Farmers' technology adoption behavior in agricultural value chain in Sichuan, China

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Outline

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1. Background

Technology plays critical role in food production.

Small farmers in Asia and Africa, e.g., China, have relatively lower adopt rates (high transaction cost, less incentive, diverse demands… …）

Many researches have already studied on small farmers technology adoption and influence factors:

- Focus on one/two technologies: seeds, fertilizer, pesticide, conservation, low-carbon, … …
- Determinants: personal and family characteristics , management environment(distance, local condition), policies
- Method: **probit\tobit/logistic, ordered-probit, bi-probit, DH model**

New trends on Agriculture in China

- Multifunction: production, socioeconomic and ecology
- Organization: farmers cooperative development quickly
- Industrial distribution: spatial aggregation and concentration
- Agricultural products: quantity increase and quality safety



New changes on Agriculture require new technology demands

- Production and postproduction during agricultural value chain;
- Cooperatives as an important platform
- a set of technologies or integrated/cluster technologies;
- Resource saving, environment friendly and food safety technologies

Few studies on the number of adopted technologies by smallholder famers, either not from agricultural value chain.

Research questions:

1. How to categorize so many technologies from agricultural value chain?

2. What are the determinants for number of technologies adopted by farmers?

- Are there any differences on determinants of adoption of agricultural technologies in production and post harvest stage?
- Does cooperative membership have an effect on # of technologies adopted?

2.Data and Variables

Data collection

Survey time: June-July. 2014

- 9 counties (2 in plain，2 in mountain, 5 in hilly)
- Valid sample: 413 (212 cooperative members and 201 non-members)
- Variables: adopted technologies, farmer demographics, income, off-farm, production info

Study Area

Technology category in value chain (How to categorize so many technologies from agricultural value chain?)

- Literature (soft and hard; not according to value chain)
- Presurvey in Wenjiang county(10 farmers)
- Experts communication

➔ **We propose a new and comprehensive classification of agricultural technologies according to agricultural production stages**

Production and post-harvest technologies analysed

Production technologies	(1) Seeds, breeds	New varieties or improved seeds, enhanced pesticide resistance, and better crop or livestock quality
	(2) Cultivation, feeding	Improved production techniques through crop rotation, conservation tillage, and animal nutrition
	(3) Pesticides, animal hygiene	Pesticide control and disease prevention of crops and animals
	(4) Fertilizer	Improved fertilization such as specialized organic and soil-improving fertilizers
	(5) Agricultural equipment	Machinery and equipment for greenhouse and livestock stables
	(6) Irrigation	Introduction of spray and drip irrigation
Post-harvest technologies	(7) Processing	Technologies of sorting, cleaning and packing
	(8) Drying, storage	Improved drying and storage facilities of agricultural products
	(9) Transportation, logistics	Improved transportation facilities and logistics
	(10) Branding, marketing	Facilitation of improved marketing channels (e.g., direct marketing)
	(11) Standardization	Application of standards, mainly including food safety, product labelling (e.g., organic), and geographical indication
	(12) Finance, management	Improvements of financing or business management, such as credit from bank
	(13) Information technology	Introduction of computer and internet usage (e.g., construction of website or management information system)

3. Method

Dependent variable: number of adopted technologies (count variable, 0, 1, 2, up to 13).
Hence, we use count data models (Cameron and Trivedi, 1986) to estimate the effects of the independent variables on the number of adopted technologies.

When the variable *Y* follows a Poisson distribution, the probability of *Y* taking the values *y = 0, 1, 2, 3…* is a function of λ, with $\lambda > 0$, which is the mean (and also the variance) of *Y*:

$$Pr(Y = y) = p(y) = \frac{e^{-\lambda}\lambda^{y}}{y!} \quad (1)$$

The Poisson regression model is then specified as log-linear model:

$$\ln(\lambda_i) = X_i\beta = \sum_{k=0}^{k} \beta_k x_{ik} \quad (2)$$

Where λ_i is the expected count number for the *i*-th observation; X_i is a vector of *k* independent variables and β is a 1-by-*k* vector of coefficients.

Variables description

Variable	Definition and measurement	Type
Technology	Number of technologies adopted (from 0 to 13)	Count
Age	below 36=1, 36-50=2, 51-65=3, above 65=4	Ordered
Education	Elementary school=1, junior middle school=1, high school=3, above high school=4	Ordered
Labor force ratio	Number of labors (age 18-65) divided by total household members	Continuous
Income	Household income in 2013 in Yuan: < 5,000=1; 5,000-10,000=2; 10,000-50,000=3; above 50,000=4	Ordered
Full-time farming	=1 if yes	Binary
Farm size	Farms size (mu)	Continuous
Cooperative	=1 if yes	Binary
Distance to market	Distance from village to county capital (km)	Continuous
Plain	=1 if in Chonzhou or Longquanyi	Dummy
Hilly	=1 if in Jianyang, Jiangyou, Qianfeng, Renshou or Pengshan	Dummy
Mountain	=1 if in Shimian or Mingshan	Dummy

Three models built:(differences on determinants of adoption of agricultural technologies in different stage?)

① **all technologies**

② **production technologies**

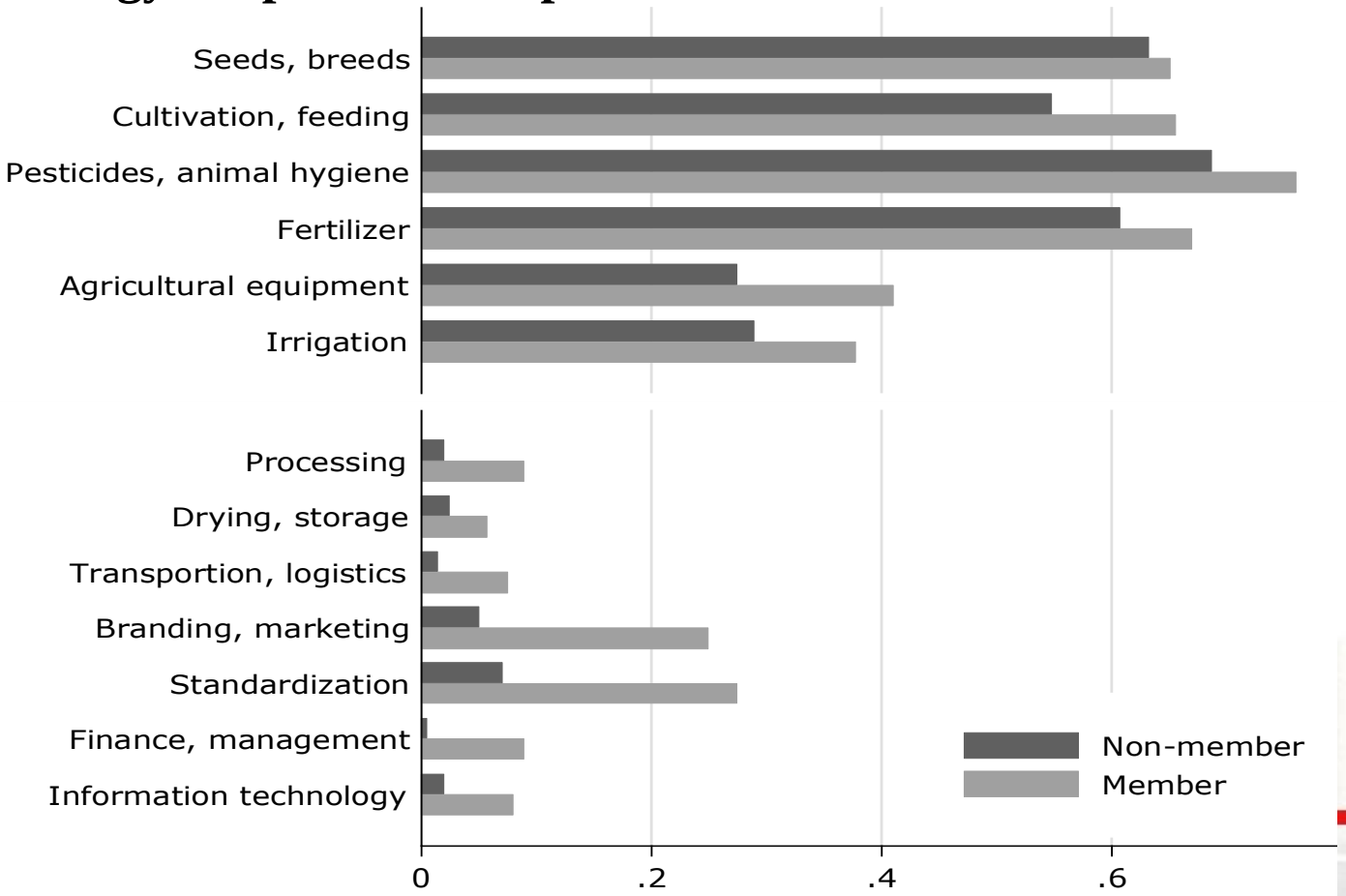
③ **post-harvest technologies**

- ✓ Overdispersion: the negative binomial model (NBM) using a likelihood ratio test
- ✓ Zero-inflation problem: using the Vuong test by the p-value
- ✓ Multicollinearity was detected among the independent variables (variance inflation factor, VIF)

4. Results and Discussions

4.1Descriptive Results:

Technology adoption for cooperative members and non-members



4.2 Regression results

Determinants of technology adoption

Variables	All technologies (NBM)	Production technologies (Poisson)	Post-harvest technologies (NBM)
Age	1.046	1.044	1.034
	(0.046)	(0.043)	(0.117)
Education	1.112**	1.071*	1.345***
	(0.046)	(0.040)	(0.135)
Labor force ratio	0.998	0.998	0.999
	(0.001)	(0.001)	(0.003)
Income	1.146***	1.113***	1.363***
	(0.043)	(0.038)	(0.127)
Log of farm size	1.061*	1.040	1.157*
	(0.037)	(0.032)	(0.084)
Full-time farming	1.019	0.990	1.126
	(0.070)	(0.063)	(0.199)
Cooperative member	1.150**	1.015	3.122***
	(0.076)	(0.063)	(0.623)
Distance to market	1.009***	1.008***	1.022**
	(0.003)	(0.003)	(0.010)
Hilly	0.781***	0.760***	0.941
	(0.059)	(0.051)	(0.210)
Mountainous	0.844**	0.812***	1.101
	(0.072)	(0.064)	(0.276)
Constant	1.839***	2.136***	0.031***
	(0.361)	(0.388)	(0.019)
Wald chi2(10)	75.48	56.34	93.47
Prob > chi2	0.00	0.00	0.00
BIC	-1950	-1709	-816
Likelihood-ratio test	36.64	0.68	21.23

4.2 Regression results

All Technologies	Production	Post-harvest
Education (+) Income (+) Distance to market (+) Farm size (+) Cooperative membership (+)	Education (+) Income (+) Distance to market (+)	Education (+) Income (+) Distance to market (+) Farm size (+) Cooperative membership (+)
Hilly (-) Mountainous (-)	Hilly (-) Mountainous (-)	

5. Conclusions and policy implication

1) **Adoption rate in postharvest much lower than production stage.** Postharvest technologies should be substantially improved based on the industries integration.

2) **Cooperative membership and farm size have significant influence on postharvest technologies adoption.** Cooperatives should be encouraged to further enhance their intermediary roles between members and technology providers to more vigorously promote suitable technologies adoption. Land transfer should be encouraged to realize economy of scale.

3) Local condition(hilly and mountain) has negative influences on production technologies adoption.

Change farming systems: grass planting for husbandry (goats, cows), fruits, **vs.** Machinery suitable for small-scale and hilly farming.

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