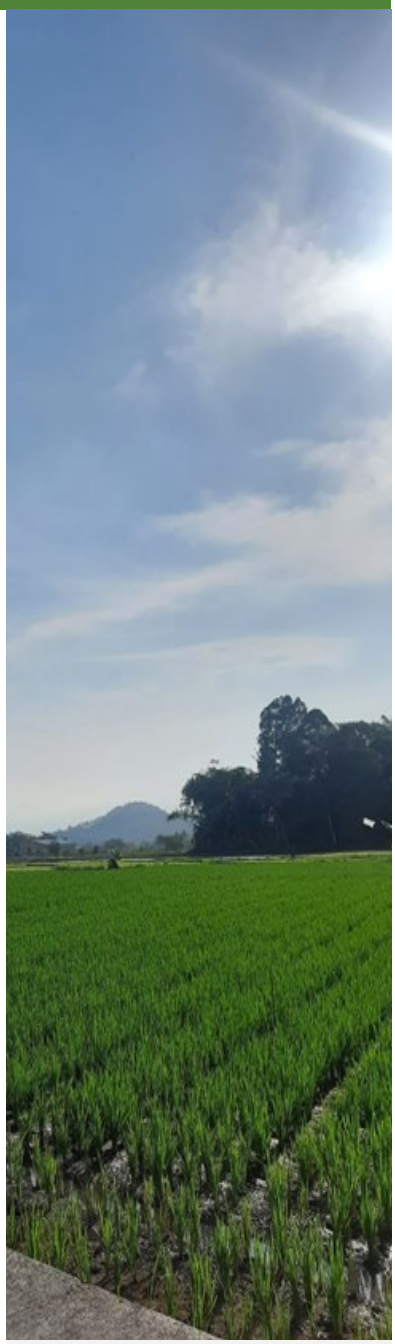
Promoting Sustainable Soil Management Amongst Indonesian Smallholder

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.

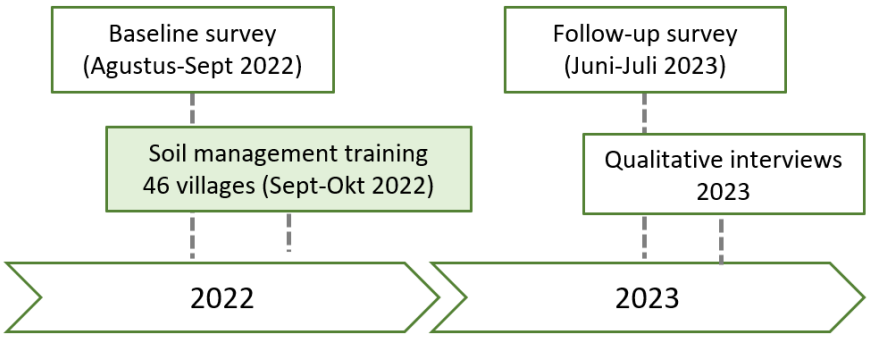
Simply comparing farmers who adopt soil management practices to farmers who do not can be misleading as adopters may differ in many other respects from non-adopters that would then be confused with adoption. Likewise, comparing the same farmers before and after training can be misleading if other factors,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

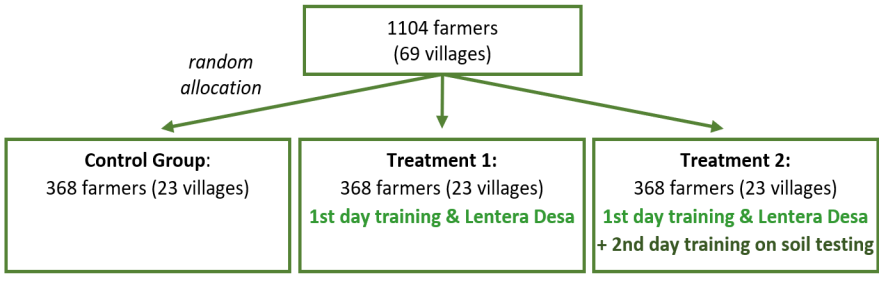


The Training

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



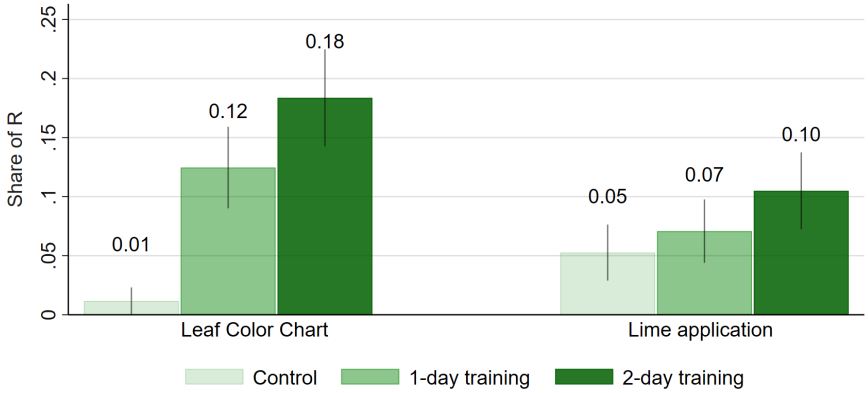
Findings: Using Organic Inputs, Lime and LCC

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



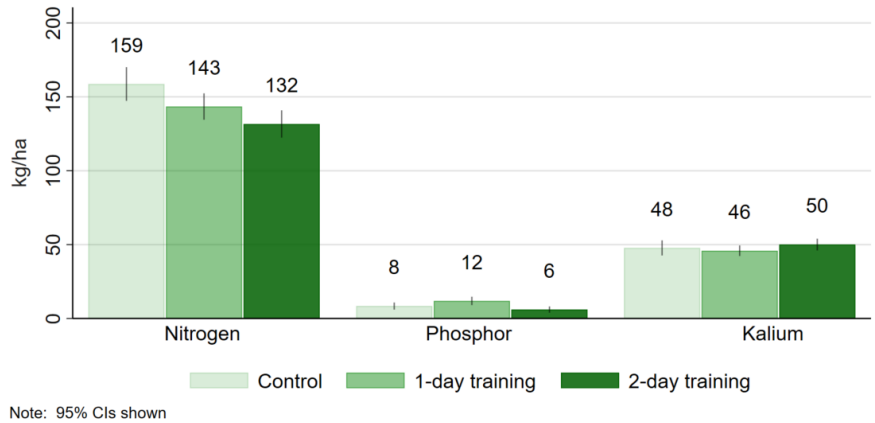
Note: 95% CIs shown

Findings: Application of Chemical Inputs

The results show that training seems to be effective in addressing the overapplication 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



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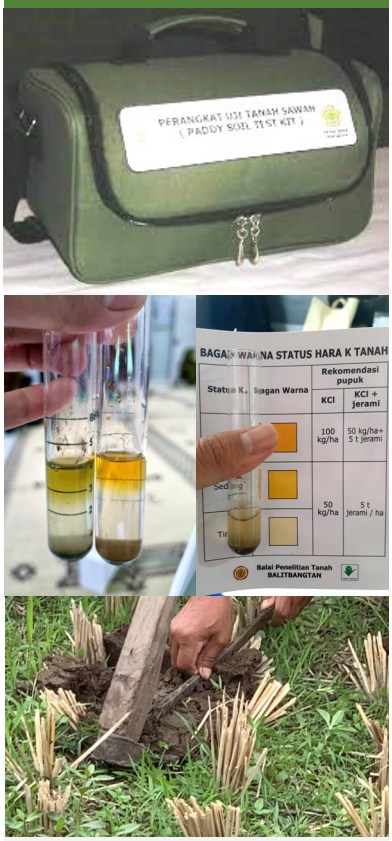

The Soil Test—PUTS

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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Deutsche Bundesstiftung Umwelt

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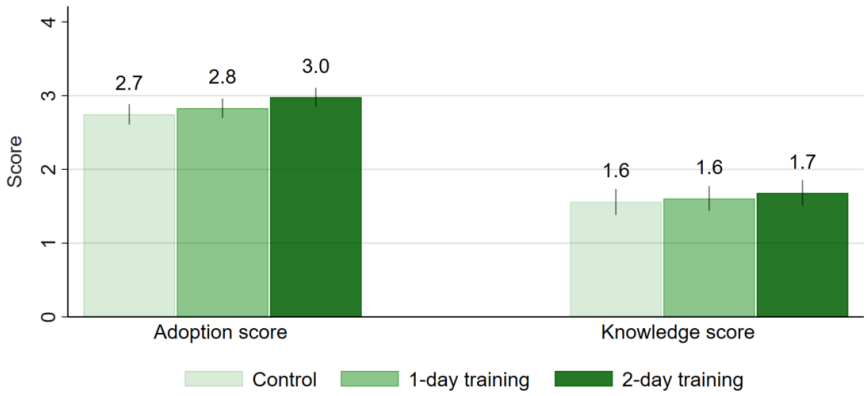
Findings: Adoption and Knowledge Score

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



Note: 95% CIs shown

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.