Environmental Investments on Private Land: Planting Trees in Chipata, Zambia

Paulina Oliva, (UCSB)

in collaboration with:
Kelsey Jack (Tufts)
Elizabeth Walker (Harvard)
Samuel Bell (Cornell)

with support from IGC, CDKN, Musika

Economic context: Environmental Investments

Long-Run Private Benefits

- Agricultural technologies with short-run costs and long-run private benefits
  - Examples: tree crops, agroforestry, conservation farming, “climate-smart” agriculture

Public Benefits

- Provide benefits to individuals other than adopters
  - Examples: carbon sequestration, soil erosion, watersheds

Policy context:
Private Initiatives and REDD+

Contract Farming Firms

- Farmer network infrastructure
- Long-term horizons

REDD+ and the Department of Forestry in Zambia

- Anticipate benefits for livelihoods and biodiversity
- Agroforestry ranked first among land use practices for REDD+ (Kokwe 2012)
- Department of Forestry has REDD+ funding for tree-planting program

Encouraging Adoption

Growing popularity of incentive-based approaches

- Payments for Ecosystem Services (PES) is a prominent example

*Context often characterized by **uncertainty** and limited liability*

- Often observe high participation (take-up) followed by low compliance (effort)

- Adding PES to farmer's revenue source alternatives is particularly valuable

Research Questions

- *How effective are incentive-based approaches in the presence of uncertainty and limited liability?*
  - Subsidies vs. Conditional Payments (Rewards)
- *What is the value of PES for the farmer?*
  - Long-run private benefits
  - As one more revenue source alternative

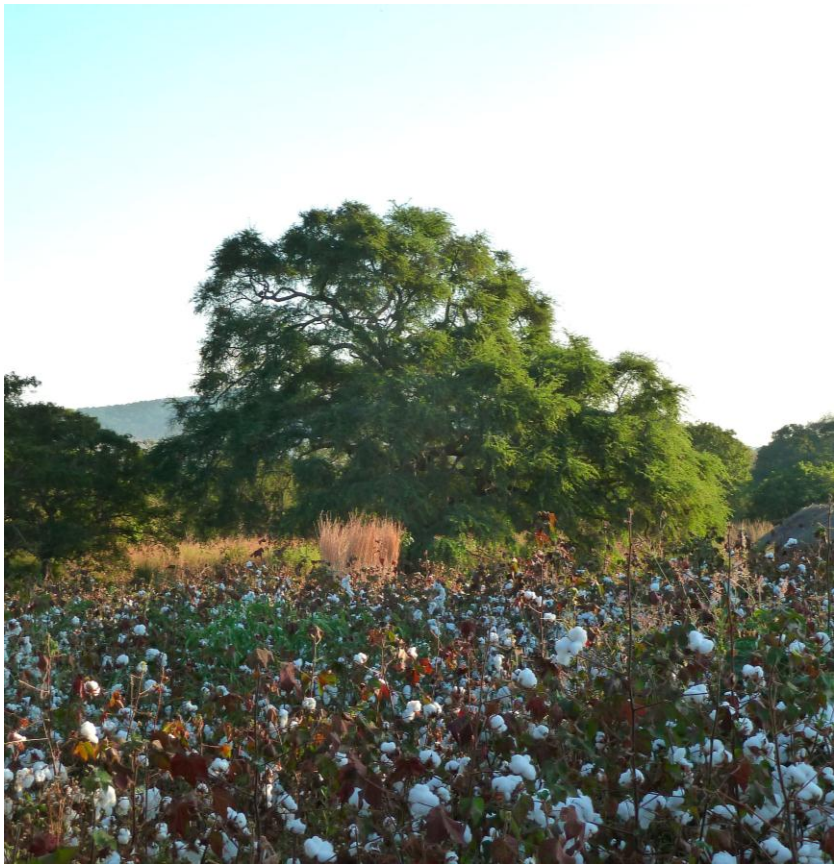
Our Study

Use of economic incentives to encourage adoption of Faidherbia albida (msangu tree) in Chipata, Zambia

Research Collaboration

- Dunavant Cotton, Ltd
- Share Value Africa, Non-Profit Org.

Musangu (*Faidherbia albida*)



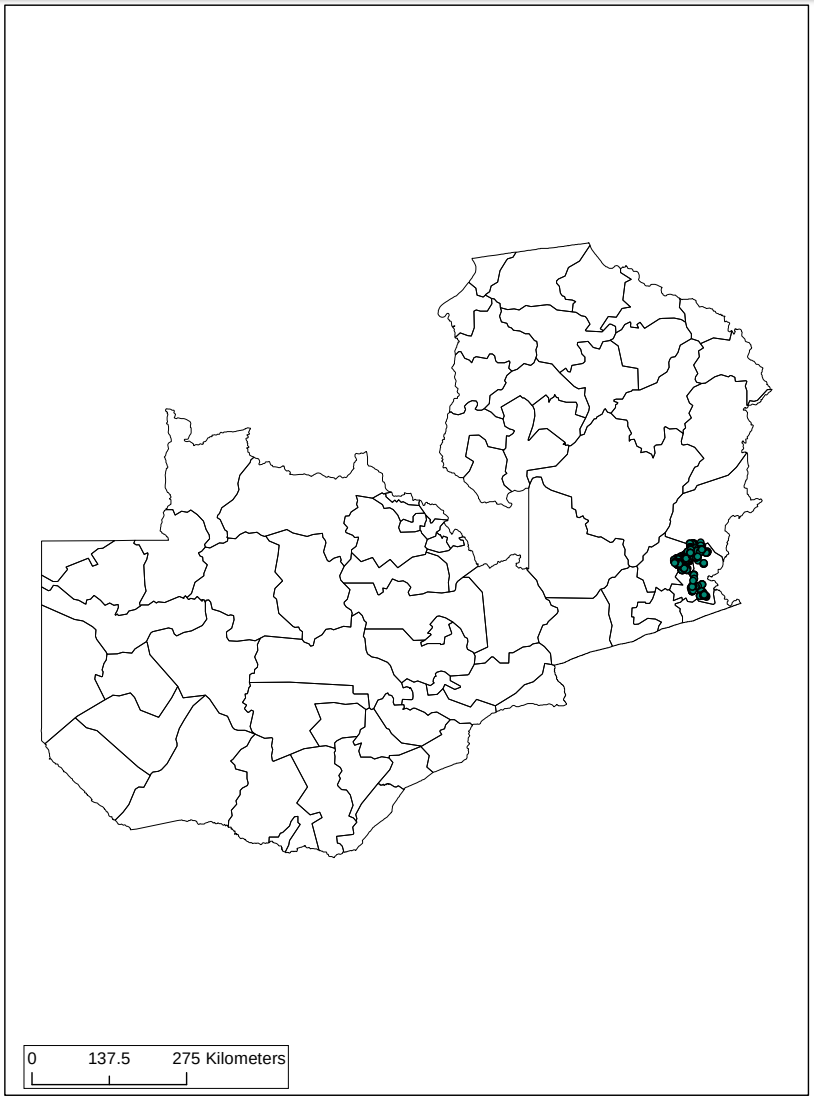
- Indigenous to Zambia
- Fixes nitrogen + sequesters carbon
- Loses leaves during rainy season
- Labor costs incurred primarily in first year
- Fertilizer benefits take 5-10 years

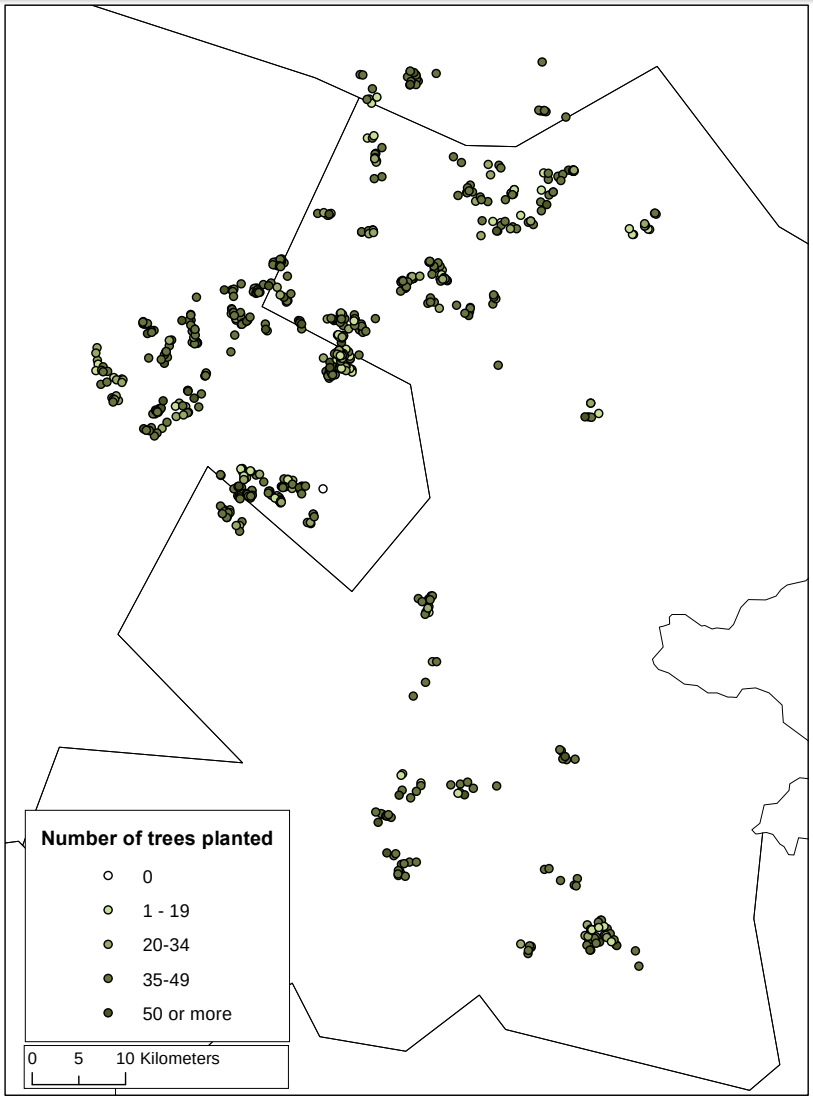
Experimental Design

- 1317 farmers, organized into 125 groups of ~10 for training
- Farmers offered contracts that provided 50 tree seedlings
  1. Group-level variation in input costs
  2. Individual-level variation in size of reward
  3. Individual-level variation in timing of reward announcement (before/after take-up)
- All contracts were conditional on 35/50 survival rate

	Variation in input cost			
	A=0	*A*=4,000	*A*=8,000	*A*=12,000
Reward before take-up	Continuous variation in reward, *R*			
Reward after take-up	*R* = 0 – 150,000			

Study setting





Data Collection

Take-up decisions: 1317

Baseline survey: 1292

… one year later …

Endline survey: 1237

Tree Monitoring: 1042

Study population

- Dunavant cotton outgrower farmers
- Mean landholding is 7 acres
- 97% of land is under cultivation
- 12% female headed households
- Report 1 month of food shortages
- No formal land title

Conceptual Framework: Take Up

Farmer's participation decision

- This decision takes place at the beginning of the year
- A farmer participates if

$$\text{Net Benefits}^* > A$$

*Account for

  - private benefits (may vary across farmers)
  - expected effort costs (may be uncertain at take up)
  - reward

Conceptual Framework: Survival

Farmer decides how many trees to care for

- This decision takes place throughout the year
- Cost of effort is no longer uncertain (i.e. shocks have occurred)

$N = 0$	If effort cost turns out to be very high (compared to private benefits and reward)
$0 < N < 35$	If reward is not enough to compensate for the cost of caring for 35 trees, but some trees are still desirable due to private net benefits
$N = 35$	If reward is enough to encourage more trees than private benefits would justify
$N > 35$	If private benefits are very high compared to costs (reward is irrelevant)

Conceptual Framework: Takeaways

1. If what explains heterogeneity in survival across farmers is differences in private costs then

- Large selection effects:
  - farmers that are more likely to participate at high input cost are also more likely to have better survival rates

- Reliable outcomes:
  - farmers that participate are likely to plant a positive number of trees.

Conceptual Framework: Takeaways

2. If what explains heterogeneity in survival across farmers is unexpected shocks to effort cost

- No selection effects:
  - Either high or low participation rates in each treatment
  - No big differences in performance across differences in input costs
  - No big differences in performance across timing of *R* treatments

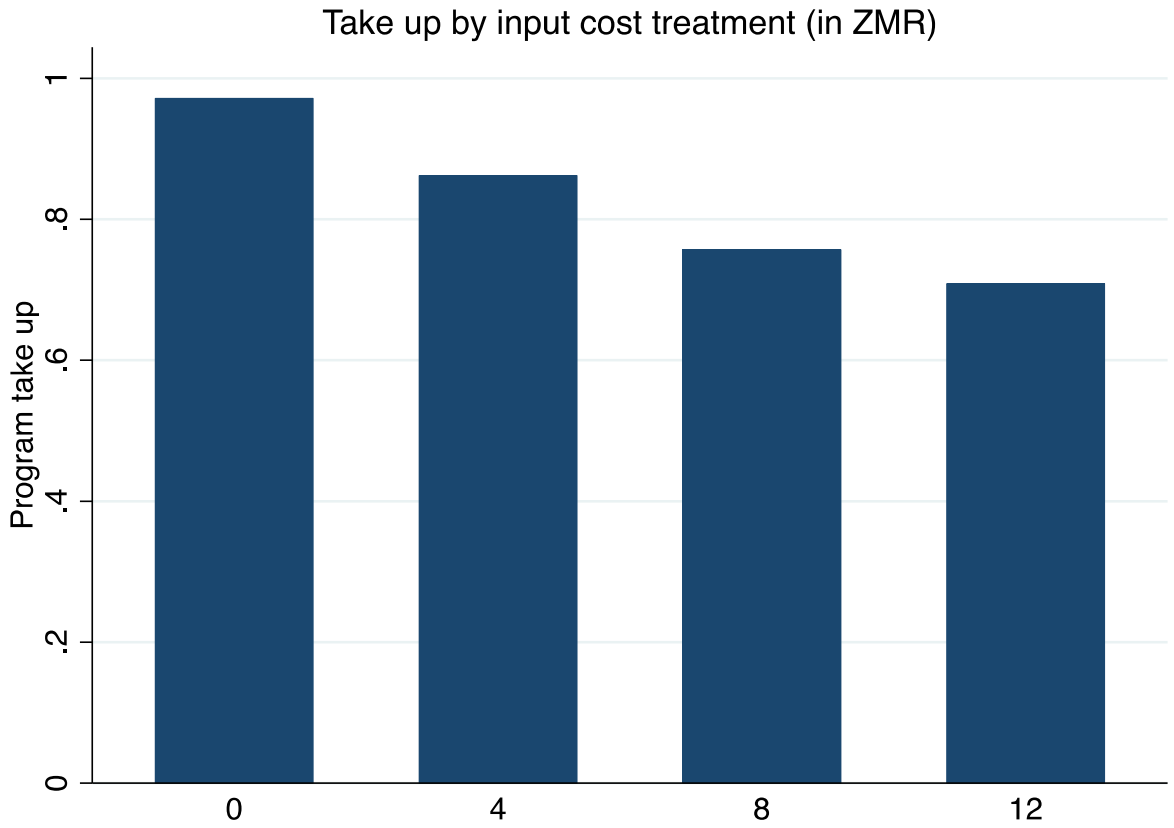
- Unreliable outcomes:
  - Many participating farmers plant 0 trees
  - Farmers performance is similarly highly responsive to *R* in both groups (known and unknown *R* before take up)

Conceptual Framework: Implications

- If heterogeneity in private benefits matters,
  - high input costs may help screen for highly productive farmers
- If unexpected shocks to effort costs matter,
  - subsidies to input costs may encourage participation w/o compromising performance
  - PES could be very valuable for farmer: it may help reduce uncertainty by adding to his revenue source options
  - performance of PES may be improved through contingent contracts

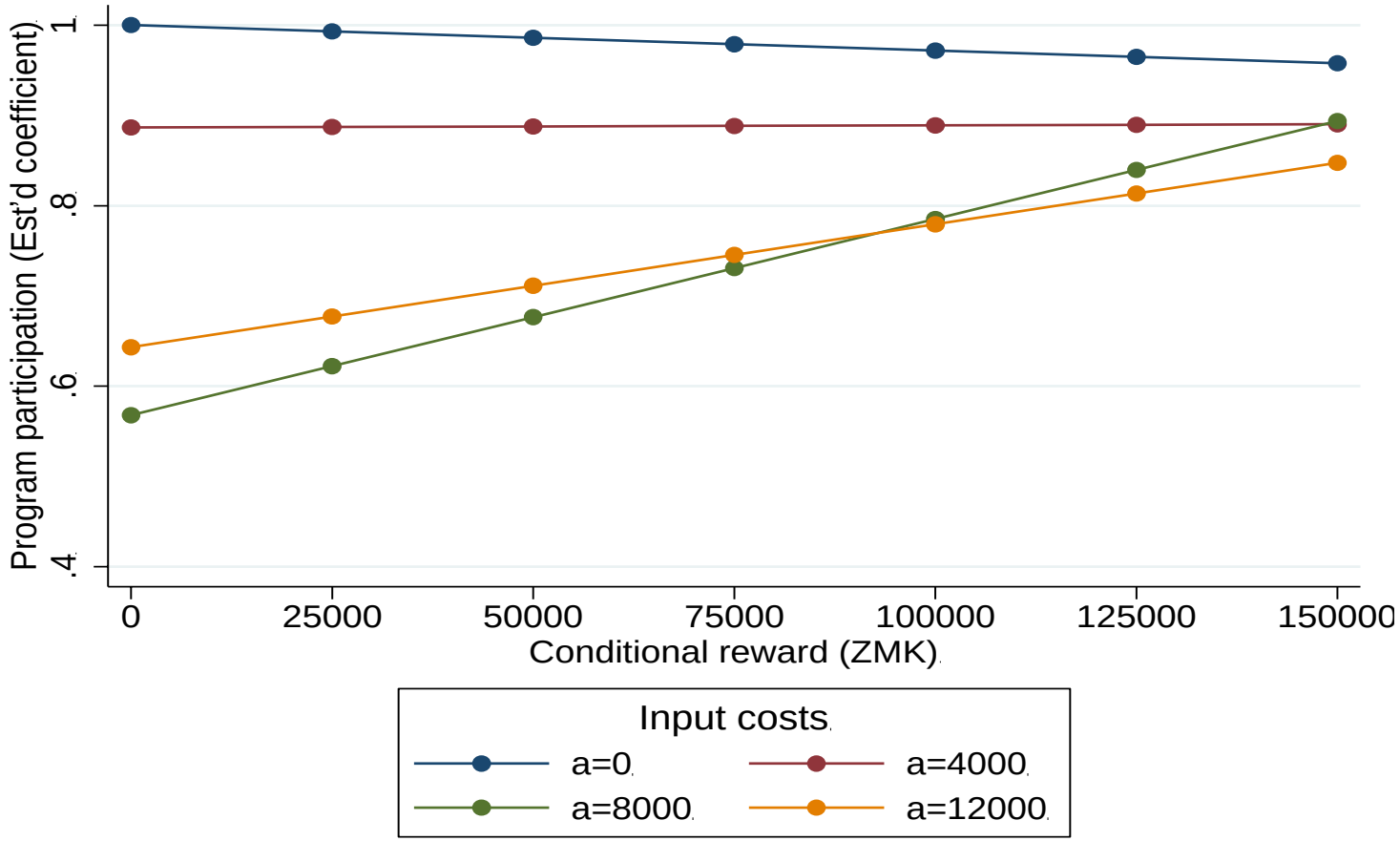
Outcome I: Take up

How do input cost subsidies affect take up?



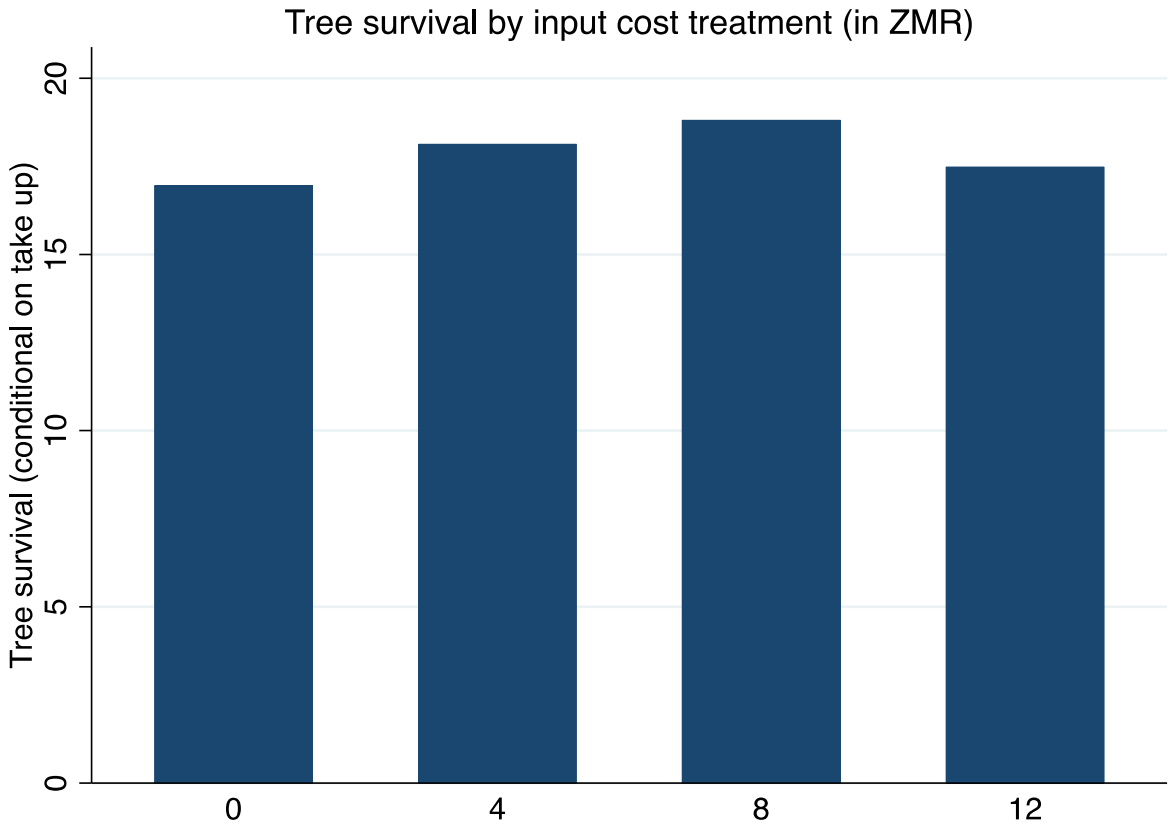
Outcome I: Take up

How does reward affect take up?



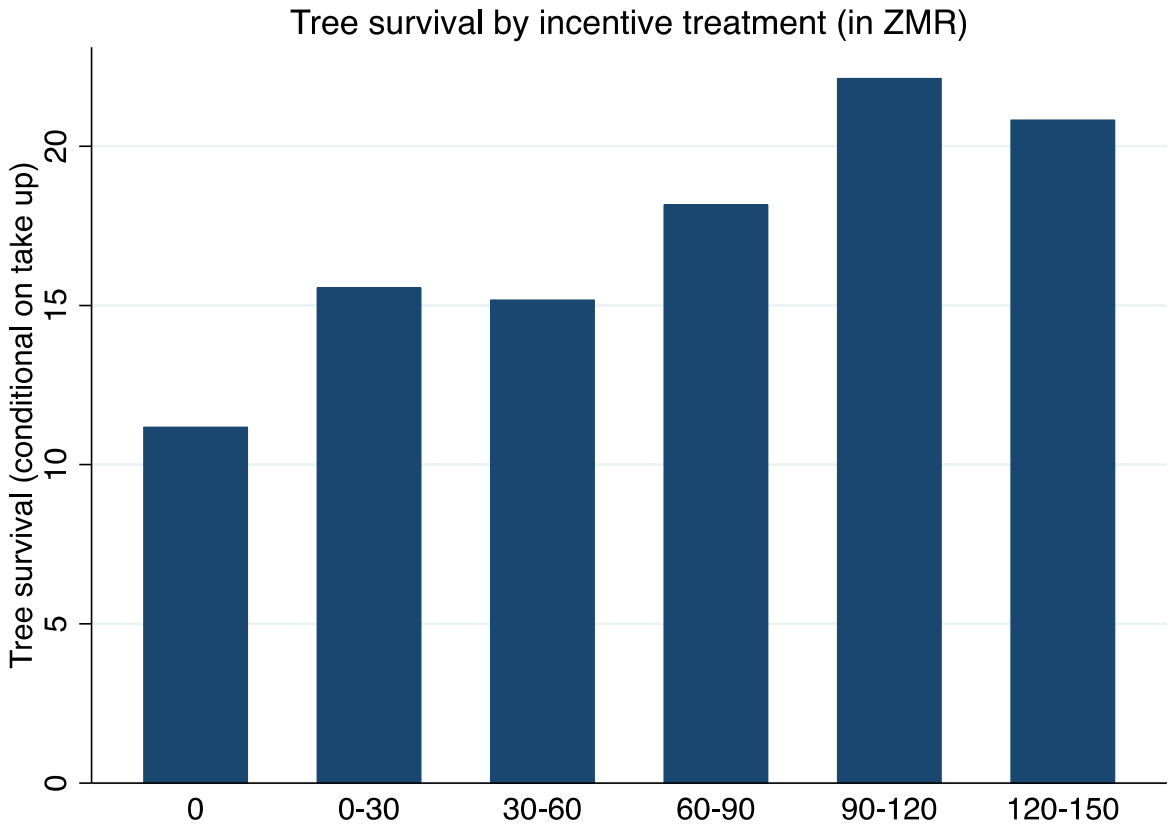
Outcome II: Tree survival – program participants

How do input subsidies affect tree survival?



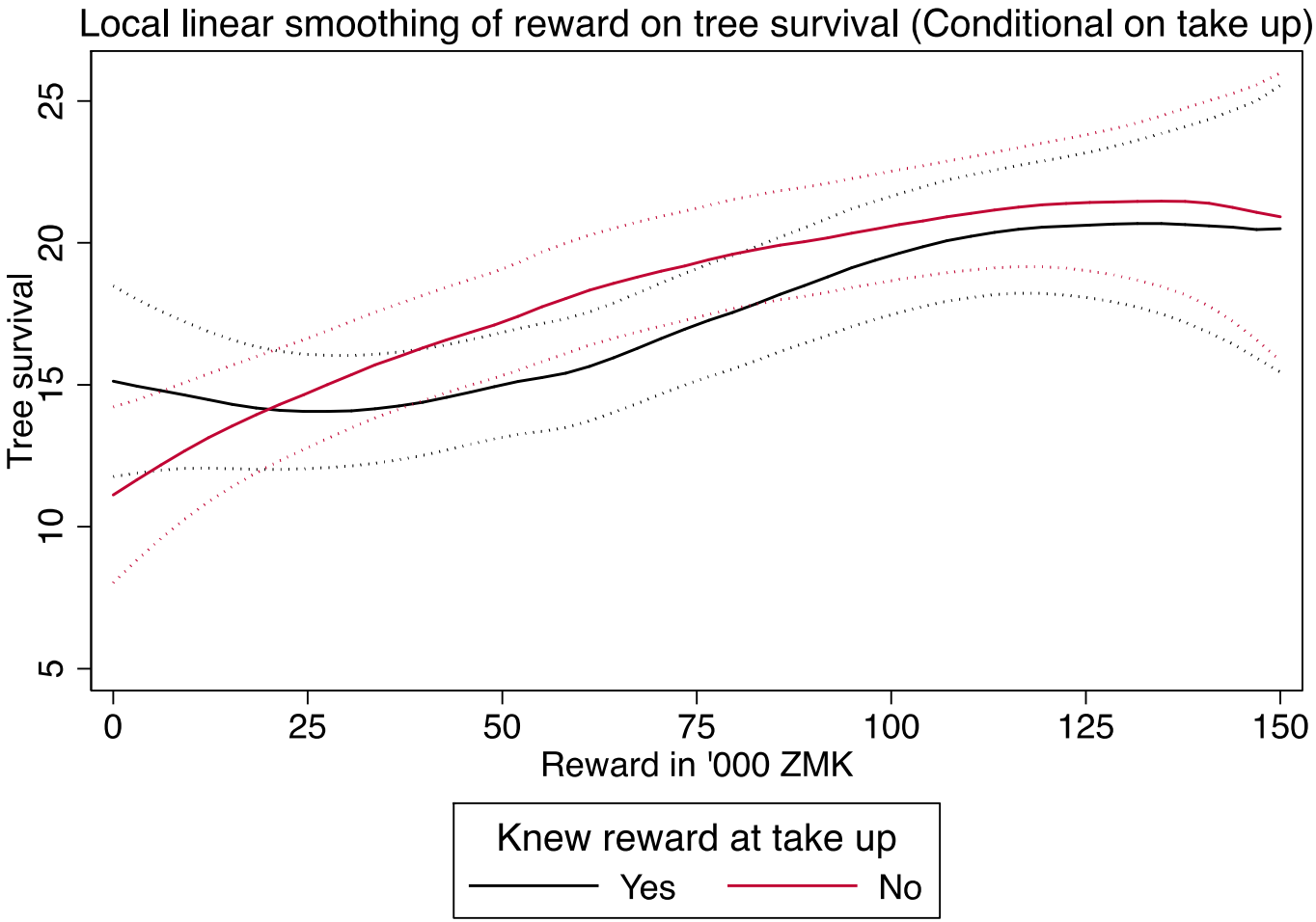
Outcome II: Tree survival – program participants

How do performance incentives affect tree survival?



Outcome II: Tree survival – program participants

Does performance differ by timing of reward?



Summary of Preliminary Results

- Economic incentives are effective at encouraging adoption
- Not much evidence for selection
- Heterogeneity in performance is likely driven by unexpected shocks to effort costs

	Share reporting
Health shocks are household's biggest challenge	0.51
Lost livestock due to illness or health	0.44
Lowest anticipated crop price above observed	0.97

- Subsidies to inputs may encourage participation w/o affecting performance
- Potentially large value of PES from adding to farmer's revenue sources, at the expense of program performance
- Contingent contracts could improve performance

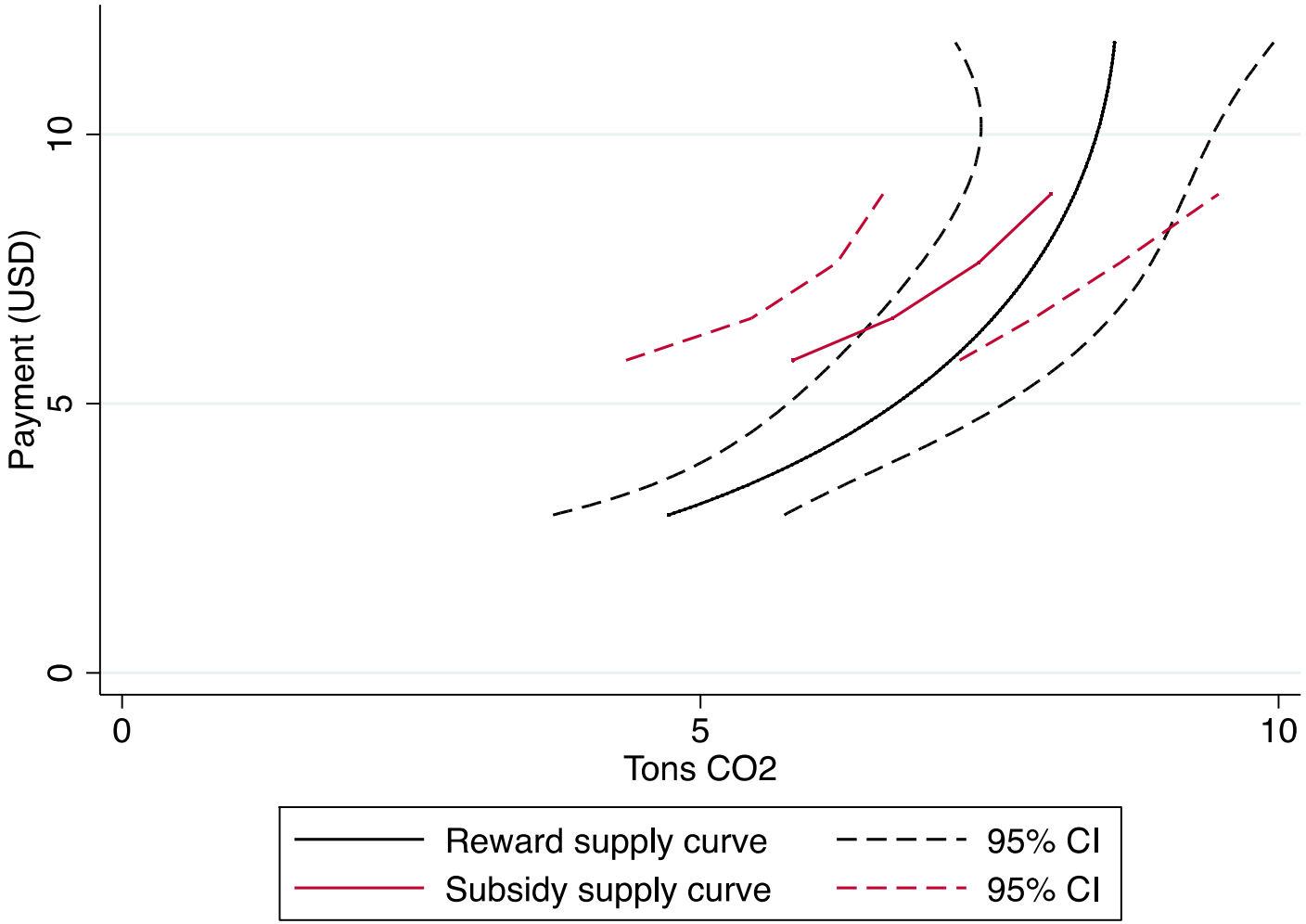
Policy Impact

- Dunavant is planning on scaling up the program to 100K farmers
- Department of forestry has started a campaign to plant 12 million trees and is using our research to inform the design

Ongoing and Future Work

- Long-run outcomes: Pending funding, monitor survival of trees beyond one year
- Estimate economic model behind conceptual framework
  - Measures of private benefits
  - Measures of effort costs
  - Measures of uncertainty
  - What is the value of adding one more alternative to revenue sources? (Option Value)
- Simulate performance of alternative contracts

Carbon Sequestration



Outcome II: Tree survival – program participants

Does the response to the reward differ by input cost?