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Editorial: Climate change mitigation strategies for sustainable crop production in sub-Saharan Africa

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Editorial on the Research Topic
Climate change mitigation strategies for sustainable crop production in sub-Saharan Africa

Agriculture forms a major component of many growing economies, especially in sub-Saharan Africa (SSA), where over 60% of the population is dependent on rain-fed agriculture. However, it is highly vulnerable to climate change. With the average temperature having risen by 1.2°C since pre-colonial times, exceeding the global average, the effects of climate change pose a challenge in feeding the ever-increasing projected 8.6 billion human population by 2030 (1). In recent times, several agriculture and soil management practices such as agricultural residue burning, application of mineral fertilizers and crop residues to the soil, the use of nitrogen-fixing crops in soil management (2), production of paddy rice, tillage practices, land use change, and other anthropogenic factors have contributed to greenhouse gas (GHG) emissions, a major contributing factor to climate change (3, 4). These have resulted in suboptimal crop yields and, consequently, hunger, malnutrition, and food insecurity.

Climate change is thus a threat to sustainable crop production and food security. While global discourses often emphasize climate adaptation, there is a growing recognition that mitigation strategies, those that reduce or sequester GHGs, must be integrated into agricultural planning to achieve long-term sustainability. Furthermore, as envisioned by the United Nation's Agenda 2030 to achieve a better and more sustainable future for all people and the world by 2030, strategies adapted to mitigating climate change effects on sustainable crop production are thus necessary for achieving the sustainable development goals (SDG) 1 and 2 with the target outcome of ending hunger and improving access to food; achieving food security and improved nutrition; promoting sustainable agriculture and resilient agricultural practices in SSA.

This Research Topic therefore explores climate change mitigation strategies as reflected across six recent studies from Ethiopia, Nigeria, Tanzania, and broader African agro-ecosystems. Drawing on empirical field trials from these countries, as well as thematic

reviews, the studies explore the integration of conservation agriculture (CA), underutilized legumes, biofertilizers, and intercropping strategies. For years, the dominant discourse in African agricultural research has focused on climate change adaptation. However, mitigation is no longer optional. Agriculture contributes approximately 20% of total GHG emissions globally (5), and SSA's share is rising due to deforestation, livestock, and fertilizer overuse. Therefore, these studies together present a roadmap for low-cost, ecologically sound, and scalable mitigation solutions that directly support sustainable crop production.

The studies reviewed under this Research Topic position African agriculture not only as a climate victim but also as a climate solution. Hailu and Teka present a thematic review of CA, highlighting how integrating mitigation into farming systems through carbon sinks, reduced tillage, and biodiversity can reduce emissions while boosting productivity. Among the most promising mitigation strategies is conservation agriculture, which contributes to climate change mitigation *via* carbon sequestration and enhanced soil organic carbon. However, the authors argue that CA adoption remains low due to a lack of mechanization, competing crop residue uses, and limited awareness. Scaling CA, thus, requires mechanization subsidies, stakeholder training, and subsidies for CA-compatible inputs. Replacing chemical fertilizers with organic and biological options is another key strategy. Marzouk et al. showed that the optimal combination of Azolla + rice straw + 50% synthetic N in Tanzanian rice paddies outperformed 100% N fertilizer treatments in terms of increased yields (5.3 t/ha) and nitrogen recovery efficiency (163%), while reducing GHG emissions, and improving soil organic carbon and pH levels. The study thus calls for biofertilizer-based nutrient management to meet the dual goals of sustainability and productivity.

In a review by Ayilara et al., the authors explore how neglected and underutilized legumes like Bambara groundnut, velvet bean, and winged bean offer both nutritional benefits and ecosystem services. They emphasized how their incorporation into intercropping systems enhances biodiversity, reduces emissions per unit of production, and improves soil quality. Yet, these indigenous species are often excluded from mainstream seed systems and research agendas. The study thus presents a strong case for mainstreaming indigenous legumes in food security and soil rehabilitation programs. Also, in a follow-up field study by the same authors, Ayilara et al., they demonstrated how intercropping legumes with maize revitalized degraded soils and boosted crop nutritional profiles *via* microbial activity. Biological interactions were found to increase soil organic matter, contributing to mitigation through natural ecosystem restoration.

In a complementary study, Tessema et al. assess the adoption of climate-smart agricultural (CSA) practices in Humbo Woreda within the Wolaita zone of South Ethiopia. Through a mixed-methods approach, the authors documented farmer-led CSA practices like agroforestry and composting as reducing GHG emissions and improving input use efficiency. Also, Dawid and Boka explore how smallholder farmers in the Arsi zone of Ethiopia perceive and respond to climate-induced risks. Using both climatic trend analysis and multivariate probit modeling, the study identifies major adaptation strategies, such as crop diversification, soil bunds and terracing, and shifting planting schedules. The study's strength lies in elevating farmers' indigenous knowledge; their observation of local indicators such as erratic rainfall and declining soil fertility, and validating it with quantitative climate records. This convergence of perspectives provides a compelling case for participatory, bottom-up climate adaptation planning.

The collection of articles in this Research Topic makes a significant contribution to the literature on climate change mitigation approaches for sustainable crop production. Methodologically, they employ a mix of reviews, field trials with focus-group discussions, a mixed methods approach, and trend analysis under different agricultural systems in SSA. The six studies reviewed demonstrate that climate mitigation in African agriculture is multifaceted in nature, as it is both feasible and transformative. For policymakers, these findings represent scalable and context-responsive solutions that can reduce GHG emissions, enhance soil health, and improve farmer livelihoods, highlighting the need to integrate agroecological and climate-smart practices into national agricultural strategies. Integrating CA, biofertilizers, indigenous crops, and farmer-centered CSA offers a practical roadmap toward resilient, productive, and low-emission farming systems. Future research must therefore build upon these insights through long-term, multi-location trials that assess environmental tradeoffs of different climate mitigation pathways, taking into consideration their financial implications as well.

Author contributions

BEA: Conceptualization, Writing – original draft, Writing – review & editing.

Conflict of interest

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