Role of Rental Markets, Access to Credit, Government Subsidy and Learning inthe Adoption of Laser Land Leveller (LLL) in India: A Discrete Time Durational Analysis

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Introduction

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- **Agriculture an important sector of Indian economy**
- **Challenges to Indian Agriculture**
  - Increasing competitive use of resources from non-agricultural sectors
  - Water scarcity is one of the most limiting factors for ensuring food security
  - Declining groundwater table
  - Increasing temperature
- Government promoting laser-assisted precision land levelling (LLL), introduced in early 2000s
- Its expansion has not been rapid in regions other than western IGP
- Need for deeper understanding of dynamic processes and institutional factors that determine large-scale adoption

Laser Land Leveller

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- Process of smoothing land surface using laser-equipped drag scraper for precision, resulting in land smoothed to within 1-2 cm of its average elevation

- **Benefits**
  - Irrigation water saving
  - Higher yields
  - Energy saving (irrigation)
  - Reduced GHG emissions (from irrigated fields):
    - Reducing pumping time required for irrigation
    - Reducing tractor cultivation time
    - Improving fertilizer and water use efficiencies


Conventional Levelling


Laser Land Levelling

Aim

Use discrete-time duration analysis (DT-DA) to examine the impact of institutional, socio-economic and plot characteristics on adoption timing (or duration to adoption) of resource-conserving technology using an example of LLL in IGPs of India

Research Gap

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Previous studies on adoption focused on:

- Farmer's adoption decisions at a particular time using logit or probit models to explain an **adoption decision at particular time** (Abdullaev et al., 2007; Ahmad et al., 2014; Ali et al., 2018; Aryal et al., 2020; Aryal et al., 2015)

- Either only single crop: rice or wheat or sugarcane; or rice-wheat as a cropping system

- Either in Haryana or Punjab or Uttar Pradesh or Haryana and Punjab

Contributions of this research

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- DT_DA model is used to study the time between the year when the technology was introduced until the moment farmers adopts it in their farm
- This model presents technology adoption as a dynamic process
- Focus the role of institutional factors in the adoption process
- This study covers three states: Haryana, Punjab, Uttar Pradesh
- Adoption on broader cropping systems: rice-wheat, sugarcane-wheat, cotton-wheat, and vegetable

Data

- **Multi-stage sampling**
  - First stage, seven districts were purposively selected based on the cropping pattern and LLL adoption
  - Second stage, villages were selected based on the rice, wheat, vegetable, sugarcane and cotton cultivation
  - Third stage, village census was carried out to get the list of adopters, non-adopters
  - Fourth stage, farm households were selected randomly from the village census

Study Area

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Haryana		Punjab		Uttar Pradesh	
Districts	Sample size	Districts	Sample size	Districts	Sample size
Karnal	160	Amritsar	120	Hapur	140
Yamuna Nagar	160	Bhatinda	120	Meerut	180
		Ludhiana	120		
Total	320		360		320

Variables used for modelling

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Dependent variable:

- Duration between the year when the technology was introduced and the year the farmer adopts the technology on their farm.
- Coded as a zero for years prior to adoption, and a one at the point of adoption

Time invariant covariates:

- **Socio-economic variables**: education, age, caste, farm size
- **Plot characteristics**: soil fertility, land level
- **Perceptions**: decline in ground water (GD), decline in groundwater problem in future (decline future)
- **Institutional factors**: training, access to credit, agricultural institution membership (AIM), distance to service providers/ rental market, source of information, seen operating

Time variant covariate: subsidy regime

Empirical Model

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Adoption function/ hazard rate/ hazard function

$$h(t) = lim_{\Delta \to 0} \frac{pr(t \leq T < t + \Delta / T \geq t)}{\Delta} = lim_{\Delta \to 0} \frac{F(t+\Delta) - F(t)}{\Delta(1 - F(t))} = \frac{f(t)}{S(t)} \quad (1)$$

Where *T* = the observed length of time (years); *t* = particular value of *T* when adoption takes place; $F(t) = P(T \leq t)$ cumulative distribution function of adoption event

$$h = h_0(t, \theta) exp\,(X, \beta) \quad (2)$$

Where $h_0(t, \theta)$ = baseline hazard function; *X* = vector of covariates; β = vector of unknown parameters

$$cloglog \equiv log[-log(1 - h)] = (Dh_0(t) + \beta' X + e) \quad (3)$$

D = time variable capturing the effect of duration dependence of baseline hazard; e~$N(0, \sigma^2)$= random error term

Results

Result of baseline hazard model

Variables	Baseline PH model	
	Coefficient	SE
D1 (2005-2007)	0.005***	(0.001)
D2 (2008-2010)	0.048***	(0.003)
D3 (2011-2014)	0.288***	(0.008)
Observations	8059	
Logliklihood	-1934.12	

- The coefficients for time dummies are positive and significant
- The magnitude of coefficient increases gradually from one period to another. It suggests that the likelihood of LLL adoption increases as the number of years increases
- The lags in adoption generally occur because farmers accumulate information before adopting decisions (Fischer et al., 1996)

Results of full hazard model

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Variables	PH Model 1	
	Coefficient	SE
Education	1.023***	(0.004)
Age	0.999	(0.005)
Caste	1.021	(0.089)
Total_land	1.029	(0.011)
Soil fertility	1.117	(0.079)
Medium_level_land	0.771***	(0.049)
Low_level_land	0.52	(0.253)
Training	1.018	(0.073)
Access to credit	1.111***	(0.043)
Agriculture Institution Membership (AIM)	1.238***	(0.102)
Distance_rental market	0.978**	(0.01)
Info_source	1.126	(0.161)
Seen_operating	1.541*	(0.37)
Groundwater_decline	1.001	(0.002)
Decline_future	1.03	(0.002)
Haryana	0.949	(0.063)
Uttar Pradesh	1.087	(0.12)
$Subsidy_t$	2.915***	(0.295)
D1	0.002***	(0.001)
D2	0.009***	(0.006)
D3	0.048***	(0.031)
Observations	8031	
Logliklihood	-1886.49	

- Access to credit, AIM, seen operating and subsidy have >1 and significant; distance to service providers is <1 and significant
- The hazard ratio on access to credit indicates that that farmer with access to credit have 1.1 times higher conditional probability of adoption
- The conditional probability of adoption is reduced by 2% for the households away from the rental markets
- The probability of adoption increased to nearly three times during the subsidy period compared to no subsidy period

Conclusion and policy implication

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- Institutional factors significantly influence the speed of adoption of LLL
- Short-term credit ease financial constraints and speed up adoption. Therefore, government should come up with the policy reforms that ease credit access
- Membership to agricultural institutions reduces adoption time by providing confidence to take risk
- Potential adopters may subsequently learn from social network of innovators and develop better understanding
- Capacity building of agricultural institutions are required for improving the technology access and welfare in rural areas

Conclusion cont…

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- Increasing access to rental markets makes technology adoption possible without owning it
- Need for organizing demonstration and field visits for farmers to remove the information barriers and doubts about new technology
- Subsidy to purchase LLL can increase the players in rental market and enhance service quality but government should identify hotspots where adoption is low and divert resources
- Subsidy being important means cost of adoption is important. Government should focus on other ways that can reduce the cost of adoption, for example, investing in more efficient ways of producing and distributing the technology

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Thank you!

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