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Integrated soil fertility management (ISFM)

Large-scale potential to improve soil carbon storage and reduce soil N_2O emissions in Kenya

Photo credit Johan Six (ETH, Switzerland)

About the initiative

Together with relevant stakeholders, including the International Institute of Tropical Agriculture (IITA) and partners from the LANDMARC H2020 research project on land-based negative emission solutions, we will explore the long-term and large-scale potential and limitations of Integrated Soil Fertility Management (ISFM) to provide sufficient and economically viable crop production and to mitigate soil GHG emissions through enhanced soil carbon storage and reduction of soil N_2O emissions in Kenya. Ecosystem, land use and economic modelling research complemented with stakeholder engagement activities will be implemented in the 2021-24 period.

Additional information - Integrated soil fertility management (ISFM)

Integrated Soil Fertility Management combines agronomic practices that include the use of mineral fertilizer, organic inputs, and improved germplasm combined with the knowledge on how to adapt these practices to local conditions with the aim of maximizing the agronomic use efficiency of applied nutrients and increased crop productivity, and thus profitability for smallholder farming systems (i.e., achieving a sustainable intensification). ISFM pursues that all inputs are managed following sound agronomic practices and promotes the use of:

a) Locally available organic resources such as crop residues, manure, compost and other types of organic wastes, rotation or intercropping with legumes;
b) Nitrogen, phosphorus and potassium mineral fertilizers and practices that enhance nutrient uptake such as micro-dosing, deep placement, banding, and harmonizing of inputs with rainfall and nutrient demands;
c) An improved germplasm (involves the selection of early maturing and drought tolerant varieties, spacing and harmonizing of planting time with rainfall predictions);
d) Liming to address soil acidity;
e) Inputs of sulphur, calcium, zinc and other nutrients to counteract nutrient deficiencies;
f) Deep tillage to resolve soil compaction;
g) Pesticides or herbicides to combat severe insect and weed infestations.

ISFM can lead to short and long term increases in crop productivity, enhanced stability of yields under adverse rainfall oscillations, increased input use efficiency and profitability of food production as related to use of land, labour, fertilizer inputs and financial investments and therefore can lead to major improvements of livelihoods. Combining mineral fertilizers and organic inputs provides conservation and build-up of soil carbon stock and reduction in soil greenhouse gas emissions due to a greater uptake of nitrogen fertilizers by crops and soil carbon sequestration. ISFM practices are designed to limit soil nutrient depletion and thus have the potential to reduce deforestation.

Despite the potential significant benefits of ISFM for food security, household income and environmental protection, the adoption of practices by farmers is usually low and incomplete, especially in African smallholder systems, due to high costs of inputs (i.e., improved varieties and mineral fertilizers require a significant investment), scarcity of organic residues and competition for residues with livestock, and low awareness about the benefits of ISFM.

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Focus Area

The long-term ISFM experiment was established at four research farms with continuous maize (*Zea mays*) in 2002 in central Kenya (Embu and Machanga) and in 2005 in western Kenya (Sidada and Aludeka). The experiment has a randomized complete block design set up in a split plot arrangement with three factors: a) quantity (main plot) and b) quantity of organic resources (main plot), and c) quantity of N mineral fertilizer (subplot). The organic resources are incorporated at the beginning of the long rain season in two different quantities (1.2 vs 4.0 t C ha^{-1} yr^{-1}) in combination with mineral N fertilization at 0 vs. 120 kg N ha^{-1} yr^{-1}. Five types of organic resources, classified in quality classes according to their lignin-, phenol- and N-content, are used: *Tithonia diversifolia* (class I), *Calliandra calothyrsus* (class II), *Zea mays* stover (class III), *Grevillea robusta* sawdust (class IV) and farm-yard manure of local quality. Research management and a regular data collection (yields, soil properties) on a plot level allowed development of a long-term dataset spanning 30-36 growing seasons. The experiment is aligned with a network of farmers and local stakeholders, which will provide a valuable asset for the LANDMARC project.

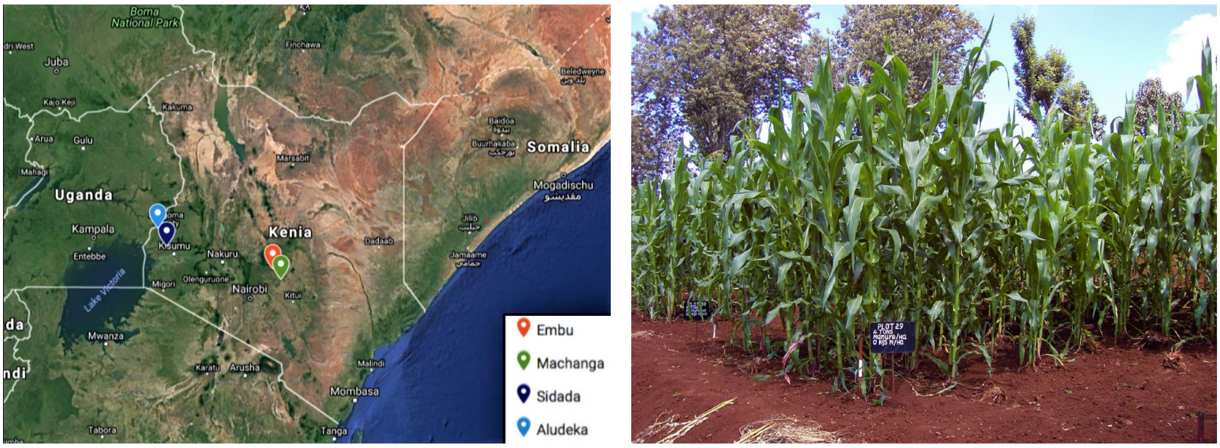

Figure 1: a) Location of the long term ISFM experiment in Kenya and b) a photograph from the experiment in Embu. Photo credit Johan Six (ETH, Switzerland)

What LANDMARC offers

LANDMARC complements the ongoing work on ISFM practices in Kenya through:

1. **Complementary data collection:** A human systems data for ISFM (i.e., local contextual data, socio-economic data such as costs, markets, policies, social acceptance, land use competition) will be collected through reviews of scientific literature, local/national databases, survey tools and stakeholder workshops.
2. **Assessment of climate vulnerability/risk and potential effectiveness of large-scale implementation of ISFM:** A climate risk and sensitivity analysis of ISFM in Kenya will be performed based on stakeholder knowledge, locally available data and by analysing the results from the Coupled Model Intercomparison Project, phase 6.
3. **Ecosystem and socio-economic impact assessment of ISFM**: A qualitative and quantitative exploratory assessment of potential co-benefits and trade-offs related to nationwide scaling-up of ISFM will be performed through the stakeholder engagement and by employing ecosystem (DayCent), land-use (ALCES, LandSHIFT) and macro-economic (E3ME) simulation models across the medium to long term. The outcomes of these analyses will have implications for the national climate change mitigation policy strategy development.

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