Are Rainwater Harvesting Techniques Profitable for Small-Scale Farmers?  
Results from a Pilot Evaluation in Niger  
Jenny C. Aker, The Fletcher School, Tufts University  
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CONTEXT

Rainfed agriculture in the Sahelian region of sub-Saharan Africa is plagued by low and erratic rainfall and strong winds, contributing to soil erosion and degradation. It is estimated that approximately 50 percent of farmland in West Africa suffers from nutrient depletion and poor soil fertility (Scherr 1999). Small-scale farmers in West Africa have traditionally dealt with poor rains and degraded soils by shifting into extensive agriculture. Yet high population density and increasing frequency of drought in the Sahel over the past 30 years has resulted in shorter fallow periods and reduced the availability of arable land, thereby making these strategies unsustainable in the longer-term (Warren, Batterbury and Osbahr 2001).

In order to deal with climatic shifts and fragile lands, sustained yield improvements in the Sahel therefore require techniques that both increase the level and duration of water stored within the soil (via rainwater harvesting, or RWH) and replete soil nutrients. While rainwater can be harvested via in-situ rainwater conservation, this technique is poorly suited to the semi-arid areas of Africa, where soil cover materials compete with livestock fodder. In such contexts, micro-catchments -- small structures constructed within a field to collect soil runoff and increase the nutrient content of the soil – are the most appropriate RWH technology. The most common micro-catchments used in the Sahelian region of West Africa are zaï/tassa (soil pits), demi-lunes (half-moons) and banquettes, some of which are indigenous to West Africa. Variations of these micro-catchment techniques have also been adapted in the semi-arid zones outside of West Africa, including Ethiopia, Kenya, Tanzania and Uganda.

Decades of research station and on-farm trials in the Sahel suggest that zaï and demi-lunes can significantly reduce soil erosion and degradation as well as the risk of crop failure (Vohland and Barry 2009), as well as increase millet yields in combination with manure or inorganic fertilizers. Yet adoption of RWH techniques remains low, especially in Niger: it is estimated that fewer than 10 percent of small-scale farmers use micro-catchments on any part of their land (WOCAT 2009).

Why is the adoption of these technologies so low?
There are numerous potential reasons, such as high construction and maintenance costs, limited access to technical information on these techniques or the fact that yield improvements and profitability may not be observed until the second year.

Over the past decade, numerous non-governmental organizations (NGOs) have promoted the adoption of RWH techniques by providing technical training and conditional cash or food transfer programs. While these programs have been successful in increasing the prevalence of RWH technique adoption in particular areas, their ability to identify the underlying barriers has been constrained by small sample sizes, selection bias and measurement error.

**INTERVENTION**

This pilot study sought to better understand the barriers to RWH adoption, as well as measure the impact of their adoption on farmers’ well-being. Using a randomized control trial in Niger, and in partnership with the Ministry of Environment and Sahel Group, farmers were offered one of three interventions: 1) training: basic training for RWH techniques, including the necessary equipment, conducted by the Ministry; 2) UCT: training on RWH techniques and an unconditional cash transfer (cash advance) worth $40, approximately 50% of the costs associated with constructing demi-lunes on one hectare of land; and 3) CCT: training on RWH techniques and a conditional cash transfer, whereby farmers receive a cash payment for every demi-lune of acceptable quality, similar to the value of the UCT. This latter intervention was similar to NGO CFW interventions in Niger.

The sample size for this pilot was 30 villages in the Dosso region of Niger, targeting villages that are the most affected by soil degradation. Within each village, 25 farmers were selected, for a total of 750 farmers. At the initial meetings, farmers were not informed of the potential cash payments, in order to encourage participation of those interested in the RWH technique technology. Approximately ¼ of the beneficiaries were women.

**RESULTS**

**Effect on Demi-Lune Adoption**

The pilot results showed that interest in these techniques was high: 85 percent of households attended the trainings, regardless of the intervention group, for a total of 637 farmers trained.

Among all of the farmers, 85% of households in the training and UCT villages constructed demi-lunes on their plots, whereas households in CCT villages were 13 percentage points less likely to construct demi-lunes. This suggests that training (alone) can be a cost-effective way to get farmers to try the technology.

Yet the unconditional cash transfer was helpful in encouraging farmers to construct more demi-lunes on their land: While households in the training villages constructed about 30 demi-lunes per hectare, those in the UCT group constructed about 47 demi-lunes per hectare. And those in the CCT villages constructed fewer than those in the training or UCT group (Figure 1). These results were confirmed by farmers’ self-reported data on demi-lune construction. This suggests that cash transfers were necessary to overcome farmers’ credit constraints associated with hiring labor.

While all of these were well below the suggested technical norms of 250 demi-lunes per hectare, the evolution of adoption suggests that farmers were “trying out” the technology over time to see how it worked. Farmers initially followed the spacing norm on their plots. In addition, two years after the
intervention, a qualitative study suggested that farmers were constructing more demi-lunes on those plots, at approximately 20 per year.

**Effects on Input Use and Production**

A key question in the adoption of any new technology is whether that technology is welfare-improving for those households. Using data from a household survey after the harvest, the pilot program suggests that demi-lune adoption was also correlated with other changes in input use, agricultural production and other measures of well-being. Overall, households in the UCT villages—who had constructed more demi-lunes than their training and CCT counterparts—were 18 percentage points less likely to use inorganic fertilizer than those in the CCT villages, and more likely to use inorganic fertilizer (manure), a key complimentary input for demi-lunes (Figure 2). Nevertheless, while inorganic fertilizers must be purchased, manure is often readily available from household livestock.

Overall, these results seem to have translated into higher agricultural production for key crops planted in demi-lunes: households in the UCT villages produced approximately 20 kg more millet than those in the training and CCT villages, respectively, with a statistically significant difference at the 5 percent level (Figure 3). This also translated into modest improvements in well-being: UCT households had higher self-reported measures of well-being and more durable assets. In particular, households in UCT villages were 12-14 percentage points more likely to own a motorcycle and cart than their training and CCT counterparts, suggesting that these households were able to invest in agricultural technology and other assets.

**NEXT STEPS**

Researchers are currently working with NGOs and the Ministry to implement a full-scale research program in 180 villages in Niger, building upon the pilot results. The full study will also measure the impacts of the technology on soil quality, a key constraint in Sahelian West Africa.
REFERENCES


