Paris School of Economics (P.S.E) – Master 2 PPD

Natural Ressources and Development: Referee Report on

Harvesting the rain: The adoption of environmental technologies in the Sahel

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1 Summary

This NBER working paper (November 2021) by Aker and Jack investigates the barriers to adopting rainwater harvesting (RWH) techniques, specifically demi-lunes, in the Sahel region of Niger, where combating land degradation and improving soil fertility are critical challenges. The authors use a randomized controlled trial (RCT) experiment with four treatment arms and a control group to test the impact of training and cash transfers on adoption. A control group to test the impact of training and cash transfers on adoption. The paper aims to determine the primary barriers to RWH technology adoption in a low-income setting with prevalent liquidity and credit constraints. It seeks to determine if providing information, cash transfers (conditional or unconditional), or a combination is effective in increasing adoption. The experiment was conducted in the Zinder region of Niger with 180 villages. Villages were randomly assigned to a control group or one of four treatments: training only, training plus early unconditional cash transfer (UCT-early), training plus conditional cash transfer (CCT), or training plus late unconditional cash transfer (UCT-late) alongside a control group with no intervention. Data collection spans baseline, midline, and end-line surveys over three years, encompassing over $2,800$ participants. This methodology directly addresses the limitations of observational studies by isolating the effects of specific interventions. The study uses data from three sources: household surveys (baseline, midline, and end-line), field observations of demi-lune construction, and a spillover sample survey. This longitudinal and multi-faceted data collection enables a robust assessment of adoption, maintenance, and longer-term impacts. All four treatments significantly increased adoption in the short- and medium-term. Training alone increased adoption likelihood by over 90 percentage points, with cash transfers showing no additional effect. Adoption resulted from a combination of hiring labor and reallocating household labor. Treated households hired more labor, reduced seasonal migration, and decreased wage work to construct demi-lunes, with no significant differences across treatment arms. Interventions significantly impacted agricultural production and land use. Agricultural production increased by 0.12 to 0.15 standard deviations across all treatments, with stronger medium-run effects. In the third year, the treated villages cultivated an additional 0.3 hectares of previously uncultivated land. A cost-benefit calculation showed that in the first year, the effects of treatment on agricultural revenue (USD 40) exceeded costs (USD 30). In addition, significant adoption spillovers occurred within villages. Farmers in treated villages were 50 percentage points more likely to have neighbors adopting demi-lunes, and in a spillover sample, farmers were 20 percentage points more likely to adopt in treatment villages.

2 Comments, critics, and suggestions

One of the key strengths of the paper lies in its robust experimental design, as it allows a clear causal interpretation of the effects of training and cash transfer interventions on the adoption of technology. The use of multiple treatments offers a nuanced understanding of how different interventions influence adoption rates. Also, the inclusion of a three-year follow-up period further proves the credibility of the key findings, as well as not only the short-term impacts but also the medium-term sustainability of the adoption. This study makes a significant contribution to the academic

literature because it demonstrates the pivotal role of information in driving technology adoption. It challenges conventional assumptions that financial constraints are the primary barrier, instead showing that well-structured training can substantially increase adoption rates, even in resource-constrained settings. This finding has important implications for the design of agricultural interventions. It suggests that targeted informational programs may be more cost-effective and impactful than financial incentives.

The study suggests several mechanisms for training effectiveness—awareness, technical guidance, social learning, and motivation but does not disentangle their individual impacts. This ambiguity limits understanding of the most influential factors. Future research should use mediation analyses or targeted experiments to isolate specific mechanisms and their contributions. The study presents medium-term (three-year) impacts but does not confirm long-term adoption or productivity gains. Disadoption—the abandonment of demi-lunes—remains unexamined. Longer follow-up periods, such as five to ten years, would provide clearer insights into sustainability and factors influencing persistence versus abandonment. Testing 37 dependent variables raises concerns about false positives. Although the authors apply False Discovery Rate (FDR) corrections, the risk of spurious findings persists. Greater transparency in reporting adjusted p-values and discussing their implications would reinforce confidence in the results.

The study focuses on a specific region in Niger and a single rainwater harvesting (RWH) technique, demi-lunes. This limits its applicability to other regions, technologies, or socio-economic contexts. The training's effectiveness may depend on cultural, environmental, or institutional factors not addressed in the analysis. Expanding the scope to include additional regions or RWH techniques could improve the study's relevance. Despite the randomized controlled trial (RCT) design, some confounding factors remain. Households in treatment villages had higher baseline experience with demi-lunes, which may introduce bias despite statistical controls and robustness checks like Lee bounds. Additionally, spillovers between villages could affect results, potentially violating the Stable Unit Treatment Value Assumption (SUTVA). These factors necessitate a cautious interpretation of the findings. Reliance on self-reported and observational data introduces potential inaccuracies, particularly in land quality assessment. Errors may underestimate adoption relative to available land. Moreover, land quality metrics do not account for soil types or slopes, reducing precision in environmental impact estimates. Incorporating remote sensing or soil testing would improve data reliability. I develop five suggestions for the authors, addressing different aspects of their work:

- Refine the Research Question: Narrow the focus to better capture the relative importance of information versus financial constraints in driving adoption. For example: "What is the comparative role of information and financial support in promoting demi-lune adoption among smallholder farmers in Niger, and what are the longer-term impacts?"
- Address Training Endogeneity: Discuss potential biases due to the bundled nature of interventions. Farmers selected for training may already be more proactive or informed, leading to potential endogeneity. Using instrumental variables (e.g., proximity to Ministry offices) or implementing within-village randomization could help isolate the training's true effect.
- Explore Heterogeneity in Treatment Effects: Investigate how adoption varies based on existing farming practices, social networks, or access to external information sources like extension services or radio. Deeper subgroup analysis could reveal which populations benefit most from interventions.
- Analyze Spillover Mechanisms: Examine how spillovers occur. Are they driven by social learning, observation, or shifts in norms? Qualitative data, such as interviews or focus groups, could offer insights into how information and practices spread within villages.
- Extend Long-Term Analysis: Expand the study to explore long-term impacts on soil fertility, land degradation, and livelihoods. Follow-up data beyond three years would provide critical insights into the sustainability of adoption and its broader effects.

3 Recommandations

I recommend this paper for a "revise and resubmit" with targeted improvements to enhance its clarity and contribution. First, the mechanisms behind training effectiveness should be clarified by analyzing whether it builds knowledge,

confidence, or social norms. Qualitative insights and pre-/post-training assessments could strengthen this analysis. Second, treatment heterogeneity deserves deeper exploration, focusing on variations by gender, economic status, and baseline conditions, using advanced econometric methods like causal forests. Third, long-term sustainability should be addressed with follow-up studies and discussions of maintenance challenges and regional scalability. Fourth, the role of complementary inputs such as fertilizers and water management should be analyzed to provide actionable insights for maximizing outcomes. Finally, the study's generalizability could be expanded by comparing findings with similar interventions in regions like East Africa or South Asia, while addressing challenges for scaling the training framework.

References for Further Guidance

To support these recommendations, the following reference could serve as a foundational basis:

Duflo, E., Kremer, M., & Robinson, J. (2011). "Nudging Farmers to Use Fertilizer: Theory and Experimental Evidence from Kenya." *American Economic Review*.

(Offers advanced econometric methods to explore treatment effect heterogeneity across subpopulations.)