Addressing climate change in Eastern Africa through evergreen agriculture

Evergreen agriculture is an aspect of agroforestry that denotes integration of appropriate tree species in annual cropping systems so as to enhance land productivity and resilience against climatic variations.

Project context

Declining soil fertility, escalating costs of farm inputs and lack of capacity are persistent problems that farmers in eastern Africa continue to grapple with. Such factors have resulted in high levels of poverty and food insecurity due to poor performance of the agriculture sector. Climate change adds a big blow to the already bad scenario with serious ramifications on the smallholder-farming sub-sector. The region is predicted to experience warmer temperatures and decreased rainfall from June to August by 2050.

This being an important season for food production in countries such as Kenya and Ethiopia, adaptation measures are necessary for sustainable food production. Evergreen Agriculture refers to the practice of incorporating selected trees and/or shrub species into annual cropping fields. It can be practiced under conventional farming practices but ideally seeks to combine agroforestry with the principles of conservation farming.

Evergreen agriculture practices are now part of the solution to tackle climate change and the adoption is on a rising trend in several countries in the region. Conservation Agriculture, including agroforestry, specialty crops, and permanent cropping systems, promotes food sufficiency, poverty reduction, and value added production through improved crop and animal production and production in relation to market opportunities.

Incorporating trees into crop farming also confers sustainability benefits through ecological intensification and may increase the resilience of the farm enterprise to climate change through greater drought resilience and improve the asset base for the farming households.

Increase in the number of trees in farmland which helps to reduce the emissions of carbon to the atmosphere. Fertilizer trees provide three different carbon sinks: above ground woody biomass (time averaged for systems that are regularly pruned or in rotation), below ground root systems (the most permanent of the sinks), and contribution to soil carbon.

The research programme in brief

In order to effectively scale up evergreen agriculture, research on three aspects is imperative: tree germplasm, agronomic practices and enabling environment. Regarding germplasm, understanding is needed on which species can be incorporated in annual cropping systems with minimum negative effects and how the seeds and seedlings of such species can be made more accessible to farmers in varying biophysical and socio-cultural environments.

Secondly, knowledge on agronomic practices is needed to understand how these species should be planted and managed in farms under varying agro-ecological conditions (i.e. where in the farm, according to what spacing and how to minimize competition with crops) so as to enhance total farm productivity using a systems-based approach.

Thirdly, it is important to explore conventional and new forms of extension that can bring knowledge to more farmers effectively and efficiently as well as the role that markets, (of

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The European Commission has funded over €200 million in research in collaboration with IFAD and the CGIAR system in order to increase the resilience of smallholder farmers to climate change and to improve food security. Projects have been undertaken in three countries to bring the power of science to bear on developing solutions that can be scaled up to reach millions of people.

The World Agroforestry Centre (ICRAF) is a CGIAR Consortium Research Centre. ICRAF's headquarters are in Nairobi, Kenya, with six regional offices located in Cameroon, China, India, Indonesia, Kenya and Peru. The Centre's vision is a rural transformation in the developing world as smallholder households strategically increase their use of trees in agricultural landscapes to improve their food security, nutrition, income, health, shelter, social cohesion, energy resources and environmental sustainability. The Centre's mission is to generate science-based knowledge about the diverse roles that trees play in agricultural landscapes, and to use its research to advance policies and practices, and their implementation, that benefit the poor and the environment.

livestock products whose productivity is enhanced by inclusion of trees), can play to provide a pull factor for adoption.

In 2010, the European Commission approved a grant to the World Agroforestry Centre (ICRAF) to test the Evergreen Agriculture concept in eastern Africa. The research involved planting trees and shrubs in maize growing farms under a conservation agriculture platform. The project was implemented in Kenya (Machakos County), Tanzania (Mbarali district) and Rwanda (Bugesera district).

Results and impact

Soil moisture retention: There was generally high moisture retention in plots where conservation agriculture was practiced with trees incorporated. Reducing tree spacing increased moisture retention. For instance in plots where *Calliandra calothyrsus* was planted at a row spacing of 1.5 m in Machakos, soil moisture increased fourfold (from 15 per cent to 60 per cent) during the short rains of 2013. This increase enabled practicing farmers to harvest maize that season while others experienced crop failure.

Increased Crop Yields: Incorporating the shrub species at spacing of more than 3 meters between rows under either conventional or conservation agriculture practices significantly increased yields of maize and intercropped legumes. Generally yields were higher in Conservation Agriculture (CA) plots than Conventional Agriculture (CoA) plots but integration of leguminous shrubs at closer spacing than 3 meters depressed yields.

Woody and leafy biomass production: Biomass yields was measured from the plots as both wood (utilizable as firewood, staking for crops etc.) and twigs (utilizable as animal fodder and/or mulch). The yields were generally higher under conservation agriculture than conventional and under closer than wider alley spacing.

Woody and twig biomass produced from shrubs can significantly improve the household economy and thus provide other means of coping with climate change. Previous ICRAF research demonstrates that farmers who grow *Calliandra calothyrsus* can provide sufficient protein supplements to one dairy cow all year round with 500 shrubs while 120 will suffice for a dairy goat.

Growing the species as Conservation Agriculture With Trees (CAWT) in alleys spaced at 4 m and 1 m spacing between rows gives about 2,500 shrubs per hectare (1,000 per acre). Assuming that half of the biomass is left as soil mulch, a farmer practicing on one hectare can provide enough supplement for two cows without compromising crop yields.

Capacity Building: The project produced three manuals for extension staff and several booklets and leaflets for farmers on the practice of CAWT. Direct training was offered to 82 extension officers across the three project sites who extended their skills to over 6,000 farmers. To test different approaches of farmer advisory, 20 volunteer farmer trainers in Bugesera and 19 in Machakos were engaged who also trained an additional 40 groups adding to the number of farmers trained.

Future directions and scaling up

To harness climate smart benefits of evergreen agriculture at scale, there is need to see more trees and shrubs established in cropping and grazing lands managed by smallholder farmers.

Specifically there is need to:-

1. **Validate viable evergreen agriculture technologies for scaling out** This requires: testing several tree species and spacing in different agro-ecological contexts; testing different methods of establishment of locally acceptable tree species, including planting and natural regeneration; and, supporting community-led seed and seedling supply systems for more farmers to plant trees.

2. **Develop evergreen agriculture scaling-up business models in order to create a business pull** This requires: identification of viable and inclusive business development options in evergreen agriculture; evergreen agriculture value chains analysis to inform business planning; implementation of business development opportunities in a co-learning approach; and, formulating scaling up strategies for each business development option.

3. **Test context appropriate scaling up models for technology options** Agro-ecologies vary easily and therefore there is need to develop and define an option by context matrix for selected technologies; evaluate extension approaches for different socio-economic contexts; test different partnership approaches for institutional synergies in scaling up; and, test and adapt communication methods to reach farmers at scale.

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