

# The welfare effects of switching to sustainable farming

## Results strictly following PAP

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### **Abstract**

The intervention provides information and two rounds of training on organic farming practices. The intervention is implemented as a randomized controlled trial (RCT). Whereas a first study has focused on the short term effects with respect to knowledge, perceptions, awareness and experimentation (Grimm & Luck, 2023), this study will take a longer horizon and focus on the adoption of organic farming practices, conversion from conventional to organic farming and the effects on farmers' welfare conditional on adoption. Welfare will be measured through agricultural profits and revenue, nutritional security, subjective wellbeing and health. This study can rely on a four-wave panel data set (baseline, two midline and endline survey) and substantial qualitative field research.

### **Summary Results (PAP)**

We estimate intent-to-treat (ITT) effects of organic farming training on Indonesian smallholders' welfare indicators. The training showed no impact on farm-level outcomes, including farming revenues, household labor allocation, total expenditures, or disaggregated spending on chemical inputs, organic inputs, and hired labor. Some evidence suggests the training reduced self-reported health issues in the treatment group. However, this effect is expected to arise from reduced chemical use and exposure during handling, yet no correlation between chemical input expenditures and health outcomes was found. These results should therefore be interpreted cautiously. Training exposure did not affect satisfaction with job, income, or free time, nor did it produce consistent effects on perceptions of farming. Respondents rated their agreement with statements such as "farming is worthwhile for youth," "farming preserves nature," and "farming is an opportunity to become wealthy." A small positive effect emerged for the perception that farming is worthwhile for the youth.

*More details, including the analysis of adoption dynamics will be published in a separate paper. This document refers purely to the outcomes outlined in the PAP.*

## **Key outcomes and empirical estimation**

### **Primary Outcomes**

Agricultural yields, revenue, profits, labor

- Agricultural revenue (per ha) during the last season measured at the respondent level & separately for rice
- Agricultural profits (per ha) during the last season measured at the respondent level & separately for rice (considering revenues, input costs, land rent costs and labor cost)
- Rice yields (per ha) during the last season at the respondent level (for those respondents that grow rice)
- Average respondent and family labor during the last season per ha (we will pay particular attention to rice plots because around 85% of respondents in previous waves cultivated at least 1 rice plot. Looking at the same commodity across respondents will increase comparability)

### **Secondary Outcomes**

Income and wealth

- Satisfaction with household income: measured on a scale from 1 (not satisfied at all) to 10 (very satisfied)
- Asset ownership index (motorcycle, car, fridge, washing machine, Laptop, TV)
- Electricity expenditures per HH member (in 000 IDR)
- Financial distress: Binary variable =1 if respondent answers that HH was in financial distress anytime during the last 6 months (financial distress: unable to fulfil usual daily expenditures)
- Nutritional insecurity: Binary variable =1 if respondent answers that HH faced with a situation when there has not been enough food to feed the HH during the last 6 months

Health

- Health perception: Respondents perception of own current health on a scale from 1 to 10. 1 means the worst health the respondent can imagine and 10 means the best health the respondent can imagine.
- Perceived health complaints: skin irritation (itchy), skin irritation (hurt), sore throat, cough, dizziness, diarrhea during the last 2 months. Binary variables=1 if respondent reports yes for the respective complaint. We will also measure this as an index variable ranging from 0 (no complaints) to 6 (suffered from all 6 complaints)

Perception & satisfaction

- Perceptions farming:
  - Perspective future generations: For the youth it is worth to engage in farming (binary=1) if respondent agrees /agrees very much

- Perspective business person: A successful farmer is regarded like a successful business person (binary=1) if respondent agrees /agrees very much
- Perspective income opportunities: Farming is a good opportunity to become wealthy (binary=1) if respondent agrees /agrees very much
- o Satisfaction:
  - Satisfaction being a farmer: measured on a scale from 1 (not satisfied at all) to 10 (very satisfied)
  - Satisfaction with amount and quality of free time: measured on a scale from 1 (not satisfied at all) to 10 (very satisfied)

### **Empirical Strategy for Intent-to-Treat Effects**

To measure the impact of the repeated training on our key outcomes of interest, we will run regressions of the following form:

$$(1) \quad Y_{iv} = \beta_0 + \beta_1 T_v + \beta_2 X_{ij}^0 + \beta_3 Y_{iv}^0 + \beta_4 S_v + \varepsilon_{ij}$$

where  $Y_{iv}$  is the outcome of interest for a given respondent  $i$  in village  $v$  measured at the time of the fourth survey wave in 2023.  $T_v$  is a binary variable indicating whether the respondent lives in a village that was assigned to the training intervention.  $\beta_1$  captures the treatment effect. While the treatment was randomized, we use additional covariates to increase the precision of the estimates.  $X_{ij}^0$  denotes a vector of control variables, measured at baseline.  $Y_{iv}^0$  denotes the outcome variable at baseline. We will include this variable as a control whenever available. Because this variable is not available for all outcomes and because for some outcomes, the baseline and endline measurements are not completely identical, we choose this ANCOVA treatment effect model.  $S_v$  captures the randomization strata and  $\varepsilon_{ij}$  denotes the individual level error term, that is clustered at the village level.

## Descriptives and Balance

**Table 1**  
Baseline summary statistics (2018)

	Sample mean	sd	Control group mean	Treatment group mean	C-T
<i>Individual and household characteristics</i>					
Male (=1)	0.83	0.38	0.79	0.87	-0.08***
Age (in yrs.)	53.75	11.78	54.40	53.09	1.31
Muslim (=1)	0.96	0.18	0.95	0.97	-0.02
Completed junior high school (=1)	0.47	0.50	0.46	0.48	-0.02
Refrigerator (=1)	0.37	0.48	0.34	0.40	-0.05
Washing machine (=1)	0.14	0.35	0.13	0.15	-0.03
Financial difficulty last 12 months (=1)	0.55	0.50	0.55	0.56	-0.01
Farming is main activity (=1)	0.78	0.41	0.79	0.78	0.00
Farmers' decisions matter (perception) (=1)	0.57	0.49	0.58	0.56	0.02
Agr. environmental pollution is a problem (perception) (=1)	0.46	0.50	0.46	0.45	0.01
<i>Agricultural characteristics</i>					
Cultivated land (in ha)	0.35	0.44	0.30	0.41	-0.11***
Land ownership share	0.61	0.43	0.62	0.61	0.01
Rice (=1 if respondent planted rice)	0.93	0.26	0.94	0.91	0.03*
<i>p</i> -value for joint orthogonality test				0.03	
<i>p</i> -value for joint orthogonality test (13 land outliers (>2ha) dropped)				0.17	

Note: Total N= 1,200 respondents at baseline, from a total of 60 villages with 20 respondents per village. The treatment group comprises 600 farmers and the control group comprises 600 farmers. C-T denotes the difference in means, significant differences are denoted as follows: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

Table 1 reports baseline summary statistics by treatment status. We employ a joint orthogonality F-test to assess baseline balance between the control and treatment groups. Despite randomization, we obtain a *p*-value below 0.10 ( $p = 0.03$ ). This appears to be driven by differences in gender composition and cultivated land size. Re-estimating the F-test after excluding outliers with cultivated land greater than 2 hectares increases the *p*-value substantially, to 0.17. Apart from these two variables, baseline characteristics are well balanced between the groups, and we find no substantial differences with respect to any of the other household and farm characteristics not shown in Table 1.

At baseline, data were collected from the full sample of 1,200 respondents. The sample size decreased to 1,148 in the first, 1,017 in the second, and 942 in the third follow-up survey, reflecting an attrition rate of 22% from baseline to 2023. Attrition was primarily due to respondents passing away, health issues preventing interviews, discontinuation of farming activities (mainly due to age), or migration.

## Results

### ITT effects on primary outcomes “Agricultural yields, revenue, profits, labor”

**Table 2**  
Treatment effects (ITT): Farm outcomes (all plots)

	(1) Revenue IDR 1,000/ha	(2) Profits IDR 1,000/ha (no HH labor)	(3) Profits IDR 1,000/ha (HH labor 15k)	(3) Profits IDR 1,000/ha (HH labor 20k)
Treatment	-1,001.915 (0.495)	-609.408 (0.542)	2,700.555 (0.186)	3,803.876 (0.160)
Control mean (2023)	5194.24	-2802.54	-28493.04	-37056.54
Assumption wage in IDR 1,000			15	20
N	942	942	942	942
R-squared adj.	0.068	0.050	0.138	0.137

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Robust p-values (clustered at the village level) in parentheses. Number of villages=60. All regressions include strata fixed effects and the following controls: gender 2018, age 2018, junior high school 2018, asset ownership 2018, farming main job 2018, land share owned 2018, land size cultivated 2018. Revenue is top-coded at the 99th percentile; profits are calculated as top-coded revenue minus top-coded expenditures. Cols. 2–4 report profit estimates under three different assumptions about the value of household labor: Col. 2 defines profits as value added (household labor left unvalued); Cols. 3 and 4 subtract an imputed household-labor cost based on, respectively, the lower and upper bound of common regional agricultural wages.

Table 2 presents the ITT effects of the training on farm outcomes per hectare, including revenue, household labor (hours per season per hectare), expenditures, and profits. A reduction in yields and high labor demands is a commonly voiced concern regarding organic farming. The results show no statistically significant impact of the training on any of these outcomes. To estimate profits, household labor hours are valued using the local agricultural worker wage at two bounds: a lower and an upper estimate (columns 4 and 5). Notably, in 2023 nearly 50% of farmers did not sell any of their harvest and 70% sold no rice; instead, much of the production was self-consumed. The organic farming training could plausibly affect revenues and profits either by raising or lowering farm output, or by enabling farmers to obtain higher prices for semi-organic or fully organic products. However, because a large share of farmers did not participate in sales, the price channel is largely inactive for this sample, which likely contributes to the null results.

**Table 3**  
Treatment effects (ITT): Farm outcomes (all plots)

	(1) HH labor (hours per season/ha)	(2) Expenditures all IDR 1,000/ha	Expenditures details		
			(3) Chemicals inputs IDR 1,000/ha	(4) Organic inputs IDR 1,000/ha	(5) Hired labor IDR 1,000/ha
Treatment	-233.217 (0.132)	-392.506 (0.614)	-43.895 (0.866)	124.052 (0.234)	-519.558 (0.275)
Control mean (2023)	1742.29	7996.78	2246.24	237.42	5188.34
N	942	942	942	942	942
R-squared adj.	0.111	0.086	0.086	0.092	0.082

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Robust p-values (clustered at the village level) in parentheses. Number of villages=60. All regressions include strata fixed effects and the following controls: gender 2018, age 2018, junior high school 2018, asset ownership 2018, farming main job 2018, land share owned 2018, land size cultivated 2018. Expenditure variables are top coded at 99%.

Table 3 reports the ITT effects of the training on disaggregated farm inputs and expenditures per hectare: household labor hours, total expenditures, and expenditures on chemical inputs, organic inputs, and hired labor. Table 4 reports the ITT effects only for rice plot outcomes. The results show no statistically significant impact of the training on any of the outcomes.

**Table 4**  
Treatment effects (ITT): Farm outcomes rice plots

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	HH labor (hours per season/ha)	Hired labor IDR 1,000/ha	Chemicals inputs IDR 1,000/ha	Rice harvest ton/ha	Revenue IDR 1,000/ha	Profits IDR 1,000/ha	Profits (with cons.) IDR 1,000/ha
Treatment	-23.915 (0.736)	-271.651 (0.348)	-264.717 (0.270)	0.008 (0.973)	-290.275 (0.553)	122.148 (0.850)	272.206 (0.688)
Control mean (2023)	552.36	4320.01	2574.18	4.57	2219.51	-5055.55	5174.29
N	873	873	873	854	854	854	854
R-squared adj.	0.132	0.074	0.124	0.077	0.072	0.096	0.083

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Robust p-values (clustered at the village level) in parentheses. Number of villages=60. All regressions include strata fixed effects and the following controls: gender 2018, age 2018, junior high school 2018, asset ownership 2018, farming main job 2018, land share owned 2018, land size cultivated 2018. Expenditure variables and revenue are top coded at 99%. The sample in Cols. (4) - (7) is smaller because 20 respondents did not harvest anything by themselves and instead sold the "right to harvest" to someone else.

## ITT effects on secondary outcomes “Income and wealth”

Table 5 reports the ITT effects of the training on farmers’ satisfaction with their income, an asset index, electricity expenses per household member and nutritional insecurity. The results show no statistically significant impact of the training on any of these outcomes.

**Table 5**

Treatment effects (ITT): Income, wealth and financial distress

	(1) Satisfaction income (1-10)	(2) Asset index (0-6)	(3) Electricity expenditure IDR 1,000/ HH member	(4) Financial distress (=1)	(5) Nutritional insecurity (=1)
Treatment	0.048 (0.752)	0.051 (0.636)	-1.935 (0.402)	-0.051 (0.242)	-0.027 (0.311)
Control mean (2023)	6.611	2.731	25.328	0.523	0.145
N	942	942	942	942	942
R-squared adj.	0.036	0.339	0.094	0.086	0.063

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Robust p-values (clustered at the village level) in parentheses. Number of villages=60. All regressions include strata fixed effects and the following controls: gender 2018, age 2018, junior high school 2018, asset ownership 2018, farming main job 2018, land share owned 2018, land size cultivated 2018. The asset index (Col. 2) reflects ownership of the following 6 assets: motorcycle, car, fridge, washing machine, Laptop, TV. Financial distress and nutritional insecurity refer to the past 6 months.

## ITT effects on secondary outcomes “Health”

**Table 6**  
Treatment effects (ITT): Health outcomes

	(1) Health perceptions (score 1-10)	(2) Health complaints index (0-6)	Health complaints					
			(3) Skin irritation (itchy) (=1)	(4) Skin irritation (hurt) (=1)	(5) Sore throat (=1)	(6) Cough (=1)	(7) Dizziness (=1)	(8) Diarrhea (=1)
Treatment	0.085 (0.538)	-0.120 (0.176)	0.001 (0.981)	-0.016 (0.420)	-0.044* (0.054)	-0.067** (0.031)	0.016 (0.558)	-0.009 (0.548)
Control mean (2023)	7.823	1.351	0.349	0.145	0.21	0.387	0.187	0.074
N	942	942	942	942	942	942	942	942
R-squared adj.	0.068	0.101	0.042	0.053	0.061	0.044	0.085	0.012

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Robust p-values (clustered at the village level) in parentheses. Number of villages=60. All regressions include strata fixed effects and the following controls: gender 2018, age 2018, junior high school 2018, asset ownership 2018, farming main job 2018, land share owned 2018, land size cultivated 2018.

Table 6 presents the ITT effects of the training on farmers' reported health outcomes. The motivation for analyzing health impacts is that frequent exposure to agricultural chemicals, often without protective gear (a common situation among Indonesian smallholders), can have adverse health effects. The results indicate that farmers in the treatment group report fewer health complaints in some categories. To investigate potential mechanisms (not part of the PAP), Table 7 examines the relationship between these health outcomes and two proxies for chemical input use: a binary indicator for any pesticide use in the last season, and nitrogen application per hectare from chemical fertilizers. We find no significant association between the chemical-use measures and reported health outcomes. The health results should therefore be interpreted with caution.

**Table 7**  
Correlation chemical inputs use: Health outcomes

	(1) Health perceptions (score 1-10)	(2) Health complaints index (0-6)	Health complaints					
			(3) Skin irritation (itchy) (=1)	(4) Skin irritation (hurt) (=1)	(5) Sore throat (=1)	(6) Cough (=1)	(7) Dizziness (=1)	(8) Diarrhea (=1)
Nitrogen kg/ha	-0.001* (0.070)	0.000 (0.531)	0.000 (0.553)	0.000 (0.740)	-0.000 (0.549)	-0.000 (0.684)	0.000 (0.424)	0.000 (0.163)
Pesticide used (=1)	-0.123 (0.346)	-0.005 (0.960)	-0.020 (0.612)	-0.037 (0.122)	0.011 (0.698)	0.058 (0.115)	-0.008 (0.784)	-0.008 (0.638)
Control mean (2023)	7.795	1.41	0.36	0.153	0.221	0.401	0.198	0.077
N	873	873	873	873	873	873	873	873
R-squared adj.	0.076	0.077	0.044	0.050	0.061	0.041	0.087	0.017

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Robust p-values (clustered at the village level) in parentheses. Number of villages=60. All regressions include strata fixed effects and the following controls: gender 2018, age 2018, junior high school 2018, asset ownership 2018, farming main job 2018, land share owned 2018, land size cultivated 2018. The sample is restricted to respondents who grew rice in 2023 as information on nitrogen kg/ha (per crop) is only available for them.

## ITT effects on secondary outcomes “Perception & satisfaction”

Table 8 presents the ITT effects of the training on farmers’ satisfaction with their job, free time, and their perception of farming. The results show no statistically significant impact of the training on most outcomes, except for the perception of whether farming is worthwhile for youth, where a positive effect is observed.

**Table 8**  
Treatment effects (ITT): Satisfaction and perception of farming

	Satisfaction (score 1 - 10)		Perception of farming (agree=1)		
	(1) Job	(2) Free time	(3) Worthwhile youth	(4) Business person	(5) Wealth opportunity
Treatment	0.171 (0.227)	-0.027 (0.824)	0.042** (0.027)	0.025 (0.369)	0.021 (0.292)
Control mean	6.916	7.209	0.893	0.966	0.876
N	942	942	942	942	942
R-squared adj.	0.031	0.080	0.043	0.093	0.061

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Robust p-values (clustered at the village level) in parentheses. Number of villages=60. All regressions include strata fixed effects and the following controls: gender 2018, age 2018, junior high school 2018, asset ownership 2018, farming main job 2018, land share owned 2018, land size cultivated 2018. Perception is coded as "agree" if respondents reported to strongly agree or agree.