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# The role of financial incentives in technology adoption
## Evidence from a framed experiment in Northern Ghana

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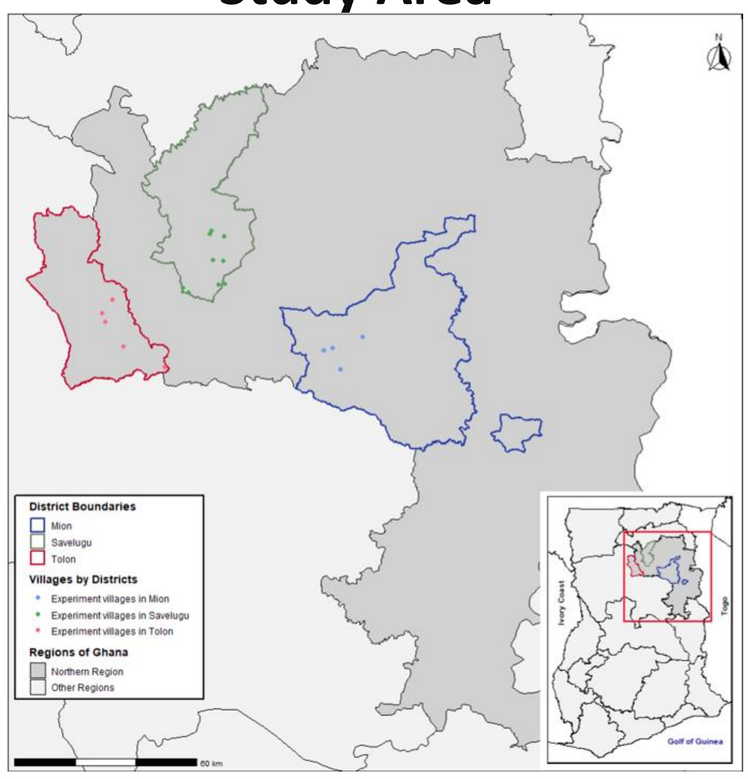
## Background

Smallholder farmers across Sub-Saharan Africa face mounting challenges from erratic rainfall, land degradation, and limited access to resources, which threatens food security and rural livelihoods (Tilman et al., 2002). In Ghana, these challenges were sharply exposed by the **severe drought in 2024**, highlighting the vulnerability of rainfed agricultural systems and the need for climate-resilient strategies (USDA, 2024).

**Sustainable Intensification** (SI)—increasing productivity on existing farmland while maintaining long-term ecological resilience—has emerged as a promising response (Pretty, 2018; Rudel, 2020). A key SI pathway is the use of **drought-tolerant varieties**, which maintain average yields, income, and food security (Bezu et al., 2014; Smale & Mason, 2014; Zeng et al., 2015). Yet adoption remains low due to high upfront costs, limited access to credit and insurance, weak extension services, and uncertainty under risk (Suri, 2011; Foster & Rosenzweig, 2010). To test this, we conducted a **framed field experiment** in mixed-cereal agricultural systems in Northern Ghana, where farmers chose between traditional and drought-tolerant maize seeds under varying cost and insurance scenarios.

## Study Area




## Research Goals

**Objective**

Understand how financial incentives influence adoption of drought-tolerant maize seeds

**Hypotheses**

**H1:** Risk averse farmers prefer drought-resistant seeds over traditional seeds

**H2:** Up-front cost of drought-resistant seeds reduces their adoption rate for risk averse farmers

**H3:** Index-based insurance increases the adoption of drought-resistant seeds when offered conditional on their adoption, compared to when it is offered for any type of seeds

**H4:** Community refunds of excess payments due to positive basis risk enhance the attractiveness of insured seeds

## Experimental Design

**Framed field experiment on maize investment decisions**

- Farmers make decisions for their main maize plot
- Choice between:
  - Traditional seeds (no cost)
  - Drought-tolerant seeds (require upfront investment)
- Decision framed using an initial endowment, from which input costs and payoffs are subtracted
- Drought occurs in 4 out of 10 seasons
- Payouts are shown in points, converted to real monetary rewards

**Randomized treatments (2 rounds):**

**Round 1 (R1):** Upfront cost levels:

**G1**) no cost (control)

**G2**) with cost (treatment 1)

**Round 2 (R2):** Insurance instruments:

**G1)** Non-conditional (control)

**G2)** Conditional (treatment 1)

**G3)** Group-based (treatment 2)

**Sampling and implementation**

- 385 farmers from 3 districts in Northern Ghana
- Randomly selected from a pool of 1,000 COINS baseline survey participants
- Random assignment to treatment groups: 189 in R1G2, 135 in R2G2, and 133 in R2G3
- Includes additional modules to elicit risk and time preferences
- Conduct $\chi^2$ tests between the conditions and run linear regressions (OLS) to control for covariates

## Selected Decision Scenarios

R1G2 : Payout Matrix

| | Initial Endowment | Cost of Seeds | Drought Season | Enough rain Season |
|---|---|---|---|---|
| **Local seeds** | 10 points | 0 points | 10 points | 110 Points |
| **Drought-tolerant seeds + Cost 10 points** | 10 points | 10 points | 50 points | 100 points |

R1G2 : Theoretical Outcomes

| | Potential loss | Variance | Expected profit | Endowment | Expected wealth |
|---|---|---|---|---|---|
| **Local** | 100 | 2400 | 70 | 10 | 80 |
| **Drought-tolerant** | 50 | 600 | 80 | 0 | 80 |

R2G2 : Payout Matrix

| | Initial Endowment | Cost of Insurance | Drought Season | Enough rain Season |
|---|---|---|---|---|
| **Local seeds (No Insurance)** | 10 points | 0 points | 10 points | 110 points |
| **Drought-tolerant seeds + Insurance Cost 5 points** | 10 points | 5 points | 65 points | 107 points |

R2G2 : Theoretical Outcomes

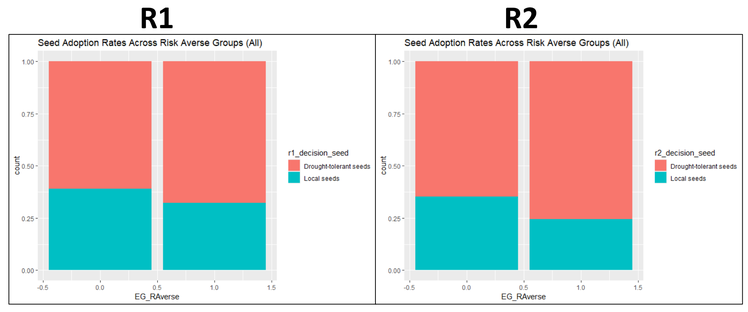
| | Potential loss | Variance | Expected profit | Endowment | Expected wealth |
|---|---|---|---|---|---|
| **Local** | 100 | 2400 | 70 | 10 | 80 |
| **Drought-tolerant** | 42 | 417 | 90 | 5 | 95 |

## Results

Seed Decision

Risk Averse (right bars) vs Non-Risk Averse (left bars) farmers

**R1** **R2**




Round 1 Treatment 1

| | $\chi^2$ | OLS | Obs. |
|---|---|---|---|
| All | 2,33 | 0,09 | 357 |
| Risk Averse | 1,68 | 0,08 | 283 |

Round 2 Treatment 1

| | $\chi^2$ | OLS | Obs. |
|---|---|---|---|
| All | $21,10^{***}$ | $0,28^{***}$ | 233 |
| Risk Averse | $13,76^{***}$ | $0,24^{***}$ | 181 |

Round 2 Treatment 2

| | $\chi^2$ | OLS | Obs. |
|---|---|---|---|
| All | $15,98^{***}$ | $0,24^{***}$ | 234 |
| Risk Averse | $13,12^{***}$ | $0,23^{***}$ | 183 |

**Note:** The tables report (i) the $\chi^2$ test value comparing seed choices (traditional vs. drought-tolerant), (ii) the treatment effect on adoption from the OLS model, and (iii) the number of observations. The first rows use all farmers; the second rows restrict the sample to risk-averse farmers. The '***' indicate strong statistical effects ($p < 0.01$)., i.e.,without them, no systematic differences were found between groups.

## Implications for Adoption

- **Risk-averse farmers** favor drought-tolerant seeds
- **Cost alone may not explain adoption**: No systematic differences were observed in R1, suggesting that the recent drought likely heightened the perceived value of resilient seeds across all groups
- **Insurance design is key**: Conditional and group-based schemes led to higher uptake of drought-tolerant seeds, highlighting their potential for scaling resilient practices
- **Test bundling**: Embedding input–insurance packages in real delivery channels can assess uptake and feasibility beyond the experiment

## Literature cited


- Bezu, S., Kassie, G. T., Shiferaw, B., & Ricker-Gilbert, J. (2014). Impact of improved maize adoption on welfare of smallholder farmers in Malawi. World Development, 59, 120–131.
- Foster, A. D., & Rosenzweig, M. R. (2010). Microeconomics of technology adoption. Annual Review of Economics, 2, 395–424.
- Pretty, J. (2018). Intensification for redesigned and sustainable agricultural systems. Science, 362(6417), eaav0294.
- Rudel, T. K. (2020). The variable paths to sustainable intensification in agriculture. Global Environmental Change, 61, 102054.
- Smale, M., & Mason, N. M. (2014). Hybrid seed and economic well-being of smallholder maize farmers in Zambia. Journal of Development Studies, 50(5), 680–695.
- Suri, T. (2011). Selection and comparative advantage in technology adoption. Econometrica, 79(1), 159–209.
- Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., & Polasky, S. (2002). Agricultural sustainability and intensive production practices. Nature, 418(6898), 671–677.
- USDA Foreign Agricultural Service. (2024). Ghana Grain and Feed - Update - 2024. Report Number: GH2024-0015.
- Zeng, D., Alwang, J., Norton, G. W., Shiferaw, B., Jaleta, M., & Yirga, C. (2015). Ex post impacts of improved maize varieties in rural Ethiopia. Agricultural Economics, 46(4), 515–526..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