

Small scale agroecological farms for reshaping food systems and climate benefits through circular economy

Climate change and variability are showing new challenges to the livelihoods of the world's poorest producers: nearly three billion people living and working in the fields, who produce the vast majority of the world's food consumption and are the most vulnerable to drought, floods, conflicts, disease epidemics and market crises.

The current global food crisis is revealing the structural vulnerability of globalized agri-food systems, highlighting climate change as a complex set of environmental, demographic, social and economic variables that generate food instability and insecurity, and whose impacts have a profound or disproportionate effect on the poorest groups in marginal settings.

In order to contribute to innovation systems that improve food security in situations of climate change such as those prevailing in the Central American Dry Corridor, the Inter-American Institute for Cooperation on Agriculture (IICA) and the Tropical Agricultural Research and Higher Education Center (CATIE) began in May 2020 the execution of the Project "Agroforestry Systems Adapted for the Central American Dry Corridor (AGRO-INNOVA)". Initiative funded by the European Union (EU) that seeks to improve the climate resilience and food security of at least 3,000 small producers of basic grains in the dry corridor of six Central American countries: Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama



Within the AGRO-INNOVA work area, research was initiated at CATIE to explore the potential of circular agrosilvopastoral systems in small-scale agroecological farms to remodel food systems and to contribute at the same time to the adaptation and mitigation of climate change. This study, consisting of a model of goat agrosilvopastoral garden that uses a circular food system of around 0.3 ha, aims to contribute to food security in the Central American Dry Corridor (CDC).

Agricultural food systems such as the one in this research are understood as those in which waste streams are minimized and reused in composting processes for the production of foods prevalent in the CDC such as basic grains, citrus, papaya, bananas, cassava, sweet potato and vegetables, among others, as well as goat products and wood. Such food systems apply practices and technologies that minimize resource input (e.g.,

the use of agrochemical inputs), encourage the use of regenerative plants (e.g., native trees), prevent the drainage of natural resources from the food system (e.g., nitrogen, phosphorus, and potassium), and add to a greater value to the food system (for example, by pasteurizing goat milk and making cheese and yogurt, among others).

The agrosilvopastoral garden (HASP, for its acronym in Spanish) model of AGRO-INNOVA is also studying the costs and revenues derived from the different interactions that exist between the different components of the system (goats, pastures, tree fodder, vegetables, fruits, basic grains and wood, among others). All HASP measurements translate into socioeconomic and environmental benefits that arise from this model, the next step being the elaboration of a proposal that allows scaling its adoption and / or adaptation at the territory and / or landscape level.

Other aspects that have been taken into account for the realization of this research applicable to small-scale agroecological farms to remodel food systems and climate benefits through circular economy are:

- Link circularity with food security and greenhouse gas mitigation.
- Include a review - systematization on how practices align with circularity principles.
- Learn from indicators, for example, how circularity indicators can be linked to other socio-economic and environmental benefits.
- Share knowledge with other regional research institutions.



Short video script of the goat agrosilvopastoral module as a small-scale agroecological farm model to reshape food systems and climate benefits through circular economy

This module aims to show agrosilvopastoral systems that in a small space of land (about 2.900 m²) have multiple benefits of the annual production of crops that interact with tree species (fruit and timber trees) and interact with the excreta of animals managed in a barn. All these interactions between components (agricultural crops, trees and / or animals – pastures) in combination with all the good agricultural practices involved in each production system, are managed under the principles of circular economy and contribute to the increase of organic matter in the soil, biodiversity, as well as to improve adaptation and mitigation to climate change, among others.



Main benefits:



Soil conservation. It is increased by the application of cover crops, mulch, crop rotations, compost and animal manure (in this case goats are used for this purpose). This with the aim of improving the cycle of essential soil nutrients and increasing the presence of micro and macro organisms that, in the context of the circular economy, contribute to the reduction of energy costs of production and replacement of synthetic fertilizers, among others.



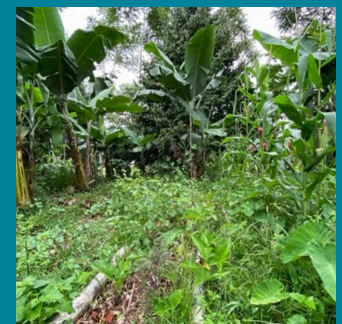
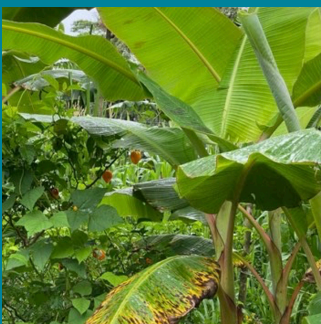
The construction of the biological diversity of the ecosystem. The agrosilvopastoral module involves multiple interactions between crops and tree species of different growth strata in combination with different cover and mulch crops. In addition to other species planted for forage supply, soil retention, as well as the other plant components, attract the presence of pollinators and other fauna diversity benefits for the entire system.



Use of bio-inputs. Cutting and hauling practices of well-managed herbaceous and woody forage species with sprinkled solid and liquid droppings and goat's milk droppings stimulate better growth and overall crop productivity. These practices allow a considerable reduction in the use of agrochemicals, reflecting on the health of the soil and the environment for the species present, but also on the health of the final consumer.



The goat barn and feeding systems. The presence of animals contributes to the generation of manure and urine that are reused as fertilizers for pastures and woody fodder, as well as to produce vegetables from the garden, causing a direct effect on tree species (fruit and timber) that are associated with crops, pastures and fodder. In addition to the highly nutritious by-products generated by goats, they have significant contributions to the food security of producing families.



In 18 months of work in this agrosilvopastoral model, 52 species have been produced in approximately 2.900^m² of arable area where the food products of these species contribute to the different nutritional groups: carbohydrates, vitamins, minerals, proteins and fibers. The results of the work in this module can be easily adopted by low-income families who contribute to their food and nutritional needs, as well as to the sale of surpluses. In this manner, the whole family will have access to goods and services, especially women, which normally contribute to the added value of the products (for example, by transforming milk into yogurt and/or cheeses, among others), as well as in the marketing of these products.



Samanea saman



Titonia diversifolia



Arachis pintoi



Hydrocotyle

Canopy

The upper level of the agrosilvopastoral module is occupied by large timber or fruit trees. These trees are invaluable carbon sinks and provide habitats for countless plant and animal species alike.

In the canopy are cedar (*Cedrela odorata*), *Samanea saman*, palms and avocado, among others.

Undergrowth

Crops in the undergrowth are used for human consumption and as feed for livestock. The most abundant crops are forage banks of *Titonia diversifolia*, *Erythrina poeppigiana*, mulberry (*Morus alba*), nacedero (*Trichanthera gigantea*), corn, citrus, plantain and others.

Ground level

The lower stratum of the Agrosilvopastoral module is occupied by a variety of vegetables, cover crops, beans and Grass (the last used to feed the goats). There are also some round-cover weeds that in most cases do not interfere with crops and help prevent soil erosion, improving biology of the soil through the contribution of biomass.

Fold (“stable for goats”)

The Agrosilvopastoral module contains a goat enclosure that can house up to 20 goats. These goats are fed using plants grown in lot p. These goats in turn produce milk that is used to provide added value in cheese and yogurt production as a sustainable integrative model for families with little land, and also produce excrement that they compost and reuse to fertilize in crops.



Goat enclosure



Young goats



Banana trees



Erythrina poeppigiana

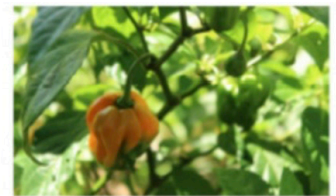
Level of bushes

The level of shrubs is occupied by various crops for human consumption, including peppers, pineapples, beans and lettuce. In addition, *Zinnia* spp. species were planted to provide habitat for pollinators.

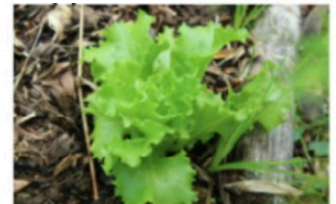
In summary, CATIE's agrosilvopastoral module is showing experiences and learnings with good practices such as: (i) visualizing high productivity in a small space, generating multiple food products and other goods and services from the components of annual, tree and animal crops; ii) improving soils, their fertility and their health; (iii) take advantage of the rainwater harvest to supply the crops and/or animals present in the module; (iv) increased percolation and retention of soil water, as well as clean and safe water runoff; (v) increasing biodiversity and ecosystem health and resilience; and (vi) investing carbon emissions through climate change adaptation and mitigation processes as a contribution of agroforestry systems.



Zinnia



Pepper



Lettuce