Jobs! The Labour Market Implications of Climate Change Adaptation in Agriculture

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ANAPRI - WORLD BANK Conference
03 November 2025, Kigali, Rwanda

Motivation

- Climate change has been shown to:
  - Reduce yields of most crops (Ortiz-Bobea et al., 2021; Wollburg et al., 2024).
  - Land, labor and inputs (Jessoe et al., 2018; Aragon et al., 2021; Dasgupta et al., 2021).
  - Structural transformation (Colmer, 2021; Liu et al., 2023; Feriga et al., 2025)
- Strong push on climate change adaptation – climate-smart agriculture (Lobell et al., 2008; Lipper et al., 2014).

Climate-smart agriculture (CSA)

- An integrated approach for transforming agri-food systems to be more environmentally friendly and resilient to climate change while ensuring food security.
- Offer trifecta wins:
    - Increase productivity with implications on welfare and food security (Lipper et al., 2014; Tabe-Ojong et al., 2023).
    - Reduce emission of greenhouse gases (Ariani et al., 2018)
    - Build farm system resilience (Michler et al., 2019; Liebenehm et al., 2023).

CSA and labour

- Possible job creation effects through labor implications including labor productivity – structural transformation
- Little work considers these possible job creation and labor effects (Fontes et al., 2020; Montt and Luu, 2020)
- Labor productivity is poorly understood despite its importance for agricultural transformation (Gallardo and Sauer, 2018; Hoerner and Wollni, 2022).
- A focus on jobs is warranted since they provide security, stability and dignity

What do we do?

- Investigate the labor and labor productivity implications of CSA
- CSA - climate-resilient seeds – improved seeds (IS), intercropping (IC) and organic fertilizers (OF)
- Examine intrahousehold labor allocation along age and gender lines
- Explore different combinations of CSA (IS + IC, IS + OF, IC + OF and IS + IC +OF).
- Implications of CSA on hired labor

Preview of findings

- Positive association between CSA and labor use (20 – 40 mandays)
- Positive association between CSA and labor productivity (18 – 45%)
- Labor implications accrue to all members of the household – evidence of child labor
- Positive association between CSA and hired labor (6 – 33 pp)
- Biggest labor implications under bundling

Data

- Panel Data
  - ❑Three wave panel data (2017 – 2019) from Ghana, Mali and Nigeria
  - ❑Multistage sampling leading 8604 observations
  - ❑Less than 6% attrition – Attrition probit regressions

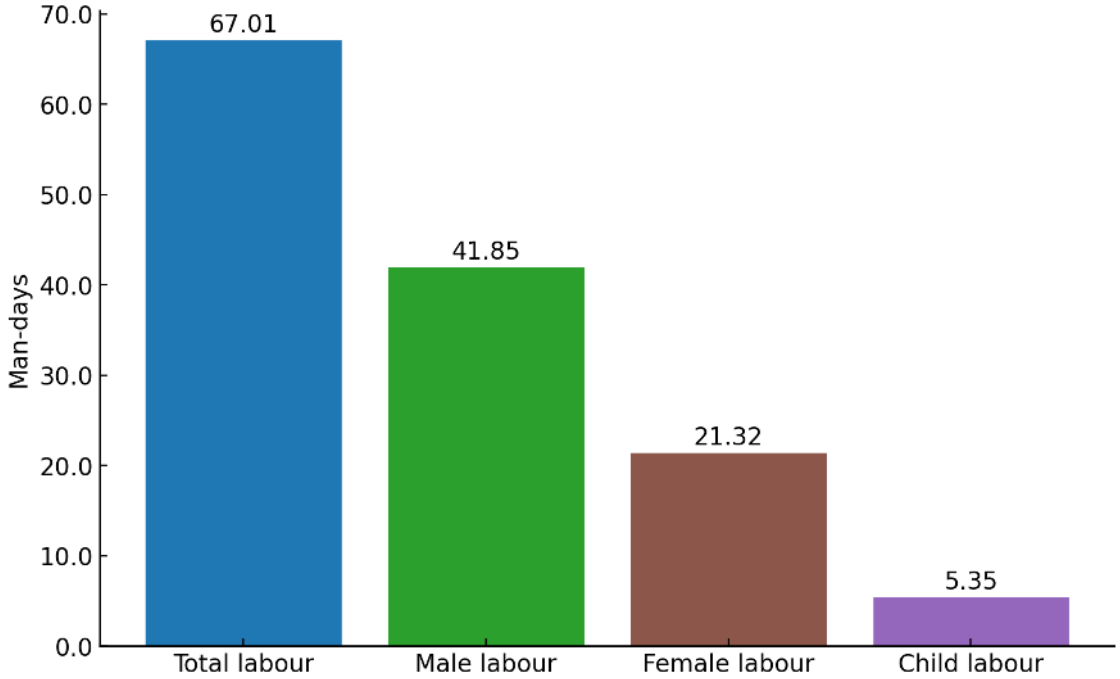
- Weather Data
  - ❑Temperature data: CPC Global Unified Temperature dataset provided by NOAA PSL
  - ❑Rainfall: CHIRPS

Measurement of outcomes

- Household labor - total number of man-days for men, women and children (<15)
- Adult male completing 7-8 hours of farm work = 1man-day (Luning, 1964).
- For women and children, this is equivalent to 0.8 and 0.5 man-days
- Labor includes agricultural activities in the farm such as clearing, ploughing, sowing, weeding, harvesting and the application of fertilizers.
- Hired labor – Dummy
- Labor productivity – output/labor (Cock et al., 2022).

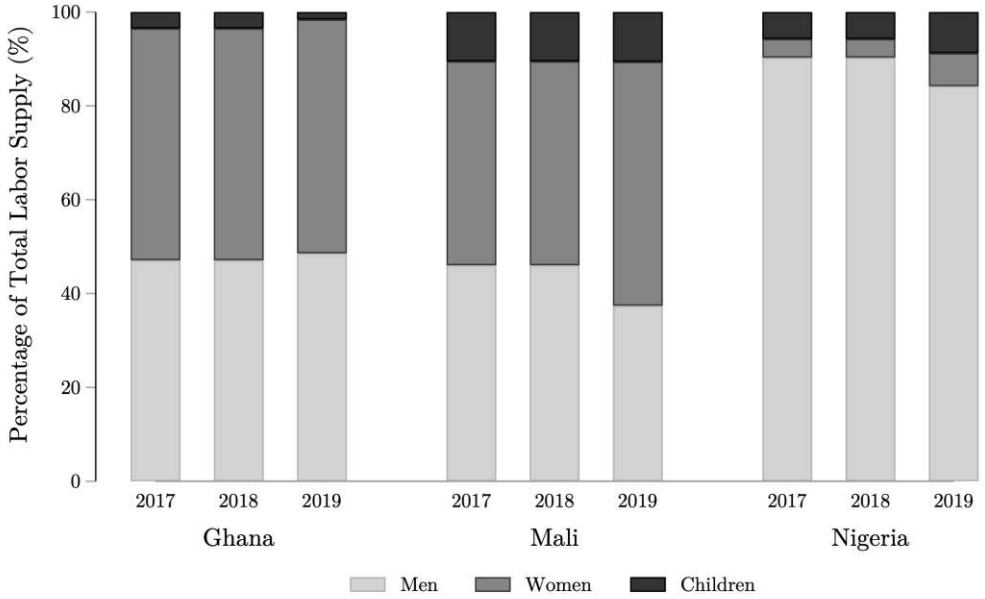
Descriptives (1/3)

Intra-household labor allocation by gender



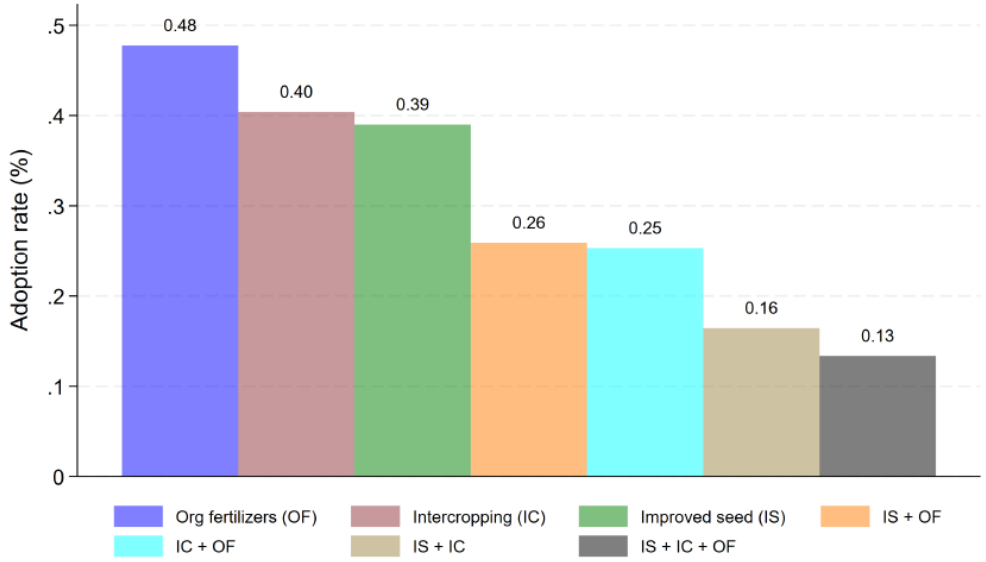
Descriptives (2/3)

Family labor supply over time in Ghana, Mali and Nigeria



Descriptives (3/3)

Average adoption rates of CSA practices



Empirical Strategy (1/3)

- We estimate regressions of the form:

- $L_{it} = \alpha + \boldsymbol{\delta CSA}_{it} + \boldsymbol{\beta X_{it}} + d_t + c_i + \mu_{it}$

- L_{it} represents labor use and labor productivity
- $\boldsymbol{CSA}_{it}$ represents CSA practices
- δ shows the relationship between CSA and labor use and productivity
- $\boldsymbol{X_{it}}$ is a vector of household level control variables
- d_t is time-fixed effects
- u_{it} is the stochastic error term
- c_i represents time-invariant unobserved heterogeneity

Empirical Strategy (2/3)

- Reverse causality – control function approach (two stage residual inclusion)
- Measurement error – IV estimators
- Time invariant unobserved heterogeneity
- Fixed effects (FE) estimator is the work horse for linear models
- Standard two-way FEs
- RE estimator is quite restrictive

Empirical Strategy (3/3)

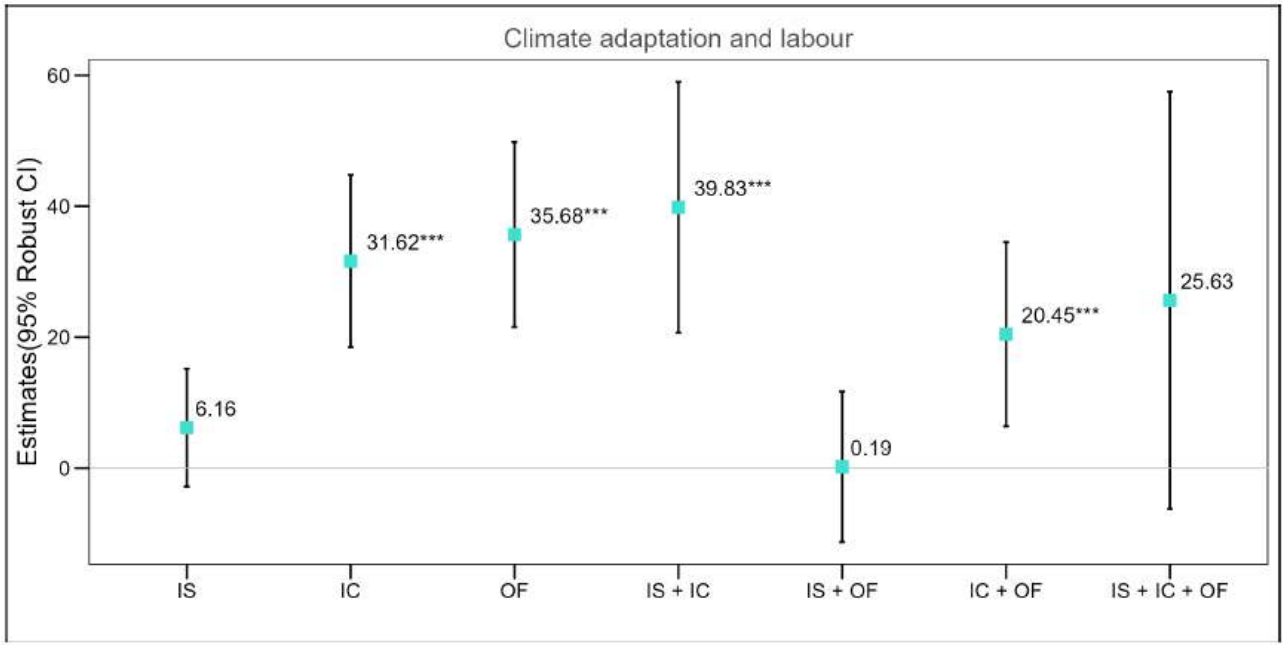
Control function approach – four IVs

- Willingness to adopt the climate-resilient seeds
- Extension access
- Distance to the village market
- Extreme heat degree days

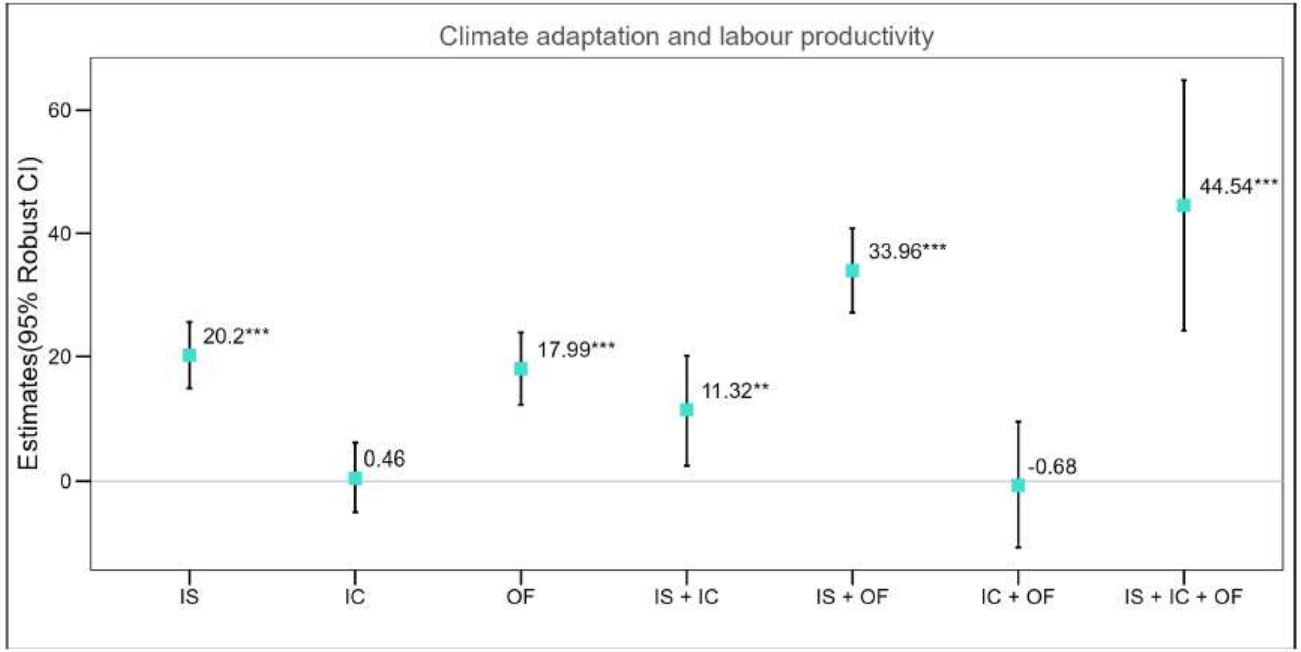
Alternative identification strategies

- Hausman Taylor IV estimator (Hausman and Taylor, 1981).
- Lewbel IV strategy (Lewbel, 2012; Aglasan et al., 2024; Won et al., 2024).
- Kinky least squares regression (Kripfganz and Kiviet, 2021).

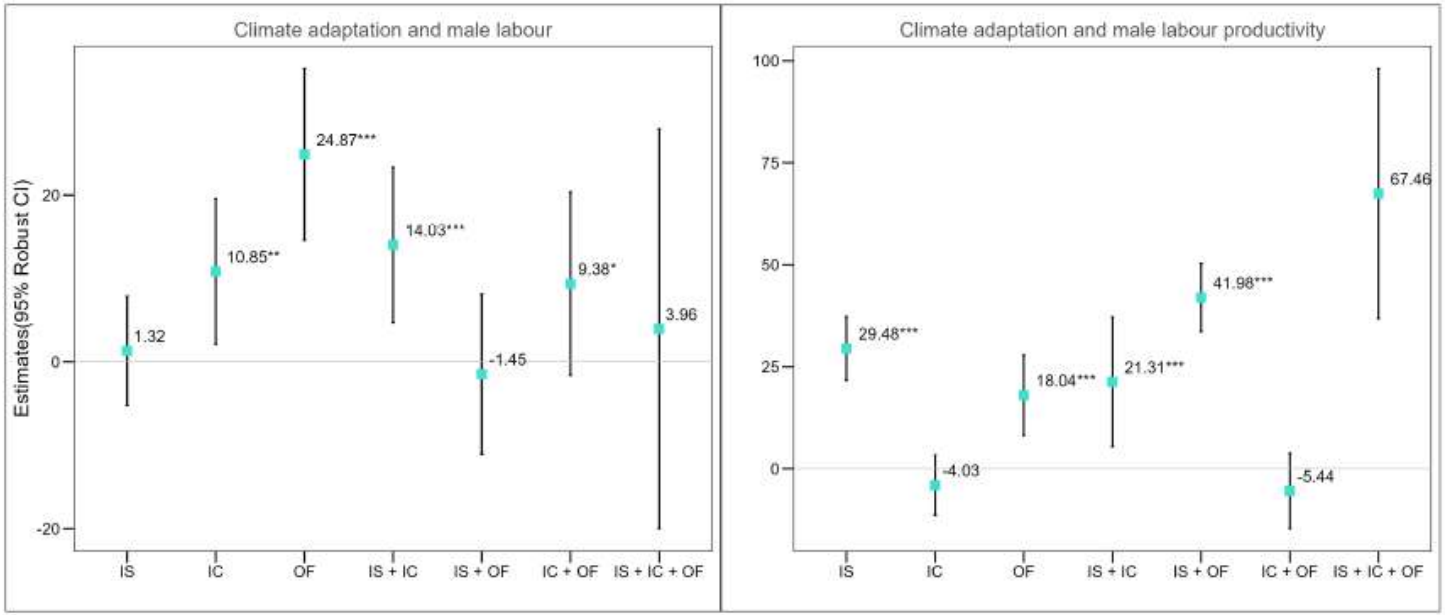
Result (1/9): CSA is associated with labor increases with some heterogeneity



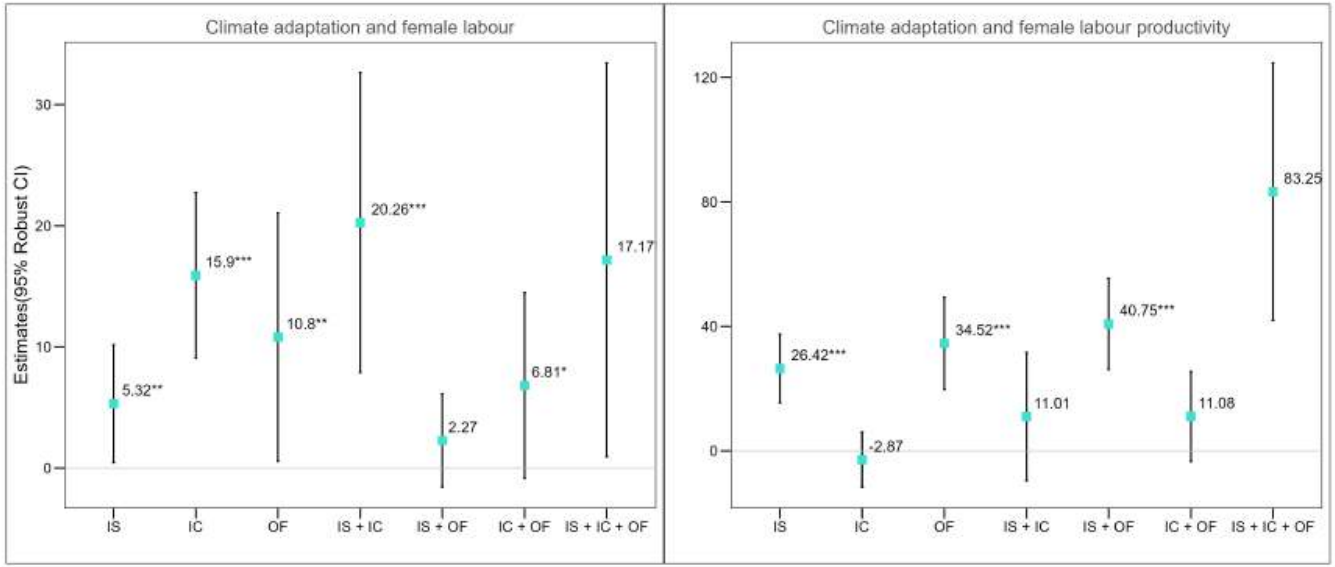
Result (2/9): CSA is positively associated with labor productivity with strong implications of bundling



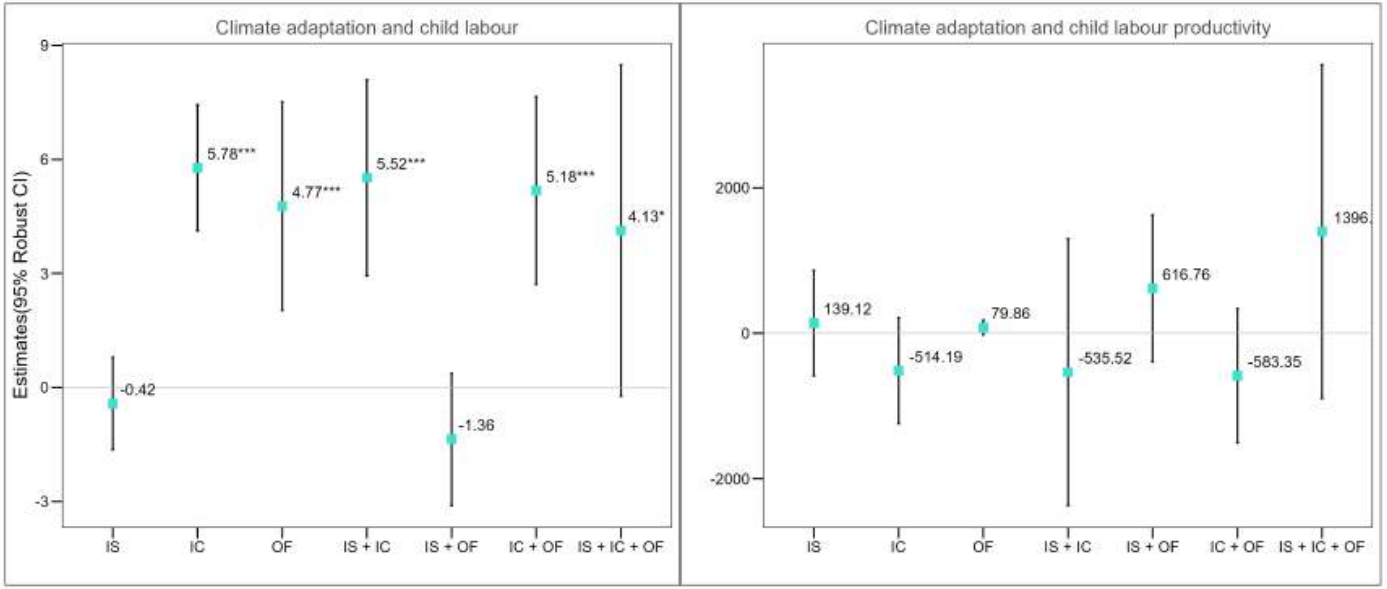
Result (3/9): CSA is positively associated with male labor and labor productivity



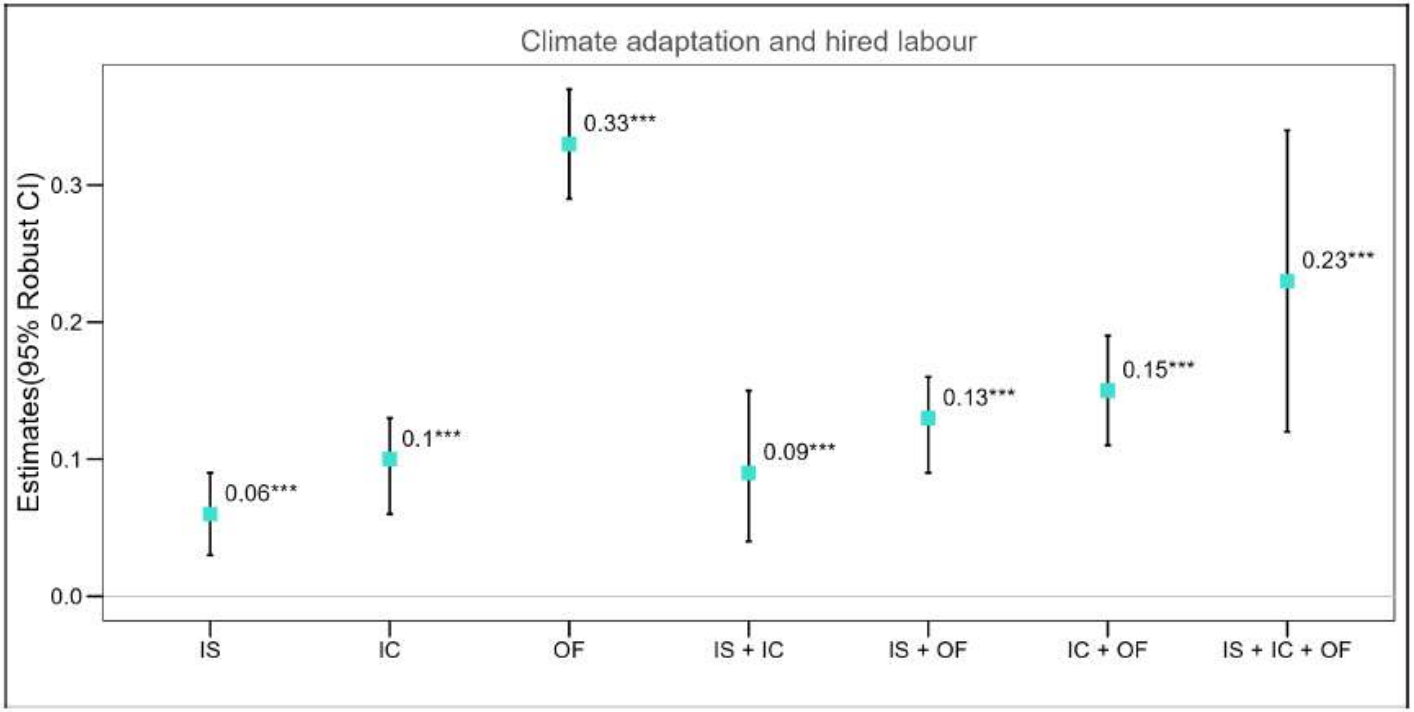
Result (4/9): CSA is positively associated with female labor and labor productivity



Result (5/9): CSA is positively associated with child labor and labor productivity



Result (6/9): Overall, CSA is positively associated with hired labor



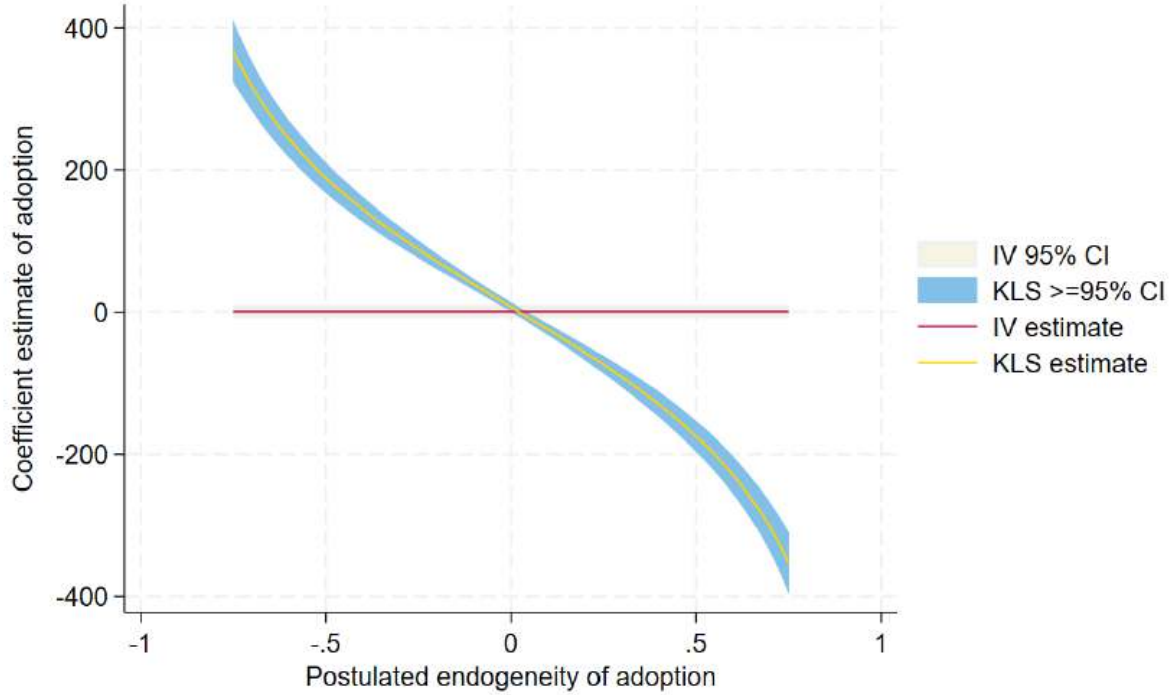
Result (7/9): Hausmann Taylor IV Estimates

CSA Practice	Total labour	Male	Female	Child
Improved seeds (IS)	18.682***	11.623***	6.786**	0.214
	(5.963)	(4.394)	(3.011)	(0.889)
Intercropping (IC)	24.688***	11.587***	8.840***	4.807***
	(3.769)	(2.784)	(1.809)	(0.532)
Organic fertilizers (OF)	28.799***	25.281***	-2.542	3.031***
	(4.992)	(3.682)	(2.703)	(0.796)
IS + IC	26.160***	17.590***	4.682**	4.420***
	(5.328)	(3.928)	(2.557)	(0.753)
IS + OF	8.624	10.447**	-4.582	0.116
	(6.151)	(4.531)	(3.074)	(0.907)
IC + OF	12.244***	11.611***	-3.184	3.570***
	(4.609)	(3.394)	(2.264)	(0.665)
IS + IC + OF	12.720**	14.549***	-4.895**	2.907***
	(5.975)	(4.401)	(2.879)	(0.849)
Observations	8,604	8,604	8,604	8,604
Number of households	2,868	2,868	2,868	2,868
Additional controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Result (8/9): Estimates from the Lewbel regression

	Labour	Labour	Labour	Labour	Labour	Labour	Labour
Improved seeds (IS)	15.519***						
	(5.645)						
Intercropping (IC)		23.203***					
		(5.188)					
Org fertilizers (OF)			35.057***				
			(6.327)				
IS + IC				23.346***			
				(6.508)			
IS + OF					6.702		
					(7.734)		
IC + OF						11.814**	
						(5.556)	
IS + IC + OF							9.159
							(7.315)
Observations	8,604	8,604	8,604	8,604	8,604	8,604	8,604
Households	2,868	2,868	2,868	2,868	2,868	2,868	2,868
Additional controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hansen J statistic	0.925						
C statistic	(0.336)						

Result (9/9): Estimates from the Kinky Keast Squares regression



Conclusion

- Climate change adaptation is labor intensive but positively associated with labor productivity
- Heterogeneity by age and gender – larger implications for women and children – child labor
- CSA can deepen gender-age inequities within households
- CSA stirs hired labor – rural employment
- Climate adaptation as a contextual buffer!