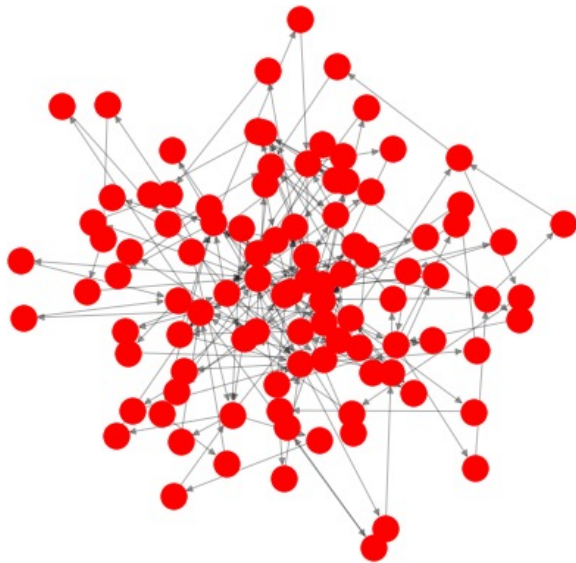


Robust Climate Adaptation Policies for Subsistence Agriculture under Deep Uncertainty



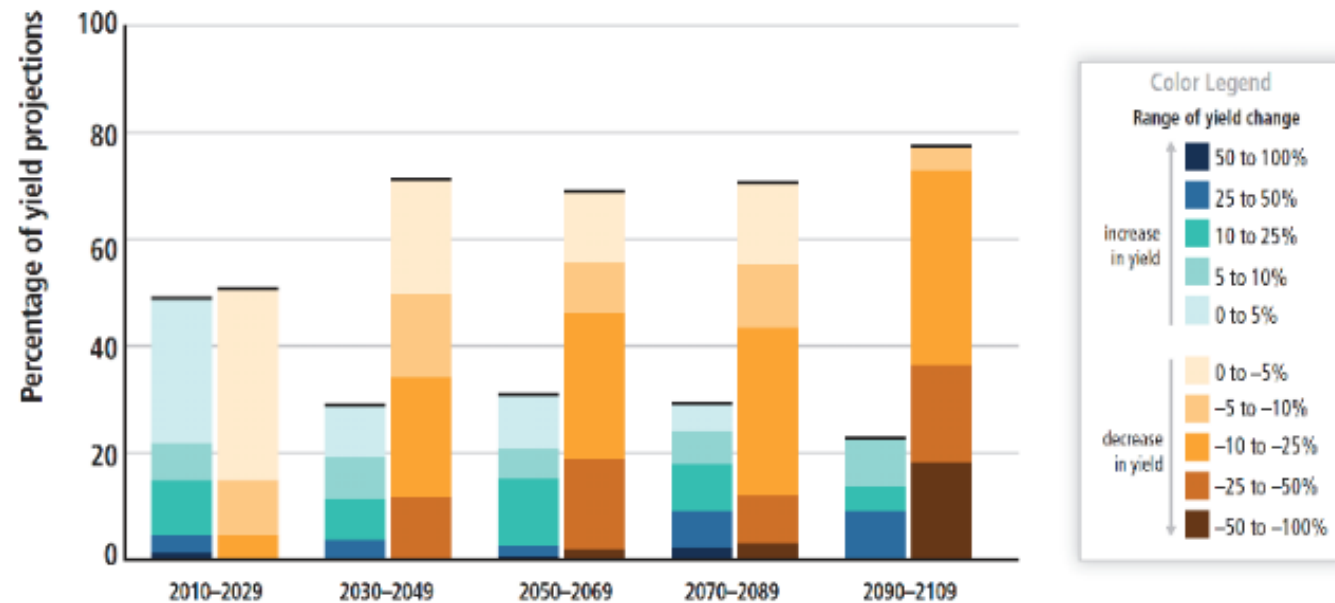
Nicolas Choquette-Levy, Frank Errickson, Anil Babu Pokhrel,
Michael Oppenheimer, Klaus Keller

Society for Decision-Making under Deep Uncertainty | 9 November 2022

Motivation: Climate impacts on rural livelihoods

- Est. 500 million households world-wide rely on smallholder farming as primary livelihood
- Climate impacts have already led to >10% loss in crop yields for some staple crops (esp. South Asia)

Simulated Future Impact of Climate on Crop Yields, 2010-2110



Source: IPCC 2014

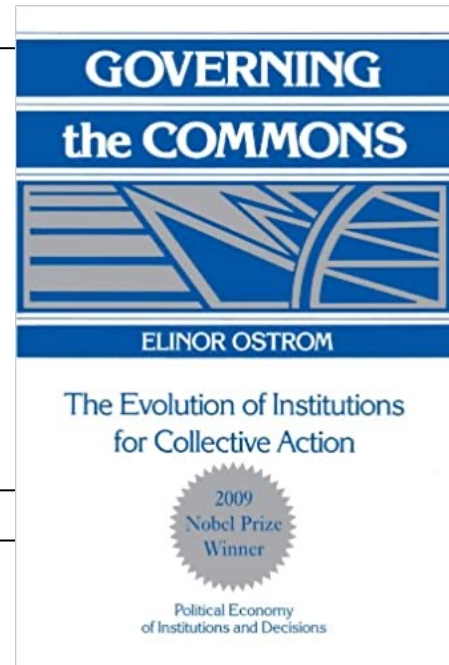
Motivation: Two Common Challenges with RDM

(1) Accounting for adaptive policymaking

- Can policy robustness be increased through dynamic adjustments?
- If so, what are the effects of time lags in signals → policy implementation?

(2) Effects of multiple levels of governance and decision making

- How do local-scale decisions affect policy objectives at larger scales, and vice versa?
- What are tradeoffs between objectives at different scales?



Motivation: Nepal Agriculture as a Mobility Case Study

- High overall vulnerability to climate risks including: floods, droughts, landslides (World Bank; ND-GAIN)
- Highly dependent on agricultural sector
 - 23% of GDP (China: 7%; Mexico: 3.8%, US: 1%)
 - 64% of employment (China: 16% , Mexico 12%, US: 2%)
- Highly dependent on migration
 - Remittances account for 24% of GDP (Mexico 4%)
- New constitution in 2015 establishes federal governance system, with distribution of competencies still in development



Source: Nepali Times

Motivation: Research Questions

- What **potential tradeoffs** exist between decision-makers at different Nepali governance scales?
- How do **sources of endogenous uncertainty** (including policy lags, policy goals) affect the ability of each stakeholder to meet its objectives?
- What **polycentric governance principles** increase policy robustness to exogenous uncertainty? Conversely, do some forms of polycentricity increase system fragility?



Methods: Agent-Based Model Outline

- **Boundaries:**
Smallholder farming community in Chitwan District, Nepal, from 2006-2050 (based on survey data)
- **Agents:**
Individual farming households
- **Agent Goal:**
Maximize income and minimize volatility across portfolio of livelihood strategies
- **Network Interactions:**
Information Sharing, Reference Points, Migrant Networks

Farmer Adaptation Strategy Portfolio



BAU: Business-as-Usual Subsistence Farming



Diverse: Cash Crops



Migrate: Rural-Urban Migration

Methods: Nepali Agriculture System Actors

National Institutions

Ministry of Forest and
Environment
*(stewards National Adaptation
Program of Action)*

Ministry of Agriculture
& Livestock
Development
*(stewards Agricultural
Development Strategy)*

Local Institutions

District Committees
*(set food security; disaster
response policies)*

Village Development
Committees
*(steward Local Adaptation
Plans of Action)*

*Not shown: NGOs, IOs,
businesses, insurance
agencies, etc.*

Farmer Organizations

Farming
Households *(make
livelihood decisions)*

Community Forest
User Groups
(make small-scale investments)

Methods: Representing “Endogenous” Deep Uncertainty

System Actor	Objectives	Key Metrics	Update Window	Key Decision Levers
National Policymaker (e.g. Agricultural Ministry)	<ul style="list-style-type: none"> ➤ Grow commercial agriculture sector ➤ Minimize poverty 	<ul style="list-style-type: none"> ➤ GDP Growth ➤ Poverty Rate 	3-5 years	<ul style="list-style-type: none"> ✓ Subsidize crop insurance ✓ Implement cash transfer <input type="checkbox"/> Invest in climate information services
Local Policymaker (e.g. Village Development Council)	<ul style="list-style-type: none"> ➤ Ensure food security ➤ Limit outmigration 	<ul style="list-style-type: none"> ➤ Cereal crop production vs. local demand ➤ Migration rate 	1-5 years	<ul style="list-style-type: none"> ✓ Subsidize cash crops ✓ Subsidize cereal crops <input type="checkbox"/> Invest in irrigation
Farming Household	<ul style="list-style-type: none"> ➤ Maximize average income ➤ Minimize income volatility 	<ul style="list-style-type: none"> ➤ Average income ➤ Income volatility 	0.5 years	<ul style="list-style-type: none"> ✓ Farm cereal crops ✓ Farm cash crops ✓ Engage in migration

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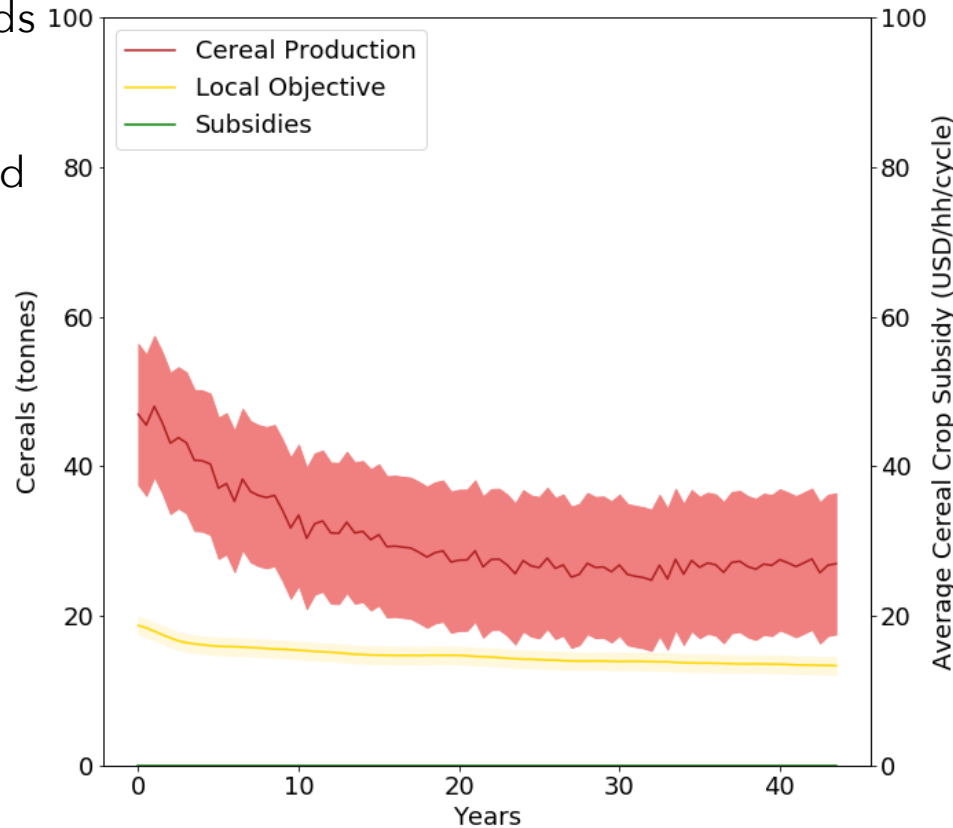
Results: "Laissez-Faire" Local Policymaker

Objective: 10%
of cereal needs met locally

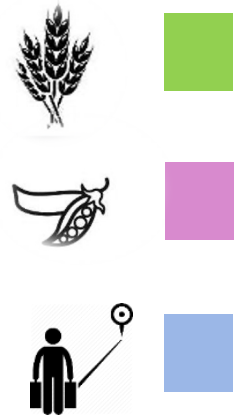
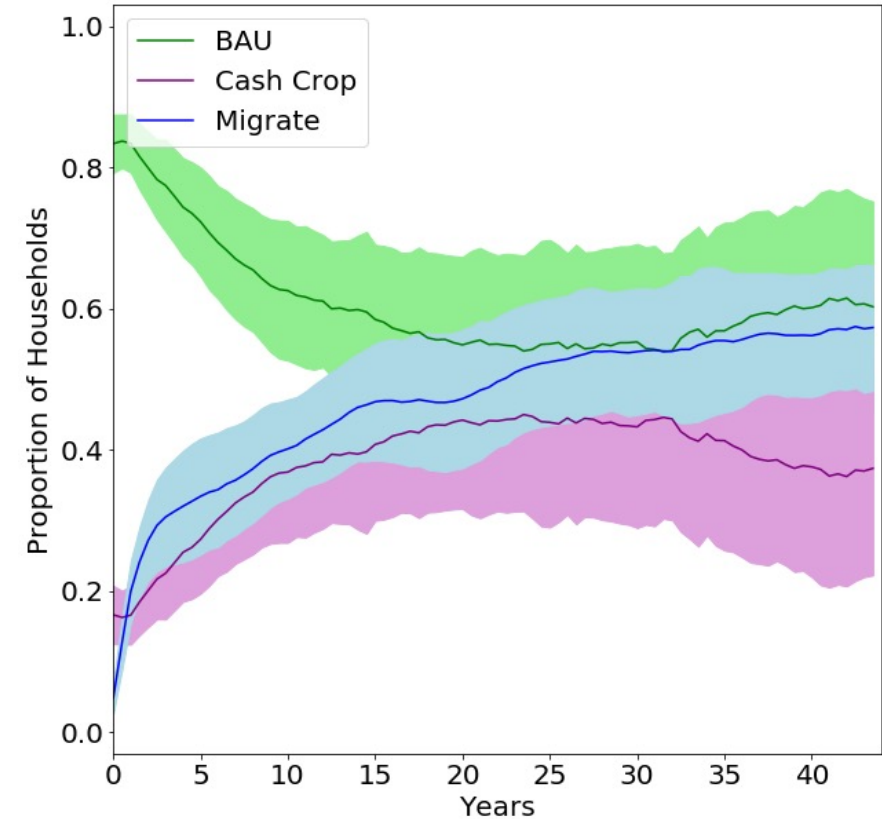
Policy updated every 5 years

Shaded Areas:
+/- 1 Std. Dev.

Food Security Metrics



Household Strategy Choices



Under "Laissez Faire" policymaker, basic food needs are met and ~40% of households switch to Cash Crops. No subsidy of cereal crops

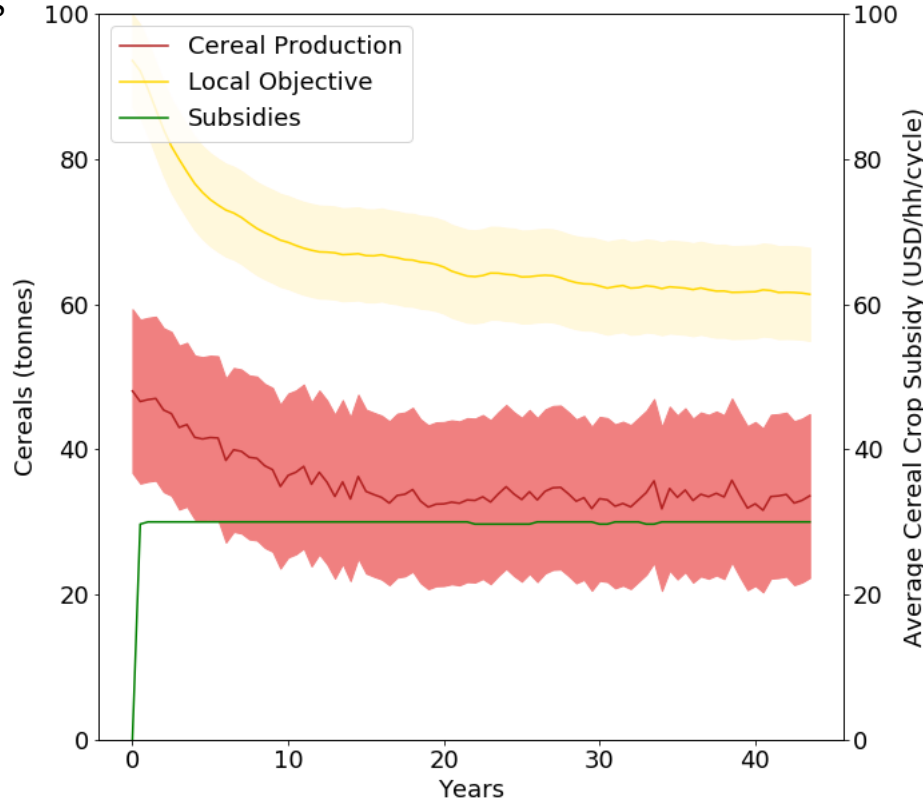
Results: "Interventionist" Local Policymaker

Objective: 50% of cereal needs met locally

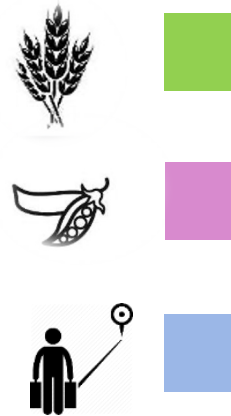
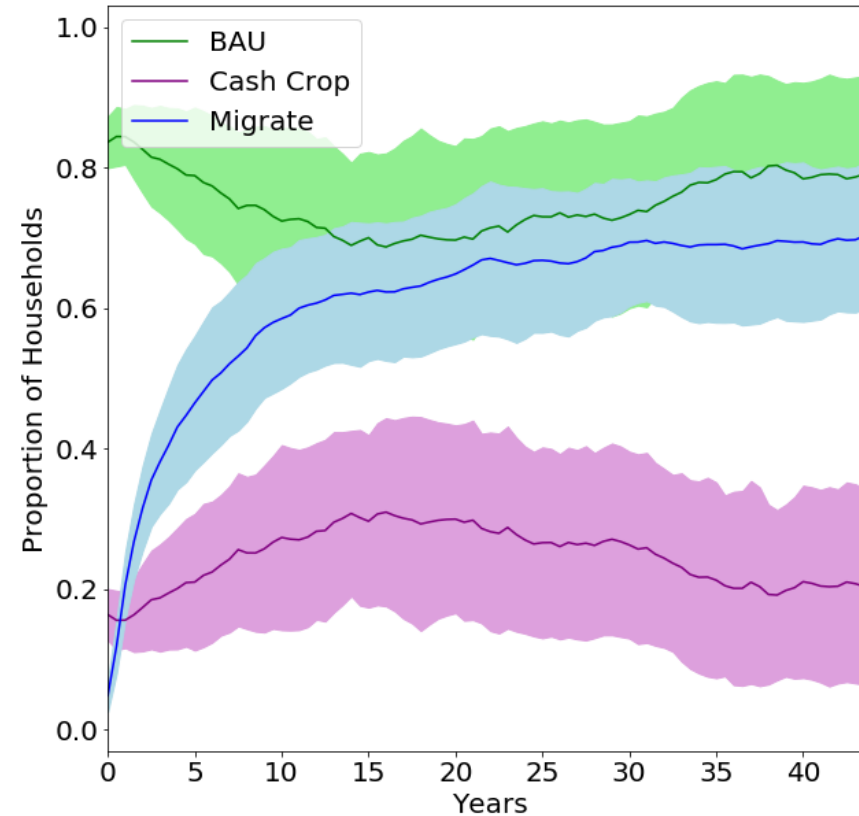
Policy updated every 1 year

Shaded Areas:
+/- 1 Std. Dev.

Food Security Metrics



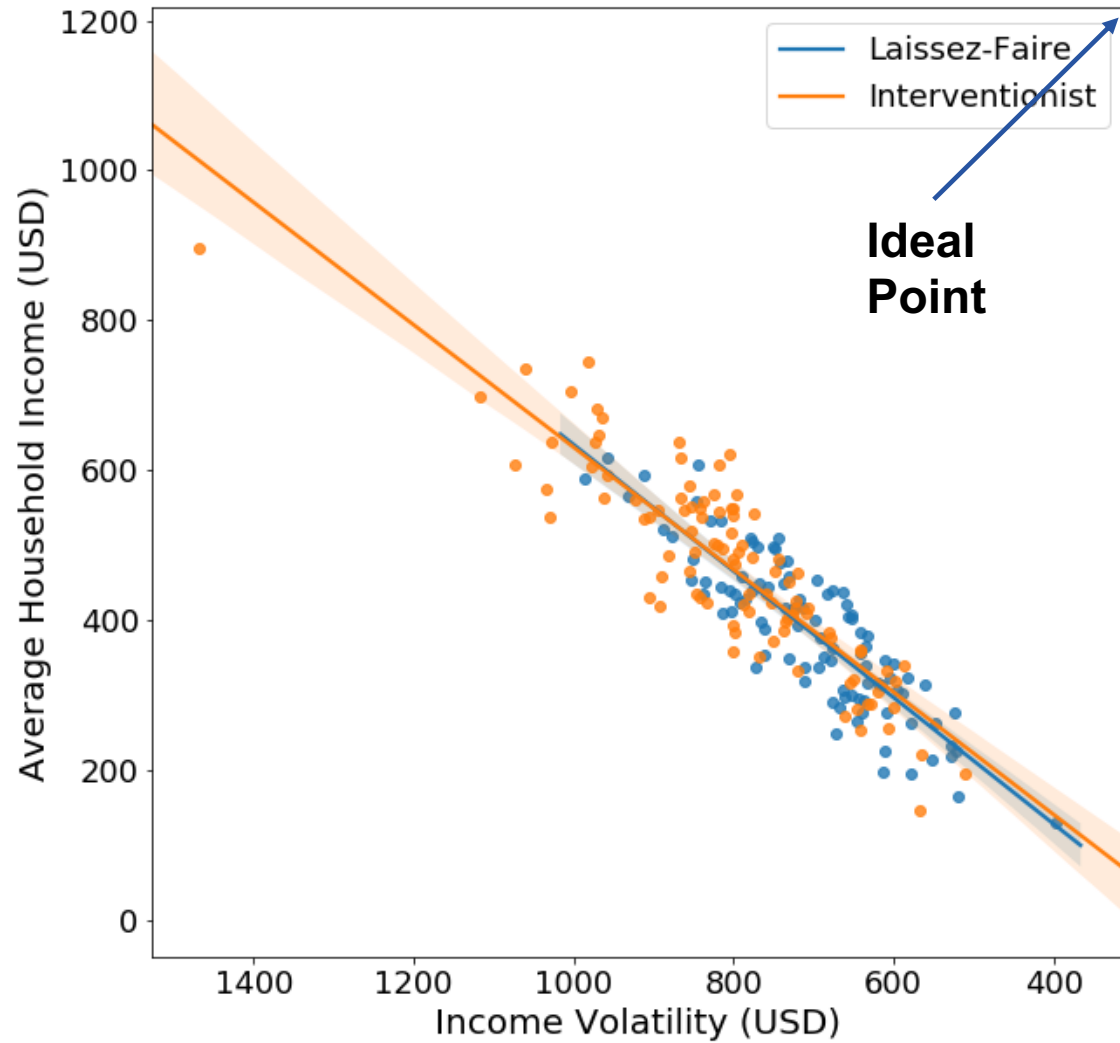
Household Strategy Choices



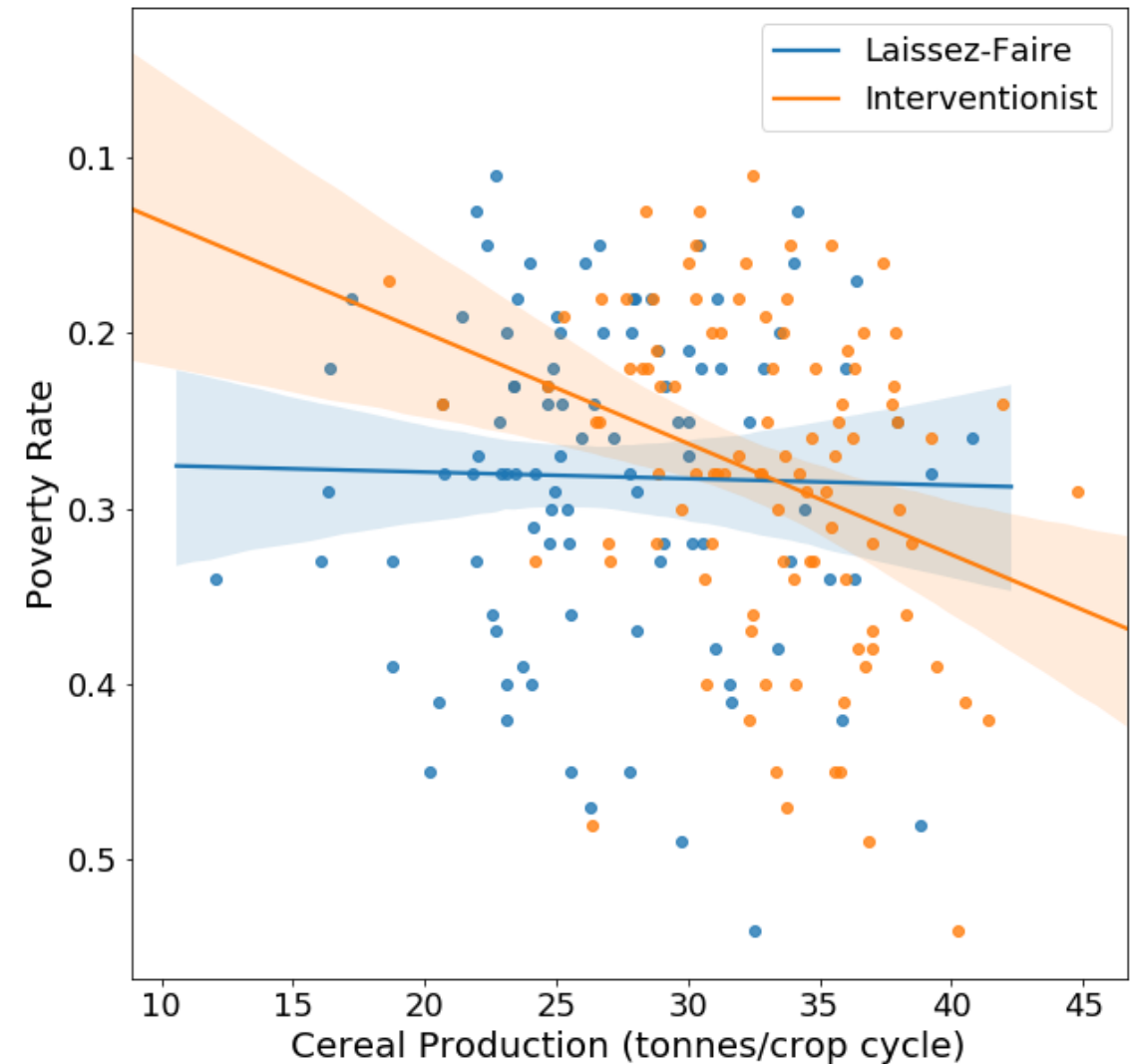
Under "Interventionist" policymaker, food security objectives are perpetually not met, leading to subsidies of cereal crops. More households engage in migration rather than diversify crops

Results: Potential Tradeoffs in Objectives

Average Income vs. Income Volatility

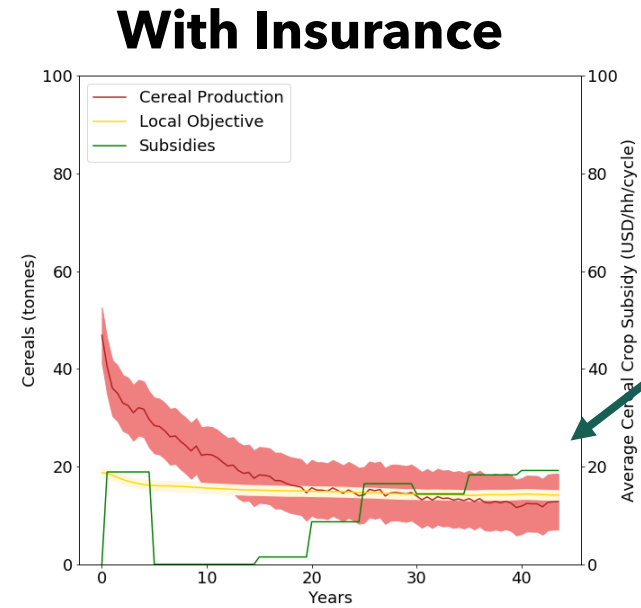
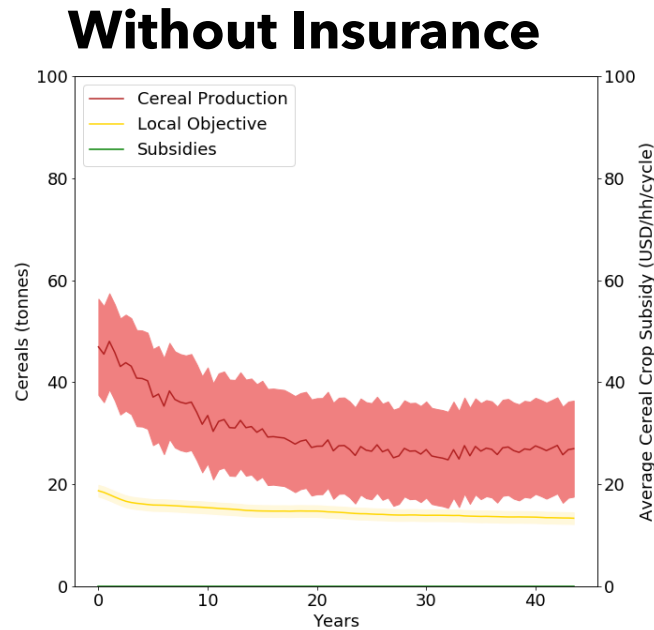


Poverty vs. Cereal Production



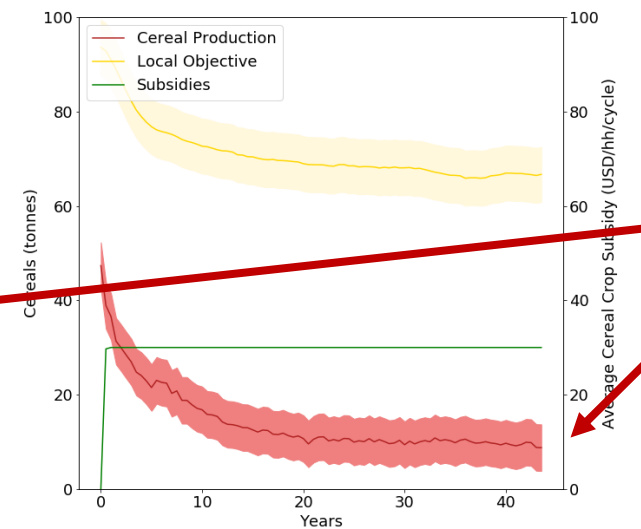
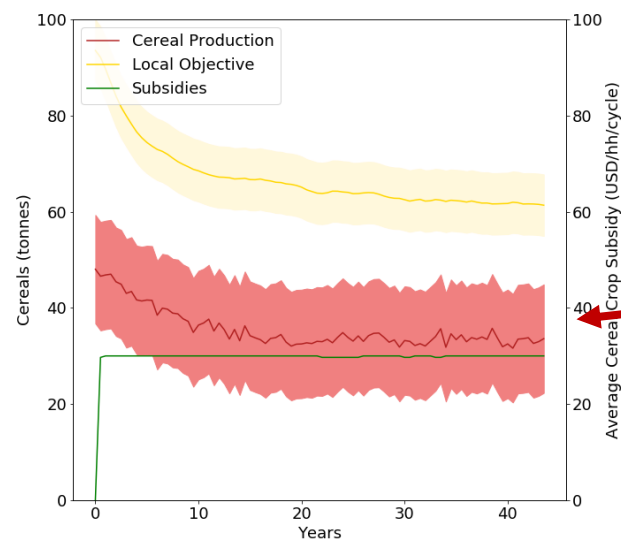
Results: Effect of National Crop Insurance Program

Laissez-Faire



Insurance induces a shift in Laissez-Faire policy strategy

Interventionist



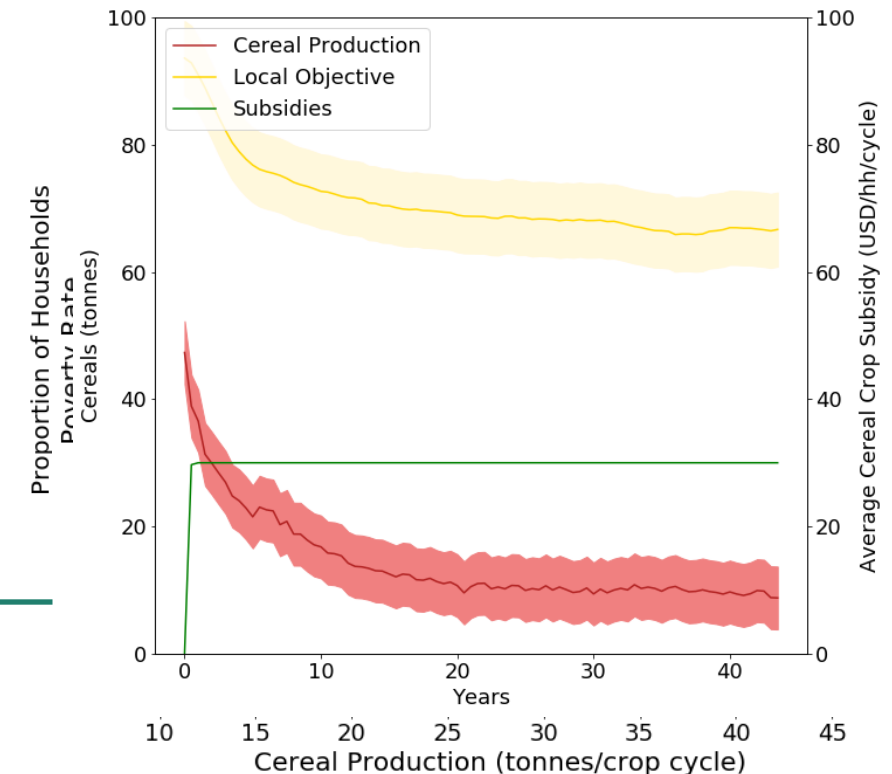
Insurance especially harms Interventionist food security goals

Discussion: Preliminary Conclusions and Next Steps

- Different endogenized policy responses may lead to qualitatively different adaptation pathways
- Potential for implicit tradeoffs in objectives across governance scales
- Top-down policies may lead to unintended consequences from local interventions, highlighting need for cross-scale coordination

Next Steps

- Expand set of policy interventions
- Endogenize national policymaker response
- Test policy robustness against exogenous uncertainty (climate, macroeconomic factors)



Thank you!

- **Edmundo, Hilda and others** for organizing this workshop!
- **Thesis Committee:** Michael Oppenheimer, Simon Levin, Elke Weber, and Doug Massey
- **World Bank Experts:** Jia Li, David Groves, Michelle Anne Winglee, Christine Heumesser
- **Funding Sources:** C-PREE, HMEI, SSHRC Canada

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