Food and Agriculture Organization of the United Nations

PROJECT BRIEF

PRO-SAHEL

INNOVATION AND TECHNOLOGY IN SMALL-SCALE IRRIGATION SYSTEMS FOR SMALL-SCALE PRODUCERS IN THE SAHEL

MULTI-DISCIPLINARY FUND (MDF)

PROJECT BRIEF

PRO-SAHEL

INNOVATION AND TECHNOLOGY IN SMALL-SCALE IRRIGATION SYSTEMS FOR SMALL-SCALE PRODUCERS IN THE SAHEL

CONTENTS

Acknowledgments

This Project Brief was written by Livia LoyDona and is based on AKADEMIYA2063's reports *Pro-Sahel – Innovations et technologies dans les systèmes de petite irrigation pour les petits producteurs du Sahel: Une feuille de route pour le développement de la petite irrigation au Burkina Faso* and *Pro-Sahel – Innovations et technologies dans les systèmes de petite irrigation pour les petits producteurs du Sahel: Une feuille de route pour le développement de la petite irrigation au the Niger*.

Editorial support was provided by Jonathan Robinson and graphic design was by Adriana Brunetti.

1. RATIONALE

The population of the Sahel is growing rapidly, pressuring millions of small-scale farmers in the region to boost food production substantially in response to the growing needs for agricultural commodities. Unfortunately, according to the latest State of Food Security and Nutrition in the World, poverty and food insecurity are also rising in the Sahel (FAO, IFAD, UNICEF, WFP and WHO, 2021; FAO, IFAD, UNICEF, WFP and WHO, 2022). Improving agricultural productivity and reversing negative trends is high among regional priorities. Structural reforms and innovative strategies must optimize the management of land, water, soil, and the demographics of the Sahel. In addition to these challenges, current strategies for agricultural development in the Sahel also need to address the impacts of the COVID-19 pandemic, regional and global conflicts, and the crisis of climate change, which puts small-scale producers in the region under further pressure, with higher energy and fertilizer costs, and increasing droughts and floods.

Water is scarce and pivotal for the Sahel, not only for increasing the productivity for millions of small-scale farmers but also for countering loss of arable land resulting from erosion and warming temperatures. A major barrier to the use of water in the Sahel is the lack of infrastructure and technologies – 45 percent of the population do not have access to water, and only 2 percent of arable land is irrigated (OECD, 2022).

Technologies that are context specific can help increase agricultural productivity and attract investments, thereby accelerating sustainable development. Investments in such technologies can improve financial returns from irrigated crop land. While irrigation technologies are a primary need in the Sahel, other technologies can also contribute to improved performance of agrifood systems. These include digital technologies, biotechnologies, mechanization technologies, food processing technologies, and renewable energy technologies (FAO, 2023). It is notable that many of the technologies currently imported into Africa cannot necessarily be used directly because they have been designed for producers with different technical capacities, farms sizes, land types and market dynamics from those that Sahelian agriculture operates with. Investing in irrigation technologies and technology systems in Burkina Faso and the Niger should result in targeted policy reforms to ensure that the technologies are adapted to the context, affordable and accessible, including when used by marginalized groups.

2. ACTIVITY

In 2021, under the leadership of the Chief Scientist Office, FAO (Food and Agriculture Organization of the United Nations) piloted the Pro-Sahel project, which aims to scale up investments in irrigation technologies for small-scale farmers in the Niger and Burkina Faso. The Pro-Sahel project invested USD 500 000 to deliver two national roadmaps for investing in and scale up of small-scale irrigation technologies. The project was conducted in close partnership with Akademiya2063, an African institution specialized in economic analysis and policy advice for African development, together with national stakeholders from the agriculture and irrigation sectors in Burkina Faso and the Niger, and FAO Country Offices, the FAO Regional Office for Africa, the Hand-in-Hand initiative, and expertise from the Investment Centre in Rome.

3. OBJECTIVES

The main objective of Pro-Sahel is scaling up tested and socially accepted small-scale irrigation technologies for high value crops for small-scale producers and innovative ways of linking them to markets. The project aims to build a well-articulated programme that promotes sustainable small-scale irrigation and increases crop productivity, diversification of crop production and post-harvest value chain activities in Burkina Faso and the Niger. Scaling up investment in irrigation technologies for small-scale farmers is intended to reach a critical mass of farmers in vulnerable and marginal communities in each country so that it optimizes impact on food security and poverty reduction. Furthermore, Pro-Sahel intends to provide a blueprint that can be used in other countries of the region to promote sustainable irrigation in line with regional policies and plans.

4. RESULTS

1. IRRIGATION TECHNOLOGIES FOR SMALL-SCALE FARMERS

Small-scale farmers in Burkina Faso and the Niger already use small reservoirs and community-based river diversion projects, treadle pumps or motor pumps, as well as California grid systems and drip systems for agricultural irrigation. These technologies are considered acceptable and profitable to scale up. According to the analysis conducted by Akademiya2063, investments in irrigation technologies should prioritize small reservoirs and community-based river diversion projects, and motor and treadle pumps. Investment in these technologies would have a significant impact on poverty reduction in rural areas of Burkina Faso and the Niger, including most of the rural population in the two countries. Among others, Akademiya2063 estimated that especially small reservoirs could be accessible by many farmers in Burkina Faso.

While, on the one hand, electric pumps are of less use in Africa due to limited access to electricity, especially in rural areas, on the other hand, the use of treadle pumps is limitated due to labour requirements (XIE *et al.*, 2014). Among motor pumps, diesel pumps and solar pumps represent untapped potential to improve the adoption of irrigation among small-scale farmers in sub-Saharan Africa, solar pumps having several advantages over diesel pumps. Solar pumps are easy to use, inexpensive in terms of maintenance, do not rely on an unsustainable fuel source and have a longer lifespan, which translates into a lower average annual costs than for diesel pumps (Hartung and Pluschke, 2018). Despite the advantages, small-scale farmers in sub-Saharan Africa find it difficult to use solar pumps because of the high initial investment cost. However, there is evidence that the adoption of solar pumps among small-scale farmers can be increased by balancing the costs in the long term, provided the farmers receive the necessary support. Case studies also show that such support is needed to create an enabling environment for the use of solar pumps among small-scale farmers (IFAD, 2020).

2. LOCATIONS FOR SMALL-SCALE IRRIGATION

A small share of the arable land is developed with infrastructure and technologies for irrigation by small-scale farmers in the Niger and Burkina Faso. An estimated 10 million hectares of arable land exist in the Niger and a potentially large area of arable land also exists in Burkina Faso where irrigation can be developed. Within this untapped potential, according to Akademiya2063, in the Niger, the most profitable locations for investment in irrigation technologies for small-scale farms are in the western area of the country. Almost all small-scale irrigation areas that can be developed are in four of the seven regions of the Niger, and in Tillabery and Dosso. In Burkina Faso, the most profitable regions for small-scale irrigation occur in the West, South-West, Centre-East and Centre, corresponding to the main irrigable plains. Most of the areas suitable for small-scale irrigation are found in four of the thirteen regions of Burkina Faso: the Boucle du Mouhoun, the Centre-West, the Hauts-Bassins and the North. Estimated returns to investment in irrigation technologies for small-scale farmers in the Niger are given in Figure 1 and in Burkina Faso in Figure 2.

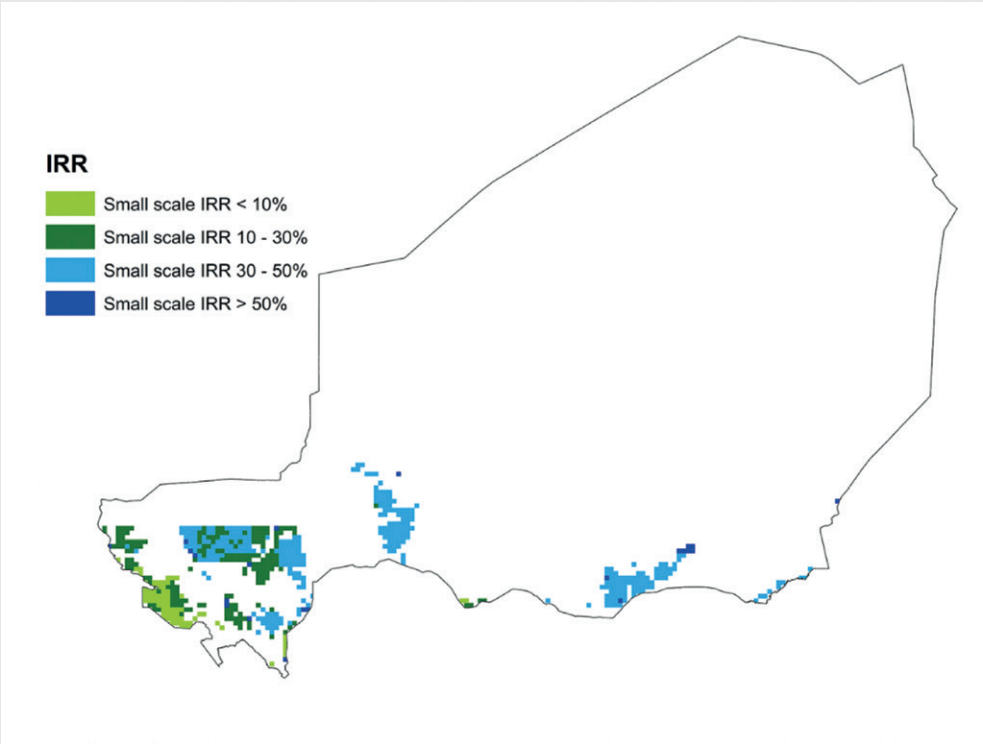
3. PRELIMINARY IDENTIFICATION OF PRIORITY CROPS AND VALUE CHAINS

The Pro-Sahel project has suggested crops and value chains that should be associated with investment in small-scale irrigation based on a review of the national yields of irrigated crops and national expert reviews. The resulting combination in Burkina Faso includes onion, tomato, potato, capsicum and maize. The value chains for rice, groundnut, black-eyed pea, and sesame have also been considered for investment. In the Niger, the value chain for onion primarily and tomato, cabbage, garlic, cassava, potato, wheat, maize, capsicum and moringa have been preliminarily considered. The priority food crops listed will benefit from further integration based on local data and additional consultation. The list will be refined in a second phase that includes consideration of value chain market reform.

4. ESTIMATED COSTS OF INVESTMENTS

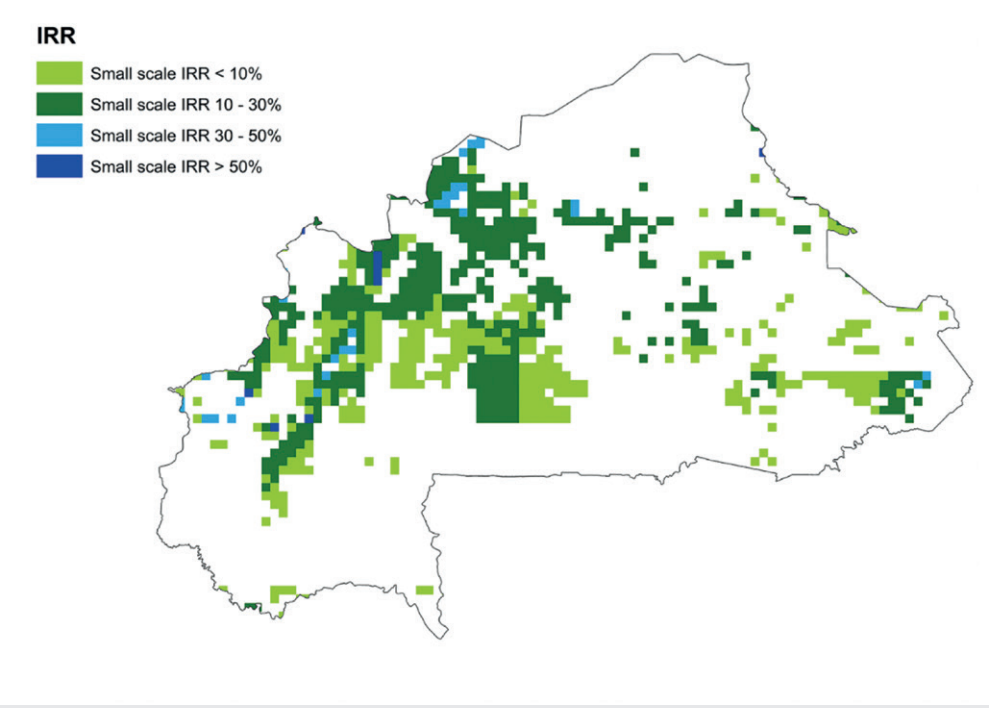
Akademyia2063 estimated the costs required for scaling up irrigation technologies for small-scale farmers in Burkina Faso and in the Niger based on the cost-benefit ratio for individual and collective irrigation systems.

Figure 1.
Estimated returns to investment in irrigation technologies for small-scale farmers in the Niger



Source: AKADEMIYA2063, 2022. *Une feuille de route pour le développement de la petite irrigation au Niger.* AKADEMIYA2063. Cited 20 December 2022.

Figure 2.
Estimated returns to investment in irrigation technologies for small-scale farmers in Burkina Faso



Source: AKADEMIYA2063, 2022. *Une feuille de route pour le développement de la petite irrigation au Burkina Faso.* AKADEMIYA2063. Cited 20 December 2022.

For Burkina Faso, Akademyia2063 estimated a total of USD 16.5, 20.7, 11.1 and 9.7 billion for covering the investment for scaling up treadle pumps, motor pumps, small reservoirs and community projects for diversion of rivers, respectively, for a maximum total cost of USD 58 billion to develop a maximum of 3.1 million hectares of land for small-scale irrigation. This investment would benefit 37.8 million people in rural areas, where about 321 000 people live in poverty. The internal rate of return is estimated to be 16 percent .

For the Niger, Akademyia2063 estimated a total of USD 989, 1010, 728 and 35 million for covering the investment for scaling up treadle pumps, motor pumps, small reservoirs and community projects for diversion of rivers, respectively, for a maximum total cost of USD 2.8 billion to develop an area of 373 thousand hectares for small-scale irrigation. It is estimated that this would benefit 4.6 million people in rural areas, lifting 648 612 people out of poverty. The internal rate of return is estimated to be 27 percent .

5. ASSOCIATED POLICY AND INSTITUTIONAL REFORMS

Policy issues related to land and water security, access to finance, enabling governance, technology ownership and improving the business environment are key to expanding the small-scale irrigation sector. Among the policy issues, the importance of mapping water resources and regulating their use for better efficiency is considered crucial to ensure sustainability without compromising water use productivity. The need to make irrigation technologies more appropriate, more accessible and more affordable for small-scale farmers is considered to be just as crucial as the need to regulate water use efficiency.

➔ OPTIONS FOR MAPPING AND MEASURING WATER RESOURCES

The cost and ease of water extraction depends on the water table's depth and potential flow. In this regard, the availability of hydrological data is essential to better support and optimize water allocation decisions. With a depth limit of 7 m for easy small-scale irrigation using distribution technologies such as pedal pumps and motorized centrifugal pumps, data are needed for identifying the favourable areas and quantities recharged each year. Further research on these water resources should be undertaken at the basin and sub-watershed level to characterize and map the resources.

➔ OPTIONS FOR PROMOTING SMALL SCALE FARMER OWNERSHIP OF TECHNOLOGIES

In addition to general farm management advice that helps producers make decisions on their farms, while considering organizational and technical-economic aspects, a more targeted, adapted and focused extension advisory system must be instituted to ensure wider and more sustainable use of small-scale irrigation in the African context (Box 1).

Box 1.
Topics for training farmers in small-scale irrigation

- Selection and targeting of irrigation technologies
- Investments and profitability of technologies
- Installation and use of technologies
- Technology management and maintenance
- Choice of crops and production schedules
- Use of complementary inputs
- Marketing of products and inputs

➔ PROMOTION OF THE LOCAL INNOVATION SYSTEM FOR SMALL-SCALE IRRIGATION

A critical intervention is the promotion of the local innovation system that will help adapt, redesign, build and maintain emerging technologies, and provide complementary inputs and advisory services. Several regulatory and programmatic actions are needed to promote local innovation in irrigation technologies. At the regulatory level, a well-defined intellectual property rights system must be established to ensure the protection of property rights and create incentives for innovators. At the programme level, the incubation of local entrepreneurs and artisans is essential to ensure the production of technologies and the availability of maintenance services at the local level. Establishing a small-scale irrigation innovation laboratory is key to creating a platform where technical and

managerial issues are addressed by all actors in the irrigation value chains. The innovation laboratory refers to the establishment of a discussion platform among researchers, farmers and entrepreneurs to identify entry points and create more opportunities for farmers and other actors to add value in the irrigation sector. In an innovation laboratory, researchers, farmers, extension actors and local entrepreneurs come together to explore constraints and opportunities and pilot solutions to improve water delivery and distribution, as well as appropriation and scaling up of technologies (Box 2).

Box 2.
Contributions of the innovation laboratory to small-scale irrigation

- Explore opportunities and constraints to identify irrigation impact pathways
- Pilot and adapt irrigation technologies
- Identify business models for technology adaptation, operation and management of the irrigation system and marketing of irrigation products
- Scale up good practices

➔ OPTIONS FOR ENSURING LAND AND WATER SECURITY

For rural small-scale farmers, water is mainly used for agricultural purposes and cannot be considered separately from land security. Moreover, globally, much of the fresh water is used for irrigation. A positive link exists between land tenure security and improved productivity through better use of agricultural technologies. Formalization of land tenure can reduce disputes and conflicts over land boundaries, including during land sales, and facilitates land transfers. Land certification can provide small-scale farmers with tenure security and better guarantees that allow them to lease land for a longer period, helping them earn additional income. This type of initiative benefits rural youth who do not own land but want to engage in agriculture by renting land.

5. CONCLUSIONS

The Pro-Sahel project, through the analysis conducted by Akademiya2063, has provided roadmaps that indicate how the use of irrigation technologies can be scaled up for expanding irrigated agriculture in Burkina Faso and the Niger. This will boost agricultural production and post-production activities and significantly reduce poverty and food insecurity. The Pro-Sahel analysis indicates the irrigation technologies for small-scale farmers to select, the most suitable locations to develop the investment, the priority crop value chains to consider for prioritization, estimated costs for investments and lays out the appropriate policy reforms for making the technologies adapted to the context in detail for each country. Furthermore, this project suggests that the impact of all other technology types is relevant to making the agrifood system more effective in the Sahel. This includes renewable energy technologies, including solar panels that make energy and irrigation accessible in remote rural areas, and mechanization and food processing to reduce food loss.

6. WAY FORWARD

A pathway is proposed for small-scale irrigation development in line with existing frameworks at continental and regional levels. The roadmap includes five broadly defined priority action areas (Figure 3) that need to be created or strengthened for effective and sustainable expansion of small-scale irrigation in Burkina Faso and in the Niger.

The pathway includes

1) strengthening the technological support system to adapt, standardize, multiply and maintain small technologies and their accessories,
2) strengthening the advisory and extension system to provide services adapted to the context of small-scale farmers,
3) directing market access options towards collective marketing and linking farmers with agro-processors and Agri-parks,
4) scaling up marketing approaches and intervention support to programmes to be more comprehensive and inclusive and to encourage farmers and the private sector to invest and

Figure 3.
Five pillars for investment in irrigation technologies for small-scale producers in the Niger and Burkina Faso (Pro-Sahel)

5) establish an institutional framework to mobilize funds and coordinate stakeholders involved in small-scale irrigation.

In addition to the details available in the national roadmaps, drafting the detailed investment plans for materializing the pathway from Pro-Sahel should consider further the impacts of irrigation technologies on climate change adaptation and mitigation in the Sahel. Appropriate digital technologies with remote sensing tools and geographic information systems for water accounting can improve estimates of water balances in future scenarios of water scarcity and make the water management systems and irrigation investment more climate smart in the Sahel.

Considering the costs that have been estimated, the feasibility of the main financing options considered in investment pathways for scale-up would benefit from further assessment, depending on the specific local context. The principal financing options include public grants, decentralized financial services, public-private partnerships, self-financing and special bank loan arrangements in the form of credit guarantees, lines of credit and working capital.

Many stakeholders of regional relevance can materialize the Pro-Sahel pathways with an integrated regional perspective and leverage the power of science, technology and innovation for transforming agrifood systems in the Sahel. These stakeholders include the African Union Commission, the Economic Community of West African States (ECOWAS), the Permanent Interstate Committee for Drought Control in the Sahel (CILSS), the United Nations Integrated Strategy (UNISS), the G5 Sahel Joint-Force, and the Coalition for the Sahel, IFAD (International Fund for Agricultural Development) Hub for Sahelian countries, the Green Climate Fund, the Global Environmental Facility, the World Bank, Akademiya2063 and others.

7. REFERENCES

FAO, IFAD (International Fund for Agricultural Development), UNICEF (United Nations International Children's Emergency Fund), WFP (World Food Program) & WHO (World Health Organisation). 2021. *The State of Food Security and Nutrition in the World 2021*. Rome, FAO.

FAO, IFAD, UNICEF, WFP & WHO. 2022. *The State of Food Security and Nutrition in the World 2022*. Rome, FAO.

FAO. 2023. In: *FAO*. Rome. Science, Technology and Innovation. Cited 30 January 2023. https://www.fao.org/science-technology-and-innovation/en

Hartung, H. & Pluschke, L. 2018. *The benefits and risks of solar-powered irrigation – A global overview*. Rome, FAO.

IFAD. 2020. *Renewable Energy for Smallholder Agriculture*. Rome, RESA.

OECD (Organization for Economic Co-operation and Development). 2022. *Natural resource governance and fragility in the Sahel*. Paris, OECD.

XIE, H., Vous, L., Wielgotz, B. & Ringler, C. 2014. Estimating the potential for expanding smallholder irrigation in sub-Saharan Africa. *Agricultural Water Management*, 131: 183–193.

MORE INFORMATION

CHIEF SCIENTIST
e-mail: chief-scientist@fao.org
website: https://www.fao.org/science-technology-and-innovation/en
Food and Agriculture Organization of the United Nations, Rome, Italy

FAO REGIONAL OFFICE FOR AFRICA
e-mail: fao-ro-africa@fao.org
website: https://www.fao.org/africa/en/
Food and Agriculture Organization of the United Nations, Accra, Ghana

AKADEMIYA2063
e-mail: kigali-contact@akademiya2063.org
website: https://akademiya2063.org/