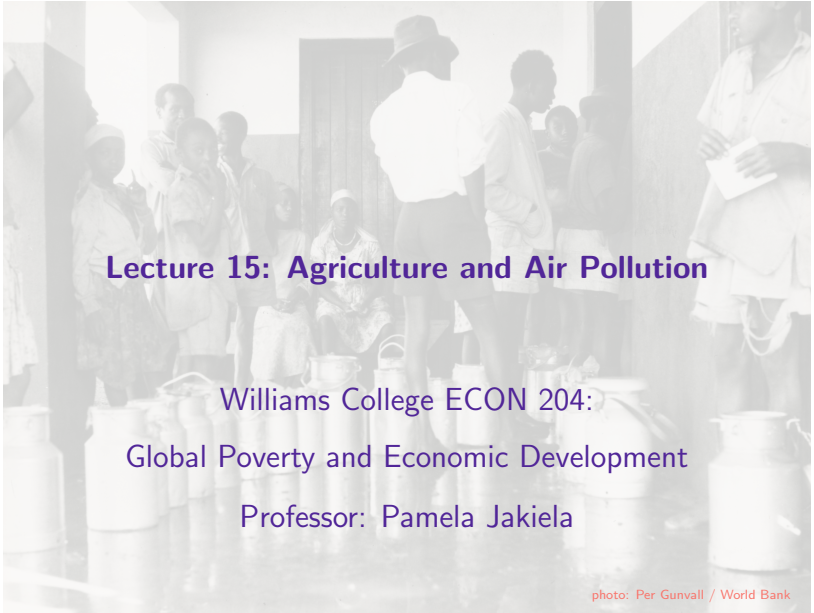


Lecture 15: Agriculture and Air Pollution

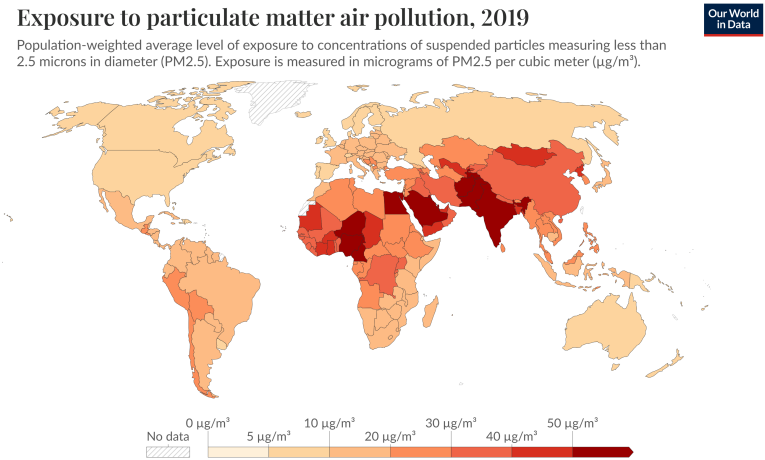
Williams College ECON 204:

Global Poverty and Economic Development

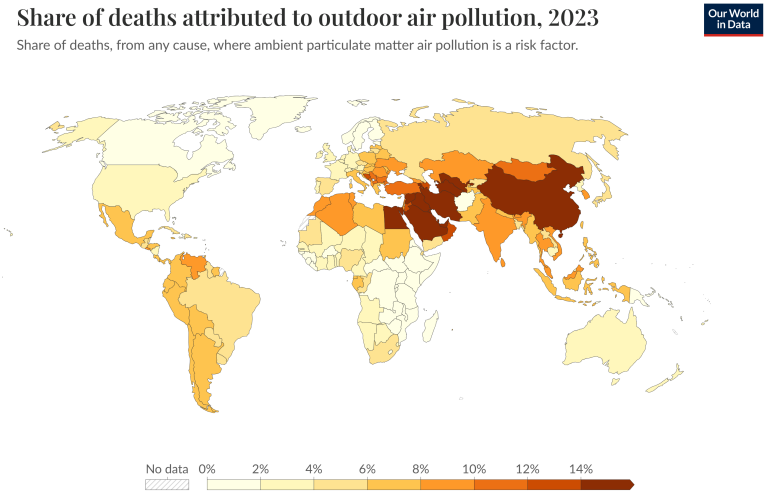
Professor: Pamela Jakiela

photo: Per Gunvall / World Bank

Outdoor Air Pollution in India



10% of Deaths in India Attributable to Outdoor Air Pollution



Crop Residue Burning in India

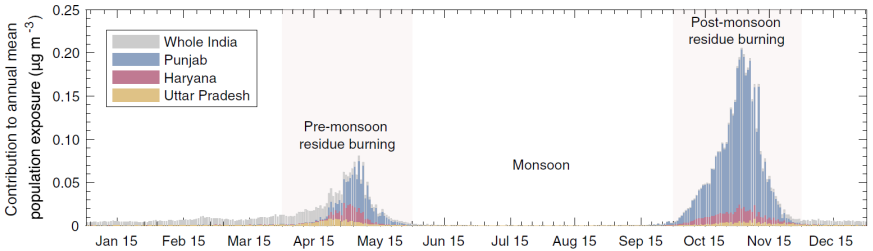


Fig. 2 | India-wide annual mean population-weighted PM2.5 exposure due to crop residue burning. Contributions are broken out for Uttar Pradesh (yellow bars), Haryana (red bars), Punjab (blue bars) and the rest of India (grey bars) by date, averaged over 2003–2019. The shaded area (light rose) in April-May and October–November denotes the dominant contribution from pre-monsoon fire season (wheat residue burning) and post-monsoon fire season (rice residue burning), respectively.

source: Lan et al. (2022)

Externalities

$$U(\text{bale crop residue}) \geq U(\text{burn crop residue})$$

$$b - p \leq b - c_{private} - c_{social}$$

- When would a farmer choose to bale their crop residue?
- When would a social planner want a farmer to bale their crop residue?
- How can the social planner intervene to correct the externality?
  - What are the pros and cons of PES as compared to other policy options?

PES Contracts: Whose Behavior Changes?

For PES (or any policy), there are farmers who will change their behavior and others who won't

- **Always-burners** burn their crop residue whether or not they are offered a PES contract
- **Never-burners** do burn their crop residue whether or not they are offered a PES contract
- **Compliers** respond to treatment: they burn their crop residue if they are not offered a PES contract, but they do not burn their crop residue when offered a PES contract

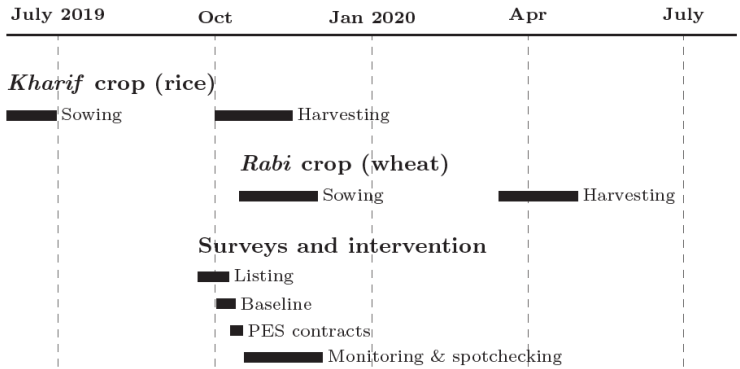
Compliers may be different depending on the policy (fines vs. PES, for example)

- Cost of PES policy depends on the total number of compliers + never-burners
- Impact of the policy only depends on the number of compliers

Studying Payments for Ecosystem Services

- How do the **upfront PES contracts** differ from **standard PES contracts**?
- Why might upfront PES be more (or less) effective than standard PES?

Studying Payments for Ecosystem Services: Timeline



source: Jack et al. (2025)

Farmers Choose PES Contracts

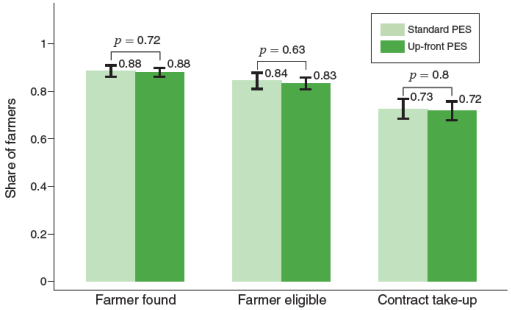


FIGURE 1. CONTRACT ELIGIBILITY AND TAKE-UP

Notes: "Farmer found" equals one if the respondent was available during the PES contract offer visit. "Farmer eligible" equals one if the respondent was available, had a bank account, and had not yet managed his crop residue. "Contract take-up" equals one if the respondent signed a contract to participate in the PES program. Treatment effects are estimated using equation (1), which includes strata fixed effects and clusters standard errors at the village level.

source: Jack et al. (2025)

Regression Specification

$$Y = \alpha + \beta StandardPES + \gamma UpfrontPES$$

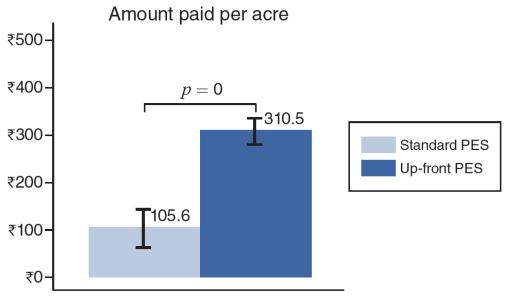
Impacts of PES Contracts on Crop Burning

TABLE 1—CONTRACT COMPLIANCE, NOT BURNING, AND CRM USE

		Unburned		CRM techniques	
	Complied with contract (1)	Max. accuracy (2)	Balanced accuracy (3)	Baler (4)	Seeder (5)
Standard PES	0.085	0.020	0.008	−0.010	−0.020
	(0.015)	(0.030)	(0.042)	(0.037)	(0.023)
Up-front PES	0.183	0.077	0.115	0.096	0.013
	(0.020)	(0.032)	(0.042)	(0.039)	(0.026)
p-value: standard PES = up-front PES	0.000	0.071	0.008	0.014	0.157
Control mean	0.000	0.091	0.202	0.199	0.102
Standard PES mean	0.084	0.098	0.198	0.171	0.087
Up-front PES mean	0.185	0.161	0.313	0.295	0.112
Observations	1,668	1,664	1,664	1,387	1,387

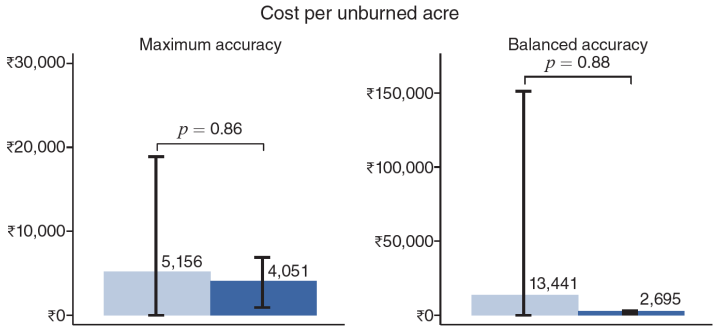
source: Jack et al. (2025)

Amount Paid to Farmers per Acre



source: Jack et al. (2025)

Cost of Reducing Crop Burning by One Acre



source: Jack et al. (2025)