



CASE STUDY

Kenya: The Effects and Prospects of Ridge-Furrow Plastic Mulching and Recycling Technology on Food Security



Summary

Africa faces severe food security challenges due to drought and land degradation. Enhancing agricultural efficiency and self-sufficiency requires updated cultivation models. The ridge-furrow plastic mulching technique, proven in China's Loess Plateau, conserves moisture, suppresses weeds, and raises soil temperature. Trials in Kenya showed promising results, with maize and wheat yields increasing by 78.7% and 68%, respectively, while recycling mulch reduces pollution. Effective promotion involves demonstration projects, farmer engagement, media outreach, and training. Government cooperation, climate adaptation, and sustained support are crucial for adoption and long-term food security.

Background

Agriculture is crucial for African economies, yet food security in semi-arid regions remains a major challenge. Africa's agricultural productivity has lagged behind Asia and Latin America due to uneven rainfall, poor soil, degradation, climate change, and outdated techniques.

The East African Plateau, covering Kenya, Uganda, Tanzania, Rwanda, and Burundi, has a tropical savanna climate with inadequate rainfall and high evaporation. In Kenya, 82% of the land is arid or semi-arid, and soil erosion impacts 11% of the total area, contributing to low agricultural productivity.

Rainfed farming in the region faces issues of drought and soil erosion, affecting staple crops

like maize. Uneven rainfall leads to runoff and erosion, depleting soil fertility. Effective strategies include reducing erosion, improving rainfall utilization, and developing cost-effective farming techniques like micro-catchment systems.

The ridge-furrow plastic mulching technique, developed in Northwest China, has proven potential to improve yields and water use efficiency. In Gansu Province, it captures rainwater, reduces runoff, and boosts grain production. Implemented on 840,000 hectares, it accounts for over 30% of the arable land and contributes 50% of the province's grain output, aiding ecological conservation by reducing erosion.

Research in semi-arid Kenya confirms the benefits of ridge-furrow mulching, enhancing yields and water use efficiency for maize and wheat. This method reduces soil evaporation, improves water infiltration, enhances moisture and temperature conditions, suppresses weeds, and curbs soil erosion.

Actions taken

Since 2011, Professor Youcai Xiong's team, supported by the international project "China-UN-Africa Water Action" (2010DFA32790), conducted micro-rainwater harvesting trials in Machakos, Kenya. Analysis indicated that over 80% of Kenya's land is arid or semi-arid, highlighting the potential for applying China's dryland techniques to sustain Kenya's population using only one-third of its arable land. The UN Environment Programme (UNEP) and local institutions recognized these findings, and demonstration events in 2013 emphasized the need for expanded Sino-Kenyan collaboration in dryland agriculture.

In 2015, the "China-UN Rainfed Agriculture Technology" project (2015DFG31840) and the key Central University Fund project "China-Pakistan Rainfed Agriculture" (Izujbky-2015-br02) commenced, fostering cooperation between Lanzhou University, UNEP, and Kenyan research institutions. This collaboration led to the establishment of the "China-Kenya Dryland Agricultural Ecology Joint Research Center." Supported by UNEP and Kenyan government bodies, research bases and farmer training schools were set up in Katumani and Juja to facilitate outreach, demonstrations, and training. In 2022, the "Efficient Utilization and Adaptive Management of Rainwater Resources" project (2022-2026) was approved, furthering collaborative efforts in rainwater harvesting and adaptive agriculture.

As part of these initiatives, the ridge-furrow plastic mulching technique (RFPMT), originally developed in Northwest China, was introduced to Kenya in 2011. Pilot tests were conducted in multiple regions, including Seku, Matuu, Kipsaina, Morpus, and Juja. The implementation of RFPMT in these areas has resulted in significant improvements in crop yields and water use efficiency, receiving positive feedback from both local farmers and government agencies. Demonstration fields were established in collaboration with key Kenyan institutions such as Jomo Kenyatta University of Agriculture and Technology (JKUAT), South Eastern Kenya University (SEKU), and the Kenya Agricultural and Livestock Research Organization (KALRO). Site selection was based on factors such as soil type, rainfall patterns, and overall land suitability, ensuring optimal implementation of the technology.

Training sessions were conducted within the demonstration fields to equip farmers with hands-on experience in forming ridges, installing plastic mulch, and planting crops. Continuous support was provided by the research team and local agricultural extension officers, covering essential aspects such as fertilizer application, pest control, and harvesting techniques. The success of these pilot programs has paved the way for further

expansion into other semi-arid and arid areas of Kenya. Moving forward, additional training programs and further research efforts are planned to refine RFPMT practices under diverse soil and climatic conditions.

Collaborative research with UNEP's Ecosystem Assessment Center continues to focus on crop suitability planning and potential assessments, with Kenyan students pursuing advanced degrees at Lanzhou University. UNEP provides soil and climate data, while Kenyan institutions offer laboratory facilities and test sites. Early-stage technology promotion has already begun in Thika and Juja, targeting rainwater harvesting and evaporation suppression for sustainable agriculture. Partnerships with input suppliers are also in place to encourage the adoption of these innovative technologies, contributing to enhanced food security and farmland management in Kenya.

Outcomes

Pilots in Kenya indicate that modifying ridge-furrow sizes and increasing planting density can enhance local water and thermal resource use. For maize, a large ridge width of 55-60 cm with a height of 5-10 cm and an optimal density of 69,000 plants per hectare has proven effective, while for wheat, a ridge width of 10-20 cm and height of 5-10 cm with a seeding density of 320 kg per hectare yields the best results.

The successful implementation of RFPMT in regions such as Seku, Matuu, Kipsaina, Morpus, and Juja has received positive responses from farmers and local governments. The technique's simplicity, low cost, and significant benefits make it particularly well-suited for smallholder-based farming systems across the East African Plateau, offering great potential for widespread adoption and improved agricultural productivity.

The application of ridge-furrow plastic mulching in Kenya has led to an increase in maize yields by 78.71% and water use efficiency by 88.09% compared to traditional methods. Conventional high-density planting with suboptimal spacing often limits the efficient use of light, heat, and water resources. In contrast, the modified ridge-furrow technique, incorporating smaller ridges and increased planting density, has improved maize yields by 39.37-58.74% and water use efficiency by 50.96-72.50%. Wheat yields have seen an increase of 68.03%, with water efficiency rising by 90.58% at an optimal seeding density of 320 kg per hectare.

Economic analyses demonstrate significant benefits, with maize output value per hectare increasing by \$870.93-1,806.01, and profit gains of \$622.08-877.16. Wheat output has risen by \$1,227.42-1,807.99, with profit margins increasing by \$967.62-1,548.19. These findings underscore the viability of the ridge-furrow mulching system for smallholder farmers, aligning with Kenya's agricultural needs and driving productivity improvements across the target regions.

The successful implementation of RFPMT relies on cooperation between governments, agricultural institutions, and local farmers. Demonstration plots and training programs play a crucial role in promoting adoption, while technical and financial support is essential to ensure long-term sustainability. Adapting the technology to local soil, climate, and crop types is critical, with optimal ridge-furrow dimensions and mulching materials tailored to specific conditions. For example, black plastic mulch has been shown to enhance yields and water use efficiency, reduce evaporation, and minimize soil erosion.

Lessons Learned

Partnerships between academic institutions, international organizations, and local stakeholders are essential for adapting innovative techniques to local contexts. Demonstration plots, farmer training schools, and collaborative research have facilitated the successful implementation of ridge-furrow plastic mulching in Kenya, showcasing the importance of tailored outreach and capacity building.

Addressing challenges like uneven rainfall, high evaporation, and soil erosion requires integrated strategies. The ridge-furrow technique combines water harvesting, erosion control, and improved agronomic practices, significantly increasing water use efficiency (up to 90.58%) and crop yields while reducing input costs. Such holistic approach improves resilience in semi-arid regions.

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Year

2011

Country

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Region

Asia

Thematic Tagging

Ecosystems/Nature-based solutions , Water services

Language English

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