#7883 CLIMATE SMART AGRICULTURE: CHALLENGES AND OPPORTUNITIES TO PROMOTE THE SYSTEM IN ETHIOPIA

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ABSTRACT

Agriculture is vital to the Ethiopian economy and its development has significant implications for food security and poverty reduction. Yet, the substantial reliance of the sector on rain-fed systems has made it vulnerable to variability in rainfall, temperature, and climate change. Climate-smart agriculture (CSA) is a viable alternative, which combines climate change and food security through the integration of adaptation and mitigation measures. Two strategies are important in the process of climate-friendly agricultural management: agricultural practices can mitigate climate changes by reducing greenhouse gas (GHG) emissions, adapting agriculture to the noticeable changes through the development of soil and water management, sustainable crop production, and livestock management. Adaptation to climate change is a major challenge for Ethiopia. A significant portion of the population is still dependent on highly climate-sensitive agriculture. Long drought spells during the small rainy season, increased temperatures, and torrential rains during summer have caused serious distress to agriculture-dependent communities in many locations. Climate change adaptation interventions needs to be implemented if achieving food security and promoting sustainable agriculture to end poverty is to be realized. The drought-prone areas in the country are likely to experience more intense and irregular rainfall, affecting yields of late maturing crops, and posing challenges to vulnerable pastoral and agro-pastoral populations. If CSA is to be applicable for farmers, cross-disciplinary research and development supported by policy and socio-economic contexts are essential to transform smallholder agriculture.

Keywords: Adaptation, climate change, climate smart agriculture, mitigation, sustainable agriculture

INTRODUCTION

Agriculture is still the key sector to meeting the basic needs and livelihoods of most people, but meeting the food demand for a growing population has been a formidable challenge for the sector. The sector is dominated by smallholder subsistence agriculture, largely rain-fed dependent and most vulnerable to climate change, and responsible for the supply of 95% of agricultural produce (EPCC 2015), with limited contribution of irrigated agriculture. It is characterized by low input-output production systems due to low adoption of improved technologies, inadequate capacity of the agricultural extension service, low adaptive capacity of smallholder farmers to climate change and limited financial resources for investment in climate change adaptation and mitigation measures to sustainably increase productivity and income, enhance resilience and reduce the adverse effects of climate change. If the business as usual approach is continued, climate change may decrease GDP by 8-10% by 2050 but if adaptation actions are applied these losses could be reduced by half (CIAT:BFS/USAID 2017). The development and dissemination of improved agricultural technologies are the major driving factors for increasing the productivity and commercialization of smallholder farming in the country.

Increasing agricultural productivity in a sustainable way to meet the growing demand of the growing population, while at the same time to adapt to and reduce the GHG emissions are the three interlinked challenges that the agriculture sector need to overcome. To address these challenges, agricultural production and food systems should undergo a complete transformation from subsistence farming to a more productive and commercial agriculture through adoption of CSA. CSA is a strategy to address the challenges of climate change and food security by sustainably increasing productivity, strengthening resilience to adapt to and reduce GHG emissions and thereby enhancing the achievement of national food security and development goals (FAO 2010). Policy imperatives for CSA include the need to increase crop yields, feed a growing population, mobilize investments to farmers and reduce GHG emissions. CSA differs from the conventional approaches as it emphasizes the capacity to implement flexible, context-specific solutions, backed by innovative policy and financing instruments. CSA represents a combination of practices that have been used in environmental ecology, conservation, climate change, and agriculture (Lipper et al. 2018). However, the relationship between agriculture and climate change is not well understood. The dual relationship between climate change and agriculture has been apparent through scientific assessments of the Intergovernmental Panel on Climate Change (IPCC) and policy reviews of development agencies (Parry et al. 2007). Agricultural systems contribute to and are influenced by climate change, with the majority of impacts being felt by developing countries. Thus, CSA is accepted globally as a feasible approach to transform and protect the agriculture sector to sustainably increase productivity, enhance resilience and reduce GHG emissions.

RESULTS AND DISCUSSION

Climate Change

Climate change affects all sections of a society, but the degree of vulnerability of each group within a community varies based on resource possession or wealth status, gender, age and location. In Ethiopia, total annual GHG emission has been estimated to be 144 Mt CO_2eq (including emissions from land-use change and forestry), approximately 0.3% of global emissions, while per capita emissions are low, amounting to 2 tons of CO_2eq annually (World Bank 2016). The agricultural sector in the country is a major contributor to national emissions, approximately 60% of total emissions. Since Ethiopia has the largest livestock population in Africa (FAO 2016), most of the agricultural GHG emissions emanate from livestock-related activities (CH_4 and N_2O emissions from enteric fermentation and manure, respectively), which account for almost 92% of agricultural emissions. Thus, the livestock sub-sector is the major emitter of methane (CH_4) while the crop sub-sector mainly releases nitrous oxide (N_2O) due to application of N fertilizer (IPCC 2007). As indicated in Fig. 1, most emissions from the forest sector are associated with deforestation due to agricultural land expansion (FAO 2016), implying that land-use change also contributes to emissions of CO_2 and N_2O. Thus, mitigation measure is very relevant on the reduction of CH_4 and N_2O, which are the major gases emitted from the agriculture sector.

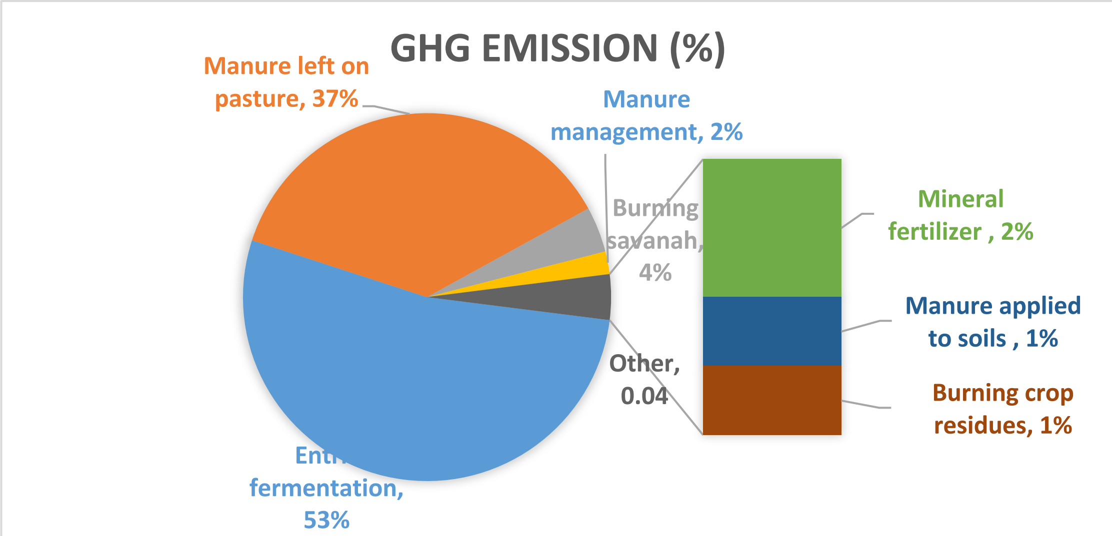

Figure 1. Sources of greenhouse gas (GHG) emissions in Ethiopia. Adapted from FAO (FAO 2016).

Climate-Smart Technologies and Practices

CSA practices include diverse on-farm practices such as agronomy, agroforestry, livestock, forestry, land use, pastoral and grazing, water and soil management, and bioenergy (Thorn et al. 2016). CSA practices and technologies should address three core components: sustainably increasing productivity, supporting farmers' adaptation to climate change, and reducing GHG emissions (FAO 2010). There are a wide range of conventional agricultural practices at farm level, which usually affect soil structure, moisture and fertility as well as contributing to erosion. Planting the same crop year after year encourages among others certain weeds, pests and diseases. Table 1 compares different aspects of conventional and CSA. CSA practices emphasize the adaptation aspect more than mitigation. Crop modelling studies indicate adaptation benefits to major crops such as rice, wheat, and maize. On-farm adaptation would lead to significant improvements to yield, avoiding damage for temperature increases of up to 1-2°C in temperate regions and up to 1.5-3°C in tropical regions (Howden et al. 2007). Generally, agricultural practices that have been found to be potentially climate-smart in a wide range of perspectives include, but are not restricted to agroforestry, improved soil management through conservation agriculture, agricultural water management such as water harvesting and drip irrigation, integrated livestock and rangeland management, soil fertility management and improved crop varieties. The practices presented in Table 1 lead to higher productivity and improve food security, but their ability to address adaptation and mitigation varies. Thus, although these technologies may be considered good for climate-smart options, it is vital for any CSA solutions to take the condition into account to decide how they contribute to productivity, adaptation/resilience and mitigation in a given location.

Table 1. Comparison of conventional and climate smart agriculture.

Aspects	Conventional agriculture	Climate-smart agriculture
Technologies	Conversion of energy sources from human to animal and fossil fuel dependent machinery.	Use of energy efficient technologies for agricultural power (such as for irrigation water pumping or tillage). Reduces amount of energy use in land preparation.
Agricultural inputs	Increased use of fertilizer, pesticides and herbicides (also highly dependent on fossil fuels), and inefficiently applied	Enhanced efficiency of fertilizer. Optimum supply of soil nutrients over time and space matching to the requirements of crops with the right product, rate, time and place.
Land areas	Expansion of agricultural land area through deforestation and conversion from grasslands to cropland.	Intensification on existing land areas as main source of production increase rather than expansion to new areas. Promote carbon sequestration including sustainable land use management.
Natural resources	Depletion of natural resources (e.g. land, water, genetic resources), which are used in the production systems.	Restoration, conservation and sustainable use of natural resources in agricultural production systems. Promote carbon sequestration including sustainable land use management.
Production and marketing	Increased specialization in agricultural production and marketing systems.	More diversification in production, input and output marketing systems.

Summary of key climate-smart agricultural practices

Crop management	Livestock management	Soil and water management	Conservation agriculture	Agroforestry	Food energy systems
• Intercropping with legumes • Crop rotations • New crop varieties • Improved storage and processing techniques • Greater crop diversity	• Improved feeding strategies • Rotational grazing • Fodder crops • Grassland restoration and conservation • Manure treatment • Improved livestock health • Animal husbandry improvements	• Contour planting • Terraces and bunds • Planting pits • Water storage • Dams, ponds, ridges • Improved irrigation system (e.g. drip)	• Minimum tillage • Crop residue retention as permanent soil cover. • Crop rotation or association (intercropping) • Balanced application of mineral and organic fertilizers	• Boundary trees and hedgerows • Nitrogen-fixing trees on farms • Multipurpose trees • Improved fallow with fertilizer shrubs • Woodlots • Fruit orchards	• Biogas • Production of energy plants • Improved energy saving stoves

Conservation Agriculture

Conservation agriculture (CA) was introduced by the FAO (FAO 2008) as a concept for resource-efficient agricultural crop production based on integrated management of soil, water, and biological resources combined with external inputs. CA is an approach to farming which can sustainably increase yields of crops. The principles of CA include minimal soil disturbance; maintenance of a mulch of carbon-rich organic matter cover that enrich the soil (e.g. crop residues including cover crops); crop rotation and intercropping including trees, which could include N-fixing legumes; and balanced application of mineral and organic fertilizers. For instance, adoption of sustainable intensification practices in Ethiopia increased farmers' income from USD 99 to USD 240 (Tesfaye et al. 2016) (Fig. 2).

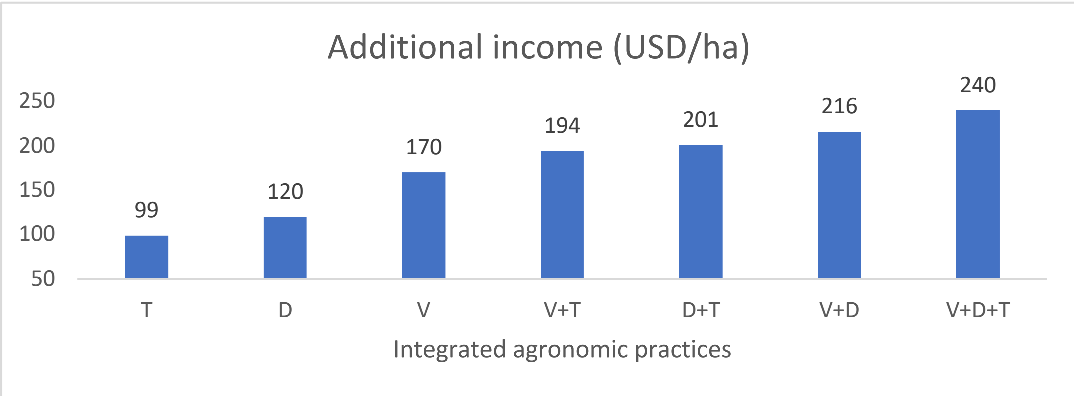

Figure 2. Additional income from adoption of integrated sustainable intensification practices in Ethiopia. Note: T =Tillage; D =Crop diversification (cereal-legume intercropping, rotation); V =Improved maize variety

Agroforestry Practices

Agroforestry has the potential to contribute to both climate change mitigation and adaptation by sequestering carbon and enhancing resilience of the agricultural systems. Trees in the agroforestry system can help fight climate change by storing carbon in their biomass. Therefore, agroforestry is considered as a practice of planting trees with crops to exploit the ecological and economic interactions of the different components within the same land management unit. Agroforestry is widely adopted as a climate-smart practice, due to its potentials for climate change mitigation, adaptation, increasing crop productivity and thereby improve food security (Coulibaly et al. 2017). Agroforestry enhances soil organic matter content, agricultural productivity, carbon sequestration, water retention, agro-biodiversity and farmers' income (Paul et al. 2017). It is increasingly widespread for restoration of degraded sloping lands, to contribute to food security and for economic development.

Challenges and Opportunities

Major productivity gains are possible in Ethiopia given the large gaps between current yields and the yields that are achievable with improved inputs and crop management practices while also maintaining low GHG emissions. The policy framework built largely on the Climate Resilient Green Economy (CRGE) strategy and an enabling institutional infrastructure would enable Ethiopia to take major steps towards mainstreaming climate change into agricultural planning and integrating the CSA into the agriculture sector. The existence of vast agricultural land in lowlands, water, diverse crop and soil types and varied agro-ecological zones in the country would enable to implement different climate smart technologies and practices across the country. The presence of trained and skilled human power in the agriculture sector at different levels is also another opportunity to successfully implement CSA.

The major challenges include shortage of relevant CSA technologies and practices; Weak coordination among stakeholders working on CSA; lack of regulatory framework for implementation of policies and strategies for CSA; low adoption of CSA practices due to poor dissemination and awareness creation mechanisms; and Shortage of finance and facilities. Poor accessibility, inadequate technology multiplication and supply, unaffordability of the CSA technologies and practices are also main challenges for implementation and dissemination of CSA practices.

CONCLUSIONS

The gaps in technology adoption and yield are yet very high in Ethiopia despite concerted efforts to increase production and productivity through the use of improved agricultural technologies and practices. There are a number of interplaying challenges from technology to farmers' capacity to use climate smart practices to boost production and productivity in the changing climate. Most importantly, there is inadequate use of agricultural technologies and improved practices in crops, livestock, and NRM. Minimum requirements need to be set for packaging CSA practices based on farming systems, agroecology, choices of agricultural enterprises and access to the market. Agro-ecological based and local-specific research and development approach has been followed for years for demonstration and scaling up of agricultural technologies. Without adoption of CSA technologies and innovations, farming communities in Ethiopia will not be able to deal with the effects of climate change and variabilities. The issue of CSA practices has to receive due attention in an effort to ensure sustainability of the rural livelihood system and food security goal of the country in the face of climate change. Thus, current and emerging policies need to include options to facilitate and accelerate uptake and scaling up strategies of CSA, and to be informed by research to achieve this.

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