundling process.	6 - 12 months for the national scale. 3-6 months for the regional scale
1.3. Link to specific stakeholders and ongoing activities		
1.3.1	Mention other crucial stakeholders/actors in the wider system influencing the scaling potential and scalability positively or negatively. If yes, please explain why and how.	Financial constraints are constantly dominant in all market segments. Financial providers and investors in the financial ecosystem are critical actors to scale SBIB to benefit a million farmers sustainably and inclusively. As the existing financial services do not favor the agricultural sector, specifically farmers and agri-businesses, they negatively influence the scalability of SBIBs in Ghana.
1.3.2	Please describe what financial, organizational, and human resources are already supporting the existing innovations within the system or can be mobilized to do so. Please also mention which stakeholders are most relevant to providing the respective support.	To scale SBIB in Sub-Sahara Africa, the following resources are needed: <ul style="list-style-type: none"> - Knowledge and data-driven tools: IWMI and other CG centers - Upgraded technologies: irrigation equipment manufacturer and distributors (e.g., Lorentz and its 1000 distributors across Sub-Sahara Africa) - Funding: development partners and NGOs projects specifically targeting irrigation; impact investors (e.g., Shell Foundation, Lorentz Foundation) - Digital innovations for financing and marketing: Agriculture-based IT companies (e.g., Farmline in Ghana, Crop2Cash in Nigeria) - Irrigation supply chain actors' investment in solar irrigation markets, especially for the countries with high potential such as West African ones.
1.3.3	Please describe what interventions and investments currently underway or planned may influence the potential take-up of the bundle elements, both positively and negatively.	In Ghana: <ul style="list-style-type: none"> - National policy and programs such as Planting for Food and Jobs promote local input supply through the formalization of input dealers at the district level. While these programs target only rain-fed agriculture, they could also support irrigated agriculture. The government registers and certifies input dealers' businesses, who are then connected to the formal service provider network and are involved in implementing the government's input subsidy program. The dealers are contracted by the agricultural office to supply inputs, mainly fertilizers, at government-subsidized prices. This increases the adoption of other agricultural inputs and innovations. The government's subsidy for fertilizers and seeds for farmers mainly targets rain-fed production and comes at a time when farmers do not have cash on hand. Government agencies and public service

		<p>providers have been embedded in supply-driven approaches and collaboration and coordination among these agencies are limited.</p> <ul style="list-style-type: none"> - Agricultural extension services focus on promoting rain-fed agriculture and irrigation schemes or irrigated farmer groups. Agricultural extension agents (AEA) make an annual plan and submit it to the regional Agriculture Extension Department to obtain funding and resources for their activities including training farmers on mainly cereal crops such as rice, millet, maize, and beans. AEAs use demonstration plots for training farmers. AEAs also facilitate the formation of farmer organizations and farmer groups, also implement government policy and strategies defined for the region and collaborate with NGOs and development projects to coordinate project activities in their respective domains. - COCOBOD has been implementing several programs to enhance the climate resilience of cocoa sector in Ghana. Across programs, irrigation is highlighted as a critical area for climate-resilient cocoa. <p>In sub-Saharan Africa (SSA):</p> <ul style="list-style-type: none"> - Private sector investment in the solar-based irrigation market: Solar-based technology supply chain actors have recently been investing more in solar technologies, especially for irrigation. For example, solar is now the cheapest form of power in many countries and its prices have dropped substantially in recent decades, from over USD 60/watt in the 1970s to between USD 0.52 and 0.72/watt in 2016. SPIPs are customized to irrigation purposes and the supply of solar irrigation technologies is more targeted to low-income but high-demand markets like SSA. The technology costs at the farm gate are significantly reduced by at least 20% compared to 15 years ago. - Blended finance and impact investment: financing actors have been innovating the sector to be digitalized and de-risking investment. - Development loan for the public sector to support farmer-led irrigation development (FLID) (e.g., WB's recent investment to FLID in SSA).
1.4. Benefits		
1.4.1	Please describe what are the benefits after adoption for the different market/customer/user segments, and when are they expected to appear (immediately, in the mid- or in the long-term)	<ol style="list-style-type: none"> 1. Increased access to financing irrigation: the pay-go/pay-own financial modality would mean that farmers pay in installments, according to what they are able to afford and their credit rating. The pay-go/pay-own ensures that adopting the innovation is affordable. Pay-go and Pay-own financing services enable farmers to access to SPIPs as a credit form, benefiting thousands of farmer clients. 2. Improved efficiency of irrigation and income: less amount of water was used for irrigation while harvesting more times and volume per time. This leads to an increase in income up to 2-3 times.

		3. Improved household nutrition: in the adopted households, especially female head ones, (green leafy) vegetables are available more for home consumption; incomes from vegetables support better the households' needs for food and expenses for children's education
1.4.2	If you conducted a Cost-Benefit Analysis: what does it show you?	Not yet
1.4.3	Please describe the return on investment for the market/customer/user segment. (This can come from the cost-benefit analysis if data is not available yet).	Farmers would have to invest in purchasing SPIPs. If resource-poor farmers can successfully collectivize production, the pump could be shared, and returns to investment would be high if input and output markets for the vegetables are stable, reliable, and accessible. For resource-rich farmers, the investment would be easier, but the ROI would be relatively small, as solar pumps are not able to generate the same level of power as diesel-powered pumps. However, in Ghana, higher-capacity pumps are available. Farmers can also use their pumps for complementary irrigation during times of drought in the main season, allowing them to secure their main season production, too.
1.4.4	Please describe whether the benefits are equitable among the market segments targeted (adopters) by the innovation bundle. y/n please explain.	Since the initiative is still in its early stages, and only the scaling pathway had been decided, the specific number of women or youth farmers that adopted the bundle is not available.
1.4.5	Please describe the differences in benefits observed.	<ul style="list-style-type: none"> - Pay-own financing services benefit male farmers more than female ones as well as resource-limited and resource-poor farmers. - The increase in income is higher for farmers cultivating in larger irrigated areas and high-value vegetables such as tomatoes, onions, peppers, watermelon, etc. This might not automatically lead to an increase in profit, and it will be concluded after the cost/benefit analysis.
1.4.6	Please describe how can benefits be made more equitable among the market/customer/user segments.	<ul style="list-style-type: none"> - Women and youth (and their official representatives in local bureaus) were included in action research activities to ensure that their concerns and suggestions and thoughts were considered. However, irrigation equipment companies often see farmers as a homogenous group with similar water resources, farming land conditions, and financial capacity to invest in irrigation and have rarely considered targeting their products to women/youth specifically. NGOs, aiming to build capacity amongst more disadvantaged groups, have sometimes focused on women farmers on the other hand. By segmenting client groups in gender-sensitive ways, businesses can better target a range of farmers, including women. This is helping accelerate the adoption of solar-powered irrigation technologies in frontier markets while promoting women's equitable participation in irrigated agricultural value chains. Women farmers are more likely to face difficulties accessing resources such as land, credit, and information that would enable them to invest in irrigation.

		<ul style="list-style-type: none"> - Private sector partners (e.g., Pumptech) together with the manufacturers (Lorentz) produce and supply new packages of SPIP and irrigation systems (sprinkler or drip) that are specified for smallholder farmers who are commonly irrigating around 1-6 acres. This also lowers the initial investment cost for smallholder farmers.
1.4.7	Please describe whether the benefits are equitable among the different actors involved in the bundling and scaling of the innovation bundle. Please mention: who benefits more and who invests (e.g., labor, human or financial resources) more?	<ul style="list-style-type: none"> - Each partner in the partnership contributes certain types of resources as described in 1.2.2. These resources are complementary to each other. This is also like the benefits that each actor gains from the scaling of SBIB. - In terms of the value chain actors involved in the scaling, government representatives for youth and gender inclusion have taken part in workshops, but lower levels of women have participated. More work can be done to increase access to the innovation bundle by women and youth. Access may not be equitable because of the gendered and age-related differences in access to finances and collateral, as well as decision-making power in a household. It should be noted that female respondents of the rapid assessment had a significantly lower education level than male respondents, possibly requiring different information campaigns and training materials.
1.4.8	How can benefits be made more equitable among actors?	Special attention needs to be paid to gendered differences in information, know-how, and challenges.
1.4.9	Describe whether other people and/or businesses benefited from the bundle's scaling without adopting the bundle themselves. y/n? if yes, please explain how they have benefited.	Recently, more private sector companies in the irrigation supply chain, government agencies, and development partners in Ghana have been joining the scaling activities as participants. These include GIZ, CIKOD (Center for Indigenous Knowledge and Organizational Development), IWAD (Integrated Water and Agricultural Development), Nandom Rural Bank, Dizengoff, and COCOBOD. Their benefits include access to SBIB-related knowledge, business and professional networks, new collaborations, and investments.
1.5. Described development outcomes targeted		
1.5.1	Nutrition, health, & food security Mention the main impact indicators in the order of their importance. Per impact indicator please indicate the time frame within which the first major impacts are expected.	Nutrition, health & food security: 1 million people meeting minimum dietary energy requirement <ul style="list-style-type: none"> - Description: Beneficiaries can meet their minimum dietary energy requirements, more affordable and healthier diets, and greater nutrition indirectly achieved, by higher income from increased vegetable production. In Ghana, women grow part for home consumption and part for selling, so growing more vegetables during the dry season likely has positive effects on their family members meeting their minimum dietary requirements. Higher-income from increased vegetable production and surplus vegetables grown could also be allocated for home consumption and higher income from increased vegetable production. Surplus vegetables grown could also be allocated for home consumption. - The time frame: 5 years - The geo-level: National and sub-national

1.5.2	Poverty reduction, livelihoods, and jobs Mention the main impact indicators in the order of their importance. Per impact indicator please indicate the time frame within which the first major impacts are expected.	Poverty reduction, livelihoods & jobs: 0.5 million people assisted to exit poverty <ul style="list-style-type: none"> - Description: Beneficiaries who are in extreme poverty may not be able to afford the payments for the solar pump. However, if those beneficiaries can take part in collective production, where the solar pump is shared, they can earn more income through vegetable sales and exit extreme poverty. Higher incomes for smallholders as increased access to irrigation can generate higher profits and incomes for farmers compared to rainfed agriculture, by potentially improving profits along the agricultural value chains, and enabling the horticultural production to reach scale. Better employment opportunities as despite the outlined support and potentials, and the benefits and availability of tested solutions, wide-scale adoption and use of innovations in agriculture is yet to be realized. Increasing access to irrigation-related innovations could improve employment opportunities in farming. - The time frame for the three indicators: 5 years - The geo-level: National and sub-national
1.5.3	Gender equality, youth, and social inclusion Mention the main impact indicators in the order of their importance. Per impact indicator please indicate the time frame within which the first major impacts are expected.	Gender equality, youth, and social inclusion: 0.5 million women and youth benefiting from investing in SBIBs <ul style="list-style-type: none"> - Description: Greater gender equality and equity, greater inclusion of women and vulnerable groups/youth into irrigation and irrigated vegetable value chain, and broader irrigation farming - The time frame for the indicator: 5 years - The geo-level: National and sub-national
1.5.4	Climate adaptation and mitigation Mention the main impact indicators in the order of their importance. Per impact indicator please indicate the time frame within which the first major impacts are expected.	Climate adaptation, and mitigation: Positive but not quantified <ul style="list-style-type: none"> - Description: lower environmental footprint (reduction of GHG emission intensities). Solar irrigation pumps save greenhouse gas (GHG) emissions and fuel costs for farmers. They can reduce CO2 emissions per energy unit of water pumping (CO2-eq/kWh) by 97 to 98 percent as compared to diesel pumps. - The time frame for the two indicators: 5 years - The geo-level: National and sub-national
1.5.5	Environmental health, and biodiversity Mention the main impact indicators in the order of their importance. Per impact indicator please indicate the time frame	Environmental health & biodiversity: Positive but not quantified <ul style="list-style-type: none"> - Description: Water use efficiency and productivity are increased with the advanced technology of SPIPs that can monitor the water pumped. The suitability of Solar-based irrigation can be identified using data-driven tools to mitigate the investment and water resource over-exploitation risk. - The time frame for the two indicators: 5 years

	within which the first major impacts are expected.	- The geo-level: National and sub-national
1.5.6	Other outcomes Mention other development, business, policy, or other outcomes that will be achieved by the innovation bundle.	Socio-economic and environmental risk mitigation: Positive but not quantified <ul style="list-style-type: none"> - Description: Decreased risk is something that all smallholder farmers look for, in addition to increased profits. Investing in the innovation bundle could either increase or decrease risk levels, depending on the specific circumstances of the farmer and their household. Helpful indicators to guide decisions on investment could also be an important outcome of the intervention. Business growth reflecting in increasing sales of irrigation equipment: Positive but not quantified Inclusive business reflecting in increasing investment in smallholder irrigation market: Positive but not quantified <ul style="list-style-type: none"> - Description: The private sector partners and entities commonly see market demand at one demand - whoever comes to buy their products. With insights into market segments/demands, businesses can tailor their business models to reach more clients thereby increasing their sales and the inclusivity of their services.
1.5.7	Systemic changes Mention any systemic changes that are foreseen to be achieved by the innovation bundle.	<ol style="list-style-type: none"> 1. Strengthening the commercial agricultural value chain that enhances the stable supply of irrigated horticultural products. 2. Inclusive business to the smallholder farmers, gender, and youths. 3. Changes in marketing strategies and business models to reach the diverse market demands/segments 4. Win-win partnerships and collaboration to grow the market and business.
1.5.8	Indicate to which SDG(s) and SDG Target(s) the Innovation is expected to contribute by 2030. Select only those SDG(s) and SDG(s) Targets to which the innovation is expected to make a significant contribution.	The targeted development outcomes will contribute to: <ul style="list-style-type: none"> - SDG 1: targets 1.1 (eradicate extreme poverty) - SDG 2: 2.1 and 2.2 (end hunger and all forms of malnutrition); 2.3 (double agricultural productivity and incomes of small-scale food producers); 2.4 (ensure sustainable food production systems); 2b (producer support) - SDG 5: 5a (give women equal rights to economic resources); 5b (enhance the use of ICTs to empower women) - SDG8: 8.2 (higher productivity through upgrading and innovation and higher value-added); 8.3 (support decent job creation and entrepreneurship); 8.6 (enhance youth employment opportunities) - SDG 10: 10.1 (reduce inequality) - SDG12: 12.3 (reduce food loss and waste) - SDG 13: Take urgent action to combat climate change

1.5.9	Action Area Outcomes* Indicate the action area outcomes that are expected to be achieved by scaling the bundle to the new context.	N/A
COMPONENT 2. Assessing the scalability and scaling potential of SBIB bundle		
2.1. Status of adoption		
2.1.1	Indicate how many users (per category) have adopted the innovation/innovation bundle to date, and where from which how many were women and/or youth.	Since the scaling depends on the dry season and has been happening during the Global Covid Pandemic followed by the economic crisis in Ghana in 2022, the number of adopters is relatively limited. The specific number of women or youth farmers that adopted the bundle is not available.
2.1.2	Describe whether the access to innovations in the bundle is equitable for those who would want/need to adopt it. y/n, if no please explain. How can equitable access be increased?	Women and young farmers are more likely to face difficulties accessing resources such as land, credit, and information that would enable them to invest in irrigation. Resource-limited and resource-poor farmers also have less access to SBIBs compared to other farmer segments.
2.1.3	Describe how can equitable access be increased.	<ul style="list-style-type: none"> - Women and youth (and their official representatives in local bureaus) were included in action-research activities to ensure that their concerns and suggestions and thoughts were considered. By segmenting client groups in gender-sensitive ways, businesses can better target a range of farmers, including women. This is helping accelerate the adoption of solar-powered irrigation technologies in frontier markets while promoting women's equitable participation in irrigated agricultural value chains. - NGOs, aiming to build capacity amongst more disadvantaged groups, have sometimes focused on women farmers on the other hand. - Private sector tailoring their business models to different client segments.

2.1.4	Describe whether the innovations in the bundle are currently affordable by the different user segments it targets. y/n, if no please explain.	<p>Pay-as-you-own (PAYOWN) financing modality is part of the innovation bundle that includes various technical and financial services that the scaling partnership provides to farmers. PAYOWN is a credit system that allows farmers to make use of equipment while paying installments to own it. Farmers differ in their financial abilities to make a deposit for a pump from Pumptech and in their ability to pay. Pumps sold under a PAY-OWN arrangement contain a chip and are connected to the PumpScanner app which tracks payments. Pumptech uses the PumpScanner as a credit control mechanism for defaulters. Pumptech offers the PAYOWN option for farmers who cannot afford to buy a pump in one payment. The PAYOWN offer includes an initial deposit depending on the terms agreed with Pumptech.</p> <p>There also is a Pay-as-you-go (PAYGO) option, where the pump remains in the property of the provider (e.g., PumpTech) and farmers pay per unit of water.</p>
2.1.5	Mention whether adopting the innovations/ bundle does require i.e., a one-time, short-term, large investment (% of income, company revenue, or project budget) or long-term, recurrent, small installments	Adopting SBIBs varies from individual to individual and from farmer segment to farmer segment. All the listed requirements are found in the reality.
2.1.6	Mention how the affordability of the innovation/innovation bundle can be increased.	Customizing financing services and products for farmers' investment in solar-based irrigation
2.1.7	Describe the most important factors/services that have been leading to the adoption of the innovation/innovation bundle (e.g., access to input/output markets, gender or youth-specific targeting, business support)	<ul style="list-style-type: none"> - Strengthening demand-supply linkages - Pay-go and Pay-own financing services - Tailoring business models to different farmer segments
2.1.8	Describe the relevant existing services (e.g., logistics, transportation, storage, import, export, banking) that could increase adoption of the innovation /innovation bundle	<ul style="list-style-type: none"> - Digital financing services (MOMO money) - Supply of diverse products and services that match different needs and ability to invest in farmer segments

2.2. Extent and speed at which the bundle can be scaled to new contexts		
2.2.1	Mention the potential geographical reach of the innovation bundle (over a specified time), i.e., the potential/projected No. of users in a year: specific communities, regions, countries, cultures, etc.	Irrigable lands where access to surface water and groundwater is available.
2.2.2	Mention and describe other customer segments that the innovation bundle could reach based on their link to or function in the value chain as well as their natural, human, physical, social, and financial capitals.	<ol style="list-style-type: none"> 1. Resource-rich farmers 2. Resource-limited farmers 3. Resource-poor farmers 4. Mobile farmers 5. Out-grower farmer scheme 6. Farmer groups/cooperatives. 7. other segments that can be identified in the specific geographical areas
2.2.3	Indicate the timeframe for scaling the bundle to the identified geographical area/user segments	1-2 years
2.3. Adaptability to different/new contexts		
2.3.1	Indicate and add any new conditions that the bundle would have to adapt to. (Multiple choice)	<ol style="list-style-type: none"> 4) different physical infrastructure (roads, markets, internet) 5) different levels of purchasing capacity/investment by customer segment 6) financing ecosystem 7) natural resources (e.g. water availability, soils, and climate conditions) and energy (e.g. sources and availability) 8) farming practices, production, and farming systems 9) different business models/practices/investments 10) presence and capacity of the private sector 11) different institutional and market environments (policies and informal institutions such as local beliefs, gender, and social norms)
2.3.2	Indicate whether the bundle is flexible to the identified different contexts.	<p>SBIB is flexible to different countries in SSA due to several reasons:</p> <ul style="list-style-type: none"> - Core innovations (e.g., SPIPs, PAYGO/PAYOWN, and tailoring business models to different farmer segments) are relatively context-independent, and they are in high demand across many countries in SSA.

		- Existing businesses and services that are currently bundled with the core innovations in Ghana can be found in many countries in SSA as well.
2.3.3	Indicate the elements in the bundle that are context-independent components	Core innovations are context-independent 1- Solar-powered irrigation pumps (SPIPs) 2- PAYGO/PAYOWN financial services to lower the initial cost of the pump 3- Tailoring business models to different farmer segments
2.3.4	Indicate the components in the bundle that is affected by the identified contextual differences.	When the institutional and market environment varies from country to country, the availability and affordability of the two core innovations (1- Solar-powered irrigation pumps and 2-PAYGO/PAYOWN financial services) could be affected significantly.
2.3.5	Indicate how should the context-dependent components be adapted to cater to the different contexts.	Bundling the core innovations with existing solutions and services has been proven as one of the ways to increase the scalability of the innovation bundle.
2.4. Desired development outcomes when scaling the bundle to new contexts		
2.4.1	Nutrition, health & food security Mention the main impact indicators and the time frame in the order of their importance.	A similar indicator to 1.5.1 can be expected in Mali, Burkina Faso, Senegal, and other SSA countries where the solar-based irrigation supply chain is well established, and the economy is driven by an open market.
2.4.2	Poverty reduction, livelihoods, and jobs Mention the main impact indicators and the time frame in the order of their importance.	A similar indicator to 1.5.2 can be expected in Mali, Burkina Faso, Senegal, and other SSA countries where the solar-based irrigation supply chain is well established, and the economy is driven by an open market.
2.4.3	Gender equality, youth & social inclusion Mention the main impact indicators and the time frame in the order of their importance.	A similar indicator to 1.5.3 can be expected in Mali, Burkina Faso, Senegal, and other SSA countries where the solar-based irrigation supply chain is well established, and the economy is driven by an open market.
2.4.4	Climate adaptation and mitigation Mention the main impact indicators and the time frame in the order of their importance.	A similar indicator to 1.5.4 can be expected in Mali, Burkina Faso, Senegal, and other SSA countries where the solar-based irrigation supply chain is well established, and the economy is driven by an open market.

2.4.5	Environmental health and biodiversity Mention the main impact indicators and the time frame in the order of their importance.	A similar indicator to 1.5.5 can be expected in Mali, Burkina Faso, Senegal, and other SSA countries where the solar-based irrigation supply chain is well established, and the economy is driven by an open market.
2.4.6	Other outcomes Please mention other development, business, policy, or other outcomes that will be achieved by the bundle.	A similar indicator to 1.5.6 can be expected in Mali, Burkina Faso, Senegal, and other SSA countries where the solar-based irrigation supply chain is well established, and the economy is driven by an open market.
2.4.7	Systemic changes Mention any systemic changes that are foreseen to be achieved by the innovation bundle.	A similar indicator to 1.5.7 can be expected in Mali, Burkina Faso, Senegal, and other SSA countries where the solar-based irrigation supply chain is well established, and the economy is driven by an open market.
2.4.8	Please indicate to which SDG(s) and SDG Target(s) the Innovation is expected to contribute by 2030. Select only those SDG(s) and SDG(s) Targets to which the innovation is expected to make a significant contribution.	The targeted development outcomes will contribute to: <ul style="list-style-type: none"> - SDG 1: targets 1.1 (eradicate extreme poverty) - SDG 2: 2.1 and 2.2 (end hunger and all forms of malnutrition); 2.3 (double agricultural productivity and incomes of small-scale food producers); 2.4 (ensure sustainable food production systems); 2b (producer support) - SDG 5: 5a (give women equal rights to economic resources); 5b (enhance the use of ICTs to empower women) - SDG8: 8.2 (higher productivity through upgrading and innovation and higher value-added); 8.3 (support decent job creation and entrepreneurship); 8.6 (enhance youth employment opportunities) - SDG 10: 10.1 (reduce inequality) - SDG12: 12.3 (reduce food loss and waste) - SDG 13: Take urgent action to combat climate change
2.4.9	Action Area Outcomes* Indicate the action area outcomes to be achieved by scaling the bundle to the new context.	N/A

2.5. Unintended or potentially negative outcomes as results of scaling the bundle		
2.5.1	Please describe what could be the undesired impacts/trade-offs and for whom/what	1. Over-exploitation of groundwater hampers environmental sustainability. 2. Water use conflict occurs
2.5.2	Please describe when the undesired impacts/trade-offs are likely to occur	1. When solar-based irrigation reaches the regional/sub-continent scale. 2. When the upstream communities over- use water for irrigation.
2.5.3	Please describe where are the undesired impacts/trade-offs likely to occur	Water scarcity areas and basins
2.5.4	Describe what adjustments to the bundle you can make to decrease the undesired impacts in the given period, and what effect could this have on its scalability	Inclusive irrigation water governance can be bundled with the SBIBs.
Component 3. Developing scaling strategies		
3.1. Characteristics of the scaling networks and ecosystem in the new scaling context		
3.1.1	If applicable, please indicate the CGIAR Initiative that led the scaling of this innovation	N/A
3.1.2	If applicable, indicate the CGIAR Initiative that tangibly contributed to the scaling of this innovation	Sustainable and Intensification of Mixed Farming System (SI-MFS)
3.1.3	Please indicate actors and stakeholders and their roles in the scaling ecosystem	Farmers and other actors in agricultural value chains, irrigation equipment, and service supply chain, financing institutions/entities, and public actors.
3.1.4	Please indicate what relationships among actors directly influence the scaling	The common relationships between these actors are win-win partnerships and collaboration in that every actor contributes resources to the scaling of SBIBs. These resources are existing and have been used for each actor's business. When the resources are mobilized for the scaling, they are complementary to each other.

3.1.5	Please indicate what are the dynamics in the presence and influence of actants (non-human factors such as pests, droughts, or technologies)	Scaling SBIBs is significantly influenced by the availability of land, water, digital innovations, and financial services. These actants are changeable factors and co-evolution with the scaling of SBIBs.
3.1.6	Please indicate what are the synergies/complementarities with existing innovation practices, services, and interventions	In most SSA countries, interventions and support for agricultural development are emphasized. With the heavy climate change impacts, coupled with water and energy scarcity in SSA, solar technologies for agriculture are complementary solutions.
3.1.7	Please indicate what are the general incentives or motivations of relevant actors in the new scaling context that drive their behavior	For private sector irrigation equipment entities, agricultural market expansion and growth are in their marketing strategies. For the public sector, including development actors research organizations, governments, and donors, environmental and social sustainability, and food security for SSA are key drivers.
3.1.8	Please indicate who might be opposed to the innovation bundles going to scale	Environmentalists and motor and electrical pump manufacturers and distributors
3.1.9	Please indicate what resources are already available to support the scaling of the innovation bundle	Financial and physical resources such as solar energy and water
3.1.10	Please indicate what kinds of investments and initiatives are underway that can retard and hamper the scaling	<ul style="list-style-type: none"> - Businesses and investments from market actors for the agricultural market - In rural areas, the use of solar panels to supply energy for drinking water supply systems has been steadily increasing - Development partners are supporting initiatives to increase investments in solar in agriculture by testing, de-risking, subsidizing and analyzing policy reform to sustainably scale solar pumps
3.1.11	Please indicate what are the operational mechanisms of the system that would enhance or inhibit the bundling mechanism	<ul style="list-style-type: none"> - Adaptive capacity - Systemic and adaptive scaling practices - Sustainable and inclusive financing modalities

3.1.12	Please describe any major gaps or barriers in the scaling ecosystem (political, social, or environmental issues) that could hinder the scaling of the bundle.	<ul style="list-style-type: none"> - Technology transfer - Dominance of the grant mechanism while lacking suitable financing modalities for rural economic development - Subsidy policy and tax exemption - Forex policy - Free-gift mentality
3.2. Potential scaling strategies/pathways		
3.2.1	Indicate what are the viable and most promising scaling strategies/pathways for the demand and scaling partners	A private sector-led scaling pathway is a viable and promising one.
3.2.2	Please indicate what are the stakeholders and their roles, goals, and available resources to engage in scaling pathways and to invest in scaling the bundle	<ol style="list-style-type: none"> 1. Private sector partners: providing/selling solar-powered irrigation pumps and accessories; water convergence and application equipment; tailoring their business models and services to different farmer segments; Investing in smallholder irrigation segments; Providing Pay-go/Pay-own services; establishing sales and service networks to expand SPIP markets 2. Research partners: provide knowledge, expertise, tools, and services to de-risk investment for the private sector partner and develop inclusive business models for solar-based irrigation to target marginalized market segments at the bottom of the pyramid and boost the sustainable market development for solar-based irrigation. 3. Government Partners: providing market linkage services by mobilizing agricultural extension agents and other actors in the irrigated vegetable value chains and facilitating the private sector partners' visibility in the regions 4. Development partners: de-risking investment to the private sector's pay-own financial investment 5. Impact investors: providing investment to an inclusive market for smallholder irrigation
3.2.3	Please indicate what the partnerships and investments needed for sustained scaling	A scaling partnership should be established among the private sector, public sector, and research partners to co-design and co-implement demand-supply linkage activities and incentivize farmers' investment in SBIBs. The scaling partnership should prioritize the establishment of sales and service networks, increase the private company's visibility and outreach in the region, capitalizing on the sale of SBIs, and facilitate sustainability and inclusivity of scaling solar-based irrigation.

3.2.4	Indicate what potential barriers must be overcome and what are your strategies to overcome and address these barriers	Hindering factors include technical issues such as product lifespan, solar panel maintenance, theft, and gender-friendliness. The misconception of solar systems for home consumption is they have short lifespans, and this has negatively influenced the reputation of solar pumps. The short lifespans of some home solar systems were attributed to users overloading the system with gadgets and lighting points beyond the stated capacity. There is also the issue of limited land, water, financial and human capital. For example, dry-season farming is difficult as the water dries up before the end of the cropping season. Investment in solar technology is often extensive and the initial cost is high for many farmers. Farmers do not have adequate finances to invest in both solar-based irrigation and inputs for irrigated farming.
3.2.5	Indicate what could be unintended impacts when the scale is reached	Like item 2.5.1: 1. Over-exploitation of groundwater hampers environmental sustainability. 2. Water use conflict occurs
3.3. Resources and conditions to implement scaling pathway		
3.3.1	Indicate the conditions for the successful operationalization of the specific scaling strategies/pathways, i.e., existing scaling networks and partnerships, existing certain complementary innovations, and services to be bundled with the scalable bundles	<ul style="list-style-type: none"> - Function solar irrigation equipment supply chains operate under the market-driven economy - Good infrastructural conditions such as access to the internet and distribution center - Existing financial services that are willing to invest in agricultural investment including irrigation - Existing multi-actor networks/partnerships for agricultural development
3.3.2	Indicate what are the different resources (time, staff, budget) needed for the specific scaling strategies/pathways	<ul style="list-style-type: none"> - Time: 2-3 years - Staff and other resources mobilized from partners
3.3.3	Reflect on whether there are any opportunities that you could build upon i.e., supportive political champions, supportive policies, and policy implementation	<ul style="list-style-type: none"> - Change in policy toward diversification of irrigation development - Agricultural turn in policy and development investment - Farmer-led irrigation development is high on the development agenda for SSA
3.3.4	Mention whose endorsement is needed to trigger larger-scale uptake	<ul style="list-style-type: none"> - Private sector investment in the agricultural market in an inclusive manner - Farmers' farming with a business mindset - Available appropriate financial services and products for diverse farmers' needs

3.4. Accelerating the scaling of SBIB bundle		
3.4.1	Indicate how, by how much, and by whom could the scaling be accelerated	<ul style="list-style-type: none"> - Impact investors and blended financing providers - Policymakers to foster a favorable policy environment for solar technologies
3.4.2	Indicate what capacities and measures of capacity building are needed to enable specific actors to speed up their actions, effectively engage, and contribute to a faster/greater scaling of the bundle. Please describe what communities of practice look like	<ul style="list-style-type: none"> - Tailoring business models to be inclusive to the diverse market demands. By segmenting customer groups and providing PAY-OWN financial services in inclusive ways, companies can better target client segments such as resource-rich, resource-limited, mobile farmers, and farmer groups. This is helping accelerate the adoption of solar-based irrigation in frontier markets while promoting women's equitable participation in irrigated agricultural value chains. - Retail distributors in the region do not stock these pumps but can order them. Pump rentals, repair, and maintenance services are rare in the supply chain. - Corporations among pump manufacturers and distributors, public and research sectors, and other value chain actors, and ongoing multi-stakeholder dialogues at different levels continuously trigger changes in solar market development. - Multi-stakeholder dialogues and corporations can i) bring actors together, ii) provide them with a space for interactive learning and collective action while stimulating private sector investments and partnerships, iii) inform public policies and programs, and iv) capitalize on the existing resources and investments to enhance system transformation beyond the scaling partnership.
3.4.3	Mention what communication channels, strategies, and events will be used for accelerating scaling	This requires the commitment and investment of private sector partners in capitalizing the partnership's investment and strengthening farmers' collective action to mobilize land and water access and financial capital. It also requires the dynamic engagement of actors in the irrigated agricultural value chain to enhance farmers' adoption of solar-based irrigation and multi-stakeholder dialogues and corporations to sustain the partnership's investment and trigger system transformation.
3.4.4	Mention what characterizes the demand and supply of the (financial) investments for accelerating scaling.	Matched demand and supply of the financial investment

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Disclaimer

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