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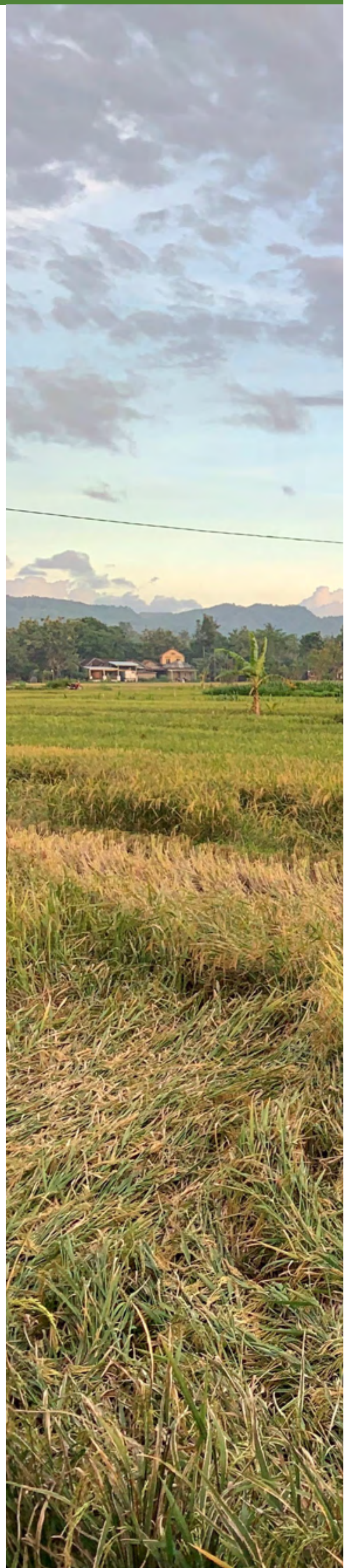

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Introduction

The intensive use of chemical fertilizers and pesticides has contributed to a significant decrease in poverty rates; however, it is also associated with negative impacts on soils, water resources and biodiversity. Presently, only a small fraction of agricultural land worldwide is cultivated sustainably prioritizing soil health. The intensive use of fertilizers and pesticides has contributed to an unprecedented reduction in poverty, however, it is also associated with negative impacts on soils, water resources, and biodiversity. In Indonesia alone, an estimated 107 million hectares of land are currently experiencing acidification, partly due to decades of excessive fertilization. The intensive and often unbalanced use of chemical fertilizers has also greatly reduced soil organic matter.

How can smallholders be supported to transition towards more sustainable agricultural practices? What motivates farmers to use organic practices in the long-term? How can soil tests and digital extension resources be introduced to farmers to protect the environment and increase farm productivity? A team of researchers from the University of Passau and the University Gadjah Mada has explored these questions in two projects funded by the German Research Foundation (DFG) and the German Federal Environmental Foundation (DBU).

Learning about the sustainable adoption of green agricultural technologies: Experimental evidence from training on organic farming

In Indonesia, numerous initiatives promote organic farming. This includes NGOs that have been active since the 1980s, governmental programs emerging in the early 2000s, and increasingly also private businesses. Despite these collective efforts, organic farming remains a marginal activity in Indonesia. Increasing the uptake of organic farming requires a better understanding of how to motivate farmers to use organic farming practices in the longer-term. This project uses an experimental design with more than 1,000 farmers to evaluate the longer-term impact of repeated organic farming training in Tasikmalaya and Yogyakarta.

A large-scale pilot experiment on low-cost soil-test kits to enhance sustainable farming among smallholders in Indonesia

Farming technologies must be adapted for use in developing and emerging countries, where farming occurs mostly on small, low-tech farms with little financial resources and little training. One promising technology in this regard is the use of simple and low cost soil tests. This project investigates how such soil tests can be introduced among smallholders to improve the health of their soils. The research is located in the province of Yogyakarta.

Extension workers play a key role in promoting sustainable soil health management. Yet, Indonesia, like many other countries, faces a shortage of extension workers. Increasing online agricultural extension is one solution to address this shortage. This project explores the potential of blended learning by evaluating a training that combines conventional face-to-face extension with digital platforms to promote sustainable farming practices.

The research findings from these two projects, their key messages and policy recommendations are presented in a series of policy briefs.

Training on and Adoption of Organic Farming Practices—A Long-Term Perspective

Training motivates farmers to use organic farming practices, but adoption is non-linear

After decades of focusing on the uptake of chemical fertilizer, promoting sustainable farming is ranking high on the policy agenda. In Indonesia, intensive cultivation combined with a high reliance on chemical fertilizer have increased soil acidity and reduced the soil organic content of rice fields. Overapplication of chemical inputs is costly to the environment and expensive for farmers. Organic farming practices offer an alternative, either to substitute part of the chemical inputs or as a complete system.

Yet, training and extension are costly for policy makers and also for farmers who invest their time. It is therefore highly relevant for policy makers to understand whether training has the intended impact and whether farmers are interested to apply the taught information.

This policy brief presents the results of a randomized experiment that was designed to evaluate the effectiveness of repeated training on organic farming. The training was targeted at smallholder farmers. The experiment was conducted in the Province of Yogyakarta and Tasikmalaya, West Java. Data was collected across four waves from 2018 to 2023. This rich data allows us to explore longer-term adoption patterns. Adoption patterns of new technologies are not necessarily linear and farmers might switch in and out of adoption in response to extension efforts.

Specifically, this policy brief addresses the following research questions:

- *What is the causal effect of repeated organic farming training on adoption, on the use of chemical inputs and on the probability of full conversion to organic farming?*
- *What adoption patterns are observed in response to repeated extension? Are farmers continuously using a practice after adoption or do they disadopt or readopt?*

Topics

- Training on organic farming
- Long-term adoption patterns
- Random experiment

The Experiment

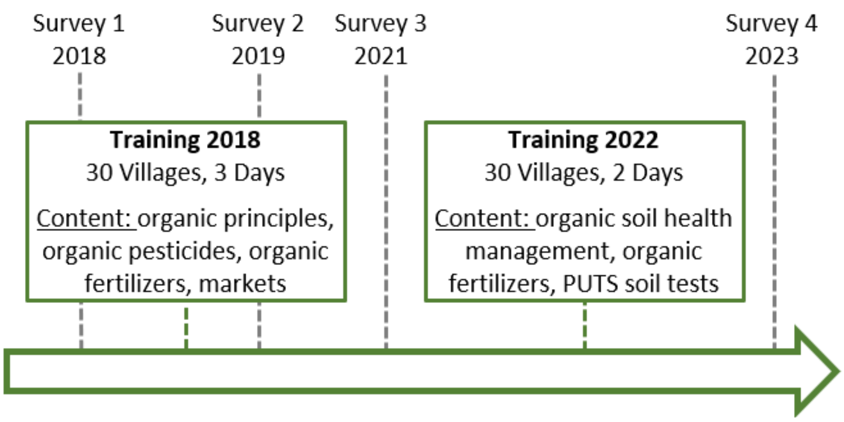
The experiment was conducted in Tasikmalaya district, West Java Province, and in three districts in the Province of Yogyakarta: Sleman, Bantul and Kulon Progo. Data was collected in 2018, 2019, 2020, and 2023. Farmers were randomly assigned to treatment or control groups at the village level. The treatment group was invited for training in 2018 and 2022. The control group did not receive any training. Figure 1 outlines the project timeline. At baseline, we interviewed 1,200 farmers, i.e. 20 from each sampled village. Most respondents in our sample are smallholders, with an average cultivated land size of 0.3 ha. In 2023, the average age in our sample was 57 years, most respondents are male.

The Training

The training was participatory and involved several practical exercises. Training was held in the respective villages to minimize travel time for farmers. In 2018, the treatment group was invited to a three-day training on organic farming, covering organic principles, input production, and marketing. In 2022, the same farmers were invited to a two-day training that focused on organic soil management and introduced the PUTS soil test kit by the Indonesian Soil Research Institute (ISRI).

Training attendance among those invited was high, with 90% in 2018 and 73% in 2022. Per invited farmer, the 2018 training incurred costs of around IDR 390k (USD 25) and the 2022 training costs of around IDR 480k (USD 31) per farmer.

Figure 1. Project timeline



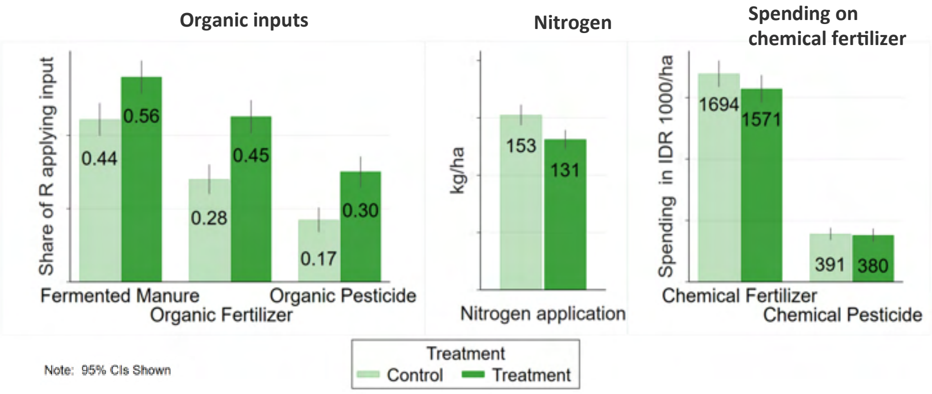
Findings: Adoption of Organic Farming Practices and Use of Chemical Inputs

The evaluation shows that **repeated training was successful in increasing farmers' uptake of organic farming practices.** Farmers who were invited for training in 2018 and 2022 were more likely to apply fermented manure in 2023. This effect is mostly driven by purchased manure. Training further increased the share of farmers who apply non-manure organic fertilizers and inputs (liquid organic fertilizer, MOL, PGPR). This is mostly driven by self-produced inputs, reflecting the focus of the training on teaching farmers how to produce own organic inputs. Similarly, training increased the share of farmers who applied organic pesticides.

However, five years after the first training, we do not find that farmers fully convert to organic farming in response to the training, they rather use the organic practices in addition to chemical inputs or to partly substitute chemical inputs.

In a context of high chemical fertilizer use, we find that training motivated farmers to apply less Nitrogen through chemical fertilizers. Compared to the control group, farmers invited to the training used, on average, 21 kg/ha (around 14 percent) less Nitrogen from chemical fertilizers on their rice plots. Yet, the effect seems to be limited to the application of Nitrogen. There is no significant effect of the training on the average chemical fertilizer spending per hectare nor on the average chemical pesticide spending per hectare.

Figure 2. Effect of training on adoption in 2023



Findings: Adoption Patterns

The adoption of new agricultural practices is a complex process. Looking at the adoption of organic pesticides, our data shows that adoption is non-linear for many farmers. Figure 3 shows that the use of organic pesticides among farmers in the treatment group increased following the first training. In 2019, 15 percent of farmers in the treatment group used organic pesticides compared to 7 percent in the control group, indicating a difference of 8 percentage points. However, by the end of 2021, the difference between farmers in the treatment group and the control group shrank to around 4 percentage points. Following the second round of training in 2022, the difference between farmers in the treatment and control group increased again to around 13 percentage points.

This adoption pattern can be explained by a high share of farmers that fall in the following categories:

- Dis-adopters: Farmers who started to experiment with organic farming by 2019, but dis-adopted at a later stage.
- Late adopters: Farmers classified as non-adopters in 2019, but later started to experiment with organic farming methods.
- Re-adopters: Farmers who adopted after the first training, dis-adopted by 2020 and re-adopted by 2023.

Interestingly, we do not find that farmer characteristics such as age or educational background are related to farmers' adoption category.

Randomized Experiment

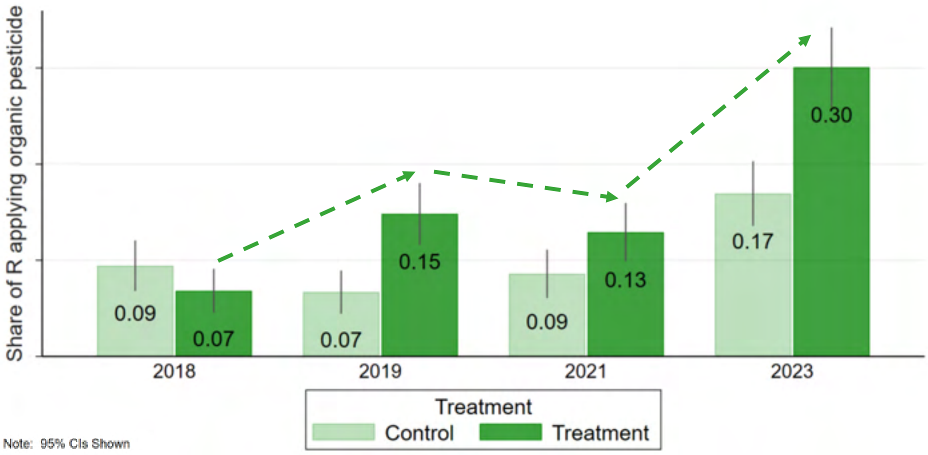
This project used a randomized controlled trial (RCT). This enables us to establish a direct cause-and-effect relationship between the training and its impact.

Simply comparing organic to non-organic farmers can be misleading as organic farmers may differ in many other respects (e.g. education or land quality) from non-organic farmers. Likewise, comparing the same farmers before and after training can be misleading if other factors, such as subsidies, change simultaneously.

Like in a medical trial, random assignment and a large sample ensures treatment and control group are similar before the training. Therefore, any difference in outcomes can be causally linked to the training, as all other factors are expected to change similarly for both groups.

The observed patterns suggest that it requires repeated extension efforts to adopt organic farming methods.

Figure 3. Adoption pattern: Organic pesticides



Findings: Motivators and Obstacles

In addition to the quantitative data, we collected qualitative data in the form of focus group discussions (FGDs) and semi-structured interviews.

Motivators: During FGDs, participant expressed their appreciation for the training because it gives them more autonomy with respect to input choices. Participants stated that one of their main motivations to use organic farming practices is to substitute chemical fertilizer. Farmers further explain that they apply organic fertilizer to improve the quality of their soil.

Obstacles: Frequently mentioned obstacles to the uptake of organic farming practices include a lack of time, especially to ferment and apply manure. Some farmers explain that due to time constraints they prefer “instant” solutions. Furthermore, farmers are concerned that prices for organic products are not high enough to compensate lower harvest quantities. In addition, farmers perceive the access to markets of organic products difficult.

Key Messages

- Training is effective to boost the adoption of some organic farming practices, but it is difficult to reach full adoption. For non-manure organic fertilizer, use is 17 percentage points higher among farmers invited for training (45% in the treatment vs. 28% uptake in the control group).
- Training reduces farmers’ application of chemical Nitrogen fertilizer.
- Farmers adoption process is non-linear; some dis-adopt, others re-adopt, and some only adopt after repeated extension efforts.
- Farmers value information on organic practices, particularly with declining fertilizer subsidies, and are motivated by soil quality improvements.
- Obstacles to wider organic farming adoption include time constraints, concerns about declining profits, and the access to organic markets.

Joint Research Project

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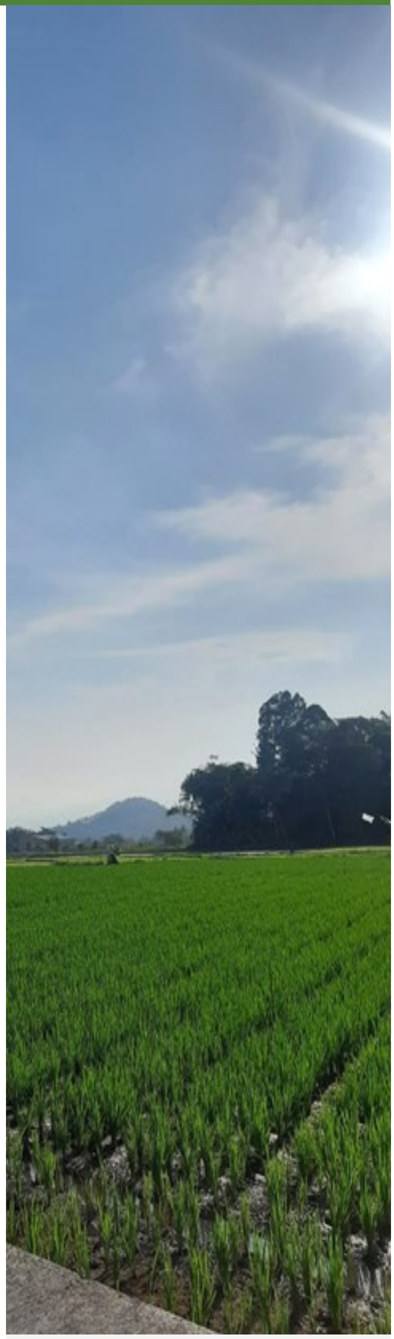
DFG

This project is related to a DBU funded project on soil testing by the same team.

Briefing Note 2, 2024



Promoting Sustainable Soil Management Amongst Indonesian Smallholder

Training improves farmers' soil fertility management. Including soil testing may make it more sustainable.

Since the 1960s, Indonesian rice farmers have widely adopted "Green Revolution" type techniques to achieve rapid productivity increases. However, the extensive use of such techniques, specifically the overapplication of chemical fertilizers, has induced environmental costs. These costs include degraded water quality, reduced soil quality and biodiversity loss. According to the National Development Planning Agency BAPPENAS (2014), the overapplication of Nitrogen-rich fertilizers has caused widespread deterioration of agricultural land. Providing farmers with information about soil nutrient principles, balanced fertilizer application recommendations, along with the provision of low-cost rapid soil tests can increase farmers' ability to manage their soils in a more sustainable way and hence mitigate further soil degradation.

This policy brief presents results from a randomized controlled trial that compares the effectiveness of a 1-day training against a 2-day training on sustainable soil management. The training was targeted at smallholder rice farmers. The second day of the 2-day training focused on soil testing using a rapid low-cost soil test kit (PUTS). Both training groups are also compared to a benchmark scenario where farmers do not get any training. Specifically, the evaluation addresses the following questions:

- *Do small-scale rice farmers change their soil fertility management behavior in response to training?*
- *Does training on and access to soil testing increase the effect of training?*
- *Does training increase farmers' knowledge around soil nutrient management?*

Topics

- Training on soil nutrient management
- Adopting sustainable farming practices
- Random experiment
- PUTS

Randomized Experiment

This project used a randomized controlled trial (RCT). This allows us to establish a direct cause-and-effect relationship between the training and its impact.

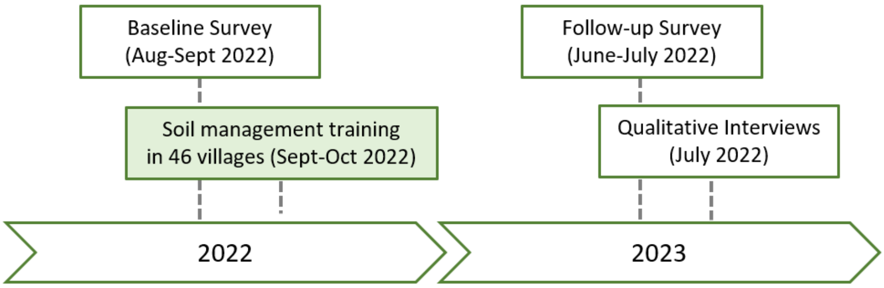
Simply comparing farmers who adopt soil management practices to farmers who do not can be misleading as adopters may differ in many other respects from non-adopters that would then be confused with adoption. Likewise, comparing the same farmers before and after training can be misleading if other factors, such as subsidies, change simultaneously.

Like in a medical trial, random assignment and a large sample ensures that treatment and control groups are statistically comparable pre-training. Thus, any difference in outcomes can be causally linked to the training; all other factors should have changed in the same ways for all groups.

The Experiment

The experiment was conducted in 69 villages across three districts of Yogyakarta province: Sleman, Bantul and Kulon Progo. Pre and post-training data were collected in August 2022 and June 2023. Respondents were sampled at the farmer group level. In total, 1,104 farmers were interviewed, i.e. 16 from each sampled village.

Figure 1. Project timeline

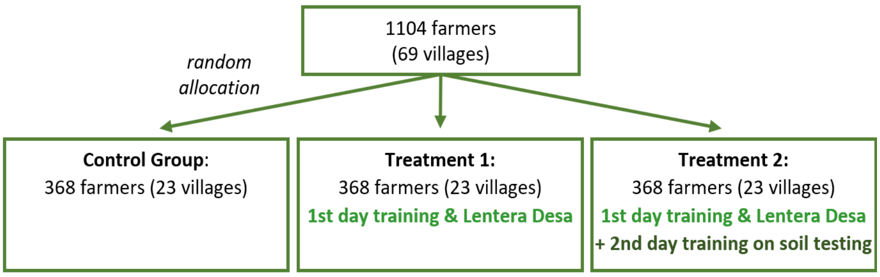


The Training

Villages were randomly allocated to three groups: control group, treatment 1 (1-day training) or treatment 2 (2-day training). Depending on the random assignment of their village, farmers were invited to a 1-day or 2-day training on soil management. The control group received no training.

The trainings were participatory and involved classroom sessions on soil nutrient principles, discussions on problems associated with chemical-fertilizer-intensive farming and practical exercises on the production of organic inputs. All invited farmers were given access to the online extension platform Lentera Desa. In the 2-day training, farmers were additionally taught how to use the PUTS soil test kit using a soil sample from their plots. After training, the group received a PUTS kit for independent use post-training. The trainings were held in the farmers' villages. Per invited farmer, the 1-day training incurred costs of around IDR 280k (USD 18) and the 2-day training costs of around IDR 580k (USD 37). The participation rate was high; on average 13.8 out of the 16 invited farmers per village participated.

Figure 2. Research design



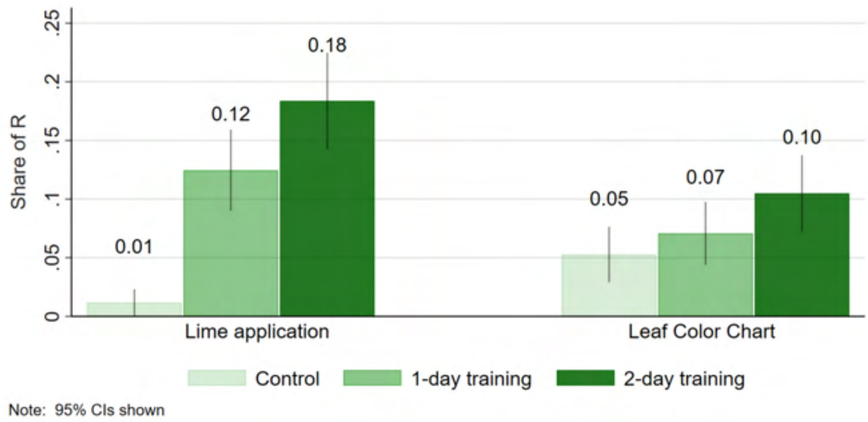
Findings: Using Organic Inputs, Lime and LCC

Organic inputs: Overall, the training had no clear impact on farmers' use of organic inputs. The considered inputs include fermented manure, liquid organic fertilizer, green manure, rice residues and MOL/ PGPR.

Lime: Trainers explained the importance of an optimal Ph level and that lime can be added to increase the Ph level. Farmers in the 2-day training additionally obtained results on the Ph level of their soil sample. We observe that the training increased the share of farmers who applied lime. The increase is larger for farmers in the 2-day training.

Leaf Color Chart (LCC): All training participants received an LCC (a simple tool indicating rice plants' Nitrogen status). Among farmers in the 2-day training, 18.4 percent used it, compared to only 1.2 percent in the control group.

Figure 3. Effect of training on Lime application and LCC

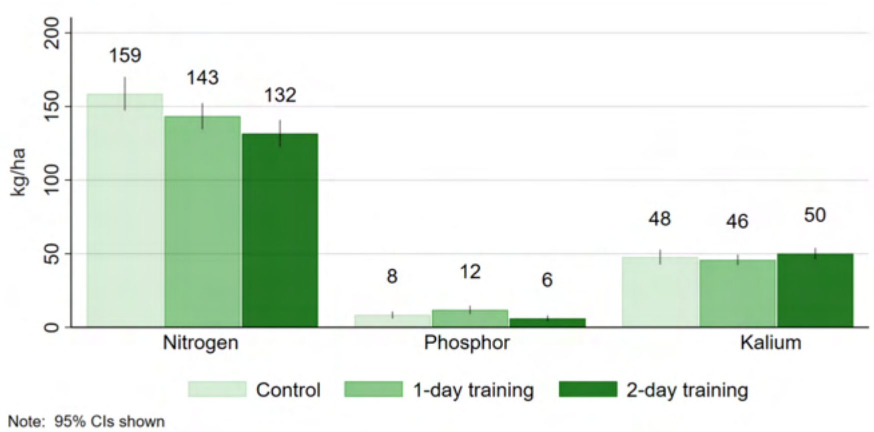


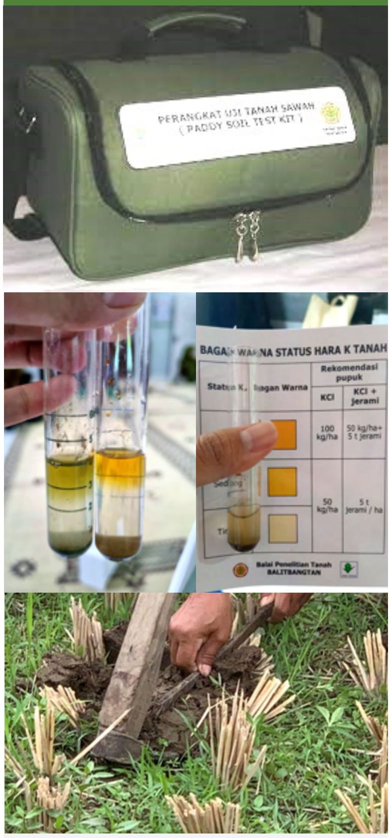
Findings: Application of Chemical Inputs

The results show that training seems to be effective in addressing the over-application of Nitrogen-rich fertilizers. Comparing the treatment groups with the control group shows that farmers who received a 2-day training applied on average **132 kg/ha** of Nitrogen, compared to **143** kg/ha in the 1-day training group and **159 kg/ha** in the control group. This finding is also in line with our finding that training increased the use of the LCC which helps farmers to adjust their Nitrogen application to the needs of the plants.

By contrast, the training has no impact on the application quantities of Phosphorus (P) and Kalium (K). Yet, the overapplication of these two nutrients is also much less frequent in our sample.

Figure 4. Effect of training on chemical inputs application





The Soil Test—PUTS

The soil test used in the experiment was developed by the Indonesian Soil Research Institute (ISRI).

The test provides information on the nutrient availability in the soil. The results are available within 30 minutes, the analysis is done directly in the field and no lab is needed.

The tests are marketed as kits (PUTS) which comprise test tubes and liquids to conduct 50 soil tests. The kit comes with a bag and a user manual that also provides recommendations how to address nutrient deficiencies. One PUTS kit costs IDR 1.8 million.

Joint Research Project

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Passau, February 2024

This project was funded by the German Federal Environmental Foundation (DBU).

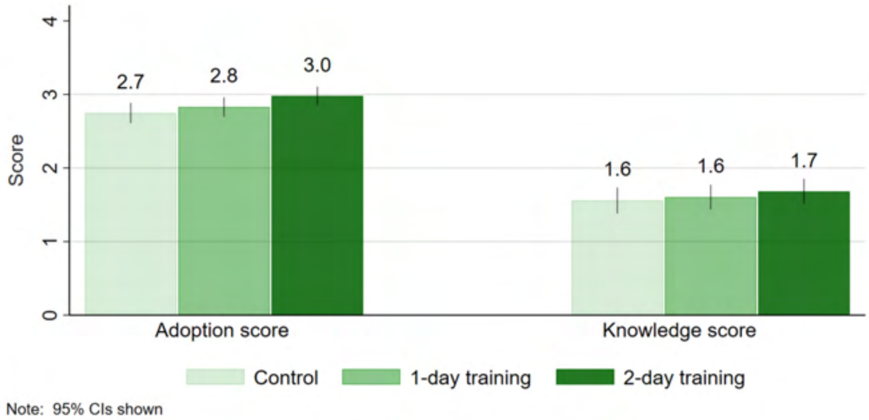
DBU
Deutsche Bundesstiftung Umwelt

This project is related to a DFG funded project on organic farming by the same team.

Findings: Adoption and Knowledge Score

A higher adoption score (max. 4) signals that the farmers' application pattern is more in line with the training recommendations (early application of Phosphorus and split Nitrogen application, early application of Potassium, and no late application of Nitrogen). Trainers further explained the role of different nutrients (mainly N, P, and K) in maintaining healthy crops. A higher knowledge score indicates that farmers answered more nutrient questions correctly. The score ranges from 0 (lowest) to 6 (highest). We do not see any clear impact of the training on the adoption score or the knowledge score.

Figure 5. Effect of training on adoption score and knowledge



Findings: PUTS use after training

One year after the training, only few farmers who were invited to the 2-day training had used the PUTS independently. This is in line with the qualitative data we collected in the form of semi-structured interviews. Farmers reported that they forgot how to use the soil test kits and do not feel confident using them without expert supervision, despite also having access to video instructions through the Lentera Desa website. Some farmers also reported that they feel hesitant to collect the soil test kit from another farmer's home.

During the qualitative interviews, respondents also expressed their appreciation for the training as it provides them with new knowledge about farming practices and tools, e.g. using leaf color charts. They also reported finding it easier to identify the characteristics of healthy soil.

Key Messages

- The training significantly reduced farmers' application of chemical Nitrogen fertilizer and increased the share of farmers applying lime. Effects are larger for the 2-day training, which included soil testing.
- Farmers value information about simple farming tools like LCCs, however, they are still hesitant to use more complex tools such as soil tests.
- To ensure long-term use, farmers may require longer training or repeated assistance from extension workers when performing soil testing.
- Training had little effect on the timing of farmers' fertilizer application, their knowledge about soil nutrients and their use of organic inputs.

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Briefing Note 3, 2024

Soil Test Innovation: Decision-making Among Smallholders Farmers

Farmers' Readiness to Adopt PUTS (*Perangkat Alat Uji Tanah Sawah-Paddy Soil Test Kit) Innovation*

Background

Increasing rice production, the primary food in Indonesia, is currently among the government's main priorities. This need is also driven by a growing population. Due to limited agricultural land, the government and farmers tried to intensify the use of the cultivated land to fulfill the need for rice. Farmers often carried out land intensification by using an increasing number of chemical fertilizers.

Farmers are using chemical fertilizers at high quantities and continuously, which ultimately has a negative impact on soil quality in Indonesia, especially in terms of soil fertility and the physical condition of the soil. Research in many journals shows that a large share of Indonesian soils has a low C-organic content. These conditions can be caused by excessive land cultivation combined with a low application of organic fertilizer to the soil. Many farmers are not aware of the deteriorating condition of their soil. Yet, when managing their farming business, farmers need to know the condition and quality of their land. Carrying out periodic soil quality assessments is necessary to determine the soil's capacity to function effectively now and in the future.

In 2012, Indonesian Soil Research Institute (ISRI), now called Indonesian Soil and Fertilizer Standardization Institute (BPSI Tanah dan Pupuk), created an innovation for testing soil quality using PUTS (Perangkat Alat Uji Tanah Sawah-Paddy Soil Test Kit). This soil test kit can measure the content of N, P, K, and the pH level. The kit also contains a recommendation book that explains how to use fertilizer according to the results of the soil assessment. This device was introduced to farmers and extension workers in the past; however, its usage is today is low because of high maintenance costs and difficult-to-find materials. This policy brief evaluates the readiness to adopt PUTS at the smallholder farmer level by considering farmer characteristics, training impact, and human capital.

Topics

- PUTS has high innovation characteristics
- Farmer tend to be ready in adopting PUTS
- Training was an important aspect in the dissemination of PUTS innovation

Method

This research was conducted quantitatively in the Special Region of Yogyakarta. All respondents received training in using PUTS in 2022. After the training, the group also received a PUTS. The survey was conducted in 2024 with 170 research respondents: in Sleman Regency (57 farmers), in Bantul Regency (39 farmers), and in Kulon Progo Regency (74 farmers).

Results

Soil health quality and fertility can be improved if farmers know the condition of their soil. Currently, farmers usually detect their soil condition from the signs that appear on their plants without any scientific measurements. Land measurement innovation with PUTS is important for farmers and farmer assistance providers, such as extension workers. Land measurement with PUTS can more accurately, quickly, and precisely determine the available level of nutrients and provide precise recommendations based on the results.

PUTS has High Innovation Characteristics

Innovations with suitable characteristics for farmers will be easily adopted by farmers. The PUTS soil test kit is an agricultural technology that suits farmers' needs, provides benefits, is not complicated to use, can be used, and is easily observed by farmers.

Figure 1. Characteristic of PUTS Innovation

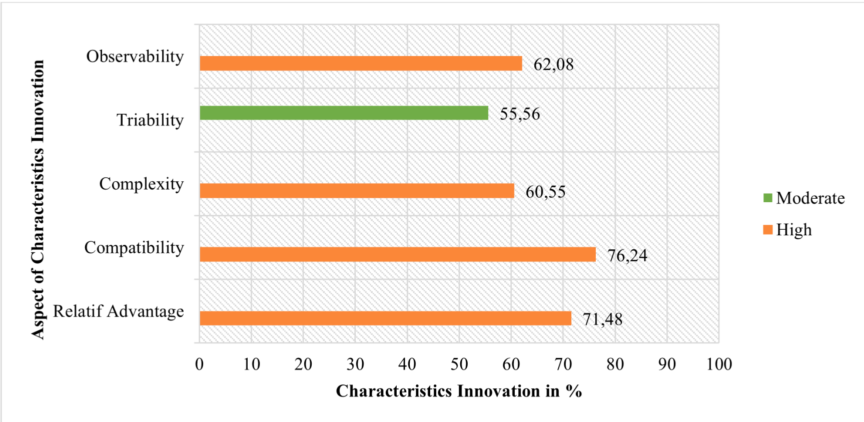
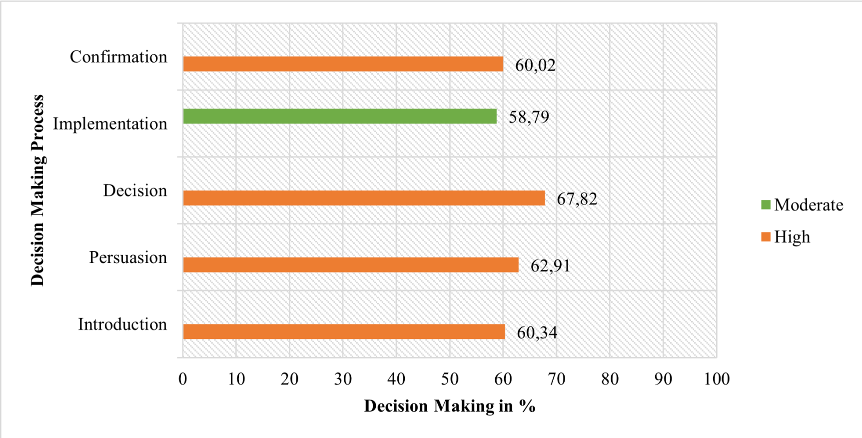


Figure 1 shows that the PUTS innovation is: a) profitable for farmers because it could determine soil health and fertilizer needs, b) suited to the needs of farmers in conditions of limited access to chemical fertilizers, c) not complicated to use because there are guidelines for use that are easy for farmers to understand, e) easy to observe analysis results related to soil pH, N, P and K nutrient levels in the soil. Yet, Figure 1 also shows that the characteristics of PUTS innovation in the triability aspect were in the moderate category. While theoretically, farmers could use the PUTS independently, farmers were still not confident in carrying out soil health measurements without assistance.

Farmers Tend to be Ready in Adopting PUTS

Decision-making to adopt PUTS innovations among farmers was measured based on the five adoption processes proposed by Rogers: the introduction, persuasion, decision, implementation, and confirmation stages.

Figure 2. Decision-Making to Adopt PUTS

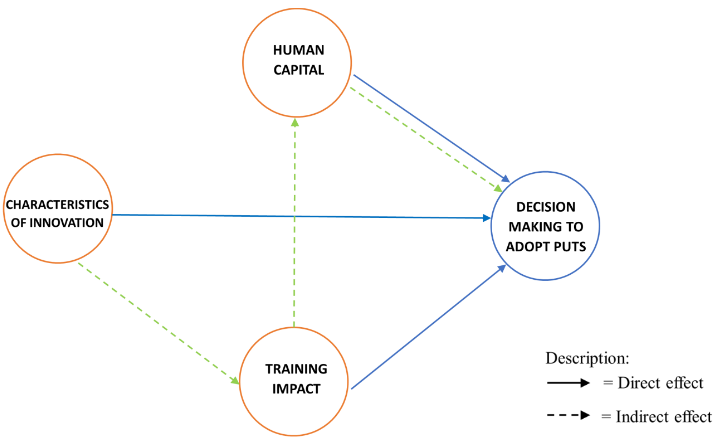


The research results in Figure 2 show that the level of achievement of PUTS adoption decision-making in the first 3 stages is high. However, at the implementation stage, farmers were still in the moderate category even though they showed high achievements at the confirmation stage. Farmers understood the importance of measuring soil health and were motivated to use PUTS. However, farmers did not use PUTS after training as they still needed more assistance in using the exclusive and expensive soil-kit.

Training was an Important Aspect in the Dissemination of PUTS Innovation

This research also shows that farmers' decision making to adopt could be influenced by the characteristics of innovation, human capital, and training.

Figure 3. Pathway Scheme of Determinant Factors in PUTS Adoption Decision Making



Farmer's Capability

The increased capability is one of the impacts of soil health management training. Farmers' capabilities were increased in both knowledge and skills. However, the proportion of increase in the knowledge aspect is more than the skill aspect:

- Farmers knew the nutrient content of the soil
- Farmers understood the importance of precision fertilization for plants
- Farmers knew how to measure the pH of paddy soil
- Farmers were able to use PUTS correctly to determine the level of nutrients available in the soil
- Farmers were still unable to calculate the amount of fertilizer by the needs of the soil

Figure 3 shows that PUTS innovation characteristics had a significant and positive effect on the impact of training. Farmers liked the presented soil health materials. They also liked presented and the technical training with respect to conducted regarding material delivery and training situations. Farmers felt that their knowledge of soil health management and using PUTS had increased. The impact of this training had a significant influence on farmers' decision-making to adopt PUTS.

The training also had a significant and positive effect on farmers' human capital. Farmers have increased their knowledge and skills in soil health management by participating in training. The combination of training methods carried out through lectures, discussions, and practice led to a good understanding of the PUTS innovations that were disseminated. Increasing farmers' human capital can change their knowledge, attitudes, and behavior and impact their decision-making to adopt PUTS. Thus, to promote the adoption of technology, we must consider the characteristics of the innovation and then introduce it with training that considers the community's social capital. **Training became a mediator in decision-making by farmers to adopt PUTS innovations**. Training is important to introduce innovation to the community.

Figure 4. Impact of Soil Health Management Training

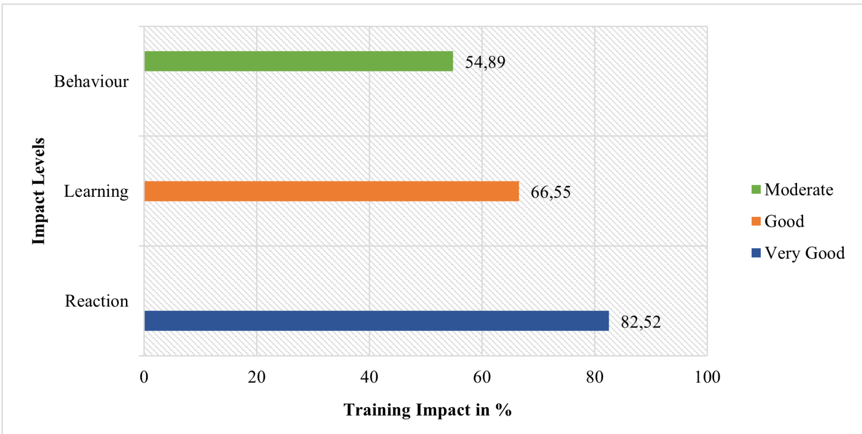


Figure 4 shows that farmers scored the impact of training on the reaction and learning aspects as very good and good. Farmers felt that the training material on soil health was appropriate to farmers' needs and liked the PUTS technology presented. The training materials delivered by the facilitator were easy for farmers to understand. From the learning aspect, this training made farmers understand soil health management well. Farmers also knew how to use PUTS correctly. Yet, the impact of training on behavioral aspects is still in the moderate category. One year after the training, most farmers still had not used PUTS in their farming business independently outside training activities. Short training (1-2 days) was not been able to change farmers' behavior; thus, more intensive assistance is needed.

Farmers still face obstacles to using PUTS in farming. Farmers were not confident enough to use PUTS independently after training, which only lasted 2 days. The expensive chemical solution refills also hindered farmers from using PUTS in their farming. Furthermore, the absence of norms or rules related to the use of PUTS makes farmers reluctant to use PUTS owned by farmer groups. The awareness regarding the urgency of measuring soil health was not yet shared among all farmer group members. Therefore, intensive assistance for farmers regarding soil health management needs to be carried out. The government needs to have policies regarding refilling PUTS chemicals. In addition, PUTS management institutions or rules for using PUTS among farmers must be formed so that farmers can access PUTS more easily.

Key Messages

- PUTS is a tool for analyzing soil fertility conditions. It is considered the most accurate and easy for farmers. However, the expensive price and the difficulty in obtaining refilled-materials make farmers less confident in using PUTS.
- Dissemination of PUTS innovation will run well if farmers received training regarding its use and benefits. This training should be carried out in stages with intensive assistance from agricultural extension workers.
- PUTS should be owned by local agricultural extension centers and farmer groups to make it easier for farmers to use them. PUTS materials should be maintained regularly because they will expire and difficult to find.
- Assistance regarding farmers' soil health management is very necessary to be carried out regularly.

Joint Research Project

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Deutsche
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UNIVERSITÄT PASSAU
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Briefing Note 4, 2024

Small-scale Farmers' Willingness to Pay for Rapid Low-cost Paddy Soil Tests

Comparing alternative provision possibilities through extension services

The over-application of fertilizer is very common, especially when fertilizer is heavily subsidized. This overuse reduces farmers' yields, leads to soil degradation and harms the environment. Soil tests can provide information that allows farmers to determine the right mix and quantity of fertilizer. This can help farmers to manage their soils more sustainably. Yet, soil tests are rarely applied, also because they typically exceed the costs that extension services can cover. This raises the question of how soil tests could be distributed to farmers in a way that ensures adoption and is at least partially cost covering. To answer this question, we investigated farmers' willingness-to-pay (WTP) for rapid low-cost paddy soil tests in Indonesia. We compare two ways how government extension offices could distribute soil tests.

Service: In the first setting, farmers are offered the service of getting one (or several) plot(s) tested by an extension worker who then also provides an individualized fertilizer recommendation based on the test results.

Club Good: In the second setting, farmer groups are offered soil test kits with material for up to 50 tests and one-day training on how to do the soil tests. In this setting, participants can share the risk and costs according to people's ability to pay. Yet, they can also free ride on others' contributions.

The Sample

Our experiment was implemented in 45 villages in the province of Yogyakarta. In each village we invited farmers to an information session on soil testing. Between 7 and 25 farmers participated. In total, we could enrol 603 participants, 295 in the 24 villages that were assigned to the service arm and 308 in the 21 villages that were assigned to the club good arm.

In our target area most farmers are smallholders, cultivating on average 0.2 ha. Rice is the main crop. Participants in our experiment were on average 54 years old and 58% have a degree from senior high school or more. Service and club good participants are comparable in terms of education and age.

Topics

- Rapid low-cost paddy soil tests / PUTS
- Farmers' willingness to pay
- Service versus group setting

Example

Service

- IDR 11,000 ✓ can buy for IDR 10,000
- IDR 10,500 ✓ can buy for IDR 10,000
- IDR 9,000 ✗
- IDR 0 ✗

randomly drawn
Price= IDR 10,000

Club good

Village 1	Village 2
IDR 50,000	IDR 50,000
IDR 20,000	IDR 30,000
IDR 10,000	IDR 30,000
IDR 0	IDR 10,000
IDR 0	IDR 0
Total bid: IDR 80,000 + subsidy = IDR 110,000 ✗	Total bid: IDR 120,000 + subsidy = IDR 160,000 ✓

randomly drawn
Price= IDR 150,000

The Experiment

To measure the WTP for soil tests, we use a Becker-DeGroot-Marschak auction (BDM). BDM is widely used in the literature and has the advantage of being incentive compatible. The principle of BDM is to offer a respondent a product and to ask for a price bid. This bid is then compared to a randomly drawn price. If the price bid is equal to or higher than the drawn price, the respondent buys the product for the drawn price. If the bid is lower, the respondent cannot buy the product. The assumption is that the BDM auction reveals respondents true Willingness to Pay (WTP). A bid too low means missing out, while a bid too high means overpaying. The product and exact procedure to measure the WTP differs between the two experimental arms.

Service arm: product = 1 individualized soil test including fertilizer recommendations by an expert

Before the bidding process, our enumerators explained the bidding process. Then all participants made their bid, privately and one after the other. They were asked how many tests they want to buy at this price if they are successful. After all participants made their bid, a price was randomly drawn. Successful participants made a down payment and a date for the soil testing service was fixed.

Club good arm: product = PUTS kit 50 soil tests and a group training session on how to use the kit

The bid by each participant represents a **contribution** to the entire kit, not an individual test. Again, the enumerators explained the bidding process. It was also explained that the two lowest non-zero bids would be doubled (subsidy). Each participant was asked how many soil tests he or she would like to perform in case the group is successful. After all participants had made their bid, a price was randomly drawn. If the sum of all bids plus the subsidy were above the price drawn, the group bought the test kit at the drawn price. Each participant paid a share of the total price (minus the subsidy) equivalent to his or her bid relative to the total bid. The group made a down-payment and the date for the PUTS delivery and training was fixed.

The Outcome of the Auction

The average WTP was IDR 15,600 (0.99 USD) in the service arm and IDR 24,200 (USD 1.54) in the club good arm (see Table 1). Hence, people were willing to pay in total more for soil tests in the club good setting. Yet, in the club good arm, participants made bids for contributions and hence the total WTP must be adjusted for the number of desired plots to be tested. If expressed on a per test basis, the WTP was very similar in both treatment arms and a little bit lower in the club good arm (15.6 vs. 14.4.).

The range between the minimum and maximum was also comparable in both settings, but in the club good setting the share of zero bids was higher by 5.7 percentage points. We asked participants who provided zero bids for the reason. Perceived lack of usefulness, land rental arrangements and affordability are by far the dominant reasons.

Among those who made a positive bid, the number of desired tests was higher in the club good arm than in the service arm (2.1 vs. 1.7). This might partly be related to the fact that participants know that the kit offers 50 tests and the group purchasing it was, on average, much smaller.

Since, we drew prices well below actual costs, 52.5% of all bids in the service good arm and 61.9% of all bids in the club good arm were successful.

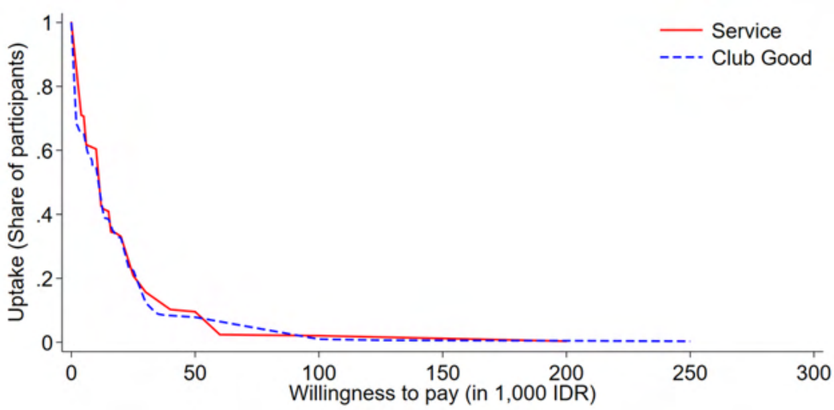
Table 1. Outcome of BDM auction

	Service	Club Good
Individual level		
WTP (total contribution) (in 1,000 IDR)	15.6	24.2
Desired # of tests per participant (if non-zero bid)	1.7	2.1
WTP per soil tets (in 1,000 IDR)	15.6	14.4
Village level		
Group size	12.3	14.7
Spread of WTP per test within group (in 1,000 IDR)	56.5	57.2
Share of zero bids by group	0.254	0.311
Outcome of BDM auction		
Successful (share individuals / share groups)	0.525	0.619
Average bid among those successful (indiv. / group)	26.95	437.46
Participants	295	306
Village groups	24	21

Demand Curves

Figure 1 relates the price and uptake for both experimental arms. The curves for both settings largely overlap. At the actual cost of IDR 36,000 per test (price of a test without any service) uptake would be about 20%.

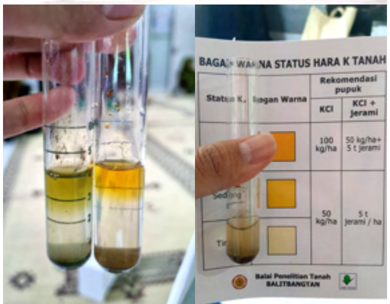
Figure 1. Demand curves



Further Data Analysis

Age is not significantly related to the bid amounts but bids increase with education. Participants with junior secondary schooling bid, on average, about IDR 5,500 more than those with no or primary schooling. This may of course also capture a wealth effect.

Bids also decrease by IDR 870 with each additional group member, possibly because farmers anticipated to learn from the tests of others. However, we find that the effect is smaller in the club good arm. This suggests that free riding on the contributions of others is not the key driver of the group size effect.



The Soil Tests—PUTS

The soil test used in the experiment was developed by the Indonesian Soil Research Institute (ISRI).

The test provides information on the nutrient availability in the soil. The results are available within 30 minutes, the analysis is done directly in the field and no lab is needed.

The tests are marketed as kits (PUTS) which comprise test tubes and liquids to conduct 50 soil tests. The kit comes with a bag and a user manual that also provides recommendations on how to address nutrient deficiencies. One PUTS kit costs IDR 1.8 million.

Joint Research Project

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Deutsche Bundesstiftung Umwelt

This project is related to a DFG funded project on organic farming by the same team.

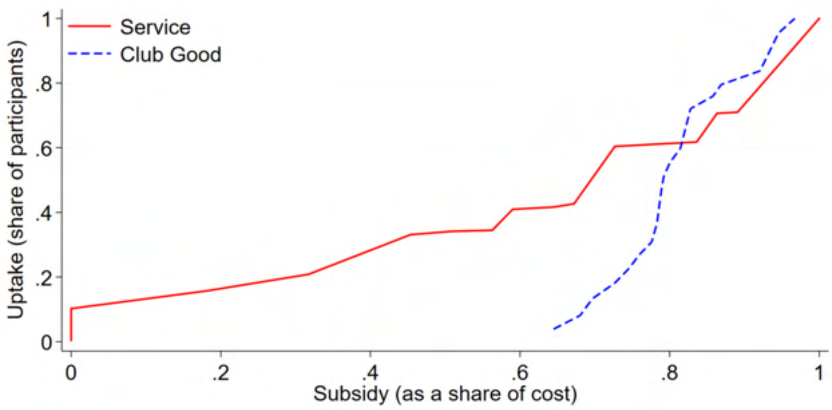
We find that the bid per test declines by IDR 4,000 with each additional desired test. This may indicate that after the first test, farmers attribute a lower value to additional tests, probably assuming that a test on one plot may also have valuable information for other (close by) plots.

Finally, we explore whether WTP varies with land ownership status. We find that the WTP declines with the share of the land under sharecropping that the farmer wants to test (vs. owned/land under fixed-rent).

Scope for Subsidies to Foster Soil Test Uptake

Figure 2 shows the take-up as a function of the share of the total cost that is subsidized for both experimental arms. For lower subsidies the provision as an individual service is the most effective. Uptake among groups is zero unless at least 60% of the costs are subsidized. But for subsidies above 75%, i.e. a farmers' contribution of 25% or less, uptake is higher in the group setting. For an 80% subsidy, the uptake is about 60% in the service arm and 70% in the club good arm. For a 90% subsidy, the difference increases to almost 20 percentage points.

Figure 2. Uptake as a function of the costs subsidized



Notes: Costs include only the costs of the soil tests without the service and training, i.e. IDR 36,600 in the service arm and IDR 1,830,000 in the club good arm. In the club good arm, uptake is weighted by group size, i.e. both lines show uptake at the individual level.

Key Messages

- Our experimental study shows that small scale farmers in Indonesia are willing to pay for/contribute to the cost of rapid low-cost soil tests.
- Yet, the WTP does not cover the cost of the tests.
- Subsidies can be justified by the potential environmental benefits that could result from the prevention of fertilizer overuse and better soil management.
- The provision could be integrated into existing extension services.
- For low subsidies the provision as an individual service is the most effective. For higher subsidies the provision of entire test kits and training are more effective to increase uptake.
- The provision in a group setting might be increase the probability that farmer associations integrate soil testing in their group activities.

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Briefing Note 5, 2024

What Determines Farmer‘s Use of Digital Extension Tools

Study about Blended Learning with The Lentera DESA Website

Background

The increasing utilization of the internet in Indonesia holds significant promise for agricultural knowledge enhancement. Farmers have diverse information needs spanning agricultural cultivation techniques, soil fertility management, pest control, post-harvest management, and market information. However, the digitalization of agricultural information is also necessitated by the shortage of extension workers Indonesia. Due to this shortage, extension workers have to fulfil multiple roles as initiators, facilitators, motivators, teachers, analysts, and change agents. To address this, collaborative efforts between extension workers and agricultural stakeholders are underway to increase the digitalization of extension services. This often involves integrating digital platforms with conventional face-to-face extension, known as the blended learning approach. Yet, not all communities can optimally utilize digital resources, especially considering the older age of many farmers.

This policy brief explores the utilization of online agricultural information by farmers in Yogyakarta through the Lentera Desa website, an online extension platform. In a blended learning setting, conventional face-to-face training was combined with digital extension services. Sampling was conducted across 46 villages in Yogyakarta. Farmers were offered either a 1-day training on soil health management or a 2-day training. The 2-day training additionally included soil testing using the PUTS. Subsequently, all farmers gained complimentary access to online training via the Lentera DESA website.

Specifically, this policy brief addressed the following questions:

1. After face-to-face training, did farmers use the Lentera Desa website? What is the extent of their use?
2. Does the type of face-to-face training influence farmers’ use of the website?
3. Which farmer characteristics influence the use of digital extension resources/the Lentera Desa website?

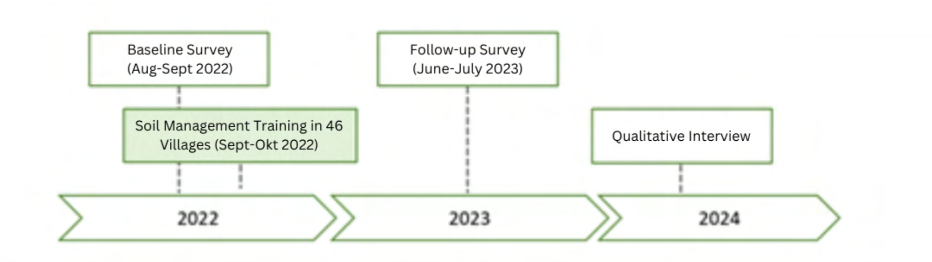
Topics

- The training and Lentera DESA
- Farmer’s use of online resources to find agricultural information
- Use of Lentera DESA
- Determines farmers’ use of Lentera DESA

Location and Respondent Characteristics

This research was conducted in 46 villages across three districts in Yogyakarta: Bantul District, Kulonprogo District, and Sleman District. Pre and post-training data were collected in August 2022 and June 2023. Respondents were sampled at the farmer group level. In total, 736 farmers were interviewed, i.e. 16 from each sampled village. The vast majority of respondents (89%) were male, with the majority being aged 51 years or older. Approximately half of the respondents has completed high school, while a small percentage (7%) hold a university degree. The remaining respondents have completed junior high school or elementary school, with a few having no formal education. Additionally, most respondents indicated that agriculture was not their main occupation and that they supplemented their income with side jobs.

Figure 1: Research Timeline



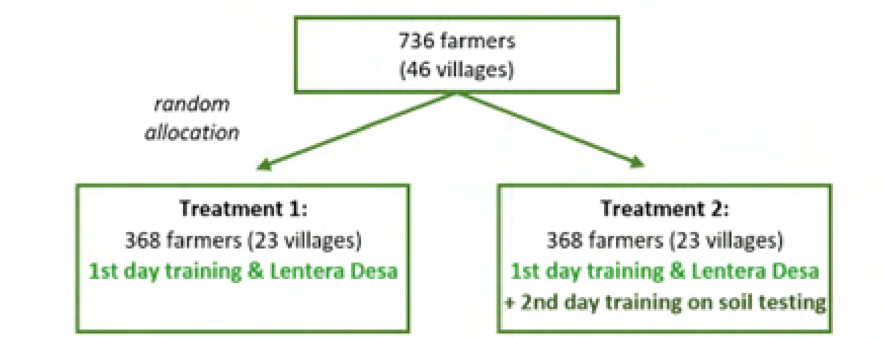
The Blended Learning

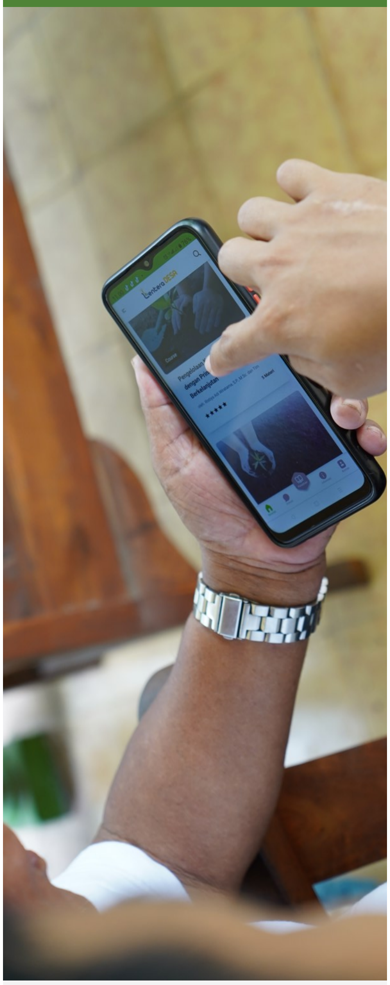
Villages were randomly allocated to three groups: control group, treatment 1 (1-day training) or treatment 2 (2-day training). Depending on the random assignment of their village, farmers were invited to a 1-day and 2-day training on soil management. The control group received no training. In this research, only the farmers in the 1-day and 2-day training group are considered.

The trainings were participatory and focused on sustainable soil health management. In the 2-day training, farmers were additionally taught how to use the PUTS soil test kit using a soil sample from their own plots. All invited farmers were given free access to the online extension platform Lentera Desa, which is operated by UGM.

smartphones.

Figure 2: Research Design



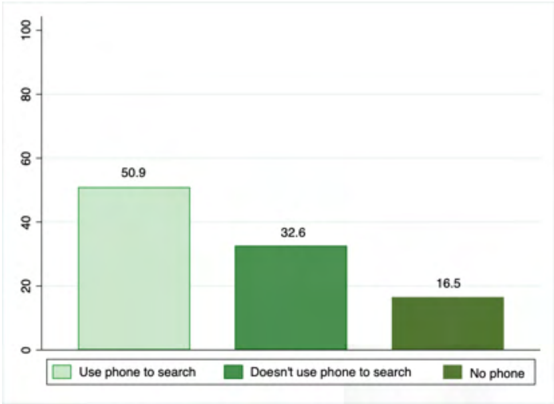


The Lentera DESA Website

Lentera Desa is an online education and training platform in the field of agrocomplex (agriculture, fisheries, and animal husbandry). On the Lentera Desa platform, farmers could access instructional videos to review and enhance the content covered during face-to-face training sessions. The videos primarily concentrate on sustainable soil health management and are typically between 2 to 10

Farmers' Use of Online Resources to Find Agricultural Information

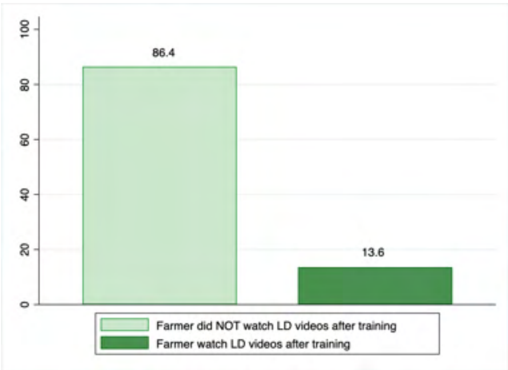
Figure 3: Smartphone Usage by Farmers



Before the training and introduction to the Lentera DESA website, 50.9% of respondents reported to use the internet to search for agricultural information. This share is quite high considering that the majority of respondents are aged 51 years or older.

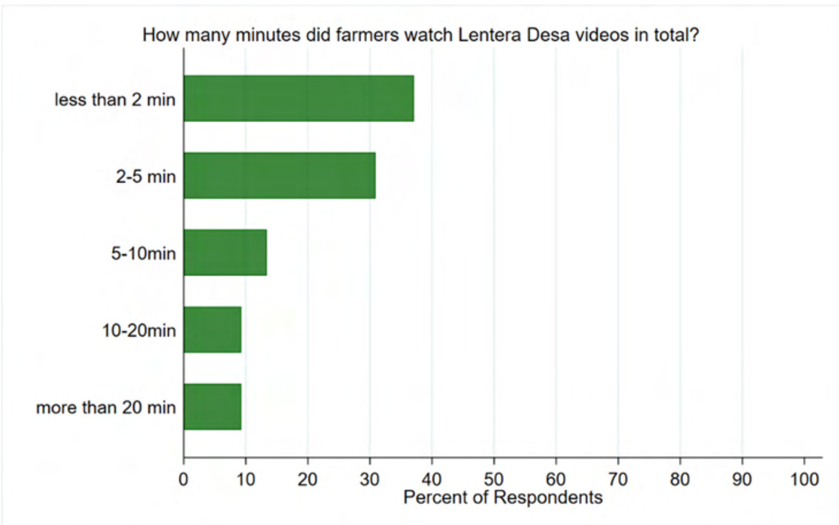
Use of The Lentera DESA

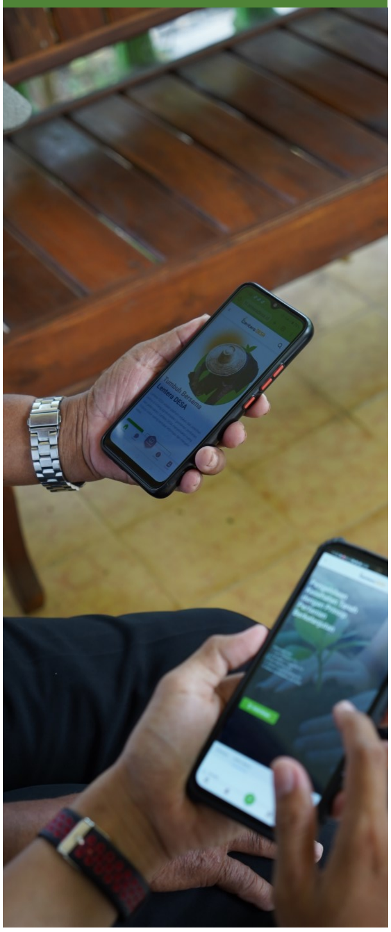
Figure 4: Use of Lentera DESA by Farmers after Training



During the training, farmers were introduced to and given free access to the Lentera Desa website in the hope that they could utilize it independently as an information source after the face-to-face training. However, while 50.9% of respondents reported that they had previously searched online for agricultural information, the take up of the Lentera Desa website is low. Only 13.6% of respondents actually used it.

Figure 5: Farmers Watch Lentera DESA in Minutes





Farmers Watch Lentera DESA

Among the farmers who logged in and watched videos on the platform, the majority (47%) spent less than two minutes viewing the content. Surprisingly, only a small fraction, comprising merely 4% or 10 farmers, watched for more than 20 minutes. The data on the duration of the total time spent watching videos indicates that training videos can be optimized by limiting them to 2-5 minutes as few farmers are willing to watch long videos. Important information can also be communicated at the beginning of the video so that farmers can immediately obtain important information from the video.

Determinants of Using the Lentera DESA Website

Training: The type of training, 1-day or 2-day training with PUTS, does not influence farmers' use of the Lentera Desa Website. This is even though the Lentera Desa website offered even more information for farmers participating in the 2-day training, including videos on how to conduct the PUTS and how to calculate fertilizer amounts.

Age: Interestingly, our data does not show that age is related to the use of the Lentera Desa website.

Education: Farmers who have a university degree are 24 percentage points more likely to use the Lentera Desa platform again after the training. Farmers with higher education who log into the Lentera Desa website after the training also spent more time watching videos.

Smartphone Ownership: Farmers who own a smartphone were more likely to log into the Lentera DESA website.

Experience with Online Information: Farmers who used the internet to search for agricultural information even before our training are also more likely to use the Lentera Desa platform. This suggests that only farmers who are already familiar with using online resources can easily access online learning platforms. Other farmers might need more guidance and practice.

Blended learning training aims to improve access to knowledge and the cost-effectiveness of training, increase the capacity of training participants, and help the facilitator's role in accompanying training participants. However, based on the research data, it is still necessary to have a facilitator role for some participants to provide direct support for using blended learning media to reach the stage where training participants can use combined learning media independently.

Key Messages:

- Half of the farmers use the internet to occasionally search for agricultural information.
- Most farmers do not immediately use online extension resources after the first introduction.
- Because most farmers spent less than 2-5 minutes watching videos, it is important to keep videos short and deliver the most important information at the beginning.
- The use of the Lentera Desa website is related to farmers' education, smartphone ownership and whether they used the internet before to search for agricultural information.
- Most farmers in Yogyakarta do not have high educational degrees and thus need more assistance with using online platforms.

Joint Research Project

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DBU
Deutsche Bundesstiftung Umwelt

UNIVERSITÄT PASSAU

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Briefing Note 6, 2024

The Challenge of Blended Learning-Based Extension

Do facilitators and Web Applications have good roles?

Blended learning combines the advantages of face-to-face meetings with the benefits of web-based learning. It integrates direct interactions with facilitators and self-directed learning. During face-to-face offline meetings, direct interaction with facilitators can enhance cognitive engagement by fostering dialogues between facilitators and participants in training or extension programs. Additionally, face-to-face meetings can initiate independent activities based on real-world issues.

Blended learning relies on integrating technology into education. Subejo (2018) argues that technology usage is influenced by gender and farmers' societal status. Male farmers tend to adopt information and communication technology faster than females. Additionally, farmers with higher societal status, like opinion leaders, are quicker to adopt technology to disseminate information among their peers. This difference arises from their need to utilize media channels for rapid and equitable information sharing among their community members.

However, farmers face difficulties in using internet-based media due to limited familiarity with device operation and limited understanding of digital content. Field data indicates that only about 5.2% of farmers in Indonesia utilize ICT for additional income generation (BPS, 2019), with age being a significant barrier to technology utilization.

On the other hand, blended learning offers a solution to align with global trends and overcome extension resources constraints. In line with these opportunities, the Lentera DESA serves as a platform dedicated to delivering online training to farmers, extension workers, and agricultural stakeholders who aim to enhance their capacity and capabilities.

This policy brief presents findings from a survey conducted among farmers who underwent training in PUTS (Soil Test). The training, employing blended learning, included two days of face-to-face sessions to introduce PUTS (Soil Test), coupled with access to the training room feature of the Lentera DESA website. Specifically, this policy briefs explores:

i) Farmer’s Characteristics
ii) Human Capital and Farmer’s Knowledge Exchange
iii) The Role of Facilitators
iv) Blended-Learning Based Extension Model for Soil Test Adoption

Topics

- Blended learning-based extension model
- Knowledge exchange about Lentera DESA
- The role of the role of training facilitator and resource person for Lentera DESA
- Adoption of soil test

The Survey

This study was conducted across three rice-producing regions, namely Sleman Regency, Bantul Regency, and Kulon Progo Regency, located in the Special Region of Yogyakarta. The selection of research locations employed a dual random sampling technique involving the random selection of districts and farmer groups. Two districts were randomly chosen from each regency, with two farmer groups selected from each district. Farmers from the selected groups were then sampled through census sampling, resulting in a total sample size of 170 farmers. Prior to the survey, all respondents had been invited to training on the utilization of the Rice Field Soil Test Device.

Findings: Human Capital and Knowledge Exchange about Lentera DESA

Figure 1. Farmers' Human Capital Level

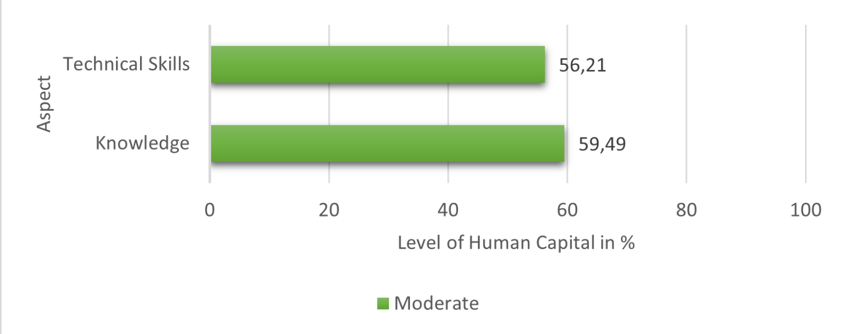
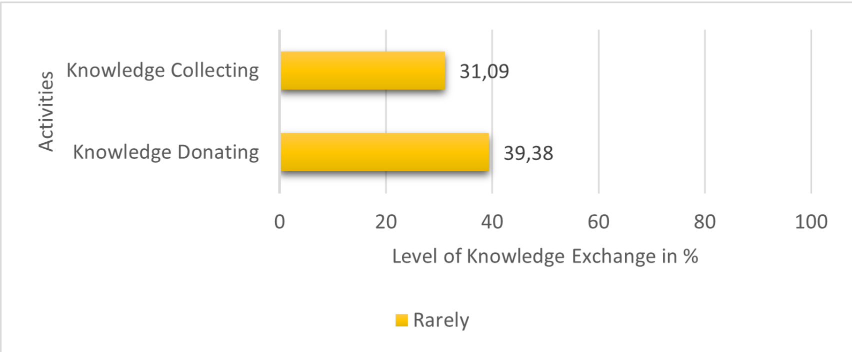


Figure 2 shows the post-training status of farmers' human capital concerning the knowledge and technical skills that are necessary for soil health preservation. Data shows that farmers' understanding of fertile soil attributes and their benefits in rice cultivation is moderate (56.21%). Likewise, farmers' proficiency in assessing fertilizer needs, employing PUTS for soil pH assessment, and formulating fertilization strategies is also at a moderate level (59.49%).

Figure 2. Farmer Knowledge Exchange Level

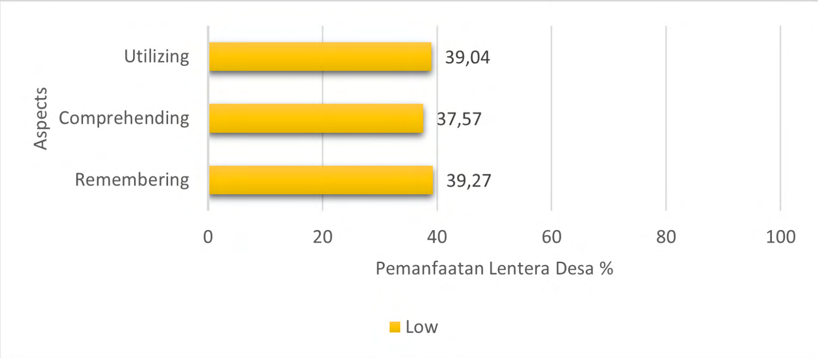


Post-training knowledge exchange activities encompass both sharing information (knowledge donating) and gathering information (knowledge collecting) among peers regarding soil fertility and PUTS. Participants of the training occasionally share insights from the training with fellow farmers, such as the importance of soil health and their experiences in conducting soil pH measurements. However, they rarely seek information on soil health maintenance and soil nutrient level assessment from their peer farmers (knowledge collecting). Overall, there is limited engagement in knowledge exchange regarding the Lentera DESA content and the platform itself.

Findings: Utilization of the Lentera DESA Web Application

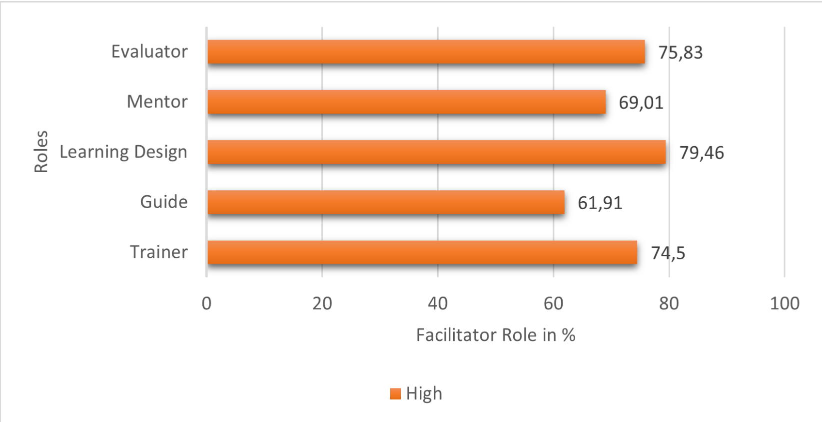
The utilization of Lentera DESA in 2023 by farmers who participated in soil health management training in 2022 was examined considering three aspects: remembering the information presented within Lentera DESA, comprehending the information available within Lentera DESA, and utilizing the information contained therein. The research revealed that only a minority of farmers were able to recall the methods of accessing Lentera DESA and the functionalities of its features. Due to the persistently low capacity for recalling access methods, both comprehension and application were also at a low level.

Figure 3. Level of Utilization of the Lentera DESA Web Application



Findings: The Role of Training's Facilitator

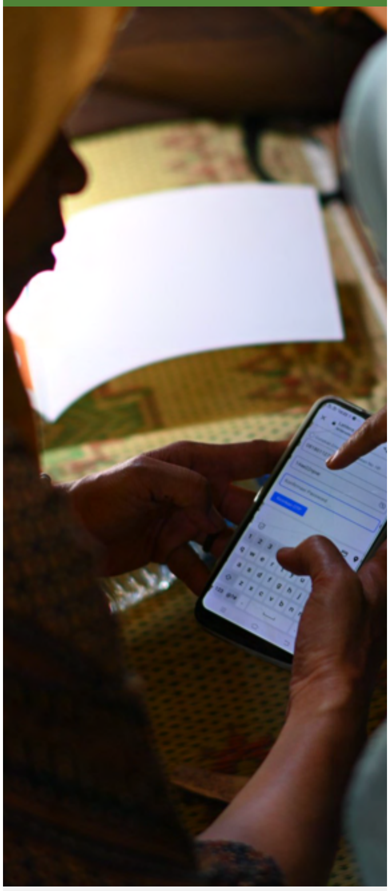
Figure 4. The Role of Training's Facilitator



Farmers stated that facilitators of the face-to-face training sessions and the speakers in the training videos which were uploaded on the Lentera DESA website performed their roles effectively. Facilitators were assessed across five roles: trainer, guide, learning designer, mentor, and evaluator. Facilitators were ranked highest in their role as learning designers (79.46%). The diverse teaching methods involving lectures, discussions, practices, and the utilization of website media (Blended learning) fostered farmers' learning interest. As a trainer, facilitators fulfilled their role by explaining how to use Lentera DESA, conveying the features available in Lentera DESA, and speakers on the Lentera DESA website providing clear information. As guides, facilitators guided farmers in using the Lentera DESA website, and speakers on the Lentera DESA website clearly guided farmers through the steps of soil health management. After the face-to-face training, facilitators evaluated farmers' learning outcomes and their skills in using Lentera DESA by applying pretest and post-test methods.

Farmers Characteristics

Most farmers in our sample (68%) are aged between 40 and 59 years old, with 19 % classified as elderly, aged over 60 years old. Most farmers (65 %) have completed senior high school, while 31% have completed basic education (junior high school or less). Regarding their experience with PUTS, nearly all farmers (95.88%) have utilized the PUTS only once, during the training. As for social media use, the most farmers have only a WhatsApp account (75%).

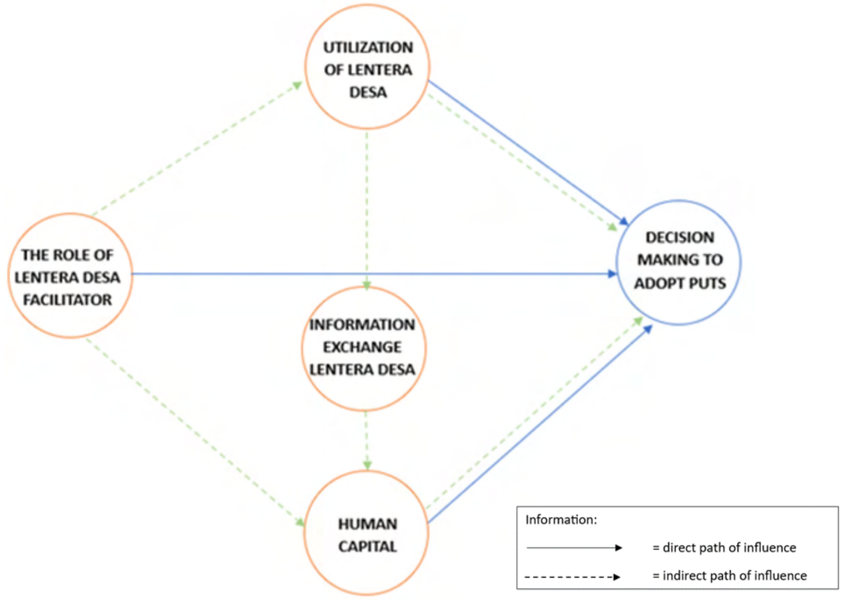


Farmers’ Acces to Information

Farmers' inclination to seek information about soil health and fertility remains notably limited. Most have never searched online to find information on fertilizer dosages. Despite the availability of WhatsApp as a valuable platform for discussions, farmers rarely interact with peers via social media to discuss soil health issues or PUTS. Thus, farmers’ awareness about the potential benefits of using internet-based platforms to access agricultural information needs to be increased.

Blended Learning-Based Extension Model for Adoption of Soil Test

Figure 5. Decision Making Adoption Process in Blended Learning-Based Extension



The results of the data analysis indicate that blended learning influences the formation of adoption decisions through five pathways.

1. **The adoption decision of PUTS is directly influenced by the role of the facilitators who conducted the face-to-face training.**

   Trainers explaining the benefits of PUTS can encourage farmers to use it. Offline training also allows for direct practice, enabling farmers to understand its usage.

2. The decision to adopt PUTS is directly influenced by human capital capability, which comprises knowledge capacity and technical proficiency in using PUTS. The higher the human capital capability, the faster the adoption of the PUTS innovation.

3. In our model, there is a direct pathway between the decision to adopt PUTS and the utilization of Lentera DESA. To access Lentera DESA, farmers must be registered as members of Lentera DESA. Utilizing Lentera DESA, farmers can calculate the fertilizer requirements needed in their fields after receiving PUTS recommendations. The information and facilities available on Lentera DESA can accelerate the adoption decision of the PUTS innovation.

4. **The utilization of Lentera DESA and human capital are directly influenced by the role of facilitators/extension workers during face-to-face training sessions**

   Up to now, farmers rarely utilize online media as information resource, despite the abundance of agricultural information available online. Enhancing farmers’ information literacy is crucial to building human capital so that farmers can improve their businesses and lives. Well-informed farmers can make better decisions and serve as experts for others, offering valuable insights into soil fertility and agricultural challenges.

5. **Facilitators can play a key role in promoting the utilization of Lentera DESA, thereby facilitating information exchange among farmers. This can potentially improve human capital capabilities and consequently impact the decision to adopt PUTS.**
   Farmers' participation in blended learning training/extension can increase information exchange among farmers. Farmers who attend training and have access to learning resources stored in web applications can use the obtained information to initiate discussions among farmers. Frequent knowledge donating and knowledge collecting among farmers increases farmers' knowledge and skills regarding soil fertility and PUTS. Therefore,

Key Messages:

- Farmers find training beneficial when trainers design engaging and enjoyable learning sessions. The role of trainers directly impacts the adoption decision of PUTS.
- Human capital can play an important role after training regarding the decision to adopt PUTS.
- Blended learning-based extension has the potential to make the training more sustainable. This is because training materials can still be accessed by farmers, allowing for continued discussion among farmers.
- Farmers forget how to access the Lentera DESA platform. Thus, when introducing online resources, farmers may require repeated instructions and practice on how to use it.

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