CARBON GOLD®

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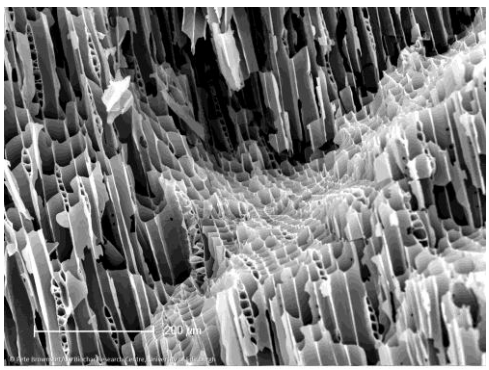
Biochar – a sustainable waste management solution and effective soil amendment for cacao growers in Central America.

Providing viable, long term, sustainable economic opportunities

The Toledo Cacao Growers Association (TCGA) is a non-profit company owned by its members. It was incorporated in 1986 "*to improve the socioeconomic standard of living of its members through competitive and diversified systems of production which incorporate sound ecological principles.*" It has 1000 members from 55 villages and over 90% are indigenous Maya farmers. Cacao is currently the only certified organic product leaving Belize. It is also Fairtrade certified. The TCGA provides viable, long term, sustainable economic opportunities to individuals who are interested and committed to organic cacao production and its related management of natural resources. The TCGA has direct links with its communities, and represents them on the international stage to promote environmental protection and sustainable livelihoods.

Biochar identified as a vital soil amendment

The implementation of improved agricultural practices is crucial to maintain the TCGA's position in the global cacao supply chain, supplying beans to Mondelēz International. As Mondelēz demands an increasingly better quality of crop and higher yields, cacao growing techniques have evolved accordingly, in order to meet demand and maximise return. As part of this process, growers are encouraged to improve soil health and so, in 2009, a project was launched to investigate the use of biochar as a soil amendment in the cultivation of cacao.



Biochar retains nutrients, preventing them from leaching away and making them more available to plants; its structure provides a home for mycorrhizal fungi and beneficial microbes to grow and flourish, which leads to strong root development and increases disease resistance. The porosity of biochar improves soil structure, retains moisture and therefore reduces the need to water.

A sustainable solution for waste management and water saving

In the Toledo district of Belize, cacao trees are prone to the fungal disease monilia, made worse by lack of airflow through the orchards. Pruning the orchards generates a greater airflow but creates a waste stream of biomass that is generally burnt or left to rot – resulting in atmospheric CO_2 emissions. The project aimed to show that these prunings could provide a sustainable source of feedstock for producing biochar.

How cacao plants are cultivated in Toledo is evolving. Traditionally, seedlings were planted directly into the soil. Growers are now raising grafted plants in nurseries, often for up to eight months before they are planted out in an orchard setting. Grafting allows for stronger rootstock to be spliced onto a superior fruiting stem – thereby increasing plant strength and yield. However, this means that young plants are subjected to a long period in a nursery environment, sometimes throughout the entire dry season when irrigation can be sporadic. As biochar has water retaining properties, its advantages to this new, nursery-based growing system were also explored.

Project Design

The project was established to encourage the sustainable production of biochar by TCGA farmers, to test its use as a soil amendment in cacao orchard and nursery settings, and was designed to complement existing pruning programmes. In phase one of the project, biochar was to be produced by TCGA farmers in situ, using cacao and shade tree prunings as feedstock. The material converted into biochar was taken from areas where the "milpa" system – also known as "slash-and-burn" – was traditionally carried out, with an aim to slow down this environmentally destructive practice and extend land use. In phase two, the resulting biochar was to be crushed and added to the soil in cacao orchards and nurseries to examine its potential as a soil amendment.

<u>Biochar production</u>

The project started by training growers to produce biochar with brick built Adam Retort kilns. It soon became apparent that it was necessary to process a more diverse supply of feedstock in faster, more easily transportable kilns. Carbon Gold therefore designed and supplied ten adapted ring kilns (SuperChar 100) to facilitate cleaner and more efficient production of biochar. TCGA farmers were trained by a Carbon Gold project officer to operate these small-scale kilns. Mondelēz International, the pilot project sponsor, provided farmers with a financial incentive – in the form of a carbon payment – to process their agricultural waste to biochar.

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One tonne of biochar is equivalent to 2.7 tonnes of carbon dioxide removed from the atmosphere.
The World Bank has identified biochar as the most effective system of greenhouse gas abatement in soil when compared to all other sustainable land management practices. In 2014 the American Carbon Registry will publish a biochar methodology allowing tradable carbon credits to be generated from approved biochar projects.


Carbon Gold trains TCGA team members to use its SuperChar 100 biochar kiln in cacao orchards

Growing Trials


Biochar being applied to cacao orchards

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Orchard Trials

Biochar was mixed with locally sourced nutrients and applied to the soil around the base of semi-mature and mature trees, around the drip line, under the leaf litter.

Within twelve months growers reported benefits to cacao trees including:

- More vigorous growth
- Improved 'flushing'
    - Cacao trees exhibit a flushing-type growth habit, with two to four growth flushes per year
- Boosted disease resilience
- Higher yields
- Earlier maturation time

Two trees of the same age; the tree on the left has been amended with biochar and is producing pods; the tree on the right is grown under standard conditions, without a biochar amendment, and is much smaller and has yet to produce any pods.

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Nursery Trials

In nursery trials testing various growing media combinations, biochar blends showed best results. TCGA's technical agronomist observed:

Faster growth

Treatment	**# of seedlings reaching 8mm diameter in 3 months growth**	**Percentage (%)**
Control	60	75%
Biochar	65	81.25%
Biochar/Fertilizer	**80**	**100%**
Fertilizer	70	87.5%
Biochar/EM	45	56.25%

Increased water retention

Seedlings planted with biochar and fertilizer were the fastest growing, with the largest, most vigorous and darkest green leaves. Biochar showed significant water retention capacity and when used in soil mixture in a nursery setting, water application can be reduced to 50%.

Biochar grown seedlings (left) survive through drought and nutrient stress compared to control (right) in TCGA nursery trials

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Funding

The project was originally supported by the Cadbury Foundation and, following positive feedback from the farmers and promising preliminary results, Kraft Foods, now Mondelēz International, continued this support and expanded the project when it acquired Cadbury in 2010.

Following the success of the trials the GEF Small Grants Programme implemented by the United Nations Development Programme (UNDP) supported a further expansion of the project, which began in September 2012

Lessons learnt – the future of biochar in Belize

Feedstock
Important lessons have been learnt during this 4 year project. TCGA farmers have developed the skills to produce and use biochar to improve their yields, increase their incomes and slow down environmentally damaging 'slash and burn' practices. Appropriate, sustainable supplies of feedstock have been identified. As cacao prunings were found to be insufficient as the sole source of feedstock, biomass from other sources will now be used, including sawmill residues. Rice husks from a local rice mill represent a further feedstock source.

Production systems
The project has also established that centralised biochar production – where biochar is made by dedicated producers with mobile kilns processing a variety of local feedstock – has proven most effective. Three of the ten farmers who participated in the trials will now be paid by the TCGA to produce and sell biochar to other cacao growers throughout the cooperative.

Optimal use
The key outcome of the project is the realisation of the benefits of biochar as an effective soil amendment and one that is imperative to the successful propagation of cacao seedlings in a nursery environment. TCGA farmers will now be propagating all of their cacao plants in nurseries, expanding to nine across the cooperative - each raising 5000 seedlings at a time. 45000 grafted cacao plants will be grown in biochar-enriched, water-retentive soil; resulting in stronger plants, increased yields and quicker and more reliable cropping.

Additional income
The project also brings financial gain to the TCGA. Biomass from the waste stream has become a valuable resource as feedstock, and as the horticultural value of biochar in the cacao growing system has been substantiated, the value of biochar is set to rise.

Bright Future
The project officer trained and employed to lead biochar production throughout the trials has won a scholarship to study agronomy in Costa Rica – the opportunity of a lifetime in a nation that is readily rediscovering the horticultural arts of its ancestors.

Quotes

Armando Choco, CEO for the TCGA said, "This project has been a fundamental milestone in the development of cacao growing in Toledo. Growers now have the new skills and equipment necessary to improve the health of their soils and produce better crops. The TCGA biochar project is an important showcase to the cacao growing industry, rural development initiatives and biochar production schemes across the globe."

Marco Figueroa, technical advisor for the biochar project, said, "We are excited by the results from the Toledo growing trials, which show that biochar is an important element in the cultivation of cacao crops. As propagation increasingly moves into a nursery setting, biochar has proven essential for retaining the water and nutrients needed to grow more resilient, faster cropping plants."

Neil LaCroix, director for sustainable supply chains for Mondelez International said, "The seed funding we provided to initiate this project was vital to the development of new farming methods that will ensure a better quality of product and improved yields for the future".

Cacao farmer, Pablo Bol says: "We are making our land more productive in the same way that our ancestors did, by spreading charcoal over the soil. We are bringing our land back to life with biochar that we make by recycling the waste from our own trees. With biochar in the soil we get more from our crops without having to 'slash and burn'. We look forward to bigger, more reliable harvests, meaning more income for us and our families. Not only does biochar improve the soil and increase plant growth, our land is no longer being degraded and remains fertile enough to prevent our crops declining. I hope to use it on more of my land in the future."