



## Do climate-smart agricultural practices support adaptation, mitigation, and productivity? A review of CSA practices used in participatory video interventions in India, Kenya, and Uganda

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### SUMMARY

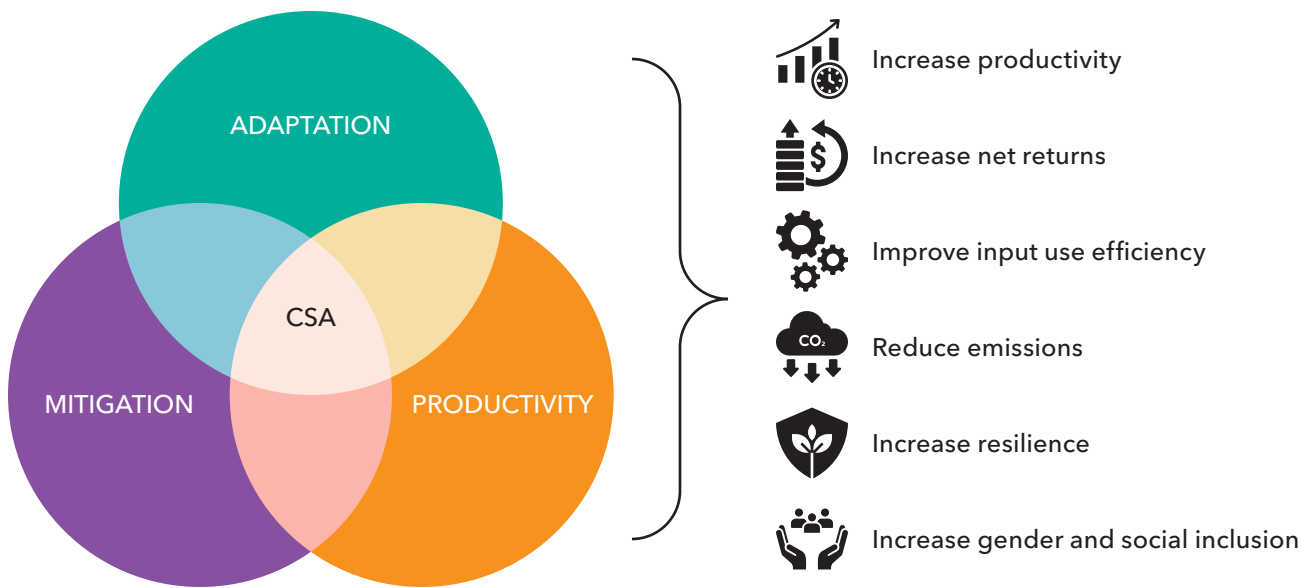
Climate change poses a threat to smallholder farmers worldwide, impacting livelihoods and agricultural production. At the same time, agrifood systems account for about one-third of all greenhouse gas (GHG) emissions. Climate-smart agriculture (CSA) offers synergistic practices that boost productivity, aid farmers in adapting to climate change, and have the potential to mitigate GHG emissions. This note reviews the extent to which a set of practices identified by smallholder farmers in India, Kenya, and Uganda for inclusion in a participatory video-based extension intervention meet the CSA criteria. The findings suggest that the practices hold triple-win potential but often several need to be applied as a package; they also need to be adapted to local conditions.

### INTRODUCTION

Climate change and population growth in sub-Saharan Africa and South Asia jeopardize agricultural production and food security. Farmers in India, Kenya, and Uganda grapple with erratic weather patterns, resulting in reduced crop and livestock productivity and sometimes production failure. In Kenya and Uganda, challenges are magnified due to the reliance on rain-fed agricultural production systems. At the same time, farmers' livelihood strategies focus primarily on income generation. This can inadvertently lead to increased GHG emissions, for example, through excessive tillage or poor livestock management.

Climate-smart agriculture (CSA) encompasses technologies, practices, tools, and policies that support climate change adaptation and mitigation, while enhancing agricultural productivity. It is composed of three pillars: (1) sustainably increasing agricultural productivity, profitability, and incomes; (2) adapting and building resilience to climate change; and (3) reducing and/or removing GHG emissions (mitigation) where possible (Figure 1). Examples of CSA approaches include investments in low-energy irrigation, mulching and planting of cover crops, and manure management to reduce emissions from animal waste.

Under the project "Reaching Smallholder Women with Information Services and Resilience Strategies to

**FIGURE 1 CSA approach**

Respond to Climate Change,” a series of CSA practices were identified by women and men farmers through qualitative fieldwork and with support from local agencies familiar with climate change challenges in the localities (see also Magalhaes et al. 2023). The identified practices address clear community needs such as lack of water, increased dry periods, pests, infertile soils, and high costs of production. However, it was not clear *a priori* if the identified practices contribute to all three tenets of CSA: productivity improvement, climate change adaptation, and mitigation. This policy note reviews the contribution of these practices to the three pillars of CSA based on the literature.

## CSA PRACTICES AND THEIR SYNERGIES

The following reviews the CSA potential of these practices, and Table 1 presents the identified practices by country as well as their hypothesized effects on productivity, climate change adaptation, and mitigation based on a review of the literature.

*Climate-smart pest management (CSPM) and disease management* comprises a range of measures, including intercropping, pruning, weeding, retention of natural habitats, and other biocontrol measures. In Uganda, for example, intercropping of coffee and bananas helps to control pests. Other CSPM practices include the use

of yellow sticky cards and pheromone traps to catch pests. CSPM helps to reduce expenditures on pesticides, makes farms more resilient to pest-related yield losses, and, by reducing pesticide use, decreases the GHG emissions intensity per unit of food produced.

*Climate-smart pig and poultry management* can reduce GHG emissions through improved manure management (a source of carbon dioxide [CO<sub>2</sub>], methane, and nitrous oxide [N<sub>2</sub>O]) as well as through climate-adapted feeding strategies. Moreover, when livestock and poultry are kept in shelters, feeding and disease treatment becomes easier, increasing production efficiency while reducing theft, external disease exposure, and, if well-ventilated, animal heat stress. Moreover, the mix of feed residues and farmyard manure can be easily gathered. Pig manure, for example, is a good substitute for chemical fertilizers; the nutrient content of poultry manure is even higher. If solid manure is composted before being applied to fields, N<sub>2</sub>O and methane emissions can be reduced. However, this process releases CO<sub>2</sub>, so it is important to cover the storage pit with leaves or wood. Using farmyard manure instead of slurry can also reduce GHG emissions. This creates an efficient organic fertilizer that can be incorporated directly into the soil, mulch, or zai pits. When properly applied, this can increase productivity, partially replace synthetic fertilizers, and improve soil fertility. Climate-smart pig and poultry farming can also increase farmer resilience through diversifying agricultural production systems;

**TABLE 1 Productivity, adaptation, and mitigation potential of CSA practices in Kenya, Uganda, and India**

CSA practice	Productivity		Adaptation	Mitigation potential
	Short-term	Long-term		
<b>Kenya</b>				
Minimum tillage	▼	▲	+	High
Planting drought-resistant crops	▲	▲	+++	Low to high, depending on whether irrigation is used, as irrigation can be energy-intensive
Mulching	▲	▲	+++	High
Cover cropping	▲	▲	++	High
Intercropping	▼	▲	+	High, in combination with minimum tillage and mulching
Zai pits	▲	▲	+++	Low, soil carbon losses due to construction
Crop rotation	▼	▲	++	High, particularly for rotation with legumes
Use of manure	▲	▲	+++	High, particularly when underutilized and as replacement for synthetic fertilizer
<b>Uganda</b>				
Climate-smart poultry management	▲	▲	+++	Medium, through improved manure management and better feeding practices
Climate-smart pig management	▲	▲	+++	Medium, through improved manure management and feeding practices
Climate-smart pest management	▲	▲	+++	Medium, through replacing synthetic with natural pest control mechanisms
Use of organic pesticides	▲	▲	+++	Medium, particularly when underutilized and as replacement for synthetic pesticides
Soil bunds	▼	▲	+++	Low, soil carbon losses due to construction
Intercropping	▼	▲	+	High, in combination with minimum tillage and mulching
<b>India</b>				
Soil testing	▲ (depends on cost)	▲	+++	High, due to optimized fertilization
Climate-smart pest management	▲	▲	+++	Medium, through replacing synthetic with natural pest control mechanisms
Use of organic pesticides	▲	▲	+++	Medium, particularly when underutilized and as replacement for synthetic pesticides

Source: Author.

pigs and poultry can generate income when crop production fails as a result of droughts, for example.

*Cover crops* reduce weed pressure, such as from the *Striga* weed in Kenya, while also reducing erosion and improving soil health. Lower weed pressure results in lower herbicide costs, making agricultural production more profitable. By sequestering carbon in the soil, cover crops also have the potential to reduce GHG emissions. When nitrogen-fixing varieties are used, N<sub>2</sub>O emissions can be reduced by sequestering nitrogen.

*Crop rotation* reduces soil nutrient depletion caused by repeatedly growing crops with the same nutrient requirements. Crop rotation with nitrogen-fixing crops can increase soil fertility, reduce denitrification, and thus reduce N<sub>2</sub>O emissions, and can reduce the need to apply fertilizers. The practice can also reduce pest pressures as different crops attract different pests.

*Drought-resistant varieties* and crops can help farmers cope with periods of mild to moderate water stress. Their use helps protect yields and income and can save water and energy. Drought-resistant varieties

## FIGURE 2

### A. Soil bunds



avoid replanting of crops and associated emissions in response to drought events and thus help maintain production levels.

*Intercropping* can improve soil conservation, reduce pathogen pressure, regulate water dynamics, and increase food production. Nitrogen-fixing legumes and deep-rooted species such as lucerne are especially promising. As an example, intercropping maize with leguminous crops in combination with minimum tillage and mulching can lead to significantly lower carbon emissions compared to monoculture maize, without yield loss.

*Minimum tillage* has the potential to reduce GHG emissions due to reduced soil organic matter decomposition compared to conventional tilling. In addition, minimum tillage improves the soil's ability to control temperature fluctuations during droughts, making production more resilient in drought-prone areas. Minimum tillage can reduce labor requirements for tilling but might increase labor needs for weeding.

*Mulching* helps to retain or increase water and nutrients in the soil. Mulching can also protect food crops from excessive heat, making crop production more resilient. For mulching, crop residues like stalks or straw can be used and placed directly on the soil. Productivity could be affected by higher labor inputs.

*Organic pesticides* substantially reduce environmental and health impacts of agricultural production, compared to synthetic pesticide use. Examples used

### B. Zai pits



in Uganda include concoctions of cattle urine, ash, tobacco leaves, pokeweed, and red pepper. In India, crown flowers are used to control termites and neem leaves in combination with cow urine, manure, and water are used to control sucking pests. Producing pesticides in-house reduces the need for synthetic pesticides, which in turn leads to cost savings.

*Soil bunds* are used by farmers to catch and retain water, especially in areas with unpredictable drought and flood spells. The bunds are dug close to crops to provide plant roots with water (Figure 2a). This practice helps farmers to maintain or increase productivity through water conservation. Soil bunds also help reduce surface water run-off and soil erosion, while reducing water and energy costs. Construction of soil bunds is generally highly labor-intensive and does remove crop area from production, which can be challenging for farmers with smaller plots.

*Soil testing* helps determine the nutrient content and pH of the soil, allowing farmers to determine the right amount of nutrients to apply to increase productivity and maintain fertility, improving their adaptive capacity. Soil testing can thus improve productivity and profitability of production systems and reduce emissions from unbalanced use and overuse of fertilizers.

*Zai pits* can be used to retain moisture when there is no rain and provide higher soil fertility through the incorporation of manure. Used extensively in dryland areas of Niger and in parts of Kenya, zai pits can reduce water erosion and sequester carbon (Figure 2b). The

capacity of zai pits to retain moisture helps farmers cope with extended dry periods or unproductive soils to maintain crop production. Manure incorporated into zai pits leads to lower GHG emissions compared to manure left in open fields, while increasing soil fertility.

## CONCLUDING COMMENTS

The CSA practices presented in this note hold great potential to sustainably increase farmers' agricultural production while helping them adapt to the adverse impacts of climate change and reduce GHG emissions.

An important aspect is that many of the practices are interrelated and only reach their full potential when applied synergistically. For example, zai pits need to be mulched and should incorporate manure to increase the soil nutrient content. Similarly, good livestock

management is needed to generate better farm manure. Therefore, for CSA practices to achieve their potential, policymakers, researchers, and practitioners must move away from isolated approaches that focus either on adaptation or mitigation or only on productivity improvements and those that focus on single CSA practices. Instead, joint strategies with holistic practices and programs adapted to local conditions must be developed and supported.

## FOR FURTHER READING

Magalhaes, M., L. Kawerau, J. Kweyu, and V. Pathak. 2023. "Qualitative Fieldwork to Identify CSA Practices Preferred by Women Farmers in India, Kenya and Uganda." In *Reaching Smallholder Women with Information Services and Resilience Strategies to Respond to Climate Change*, edited by C. Ringler, M.F. Alvi, B. Birner, C. Bosch, E. Bryan, F. Githuku, R.S. Meinzen-Dick, P.B. Rwamigisa, and M. Shah. Washington, DC: International Food Policy Research Institute. <https://doi.org/10.2499/p15738coll2.136965>

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This work received financial support from the German Federal Ministry for Economic Cooperation and Development (BMZ) commissioned and administered through the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) Fund for International Agricultural Research (FIA), grant number: 81235251.

This publication has been prepared as an output of the project Reaching Smallholder Women with Information Services and Resilience Strategies to Respond to Climate Change. It has not been peer reviewed. Any opinions stated herein are those of the author(s) and are not necessarily representative of or endorsed by the International Food Policy Research Institute.

Photos: C. Schubert / CCAFS; K. Trautmann / CCAFS.

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