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

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Abstract

Agroforestry has long been regarded as a means for income smoothing for poorer household, however, little attention was given to differentiating between farmers with different income level, their ability to adopt, and the economic outcomes of adoption. This paper examines institutionalized training effects in promoting agroforestry by distinguishing between poorer and higher income farmers to see agroforestry system's relevance to the poor, the extent of adoption, and its economic consequences. We found that after the training, poorer farmers tend to cultivate more crops relative to richer farmers, which is significantly contributed by leguminous and industrial crops. After the training, the poor also tend to increase the depth and size of social network with their peers and agricultural specialists. Impact evaluation assessments also show that agroforestry is negatively associated with income vulnerabilities, indicating the training program's relevance for poverty eradication strategy.

JEL Classification Codes: O1, O2, Q22

Keywords: agrofrestry; agricultural training; impact evaluation; social network, information diffusion

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I. INTRODUCTION

Improving rural livelihood has been a continuous challenge faced by developing countries where threats of food security and environmental deterioration on fragile agriculture lands problems collide with income vulnerability. Agroforestry is currently seen as an alternative paradigm for rural development worldwide that is centered on species-rich, low-input agricultural techniques including a diverse array of crops, rather than on high-input monocultures with only a small set of staple food crops (Leakey 2001; Leakey 2001). Some forms of agroforestry techniques require low external inputs (pro-poor) and efficient integration of trees, making them good candidate for achieving both sustainable livelihood and ecological objectives (Koohafkan, Altieri et al. 2012). The simplest and most traditional agroforestry practices are to diversify crops or inter-cropping. Economically, agroforestry can diversify farm operations (Caviglia‐Harris and Sills 2005) and livelihood strategies (Cramb and Culasero 2003)—to reduce risk and increase resilience, especially for smallholder farmers (Lin 2011). In the longer term, agroforestry can reduce poverty by enhancing farm income (Leakey and Tchoundjeu 2001), providing provision for fodder, fuelwood, and medicinal purposes (Akinnifesi, Sileshi et al. 2008), generating employment (Asaah, Tchoundjeu et al. 2011), ensuring food security (Garrity, Akinnifesi et al. 2010), and enhancing livelihood opportunities (Leakey, Tchoundjeu et al. 2005). Agroforestry can bring not only economic but also environmental benefit, including soil and water conservation (Bekele-Tesemma 1997), increased soil fertility (Young 1989), and improved or maintained surroundings (Regmi 2003).

Development intervention promoting agroforestry varies, from participatory programs incorporating both technical training and knowledge sharing to improve ecological and economic well-being (Fischer and Vasseur 2002; Asaah, Tchoundjeu et al. 2011), to various financial aid programs in the form of subsidies to diversify farm management and encourage forest-tree planting (Thacher, Lee et al. 1996; Mehta and Leuschner 1997; Carvalho, Coelho et al. 2002). Educating people about conservation and preservation is a necessity in preventing environmental degradation, but the content should be suitable to farmers' interest. To address this, interventions designed to increase investment in human capital,

amongst other methods of intervention, are more favorable, as not only they provide farmers with theories and practical knowledge regarding the correct techniques, but also encourage positive attitude changes resulting from various interactions with agrarian actors during and upon returning from the training.

Most impact assessments largely focus on measuring adoption, yields, and economic gains—poverty reduction was assumed to follow. The research challenges lie in how to differentiate the poorer within the community; and how to assess whether the technologies are relevant to the poor and how they affect them. Little attention was given to differentiating between farmers with different levels of assets and different social characteristics, ability to adopt, and the ultimate economic outcomes of adoption. This paper aims to fill the gap in explaining linkage amongst the variables of economic, ecological and social aspects of agroforestry, using the situation and condition of rural Indonesian livelihood. To serve the purpose, we carried out randomized-controlled trial to select coffee and/or cocoa farmers in the region for participating in institutionalized training. Program evaluation spans in two-year period, ensuring that we captured the short- and mid-term impact of the program.

We found that farmers who are generally poorer tend to diversify more or keep their number of crops after returning from the training, in contrast to the general training participants who reduce crop diversity. Perceived agroforestry benefits are different across poorer and relatively well-off farmers. The former reported that agroforestry has improved their food incomes and provided provisions for medicinal purposes, while the latter testified that they experienced conserved soil and water, and obtained provision for fuelwood. Further, poorer farmers are found to increase their depth and size of network upon returning from the training program, which is likely to influence agroforestry adoption. Positive network associations between training participants to non-participants on promotion of such practices are found, indicating the presence of spillover. Finally, we discovered that agroforestry in medium-term is negatively correlated with income vulnerability. Increased income for poorer farmers is obtained from legume crops commodities, which shows a significant upsurge after returning from

the training.

The rest of the paper is organized as follow: Section II provides theoretical ground and hypothesis; Section III elaborates on study area and situation in Indonesia; Section IV describes the survey methodology and social intervention; Section V builds on empirical strategy; Section VI draws the estimation results and finally Section VII concludes with discussion.

II. CONCEPTUAL FRAMEWORK

This paper aims to examine the impact of institutionalized training upon agroforestry adoption, perceived benefits, and eventually farm income stability. To serve the purpose, we present several hypotheses:

Hypothesis 1: Training participants will have higher index of plant diversification relative to non-participants.

For a successful adoption, agroforestry techniques should be compatible with local practices and traditions, and also farmers' beliefs, values and social system (Barr and Cary 2000). Awareness of possible new practices is not sufficient to ensure their implementation. We consider training as intervention because behavior change plays bigger role than technical and financial consideration (Kilpatrick, Bond et al. 2003); and values and attitudes must change before behavior changes (Kilpatrick and Johns 2003). In training, farmers are exposed to new channels of knowledge and opportunity to interact with trainers (agricultural experts) and fellow training participants (peers). These features in training are expected to have crucial role in propelling the implementation of agricultural technologies.

Adoption patterns between small and large farmers may differ. For medium and large farms, fallow and extensive grazing are still important and intensive agroforestry systems may not yet be economically appropriate. In contrast, for smallholders intensive system may be more interesting but food security and risk issues play a more critical role than for large farmers. Poorer farmers may find agroforestry profitable, but the adoption is often hampered by limited land, labor, and capital resources and their

need to ensure food security and reduce risks. Netting (1993) suggests that the main strategy for combining high production per unit area with risk reduction and sustainability in agriculture is diversification, indicating its suitability for poorer farmers. Agroforestry systems that offer short-term benefits are preferable, as the mechanism allows farmers to sustain longer-term investments in agroforestry.

Hypothesis 2: Training participants will have better awareness on perceived agroforestry benefits relative to non-participants.

Environmental and economic benefits of agroforestry are recognized. Ecological benefits include improving soil and water conservation and improved surrounding due to woody trees, while economic benefits captured in this study are the chances of reducing complete crop failure, provision for medicinal purposes and fuelwood. Pastur, Andrieu et al. (2012) posits that farmers who do acknowledge the merits of agroforestry will incorporate certain techniques into their farming practices if they can afford it.

Hypothesis 3: upon returning, we expect training participants to have enlarged their network depth and size, which influenced adoption.

Farmers who have larger networks are more likely to make changes in their practice. Rogers (2010) concluded that early adopters have greater social participation after examining studies in agricultural and non-agricultural settings in developed and developing countries. Interaction with others including neighbors, experts, and families have influence on changing values and attitudes (Wood 2000). Thus, farmers who participate in agricultural and community organizations are more likely to adopt innovations because not only do they become aware of a wider variety of new practices, they also have opportunity to test and change values and attitudes. Network mechanism amongst poorer- and well-off farmers may likely differ, as social status within villages affects outcomes of dissemination methods. The former will possibly solicit more information from peers, while the latter may primarily obtain knowledge from agricultural specialists (extension agents).

Hypothesis 4: Training participants regardless of income group have higher propensity to diffuse knowledge regarding agroforestry practices to non-training participants.

All training participants, in spite of the different income groups, are presumed to increase their communication intensity with their agricultural advice network upon returning from the training. As information is embedded in social interactions (Granovetter 1973), knowledge from the training is also more likely to be transferred from training participants to non-participants. As agroforestry benefits are informed during the training course, farmers may be able to understand its merits thus accelerating the implementation of agroforestry practices in their community. In this paper, we expect to see positive association between network ties to training participants and adoption of more agroforestry practices for non-training participants.

Hypothesis 5: In the medium to long-term timeline, agroforestry adoption will have indirect impact reducing income vulnerabilities especially for poorer farmers.

To cope with risk, vulnerable households can smooth the income by making conservative production or employment choices and diversifying economic activities (Morduch 1995). Diversified production provides smallholders with the opportunity to select a particular crop or crops for commercial production (such as coffee or cocoa in the area) in order to increase farm-generated income while meeting the increasing demands for local produce. Based on previous studies such as Omamo (1998) and Gaiha and Imai* (2004) who demonstrated that crop diversification reduces vulnerabilities, we hypothesize that crop diversification will generally reduce households' income variation, which will primarily benefit the poorer farmers and protect them from external shocks.

III. STUDY SITE

III. 1. Study Context

Most of the 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,

Suryahadi et al. 2000). Despite the declining share in GDP, agriculture still provides income for majority of Indonesian (in 2012, 49 million employment or 41% of the total labor force[c]). Lampung Province, the study field site, is one of top producers of Robusta coffee and cocoa beans. Coffee- and cocoa-based agroforestry systems are appealing to farmers because these crops are highly valued commodities and can create jobs (Budidarsono and Wijaya 2004). Smallholder farmers in Lampung cultivate a variety of tree gardens, including monocultural systems, multispecies gardens, and agroforests – tree garden systems that resemble natural forests (Roshetko and Purnomosidhi 2008).

Our study took place in Tanggamus district as it currently tops the coffee and cocoa producing districts in Lampung. Coffee producing areas span around 43,941 hectare with 30,143 tons of product annually[d]. Geographic location of the survey lies in 104°18' - 105°12' East and 5°05' - 5°56' South.

III. 2. Agriculture Characteristics and Techniques

Farm management in Tanggamus varies from traditional shaded coffee-garden to complex agroforestry system that combines many species of trees with various types of agricultural crops. Traditional agroforestry practices, such as the planting of fruit trees in home gardens and close to family dwellings are prevalent amongst shareholders farmers. Tree garden systems are known to maintain high-quality soil while conserving water (Castillo and Toledo 2000; van Noordwijk, Agus et al. 2011). Apart from coffee and cocoa as the main cash crops, farmers benefit from various provisions such as firewood, fodder, fruits, and medicinal plants. In the study area, annual crop plants such as rice, cucumber, tomato; perennial fruits such as banana, papaya, avocado, durian, snake fruit (*Salak*); perennial industrial crops such as cocoa, coffee, coconut, rubber, and oil-palm; perennial herbs such as ginger, nutmeg, pepper, long pepper, chili; perennial vegetables such as breadfruit, eggplant, cabbage, and wood plants such as teak, albasia, and mahogany are cultivated. Unlike annual crops, perennials are planted once and live for years, producing many consecutive harvests.

[c] http://www.indonesia-investments.com/culture/economy/general-economic-outline/agriculture/item378 accessed 2015/09/15
[d] http://tanggamuskab.bps.go.id/ accessed 2015/09/15

Official extension system in Indonesia is carried out through farmer groups, following Law 16/2006 on Extension System for Agricultural, Fishery and Forestry (Neilson 2008). A farmer group consists of farmers living in nearby neighborhoods and cultivating the same commodity of interest. It usually comprises 20 to 30 people living in the same neighborhood, but may not necessarily represent everyone in a village. One or two extension workers are assigned to each group to monitor the farmers' progress and advances at least once a month through monthly group meetings.

IV. DATA

IV. 1. Description of Household Survey

(Figure 1 here)

As indicated in Figure 1, this study was carried out between September 2012 and September 2014. The 2012 baseline survey was conducted to all household heads in 16 randomly selected coffee- and cocoa-producing farming groups in the district of Tanggamus, in Pulau Panggung and Sumberejo sub-districts, which are the district's top producing areas. The 16 selected Farmers Groups listed 398 households as members in 2008, according to the latest data compiled by the local government. During the September 2012 survey, we administered the questionnaire to 312 out of the 398 households (78%). Face-to-face interview was carried out to self-identified household heads, which particularly asked about their socio-economic characteristics, agricultural activities, as well as agricultural advice network. GIS locations of households are shown in Figure 2.

(Figure 2 here)

IV. 2. Social Intervention: Agricultural Training

We administered the baseline survey in September 2012 and found that on average, farmers cultivate two plant categories in their farmlands (Table 3). Their median annual farm income is around Rp. 12,800,000 (or US$ 1000). Most farmers belong to smallholder category with the average cultivated land of 1 hectare.

In the study area, information disseminates through extension visit to regular farmer group meetings. Farmer preferences for species being cultivated depend on household needs and markets (Wiersum 2006). However, extension services generally make recommendations on new species according to biophysical criteria with less consideration on markets. Knowledge variation also exists amongst extension workers, and in some isolated area, extension coverage does not work strongly. Aside from extension workers and fellow farmers, farmer in the district almost never gets exposed to new channel of information. Critics to group-based approaches mentioned that the system works better for the non-poor than for the poor, as it sometimes tend to disadvantage farmers of lower social status who are less likely to participate in or dominate groups (Place, Adato et al. 2007).

Thus, we decided to carry out an institutionalized training by professionals from the national research institute; a training program that is usually offered to train extension agents. Our purpose is to examine whether exposing institutionalized training directly to farmers has any impact upon farmers' attitude and perception towards diversification. In February 2013, we invited randomly selected 156 farmers, or 50% of the total 312 respondents, to attend a three-day training program: the first and second day would focus on training in coffee and cocoa cultivation respectively, and the last day would be spent on a field trip to a coffee-and-cocoa pilot farm. For heterogeneity purposes, we administered the training in three different locations, namely (1) in Tanggamus, the district where the farmers live; (2) in Kalianda, South Lampung, a more touristy district located around 170 km from Tanggamus but still in Lampung province; and (3) in Garut and Ciamis, the districts producing coffee and cocoa, respectively, on more developed Java Island. The program was made to happen by the coordination of four district governments. Figure 3 displays the geographical locations of the training areas.

(Figure 3 here)

(Table 1 here)

The invited 156 farmers were randomly placed into three groups according to the location where their training would be conducted. Of the total 156 farmers, 52 farmers were randomly assigned to each one

of the three training locations. Table 1 shows the actual number of training participants, which is 120 out of the 156 invited farmers, or around 79%. Specifically, 39 farmers (75%) were able to participate in the training in their hometown, 39 (75%) attended training in intra-island location but still located in the same province, and 42 (81%) participated in inter-island training, respectively. Distribution is even amongst poorer farmers and relatively well-off farmers, indicating that randomization works well. Accommodation, food, and travel insurance during the trip and the training were provided for farmers participating in intra-island and inter-island training.

Two professional trainers from the Indonesian Coffee and Cocoa Research Institute (ICCRI) were invited to provide lectures during the first two days. The trainers and training-program materials were identical at each location. We ensured that all training locations offered similar environments. The in-class training materials for coffee and cocoa on the first and second days consisted of basic cultivation training, such as (1) information on shade trees and crop diversification; (2) information on fertilizer, including ways to procure organic fertilizers from livestock; (3) ways to select high-yield varieties and crop and pest management. The third day primarily consisted of a pilot-farm visit where trainers gave practical information on how to maintain a plantation using the situation and conditions in the pilot farm as an example.

(Table 2 here)

Table 2 displays the general household characteristics of the invited and uninvited groups to confirm our randomization process. Education, income, and community characteristics do not significantly differ between invited and uninvited farmers.

(Table 3 here)

Post-evaluation surveys were conducted twice, in September 2013 and then in September 2014, making a three years panel dataset. Table 3 shows whether diversification pattern changed due to training participation. All respondents reported a significant increase for crops cultivated, particularly for spice and fruits, even though the non-training participants seem to contribute more. In terms of

perceived benefits, all respondents testified that they significantly felt the conserved soil and water happening in their farmland. However, for provision for medicinal purpose, only training participants felt the benefits.

(Table 4 here)

Lastly, Table 4 illustrates various social network variables. Richer training participants in general talk significantly more with their agricultural informants compared to poorer training participants. However, after the training, the difference becomes no longer significant.

V. EMPIRICAL STRATEGY

V. 1. Dependent Variables

This paper examines institutionalized effects upon the difference in agroforestry adoption patterns between low- and high-income farmers. We found that farm income is skewed towards low income; hence we regard poorer farmers as those whose income falls below median farm income. As an addition, this study distinguishes between the impact of the training in general, and the impact of training on different income group. In particular, we intend to examine whether training has had any impact upon these variables:

1. **Agroforestry index**

   (Table 5 here)

   In this paper we constructed two different agroforestry index: by crop category and by crop diversity. Crop category consists of cereal, leguminous, industrial, spices, vegetable, fruit crops and hardwood crops, while crop diversity comprise of each different variety of crop (see Table 5). The index is constructed as the total number of commodity that the farmers cultivate in the farmland.

2. **The perceived benefits of agroforestry**

   For those cultivating more than one crop category or crop diversity, we asked whether farmers feel the benefits of agroforestry after they implemented agroforestry (that is agroforestry index > 1)

3. **Network of training participants upon returning from training**

   Farmers tend to discuss with others, particularly with people in their farmers group, regarding farming activities. First, we ask farmers all the name of such people, then we identify whether their advice network belong to the same training group, different training group, or people who do not go to the training at all.

4. **Network with peers and experts for all respondents**

   We ask all respondents whether they know an extension agent (knowing means mutually, so they could contact them directly) and whether they communicate frequently. We also ask farmers' agricultural information sources, both people from within the farmers' group or outside the farmers' group.

5. **Income smoothing**

   To examine the income smoothing, we employ coefficient of variation (CV) of farmers' farm income within 3 years timespan. The Coefficient of Variation is a distribution's standard deviation divided by its mean. To check for robustness, we use the real value and log value of farm income.

V. 2. Estimation Strategy

As is always the case with impact-evaluation studies, participation in training is likely to cause a self-selection bias. Although we randomly invited farmers to participate and Table 2 shows that on average no differences exist between invited and non-invited farmers, the decision of whether to participate in training is ultimately the farmer's choice and thus the model may suffer from endogeneity in this variable. To examine the pure effect of training participation, we employ the Local Average Treatment Effect (LATE) model and instrument the participation status with random invitation status. Thus, we report the treatment effect on the treated (TOT) rather than the intention-to-treat (ITT) effects[e].

Among the models tested are the Fixed-Effect and Random-Effects instrumental variable models. However, due to the Hausman-test result, which supported the validity of employing the Random-

[e] The results of ITT, which are similar to the TOT estimation we present here, are available upon request

Effects model, in addition to the ability to fit more into the data and the analysis, we decided to employ the Random-Effects-IV model as follows:

1. Effects of Training on Agroforestry Index

$$Agroforestry\ \ Index_{i,t}^{j} = \alpha + \beta_1 Training_{i,t} * Post2013 + \beta_2 Post2013 * Training_{i,t} * Low\ \ Income + \beta_3 Training_{i,t} * Low\ \ Income + \beta_4 Post2013 + \beta_5 Low\ \ Income + \beta_6 Training_{i,t} + u_i + w_{i,t} \quad (1)$$

2. Effects of Training on Perceived Benefits of Agroforestry on Condition of Practicing It

$$Perceived\ \ Benefit_{i,t}^{j} = \alpha + \beta_1 Training_{i,t} * Post2013 + \beta_2 Post2013 * Training_{i,t} * Low\ \ Income + \beta_3 Training_{i,t} * Low\ \ Income + \beta_4 Post2013 + \beta_5 Low\ \ Income + \beta_6 Training_{i,t} + u_i + w_{i,t} \quad if\ Agroforestry\ Index > 1 \quad (2)$$

where i is the household head in year t. In (1), the dependent variable is agroforestry index j, constructed either by the sum of crop category or crop diversity. The independent variable is the interaction term between the training participation dummy and the year after training (post-2013), to see training effects upon adoption. We also construct the same interaction terms for poorer farmers or farmers with below median farm income.

In (2), the dependent variable is perceived benefits of agroforestry, constructed as agroforestry benefits dummy (= 1 if experienced the benefits) predicated on the condition of cultivating more than 1 commodity in the farmland.

To examine the factors driving agroforestry adoption, we analyze how farmers' social networks have changed due to training. For this we have the following model:

3. Effects of Training on Various Social Network Variables (Poorer vs Richer Farmers)

$$Advice\ \ Network_{i,t} = \alpha + \beta_1 Training_{i,t} * Post2013 + \beta_2 Post2013 * Training_{i,t} * Low\ \ Income + \beta_3 Training_{i,t} * Low\ \ Income + \beta_4 Post2013 + \beta_5 Low\ \ Income + \beta_6 Training_{i,t} + u_i + w_{i,t} \quad (3)$$

In (3), the dependent variable is various social network variables. We asked farmers to recall the names of people outside their household from whom they seek advice, can learn from, or from whom they can generally obtain useful information about farming practices, particularly about coffee and/or cocoa, which we later constructed as personal network variables as follow:

(PN1) Training participants' agricultural advice network upon returning from training

We investigated whether training participants increase their communication intensity with fellow farmers who went to the same training group, a different training group, or farmers who did not go to the training at all.

(PN2) Farmers' meeting frequency with their agricultural informants

We examined whether training has had any impact upon farmers' meeting frequency with their agricultural informants in general.

(PN3) Farmers' network ties with agricultural specialists

We surveyed farmers' communication frequency with agricultural specialists, namely extension agents. Extension agents are regarded as more advanced sources of information than fellow farmers and are readily accessible for consultation. However, data on networking with experts are only available for 2012 and 2013.

4. Information Spillover from Training Participants to Non-training participants

$$Agroforestry\ \ Index_{i,t}^{j}$$

$$= \alpha + \beta_1 Network\ \ with\ \ Participants_{i,t} * Training_{i,t} * Post2013$$

$$+ \beta_2 Network\ \ with\ \ Participants_{i,t} * Training_{i,t} * Post2013$$

$$* Low\ \ Income + \beta_3 Network\ \ with\ \ Participants_{i,t}$$

$$+ \beta_4 Network\ \ with\ \ Participants_{i,t} * Low\ \ Income + \beta_5 Training_{i,t}$$

$$* Post2013 + \beta_6 Post2013 + \beta_7 Training_{i,t} * Post2013 * Low\ \ Income$$

$$+ \beta_8 Training_{i,t} * Low\ \ Income + \beta_9 Low\ \ Income + \beta_{10} Post2013 + u_i$$

$$+ w_{i,t}\ \ if\ \ non - training\ \ participants = 1$$

(4)

In (4), we particularly examine the spillover of training participants by income group on agroforestry practices to non-participants. For this estimation, separate regression is run for the non-training participants. The main variable of interest is network with training participants post training, which is defined as farmers' agricultural advice network who attended the training. Farmers are asked from whom they get information pertaining to farming practices, and then we identify whether these individuals were selected to attend the training and have actually attended the training. This network variable may possibly be endogenous because those who diversify more may be influential thus already having more networks to begin with. Furthermore, this variable is treated as an independent variable in further analysis. To deal with endogeneity, social network with training participants is instrumented with social network with farmers who are invited to the training, as invitation to attend the training is randomized.

5. Agroforestry Effects on Income Vulnerabilities

$$Coefficient\ \ of\ \ Variation\ \ of\ \ Farm\ \ Income$$

$$= \alpha + \beta_1 Agroforestry\ \ Index + \beta_2 Agroforestry\ \ Index$$

$$* Low\ \ Income + \beta_3 X + u_i$$

(5)

Finally, (5) models the impact of agroforestry on income smoothing or coefficient of variation of farm income. We employ pooled ordinary least square (OLS) for this estimation. The independent variables are various household characteristics.

VI. RESULTS

VI.1. Training Effects on Agroforestry Index

(Table 6 here)

Table 6 illustrates training effects on agroforestry index. In general, training participants cultivate lesser crops than before the training by almost 0.5 points. However, relative to their richer counterparts, poorer farmers significantly increased their crop diversity or kept their number of crops by 0.4 points even after village dummies are controlled. General training participants may learn from the training that the commodities they are currently cultivating are not aligned with their livelihood strategies i.e. not suitable financially or environmentally, and that they better convert the less-profitable crops into main cash crops. On the contrary, the poorer in the community behaves differently after the training, that they opt to increase the diversity or keep the number of crop category probably due to capital constraints. This finding may mean that: (1) the poor may become more knowledgeable regarding the benefits of diversifying their farm after the training, hence adapting their livelihood strategy to diversify their crops upon returning from the training program, or (2) even if they intend to specialize on the main cash crops, they are unable to do so due to capital constraints, hence keeping the number of crop category.

The fact that general training participants diversify less after the training proves that the first hypothesis is not supported. In order for agricultural practices to be adopted fully, farmers have to be aware of its merits. In this context, agroforestry may not be appropriate for farmers in general. However, this study provides more evidence that the poor behaves differently when it comes to diversifying their farm strategy, making agroforestry an effective measure for the poor to optimize their farm management.

VI.2. Training Effects on Agroforestry Merits

(Table 7 here)

Table 7 exhibits the effects of training on perceived merits of agroforestry after implementing it in the farmland. Column 1 to 4 reported the perceived benefits of agroforestry according to crop category while column 5 to 8 provided similar analysis according to crop diversity. In column 1, 2 and 6, all training participants reported that they benefit from agroforestry particularly the conserved soil and water and the provision for fuelwood. In the case of poorer farmers in column 3, 4, and 7, they testified that they benefited from the provision of medicinal purposes and increased food income. Weaker effects on agroforestry are seen when analysis is conducted based on plant diversity or simply the number of crops cultivated.

This finding suggests that different perceived benefit is seen between lower vs. higher income training participants, in which the second hypothesis is supported. Higher income farmers tend to feel the environmental merits of diversification i.e. conserved soil and water and economical i.e. provision of fuelwood. On the other hand, lower income farmers benefit from medicinal purposes and increased food income. Franzel and Scherr (2002) argued that it is likely to take three to six years before agroforestry's ecological benefits begin to be fully realized compared to the few months needed to harvest and evaluate a new annual crop or method. The findings may mean that (1) for environmental benefits, agroforestry has delivered the merits since before the training, but farmers just realized it after the training due to increased knowledge, and (2) for economic benefits, the farmers are already informed regarding the advantages since before the training, but they experienced it after implementing the techniques post-training. Poorer farmers may have realized that diversifying the crops may help increasing food income, but they also have lacks of knowledge regarding suitable crops or technical matters. After obtaining the correct knowledge, they implemented it in their farmland thus experiencing the benefits.

VI.3. Training Effects upon Social Network Variables

(Table 8 here)

Various social networks of training participants are examined in Table 8. We found that in general training participants who belong to same training group do not significantly communicate amongst themselves upon returning, and they even significantly have less contact with agricultural informants who went to the different training location. However, column 3 shows that poorer farmers, who are trained, tend to communicate more with people who did not go to the training at all. They are also found to meet agricultural network more frequently, once every one or two days (column 4). However, participants from this income group do not significantly increase contact with agricultural specialists.

Poorer training participants are found to have increased the size and depth of network, while participants in general have reduced their network intensity, indicating the third hypothesis to be only partially supported. Poorer training participants, who often are more marginalized and having less opportunity to improve their formal knowledge may have experienced changes in their mindset and attitude after the training. Upon returning, they are more likely to be pro-active in information gathering thus the significant increase in their network size relative to their richer counterparts. On the contrary, richer training participants seem likely to value new information more than the poor, making them less enthusiastic to exchange information with their network.

VI.4. Information Spillover from Participants to Non-participants

(Table 9 here)

Effects of information spillover from training participants to non-training participants on agroforestry practices are exhibited in Table 9. Column 2 demonstrates that having more ties with training participants who belong to low income category are associated with significant increase in agroforestry index (by diversity) amongst farmers in general, while column 3 reports that training participants in general drive significant influence to non-training participants in increasing their agroforestry index (by

category).

Training participants in general appear to successfully promote agroforestry practices to non-participants, suggesting the fourth hypothesis to be partially supported. Poorer training participants are also found to drive spillover to all farmers in general but not to non-participants. Upon returning from the training, all training participants regardless of income group may have become more open-minded, thus becoming more enthusiastic to enlarge their network size by communicating more with their peers. These changes in their communication trends may lead to stronger information spillover particularly to non-training participants, stirring them to have higher chances to practice more agroforestry.

VI.5. Agroforestry impact upon income smoothing

(Table 10 here)

Farmers' average produce sold annually and their income report are reported in Table 10. Evidence is found that after the training, poorer training participants have significantly increased their production of leguminous and industrial crops (column 2 and 3). We later confirmed with the income report which shows that poorer farmers indeed have increased their income for leguminous crops (column 9) and even their total farm income in general (column 15). This is contrast with training participants in general who reported a decline in income for the same commodity. It could possibly that higher-income training participants have stopped cultivating leguminous crops but done more intensification on main cash crops instead.

(Table 11 here)

Table 11 examines the correlation of agroforestry on income vulnerability. Column 1 to 4 show that agroforestry, both according to crop category or diversity, has significantly negative association on farm income variation. This indicates that for each addition of commodity, the income variation becomes smaller. However, as agroforestry variables are used in the previous sections as a dependent variable,

it may be endogenous. A dummy on agroforestry is constructed as having cultivated more than 1 crop in the farmland, which still shows strong negative effects on income variance.

The income report shows that diversification helps poorer farmers stabilize their farm income, which is consistent with the fifth hypothesis. In the previous sections, evidences are found that poorer training participants tend to keep the number of crop category or increase the crop diversity after returning from training. Deeper examinations discover that the poor may have significantly cultivated more of legume and industrial crops, and they also significantly increase their farm income post-training relative to the rich. With less diversity, the income decreased for the rich while it increased for the poor because: (1) Crop specialization takes longer to grow, (2) as the poor kept the number of crop category relative to the rich, the poor may have benefited from lower supply in the market in the short term.

This section concludes that agroforestry is found to be relevant for the poorer households to increase their farm income and stabilize their earnings, and training is an appropriate strategy to spread awareness and change mindset regarding agroforestry practices.

VII. CONCLUSIONS

This paper aims to investigate the impact of institutionalized training on the adoption and perceived benefits of agroforestry practices particularly differentiating between the poorer and higher income farmers. To see the adoption mechanism, various social network ties amongst training participants as well as interaction with peers and experts resulting from the training are examined. Training spillover from participants to non-participants upon returning from the training is also incorporated in the analysis. The highlights of this paper are as follow:

First, different attitudes on agroforestry are identified between poorer and richer training participants. Richer training participants in general reduce their number of crops in their farmland upon returning from the training, in contrast to their poorer counterparts who increase their crop diversity or keep the number of crop category. Training participants coming from below-median farm

income are the most benefited from the agroforestry training program, because agroforestry practices help stabilize their income. The results suggest that the poor tend to be more diversified in terms of crop diversity or keep the crop category in their limited farmland. Post-training, poorer farmers may think that cultivating main cash crop is not sufficient, because: (1) crops are harvested after several months; (2) yields may not be as high due to limited land size and intensive management required; and (3) market uncertainty. Poorer farmers may look for options to diversify their cropping systems and to increase incomes, and training has helped them to achieve the objectives.

On contrary, general training participants may learn from the training that the commodities they had in the farmland are not suitable environmentally and financially, thus reducing crop diversity or replace it with other commodities. Some with relatively larger farmland may opt to concentrate on main cash-crops instead due to some considerations they weigh from the training. We also found that larger farms are generally more diversified (see Culas and Mahendrarajah (2005)), but the training has helped the poorer to achieve the optimum level of diversification to protect them from risks. They may find the right recommendation and knowledge from the training thus implemented the techniques in their farmland upon returning from the training.

Second, perceived merits of agroforestry may differ between richer and poorer farmers; the former tends to see its environmental benefits while the latter emphasizes on economic merits. While higher income farmers tend to reduce crop diversification after the training (in contrast to lower income farmers), they still testify agroforestry benefits despite reducing it. The results found that richer farmers may have confirmed the ecological benefits that are both theoretical and technical, while poorer farmers confirmed the economic benefit that is practical. From a policy point of view, agriculture technology adoption for the poor may be advisable to emphasize the economic gains more than the environmental merits

Third, the change in the poor's attitude on farming practices may be primarily driven by the increase in their size and depth of social network ties. The poorer trained-farmers may have stronger motivation than the average training participants in general, as they tend to increase communication

frequency with their peers, except with fellow farmers who went to the training. This significant increase in their depth and size of network may have propelled adoption of crop diversity. The finding is in line with Kilpatrick and Rosenblatt (1998), who posit that farmers who solicit information from peers tend to belong to lower socio-economic status and smaller farms. Burkhardt (1994) argues that the individuals with whom a person interacts directly influence beliefs about personal mastery, but attitudes and behaviors are more affected by structurally equivalent co-workers. In this case, interaction with peers is a stronger driver to perform adoption. However, richer participants behave differently, as they tend to limit information exchange with their network upon returning from the training, because they tend to value information more than the poor.

Fourth, all training participants in general are found to significantly diffuse knowledge regarding agroforestry practices to non-training participants. The training experience may have stimulated them to be more enthusiastic in knowledge gathering activities with their peers, thus may positively influence their non-trained counterparts to practice more diversification. Spillover from poorer training participants to all farmers in general is also identified. Poorer training participants who often lack the opportunity to access formal training may also have experienced significant changes in their attitudes related to farming and even personal development.

Sixth, with less diversity, the income decreased for the rich while it increases for the poor, particularly for leguminous crops. This is 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, significantly increasing their farm income in the short term. Leguminous trees complement and increase farm profit level, and are probably the most efficient in terms of cost benefit, to be adopted by poor farmers. More evidence are found that poorer training participants produced more of leguminous and industrial crops (probably as a strategy to stabilize their income), resulting in significant upsurge in their aggregate farm income. Dercon and Krishnan (1996) found that in Tanzania and Ethiopia, the poor typically enter into activities with low entry costs for income smoothing. In the context of Indonesian rural households, leguminous and industrial crops may be perceived as low cost and risk, but with decent returns.

Legume and industrial crops can serve as food, shades trees, while providing beneficial environmental benefits at the same time, hence are preferred by poorer farmers. Future development programs on sustainability should consider variation to distinguish farmers according to socio-economic characteristics while using low-cost, community-based dissemination approaches.

All in all, diversification may advance household welfare particularly for low income farmers, as it helps to reduce income vulnerabilities. However, agroforestry examined in this chapter may not generate a reduced deforestation, as we have limitation in incorporating ecological and biophysical criteria of the surveyed sample. We also believe many excesses following agroforestry adoption that affect income remains uncaptured in this study, amongst them are the provision of fodder, fuelwood, and medicinal purposes that are difficult to appraise monetarily. These provisions, which also could be obtained from leguminous produce, can diversify farmers' farm income thus reducing vulnerabilities.

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Figure 1: *Timeline of the research*

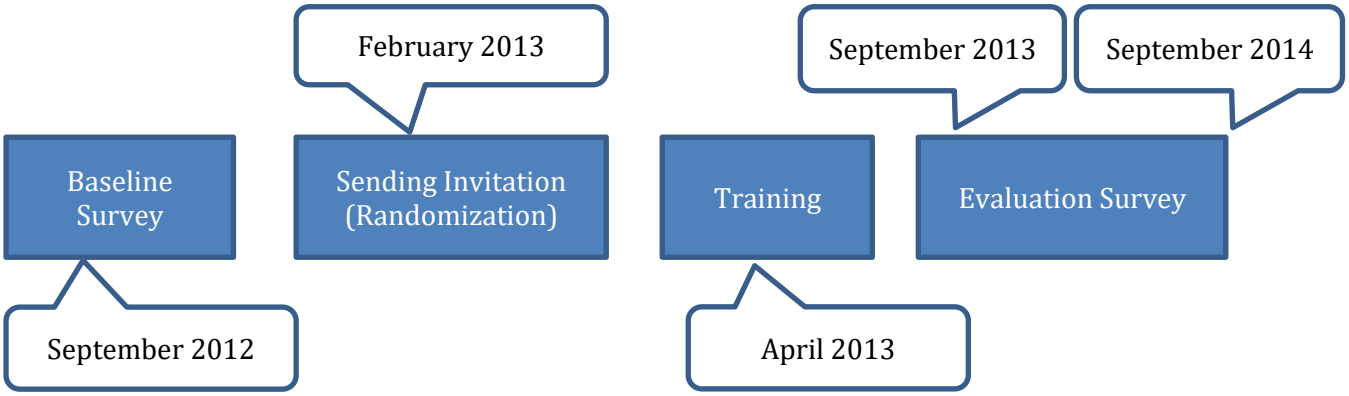


Figure 2: *Location of households*

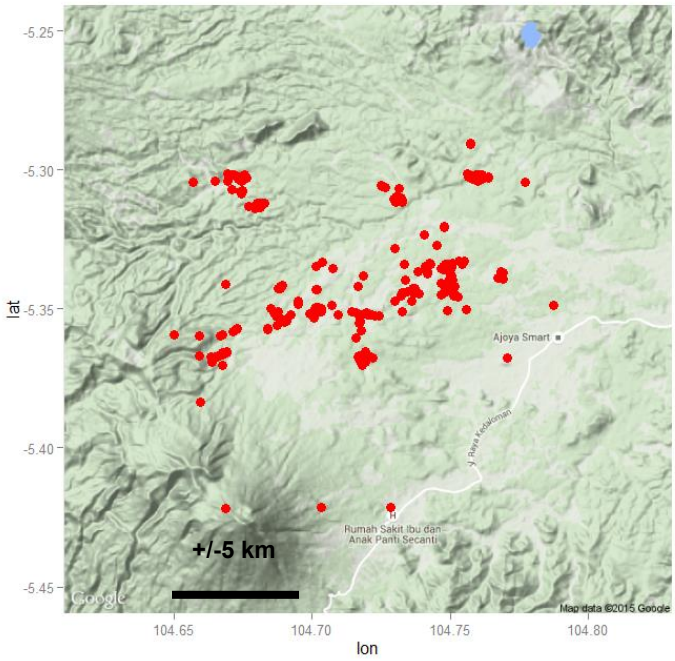
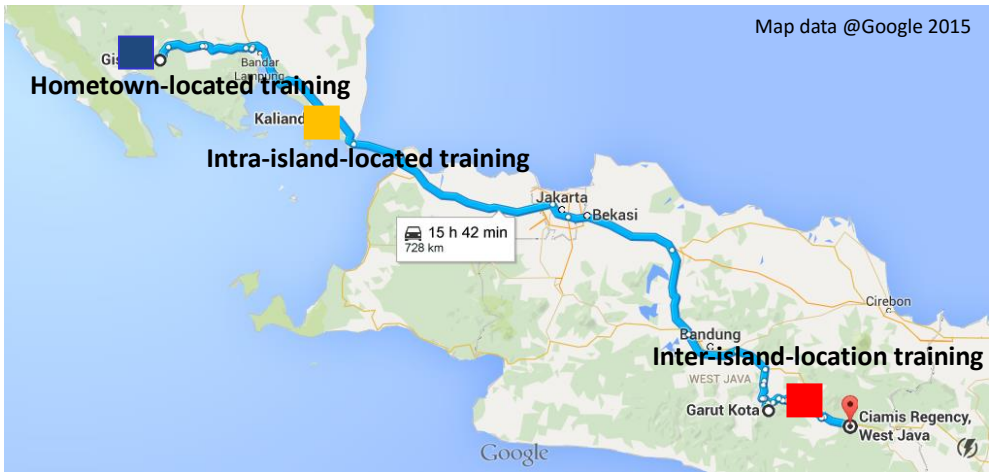


Figure 3: *Training Location*



Legends:
= Tanggamus district – the district which the respondents reside (hometown)
= South Lampung district – different district but still in the same province (intra-island)
= Garut and Ciamis district– districts located in the different island (inter-island)

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Table 1: *Training Participation*

	Non-invited respondents		Invited by lottery				Training Participation Rate
			Participating respondents		Non-participating respondents		
	Below Median Farm Income	Above Median Farm Income	Below Median Farm Income	Above Median Farm Income	Below Median Farm Income	Above Median Farm Income	
Training in hometown			19 (6%)	20 (6%)	5 (2%)	8 (3%)	75%
Training in intra-island			20 (6%)	19 (6%)	7 (2%)	6 (2%)	75%
Training in inter-island			20 (6%)	22 (7%)	3 (1%)	7 (2%)	81%
Total	82 (26%)	77 (25%)	59 (49%)	61 (20%)	15 (5%)	21 (7%)	
	156 (50%)		120 (38.5%)		36 (11.5%)		
Grand Total	312 (100%)						

Table 2: Descriptive statistics of the invited and uninvited farmers

Variable	Not Invited to Training						Invited to Training					
	All		Above Median Farm Income		Below Median Farm Income		All		Above Median Farm Income		Below Median Farm Income	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Household Characteristics												
Age of Household head	46.81	11.79	46.10	11.43	47.46	12.1	44.66	10.85	45.32	10.45	43.88	11.26
Household head Years of Education	8.43	3.55	8.62	3.53	8.254	3.577	8.31	3.23	8.40	3.09	8.21	3.40
Owned farmland	1.20	1.072	1.55	1.26	0.87	0.71	1.11	0.90	1.36	0.98	0.83	0.70
Log of owned farmland	-0.09	0.75	0.19	0.71	-0.35	0.69	-0.13	0.76	0.14	0.66	-0.43	0.75
Cultivated farmland	1.15	0.98	1.50	1.15	0.82	0.64	1.09	0.86	1.32	0.93	0.835	0.67
Log of cultivated farmland	-0.10	0.78	0.19	0.69	-0.37	0.768	-0.11	0.71	0.14	0.63	-0.39	0.70
Farm income (in million Rp.)	18	25.2	27.1	30.6	10.1	15.4	19	28.5	27.4	31.1	9.4	21.6
Log of farm income	16.08	1.26	16.71	0.97	15.5	1.23	16.15	1.22	16.74	0.96	15.48	1.14
No. of Mobile Phone	1.64	1.14	1.73	1.18	1.553	1.101	1.58	1.15	1.74	1.17	1.40	1.09
Coefficient of Variation of Farm Income	67.62	37.99	58.80	36.20	75.58	37.87	57.11	36.19	53.15	33.20	61.62	38.93
No. of Motorbike	1.34	0.87	1.47	0.91	1.224	0.825	1.45	0.99	1.68	1.04	1.19	0.85
Walking distance to farmland (in minutes)	19.62	21.89	20.20	17.73	19.11	24.99	24.67	62.02	32.26	84.47	16.41	12.38
Walking distance to paved road (in minutes)	3.42	6.74	3.58	6.70	3.272	6.781	4.08	7.97	3.42	6.95	4.80	8.94
Observations	477		231		246		456		240		216	
Agriculture Characteristics												
Diversification Index (no of crops)	2.58	1.04	2.79	1.04	2.39	0.99	2.70	1.02	2.86	0.99	2.52	1.02
Cereal (= 1 if planting)	0.19	0.40	0.18	0.39	0.21	0.41	0.15	0.36	0.15	0.35	0.16	0.37
Legume (= 1 if planting)	0.05	0.21	0.07	0.26	0.02	0.14	0.09	0.29	0.11	0.31	0.08	0.27
Industrial Crop (= 1 if planting)	0.93	0.26	0.96	0.20	0.90	0.30	0.95	0.21	0.97	0.17	0.94	0.25
Spice (= 1 if planting)	0.59	0.49	0.71	0.46	0.48	0.50	0.60	0.49	0.69	0.46	0.51	0.50
Vegetable (= 1 if planting)	0.03	0.17	0.04	0.19	0.02	0.15	0.03	0.18	0.03	0.16	0.04	0.20
Fruit (= 1 if planting)	0.66	0.47	0.71	0.45	0.62	0.49	0.73	0.44	0.78	0.42	0.68	0.47
Hardwood (= 1 if planting)	0.15	0.36	0.16	0.36	0.15	0.36	0.14	0.35	0.15	0.36	0.13	0.34
Observations	477		231		246		456		240		216	
Perceived Benefit of Diversification (Only in 2012 and 2013)												
Conserved Soil and Water (= 1 if experiencing)	0.47	0.50	0.49	0.50	0.45	0.50	0.50	0.50	0.54	0.50	0.46	0.50
Reducing Crop Failure (= 1 if experiencing)	0.51	0.50	0.55	0.50	0.48	0.50	0.49	0.50	0.48	0.50	0.51	0.50
Procuring for Medicinal Purpose (= 1 if experiencing)	0.15	0.36	0.14	0.35	0.16	0.37	0.15	0.36	0.13	0.34	0.17	0.38
Procuring for Fuelwood (= 1 if experiencing)	0.75	0.43	0.78	0.42	0.73	0.45	0.80	0.40	0.81	0.39	0.78	0.41
Improved Surrounding (= 1 if experiencing)	0.78	0.42	0.79	0.41	0.76	0.43	0.85	0.36	0.87	0.34	0.82	0.39
Observations	318		154		164		304		160		144	

Table 3: *Descriptive Statistics of the Agroforestry Adoption Prior to and After the Training*

Variables	All Farmers			Training Participants			Non-Training Participants			Mean Difference between Training Participant vs Non-training Participant)	
	Before 2013	After 2013	Difference	Before 2013	After 2013	Difference	Before 2013	After 2013	Difference	Before 2013	After 2013
Agroforestry Index (by crop diversity)	3.14 (1.56)	3.47 (1.31)	0.337***	3.27 (1.48)	3.50 (1.25)	0.22	3.05 (1.60)	3.46 (1.34)	0.406**	0.22	0.04
Agroforestry Index (by crop category)	2.39 (1.11)	2.76 (0.96)	0.371***	2.52 (1.12)	2.80 (0.93)	0.277**	2.307 (1.09)	2.736 (0.98)	0.429***	0.222**	0.069
Log of Farm Income	16.19 (1.29)	16.06 (1.22)	-0.129	16.203 (1.13)	16.05 (1.17)	0.154	16.19 (1.37)	16.08 (1.24)	0.114	0.0095	0.029
Cereal (= 1 if planting)	0.176 (0.38)	0.173 (0.38)	-0.003	0.126 (0.33)	0.147 (0.35)	0.021	0.208 (0.41)	0.190 (0.39)	0.018	-0.082*	-0.043
Legume (= 1 if planting)	0.093 (0.29)	0.057 (0.23)	-0.03**	0.126 (0.33)	0.075 (0.26)	-0.05	0.072 (0.26)	0.046 (0.21)	0.02	0.053	0.029
Industrial Crops (= 1 if planting)	0.945 (0.23)	0.938 (0.24)	-0.006	0.974 (0.15)	0.953 (0.21)	0.021	0.927 (0.26)	0.929 (0.26)	0.002	0.047*	0.024
Spice (= 1 if planting)	0.508 (0.50)	0.639 (0.48)	0.131***	0.537 (0.50)	0.626 (0.48)	0.088	0.489 (0.50)	0.648 (0.48)	0.158***	0.048	0.022
Vegetable (= 1 if planting)	0.038 (0.19)	0.028 (0.17)	-0.009	0.025 (0.157)	0.037 (0.19)	0.012	0.046 (0.21)	0.023 (0.15)	0.023	-0.021	0.014
Fruit (= 1 if planting)	0.524 (0.50)	0.782 (0.41)	0.258***	0.613 (0.489)	0.844 (0.36)	0.231***	0.468 (0.50)	0.744 (0.44)	0.276***	0.144**	0.099***
Hardwood (= 1 if planting)	0.135 (0.34)	0.154 (0.36)	0.019	0.142 (0.351)	0.134 (0.34)	0.008	0.130 (0.34)	0.166 (0.37)	0.036	0.012	-0.032
Observations	311	622		119	238		192	384			
Conserved Soil and Water (= 1 if experiencing)	0.389 (0.49)	0.581 (0.49)	0.192***	0.361 (0.482)	0.647 (0.48)	0.285***	0.406 (0.49)	0.541 (0.50)	0.135***	0.044	0.105*
Reducing Crop Failure (= 1 if experiencing)	0.511 (0.50)	0.49 (0.50)	-0.019	0.487 (0.546)	0.501 (0.50)	0.058	0.526 (0.50)	0.458 (0.50)	0.0677	-0.038	0.087
Procure for Medicinal Purpose (= 1 if experiencing)	0.147 (0.36)	0.154 (0.36)	0.006	0.100 (0.30)	0.21 (0.41)	0.109**	0.177 (0.38)	0.119 (0.33)	0.057	-0.076*	0.090**
Procure for Fuelwood (= 1 if experiencing)	0.82 (0.38)	0.726 (0.45)	-0.096***	0.831 (0.375)	0.773 (0.42)	0.058	0.817 (0.39)	0.697 (0.46)	-0.119***	0.014	0.075
Improved Surrounding (= 1 if experiencing)	0.794 (0.40)	0.826 (0.38)	0.032	0.831 (0.375)	0.890 (0.31)	0.058	0.770 (0.42)	0.786 (0.41)	0.015	0.061	0.104**
Observations	311	311		119	119		192	192			

Standard deviations are in parentheses. ***, **, and * signify statistical significance at the 1%, 5% and 10% level, respectively.

Table 4: *Summary Statistics of Farmers' Network*

VARIABLES	All Farmers (Participants and Non-participants)						All Training Participants						Non-training participants					
	Before 2013			After 2013			Before 2013			After 2013			Before 2013			After 2013		
	Below Median Farm Income	Above Median Farm Income	Diff	Below Median Farm Income	Above Median Farm Income	Diff	Below Median Farm Income	Above Median Farm Income	Diff	Below Median Farm Income	Above Median Farm Income	Diff	Below Median Farm Income	Above Median Farm Income	Diff	Below Median Farm Income	Above Median Farm Income	Diff
Number of agricultural informants who went to the same training location							0.61 (0.87)	0.52 (0.85)	-0.09	0.491 (0.72)	0.39 (0.625)	-0.1						
Number of agricultural informants who went to the different training location							0.77 (0.87)	1 (1.02)	0.22	0.78 (1.06)	0.73 (1.02)	-0.05						
Number of agricultural informants who did not go to the training							2.71 (2.13)	4.76 (3.60)	2.1***	2.83 (1.95)	3.80 (2.61)	0.9**						
Observations							59	60		118	120							
Number of agricultural informants whom respondent meets at least once every 1-2 days	2.73 (3.14)	3.76 (3.62)	1.03***	1.38 (2.65)	1.49 (2.31)	0.10	2.37 (2.52)	3.84 (2.98)	1.47**	1.46 (2.36)	1.51 (2.72)	0.047	2.95 (3.47)	3.71 (3.97)	0.76	1.33 (2.29)	1.47 (2.61)	0.14
Observations	153	154		290	302		59	60		118	120		95	97		176	183	
Know extension agent and have contact at least once every 1-2 days (if Yes = 1, only in 2012 and 2013)	0.188 (0.39)	0.26 (0.44)	0.07	0.22 (0.42)	0.18 (0.38)	-0.03	0.135 (0.35)	0.28 (0.45)	0.14**	0.254 (0.44)	0.26 (0.445)	0.01	0.22 (0.41)	0.25 (0.43)	0.02	0.2 (0.40)	0.13 (0.34	-0.06
Observations	153	154		154	157		59	60		59	60		95	97		95	97	

Standard deviations are in parentheses. ***, **, and * signify statistical significance at the 1%, 5% and 10% level, respectively.

Table 5: *Agroforestry Index*

Crop Category	Cereal	Leguminous Crop	Industrial Crop	Spices Crop	Vegetable Crop	Fruit Crop	Hardwood
Crop Diversity	Rice Corn	Dogfruit Petai Almond Peanut Soybean	Coffee Cocoa Coconut Rubber Tobacco Palm	Pepper Chili Nutmeg Clove Ginger	Spices Tomato Cabbage Eggplant Cucumber	Banana Durian Snakefruit Papaya Avocado	Albasia Teak Mahogany

Table 6: *Training Effects on Agroforestry Index*

VARIABLES	Index by Category		Index by Diversity	
	(1)	(2)	(3)	(4)
Training * Post 2013 * Low Income	0.438**	0.431**	0.474*	0.479*
	(0.217)	(0.218)	(0.282)	(0.281)
Training * Post 2013	-0.496***	-0.468*	-0.470*	-0.424*
	(0.192)	(0.193)	(0.248)	(0.249)
Training Dummy * Low Income	-0.213	-0.207	0.115	0.156
	(0.248)	(0.245)	(0.350)	(0.345)
Training Dummy	0.419**	0.376*	0.112	0.0192
	(0.195)	(0.194)	(0.272)	(0.271)
Low Income	-0.406***	-0.413***	-0.685***	-0.744***
	(0.110)	(0.110)	(0.161)	0.162
Year of 2013	0.653***	0.629***	0.714***	0.682***
	(0.0900)	(0.0910)	(0.117)	(0.118)
Year of 2014	0.303***	0.283***	0.141	0.108
	(0.0900)	(0.0907)	(0.117)	(0.117)
Constant	2.474***	2.395***	3.416***	3.494***
	(0.0790)	(0.172)	(0.136)	(0.250)
Village Fixed Effects	NO	YES	NO	YES
Observations	933	926	933	926
Number of Household id	311	311	311	311
Hausman test	1.000	0.000	0.996	0.994

Estimation is based on Random-Effects Instrumental Variable models. Standard errors are in parentheses. ***, **, and * signify statistical significance at the 1%, 5% and 10% level, respectively. All training dummy is instrumented by all lottery result. Village dummies and crop category dummies are not shown for brevity.

Table 7: *Training Effects on Perceived Benefits of Agroforestry if Practicing It*

VARIABLES	If Index by Category > 1				If Index by Diversity > 1			
	Conserved Soil and Water	Provision for Fuelwood	Provision for Medicinal Purposes	Increased Food Income	Conserved Soil and Water	Provision for Fuelwood	Provision for Medicinal Purposes	Increased Food Income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Training * Post 2013 * Low Income	-0.146	-0.142	0.255**	0.191*	-0.0967	-0.148	0.271**	0.161
	(0.148)	(0.113)	(0.118)	(0.113)	(0.142)	(0.108)	(0.115)	0.171
Training Dummy * Low Income	0.00443	0.103	-0.180*	-0.146	0.0199	0.0758	-0.189*	-0.105
	(0.141)	(0.109)	(0.108)	(0.113)	(0.136)	(0.105)	(0.104)	0.109
Training * Post 2013	0.233*	0.253**	0.148	-0.0338	0.191	0.231**	0.0739	-0.0263
	(0.130)	(0.0993)	(0.105)	(0.0995)	(0.126)	(0.0957)	(0.102)	0.0948
Training Dummy	-0.0734	-0.107	-0.0792	-0.00457	-0.0263	-0.0894	-0.00901	-0.0215
	(0.108)	(0.0833)	(0.0829)	(0.0859)	(0.0948)	(0.0801)	(0.0801)	0.0832
Low Income	-0.0317	-0.00162	0.0670	0.0236	-0.0427	0.00431	0.0522	0.00247
	0.0649	0.0503	(0.0494)	(0.0538)	(0.0631)	(0.0485)	(0.0476)	0.0526
Year of 2013	0.151**	-0.193***	-0.0997**	-0.0597	0.162***	-0.186**	-0.0804*	-0.0747*
	(0.0586)	(0.0447)	(0.0483)	(0.0462)	(0.0557)	(0.0424)	(0.0466)	0.0436
Constant	0.433***	0.917***	0.0909	0.771***	0.419***	0.913***	0.0608	0.830***
	(0.0542)	(0.0418)	(0.177)	(0.186)	(0.0521)	(0.0399)	(0.174)	0.184
Village Fixed-Effects	NO	NO	YES	YES	NO	NO	YES	YES
Crop Category Dummy	NO	NO	YES	YES	NO	NO	YES	YES
Observations	511	511	506	506	544	544	539	539
Number of id	292	292	289	289	300	300	298	298
Hausman test	0.0217	0.259	0.715	0.185	0.0089	0.1715	0.5539	0.6690

Estimation is based on Random-Effects Instrumental Variable models. Standard errors are in parentheses. ***, **, and * signify statistical significance at the 1%, 5% and 10% level, respectively. All training dummy is instrumented by all lottery result. Village dummies and crop category dummies are not shown for brevity.

Table 8: *Effect of training on the size and depth of social networks*

VARIABLES	Only for Training Participants			All Farmers	
	No of agricultural informants who went to the same training location	No of agricultural informants who went to the different training location	No of agricultural informants who did not go to the training (may or may not be farmers)	No of agricultural informants whom respondent meets at least once every 1-2 days	Knowing extension agent and having contact at least once at least once every 1-2 days (=1 if Yes)
	(1)	(2)	(3)	(4)	(5)
Training * Post 2013 * Low Income	0.00636	0.275	1.085**	1.760***	0.161
	(0.148)	(0.180)	(0.531)	(0.619)	(0.112)
Training * Post 2013	-0.00315	-0.397***	-0.160	-0.863	0.0422
	(0.113)	(0.137)	(0.404)	(0.549)	(0.0984)
Training Dummy * Low Income	0.0935	-0.220	-2.055***	-1.0520	-0.31***
	(0.135)	(0.185)	(0.452)	(0.652)	(0.106)
Training dummy				0.633	0.137*
				(0.524)	(0.0824)
Low Income				-0.445*	0.0694
				(0.258)	(0.0492)
Year of 2013		0.261**		-0.445*	-0.0692
		(0.104)		(0.258)	(0.0427)
Year of 2014	-0.244***		-1.597***	-3.244***	
	(0.0857)		(0.306)	(0.260)	
Constant	0.517***	1***	4.767***	3.456***	0.197***
	(0.0953)	(0.130)	(0.318)	(0.253)	(0.0413)
Observations	357	357	357	899	622
No of id	119	119	119	311	311
Hausman test	0.9931	0.000	0.000	0.6278	1.000

Estimation is based on Random-Effects Instrumental Variable models. Standard errors are in parentheses. ***, **, and * signify statistical significance at the 1%, 5% and 10% level, respectively. Training dummy is instrumented by lottery result.

Table 9: *Information spillover from training participants to non-training participants*

VARIABLES	All Farmers		Non-training Participants	
	Agroforestry Index (by Category)	Agroforestry Index (by Diversity)	Agroforestry Index (by Category)	Agroforestry Index (by Diversity)
	(1)	(2)	(3)	(4)
No of Information Source who are Training Participants	0.0140	0.0480	0.0260**	0.0154
*Post2013	(0.0105)	(0.0483)	(0.0132)	(0.0584)
No of Information Source who are Training Participants	-0.00929	-0.00477	-0.0189**	-0.0299
	(0.00811)	(0.0386)	(0.00924)	(0.0437)
No of Information Source who are Training Participants	-0.00909	0.119**	-0.00867	0.0998
and Belong to Low Income Category * Post 2013	(0.0132)	(0.0597)	(0.0157)	(0.0675)
No of Information Source who are Training Participants	0.00942	-0.0124	0.00763	-0.00232
and Belong to Low Income Category	(0.0106)	(0.0506)	(0.0125)	(0.0574)
Training * Post 2013 * Low Income	0.0307	-0.233		
	(0.0441)	(0.193)		
Training * Low Income (1 = Yes)	-0.0491	0.585**		
	(0.0389)	(0.215)		
Training * Post 2013	-0.0582	0.150		
	(0.0356)	(0.155)		
Training (1 = Yes)	0.0668**	-0.433**		
	(0.0308)	(0.166)		
Low Income (1 = Yes)	0.0113	-0.308**	-0.00243	-0.178
	(0.0182)	(0.112)	(0.0204)	(0.113)
Year of 2013	0.0231	-0.141	0.00590	-0.0288
	(0.0200)	(0.0898)	(0.0226)	(0.0977)
Year of 2014	0.0278	-0.323***	0.00357	-0.210**
	(0.0188)	(0.0842)	(0.0211)	(0.0904)
Constant	0.0176	0.339	0.0808	-0.00469
	(0.0514)	(0.295)	(0.0531)	(0.339)
Category Dummy	YES	YES	YES	YES
Village Fixed-effects	YES	YES	NO	YES
Observation	899	899	549	548
No of id	311	311	192	191
Hausman test	0.8437	0.8437	0.3834	0.7556

Estimation is based on Random-Effects Instrumental Variable models. Standard errors are in parentheses. ***, **, and * signify statistical significance at the 1%, 5% and 10% level, respectively. All training dummy is instrumented by all lottery result. No of information sources who are training participants are instrumented with no of information sources who are selected to participate according to lottery result. Age and years of education of household head as well as cultivated farmland (in Log) are included but not reported for brevity.

Table 10: *Effects of Training on Agricultural Produce Sold (in Kg) and Income (in Rp)*

VARIABLES	Produce Sold (in Log)							Farm Income (in Log)							
	(1) Cereal Crops	(2) Leguminous Crops	(3) Industrial Crops	(4) Spice Crops	(5) Vegetable Crops	(6) Fruit Crops	(7) Hardwood	(8) Cereal Crops	(9) Leguminous Crops	(10) Industrial Crops	(11) Spice Crops	(12) Vegetable Crops	(13) Fruit Crops	(14) Hardwood	(15) Total Farm Income
Training * Post 2013	0.613	0.436*	0.814*	-0.0173	0.0729	1.020	0.0867	1.229	1.360**	0.598	-1.439	0.130	1.803	0.269	1.307**
* Low Income	(0.429)	(0.236)	(0.488)	(0.501)	(0.196)	(0.629)	(0.120)	(0.925)	(0.610)	(1.039)	(1.520)	(0.393)	(1.208)	(0.415)	(0.245)
Training * Post 2013	-0.561	-0.641***	-0.997**	0.0633	0.0165	-0.908	-0.0219	-1.169	-1.726***	-0.859	1.674	0.0113	-1.287	-0.206	-0.695***
	(0.379)	(0.209)	(0.432)	(0.443)	(0.174)	(0.557)	(0.106)	(0.818)	(0.540)	(0.919)	(1.344)	(0.347)	(1.068)	(0.367)	(0.28)
Training Dummy *	-0.497	-0.261*	-0.0442	0..260	-0.00194	-1.251	0.00276	-1.149	-0.817	0.820	1.397	-0.0199	-1.810	0.0986	-1.033***
Low Income	(0.460)	(0.246)	(0.553)	(0.563)	(0.212)	(0.778)	(0.114)	(1.014)	(0.649)	(1.243)	(1.797)	(0.421)	(1.492)	(0.393)	(0.266)
Training dummy	-0.170	0.465**	0.377	-0.267	0.204	1.227**	0.00519	-0.443	1.400***	0.344	-1.144	0.417	1.903	-0.0559	0.576***
	(0.367)	(0.197)	(0.438)	(0.447)	(0.169)	(0.610)	(0.0925)	(0.807)	(0.519)	(0.979)	(1.417)	(0.337)	(1.170)	(0.320)	(0.211)
Low Income	-0.0893	-0.0801	-1.375***	-1.213***	0.0122	-1.159***	0.00517	0.0173	-0.215	-2.564***	-3.292***	0.0243	-2.146***	0.0985	-1.056***
	(0.202)	(0.105)	0.250	(0.254)	(0.0935)	(0.366)	(0.0452)	(0.450)	(0.283)	(0.577)	(0.830)	(0.185)	(0.702)	(0.157)	(0.120)
Year of 2013	0.138	-0.0759	0.267	0.617***	-0.00190	2.089***	0.104**	0.401	-0.178	-0.436	1.686***	-0.00949	3.508***	0.394**	-0.104
	(0.179)	(0.0986)	(0.204)	(0.209)	(0.0820)	(0.263)	(0.0500)	(0.386)	(0.255)	(0.434)	(0.635)	(0.164)	(0.505)	(0.173)	(0.103)
Year of 2014	-0.0267	-0.0324	-0.154	-0.314	-0.0823	2.208***	0.0066	-0.0424	-0.213	-0.222	0.596	-0.166	3.943***	0.0887	-0.0730
	(0.179)	(0.0983)	(0.203)	(0.209)	(0.0817)	(0.262)	(0.0498)	(0.385)	(0.254)	(0.433)	(0.633)	(0.164)	(0.503)	(0.173)	(0.106)
Constant	0.405	0.0637	6.500***	2.195***	0.207	3.775***	0.0255	0.495	0.166	16.69***	6.305***	0.413	8.075***	0.0249	16.73**
	(0.318)	(0.167)	(0.390)	(0.396)	(0.147)	(0.565)	(0.0734)	(0.706)	(0.446)	(0.894)	(1.287)	(0.291)	(1.084)	(0.254)	(0.183)
Village Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	926	926	926	926	926	926	926	926	926	926	926	926	926	926	926
No of id	311	311	311	311	311	311	311	311	311	311	311	311	311	311	311
Hausman test	0.9993	0.0039	0.8167	0.9106	0.9953	0.1892	0.9980	0.8641	0.0363	0.9786	0.9965	0.0040	0.2670	0.9954	0.0002

Estimation is based on Random-Effects Instrumental Variable models. Standard errors are in parentheses. ***, **, and * signify statistical significance at the 1%, 5% and 10% level, respectively. All training dummy is instrumented by all lottery (invitation) result. Village dummies are not shown for brevity.

Table 11: *Impact of Agroforestry on Farm Income Coefficient of Variation (CV)*

	CV of Log of Farm Income			
VARIABLES	(1)	(2)	(3)	(4)
Agroforestry Index by Category	-0.132***			
	(0.0479)			
Dummy Agroforestry by Category (= 1 if having more than 1 crop index)		-0.287*		
		(0.166)		
Agroforestry Index by Diversity			-0.121***	
			(0.0383)	
Dummy Agroforestry by Diversity (= 1 if having more than 1 crop variety)				-0.515**
				(0.232)
Year of 2012	0.0115	-0.00582	0.0349	-0.0268
	(0.112)	(0.108)	(0.111)	(0.106)
Year of 2013	0.0414	0.00178	0.0685	0.00232
	(0.114)	(0.112)	(0.116)	(0.112)
Age of Household Head	0.00673	0.00719	0.00738	0.00747
	(0.00493)	(0.00574)	(0.00572)	(0.00573)
Years of Education of Household Head	0.00940	0.00977	0.0119	0.0131
	(0.0155)	(0.0152)	(0.0151)	(0.0149)
Log of Cattle Value	0.00407	0.00298	0.00359	0.00359
	(0.00780)	(0.00700)	(0.00699)	(0.00705)
Household Member	-0.116***	-0.116***	-0.114***	-0.111***
	(0.0360)	(0.0363)	(0.0363)	(0.0363)
Native	-0.161	-0.148	-0.149	-0.142
	(0.199)	(0.178)	(0.177)	(0.178)
Second Generation Migrant	-0.0441	-0.0371	-0.0636	-0.0396
	(0.113)	(0.105)	(0.106)	(0.106)
Constant	1.570***	1.504***	1.590***	1.679***
	(0.427)	(0.509)	(0.491)	(0.514)
Village Fixed Effects	YES	YES	YES	YES
Observations	859	859	859	859
R-squared	0.081	0.078	0.087	0.084

Results are based on Pooled-OLS estimation. Heteroskedasticity-robust standard errors are in parentheses. ***, **, and * signify statistical significance at the 1%, 5% and 10% level, respectively.