Combining Soil-Specific Recommendations with Vouchers to Increase Fertilizer Use and Yields among Farmers in Tanzania

Researchers:

Malgosia Madajewicz

Christopher Magomba

Hope Michelson

Sector(s): Agriculture

Fieldwork: Sokoine University of Agriculture (SUA)

Target group: Farmers

Outcome of interest: Technology adoption Productivity

Intervention type: Information Monetary incentives Non-monetary incentives Vouchers

AEA RCT registration number: AEARCTR-0005470

Research Papers: The joint effects of information and financing constraints on technology adopti..., Relaxing Credit and Information Constraints: Five-Year Experimental Evidence fr...

Partner organization(s): United States Agency for International Development (USAID), Columbia University Earth Institute, Sokoine University of Agriculture (SUA), BASIS Feed the Future Innovation Lab for Markets, Risk and Resilience

Crop yields are generally low among small-scale maize farmers in sub-Saharan Africa. Contributing factors include low use of fertilizer, due in part to financial constraints and outdated recommendations regarding the correct types and amounts to apply. A team of researchers conducted a randomized evaluation in rural Tanzania to establish the effects of providing farmers with soil-specific fertilizer recommendations based on tests of their own plots and/or input vouchers to purchase fertilizer. Outcomes of interest included farmers' fertilizer use and maize yields. Farmers who received both recommendations and vouchers increased their fertilizer use and adjusted the type of fertilizer they used while maintaining stable yields in a drought year. Those who received only the plot-specific recommendations did not change their use, and their yields declined in the drought. The group that received vouchers increased their use of urea but did not change their fertilizer type, and their yields also declined. Changes were not sustained three years after the study was completed, as fertilizer use and maize yields returned to pre-intervention levels.

□□□□□□□ □□□□□□□

Small-scale farmers in sub-Saharan Africa have limited information about the soil nutrient limitations of their own plots and what fertilizers to use to address them. They also face financial constraints (limited access to capital, credit, and insurance) that can keep them from investing in these inputs. Government extension is under-funded and offers generalized and often dated nutrient recommendations at large spatial scales that do not reflect actual nutrient needs, which vary across individual plots. For example, they tend to prioritize the use of nitrogen-based fertilizers, which fail to address important soil deficiencies such as sulfur or potassium. Inaccurate recommendations can lead farmers to learn that fertilizer does not improve yields. Fertilizer application rates remain low despite their potential benefits, leading to persistently low crop yields and contributing to ongoing

poverty and food insecurity.

Providing farmers with plot-specific fertilizer recommendations based on soil tests could increase fertilizer use and improve crop yields by helping farmers learn the correct type and amount of fertilizer for their plots and crops. However, information, alone may not be enough. Farmers often operate with limited cash flow and restricted access to credit, which increases the risk of investing in new agricultural inputs. Can providing farmers with a combination of tailored fertilizer recommendations and subsidies increase adoption of appropriate fertilizers and crop yields?

□□□□ □□□□□□□

In the Morogoro Rural District, a major maize-producing area in central-eastern Tanzania, agricultural productivity remains low, with yields averaging 567 kg per acre. Fewer than one percent of farmers applied fertilizer in the region at the study's start.

Government fertilizer recommendations, which were based on soil tests conducted in the 1980s, do not account for local soil differences and exclude nutrients beyond nitrogen and phosphorus. Accessing plot-specific soil fertility information is difficult for a small farmer. Commercial tests tend to cost US$60 per sample, and national laboratories can take over a year to process results. As a result, farmers rely on crop performance to assess soil quality, which provides an imperfect signal of actual soil nutrient levels. Technologies like SoilDoc, a portable diagnostic kit capable of providing rapid, plot-specific recommendations, have been developed to improve access to soil information for small-scale farmers, but have not been deployed at scale.

Farmers in this study cultivated relatively small, rain-fed maize plots; on average, they managed 2.55 acres within total landholdings of about 5.2 acres. Approximately 68 percent of household heads completed at least elementary school, and knowledge of recommended fertilizer practices was limited, with only 3.7 percent of farmers aware of the regional guidelines from the government at baseline. Fewer than 1 percent of farmers applied fertilizer at baseline; among those who did, the average amount applied was 0.46 kg per acre.

A farmer holding a maize cob in Tanzania.

Shutterstock.com

□□□□□□□ □□□□□□□ □□ □□□□□□

Researchers conducted a randomized evaluation in Morogoro Rural District to determine the impact of providing farmers with soil-specific fertilizer recommendations and/or input vouchers, which provided funds to purchase fertilizer. The research team studied the effects on farmers' fertilizer use and maize yields.

The study implemented a two-stage randomization. The team identified maize-growing villages accessible by road, and randomly allocated 20 villages to the intervention and 27 to the comparison group. In each village, the team randomly selected 40 residents who cultivated maize to participate in the study. The team randomly assigned these 40 residents in each treatment village to one of four groups:

1. *Customized recommendations-only (191 farmers)*: Farmers in this group were offered personalized fertilizer recommendations based on soil tests of their main maize plot. These tests assessed deficiencies including nitrogen, phosphorus, potassium, and sulfur, and they measured pH. Soil scientists from Sokoine University of Agriculture (SUA) collected and analyzed the soil samples. They then met separately with groups of farmers in person and translated the results into clear fertilizer recommendations. These were provided in advance of the 2016 planting season.
2. *Voucher-only (198 farmers)*: Farmers were offered vouchers worth TZS 80,000 (approximately US$40) to offset the cost of purchasing any fertilizer—an amount sufficient to cover the cost of fertilizer for half an acre following standard government recommendations. The voucher could be used to buy any agricultural input from a visiting dealer or partially

redeemed for cash at 85 percent of the voucher's value, if farmers preferred not to purchase inputs.

3. *Customized recommendations + voucher (203 farmers)*: Farmers in this group were offered both the customized fertilizer recommendations and the vouchers.
4. *Comparison group (458 farmers):* Farmers in the comparison group were only offered the standard government fertilizer guidelines shared during community meetings, and received their tailored recommendations after the intervention.

The study included farmers in each treatment village as well as farmers from comparison villages in the comparison group in order to test whether farmers who were not offered the intervention directly but lived near participating peers would adopt similar fertilizer practices.

Two components of the intervention were the same for all farmers in treatment and comparison groups. First, all farmers received information about the government fertilizer guidelines from the study team in order for the study to examine the effect of plot-specific soil information compared to uniform exposure to government guidelines rather than to the mix of exposure to guidelines and lack of any information that existed in practice. Second, access to inputs such as fertilizer is constrained not only by lack of cash or credit but also by the transaction costs of accessing fertilizer. The team held these transaction costs constant across the groups by contracting input suppliers to visit each participating village to sell fertilizer. This allowed the study to test the effect of relaxing the information and credit constraints without contamination by heterogeneous transaction costs.

The researchers conducted surveys at the beginning of the evaluation in August 2014, in August 2015, and again in August 2016. They collected data on household characteristics, land use, farming practices, fertilizer choice (e.g., ammonium sulfate (SA), urea, DAP, CAN, and Minjingu), fertilizer application, and maize yields.

□□□□□□□ □□□□□□□ □□□□□□□□□ □□□□ □□□□□□□□

Only farmers who received both tailored, plot-specific recommendations and input vouchers increased their fertilizer use and yields relative to the comparison group during the intervention season. Farmers who received only recommendations or only vouchers neither changed their fertilizer adoption (though farmers who received vouchers increased their use of urea a little) nor maintained their yields. The growing season following the intervention was marked by a severe drought. The group that received recommendations and vouchers maintained their yields while yields declined in the other groups. The results suggest that agronomic advice and financial support are both necessary to improve productivity.

Meeting attendance: Eighty-six percent of farmers in the customized recommendations + voucher group attended project meetings, and 82 percent visited input dealers, compared to 63 percent and 24 percent, respectively, in the voucher-only and customized recommendations-only groups.

Researchers suggest that higher meeting attendance and direct engagement with input dealers may have contributed to increased fertilizer purchases.

Fertilizer use - amount: Farmers in the customized recommendations + voucher group increased their fertilizer application by an average of 23 kg per acre compared to farmers in the comparison group (an increase of 5,000 percent). In contrast, farmers in the voucher-only group increased their fertilizer use by 10 kg per acre. Farmers in the customized recommendations-only and comparison groups showed no meaningful change in fertilizer use, suggesting that recommendations alone were ineffective at changing farmers' behavior.

Fertilizer use - type: 49 percent of farmers in the customized recommendations + voucher group purchased SA with urea to address a widespread sulfur deficiency, while only 4 percent of farmers in the voucher-only group did so. Most farmers in the voucher-only group purchased only urea (27 percent) or decided to redeem their vouchers for cash (69 percent), suggesting that, in the absence of relevant agronomic advice, the subsidy alone did not lead to optimal choices of type or amount of fertilizer.

Yields: During the evaluation, farmers experienced a drought that limited growth potential, dampening production among all farmers over the 2014–2016 seasons. Only farmers in the customized recommendations + voucher group maintained their yields, while yields in the comparison group decreased by 121 kg per acre, with similar declines in the voucher-only and recommendations-only groups.

Revenues: Researchers estimated revenues and profits using observed yield gains and local maize prices reported by a subset of farmers who sold maize during the study period. They estimated that farmers who received both customized recommendations and input vouchers increased their expected revenue by TZS 54,300 (approximately US$27) per acre relative to the comparison group. Among these, farmers who applied both SA and urea, more closely following the tailored recommendations, had a revenue increase of TZS 110,800 (approximately US$55) per acre. In contrast, the profits and revenues of the farmers who received only vouchers or only recommendations did not change.

Cost analysis: Researchers estimate that farmers who applied the recommended mix of SA and urea used an average of 24 kg per acre of each and spent a total of about TZS 62,400 (approximately US$31). If they also covered the cost of soil tests (around TZS 10,000 or US$5) and the cost of traveling to procure fertilizer (estimated at TZS 1,250 or US$0.6), the total cost for a one-acre farm would be TZS 73,650 (about US$37). Based on the estimated increase in revenue from higher maize yields, this fertilizer investment could generate additional profits equivalent to around 7 to 9 days of a farmer's median daily wage, a steep cost, particularly in a difficult drought year like 2016, when yields were low. This demonstrates how financial assistance is critical to enable farmers to invest in inputs.

Effects on neighboring villages: Farmers in the comparison group who lived in intervention villages but did not receive recommendations or vouchers did not change their fertilizer use. This suggests that tailored recommendations were not shared with nearby farmers, or these farmers did not utilize the shared information.

Long-term effects: Five years after the initial experiment, researchers conducted a follow-up study to assess whether the earlier effects persisted once vouchers were discontinued and when fertilizer recommendations were extended to all farmers. The earlier gains in fertilizer use and yields did not persist. By 2019, fertilizer application rates had returned to pre-intervention levels and maize yields were similar across all groups. Researchers interpret these findings as evidence that financial constraints at the beginning of the planting season remain an important barrier to fertilizer use. Even farmers who experienced higher yields during the intervention and observed the benefits of using the recommended fertilizers did not continue applying fertilizer once financial support ended, suggesting that affordability is the main constraint to sustained adoption.

https://www.sciencedirect.com/science/article/abs/pii/S030438782100081X?via%3Dihub