

Are Rainwater Harvesting Techniques Profitable for Small-Scale Farmers? The Adoption and Impact of RWH Techniques in Niger

Researchers:

Jenny Aker

Kelsey Jack

Sector(s): Agriculture, Environment & Energy

Fieldwork: Sahel Consulting Group

Location: Niger

Sample: 2861 smallholder farmers in 180 villages

Target group: Farmers Rural population

Outcome of interest: Technology adoption Climate change adaptation Productivity

Intervention type: Cash transfers Information Natural resource management Sustainable farming Unconditional cash transfers

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In low-income contexts, liquidity and credit constraints can hinder the adoption of improved agricultural and environmental technologies. In Niger, researchers conducted a randomized evaluation to test the impact of providing training and conditional or unconditional cash transfers on farmers' adoption and use of an environmental technology, their resulting land use, agricultural production and profitability, and labor allocation. Results showed that providing farmers with training led to a substantially higher probability of adopting the technology, while the conditional or unconditional cash transfers had no additional effect on farmers' decision to adopt.

Policy issue

Global agricultural yields have more than doubled since the 1960s, but productivity has stagnated in much of sub-Saharan Africa, causing many farmers to clear more land for agriculture to meet growing food demand. This expansion often pushes production onto increasingly rocky, sandy, or shallow soils with limited soil nutrients and water availability, leading to rapid depletion and degradation of farmland. Climate change and barriers to information on sustainable agricultural practices hinder the adoption of environmentally-friendly agricultural technologies. Demi-lunes, water collection pits, are one such technology that can help farmers restore their land by briefly capturing rainfall and runoff for soil nutrient replenishment, but farmers do not often know how to construct them correctly or cannot afford to build them. Can providing households with information and cash transfers increase their construction of demi-lunes and, therefore, production and soil fertility?

Context of the evaluation

Niger is one of the lowest-ranked economies on the UN's Human Development Index,¹ with 80 percent of its people living on less than US\$3 per day.² Due to its semi-arid climate, rainfed agriculture is the primary source of livelihood, where approximately 94 percent of the population lives on 20 percent of the land. Niger has a single rainy season from June to September, with harvest between October and January. After harvest, there is less access to food, income, and labor, triggering seasonal migration to neighboring countries, when many households send at least one member abroad for work. In addition, severe soil degradation is a common problem, with at least 50 percent of land under cultivation experiencing soil erosion.

Demi-lunes can be an appropriate rainwater harvesting technique for land restoration and climate change adaptation. When constructed correctly, they can capture rainwater for a short period of time (2-3 days), stymie soil runoff, and increase soil nutrient content. The Nigerien Ministry of Environment recommends building 250-300 demi-lunes per hectare of degraded land. Each demi-lune costs about US\$80 to construct, primarily for labor, but once constructed, they do not require maintenance until three years later at which time the land should show signs of restoration.

Eligible households were comprised of about eight people, with four adults, and owned or cultivated approximately 4 hectares of land, at least half of which was degraded. Households primarily grew millet, sorghum, cowpea, and peanuts. While only one-third of households had prior experience constructing demi-lunes, over 60 percent of farmers had heard about demi-lunes prior to the start of the study.



Farmers in Niger struggle with soil erosion and degradation.

Details of the intervention

Researchers conducted a randomized evaluation to test the effect of training and cash transfers on farmers' adoption of demi-lunes, agricultural production and profitability, land use, and household labor allocation to agriculture. Within each of the randomly selected 180 villages, researchers randomly selected sixteen individuals, eight men and eight women, ensuring gender balance. They then randomly assigned these 2,861 participants to one of five groups:

1. *Training*: Eligible farmers from the forty villages in this group were offered an interactive classroom and practical training covering a) an explanation of demi-lunes and their purpose; b) the steps for constructing and maintaining demi-lunes, including how to plant in and around them; and c) the technical norms for construction, including the appropriate land type, dimensions, and orientation.
2. *Unconditional Cash Transfer - Early (UCT-early)*: Eligible farmers from forty villages were offered the training and an unconditional cash transfer of US\$20 that was paid one month after the training and was independent of whether farmers chose to construct demi-lunes).
3. *Conditional Cash Transfer (CCT)*: Eligible farmers from forty villages were offered the training and a conditional cash transfer of US\$0.40 per quality demi-lune constructed. The CCTs were paid four months after initial training (at the onset of the rains) and were dependent on verified demi-lunes constructed on the farmers' land.
4. *Unconditional Cash Transfer - Late (UCT-late)*: Eligible farmers from thirty villages received the training and an unconditional transfer of US\$20.50, timed to coincide with the CCT payout. Researchers added US\$0.50 onto the transfer to compensate for the delay in payment relative to the UCT-early group. The primary goal of this intervention was to identify differences in the UCT-early and CCT arms, which differed in conditionality and timing.
5. *Comparison*: Eligible farmers in another thirty villages did not receive any training or cash transfer for the duration of the study.

Researchers also selected 670 individuals, two men and two women per village, who were not included in the rollout of the intervention to assess any spillovers from the study, namely whether neighboring farmers learned about and constructed their own demi-lunes.

Between 2018 and 2021, researchers conducted household surveys before the start of the intervention, nine months into the evaluation, and two years after the intervention, collecting information on household demographics, assets, agricultural production, land and labor outcomes, and demi-lune construction. During the final survey, the survey team conducted a nudging experiment, reading a script to each respondent. Households were randomly assigned to one script. Each script addressed one of five reasons a farmer might not adopt demi-lunes, namely: the need to seek permission before building, waiting too late in the dry season, feeling pressure from the researchers to construct them, clearly understanding the associated costs and benefits, and being familiar with the inputs required for construction.

In assessing the benefits and costs of the study, the researchers carefully weighed the risks. Overall, it was determined that, since the technology under consideration (the demi-lune) focused on severely degraded land that could not be cultivated, it was not substantially increasing households' risks. There was a small risk that households could have expended effort and adopted with little benefit, but this was not evident in the study results.

Results and policy lessons

Researchers found that providing farmers with training increased adoption, but conditional or unconditional cash transfers had no additional effect in the medium- or long-term. Adoption of demi-lunes led to an increase in agricultural output, a reduction in land turnover, and adoption among neighboring farms and spillover farms as well up to three years later.

Demi-lune adoption: All four interventions resulted in increased adoption of demi-lunes, and beyond being offered the training, there were no meaningful differences in adoption between the intervention groups after the first year. Specifically, farmers in participating villages were 91 percent more likely to adopt demi-lunes compared to 4 percent of households in comparison villages. On average, farmers who participated in the interventions adopted between 28–40 additional demi-lunes relative to the comparison group.

Three years after the intervention was delivered, farmers were still actively using their demi-lunes: farmers in intervention villages were 74 percentage points more likely to have operational demi-lunes relative to farmers in comparison villages. This is only slightly less than the percentage of farmers who had originally adopted any demi-lunes. Similarly, there were important spillovers: farmers in intervention villages were 50 percentage points more likely to have neighbors who adopted demi-lunes, with adoption observed on an additional 0.7 neighboring fields.

Labor allocation: In the first year, households in the intervention groups hired more outside labor, sent fewer household members to work off-farm, and reallocated family labor to construct demi-lunes. Specifically, intervention households used an additional 15 person-days of family labor to construct demi-lunes relative to two person-days among households in the comparison group. In addition to demi-lune construction, households also hired outside laborers for other agricultural tasks. These results did not vary meaningfully between the intervention groups.

Agricultural production, land use, and profitability: Total agricultural production increased by 0.12 to 0.15 standard deviations relative to comparison group households, with stronger effects over time. Households in intervention villages had a 40 percent lower likelihood of crop failure than those in the comparison group in the first year, but this did not persist in the longer-term. Concretely, improvements in production translated to a 80–90 kilogram increase in the amount produced, primarily through sesame and sorghum.

In terms of land use, intervention households were 33 percentage points more likely to cultivate previously uncultivable land, planting an additional 0.3 hectares relative to comparison households. Specifically, participating households were 33 percent less likely to retire land from planting due to degradation, and farmers did not buy, sell, or rent more land as a result of the intervention.

In terms of profits, intervention households increased their agricultural revenues by US\$34–37 in the first and third years, suggesting that farmers in intervention villages earned 10–13 percent more than farmers in the comparison group. However, intervention households also about US\$20 on hired labor and materials and foregoing approximately US\$15 from income from family labor that was reallocated to work on the farm. This suggests a benefit of US\$3 for demi-lune construction and use in the first year. These added benefits persisted and increased after the first year due to costs being incurred in year one while benefits continued to accrue in year two and three.

Researchers suggest that the key results were driven by training farmers on the correct specifications to construct demi-lunes, increasing farmers' technical knowledge and social interaction around the technology. The conditional or unconditional transfers did not meaningfully affect farmers in this context, suggesting that they could come up with the financial resources to cover agricultural investments when the primary constraint to adoption was alleviated.

At the end of the evaluation, the researchers rolled out the successful intervention (the training) to all of the villages assigned to the comparison group and provided feedback to the Ministry, stakeholders and the communities on the results. Informed by the results, the researchers are scaling up the intervention with the Ministry of Environment in Niger.

2. World Bank national accounts data, and OECD National Accounts data

files. <https://data.worldbank.org/indicator/NY.GDP.PCAP.KD.ZG?end=2021&locations=NE&start=1990>