The Pyrolysis of Biomass to give us Biochar and using it as a Soil Improver

Presented by
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It is not a new idea

The productivity of Amazonian dark earth soils – created by early agriculturalists using charcoal – first stimulated interest in biochar as both a sequestering agent and as an agent to promote agricultural productivity

Amazonian dark earth - *terra preta*

Left a nutrient-poor *oxisol*; right an oxisol transformed into fertile *terra preta* - photo courtesy of Bruno Glaser

Chernozem – black soil in Ukraine: Pyrolytical origin through prairie fires

What is new is:-

- Relative rapid increase (last 10 – 15 years) in the Global R&D sector's race to understand more about it and what it can do for us all.

- As the results come in - they suggest ***biochar as a soil amendment***, if managed in the right way, can help us take serious steps for the betterment of our environment and help support a sustainable biosphere.

- We now have to be willing to take these steps quickly.

Unlike compost or plant residues, biochar does not degrade in soils

- Compost and other organic material in soils is valuable but mineralises (converts to CO_2) in just a few years.

- Biochar will remain essentially unchanged for hundreds or even thousands of years – carbon sequestration really is possible

Some of the benefits in areas being studied

- Reduced leaching of nitrogen into the ground water – aiding nitrogen transformation in the soil
- Possible reduced emissions of nitrous oxide
- Increased cation exchange capacity resulting in improved soil fertility
- Moderating of soil acidity
- Increased water retention
- Increased number of beneficial soil microbes

There many types of Biochar

- Each have their different characteristics
- So some types are more helpful than others
- Classification is therefore most important
- Feedstock is fundamental in what you get – woody versus grassy stuff - BIG difference
- Choosing the kind of pyrolysis is key to getting the best biochar and highest yield for improving the soil
- Therefore “certification” of quality comes to mind

For the best plant growth results biochar is not used on its own

- Mixing with compost materials containing organic carbon, vermicasts and seaweed for example is beginning to find itself in the European horticultural marketplace

- The rate of application to the soil varies in obtaining different yields for different crops –some like 10tonnes per hectare – some may like 50tonnes

- How it is put onto or into the soil will effect performance of differing plants and their root systems

In poor Australian soils, enhanced productivity can be substantial

"Trials of agrichar - a product hailed as a saviour of Australia's carbon-depleted soils and the environment - have doubled and, in one case, tripled crop growth when applied at the rate of 10 tonnes per hectare ... For the wheat, agrichar alone was about as beneficial for yields as using nitrogen fertiliser only ... Soil biology improved, the need for added fertiliser reduced and water holding capacity was raised ... The trials also measured gases given off from the soils and found significantly lower emissions of carbon dioxide and nitrous oxide..."

http://www.dpi.nsw.gov.au/research/updates/issues/may-2007/soils-offer-new-hope

Pore Diameters

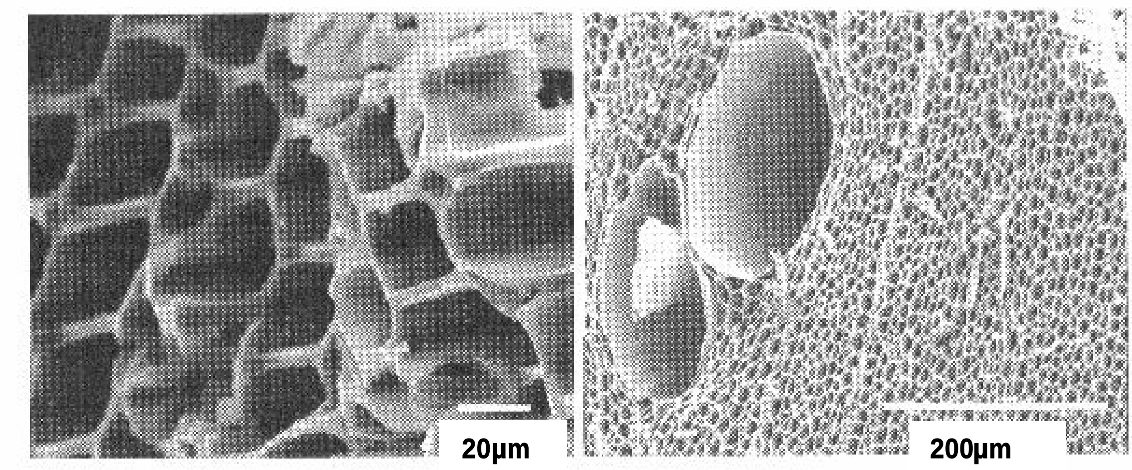


Figure 6.1 *The porous structure of biochar invites microbial colonization*

Source: (left photo) S. Joseph; (right photo) Yamamoto, with permission

Bamboo biochar: **0,001 – 1000 µm**
Wood biochar: **10 -3000 µm**

Bacteria: 0,3 – 3 µm
Fungi: 2 – 80 µm
Protozoa: 7 – 30 µm
Nematodes: 3 – 30 µm

Root hairs: 5 – 17 µm
Fine roots: - 800 µm

Microbial Colonization of biochar

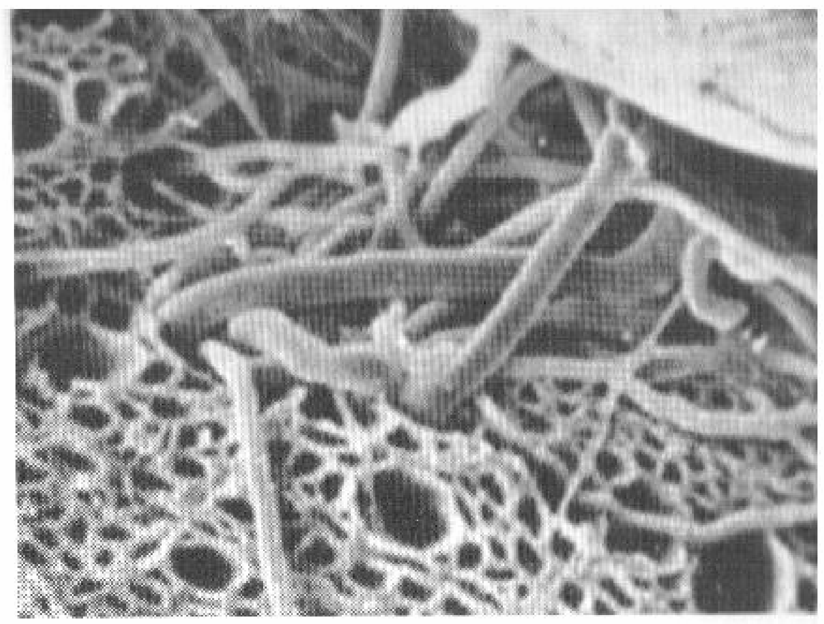
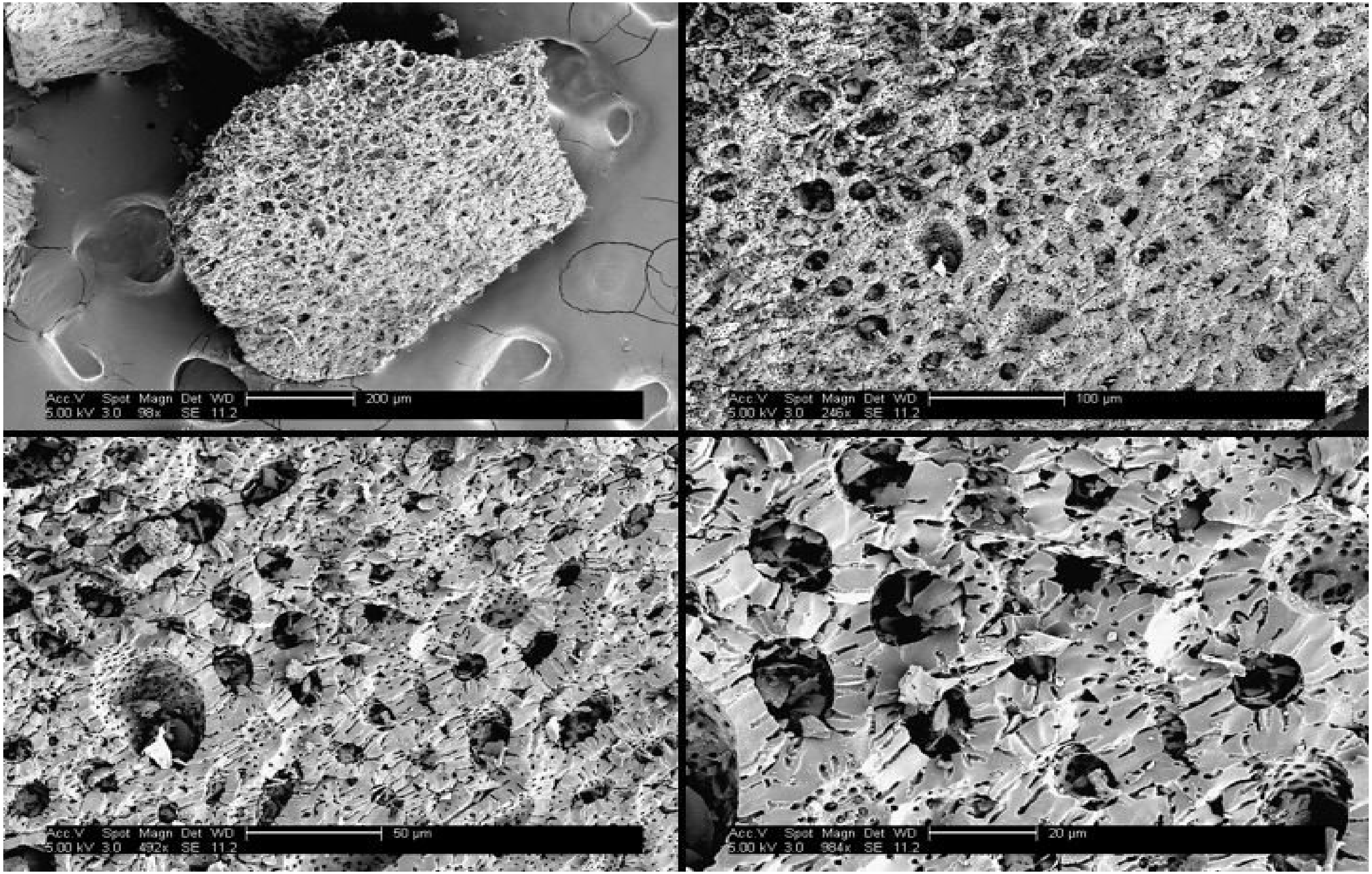


Figure 6.2 *Arbuscular mycorrhiza (AM) Fungal hyphae growing into biochar*
Pores from a germinating spore

Source: Ogawa (1994)

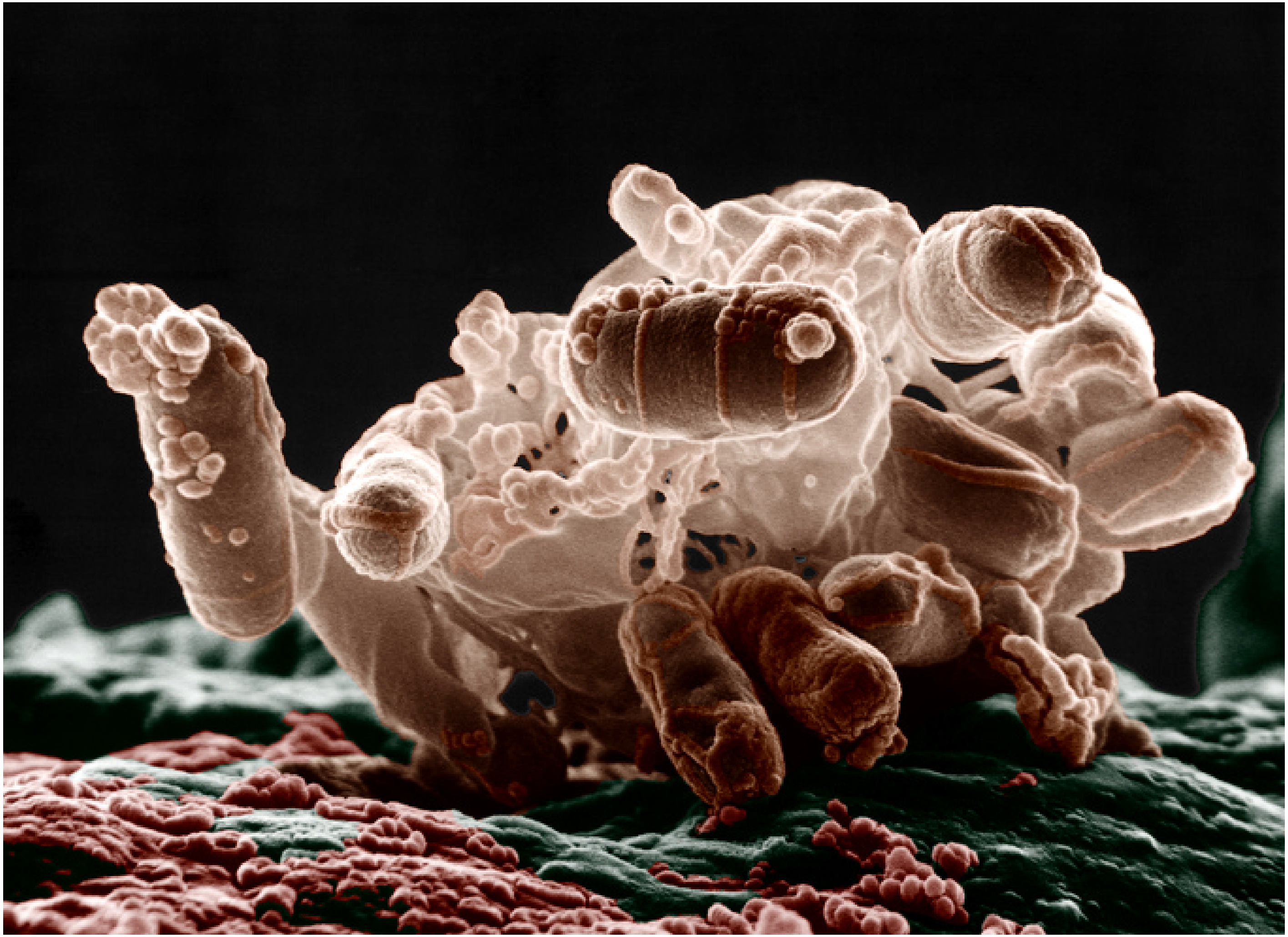
Source: BIOCHAR, Environmental Management (Lehmann and Joseph) 2009



The highly porous structure of the biochar enables the high nutrient and water retention capacity. Specific surface of biochar is about 300m^2 per gram.

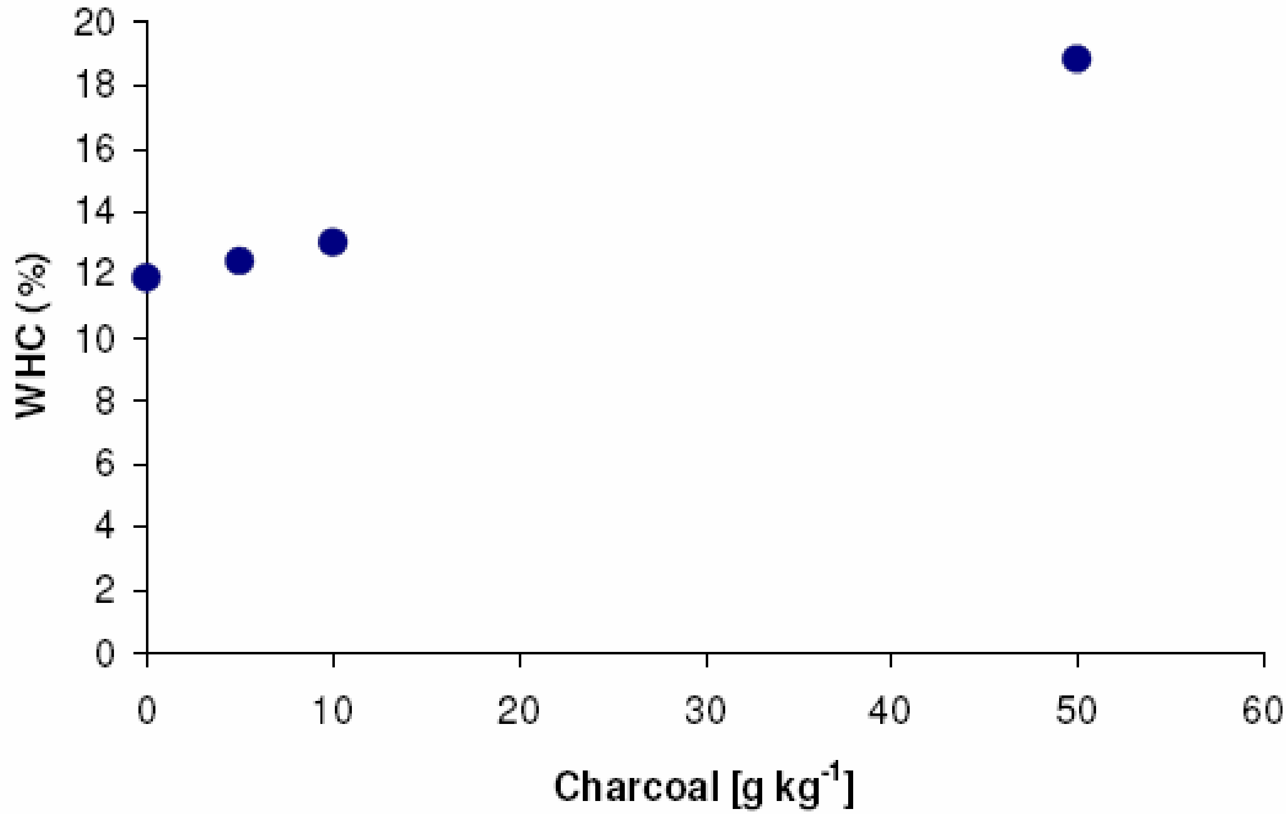
Root hairs of a mustard plant grown into the biochar

Photo: Andreas Thomsen 2009



The decisive criterion for the efficiency of biochar as a soil amendment is its biological activation.

Water Retention



Briggs et al. (2005)

Water retention capacity depending on biochar content

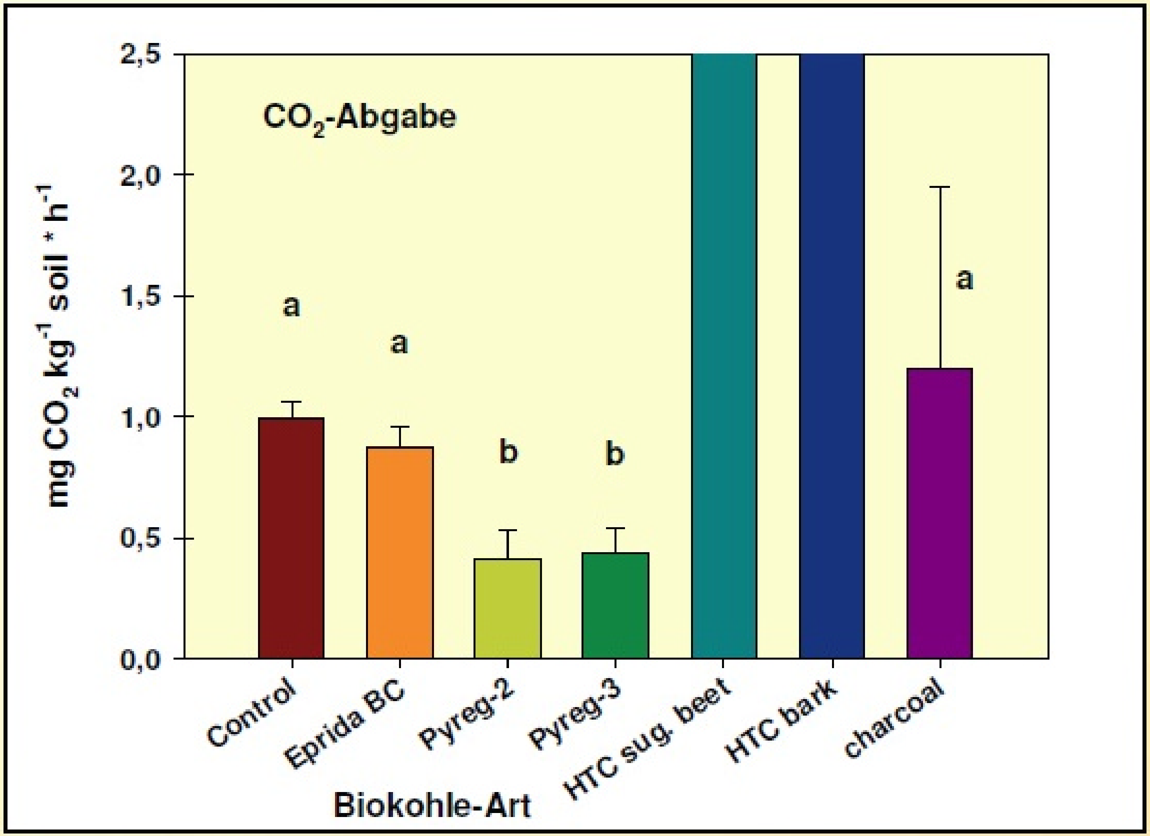
Other benefits gained by using biochar in the soil

- Sequesting carbon from the carbon cycle

Diverting 1% of annual net plant uptake into biochar would mitigate 10% of current anthropogenic C emissions

- Reduces the amount of man-made inorganic NPK type fertilizers needed to maintain crop yields, hence saving energy in manufacture
- Very useful in land remediation programmes reducing the 3 main GHG emissions
- Hopefully, soon the confirmation it can play a significant part reducing N_2O emissions from normal soils - in a global scenario

Reduction of Greenhouse Gas Emissions through Biochar



Lab trials: 8 g BC on 100g brown earth, 65% WHC_{max}

Claudia Kammann,
Institute of Plant Ecology, University of Giessen, 2010

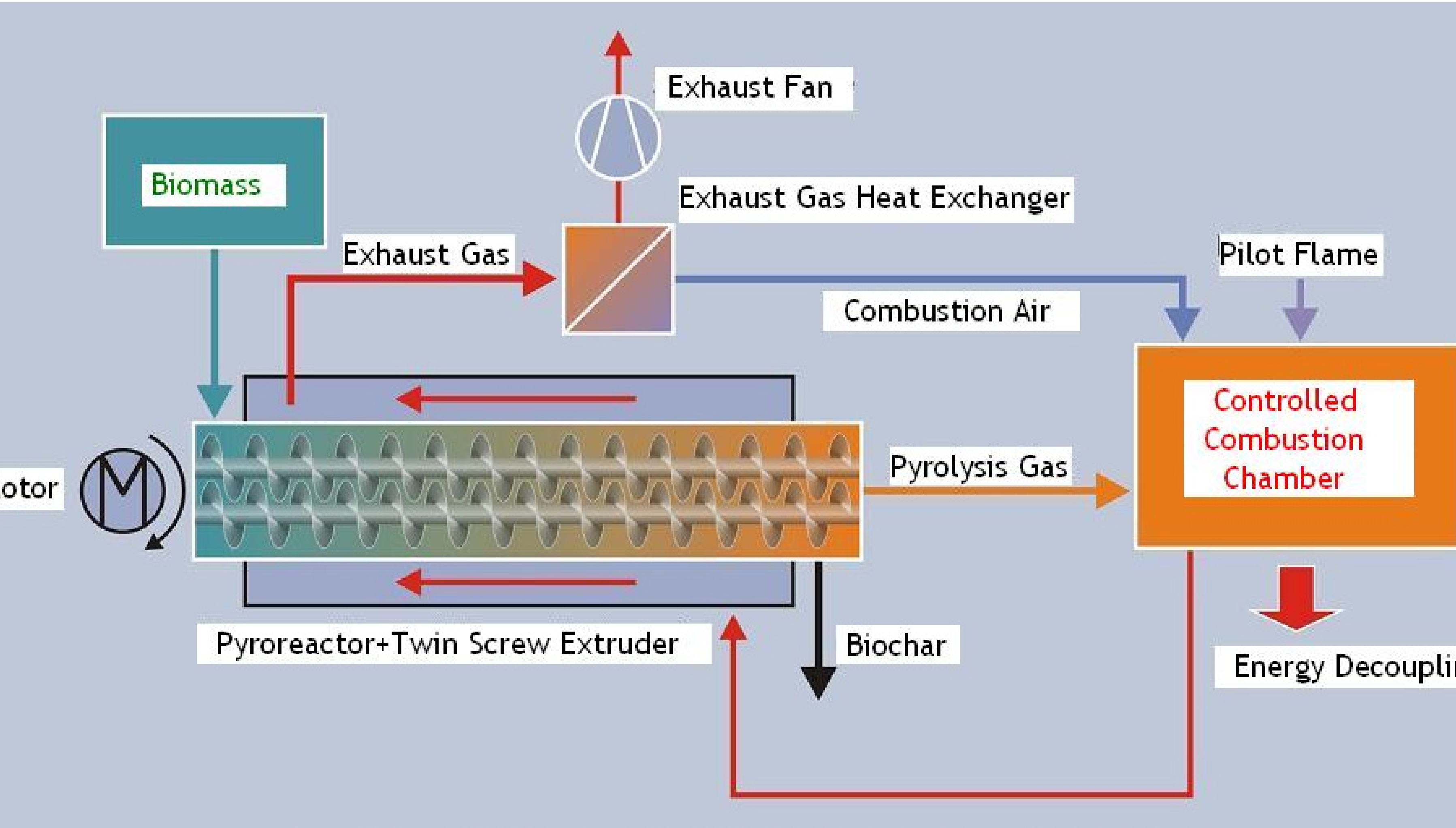
EXAMPLE of our work

Biomass to Biochar miscanthus before and after **Slow Pyrolysis**

Some facts about the current commercial Model 500 Slow Pyrolysis equipment operating on green waste

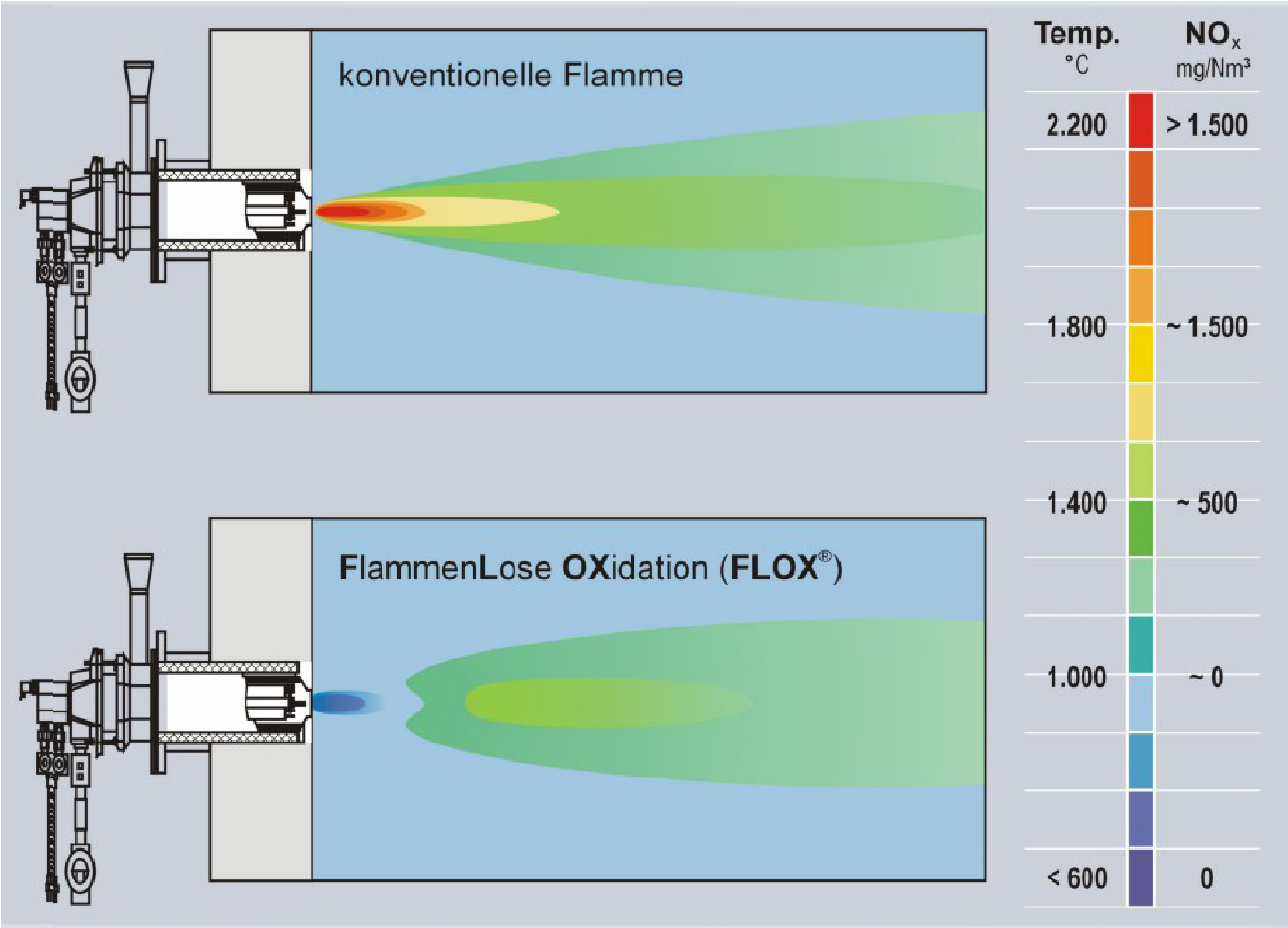
Key process and operational features

- Aims to maximise the yield of high quality biochar products, rich in fixed carbon, from a wide range of feedstock
- Burns all the syngas and tar type by-products of pyrolysis to produce useful heat
- Uses part of the heat to perpetuate the production of biochar
- To provide a multi-selection control system enabling the use of a wide range of biomass wastes
- Maintain low emissions and dust levels ensuring they remain well below regulations
- Export the spare heat for other applications

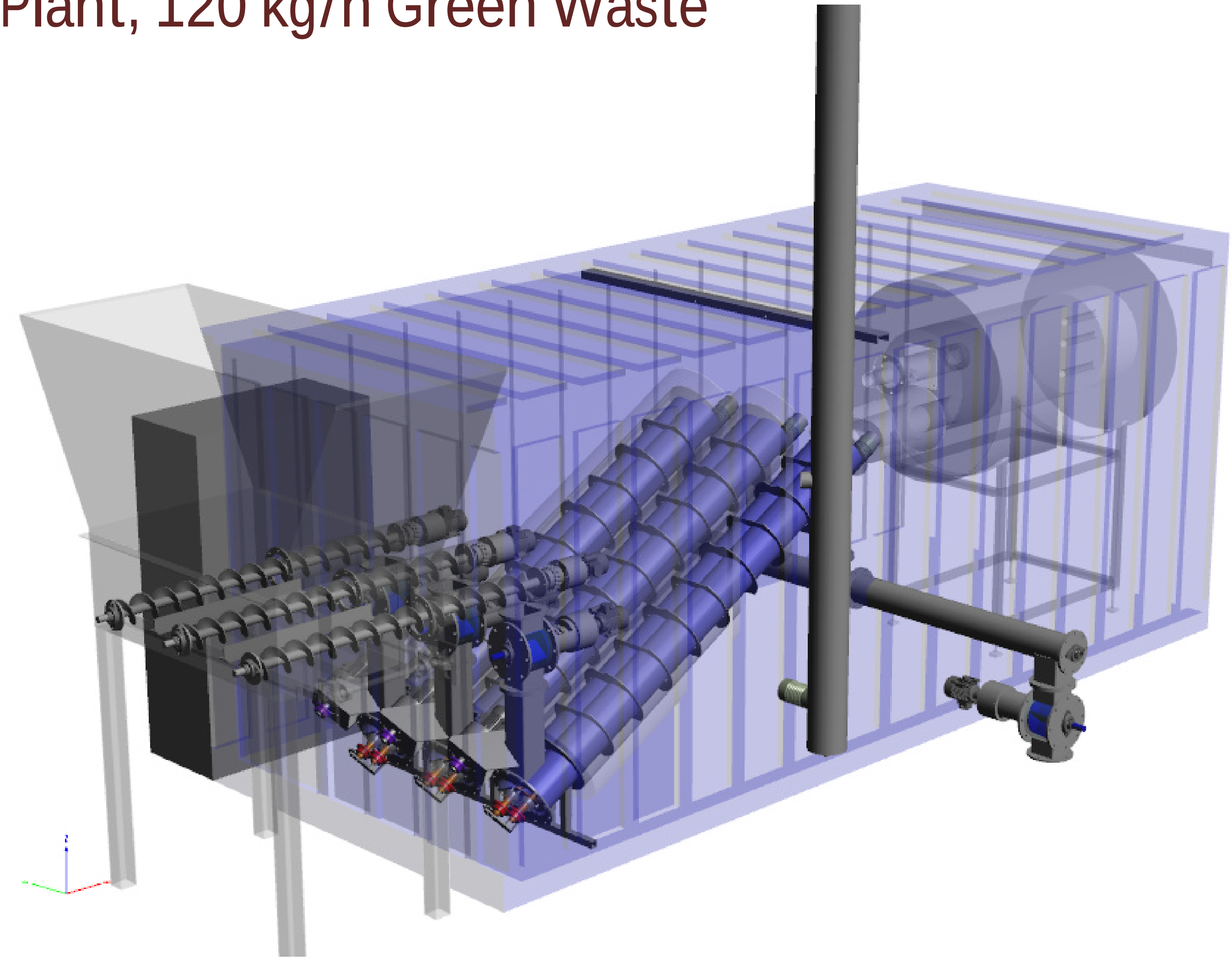


Schematic Diagram of a Pyrolysis Process to Produce Biochar

FLOX® - Flameless Oxidation in the Combustion Chamber



0.5 MW-Plant, 120 kg/h Green Waste



Pyrolysis reactor, Pyreg 500

In the pyrolysis reactor the biomass gets heated from 450 to 600°C. The long Carbon-molecules break up to syngas and biochar. It’s a continuous process.

All organic matter can be pyrolysed: green clippings, pomaces, wood, sewage sludge, dung, plastics.

The Pyreg 500 produces some 350 tonnes biochar per year.

f the 3.7 Million tonnes of grape pomace that are produced every year in the world would
oe transformed into biochar:

2.5 Million tonnes of CO_2 eq. could be saved

450 TWh thermal energy (T=x10^{15})

REG

Potential Global Importance

“There is one way we could save ourselves, and that is through the massive burial of charcoal”

James Lovelock originator of *Gaia theory*