

Half-Moon Water Harvesting Technique For Agriculture: A Case Study of Degraded Land Reclamation at Abdullahi Fodio University of Science and Technology, Aliero (AFUSTA)

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Abstract

Land degradation remains one of the most serious environmental and socio-economic challenges confronting arid and semi-arid regions worldwide, with particularly severe consequences in sub-Saharan Africa. In northern Nigeria, the combined effects of climate variability, unsustainable land-use practices, soil erosion, and declining vegetation cover have accelerated ecosystem degradation and undermined agricultural productivity and rural livelihoods. This study evaluated the effectiveness of the half-moon water harvesting technique as a low-cost, climate-smart, and sustainable approach to degraded land reclamation at Abdullahi Fodio University of Science and Technology, Aliero (AFUSTA), Kebbi State, Nigeria. The study was conducted during the 2025 rainy season using two severely degraded plots. Semi-circular micro-catchments (half-moons) with a diameter of 4 m and a depth of 0.15–0.25 m was constructed with their open ends facing upslope to capture surface runoff and enhance water infiltration. Organic manure was incorporated into each structure to improve soil fertility and support vegetation establishment. Baseline conditions were documented prior to intervention, and post-intervention assessments focused on changes in soil moisture retention, runoff behavior, and vegetation recovery. The results revealed marked improvements in soil moisture retention, substantial reduction in surface runoff, and visible regeneration of vegetation within treated plots compared with pre-intervention conditions. The half-moon structures created favorable micro-environments that supported tree seedling establishment and improved soil physical conditions. The findings demonstrate that half-moon water harvesting is an effective and locally adaptable land restoration technology with strong potential for scaling up in Nigeria's drylands. The study contributes empirical evidence to the growing body of knowledge on indigenous water harvesting techniques and underscores their relevance to sustainable land management, climate change adaptation, and ecosystem resilience. Integration of such approaches into national land restoration and climate adaptation policies is recommended in support of the Sustainable Development Goals, particularly SDG 15 (Life on Land).

Keywords: Land Degradation, Half-Moon Technique, Water Harvesting, Soil Restoration, Sustainable Land Management, Dryland Ecosystems

INTRODUCTION

Land degradation is increasingly recognized as a critical global environmental problem with far-reaching ecological, economic, and social consequences. It is broadly defined as the long-term reduction in the productive capacity of land caused by human-induced and natural processes such as deforestation, overgrazing, inappropriate agricultural practices, soil erosion, and climate variability [1]. Current estimates indicate that nearly one-quarter of the Earth's land surface is degraded, directly affecting approximately 1.5 billion people worldwide, most of whom depend on land-based resources for their livelihoods [2].

Dryland ecosystems are particularly vulnerable to degradation due to their fragile soils, low organic matter content, sparse vegetation, and highly variable rainfall regimes. In sub-Saharan Africa, land

degradation has emerged as a major constraint to agricultural productivity, food security, and poverty reduction. More than 60% of agricultural land in the region is considered degraded, resulting in declining crop yields, reduced grazing potential, and increased susceptibility to droughts and floods [3].

Nigeria's northern region, encompassing the Sudan and Sahel savanna zones, is among the most affected areas. The region experiences severe soil erosion, desert encroachment, nutrient depletion, and progressive loss of vegetation cover. These challenges are compounded by population growth, fuelwood extraction, overgrazing, and the impacts of climate change, including erratic rainfall patterns and prolonged dry spells [3,4]. Despite numerous government-led and donor-supported interventions, land degradation continues to intensify, indicating the

need for alternative and more sustainable land management strategies.

Conventional soil and water conservation measures, such as mechanical terracing, contour bunding, and chemical fertilizer application, have often proven costly, labor-intensive, or environmentally unsustainable. In many cases, these approaches are poorly adopted by local communities due to high financial requirements and limited technical capacity. Consequently, attention has increasingly shifted toward indigenous, low-cost, and community-driven technologies that are environmentally sound and socially acceptable [5].

Water harvesting techniques have gained prominence as effective tools for restoring productivity in rainfed and water-scarce environments. By capturing, storing, and efficiently utilizing rainfall that would otherwise be lost as runoff, these techniques enhance soil moisture availability and improve crop and vegetation performance [5]. Among the various water harvesting methods, the half-moon technique—widely practiced in the Sahel region—has demonstrated considerable success in rehabilitating degraded lands, improving soil fertility, and promoting vegetation regeneration in countries such as Burkina Faso, Niger, and Mali [6,7].

Despite its documented benefits elsewhere, the adoption and empirical evaluation of the half-moon water harvesting technique in Nigeria remain limited. There is a paucity of site-specific scientific evidence assessing its performance under Nigerian ecological and socio-economic conditions. This knowledge gap constrains informed decision-making and limits the integration of the technique into national land restoration and climate adaptation programs. This study therefore aims to assess the effectiveness of the half-moon water harvesting technique in reclaiming degraded land at AFUSTA. The study contributes to existing knowledge by providing empirical evidence from a Nigerian context and aligns with the BCSF-2026 conference theme of building capacities for sustainable futures through science, technology, and innovation.

MATERIALS AND METHODS

Study Area

The study was conducted at Abdullahi Fodio University of Science and Technology, Aliero (AFUSTA), Kebbi State, Nigeria, during the 2025 rainy season (August–September). The study area lies within the Sudan savanna ecological zone at approximately latitude 12°18' N and longitude 4°29' E. The climate is tropical continental, characterized by two dominant air masses: the tropical maritime air mass from the Atlantic Ocean and the tropical continental air mass from the Sahara Desert. These

air masses give rise to two distinct seasons—a wet season (May to September) and a dry season (October to April).

Mean annual rainfall ranges between 700 and 800 mm, while temperatures are generally high, with a mean annual temperature of about 26°C. During the harmattan period (December–February), temperatures may drop to about 21°C, while peak temperatures of up to 40°C are common between April and June. The natural vegetation is predominantly Sudan savanna, characterized by scattered trees, shrubs, and grasses. However, extensive land degradation has resulted in reduced vegetation cover and increased soil erosion in many areas.

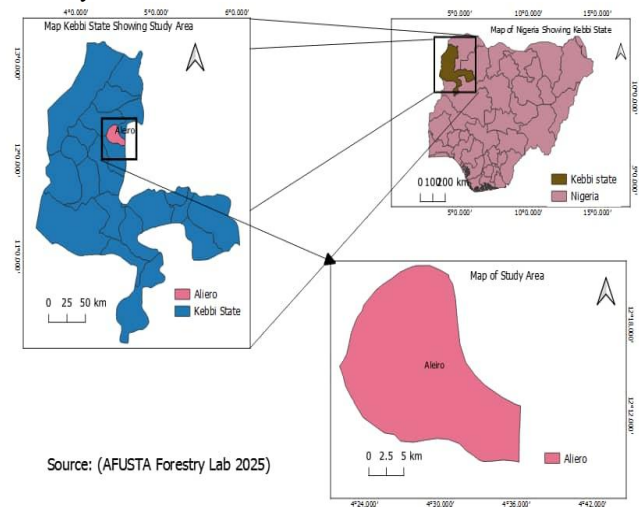


Figure 1: Map of the study area

Materials

Materials used for constructing the half-moon structures included hoes, shovels, diggers, and a 2 m swiveling compass to mark semi-circular structures with a diameter of 4 m. The earth bunds had a height ranging from 0.15 to 0.25 m. Organic manure was applied within the half-moons to enhance soil nutrient availability, improve soil structure, and support plant establishment.

Methods

Two degraded plots were selected for the experiment. Baseline conditions were documented through visual assessment of soil surface characteristics, erosion severity, and vegetation cover prior to intervention. The half-moon water harvesting technique was implemented by constructing semi-circular earth bunds with the open side facing upslope to intercept surface runoff. The structures were arranged in staggered rows to maximize water capture and infiltration while minimizing runoff loss.

Spacing between rows was maintained at approximately 2 m, while spacing between individual half-moons within rows ranged from 1 to 1.5 m

depending on slope gradient and soil conditions. Organic manure was incorporated into each half-moon to enhance nutrient availability. Post-intervention observations focused on soil moisture retention, runoff reduction, and vegetation establishment.

RESULTS

Pre-intervention Conditions

Before the intervention, the study area exhibited severe land degradation. The soil surface was compacted and largely unable to retain water, with approximately 70% of the land affected by surface runoff and erosion. Vegetation cover was minimal, and no visible plant growth was observed on the degraded plots.



Figure 2: Degraded land that cannot hold water and no plant growing

Post-intervention Observations

Following the construction of half-moon structures, significant improvements were observed. Rainwater that previously flowed off the site was effectively captured and retained within the half-moons. Soil moisture levels increased noticeably, creating favorable micro-environments for plant establishment. Vegetation growth, including tree seedlings, was observed within the half-moons, indicating successful restoration of ecological functions on the degraded land.



Figure 3: Degraded land with water collected in the half-moon and trees growing

DISCUSSION

The results of this study clearly demonstrate the effectiveness of the half-moon water harvesting technique in improving soil moisture retention,

reducing surface runoff, and facilitating vegetation establishment on degraded land at AFUSTA. The transformation observed between pre- and post-intervention conditions highlights the capacity of simple micro-catchment structures to restore critical ecosystem functions in semi-arid environments.

The improved soil moisture conditions observed within the half-moon structures can be attributed to their ability to intercept and concentrate rainfall and surface runoff, thereby enhancing infiltration and reducing erosive water flow. Similar findings have been reported in Sahelian countries, where half-moon and related micro-catchment techniques significantly increased water infiltration and soil moisture availability [6,7]. Sawadogo et al. [7] reported that half-moon structures increased infiltration rates by up to 70% and reduced soil erosion by more than 50% compared with untreated plots.

Vegetation recovery observed in the treated plots further underscores the ecological benefits of the technique. By creating localized micro-environments with improved moisture and nutrient availability, half-moons support seed germination, seedling survival, and plant growth. The incorporation of organic manure in this study likely enhanced soil structure and nutrient availability, further supporting vegetation establishment. These findings are consistent with earlier studies emphasizing the synergistic effects of water harvesting and organic soil amendments on land restoration outcomes [5,8].

Beyond biophysical benefits, the half-moon technique offers important socio-economic advantages. Its reliance on locally available materials, minimal technical requirements, and compatibility with traditional land management practices make it highly accessible to smallholder farmers and rural communities. This aligns with broader sustainable land management principles that emphasize community participation, cost-effectiveness, and long-term environmental sustainability [6].

The limited adoption of half-moon water harvesting in Nigeria has been partly attributed to the lack of localized empirical evidence demonstrating its effectiveness. By providing site-specific evidence from a Nigerian semi-arid environment, this study addresses a critical knowledge gap and strengthens the case for wider adoption and policy support. Integrating such indigenous and climate-smart technologies into national land restoration strategies could significantly enhance Nigeria's capacity to address land degradation, improve food security, and build resilience to climate change.

LIMITATIONS OF THE STUDY

Despite its positive findings, the study has certain limitations. The assessment was based primarily on short-term field observations during a single rainy season, limiting the ability to evaluate long-term impacts on soil fertility, biomass accumulation, and crop productivity. In addition, quantitative measurements of soil moisture and vegetation parameters were not conducted, which may affect the generalizability of the results. Future studies should incorporate long-term monitoring and quantitative data collection to strengthen empirical evidence.

CONCLUSION

This study provides empirical evidence that the half-moon water harvesting technique is an effective, low-cost, and sustainable approach for reclaiming degraded land in semi-arid environments of northern Nigeria. The technique significantly improved soil moisture retention, reduced surface runoff and erosion, and promoted vegetation recovery on previously unproductive land at AFUSTA.

By demonstrating the practical benefits of an indigenous water harvesting technology under local ecological conditions, the study contributes to the growing body of knowledge on sustainable land management and climate-smart agriculture. The findings highlight the potential of half-moon water harvesting to enhance ecosystem resilience, support agricultural productivity, and improve rural livelihoods in dryland regions.

Given its simplicity, affordability, and adaptability, the half-moon technique is well suited for scaling up through community-based land restoration initiatives and national environmental programs. Policymakers, development agencies, and extension services are encouraged to promote the integration of this technique into land restoration, climate change adaptation, and sustainable agriculture frameworks. Such efforts will be instrumental in advancing national development objectives and achieving global commitments, particularly Sustainable Development Goal 15 (Life on Land).

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