

## Context

Under the Government of Rwanda's goal of Rural Transformation as set out in PSTA-4 and NST-1, irrigation is a key pillar in the agriculture development agenda. Land Husbandry, Water Harvesting and Hillside Irrigation (LWH) is a flagship project of the government of Rwanda with the goal of transforming hillside production, increasing rural productivity in an environmentally sustainable manner.

The World Bank's Development Impact Evaluation (DIME) unit has been leading with an impact evaluation of 4 irrigation schemes developed by LWH. The irrigation schemes all involve terraced hillsides, and a main canal which directs water along hillside contours.

## Impact Evaluation

There is very little rigorous evidence on the returns to irrigation in sub-Saharan Africa for smallholder farmers. This impact evaluation speaks to that knowledge gap. It measures the welfare impacts of access to irrigation for smallholders and examines the constraints to adoption.

The evaluation uses a spatial regression discontinuity design. Plots located just above the canal (not irrigated) are compared to those just below (with access to irrigation). Randomized trials within the irrigation schemes provide evidence on the constraints to adoption.



*Illustration of spatial regression discontinuity design: plots located just above canal are compared to those just below*

## Sample and data

The sample is constructed aerially, by randomly selecting plots at set distances from the canal and then identifying the associated household to interview. Households answered detailed survey questions about the sampled plot, as well as the other plots they cultivated. In total, the evaluation includes 4 years of data on 3,000 plots. The data covers the dry season ("C") in 2014, 2016, 2017, and 2018; and the rainy seasons ("A" and "B") in 2015, 2017 and 2018.

## Impact of irrigation on farmer welfare

Irrigation has large, positive welfare impacts for smallholders.

### ➤ Hillside irrigation boosts on-farm cash profits by 70 percent

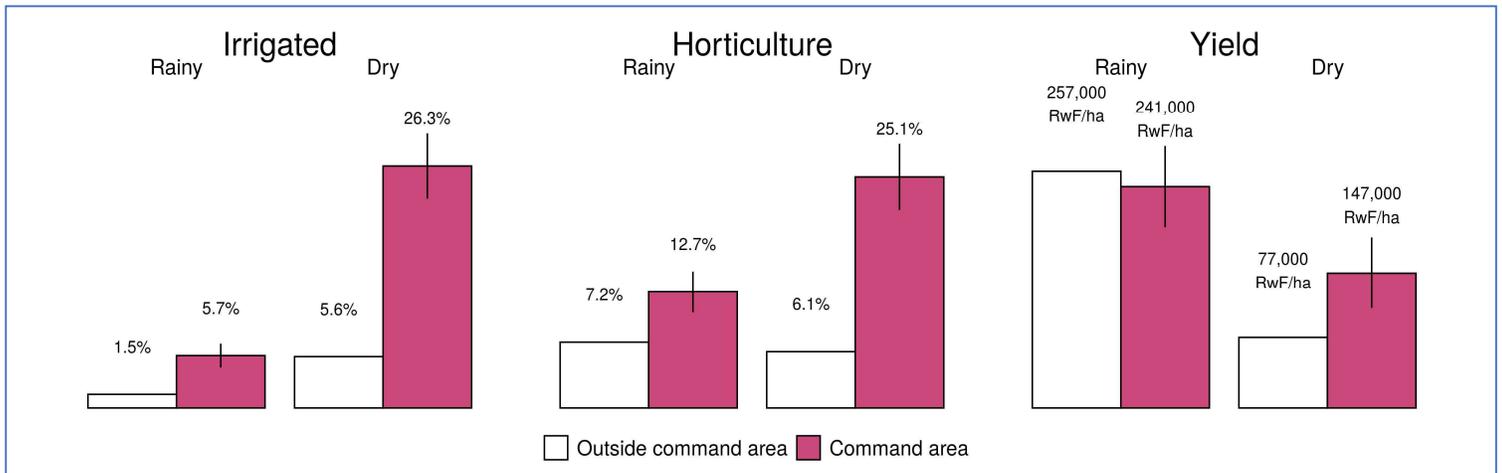
Horticultural crops are much higher value than staple crops, and the shift in production decisions is reflected in farmers' returns. Dry season yields are 90% higher for plots in the command area, compared to plots outside, an increase of 400,000 RWF/ha (approximately \$435/ha) on irrigated plots.

### ➤ Farmers with access to irrigation are much more likely to grow horticultural crops

Nearly all irrigated plots are used for horticulture. Plots in the scheme are 4 times more likely to be used for horticulture than plots outside in the dry season, and nearly 2 times more likely in rainy seasons. Horticulture replaces production of staple crops such as bananas.

### ➤ Hillside irrigation primarily impacts dry season cultivation

1 in 4 plots in the irrigation schemes are irrigated in the dry season, compared to only 1 in 20 plots outside the scheme. In the rainy season, irrigation usage is much lower on all plots. Access to irrigation does not increase the likelihood a plot is cultivated during the dry season.



➤ **Despite potential profits, adoption is partial: only 1 in 4 plots in the schemes are irrigated**

Moreover, adoption has not increased over time; 2-4 years after the schemes came online dry season cultivation has remained constant at about 25%. If all plots were irrigated, welfare impacts would be 2-3 times higher.

**Constraints to adoption**

Why aren't more farmers using irrigation?

➤ **Horticultural production is input intensive**

Farmers use significantly more of all types of inputs for horticulture than for staple crops: more household labor, hired labor, and agri-inputs (e.g. fertilizer). Horticultural production is especially input-intensive compared to banana production.

➤ **Information and credit not binding constraints**

A randomized trial measured the impact of offering farmers in the schemes free horticulture minikits. The minikits included seeds and fertilizer for 2 ares (0.02 ha) of horticulture. Results show that households who received the minikits were not more likely to irrigate or grow horticulture than other farmers. Households who did not receive minikits used inputs from other sources. This shows that access to information or agri-inputs are not important constraints for take-up of irrigation.

➤ **Labor is the more important constraint**

84% of all labor on sampled plots is provided by household members. Horticultural production is significantly more labor-

intensive than staple production; expanding irrigation would also imply hiring workers from outside of the household.

➤ **Thin labor markets are a significant barrier to wider adoption of irrigation**

If labor markets function well, small and large households should be equally likely to irrigate their plots. However, results show that labor markets are thin. Smaller households are less likely to irrigate multiple plots, implying they are not able to meet labor demands.

**Sustainability**

Incomplete adoption of irrigation needs to be addressed to maximize returns and ensure sustainability of the large investment the Government of Rwanda has made in these hillside irrigation schemes.

➤ **Low adoption threatens sustainability**

At current low levels of adoption, even the large yield gains observed do not generate enough surplus to pay for even routine maintenance.

➤ **Improving land and labor markets would maximize impact and sustainability.**

Many farmers struggle to irrigate multiple plots, and those plots remain uncultivated during the dry season. More functional land markets would allow households to rent out the plots they cannot themselves cultivate. More functional labor markets would allow households to hire workers to meet the labor demands that cannot be met by their own members.

**Irrigation has huge potential benefits for smallholder farmers; the increases in yield and profits realized in the schemes are large and economically meaningful for smallholder farmers. Increasing the use of irrigation will accelerate the impact and sustainability of the government investments and accelerate rural transformation.**