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Fighting climate change with green charcoal and increasing agricultural productivity

Founded in Brazil in 1986, Pro-Natura was one of the first Non-Governmental Organisations from the South to internationalise: after the Rio Summit in 1992 Pro-Natura International was born, with its headquarters in Paris. More than 500 high-level volunteers are mobilised in programmes in the global South, bringing together the fight against poverty with biodiversity conservation and the mobilisation against climate change.

Two billion people must face the problem of domestic energy needs that pushes them to deforestation, adding to the problems of drought and desertification. To fight this, Pro-Natura invented and developed the innovative technology of "green charcoal". This technology proves to be very competitive in relation to wood charcoal, has a positive effect in terms of climate change and in recognition of this, received the 1st place prize for technological innovation from the Altran Foundation in 2002.

In Africa, Latin America and Asia - including India and China - wood is becoming harder to find and in general alternative energies are not available or affordable for households. Two billion people across the world therefore depend on wood generating deforestation for their domestic energy needs - particularly in Africa, where it represents 89% of energy sources. This use of unsustainable wood is a major cause of deforestation, which poses a serious ecological risk. Deforestation accentuates drought, desertification and climate change.

The exclusive use of wood as a domestic fuel presents numerous other major disadvantages:

- As deforestation progresses, the burden on women and children mounts: they must travel longer and longer distances to supply themselves with the wood and other forest products they need. This additional obligation diminishes the time they could dedicate to other tasks such as education, which are nonetheless indispensable. In the Sahel for example, women must at times travel 20 kilometres a day to find the wood necessary to cook their food;
- With less fuel available, the quantity and quality of food diminish;
- Supplying the necessary fuel energy demands an increasingly large proportion of revenues;
- Finally, smoke released is harmful to the eyes and lungs, the WHO estimates that 1.6 million women and children die prematurely because of wood smoke in poorly ventilated homes.

Taken together, the serious constraints of wood use by these populations reduce the possibilities for improving their living conditions and impede economic progress.

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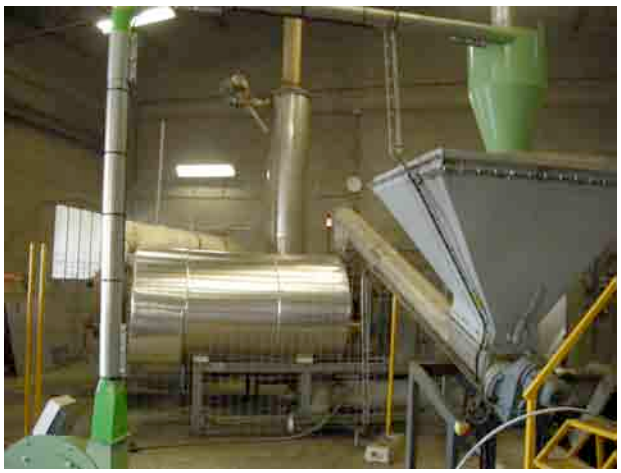
In 2002 Pro-Natura won the Altran Foundation's first prize for technological innovation, for the ecological production of green charcoal



The method employed here involves unused agricultural residues or renewable biomass which would otherwise go to waste, and transforming them into briquettes of green charcoal, a wood charcoal substitute. Pro-Natura thus proposes an alternative domestic fuel made of vegetable carbon, obtained through a proven, clean and efficient process, based on the continuous carbonisation of renewable biomass. Savannah weeds, reeds, wheat or rice straw, cotton and corn stems, rice or coffee husk and bamboo can all be used to produce green charcoal. Any form of wood, including sawdust, can also be carbonised, with a yield around 3 times higher than would be the case using classical batch processes. A Pyro-6F machine allows for the economical and ecological production of between 4 and 5 tonnes of green charcoal per day. The first French-made machine has been in use in the Saint-Louis region of Senegal since the end of 2007 (see photo above) and the 'Herisson Vert' company now operates it.
This technology has been transferred to the new Paris-based company Green Charcoal International, which produces the machine.

Carbonisation of biomass is made in a continuous manner

Rachid Hadibi inventor of the Pyro technology

It relates to a continuous carbonisation of vegetable matter, followed by an agglomeration into briquettes or bars. This technology is based on the use of a retort heated to 550°C in which the biomass flows continuously, in the absence of oxygen. The temperature of the retort is maintained constant with the combustion of the pyrolysis gases that are recycled and burned in a second post-combustion chamber, thus avoiding the release of Greenhouse Gases in the atmosphere.
One of the originalities of the process is that once the machine is preheated, the process produces its own energy, except for the transfer of the biomass, which is done with a small low-energy consumption electric motor. This process is therefore practically autonomous in terms of energy and its yield (weight in green charcoal in relation to weight of the biomass at less than 15% moisture) reaches 30-45% according to the type of biomass. In addition to the advantages of the carbonisation process in the retort, the cost of running the reactor is lowered by the continuous production, thus avoiding stopping the machine each time to recuperate the charcoal.
The technology has now been transferred to a new Paris-based social enterprise, *Green Charcoal International*, which now constructs the Pyro-6F machines and continues R&D.
The complete combustion of the pyrolysis gases with this technology allows not only to permanently maintain a carbonisation temperature around 550°C for a biomass of a maximum of 15% moisture content, but also to allow for producing heat between 120 and 150 kW serving to:

- Preheating a second reactor and heat a dryer; or
- Heating greenhouses or any other facilities.

Agglomeration of these vegetable charcoal briquettes

After carbonisation, an agglomeration of these charcoal fines is necessary to facilitate the combustion and transport of the briquettes obtained. The agglomeration techniques are in two main families: compression techniques and pelletisation (a non-compressing technique). The fabrication of briquettes or charcoal nuts demands a binder to mix with the charcoal fines. This binder can either be starch, Arabic gum, molasses or clay.

Application of green charcoal to the increase of agricultural productivity

The fertilisation of the soil by green charcoal is an ancestral practice initiated more than 7,000 years ago by pre-Columbian Indians in the Amazonian regions. According to the most recent studies, these enrichments applied by the Indians on their fields consisted principally in a mixture of carbonised matters (such as wood charcoal, called **biocha** in this context) and organic waste, which led to the formation of a particular soil of a deep colour and of remarkable fertility, the 'Terra Preta'.

The properties of these soils were conserved until today and discovered recently by the scientific community, which accords it a strongly increasing interest [see 1,2 references to articles in 'Nature']. Recent research thus showed that the great fertility of the Terra Preta results principally from the presence of numerous carbonised particles that act as a 'nest' facilitating the fixation of water and nutrients and the development of a rich population of microorganisms in the soil responsible for the improved growth and resistance of the plants that grow there. This also explains why optimal fertility is in fact obtained in combining enrichment by biochar (typically 1 up to 5 kg of biochar with a granularity smaller than 2 mm per m^2 of soil) with a complementary traditional fertilisation (compost, manure…) bringing the essential microelements to 'nest' there. If the exact duration of retention of the carbon by the Terra Preta still remains clouded in mystery, the 'Terra Preta' soils discovered prove that this longevity can easily reach several thousands of years, which permit us to consider this as a real 'carbon sink' capable of offering an effective, clean and sustainable solution to climate change by absorbing and stocking the excess CO_2 from the atmosphere as carbon. Biochar is made largely of carbon, which the crops or trees previously sucked out of the air in the form of CO_2. Unlike crop wastes and wood, it's an extremely stable substance, which if mixed into soil will safely lock up its carbon content for hundreds or even thousands of years – a biological form of carbon capture and storage.

Faced with this fact and the results of numerous conclusive tests on biochar conducted in the last years around the world and showing an increase in soil productivity of around 100 to 200%, Pro-Natura decided to encourage the use of its green charcoal as biochar and has launched in 2008 a biochar pilot project on its main Green charcoal production site at Ross Bethio, Senegal. Pro-Natura provides biochar, training and financial incentives to local farmers in order to facilitate the adoption of new sustainable agricultural practices based on biochar and organic fertilizers.

Besides their direct benefits for the farmers, these trials also contribute to the scientific research since they are supervised by eminent soil scientists from the biochar research community such as Dr. Bruno Glaser from Bayreuth University (Germany).

Additionally, Pro-Natura also promotes biochar on the international scene of political negotiations on climate change and rural poverty agendas and presented its technology and projects at the 2nd International Biochar Conference in Newcastle in September 2008.

While the reduction of greenhouse gases (GHG) emissions generated by the use of green charcoal as domestic fuel has already been precisely accounted as carbon credits validated on the voluntary market, Pro-Natura aims now at validating the carbon credits corresponding to the carbon sequestered through green charcoal used as biochar in soils. An early calculation of these carbon credits showed that, under conservative assumptions, at least 3 tCO_2 could be sequestrated by every ton of biochar incorporated in the soil (i.e. 30 tCO_2/ha for a typical amendment of 1 kg biochar per m^2). Selling these carbon credits has the potential of providing an additional source of revenues that could help replicating this sustainable approach further in other regions of developing countries deeply affected by rural poverty and threatened by climate change.

[1] ***Putting the carbon back: Black is the new green***, Nature 442, 624-626, 2006
[2] ***A Handful of Carbon***, J. Lehmann, Nature 447, 2007

With this “win-win” strategy, it is thus possible to render the carbon footprint globally negative (by taking more carbon from the atmosphere than is emitted), while fighting effectively against poverty and hunger by the sustainable and lower cost increase of productivity of the land and the reduction of the dependence on traditional, expensive and polluting chemical fertilisers.

Potential in the fight against climate change

The reactor functions without any GHG emissions other than CO_2 recycled in the process of regeneration of the renewable biomass. While remaining comparable to traditional wood charcoal in terms of caloric power, green charcoal presents the following advantages:

- Avoids the pressure on forests through the substitution of other renewable forms of biomass in place of wood. This avoided deforestation represents an additional sequestration of carbon compared to the baseline;
- Avoids the combustion of agricultural residues as traditionally performed in the baseline, which leads to a reduction in CO_2, CH_4 and N_2O emissions;
- Eliminate the CH_4 emissions of traditional carbonisation, through the use of Pro-Natura’s efficient pyrolyzers. This technology improves the yield of carbonisation significantly (30-45%) compared to traditional production methods (10-15%).

Estimation of emission reductions is based on the following hypotheses:

- Every ton of avoided wood charcoal corresponds to the avoidance of the deforestation of 5.5 tons of dry wood. This conservative hypothesis was chosen by the World Bank Carbon Funds;
- Every ton of avoided wood charcoal prevents an emission of CH_4 that is equivalent to 3.5 tCO_2. This value is an average between the emissions of the least sophisticated traditional carbonisation techniques of the Sahel (which are common in the baseline) and the value used for the ‘Plantar’ project, in which sophisticated ovens are used;
- Every ton of biomass used as feedstock for the production of green charcoal avoids the emission of GHG equivalent to 0.06 kg of CO_2 due to brush burning of unused biomass.

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