PRO-NATURA INTERNATIONAL
Innovation towards Sustainable Development
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NEWSLETTER JUNE 2018

BIOCHAR FOR A VERY PRODUCTIVE AND ECOLOGICAL AGRICULTURE MITIGATING CLIMATE CHANGE

Biochar (a form of ecological charcoal) has been called **"The Third Green Revolution"**. When used in fine granular form (less than 2 mm) and combined with organic fertilizers like camel or cow dung, it can be applied to different soil types across a variety of climatic conditions. The poorer the soils, the more the effect of biochar is spectacular.

Adding biochar to the soil in the South of Algeria

Our experience under different climates has shown that a single application of approximately 10 tonnes per hectare can **increase crop productivity to levels that range from 50 to 200%.** Just one application provides and maintains long-lasting soil fertility benefits that enhance carbon sequestration in the soil, thus fighting climate change.

Today, biochar research shows measurable, replicable improvements in soil productivity:

- Enhances the soil biological activity (40% increase in mycorrhizal fungi)
- Improves nutrient retention in soils (50% increase in Cation Exchange Capacity)
- Improves the water retention capacity of soils (up to 18% increase)
- In terms of carbon sequestration, 1 tonne of biochar is equivalent to 2.7 tonnes of CO_2
- Increases the pH of acidic soils (1 point pH increase)
- Increases soil organic matter

Five weeks later a Biochar Super Vegetable Garden

Pro-Natura has won 1er Prize for technological innovation from the Altran Fondation

CarboChar-1

This innovation consists in recovering unused agricultural residues or other types of renewable biomass that cannot be used in another way, in order to carbonize them by continuous pyrolysis. For example, straws of wheat, rice, cotton stalks, millet, corn stalks, rice husks, coffee parches, bamboos, olive cake, dried palms, can be used to make biochar. The wood can also be charred in all its forms, including sawdust with a yield about 3 times higher than conventional carbonization processes.

Each CarboChar-3 is producing around 5 tonnes of biochar per day.

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This innovative technology is based on the use of a heated retort at 550 ° C through which the biomass flows in the absence of oxygen. The temperature of the retort is kept constant by the combustion of the pyrolysis gases which are recycled and burned in a post combustion chamber, thus avoiding the emission of greenhouse gases (GHG). One of the originalities of the process is that once the machine is preheated, the process produces its own energy. Feeding the biomass, obtained by a small electric motor of low consumption, finally constitutes the only external energy demand of the system. This process is therefore virtually autonomous in terms of energy and its yield (weight of green coal produced relative to the weight of the biomass at 15% humidity) reaches 30% to 45% depending on the type of biomass. In addition to the benefits of the retort carbonization process, the operating cost of the reactor is reduced by continuous production.

This process also makes it possible to obtain optimum energy efficiency with regard to carbonization in a retort, thanks to the excellent control of the combustion of the pyrolysis gases ensuring the operating autonomy of the reactor.

Biochar as a means to fight climate change creating a large carbon sink

By growing plants absorb CO_2, producing biomass that contains carbon. Rather than allowing unused plants to decompose and emitting CO_2, pyrolysis converts about half of the carbon into a stable, inactive form. Photosynthesis absorbs CO_2 from the atmosphere, biochar stores carbon in a solid and beneficial form. Biochar also reduces emissions of other greenhouse gases, including methane and nitrous oxide. A recent study estimates that 12% of greenhouse gas emissions from human activity could be offset by the use of biochar7, with 1 tonne of biochar being equivalent to 2.7 tonnes of CO_2.

The longevity of biochar in the soil can reach several thousand years, allowing them to be considered as carbon sinks (Woof D, Amonette J, Street-Perrot A, Lehmann J, Joseph S, sustainable global biochar to mitigate climate change, Nature Communications 2010).

In Belize biochar-treated cacao tree on the left has started producing pods significantly earlier than the non-biochar treated tree on the right – both are three years old

Most biochar-related activity is linked to the International Biochar Initiative based at Cornell University: www.biochar-international.org

Summary of key scientific publications regarding biochar on the main tropical crops

Type of crop	Authors	Location	Type of soils	Quantity of biochar (t/ha)	Yield increases (%)
Rice	Asai et al.	Houay-Khot, Nord du Laos	upland	8	70%
Rice	Steiner et al.	Manuas, Brésil	xanthic ferralsol / laterite	11	73%
Rice	Masulili et al.	Sungai Kakap, Indonesia	acid sulphate soil	10	93%
Rice	Zaitun et al.	Empretring, Indonesia	-	10	57%
Sugarcane	Chen et al.	Okinawa, Japan	shimajiri maji (clay)	7,2	78%
Tomato	Effah et al.	Kade, Ghana	forest ochrosol	7	177%
Cotton	Reddy	Midjil Mandal, Andrha Pradesh, India	alkaline	3,75	100%
Cabbage	Carter et al.	Siam Reap, Cambodia	sandy acidic	100	750%
Maize	Major et al.	Llanos Orientales, Colombia	savanna oxisol	8	71%
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Maize	Kimetu et al.	Vihiga, western Kenya	highly degraded ultisol	6	71%
Peanuts	Islami et al.	Malang, Indonesia	clay loam	15	54%
Cowpea	Tagoe et al.	Gifu, Japan	sandy loam	-	146%
Casava	Islami et al.	Malang, Indonesia	clay loam	15	32%
Onion	Pro-Natura	Senegal	-	10	50%

Summary of major scientific publications showing the effects of biochar on major temperate crops

Type of crop	Authors	Location	Type of soils	Quantity of biochar (t/ha)	Yield increases (%)
Rice	Lugato et al.	Northern Italy	aguic hapludalf	40	36%
Rice	Zhang et al.	Shenyang, China	sandy loam	30	40%
Maize	Uzoma et al.	Tottori, Japan	sandy soil	15	150%
Maize	Peng et al.	Yingtan, China	ultisol	2,4	64%
Soyabean	Tagoe et al.	Gifu, Japan	-	4	43%
Wheat	Van Zwietan	NSW, Australia	ferralsol	15	170%
Wheat	Vaccari et al.	Postoia, Italy	silty loam	30	33%
Canola	Pervej-Ahmed et al.	Saskatchewan, Canada	brown loaml	1	20%
Barley	Gathorne-Hardy et al.	United Kingdom	light soil	20	43%
Choux	Jia et al.	Nanjing, China	fimi-orthic anthrosol	30	96%
Radish	Chan et al.	NSW, Australia	chromosol	10	42%
Sweet pepper	Graber et al.	Israel	commercial soilless mixture	8	79%
Citrus	Ishii et al.	Matsuyama, Japan	-	83	57%
Quinoa	Kamman et al.	Germany	sandy loam brown earth	100	44%