Role of Agronomical Knowledge in Crop Diversification and Adoption of Hybrid Rice Seeds: A Case Study of Nepal

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Soumyajit Chakraborty, UNM ***Alok K. Bohara, NSC & UNM*** ***Nayan K. Joshi, CIMMYT-Nepal***

Introduction

- Agricultural reforms in late ’80s and liberalization policies
- Globalization: (a) improving own agrarian sector
  (b) importing cheap imports from developed countries
- South Asian countries: Agriculture → Labor-intensive sector
- Technological rigidities in staple crops
- Subsidies in cash crops
- Nepal → 70% of population in agriculture → 33% of GDP → 18-20% cultivable land

Introduction, cont'd

- Crop diversification → risk-averse strategy

- Crop diversification in: (a) cash crops
  (b) staple crops

1. Farm-level income ↑
2. Employment ↑
3. Biodiversity loss ↓

   (*Pingali and Rosegrant, 1995; Ramesh Chand, 1996; Ryan and Spencer, 2001*)

- Crop biodiversity → fundamental to ensure food security (*Khoury et al., 2014*)

- 70-100 % of excess demand for food by 2050 (*FAO*)

Introduction, cont'd

- Smallholder famers → very reluctant to adopt new technology
  → traditional practices

- Crop diversification in: (a) cash crops – subsidies are here!
  (b) staple crops – price supports mainly!

- Promotion of labor-substituting technologies

- Farm-level input subsidies

- Micro-credit opportunities

- Agronomical knowledge

Quick Literature Review

- Theoretical models of a representative farmer's decision in:
  (a) adopting hybrid seeds
  (b) adopting advanced technology
  (c) crop diversification

- *Feder and Slade (1984)*: human capital model with land constraints

- *Isham (2002)*: importance of social capital as well as a decision variable

- *Ghandim and Pannell (1999)*: 'learning by doing'

- *Leathers and Quiggin (1991)*: nature of risks → hedging against uncertainty → crop diversification

- *De Falco and Perrings (2005)*: dynamic optimization → risk-averse farmers' attitudes

Adding ***any Δ*** to literature?

- Linking agricultural extension services *directly* to farmers' decisions

- Access to: (a) extension services
  (b) agro-vets
  (c) agro-markets

- There might be an *indirect* linkage:
  - Agricultural extension services → agronomical knowledge → farmers' agricultural decisions

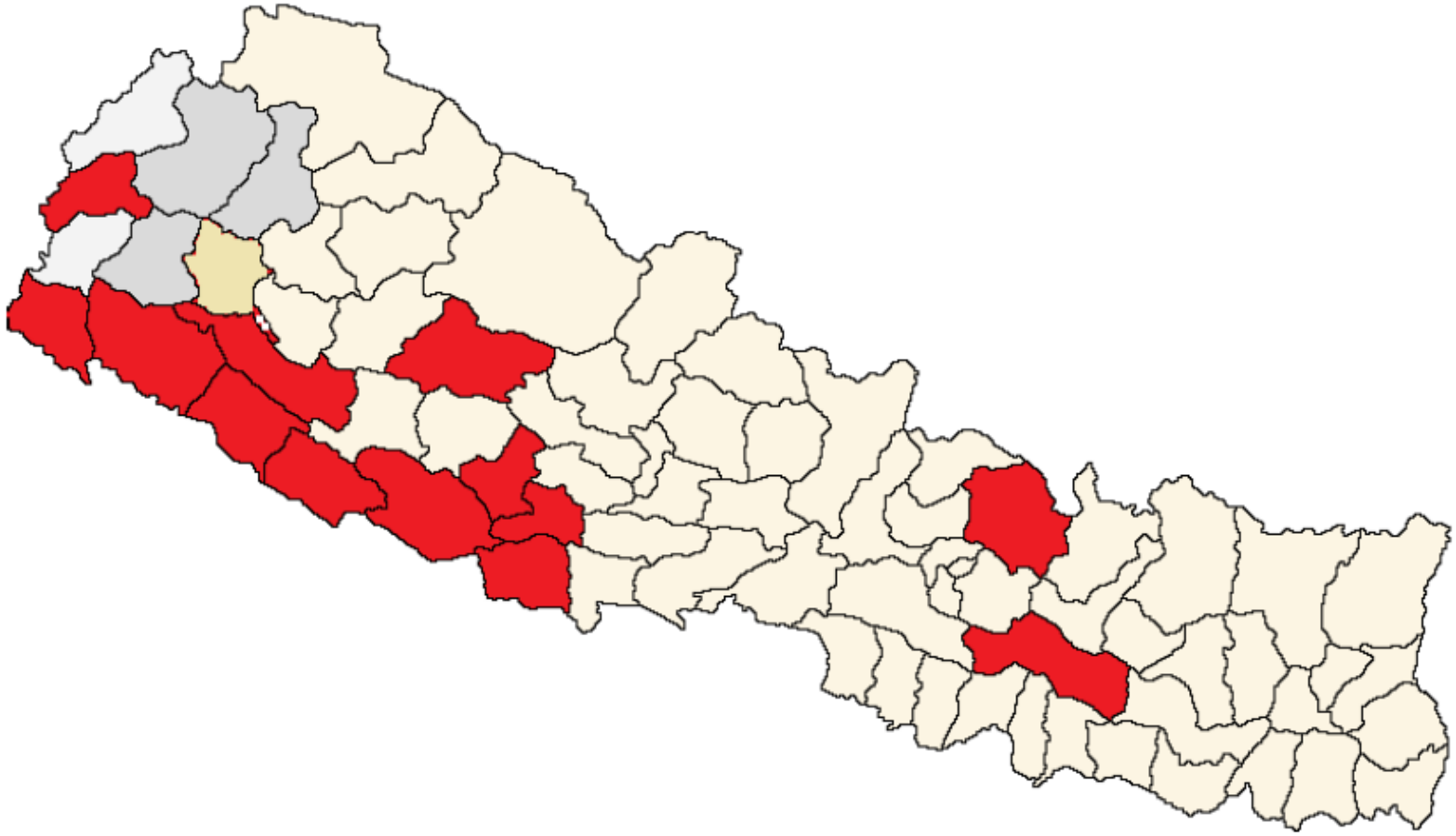
- Most common techniques → 'decision' as a latent variable

- *Croppenstedt and Demeke (1996)*: 'decision' as a selection variable

- *Doss and Morris (2001)*: 2-stage model of fertilizer and maize variety adoption

Data

Figure 1: NSAF Baseline Survey Districts



Note: Red colored ones are the survey districts
Source: NSAF Baseline Survey, Preliminary Draft

Data, cont'd

- Nepal Seed and Fertilizer (NSAF) Baseline data , 2016

- NSAF is a 5 years (2016-2021) project funded through USAID's *Feed the Future* program

- Aims: (a) improving seed and fertilizer value chains in ZOI (20 districts) → 5 earthquake affected districts
  (b) improving agricultural capacity of both public and private sectors
  (c) extending agronomical knowledge
  (d) 6 *target crops*: rice, maize, lentil, tomato, cauliflower, and onion
  (e) 25 NSAF districts

- Our data has 13 districts including 2 earthquake affected ones → **600 HHS**, 95 Agro-vets, 10 seed companies, 13 Agro-development offices

- **1,932 individual farmers**

Data, cont'd

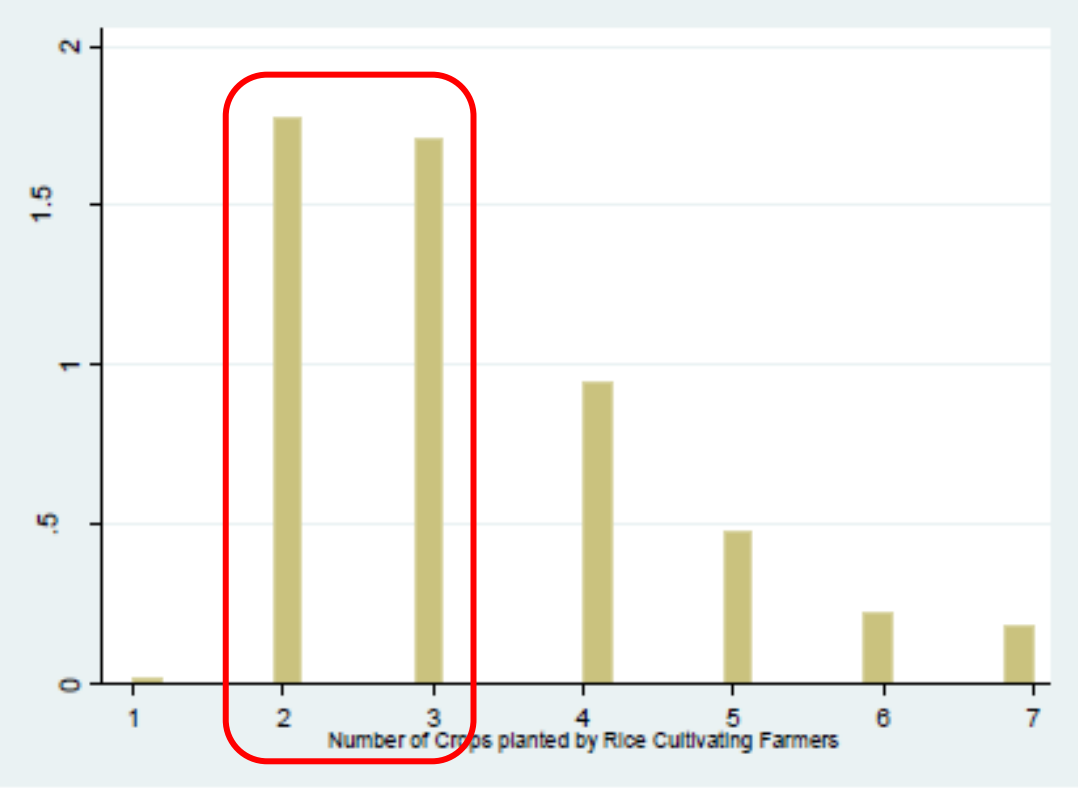
Table 1: Descriptive Statistics of Socioeconomic and Some Selected Variables

Variables	*Mean*
Age	45.28
Female (%)	47.62
Region (*Base: Other regions*)	
Far western (%)	80.07
Caste (*Base: Other Castes*)	
Upper Castes (%)	38.87
Education Level (*Base: High School*)	
Above High School (%)	29.91
Access to Agro-Vet within 60 minutes of walking distance (%)	92.24
Access to Agri-market within 60 minutes of walking distance (%)	85.97
Access to Agri-extension by walking distance (%)	
Under 30 minutes	57.92
Between 30-60 minutes	25.62
Between 60-120 minutes	10.51
Beyond 120 minutes	5.95
Attendance in Agri-fair in Last 2 Years (%)	10.66
Observations*	1,932

Source: Author's calculation from NSAF Data
** Observation for Education level is 1,518*

Data, cont'd

Figure 2: Crop diversification by number of crops



Source: Author's calculation from NSAF Data

Table 2: Descriptive Statistics of Outcome and Explanatory Variables

Variables	*Percentage Share*
Use of Hybrid Rice Seeds	33.44
Crop Diversification by Number of Crops	
1	0.31
2	33.28
3	32.14
4	17.75
5	8.95
6	4.19
7	3.36
Agronomical Knowledge Index (0-9 Scale)	
0	31.68
1	19.25
2	10.14
3	12.58
4	8.44
5	7.30
6	4.24
7	3.62
8	1.19
9	1.55

Source: Author's calculation from NSAF Data

Methodology

$$Number\_of\_crops_i = \beta_0 + \beta_1 * agro\_knowledge + X_i'\beta + \varepsilon_i : \text{Poisson regression}$$

$$Use\_of\_hybrid\_seed_i = \beta_0 + \beta_1 * agro\_knowledge + X_i'\beta + \mu_i : \text{Logit regression}$$

The instrumental variable approach with additive two-step GMM and probit also have been used to get some *preliminary ideas*.

Empirical Results

Table 3: Poisson model for Crop Diversification

	Dependent Variable: Number of Crops				
Variables	(1) OLS	(2) OLS	(3) Poisson	(4) Poisson	(5) Poisson with Exposure
Agronomical Knowledge	0.221***	0.154***	0.0630***	0.0413***	0.0413***
	(0.0142)	(0.0171)	(0.00375)	(0.00449)	(0.00657)
Age		-0.00697***		-0.00209***	-0.00209
		(0.00251)		(0.000760)	(0.00133)
Female		-0.259***		-0.0787***	-0.0787***
		(0.0658)		(0.0196)	(0.0301)
Region (*Base: Other regions*)					
Farwestern		0.891***		0.324***	0.324***
		(0.0714)		(0.0254)	(0.0446)
Caste (Base: Other Castes)					
Upper Castes		0.0556		0.0195	0.0195
		(0.0650)		(0.0193)	(0.0301)
Education Level (Base: High School)					
Above High School		0.232***		0.0676***	0.0676**
		(0.0689)		(0.0200)	(0.0312)
Agro-Vet within 60 minutes		0.286***		0.111***	0.111
		(0.105)		(0.0353)	(0.0724)
Agri-fair meeting		0.0505		0.0111	0.0111
		(0.110)		(0.0300)	(0.0436)
Agri-Extension Distance		-0.240***		-0.0732***	-0.0732***
		(0.0351)		(0.0108)	(0.0200)
Constant	2.788***	2.722***	1.036***	0.943***	-1.002***
	(0.0341)	(0.200)	(0.0113)	(0.0653)	(0.116)
Observations	1,932	1,518	1,932	1,518	1,518
R-squared/Pseudo R-squared	0.150	0.256	0.039	0.039	0.039
Log Likelihood	-	-	-2560.85	-2560.85	-2560.85

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Source: Author's calculation from NSAF Data

Empirical Results, cont'd

Table 4: Logit model for Adoption of Hybrid Seeds

	Dependent Variable: Use of Hybrid Rice Seed			
Variables	(1) OLS	(2) OLS	(3) Logit	(4) Logit
Agronomical Knowledge	0.0430***	0.0323***	0.189***	0.167***
	(0.00482)	(0.00600)	(0.0217)	(0.0315)
Age		0.00277***		0.0159***
		(0.000977)		(0.00546)
Female		0.0403*		0.231*
		(0.0235)		(0.126)
Region (*Base: Other regions*)				
Farwestern		0.135***		0.927***
		(0.0282)		(0.214)
Caste (Base: Other Castes)				
Upper Castes		-0.205***		-1.155***
		(0.0228)		(0.140)
Education Level (Base: High School)				
Above High School		0.000181		-0.0481
		(0.0242)		(0.136)
Agro-Vet within 60 minutes		-0.0560		0.250
		(0.0435)		(0.422)
Agri-fair meeting		0.0566		0.283
		(0.0425)		(0.208)
Agri-Extension Distance		-0.121***		-0.719***
		(0.0143)		(0.105)
Constant	0.239***	0.329***	-1.134***	-1.499**
	(0.0140)	(0.0849)	(0.0715)	(0.659)
Observations	1,932	1,518	1,932	1,518
R-squared/Pseudo R-squared	0.044	0.171	0.039	0.158
Log Pseudolikelihood	-	-	-1189.46	-807.42

Robust standard errors in parentheses

**** $p<0.01$, ** $p<0.05$, * $p<0.1$*

Source: Author's calculation from NSAF Data

Empirical Results, cont'd

Table 5: IV Poisson GMM Results for Crop Diversification

	Dependent Variable: Number of Crops		
	(1)	(2)	(3)
	Instrumented: Agronomical Knowledge		
	Instrument: Distance to Agricultural Extension Services (in Minutes of Walk)		
Variables	30 < t ≤ 60	60 < t ≤ 90	90 < t ≤ 120
Agronomical Knowledge	0.123***	0.123***	0.121***
	(0.0236)	(0.0202)	(0.0187)
Age	-0.00168*	-0.00167*	-0.00169*
	(0.000905)	(0.000895)	(0.000876)
Female	-0.0210	-0.0208	-0.0222
	(0.0242)	(0.0236)	(0.0236)
Region (*Base: Other regions*)			
Farwestern	0.0819	0.0809	0.0898
	(0.0737)	(0.0619)	(0.0574)
Caste (Base: Other Castes)			
Upper Castes	-0.0446	-0.0448	-0.0426
	(0.0287)	(0.0274)	(0.0261)
Education Level (Base: High School)			
Above High School	0.0353	0.0352	0.0362
	(0.0243)	(0.0237)	(0.0234)
Agro-Vet within 60 minutes	0.157***	0.156***	0.160***
	(0.0421)	(0.0415)	(0.0401)
Agri-fair meeting	-0.103**	-0.103**	-0.0987**
	(0.0492)	(0.0468)	(0.0453)
Constant	0.764***	0.765***	0.762***
	(0.0616)	(0.0623)	(0.0619)
Observations	1,518	1,518	1,518

Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*
Source: Author's calculation from NSAF Data

Table 6: IV Probit Two-Step Results for Adoption of Hybrid Seeds

	Dependent Variable: Use of Hybrid Rice Seed		
	(1)	(2)	(3)
	Instrumented: Agronomical Knowledge		
	Instrument: Distance to Agricultural Extension Services (in Minutes of Walk)		
Variables	30 < t ≤ 60	60 < t ≤ 90	90 < t ≤ 120
Agronomical Knowledge	0.984***	0.780***	0.919***
	(0.226)	(0.198)	(0.290)
Age	0.0125**	0.0118**	0.0126**
	(0.00568)	(0.00493)	(0.00550)
Female	0.580***	0.509***	0.567***
	(0.154)	(0.135)	(0.169)
Region (*Base: Other regions*)			
Farwestern	-1.704***	-1.213**	-1.554**
	(0.577)	(0.509)	(0.732)
Caste (Base: Other Castes)			
Upper Castes	-1.238***	-1.130***	-1.238***
	(0.194)	(0.172)	(0.232)
Education Level (Base: High School)			
Above High School	-0.426**	-0.327**	-0.390**
	(0.169)	(0.147)	(0.183)
Agro-Vet within 60 minutes	0.173	0.472*	0.394
	(0.322)	(0.269)	(0.306)
Agri-fair meeting	-0.992***	-0.705**	-0.901**
	(0.357)	(0.306)	(0.425)
Constant	-1.666***	-1.922***	-1.873***
	(0.417)	(0.359)	(0.395)
Observations	1,518	1,518	1,518

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's calculation from NSAF Data

Conclusion and Policy Perspectives

- Agronomical knowledge → significant and positive effects on farmers' decisions
- Agro-extension services play pivotal role
- **(a)** Availability of seeds and fertilizers and **(b)** Affordability of seeds and fertilizers
- **(a)** and **(b)** sometimes are intertwined with eco-political conditions
- Certain price support policies are climate specific
- Bringing in more projects like NSAF, land reforms *e.g. Operation Barga*, issues of migration, female farmers, micro-credit opportunities

Thanks!

Nepal Study Center
The University of New Mexico

CIMMYT MR
International Maize and Wheat Improvement Center