International Maize and Wheat Improvement Center

Policy Brief

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Promoting Climate Smart Agriculture in Malawi for Sustainable Food Security

Overview

Climate change is increasingly constraining the ability of forest ecosystem services to sustain agricultural production and improve food security and incomes of smallholder farmers in Malawi. In Malawi, smallholder agricultural productivity is low with very poor diversification of the production systems. Rainfall distribution within and between seasons is often erratic, and water use efficiencies are low because of low soil fertility. On the other hand, the use of chemical fertilizer is low and risky in terms of potential economic losses for cash constrained smallholders. Soil organic carbon levels in many places have declined significantly, leading to poor responsiveness of soils to fertilizer inputs.

In 2014, USAID and the Government of Malawi initiated the project Protecting Ecosystems and Restoring Forests (PERFORM), managed by TETRA-Tech.

Alternative production practices that may improve system profitability, productivity and resilience, are linked to input and marketing opportunities, and to farmer incentives and preferences. Therefore, sustained productivity increases should not only depend on chemical fertilizer, but on a combination of on- and off-farm strategies. Climate smart agricultural (CSA) practices in Malawi such as agroforestry, fertilizer tree systems, farmer managed natural regeneration of trees, conservation agriculture (CA), drought tolerant crops, and crop diversification are among such strategies aimed at increasing productivity of smallholder farming systems.

The U.S. Agency for International Development (USAID)-funded Protecting Ecosystems and Restoring Forests in Malawi (PERFORM), was launched in 2014. Led by Tetra Tech, PERFORM was designed as the flagship implementation vehicle for the Enhancing Capacity for Low Emission Development Strategies (EC-LEDS) partnership between the United States Government (USG) and the Government of Malawi (GoM), and as a core component of environment programming under USAID/Malawi's Development Objective Assistance Agreement with the GoM. The main goal for PERFORM's five-year engagement was to make a lasting improvement in Malawian quality of life. To do that, PERFORM aligned with Malawi's Growth and Development Strategy to promote forest conservation and green growth. At the site-level PERFORM activities were designed and implemented to address drivers of deforestation and forest degradation, and included a mix of forestry, agriculture/livelihoods and energy focused activities. In Machinga District, adjacent to the Liwonde Forest Reserve, this includes a mix of CSA activities designed to improve near-term food security, and build resilience in the longer-term. CIMMYT reviewed the CSA technologies being implemented by the PERFORM project to quantify the benefits versus costs. This brief is based on a CSA synthesis report compiled from biophysical and socioeconomics studies carried out in the five communities surrounding Liwonde forest Reserve in Machinga district representing two agro-ecological zones. The main focus of the studies was to evaluate the potential of the promoted CSA practices in building climate change resilience and assess farmer perceptions of their impact.

Data Source and Analysis

Among the CSA technologies promoted by PERFORM in Machinga district, the biophysical studies focused on three CSA technologies, namely CA, a local soil fertility management innovation known as MBEYA[1], and maize-pigeonpea intercropping.

[1] MBEYA fertilization strategy is a local innovation for soil fertility management that enables efficient use of nutrients through combining organic and inorganic fertilizers and incubating the mixture for a few weeks before applying the fertilizer to the field.

Five communities were selected for both biophysical and socioeconomic studies assessing the merits of CSA interventions. These included Upper Ntubwi, Domasi and Nsanama, representing the high potential rainfall areas of the district, and Lower Ntubwi and Mbonechera communities, representing the low potential rainfall area.

The biophysical studies addressed three aspects: (i) field measurements of annual biomass, residue soil cover and water infiltration characteristics; (ii) laboratory chemical and physical analysis of soil samples collected from both CSA and non-CSA fields within each of the 114 sampled farms; and (iii) assessing maize yields from the 3 CSA interventions implemented and managed by farmers on their own and using their own resources at the end of 2018/19 season, on 64 farm households.

For the socioeconomics studies, a mixed methods approach combining focus group-based participatory appraisal tools and semi structured interviews, was used to obtain a thorough understanding of the vulnerabilities of the five communities to climate change and assess the efficacy of suites of adaptation options promoted. In each community we undertook four focus group discussions comprising 10–12 farmers in genderseparated groups and categorized the data into themes regarding the vulnerability, adaptation strategies and technology trends. Semi-structured interviews were carried out with 102 individuals to support the qualitative analysis. Long-term on-farm trial data generated from the district was then used to complement the qualitative and quantitative interviews to validate the farmers' perceptions on performance of CSA technologies.

Main Findings

Quantification of CSA practices cost and benefits

The biophysical results show that the average annual biomass inputs from the evaluated CSA practices amounted to 3,400, 2,900 and 3,800 kg/ha/yr for CA, MBEYA fertilization strategy and maize-pigeonpea intercrops, respectively. Climate smart agriculture technologies, particularly the pigeonpea intercrops, not only improved annual biomass inputs but also increased water infiltration. Superior soil quality attributes were observed across the 3 CSA practices, particularly in terms of soil nutrient content and soil organic carbon, which increased between 42% and 48% for the 3 CSA interventions evaluated. For example, soil organic carbon under CA increased from 7.0 g/kg for conventional practices to 11g/kg soils, while lower bulk densities were observed from CA (1,280 versus 1,330 kg/m^3).

The integration of soil and water conservation strategies such as CA, farmer managed natural forest regeneration, with crop species diversification and drought tolerant varieties was commonly practiced in Mbonechera, Nsamana, and lower Mtubwi by about 10 %, 20%, 12% of the farmers on at least 0.25 hectare, respectively. The Mbeya fertilizer strategy in combination with CA was also a commonly practiced CSA strategy in Nsanama, and lower Mtubwi. On average, the CSA technologies had average maize grain yields of 3,834 kg/ha compared to conventional practices with 2,916 kg/ha during the 2018/19 season. The most apparent yield increases were derived from the CA systems, with 51% increase compared to 9% and 19% for maize intercropped in pigeonpea and the Mbeya systems, respectively (Figure 1).

Furthermore, field observations suggested that the benefits of CSA practices such as improved yields, soil fertility and water conservation were greatest when farmers combined CA, drought tolerant maize varieties, and pigeonpea intercrop simultaneously and consistently in both agro-ecological zones. This was also complemented by the results from the onfarm quantification of benefits and costs of different CSA strategies (Figure 2). In agreement with the maize pigeonpea intercrops measured yields of 2018/19 as

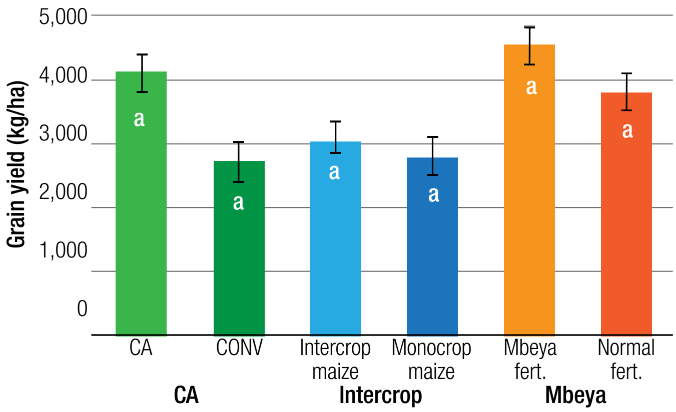

Figure 1. Maize yield responses to CA Mbeya fertilization and pigeonpea intercrop systems as practised by farmers in 2018/19 in five communities of Machinga district. *Note: Error bars denote LSD (0.05) for each cropping system.*

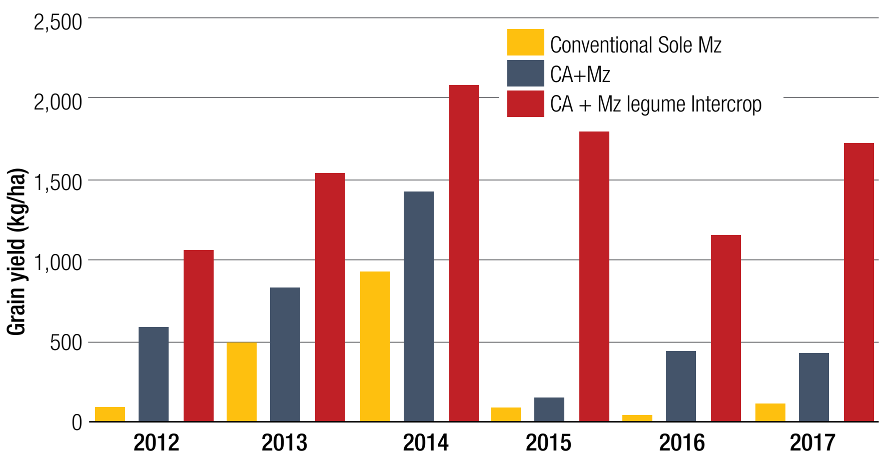

Figure 2. Net benefits of CSA technologies based on long-term experimental data from Machinga district. *Note: Mz= Maize; CA= Conservation Agriculture.*

practiced by farmers on their own, the long-term experimental data also confirmed that CA maize-legume intercrop progressively yielded the highest net-benefits through yielding crops (maize+pigeonpea) with the lowest variability across seasons. In practice, farmers implemented only a subset of the promoted CSAs depending on their resources, preferences, cropping systems and quality of extension.

Overall, biophysical and socioeconomic cost-benefit quantification results show that the efficacy of CSA options are context-specific and conditioned by microclimate and the CSA technology combination applied.

Integration of CSA practices and non-agricultural strategies

The Participatory Rural Appraisal (PRA) matrix ranking results showed that combining a suite of CSA practices and nonagricultural adaptation strategies is more effective in helping farmers in building forest ecosystems services and agricultural resilience. For example, integration of CSA options such as drought tolerant crop varieties, crop species diversification and tredible pumps and non-agricultural innovations such rocket stoves and regeneration of trees along streams and rivers were the highly rated adaptation strategies for climate resilience by communities in the high potential, rainfall zone. For Mbonechera and Lower Mtubwi communities, integration of agricultural innovations such as chicken pass-on, CA combined with crop diversification, and drought tolerant crop varieties and non-agricultural innovations such as a savings club and rocket stoves were considered effective in building forest resources and agricultural resilience (Figure 4 and 5). These results show that interventions aimed at reducing the vulnerability of forest resources and agricultural production to climate shocks should not only focus on agricultural technologies but also non-agricultural technologies.

Figure 3. Combined CA and agroforestry applied in Nsanama community in 2018/19.

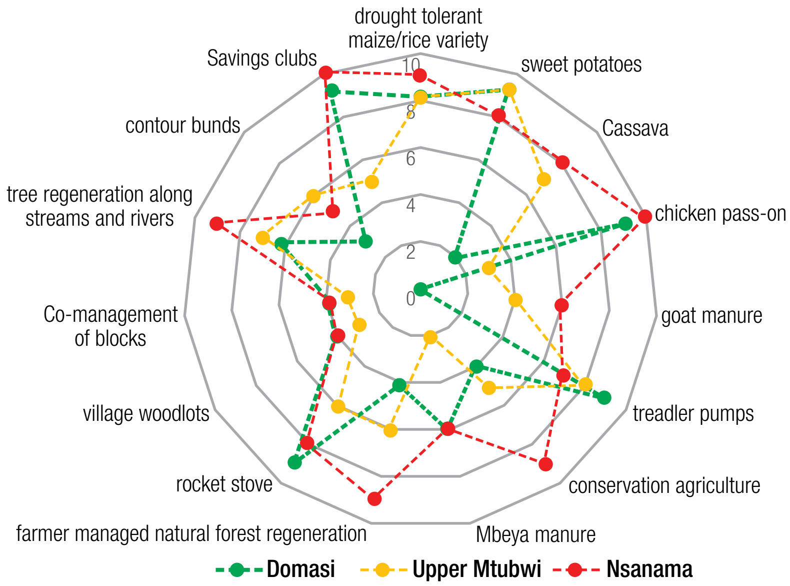

Figure 4. Integrated strategies for improving Agricultural and forest ecosystems resilience to climate change and variability high potential communities.

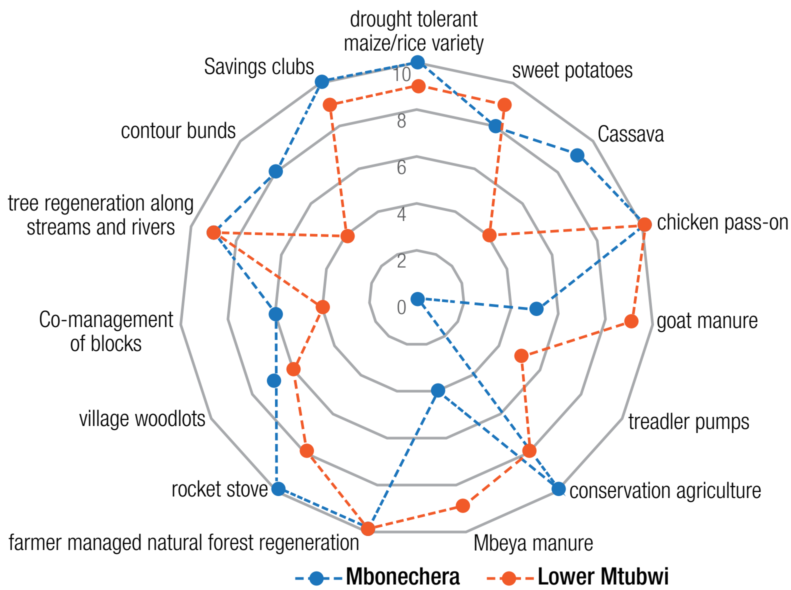

Figure 5. Integrated strategies for improving Agricultural and forest ecosystems resilience to climate change and variability low potential communities.

Policy lessons learned

Improved household food security and resilience

Together, the biophysical and socioeconomic cost-benefit quantification results show that a combination of CSA options provide optimum yields and net returns. These results reveal that the best synergies between productivity and adaptation are obtained when a combination of CSA practices are adopted in these diverse smallholder production systems.

Combinations of CA, drought tolerant maize varieties, and pigeonpea intercropping gave the highest yields and net incomes. These results emphasized the importance of diversification and multi-functional technologies as the best approach to mitigate climate change and variability impacts.

The biophysical results showed that CA, Mbeya fertilization and pigeonpea intercrops are more productive than those under conventional till systems within the same households. Improved soil quality from CSA systems contributed to the improved agricultural resilience and sustainability in the long run.

Diverse strategies for improving agricultural and forest ecosystems resilience to climate shock

The socioeconomic findings showed that combining a suite of CSA practices and non-agricultural adaptation strategies such as savings clubs and rocket stoves were considered more effective in helping smallholder farmers in building forest ecosystems services and agricultural resilience. The importance of combining CSA strategies and non-agricultural adaptation strategies that provide easy access to money in times of need, such as chickens, goats, and savings clubs is paramount to improved resilience of forest ecosystems and agricultural systems.

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