

EFFECT OF ORGANIC FERTILIZER USE ON CROP YIELD AND SOIL HEALTH IN MAIZE PRODUCTION IN KENYA

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Background

Sub-Saharan Africa faces an elevated risk of food insecurity. The agricultural sector in Sub-Saharan African countries encounters significant challenges in increasing crop production to meet the ever-growing food demand driven by population growth and economic development. Nutrient management is a critical component of crop production, yet nutrient input levels in the region are notably low. In many areas of cropland, nutrient balances are in deficit (Liu et al., 2010). At the recent Africa Fertilizer and Soil Health Summit, African leaders pledged to strengthen nutrient management practices to enhance food production through increased fertilizer use.

Fertilizers can be categorized into different types. Most discussions on fertilizer policy to date have focused on inorganic fertilizers, which are produced through industrial processes. In contrast, organic fertilizers are derived from naturally occurring materials. The use of organic fertilizers may offer additional long-term benefits, particularly for improving soil health. Notably, soil organic carbon is a key indicator of soil health, and organic fertilizers, being rich in carbon, can contribute to increasing soil carbon content.

A study was conducted to evaluate the impact of organic fertilizers on crop productivity and soil health, focusing on maize production in Kenya. Maize is the primary staple crop in Kenya, with a harvested area of 2.1 million hectares, representing about 40% of the total harvested area for all crops in the country (FAOSTAT). Maize is also the largest consumer of fertilizers in Kenya. It is estimated that maize cultivation uses 2.8 million tons of fertilizers annually, accounting for approximately 50% of the country's total fertilizer consumption. Fertilizers are applied on about 70% of the maize-planted area (IFDC & AFAP, 2018). However, the average maize yield in Kenya remains low, at less than 2 metric tons per hectare (FAOSTAT), indicating suboptimal management practices or inadequate input levels, including insufficient fertilizer use (De Groote, 2023).

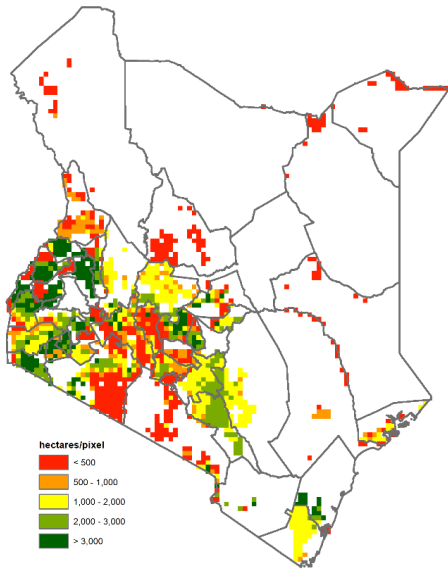
Data and method

The study utilized DNDC (DeNitrification-DeComposition), a process-based simulation model of carbon and nitrogen biogeochemistry in agro-ecosystems, to estimate maize yield and soil organic carbon under varying levels of organic fertilizer application. The simulations assume that the organic fertilizers are primarily derived from livestock manure, with a scenario involving incremental increases in organic fertilizer use alongside the current application of inorganic fertilizers.

Figure 1(a) illustrates the spatial distribution of maize cultivation in Kenya with a spatial resolution of approximately 10 km by 10 km, derived from the IFPRI [SPAM](#) database. To support the simulations, a spatial dataset was further developed, mapping fertilizer application rates by downscaling aggregated national statistics on fertilizer use for maize. This dataset is presented in Figure 1(b).

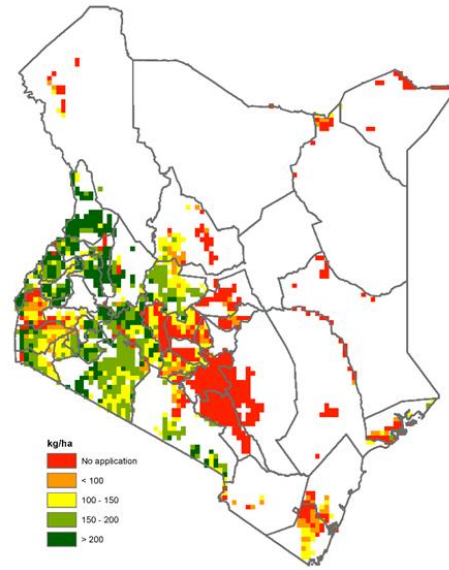
Figure 1 Harvested Area and Fertilizer Application Rate in Maize Production in Kenya

(a) Harvested area



Source: IFPRI.

(b) Fertilizer application rate



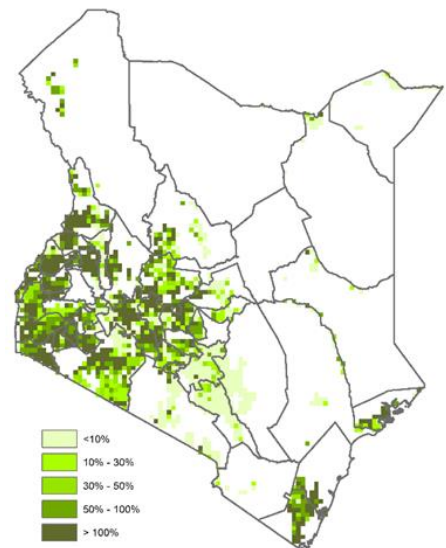
Source: Authors.

Key findings

Effect of Organic Fertilizer Use on Maize Yield

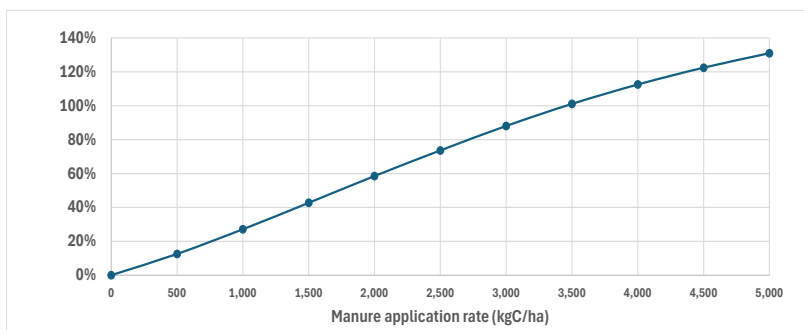
The use of organic fertilizers significantly boosts maize yields. Yield improvement at the pixel level, expressed as percentages and estimated at an organic fertilizer application rate of 3,500 kgC/ha, is illustrated in Figure 2. The spatial pattern of yield increase is consistent across different rates of organic fertilizer application. National averages of maize yield increases at varying levels of organic fertilizer use are shown in Figure 3. As indicated, when the application rate of organic fertilizers exceeds 3,500 kgC/ha, the average maize yield in Kenya is projected to double.

Figure 2 Projected Yield Increase with an Organic Fertilizer Application Rate of 3,500 kgC/ha



Source: Authors.

Figure 3 Projected yield increase under varying organic fertilizer application rates in Kenya (Source: Authors)



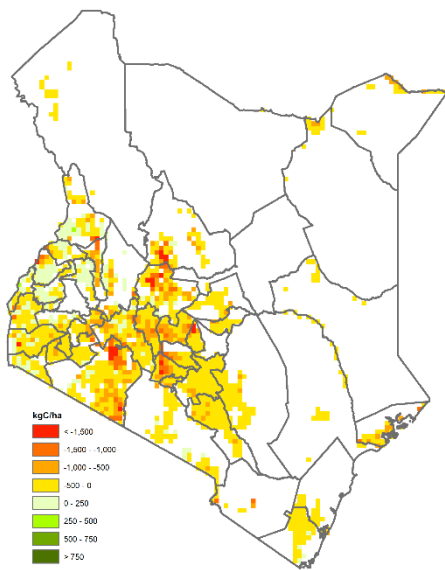
Effect of Organic Fertilizer Use on Soil Health

The estimated annual rate of change in soil organic carbon under baseline fertilizer-use conditions (depicted in Figure 1(b)) is presented in Figure 4(a). Negative values indicate soil organic carbon depletion, while positive values represent soil organic carbon accumulation. Currently, most areas experience soil organic carbon depletion. Simulations suggest that increased use of inorganic fertilizers alone will not significantly address this issue. However, organic fertilizer use can reverse this trend. Soil organic carbon changes at the pixel level, based on an organic fertilizer application rate of 3,500 kgC/ha, are shown in Figure 4(b). National averages of soil organic carbon change rates at varying levels of organic fertilizer use are summarized in Figure 5.

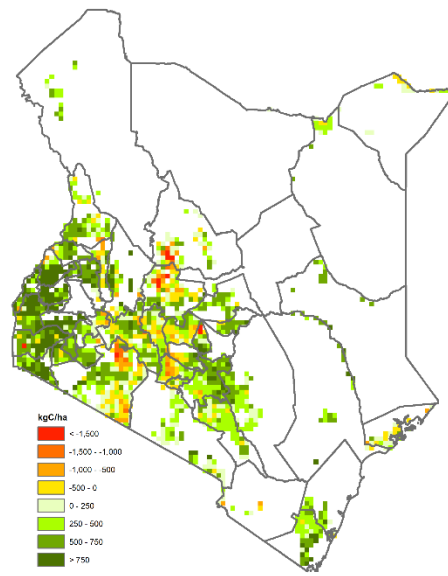
Figure 4 Effect of organic fertilizer use on soil organic carbon (SOC)

(a) SOC changes with inorganic fertilizers only

(b) SOC changes with organic fertilizer application

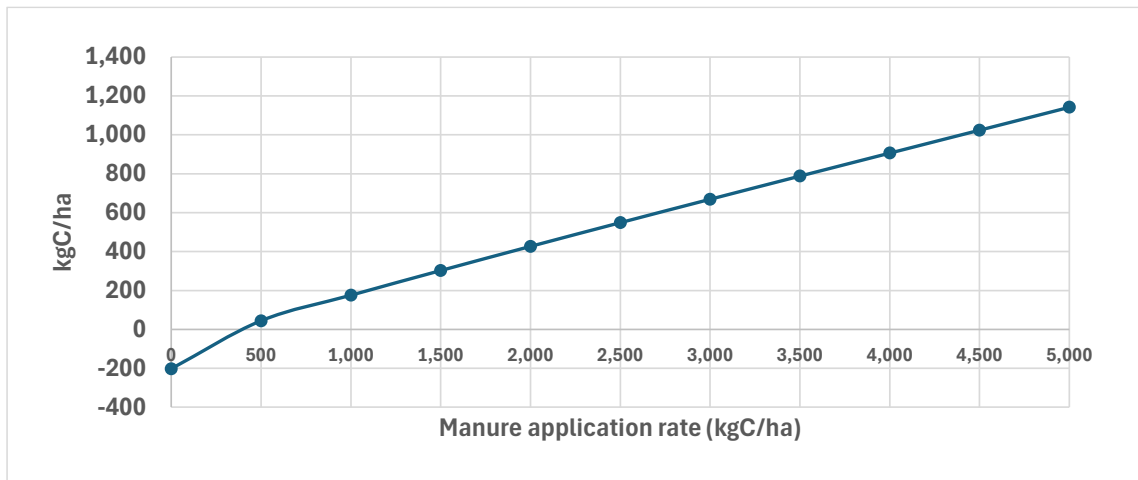


Source: IFPRI.



Source: authors.

Figure 5 Projected changes in soil organic carbon under varying organic fertilizer application rates in Kenya (Source: Authors)



Concluding remarks

The results of the study indicate that organic fertilizers can effectively improve maize yields while also contributing to better soil health. However, it is important to note that, although these findings suggest organic fertilizer use could be a viable strategy for enhancing maize productivity and promoting soil health from an agronomic perspective, its adoption faces several socioeconomic barriers. Organic fertilizers typically have lower concentrations of key nutrients, making them bulkier and heavier than inorganic options. This increases the labor and cost associated with their storage, transport, and application. Furthermore, the market for organic fertilizers remains underdeveloped. Addressing these challenges will require further research and targeted efforts in the future.

References

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