

Title: Certification, climate risk, and farmer vulnerability: Evidence from coffee systems in Rwanda.

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Introduction

- Voluntary sustainability standards (VSS) can improve coffee productivity and farm economic returns. (Paz et al., 2026)
- VSS can strengthen farmers’ climate resilience by promoting climate-smart practices
- Limited evidence on whether VSS buffers climate shocks.

Data

- Household-level panel from 2022,2023,and 2024 linked to historical climate data from 1972-2021.
- Matching climate conditions to different stages of the coffee production.

Estimation strategy

Inverse Probability Weight (IPW) with Mundlak/CRE to address observable selection into certification while accounting for correlated, time-invariant farmer heterogeneity.

Outcomes

- **Coffee yield:** per are – to capture weather variability
- **Profit :** per are to capture consequences for economic returns.

Climate indicator – Rainfall anomaly

- Stage-specific rainfall relative to the location-specific 1972–2021 historical norm
- Negative = drier than normal | 0 = historical norm | Positive = wetter than normal.



What affects coffee at which stage?

- 3 main stages of coffee – Flowering, Fruit development and Filling/maturing.
- Wetter-than-usual conditions during flowering are associated with 6.7 kg/are lower coffee yield and about 3000RWF less profit.

Variable	Flowering	Fruit development	Maturation
Panel A. Coffee yield (kg per are)			
Rainfall anomaly	-6.673** (2.637)	-1.881 (5.211)	-1.015 (4.651)
Certified farmers	23.644 (19.255)	19.798 (18.035)	21.963 (18.599)
Panel B. Profit (1,000 RWF/are)			
Rainfall anomaly	-3.028** (1.446)	-1.160 (3.002)	-0.994 (2.554)
Certified farmers	9.485 (12.018)	7.385 (11.363)	8.954 (11.869)
Observations	2470	2470	2470

Higher flowering-stage rainfall is associated with lower coffee yield and profits, but certification does not significantly buffer this effect

- Certified farmers show a smaller negative rainfall relationship, but the interaction is not statistically significant.
- No robust evidence that certification buffers rainfall shocks.

	(1) Coffee yield per are	(2) Coffee profit (1,000 RWF/are)
Rainfall anomaly	-6.167* (3.148)	-3.069* (1.748)
Certified farmer	14.990 (13.309)	3.815 (7.392)
Certified farmer × rainfall anomaly	2.508 (2.344)	1.417 (1.302)
Observations	2470	2470

Next step - Examine the mechanisms through which certification may shape farmers’ capacity to cope with climate variability, including agroforestry and other adaptive practices.