Combating climate change from the trenches

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Land degradation is a serious cause for concern in sub-Saharan Africa where it affects more than two-thirds of its territory. The heavy reliance on an agriculture that is highly vulnerable to climate change, and the ever-increasing pressure on soil and water resources from growing population are posing severe constraints on food security to those already at high risk of poverty and chronic food shortages. In view of the widespread degradation caused by agricultural activities in semi-arid environments, soil and water conservation measures were introduced in East Africa in the late 1960's. The measures most commonly used in that region are the Fanya-juu terraces, which are constructed using a combination of trenches and mounds.

Researchers from an international consortium led by members from the Karlsruhe Institute of Technology (KIT-Germany) have just concluded the most comprehensive assessment to date about the impact that soil and water conservation measures have on soil carbon sequestration. The team studied multiple Kenyan farms having terraces established over 30 years ago and compared them with other land uses. They observed that farms with conservation measures stored above a third more soil organic matter than those under conventional agricultural practices.

This study proves that the establishment of soil and water conservation structures in erosion-prone agricultural landscapes is so effective in both preserving valuable topsoil and promoting plant growth that it has led to the recovery of organic matter levels comparable to those observed in neighboring semi-natural ecosystems. This is good news to add to findings from work conducted in East Africa, which revealed that the

use of Fanya-juu terraces increase crop yields by at least 25%. 'Fanya-juu' in the local Kiswahili language translates as 'throw it upwards', which literally reflects the way these structures are constructed. Trenches are dugout along the contour lines and the soil extracted is used to form parallel embankments (mounds) on the up-slope side of each trench. Terrace beds develop gradually behind the mounds as soil naturally moves down from the upper part of the terrace, resulting in a more optimal preservation of both water and nutrient-rich topsoil compared to conventional agriculture.

Gustavo Saiz is the scientist from KIT leading the research and explains that 'Terraces have been used by many civilizations throughout history mainly to increase crop yields, restore degraded land and protect human settlements from landslides. Fanya-juu terraces are relatively easy-to-implement, cost-effective techniques that have the real potential to reduce soil loss, increase crop yields and enhance the sequestration of atmospheric CO2 in the soil'. He further comments that 'Digging trenches to combat climate change may be seen as something ludicrous, particularly in the high-tech age we live in, but in most cases it is only the most simple and affordable solutions the ones that can effectively be implemented by populations with very scarce resources. It is obvious that establishing terraces cannot be seen as the final solution for mitigating the huge problem of climate change, but considering the multiple benefits derived from their use they may be seen like a small step in the right direction'.

Researchers collected and processed nearly one thousand soil samples, analyzing among other variables the elemental and stable isotopic composition of carbon and nitrogen. Organic matter plays a crucial role on determining soil quality, and its enhancement may generate production, adaptation and mitigation benefits through the regulation of carbon, oxygen and plant nutrient cycling. This promotes carbon sequestration and enhanced ecosystem resilience to drought and

flooding, as it has been further corroborated by work entitled 'Climate-smart soils' just published in the journal *Nature*. Integrative approaches such as climate–smart agriculture advocate for the implementation of agricultural practices and technologies aiming at increasing productivity in a sustainable manner.

Dr Saiz explains that 'Besides being more efficient at storing water than conventional agricultural systems, Fanya-juu terraces help preserving valuable topsoil rich in SOM, thus promoting the use fewer chemical inputs to sustain yields, which have evident positive economic and ecological consequences to both livelihoods and the environment. Soil and water conservation measures hold great potential for increasing organic matter levels because the regions where these are implemented are often heavily degraded. Indeed, the semi-arid regions of Africa are reported as having the largest potential for soil organic carbon sequestration in the World'.

Besides members from KIT, the research group was made up of scientists from the International Livestock Research Institute (ILRI), the University of Eldoret (Kenya), and the Centre for International Forestry Research (CIFOR).

More information: Gustavo Saiz, Long-term assessment of soil and water conservation measures (Fanya-juu terraces) on soil organic matter in South Eastern Kenya, *Geoderma* (2016). DOI: 10.1016/j.geoderma.2016.03.022

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