Reducing Income Vulnerabilities through Agroforestry Training: Evidence from a Randomized Field Experiments in Indonesia

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Overview: Agriculture in Indonesia

- Agriculture's share in GDP is declining, but still provides income for majority of Indonesian (in 2012, **49 million employment** or **41% of the total labor** force)

	2010	2011	2012	2013	2014
Agricultural growth (annual percent change)	2.9	3.0	4.0	3.4*	2.4*

Source: World Bank

- Only during the Asian Financial Crisis (late 1990s) this share grew significantly because unemployment in both the industry and services sectors was absorbed by the agriculture sector (mostly informally)

	1995	1996	1997	1998	1999	2000	2001	2002
Share of agriculture in GDP (% of GDP)	17.1	16.7	16.1	**18.1**	**19.6**	15.6	15.3	15.5

Source: World Bank

*estimated

Significance of Coffee and Cocoa for Indonesia

Estimated Cocoa Production in 2011/2012

Country	Annual Production (in tonnes)
1. Ivory Coast	1,410,000
2. Ghana	860,000
3. Indonesia	**480,000**
4. Nigeria	210,000

Source: International Cocoa Organization (ICCO)

Top 5 Coffee Bean Producers in 2013

Country	Annual Production (in bags of 60 kg)
1. Brazil	49,152,000
2. Vietnam	27,500,000
3. Indonesia	**11,667,000**
4. Colombia	11,000,000
5. Ethiopia	6,600,000

Source: International Coffee Organization

- Indonesia has 1.3 million hectares of coffee plantation and 1.5 million hectares of cocoa plantations (source: Reuters Factbook)
- More than 90 percent of these are small-scale producers (source: ICCRI data)

Problems in Indonesia

- Economically marginalized people lives in rural area and depends on agriculture and forestry
- In 1999, 76% of Indonesians living below the poverty line live in rural areas (Pradhan et al., 2000)
- Problems: land use change from forest to residential land and plantations due to population growth
- Agroforestry as an alternative paradigm for rural development
  - low external inputs (pro-poor)
  - Helps to achieve sustainable livelihood and ecological objectives (Koohafkan et al., 2012)

Past Social Intervention in Agroforestry

1. Financial aid
   - To encourage tree planting and diversify farm management (Mehta and Leuschner, 1997, Carvalho et al., 2002, Thacher et al., 1996)
2. Technical Training
   - Knowledge sharing to improve ecological and economic well-being (Fischer and Vasseur, 2002, Asaah et al., 2011)

- I chose the latter as investment in human capital has multiplier effects upon social and economic well-beings.

Fieldwork Site: Tanggamus district, Lampung

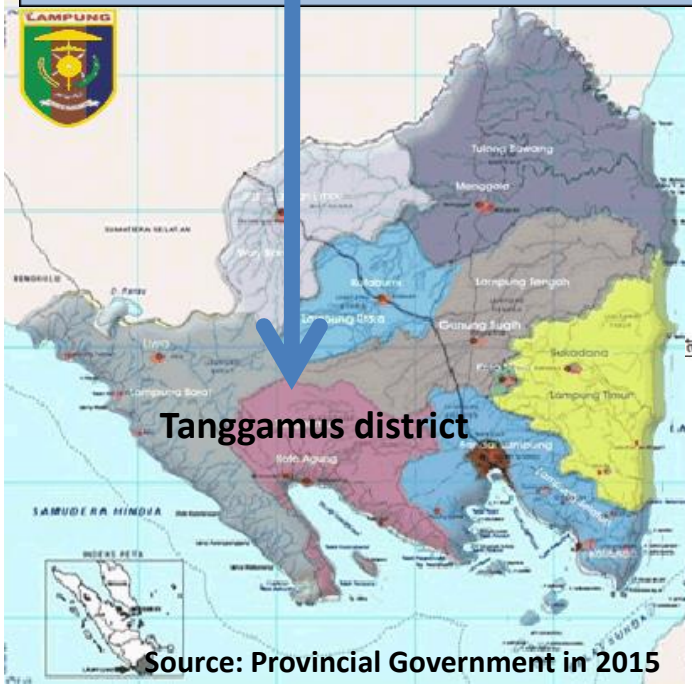
Major coffee and cocoa producer

Total Area: 2,731.61 km^2

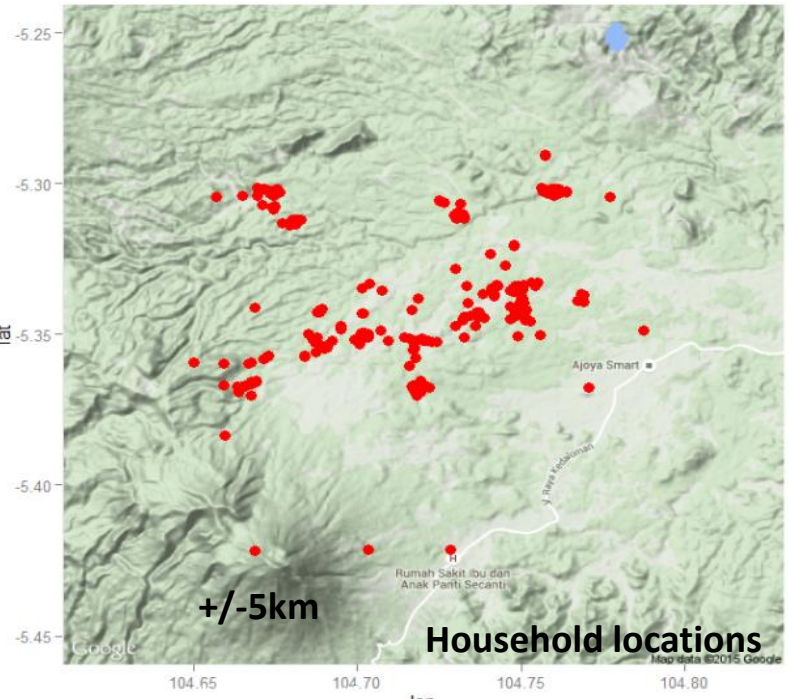
Population: 548.728 (2013)

Density : 200,88 people/km^2

Total Farmland: 91.620,64 Ha



Source: Provincial Government in 2015



Randomization Methods

Largest coffee and Cacao producing district in Lampung Province and due to the ease of access and professional contact

Tanggamus district

Biggest Coffee and Cacao producing sub-district

Pulau Panggung sub-district

Sumberejo sub-district

In total there are 36 Farming Groups (each has 20-30 members)

9 randomly chosen farming groups

7 randomly chosen farming groups

Total observation: 312 out of 398

(~80% response rate)

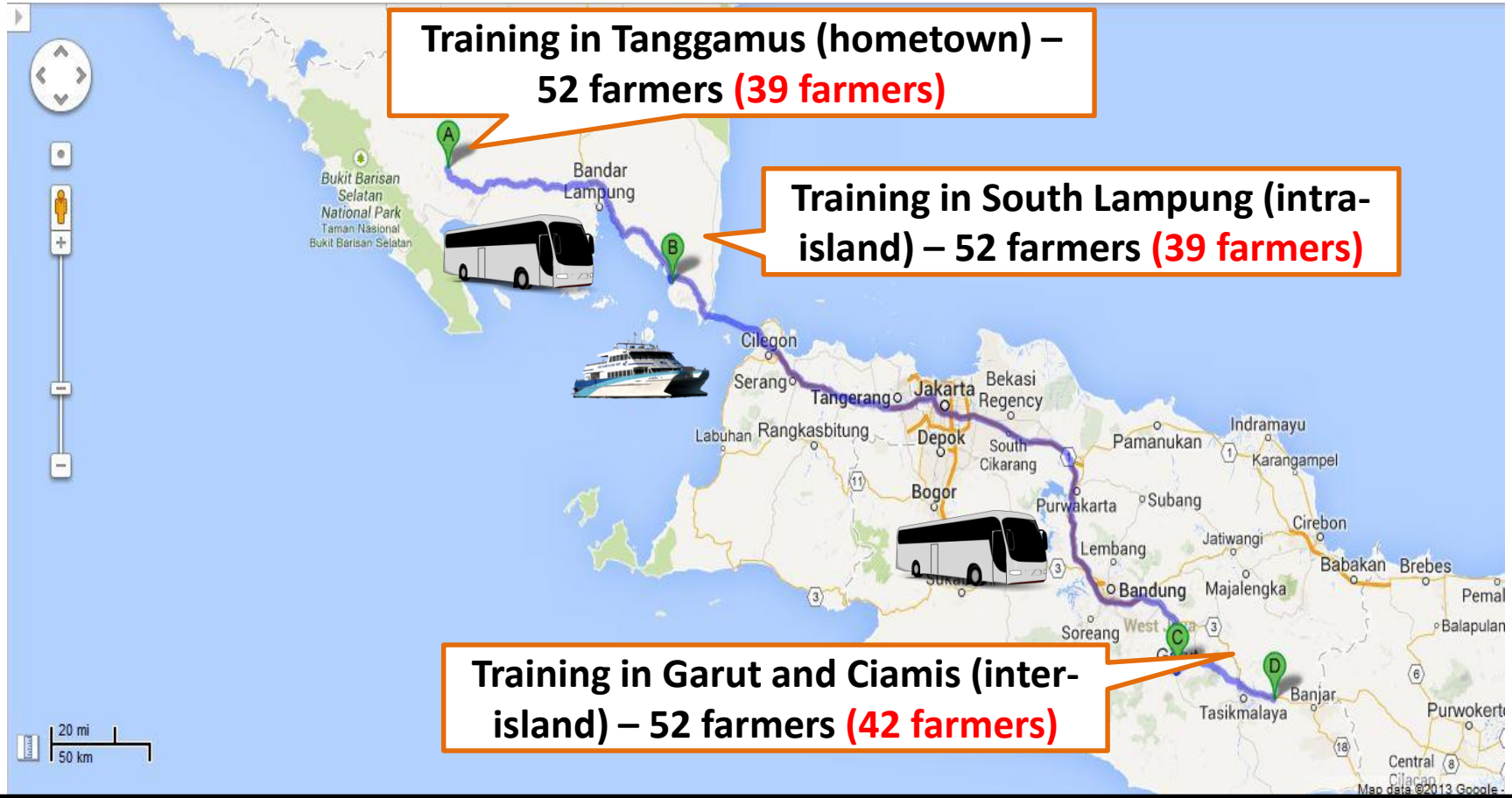
Research Timeline

Social Intervention: Agricultural Training

1. Variation of extension services coverages across groups and villages
   - Critics to farmers-group / group-based approach
2. No farmer in the district has undergone institutionalized training
   - Training is only administered for extension officials
3. Farmers in the district are unlikely to travel frequently to the nearest big city or town
   - Field trip features to motivate farmers

Social Intervention: Agricultural Training

- Total 312 household from 14 villages (16 farmers group)
- Randomly select 156 people to undertake 3 days training
- 120 people (~80%) showed up for the training



Training Location

Tanggamus (Hometown)

South Lampung (Intra-island)

Garut and Ciamis (Inter-island)

- What location represents:
  1. Distance
  2. Field trip component i.e. more matured and developed in terms of coffee and cocoa production, more developed as an area, extension services are more advanced

Social Intervention: Agricultural Training

1. In-class training on coffee (day 1) and cocoa (day 2) cultivation, plant diversification, and agriculture technology, followed by 10qs quiz

2. Pilot farm visit in each location

Same training is given by same trainers regardless of location….

Social Intervention: Agricultural Training

3. Participants bonding and ice-breaking (singing, quiz, games) and **visit touristy places**

For remote-location training only

4. Facilitate contact and learning between trainers and "successful" farmers in each location

… however, personal experience and exposure may be different across different training group

Agroforestry Index

1. By Crop Category

Sum of

Cereal

Legume

Industrial Crop

Spices

Vegetable

Fruits

Hardwood

2. By Crop Diversity

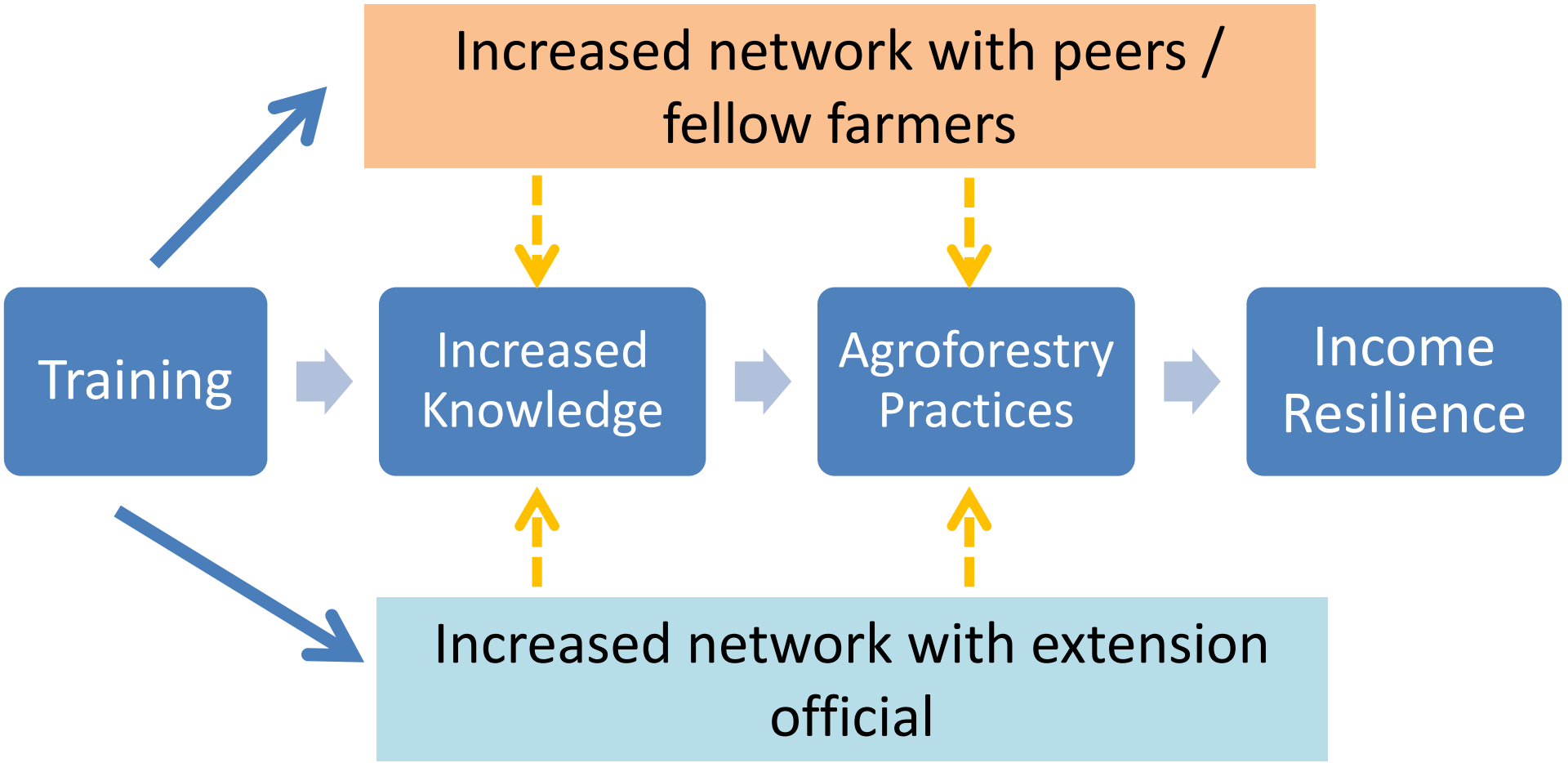
Sum of

Cereal Crops	Legume Crops	Industrial Crops	Spice Crops	Vegetable Crops	Fruit Crops	Hardwood
Rice	Soybean	Coffee (Arabica)	Chili	Cabbage	Durian	Teak
Corn	'Petai	Coffee (Robusta)	Nutmeg	Cucumber	Snakefruit	Mahogany
	Peanut	Tobacco	Clove	Eggplant	Banana	Albasia
	Almond	Cocoa		Tomato	Avocado	Jabon
	Dogfruit	Palm			Papaya	Other Wood
		Coconut				
		Areca				

Perceived Agroforestry Benefits

What are the benefits you experienced after diversifying the farm? (only in 2012-2013)		
Environmental Benefits	Conserved Soil and Water	●
	Improved Surroundings	×
	Increased Soil Fertility	×
	Provision for Shade Trees	×
Economical Benefits	Increased Variety of Food Income	●
	Provision for Fuelwood	●
	Provision for Medicinal Purposes	●
	Reducing Complete Chances of Crop Failure	×
	Increased Family Income	×
	Provision for Fodder	×

Conceptual Framework



Hypothesis

Hypothesis 1:

Training participants, regardless of income group, diversify more post training

Hypothesis 2:

Training participants are more aware of the perceived benefits of agroforestry due to increased knowledge

Hypothesis 3:

Training participants, regardless of income group, will have more intensified social network post training

Hypothesis

Hypothesis 4:

Training participants, regardless of income, have higher propensity to diffuse knowledge of agroforestry to non-training participants

Training → Increased Knowledge → Agroforestry Practices → Income Resilience

Hypothesis 5:

Agroforestry has indirect impact reducing income vulnerabilities

Increased network with extension official

Estimation Model: Local Average Treatment Effect

Random Effects Instrumental Variable Model

1. Effects of Training on Agroforestry Adoption

$$Agroforestry\ Index_{i,t} = \alpha_1 + \boldsymbol{\beta_1 Training_i * Post2013} + \beta_2 Training_i + \beta_3 Post2013 + w_i + u_i$$

Instrumented by Invitation (Lottery)

2. Effects of Training on Agroforestry Perception

$$Agro - Perception_{i,t} = \alpha_1 + \boldsymbol{\beta_1 Training_i * Post2013} + \beta_2 Training_i + \beta_3 Post2013 + w_i + u_i$$

Instrumented by Invitation (Lottery)

if Agroforestry Index > 1

3. Effects of Agroforestry on Income Smoothing

$$Coefficient\ of\ Variation\ (CoV) of\ Farm\ Income = \alpha_1 + \boldsymbol{\beta_1 Agroforestry\ Index} + \beta_2 X + u_i$$

(Mean/Std Deviation)

Estimation Model: Local Average Treatment Effect

Random Effects Instrumental Variable Model

4. Effects of Training on Social Network

$$Social\ Network_{i,t} = \alpha_1 + \boldsymbol{\beta_1 Training_i * Post2013} + \beta_2 Training_i + \beta_3 Post2013 + w_i + u_i$$

Instrumented by Invitation (Lottery)

5. Spillover from Participants to Non-participants

$$Agroforestry\ Index_{i,t} = \alpha_1 + \boldsymbol{\beta_1 Network\ with\ Participants * Post2013} + \beta_2 Network\ with\ Participants + \beta_3 Post2013 + w_i + u_i$$

Instrumented by network with people who were invited to the training

if $Non - training\ Participants = 1$

Findings: Agroforestry Index

	Index By Category	Index By Diversity	Conserved Water	Fuelwood	Medicinal Purposes	Increased Food Income
Post 2013 * Training * Low Income	0.438** (0.217)	0.474* (0.282)	×	×	0.255** (0.118)	0.191* (0.113)
Post 2013 * Training	-0.496*** (0.192)	-0.470* (0.248)	0.233* (0.130)	0.253** (0.0993)	×	×

	Log of Farm Income		Log of Produce (in Kg)	
	All Crops (combined)	Legume Crop	Legume Crop	Industrial Crop
Post 2013 * Training * Low Income	1.307*** (0.245)	1.360** (0.610)	0.436* (0.236)	0.814* (0.488)
Post 2013 * Training	-0.695*** (0.218)	-1.726*** (0.540)	-0.641*** (0.209)	-0.997** (0.432)

***, **, and * signify statistical significance at the 1%, 5%, and 10%

Findings: Agroforestry Index

General training participants diversify less after the training, because they tend to specialize on the main cash crops, but the poor behaves differently due to capital constraints…

Post 2013 *	-0.496***	-0.470*	0.233*	0.253**	✗	✗

… with less diversity, the income decreased for the rich while it increases for the poor, because:

1) Crop specialization takes longer to grow
2) As the poor kept diversity relative to the rich, the poor may have benefited from lower supply in the market

	(0.218)	(0.540)	(0.209)	(0.432)

***, **, and * signify statistical significance at the 1%, 5%, and 10%

Findings: Spillover from Training Participants

	All Farmers		Non-training Participants	
	Agroforestry Index by Category	Agroforestry Index by Diversity	Agroforestry Index by Category	Agroforestry Index by Diversity
Network with Training Participants * Post 2013	×	×	**0.0260** **(0.0132)**	×
Network with Training Participants * Post 2013 * Low Income	×	**0.119**** **(0.0597)**	×	×
Network with Training Participants	**-0.0130*** **(0.00778)**	×	**-0.0189**** **(0.00924)**	×
Network with Training Participants * Low Income	×	×	×	×

Training participants may have been successful in promoting more diversification to non-training participants

***, **, and * signify statistical significance at the 1%, 5%, and 10%

Findings: Social Network and Income Smoothing

	Training Participants			All Farmers	
	No of Advice Network from Same Training Group	No of Advice Network from Different Training Group	No of Advice Network from Non participants	No of Frequently Met Agricultural Informants	Having Frequent Contact with Extension Agents
Post2013 * Training * Low Income	×	×	1.085** (0.531)	1.760*** (0.619)	×
Post2013 * Training	×	-0.397*** (0.137)	×	×	×

	CV of Farm Income	CV of Log of Farm Income
Agroforestry Index	-3.861*** (1.237)	-0.156*** (0.0463)
Agroforestry Dummy (= 1 if diversifying)	-11.66*** (3.934)	-0.401** (0.163)

***, **, and * signify statistical significance at the 1%, 5%, and 10%

Findings: Social Network and Income Smoothing

	Training Participants			All Farmers	
	No of Advice Network from Same	No of Advice Network from Different	No of Advice Network	No of Frequently Met	Having Frequent Contact with
Post2013 * Training	×	-0.397*** (0.137)	×	×	×

Poorer trained participants increased the size and depth of their social network which may explain why they keep the diversity, but the rich talk less with their network, probably they value information more than the poor…

	CV of Farm Income	CV of Log of Farm Income
(= 1 if diversifying)	(3.934)	(0.165)

Agroforestry in general is negatively associated with income variation, indicating its role in stabilizing income, especially for the poorer farmers…

***, **, and * signify statistical significance at the 1%, 5%, and 10%

Revisiting the Hypothesis

Hypothesis 1: ✕ Not supported

Training participants diversify more post training

Diversification may not be appropriate for richer farmers

Hypothesis 2: ✓ Supported

Training participants are more aware of the perceived benefits of agroforestry due to increased knowledge

Different perceived benefits are seen between the poor vs the rich farmers

Hypothesis 3: ✕ Not supported (Mixed)

Training participants will have more intensified social network post training **(only the poor)**

Strengthened network may have affected attitudes on agroforestry

Revisiting the Hypothesis

Hypothesis 4: ✓Supported (only partially)

Training participants, regardless of income, have higher propensity to diffuse agroforestry adoption to non-participants

The rich diffuse to non-participants, the poor diffuse to everyone in general

Hypothesis 5: ✓Supported

Agroforestry has indirect impact reducing income vulnerabilities

Agricultural diversification is negatively associated with farm income variation in 3 years timespan

official

Policy Implication

- Agroforestry training can help poverty eradication, by promoting income stabilization
  - Different attitudes on agroforestry are identified between the rich and the poor
  - … as well as the perceived benefits of agroforestry
- The changes in the poor's attitude are driven by the changes in their size and depth of social network
- All training participants diffuse knowledge of agroforestry to non-training participants
- Agroforestry may advance farmers' welfare, esp. the low income, and it reduces income vulnerabilities
- Future development initiatives should consider variation to distinguish farmers according to socio-economic characteristics


THANK YOU

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