The Impact of Providing Land Tax Subsidies, Local Monitoring, and Minikits on Irrigation Use in Rwanda

Researchers:

Maria Jones

Florence Kondylis

John Loeser

Jeremy Magruder

Sector(s): Agriculture

Fieldwork: IPA Rwanda

Location: Karongi and Nyanza Districts

Target group: Farmers

Outcome of interest: Earnings and income Technology adoption Profits/revenues

Intervention type: Fertilizer and agricultural inputs Technology

AEA RCT registration number: AEARCTR-0001323

Data: ICPSR

Research Papers: “Factor Market Failures and the Adoption of Irrigation in Rwanda.”

Partner organization(s): MINAGRI Ministry of Agriculture and Animal Resources, LWH Project Implementation Unit, World Bank Rwanda Country Management Unit, European Union (EU), Global Agriculture and Food Security Program (GAFSP), World Bank i2i Fund, International Initiative for Impact Evaluation (3ie), International Growth Center (IGC)

Farmers in sub-Saharan Africa tend to adopt agricultural technology, such as irrigation, at low rates, despite the existence, availability, and potential benefits of such technologies. In rainfed agriculture systems with only one or two harvests, irrigation affords farmers an opportunity to grow and harvest vegetables during the dry season. Building off of previous quasi-experimental research, researchers conducted three randomized evaluations to test the impact of providing farmers with land tax subsidies, different ways of monitoring water access and the canal’s operations and maintenance, or farming minikits on farmers' use of irrigation on their cultivated land. Researchers found that none of the interventions affected farmers’ choices to adopt irrigation, suggesting that there were more binding factors that constrained farmers’ decision-making.

Policy issue

Farmers in sub-Saharan Africa tend to adopt agricultural technology, such as irrigation, at low rates, despite the existence, availability, and potential benefits of such technologies. Irrigation, specifically, can increase agricultural production by creating new or elongating cropping cycles, providing water on demand to more water-intensive plants, and overcoming the risk associated with unpredictable rains. However, the creation and maintenance of irrigation canals is costly and requires meaningful continued financial support. Overcoming these large start-up costs and defining who should be responsible for maintenance remains a challenge. For example, if governments support canal creation and want investments to pay off, then farmers must use

them to irrigate their crops. While water access from canals is improved, there are other barriers to production, like increased labor needed to manage production, land access, and increased input demands for new crops, like horticulture. If there are failures in farmers' access to any of these other markets, then there could be reason for farmers to forgo irrigation. Can direct support to farmers through subsidies, minikits, and monitoring overcome land, labor, and input market inefficiencies that prevent irrigation use?

Context of the evaluation

In Rwanda, agriculture is a key economic activity for more than half of the population,[1] and many farmers depend on rainwater during the standard growing cycles, September to January and February to May, to grow staples, like maize and beans, bananas, and vegetables.[2] In dry years, there is not enough rain from February to May to support a second harvest, negatively affecting farmers without access to irrigation.

In 2015, the Rwandan government finished constructing three new irrigation systems in the Karongi and Nyanza Districts. Farmers uphill from the systems' canals did not get access to free irrigation, but farmers who were located downhill from the systems' canals received free irrigation access. The canal had to be steep enough to get water to flow, but not so steep that the water flowed too fast. The water pressure was weakest near the irrigation system when too many farmers used too much water concurrently.

In 2012, while the canal was being constructed, the average household from affected areas had four people. Most (92.6 percent) people lived in rural areas, and about 90 percent of the eligible land was farmed by the owners. Farmers paid land taxes annually, which were up to RWF 77,000 or US$96.25 per 2.47 acres, which was equivalent to about 20 percent of measured yields from dry season irrigation intervention. Using the rollout of the irrigation systems, researchers quasi-experimentally studied the effect of access to irrigation on farmers' irrigation use, inputs usage, like labor allocation, land productivity, and agricultural profitability.

A hill is irrigated by a canal in Rwanda

John Loeser, Innovations for Poverty Action Rwanda

Details of the intervention

To complement the aforementioned quasi-experimental research, researchers conducted three randomized evaluations to test the impact of offering monitoring operations and maintenance (O&M), land tax subsidies, and horticultural minikits on irrigation use among farmers from eligible households.

Evaluation 1: Operations and monitoring intervention:

To assess whether farmers' decision to take up irrigation would be affected by the quality and maintenance of irrigation infrastructure, 225 water user groups, which, on average, had about 4 farmers each, were randomly assigned to one of three intervention groups in 2016 and 2017:

1. Elected monitors: Seventy-five water user groups, or about 310 farmers, were offered the chance to elect one of their members to monitor the timing of farmers' water use and communicate operations and maintenance issues to their water user association.
2. Elected monitors who lived close to the irrigation system: Seventy-five water user groups, or about 310 farmers were offered the chance to elect monitors who lived near the irrigation systems to carry out these tasks. Proximity to the irrigation system was included to assess whether monitors had an incentive to get people to use water at their designated time because water pressure was weakest near the start of the canals when too many farmers were using water at the same time.

3. Comparison: One hundred water user groups, or about 413 farmers, were assigned to irrigation project staff who carried out these monitoring activities.

Evaluation 2: Land tax subsidies

To pay for O&M, the government taxed farmers with access to irrigation. Though land taxes were levied on all farmers with or without irrigation access, researchers posited that land taxes could have discouraged irrigation adoption if farmers thought taxes were more likely if they used irrigation, so in 2017, 512 out of 929 farmers in 225 water user groups participated in at least one subsidy lottery. Of these 512, 443 (87%) entered exactly one lottery:

1. Half subsidy, one season: Just over 102 households were offered a subsidy to cover half their taxes for a season, equal to about RWF 4,278 or US$5.35.
2. Full subsidy, one season: Just over 102 households were offered a subsidy to cover all of their taxes for a season, equal to about RWF 8,556 or US$10.70.
3. Full subsidy, two seasons: Just over 102 households were offered a subsidy to cover all of their taxes for two seasons, equal to about RWF 17,112 or US$21.39.
4. Comparison: About 205 households were not offered a subsidy.

Evaluation 3: Horticultural minikits

To assess whether lack of information or money constrained farmers' adoption, researchers randomly offered farmers from water user groups minikits that contained enough seed, fertilizer, and insecticide to cultivate 5 percent of an acre of land. In 2017, 929 farmers in 225 water user groups were randomly assigned to one of four groups:

1. Twenty percent coverage: About 186 of the farmers were given a 20 percent chance of being offered a minikit.
2. Sixty percent coverage: About 186 farmers were given a 60 percent chance of being offered a minikit.
3. Full coverage: About 186 farmers were given a 100 percent chance of being offered a minikit.
4. Comparison: About 372 farmers were not offered a minikit.

Across all evaluations, baseline data was collected from August to October 2015, and there were three follow-up surveys from May to June 2017, November to December 2017, and November 2018 to February 2019. Researchers collected information on access to irrigation, adoption of irrigation, taxes owed, take up of the interventions, and number of days farmer used irrigation.

Results and policy lessons

Monitoring O&M did not increase farmers' adoption of irrigation. Horticultural minikits slightly decreased farmers' adoption of irrigation. Tax subsidies increased adoption of irrigation, but taxes were largely unpaid, meaning taxes were likely not the main constraint on irrigation use. There were some positive effects on shorter-term outcomes, such as taxes owed and paid and the take up of minikits. These results complement the quasi-experimental study, which estimated that labor and land market challenges, like differences between the value of paid farmhand labor and household labor or the intensity of labor activities under irrigated versus rainfed systems and land sales and ownership, were associated with the low adoption of irrigation.

Monitoring O&M and horticulture minikits' effects on irrigation use: The provision of irrigation monitoring did not change the number of days participating farmers used irrigation nor how many days they went without irrigation, suggesting that the newly constructed irrigation infrastructure did not have substantial enough operations and maintenance issues to interrupt the use of irrigation. Households offered minikits decreased participating households' use of irrigation by 0.5 percentage points relative to the comparison group's 36.9 percent irrigation rate.

Taxes owed and paid: Subsidies reduced taxes owed by the intervention groups, on average, to RWF 1,800 or US$2.25 relative to the comparison group's farmers average tax bill of RWF 9,600 or US$12, an 81 percent reduction. The intervention groups paid about RWF 300 or US$0.38 of their taxes, whereas the comparison group paid about RWF 500 or US$0.63 of their taxes. If farmers thought tax rates would have been enforced, then the taxes could have stood in the way of irrigation use. This was not the case: In response to the subsidies, the intervention group increased their use of irrigation by 2.4 percentage points. Few farmers in any group fully paid their taxes, suggesting farmers were likely aware they would not be made to pay their entire tax bills or paying would not interfere with irrigation use. The taxes likely did not stand in the way of irrigation use.

Take up of minikits and decisions to cultivate horticulture: Households offered minikits, were 40 percentage points or 666.7 percent more likely to take up the minikits than the comparison group's 6 percent chance of taking up the kit. Minikits led to a 3.5 percentage point increase in horticulture cultivation relative to the comparison group's 33.1 percent horticulture cultivation

This suggests that information and the cost of non-labor inputs were not binding constraints in farmers' decision to use irrigation for water-intensive horticulture.

Spatial discontinuity estimates of the impacts of hillside irrigation on agricultural productivity, from hillside irrigation schemes where 30 percent of farmers were observed using irrigation during the dry season, were cited in the national agricultural sector strategy to motivate prioritizing efficient and effective usage of existing irrigation resources.

Altogether, the results of this study indicate there is room for additional research on how inputs like labor, land, and farming supplies influence the use of technology such as irrigation.

Jones, Maria, Florence Kondylis, John Loeser, and Jeremy Magruder. 2022. "Factor Market Failures and the Adoption of Irrigation in Rwanda." *The American Economic Review*, 112, no. 7 (July): 2316–52. doi: https://doi.org/10.1257/aer.20210059.

---

1. International Labour Organization. "ILO modelled estimates database" ILOSTAT. Accessed February 07, 2024. ilostat.ilo.org/data.
2. Climate Risk Profile: Rwanda (2021): The World Bank Group