Impact of Climate Variability on Crop Selection & Rotation

Bugesera District, Rwanda · Smallholder Farmers · 2018–2023

Study Design

Study area
Bugesera District · 1,288 km²

Sample
240 farmers · 6 seasons · 1,440 obs.

Methods
Panel data (FE logit)
Random Forest
Gradient Boosting + SHAP

Climate inputs
Rainfall CV · Drought (SPI < −1)
Temperature · Seasonal total

Seasonal rainfall trend



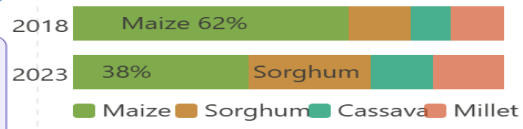
Temperature rise (2018→2023)



Key Findings

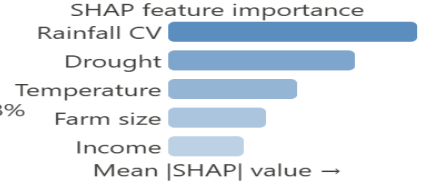
Rainfall CV threshold
28%
triggers shift away from maize

Crop share shift (2018→2023)



Income-conditioned effect
1.8×
stronger for low-income farmers

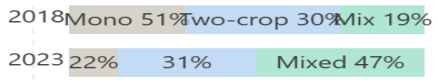
SHAP feature importance



Model accuracy on held-out test set

FE Logit	Rand. Forest	Grad. Boost
78.6%	84.2%	87.4% AUC 0.91 ★

Rotation regime shift



Policy Levers

Early-warning advisory
Couple Meteo Rwanda forecasts with Gradient Boosting at CV ≥ 28%

Seed distribution
Target farmers below 250,000 RWF/season with drought-tolerant vars.

Land consolidation
Align programmes with 1.5 ha rotation threshold to maximise diversity gain

Extension + SMS/USSD
Embed predictive models in seasonal advisories

Behavioral thresholds
- ○ Rainfall CV ≥ 28%
- ○ Income < 250K RWF
- ○ Farm size ≥ 1.5 ha

Methods are complementary
Econometrics → causal effects
ML + SHAP → non-linear thresholds

Dushime et al. · TAIRI Lab, ACEIoT, University of Rwanda · IEEE Access (2026)
Funding: FCDO · IDRC · AI4D programme