PARI Policy Brief No 12

PARI
January 2019

SMALL-SCALE IRRIGATION POTENTIAL IN SUB-SAHARAN AFRICA

Targeting investments in technologies, locations and institutions

The limited access to water the during dry season or a drought greatly restricts farming opportunities and productivity increases in Sub-Saharan Africa. Irrigation can thus be a promising solution to boost levels of agricultural productivity. However, only about 4% of land in the region is irrigated. This is not necessarily due to physical water scarcity. Rather, the main constraint of irrigation is economic water scarcity, i.e. investments in the management of water resources are not substantial enough to meet water demand and farmers do not have the financial means to exploit water resources on their own. Research has shown that small-scale irrigation systems can help adress this economic water scarcity in Africa.

Why small-scale irrigation?

Small-scale irrigation systems carry a lower initial cost compared to large-scale systems. They are also easier to manage and fit more flexibly into distinct types of farming and cropping systems. A wide range of small-scale irrigation technologies has been introduced to smallholder farmers in SSA, including rainwater harvesting, flood recession, floodwater spreading, river diversion, treadle pumps, motor pumps, solar-powered pumps and porous jars.

Both small-scale and large-scale systems have significant potential for profitable irrigation in Africa.

- Investing $32 billion in **large-scale dam-based projects** would increase the area under irrigation by 16.3 million hectares with an average internal rate of return (profitability of an investment over time) of 7%. For large-scale dam-based schemes, irrigation to the field is assumed to be gravity-fed.
- **Small-scale irrigation** could potentially be developed on 7.3 million hectares although the potential varies between countries in the range of 0 to 2.5 million hectares (Figure 1 shows the areas where small-scale irrigation was estimated as profitable).[1] The internal rate of return for small-scale irrigation expansion averages 28%, significantly more than the rate of return on dam-based, large-scale irrigation.

Higher rates of return for small-scale irrigation are due to the size and high potential of rainfed areas located away from large-scale projects that could be profitably converted to small-scale irrigation but are not necessarily suitable for dam-based irrigation. Large-scale investments are sensitive to spatial proximity to the dam and the costs that are involved in conveying the impounded water. The potential for small-scale irrigation, on the other hand, depends on the availability of surface-water runoff, on-farm investment costs, crop mix and market accessibility.

Identifying suitable small-scale irrigation technologies

The costs and benefits of potentially expanding four small-scale irrigation technologies motor pumps, treadle pumps, communal river diversion and small reservoirs were assessed.[2]

Table 1 shows that **area expansion potential** is largest for **motor pumps** and **treadle pumps**. However, due to their heavy reliance on groundwater, these technologies may cause an overdraft of existing water resources and other environmental risks especially in dry years. Area expansion potential for the **communal river diversion** and **small reservoirs** is relatively smaller, yet these have larger potential to reach the rural population. This could be because smallholder irrigation is used largely to extend cultivation into a

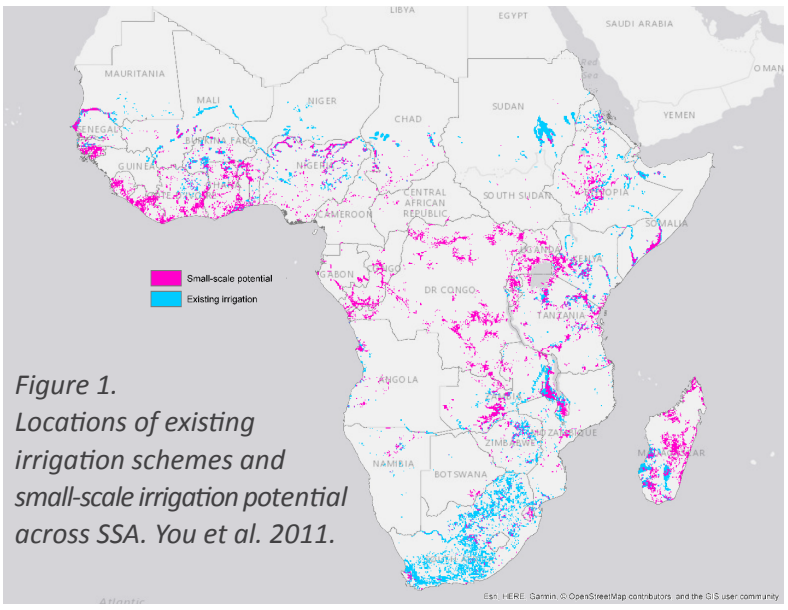

Figure 1. Locations of existing irrigation schemes and small-scale irrigation potential across SSA. You et al. 2011.

Table 1 Estimated potential of four types of small-scale irrigation technologies in SSA

Small/scale Irrigation Technology	Application area	Net revenue	Rural population reached	Water consumption
	M ha	US$ BN per year and per million ha irrigated	Million people per million ha irrigated	BN m³ per year and per million ha irrigated
Motor pumps	29.66	0.7	6.2	2.3
Treadle pumps	24.35	0.8	10	2.3
Communal river diversion	20.44	0.7	5.5	3.0
Small reservoirs	22.18	0.9	16.6	2.6

Source: Xie et al. 2014.
Notes: Estimated application areas are sensitive to the irrigation costs. The farmers' cost values assumed in the analysis to generate estimates in Table 1 are (1) motor pumps: US$263/ha-yr.; (2) treadle pumps: US$259/ha-yr., (3) communal river diversion: US$640/ha-yr. and (4) small reservoir: US$200/ha-yr. The capital investment cost of small scale reservoirs is assumed to be government financed and was not included in the estimation; thus, overall cost can be higher.

second season. Most of SSA has a tropical climate in which temperatures are high throughout the year, and farming activities typically follow rainfall patterns. Irrigation therefore makes dry-season cultivation on the same plot possible.

Methodology:
To estimate costs and benefits, an integrated modeling technique was used that combines geospatial data analysis with a predictive hydrologic model, an economic model as well as the optimization of mix of 13 major crops (Xie et al., 2014). High-value crops such as vegetables and staple and cash crops such as maize, rice, wheat, legumes and sugarcane were included. This integrated framework allowed for an analysis of how each method would affect both farmers and the environment.

Policy Recommendations

Detailed ex-ante evaluations that take into account a host of influencing factors - institutional, agronomic, human, and environmental are essential to fully understand the potential of small scale irrigation projects. **Strategies to expand irrigation need to consider factors that can undermine farmers' willingness and ability to make long-term investments in irrigation technologies.** Well-established **land tenure**, water rights and their enforcement, for instance, are expected to collectively encourage farmers to invest in small-scale irrigation while facilitating access to credit that con cover the costs of operations, maintenance and further expansion of the irrigation scheme. Land rights could also empower farmers to flexibly make farm decision on their own and to choose to grow high-value cash crops with irrigation during off-seasons.

Incentives, regulations, and monitoring systems that minimize any unintended consequence of small-scale irrigation expansion must be established in areas that suffer from seasonal scarcity of physical scarcity. Empowered Water Users' Associations can perform critical functions in community-based small-scale irrigation schemes. Women's particitpation and leadership in WUAs could also play an important role in promoting gender-balanced impacts.

This Policy Brief is based on the study: [1] You, L et al. (2011) „What is the irrigation potential for Africa? A combined biophysical and socioeconomic approach, Food Policy 36(6): 770-782.
[2] Xie, H et al. (2014) Estimating the potential for expanding smallholder irrigation in Sub-Saharan Africa, Agricultural Water Management 131: 183-193.
Available at www.research4agrinnovation

PARI implementing partners: ZEF/University of Bonn, University of Hohenheim, Technical University Munich, the Forum for Agricultural Research in Africa (FARA) and its national partners, the African Growth and Development Policy Modeling Consortium (AGRODEP) facilitated by the International Food Policy Research Institute (IFPRI, Africa Office), and research collaborators in India.

PARI is funded by the German Federal Ministry for Economic Cooperation and Development (BMZ).

IMPRINT
Center for Development Research (ZEF)
Genscherallee 3 | 53113 Bonn | Germany
E-Mail: presse.zef@uni-bonn.de
Phone: +49-(0)228 - 73 18 46
Brief prepared by: Jawoo Koo, Olawale Olayide and Saadatou Sangaré
Layout: ZEF PR

AGRODEP African Growth & Development Policy modeling consortium FACILITATED BY IFPRI

zef Center for Development Research University of Bonn