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Las Flores, Cuero catchment, June 2013. *Inga edulis* hedgerows, seven months after being planted. Photo: Inga Foundation

Inga tree agroforestry in Honduras

Mike Hands and Lorraine Potter

"Inga agroforestry halts devastating slash-and-burn practices and replaces them with regenerative agroforestry"

Introduction

Slash-and-burn agriculture is a critical problem in Honduras and across the tropics. It is environmentally devastating, damaging communities and making them more vulnerable to natural disasters. It is currently used by 200 to 500 million people in the tropics as they have no alternatives (Stief 2021). For generations, subsistence farmers have clear-cut and burned patches of rainforest to create plots of fertile soil for basic food crops. As a result, soil fertility does not last; in addition, crop failure and subsequent erosion force families to keep clearing new plots of rainforest every few years just to survive. Large areas of rainforest are destroyed worldwide every day, releasing huge quantities of carbon. The climate crisis exacerbates the problem, causing poverty, drought, floods and heat. Millions of people in the global south do not just face malnutrition — over 20% of the children in Honduras have poor diets that stunt their growth — but possible starvation, with no other option than to become climate refugees.

Agroforestry is an ancient agricultural practice. Cultures such as that of the Lenca people of Honduras call it "traditional technique" (Pelliccia 2018); it provides food, firewood and cash crops along with other benefits as farmers grow coffee and crops in between the trees. The tree genus *Inga* in Central and South America takes this technique to high levels of sustainability and resilience. A specialized agroforestry system developed by the Inga Foundation uses several species of the tree to support organic farming livelihoods, environmental protection, and resistance to climate shocks. The model saves rainforests from slash-and-burn practices, regenerates steep degraded land, and — by providing food security — prevents families from becoming climate refugees.

Established in 2007 and based on more than 20 years of research, the Inga Foundation is led by an all-Honduran team of foresters/agronomists and nursery and field technicians. One foundation member, who collaborates with regional NGOs and with the Royal Botanic Garden in Kew, UK, demonstrated that an agroforestry model using the nitrogen-fixing genus *Inga* spaced tightly in rows provides food, shade, fertilizer, firewood and soil and water protection. The foundation's Land For Life Project was designed to demonstrate, at the landscape scale, that a viable alternative to slash-and-burn is capable of truly sustainable agriculture.

Smallholders are feeding the world — they just are not recognized for it, nor do they receive any of the massive subsidies that industrial agriculture gets. Small-scale farmers in developing countries already bear the brunt of the climate crisis, yet they have received little of the promised funding to help them adapt to degraded land, drought, floods and heat. In tropical regions with little to no technology or infrastructure, few resources such as water for irrigation, and widespread food insecurity, there is a growing need for low-input solutions like the *Inga* model.

Features of the model

The foundation assists the families with their *Inga* seedling planting and they plant their own basic grain crops of their choice (maize or beans). A total of about 50,000 grain seeds are sown in a 1-ha plot to secure a family's basic needs. The planting density of the *Inga* trees in an alley plot is 5,000 per ha. *Inga* tree seedlings are planted 50 cm apart in rows and along contours on steep slopes, with rows about 4 m apart; they require no agrochemicals, chemical fertilizers, fossil fuels, heavy equipment, herbicides or pesticides.

The trees establish quickly, including on sites with invasive grasses, with a survival rate of 98%. Only small amounts of inexpensive mineral rock phosphate and magnesium/sulphur are needed as supplements (no chemical

Alley of *Inga edulis* at two years' growth and ready for the first pruning. No herbicides have been used. The aggressive grasses that dominated the site have been eliminated by shade alone. Photo: Inga Foundation

First pruning of an *Inga* alley plot. Deep, tough mulch will protect the soil surface from erosion and sun. Weed growth is suppressed and moisture is retained beneath the mulch. Photo: Inga Foundation

fertilizers). Maize or beans are planted between tree rows, at the same time as the tree seedlings. After 18 to 24 months, the *Inga* trees are pruned, to reduce their height from about 6 m to 1.5 m. Branches and pruned material supply firewood and the stripped leaves provide a soil-protecting mulch. Crops are planted again between the rows in the mulch and the *Inga* trees regrow. After the crops have matured, they are harvested and the cycle repeats.

The other three parts of the *Inga* tree model are cash crops, hardwood trees for future income, and citrus tree plots. The *Inga* trees are interplanted with these crops and serve as nurse trees: improving the soil by providing all the needed fertilizer and by providing shade (for crops such as vanilla, cocoa and turmeric) and mulch. The *Inga* seedlings are planted at a rate of 200–2,000 trees per ha. Smallholder families make their own decisions about whether to plant a cash crop, fruit trees or hardwood trees.

The strategy for the model has been developed from the starting point of the functioning of the tropical rainforest itself, together with in-depth studies into the impact of slash-and-burn on forest ecology and with long-term studies into possible alternatives. The strategy addresses the deep causes of historical and present-day environmental degradation and is both remedial and regenerative. By regenerating historically degraded soil fertility on these long-deforested hill slopes the model positively addresses 12 of the Sustainable Development Goals without negative impact.

Approach

This agroforestry model is being implemented in two river valleys in northern Honduras and has now reached more than 450 subsistence farming families. Now in its twelfth year, the model allows families who planted their basic grain crops with the *Inga* model to have food when their neighbours who were still using slash-and-burn saw their crops either dry up or wash away. By allowing families to stay on one plot of land, the model helps address the socially destructive rural-to-urban and out-of-country migration that results from the failure of slash-and-burn to sustain subsistence agriculture.

The *Inga* approach works with nature, builds crop diversity, and empowers marginalized farmers. Rural subsistence families provide the land, labour and care and the foundation provides the training, native seeds and assistance with planting and the first pruning. The model yields abundant firewood for household needs; excess firewood can be traded or sold. Standing trees are no longer cut down. The thick mulch obtained when the leaves from the pruned branches are stripped has strong fertilizing and protecting effects, along with the nitrogen-fixing effect of the *Inga* trees.

Benefits of *Inga* agroforestry

The model is a socially and ecologically sustainable solution that benefits rural smallholder farmers and the planet. According to Project Drawdown, a think tank working on climate solutions, agroforestry can achieve carbon sequestration rates comparable to those of afforestation and forest restoration, with the added benefit of producing food (Rainforest Alliance 2021). The *Inga* agroforestry model's subsistence farming families have planted more than 6 million native trees; these anchor, enrich and regenerate land, even steep, depleted land. The system contributes to reducing CO_2 emissions and provides up to 100% food security; it also allows families to grow organic cash crops (vanilla, rambutan, cocoa, turmeric, allspice, black pepper and pineapple).

Economic and integrated benefits

IUCN's 2019 report on Honduras, an economic analysis of 11 restoration actions in the country (Nello et al. 2019), used 14 financial indicators, four environmental indicators and two social indicators to compare restorative techniques using multiple criteria. It reported that one of the most effective actions to generate income and environmental benefits was the restoration of degraded lands for the production of basic grains through the implementation of the *Inga* agroforestry system.

In Ixcán, Guatemala, an NGO trained by the Inga Foundation had its Inga project analyzed by researchers from the Inter-Institutional Agreement for Valle del Cauca Agricultural Production (CIPAV). Results (Climate CoLab 2012) showed that Inga plots yielded approximately 350 kg more maize per ha than traditional monocrop plots, a value of approximately USD 558 per harvest. The measure of extreme poverty in Guatemala (the amount needed for an individual to meet basic nutritional needs), is approximately USD 569 per year.

The benefits of the foundation's activities in Honduras since 2012 can be summarized as follows:

- CO_2 emissions avoided or sequestered— the foundation's carbon model predicts total avoidance or sequestration of 611,187 tonnes of CO2 (Hands 2021);
- avoidance of air pollution from not burning 3,960 ha of fallow vegetation;
- 5,840 ha of total land restored to agroforestry since the program began in 2012;
- increased biodiversity through standing trees not being cut for firewood and by biological corridors being created;
- sustainable food security;
- avoidance of slash-and-burn agriculture;
- regeneration of steep, highly degraded land;
- improved nutrition;

Long-term experimental *Inga* alleys about two weeks after tree pruning and maize sowing. This is a demonstration site in an ideal flat location. The realities for subsistence farming families are very different. The site does, however, show how the system looks and works. No herbicides are used in these plots. The trees (15 species) in the background were planted within a matrix of *Inga* in 2000. Photo: Inga Foundation

Pepper (*Piper nigrum*) on living stakes of *Gliricidia sepium* within *Inga edulis* alleys. The pepper is interplanted with developing turmeric (*Curcuma longa*) and plantain (*Musa* sp.). Photo: Inga Foundation

- protection of watersheds, with no agrochemical run-off;
- improved rural livelihoods, including for women and young people;
- no debt or loans;
- prevention of erosion and mudslides;
- provision of renewable firewood without harvesting standing trees;
- reduced out-migration;
- elimination of herbicides, fungicides and pesticides; and
- elimination of chemical fertilizers, fossil fuels, GMO seeds and heavy equipment.

The Inga Foundation has facilitated its agroforestry model in 15 countries with farmers, NGOs and government agencies by providing training and native seeds at no cost. Its nurseries have provided more than 400,000 cacao plants and 85,000 pepper plants (for cash crops) along with tens of thousands of rambutan, avocado, pineapple, vanilla and other cash crop plants that families may choose at no cost.

Families are able to harvest beans and maize with no irrigation and little rain due to the thick leaf mulch from the pruned trees in the alleys, which cools the soil and retains moisture. Even in this region, which is experiencing severe climate shocks, it provides what farming families need most: food security.

Families can achieve self-sufficiency and food security within two years and they in turn can assist neighbours and relatives to do the same. It is a solution for the tropics that is owned and driven by communities through demonstration and farmer-to-farmer sharing. *Inga* agroforestry offers local solutions for climate resilience that empower local economies.

The model has proven to be a regenerative system that supports rural populations and natural resources. It is environmentally and economically sound in achieving both short- and long-term goals of climate resilience, food security, environmental protection, economic viability, and quality of life.

Resilience and replication

Adaptation to climate change needs local acceptance and community development at its core. The *Inga* tree model was set up in a way that allows families to choose to participate and puts them in full control of their plots. They determine what to plant as their basic grains and later, cash crops, and whether to plant fruit trees and hardwood trees. The foundation's nurseries provide the cultivars.

The status quo is the greatest barrier to a transformative food system that is localized and responsive to the needs of the people. The 54 leading countries of the world spend roughly $700 billion a year on farm subsidies, equal to 12 percent of gross farm revenues, according

Young cacao developing beneath the shade of *Inga edulis*. Weeds are largely controlled here by shade. Previously this site had been dominated by invasive grasses. Photo: Inga Foundation

to the Organisation for Economic Co-operation and Development (Abbott 2020). La Via Campesina also makes the case for overhauling humanity's destructive relationship with nature (La Via Campesina 2021). They are an international farmers' group founded in 1993, with 182 organizations in 81 countries.

The need for agroforestry in subsistence farming is an urgent priority, especially in the equatorial regions predicted to experience severe climate shocks of heat, drought and hurricanes. Smallholders have shown how the *Inga* agroforestry model can be replicated across entire landscapes. It is hoped that this will convince decision-makers in international institutions that such massive transformations in the rural economies of tropical countries are possible, economical and highly effective. The model needs to be self-replicating so it will require no further input from the foundation to spread from farmer to farmer. Because it is novel and revolutionary, however, the model now requires a concentration of effort and resources to achieve a critical mass of families.

Costs

The current all-in cost of USD 0.75 per tree will decrease as the model is replicated, more nurseries are established, and more training hubs are created. Although different countries have different land tenure, capabilities and community needs, there are many similarities that will make scaling efficient. The design of the model addresses barriers so that it can function as a systematic, low-input, integrated effort. The team is committed to seeing it replicated widely, with the demonstration farm becoming a full-time teaching centre.

The total cost of the project since its inception in January 2012 through to December 2021 is USD 1.68 million.

This includes all capital items such as vehicles, land, permanent equipment, etc., and works out to about USD 3,500 per family, given that some capital expenditure has already taken place.

Conclusions

The *Inga* agroforestry model allows governments in the humid tropics to fulfil their tree-planting initiatives while transforming lives for the rural poor. The foundation cannot change policies that favour and fund industrial agriculture. What it can do is gain visibility and showcase successes at the landscape level, and the possibility of replication with training hubs and nurseries for native seeds and trees. It is hoped that more achievements will create a critical mass that leads to additional funding and that the system will eventually spread on its own. The foundation works to attract mainstream environmental and capacity-building funding—to get the stories of resilience out to a wider audience and show people what is possible.

In a biological corridor, a 14-year-old *Terminalia oblonga* emerges from the *Inga* canopy. Left: *Inga vera*; right: *Hymenaea courbaril* and *I. vera*. Photo: Inga Foundation

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https://vimeo.com/572617005 8-minute Vimeo link- Transforming Lives and Landscapes - The Inga Tree Model

https://www.youtube.com/watch?v=D1lrp0rC9mE&list=LL&index=101 Mike Hands presentation on Inga Alley Cropping at Knowledge Partners Program

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