Weather and climate information systems for climate-resilient growth: Evidence from a quasi-experiment in Rwanda

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- Rwanda's agricultural sector is susceptible to climate-induced weather shocks, with losses in drought years ranging from 20% to 60% depending on the commodity.
- The national agricultural sector strategic plan prioritises preparedness over response to promote climate resilience and productivity. Preparedness is primarily achieved through Weather and Climate Information Services (WCIS) which currently reaches half of the population.
- In this study, we evaluated the farm productivity benefits of accessing WCIS using Rwandan household data from the EICV survey. We find that accessing WCIS increases the likelihood of fertiliser and improved seed use by 9% and 8%, respectively. However, WCIS had no statistical effect on farm productivity. Data from the study suggests that this might be due to the quality of information disseminated by WCIS.
- With roughly half of the population not accessing WCIS, the study recommends increasing the effectiveness of existing coverage by giving farmers a more significant role in the co-generation of WCIS. The study recommends prioritising regions most vulnerable to climate change while expanding services to underserved populations.

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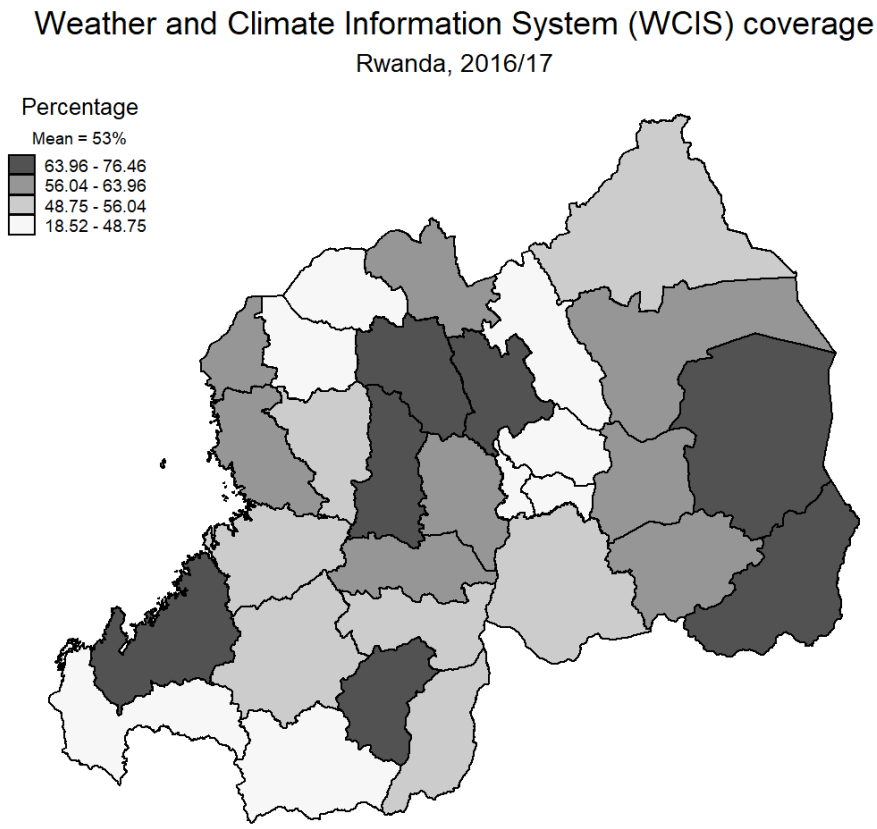
Overview of the research

Rwanda's agricultural sector is susceptible to climate-induced weather shocks. For example, drought conditions in 2008 caused maize yield losses of 37% in the Eastern province and Milk production losses of roughly 60% in the Northern and Eastern provinces[1]. Rwandan authorities keen to promote resilient economic growth in the agricultural sector have prioritised preparedness over response. The second pillar of Rwanda's Strategic Plan for Modernising Agriculture (PSTA4 2018-2024) aims to create productive jobs in the farm sector by improving land productivity and market integration. One planned activity under this pillar is providing Weather and Climate Information Services (WCIS) led by Rwanda Meteorological Agency (RMA)[2].

Figure 1: Rwanda map of WCIS coverage by district



Source: Author's calculations from EICV-5 data

Since its establishment in 2011, the Rwanda Meteorological Agency has built one of the most advanced observation systems on the African continent. In 2020, it comprised a sophisticated infrastructure network of 5 synoptic surface stations, 9 Agro-meteorological stations, 79 climate stations, 71 rainfall stations, 56 automatic weather stations, 100 automatic rain gauges, one weather radar,

[1] CIAT. Climate Smart Agriculture in Rwanda. June 2015. Pg 5
[2] Government of Rwanda. Strategic Plan for Modernisation of Agricultural Transformation 2018-24. Pg 52

and two satellite ground receivers. The dense network allows for real-time transmission of weather systems, such that in 2017 Rwanda was the first country in Africa to adhere to international standards of weather forecast methodology[3]. The rapid expansion of observation infrastructure has occurred alongside nationwide dissemination of WCIS, reaching half the population by 2016/17. Given the significant investment in observation infrastructure, the ongoing revision of the Meteorological Agency Policy seeks to focus on the efficacy of its services to users.

As such, this research addressed two main questions:

1. Does accessing WCIS induce farm intensification practices?
2. Does accessing WCIS improve farm productivity?

The study used Rwandan household data from the EICV-5 survey to address these questions. The survey comprises 14,508 households with information across various socio-economic indicators, including whether they accessed WCIS. This study was conducted on households only after they accessed Weather and Climate Information. Because the data contains only observations of the farmers that use Weather and Climate Information, comparing farm outcomes of users and non-users risks conflating the impact of Weather and Climate Information with other contributing factors. Therefore, the study used Propensity Score Matching (PSM) to address selection bias.

Summary of key findings

The 2016 – 2019 Rwanda Meteorological Agency policy focused on upgrading the observation infrastructure to one of the most advanced on the African continent, compliant with international standards[4]. Going forwards, the focus is on maximising the impact of the weather information disseminated.

The findings reveal key insights to increase the effectiveness of WCIS in the revised RMA strategy:

- WCIS increases the likelihood of fertiliser and seed use by 9% and 8%, respectively.
- However, weather and Climate Information had no statistical effect on farm productivity. The low treatment effect of Weather and Climate Information suggests that maximising their impact requires the improved quality of information transmitted to farmers.

How do these results compare with previous research on agricultural climate resilience policies? Like Rwanda's WCIS, crop insurance to farmers is observed

[3] CIAT. Climate Services for Agriculture: Empowering Farmers to Manage Risk and Adapt to a Changing Climate in Rwanda. May 2021. Pg 8
[4] Rwanda Meteorology Agency Strategic Plan Jul 2016 – Jun 2019. Mar 2017, Pg 58

to shift farm practices towards risker higher return activities in multiple contexts[5]. However, contrary to the current study, resistant varieties generate up to 45% productivity gains in some contexts[6].

Our study findings are partially consistent with theoretical predictions and empirical literature. Specifically, while the higher likelihood of adopting farm intensification practices resulting from weather and climate information is consistent with the Theory of Production Under Uncertainty, the insignificant impact is contrary to previous research findings This is likely driven by the scope of our analysis, which suggests difficulties with achieving impact at scale, even with successful pilots. Therefore, the study provided practical recommendations to maximise the impact of Rwanda's WCIS going forwards. One limitation of this analysis is that using cross-sectional data from 2016/17 means that the results are generalisable to periods of comparable biophysical conditions.

Policy recommendations

- **Accord data users a more significant role in the co-generation of WCIS to enhance their effectiveness.**

At the core of effective WCIS are actionable data.[7] The implication is that Weather and Climate Information Systems are most effective when quality observation data is customised to local contexts through end-users participation. The Rwanda Meteorological Agency has one of the most advanced observation systems on the African continent, with real-time transmission capabilities. However, the involvement of data users (farmers) in co-generating forecasts would ensure that the reported shifts in central tendency are consistent with experienced (farm) outcomes[8]. Unlike top-down media-based channels that don't allow user feedback, farmer-led dissemination strategies would ensure a closer link between forecasts and farm outcomes.

- **Prioritise existing WCIS resources to the most climate-vulnerable maximum impact of scarce resources.**

Roughly half of Rwanda's population still needs to be covered by WCIS. Whereas it might be attractive to pursue universal coverage, fiscal constraints dictate that the available resources are efficiently allocated based on climate vulnerability, summarised in Figure 2 below.

  - Prioritise weather and climate observation infrastructure investments in the most vulnerable regions to climate change and

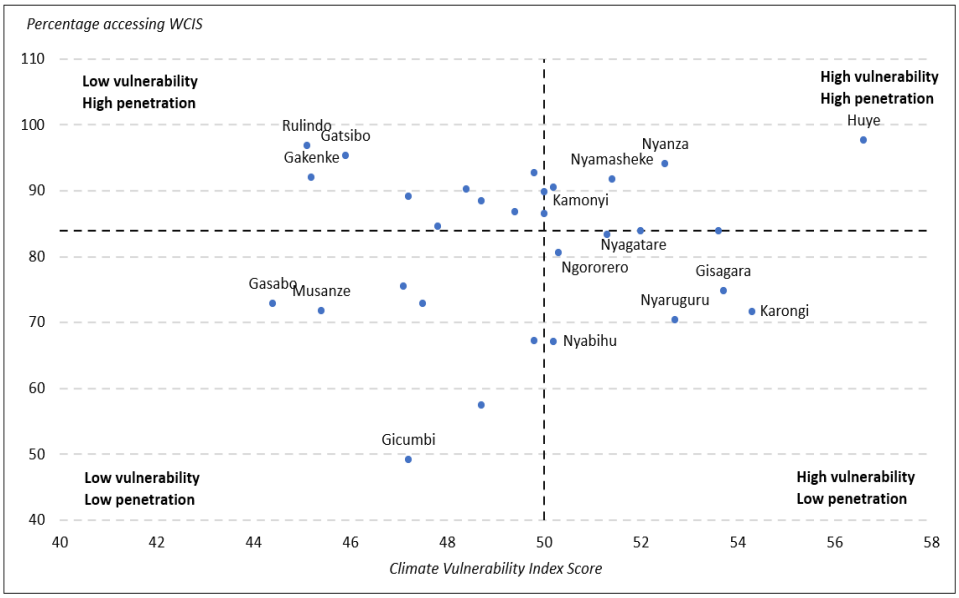
[5] See Cai et al. (2009) in Southwest China and Cole et al. (2013 and Cole, Giné, and Vickery (2017) in India
[6] See Dar et al., (2013) in India.
[7] Allis et al. 2019. The Future of Climate Services. Dec 2019
[8] Meza, 2008. Economic Value of Climate Forecasts for Agriculture. May 2008. Pg 1270

where there is low service capacity by Weather and Climate Information. These districts include Nyagatare, Gisagara, Nyaruguru, Ngororero, and Karongi.

- In regions with high vulnerability and Weather and Climate Information penetration, authorities should strengthen information diffusion. These districts include Huye, Nyamasheke, Nyanza, and Kamonyi.
- In the least vulnerable districts to climate change, with weak incentives to adopt Weather and Climate Information, authorities must raise awareness of its benefits. These districts include Rulindo, Gatsibo, Gakenke, Gasabo, Musanze, and Gicumbi.

In conclusion, this research tested the hypothesis that enhancing the certainty of production risk by providing farmers with weather and climate information encourages informed production decisions and farm productivity by consequence. However, the results show that while weather and climate information slightly increase the likelihood of adopting farm intensification practices, more is needed to foster productivity gains. Therefore, to enhance the role of Weather and Climate Information as an instrument for Rwanda's climate resilience, the study recommends prioritising weather and climate observation resources to climate-vulnerable regions and, according to farmers, a more significant role in generating forecasts.

Figure 2: Rwanda classification of districts by climate vulnerability and penetration of WCIS



Source: Author calculations based on EICV Data and REMA(2019)

Note: The four quadrants are deliniated by the median score of vulnerability and penetration rates indices across districts in 2018