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Combining Agroforestry and Biochar

The Best Nature-Based Solution to Mitigate the Climate Crisis

Pro-Natura is collaborating with ICRAF to combine agroforestry, biochar and electricity co-generation

Agroforestry is a set of land management techniques involving the **combination of multipurpose trees with crops and/or with livestock**, in accordance with local traditions.

The International Centre for Research in Agroforestry (ICRAF) is a centre of science and development excellence that harnesses the benefits of trees for people and the environment. It is leveraging the world's largest repository of agroforestry science and information, and developing knowledge practices to **ensure food security and environmental sustainability**.

ICRAF is the only institution that does globally significant agroforestry research in and for all of the developing tropics.



Pro-Natura training in Ivory Coast

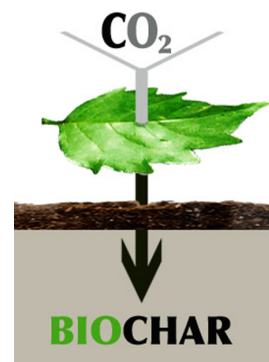
Biochar has beneficial effects on climate and trees

By growing, plants absorb CO₂, producing biomass that contains carbon. Rather than allowing unused plants to decompose and emit CO₂, pyrolysis (heating in oxygen-deprived conditions) converts about half of the plant's carbon into a solid form. The resulting product, called **biochar**, is used as an **ecological soil amendment for both soil health and carbon sequestration**.

Sustainable biochar systems are carbon negative by transforming the carbon in biomass into stable structures which remains trapped in soils for hundreds and even thousands of years. Biochar therefore acts as a **carbon sink**, allowing a net reduction of CO₂ in the atmosphere.

In the 2018 IPCC Special Report on Global Warming, biochar is credited as a promising negative emission technology for **large-scale carbon sequestration** (www.ipcc.ch/report/sr15). When combined with agroforestry and electricity co-generation (see hereafter), it is possible to minimise the cost of carbon credits and maximise the benefits regarding livelihood of the local population together with the conservation of biodiversity.

Regarding the effect of biochar on trees, a lead meta-analysis from Thomas & Gale (2015) is showing a **41% increase in tree biomass** on a mix of temperate and tropical trees, with a much higher impact on tropical trees where the increase can reach up to 300%.



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Biochar has a positive impact on associated crops

Our experience under different climates has shown that a single application, between 5 to 10 tonnes per hectare, **increases crop productivity from 50% to 200%**. Just one application provides and maintains long-lasting soil fertility benefits that enhance carbon sequestration.

Beyond carbon sequestration, biochar offers numerous other benefits:

- **Soil fertility:** Biochar can improve soil fertility, stimulating plant growth, which then absorb more CO₂ in a positive feedback effect. It enhances the soil biological activity, increases the pH of acidic soils, improves nutrient and water retention in soils, and increases organic matter.
- **Reduced emissions from feedstocks:** Converting agricultural and forestry waste into biochar can avoid CO₂ and methane emissions otherwise generated by natural decomposition or burning the waste.
- **Reduced fertilizer inputs:** Biochar can reduce the need for chemical fertilizers, resulting in reduced emissions of greenhouse gases from fertilizer manufacture and use.
- **Reduced emissions from agricultural soils:** Biochar can reduce emissions of nitrous oxide (N₂O) and methane (CH₄), two potent greenhouse gases released by cultivated soils.



Rice without vs rice with biochar (Senegal)

As a feed additive, biochar rapidly improves animal health, feed efficiency and soil organic matter

On health, the incidence of diarrhoea rapidly decreases, allergies disappear, feed intake is improved, and animals become calmer. On feed efficiency, by passing through the digestive system, biochar gets charged with plant nutrients that tend less to be lost through leaching or by gaseous emissions.

It also reduces CH₄ emissions: feeding biochar to livestock at rates of 1% of the daily feed intake reduces CH₄ emissions by 12% (Leng et al., 2012).

It avoids the contamination of soil from antibiotics and other pharmaceutical products, pesticides and other toxic substances in animal manure.

Biochar production can be done with co-generation of renewable electricity

Pro-Natura has pioneered the development of biochar in Africa by developing a biochar production technology that was awarded the 1st Prize for technological innovation from the Altran Foundation.

The technology, designed by Eng. Rachid Hadibi, is using continuous pyrolysis to carbonise unused agricultural residues, or other types of renewable biomass otherwise unused. For example, wheat and rice straw, cotton stems, corn stalks, rice and coffee husks, sugar cane bagasse, can be used to make biochar. Wood residues can also be carbonised with a yield about 3 times higher than conventional processes.



CarboChar-1

The technology, called **CarboChar**, can produce between 1 to 10 tonnes of biochar per day depending on the size of the machine. It provides a 35% to 45% yield (weight of biochar produced relative to the weight of the biomass at 15% humidity) depending on the type of biomass. In addition, continuous pyrolysis allows the process to be virtually autonomous in terms of energy, while also reducing operating costs. The heat energy generated during biochar production can be used to displace electricity from fossil fuels.

CarboChar-3 and 4 can also co-generate electricity. They respectively produce 1MW and 2MW of sustainable heat that can be converted into electricity with an ORC (Organic Ranking Cycle) technology transforming thermal energy into mechanical energy and finally into electricity through an electrical generator.

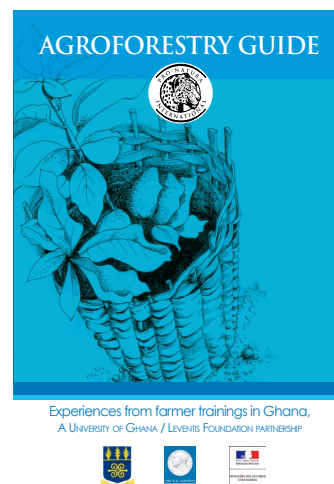


Example of ORC made by Enertime

Agroforestry with biochar is contributing greatly to help Reducing Emissions from Deforestation and Forest Degradation (REDD+)

Pro-Natura has developed a **multi-dimensional computer model** that is considering the carbon sequestration in the trees and in the soil, as well as the avoided emissions linked to the renewable electricity generation. The model also helps optimise the income of the local farming communities by advising them on climate-smart farming with the optimum mix of crops and trees.

One of the aims is to **massively scale up restoration of degraded and destroyed ecosystems** as a proven measure to fight the climate crisis and enhance food security, water supply and biodiversity.



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