Biochar: what are the prospects?

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A pilot biochar reactor in Gosford

When added to soils biochar has the potential to sequester (lock up) carbon for hundreds of years, reduce greenhouse gas emissions and improve agronomic performance. However, this potential remains to be proven which is why Industry and Investment NSW (I&I NSW) is undertaking research to quantify the potential benefits and drawbacks of biochar use in agriculture.

What is biochar?

Biochar is the charcoal like material produced by heating biomass in an oxygen-limited environment (www.anzbiochar.org).

There is growing interest worldwide in the use of biochar as a soil amendment. It has the potential to both sequester carbon and enhance agricultural productivity. Some biochars have been shown to be stable for hundreds of years in soil.

The biochars used in trials by I&I NSW were produced using BEST Energies' slow pyrolysis process, but a range of methods to produce biochars exist.

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What is slow pyrolysis?

Slow pyrolysis utilises a kiln that is heated externally to achieve temperatures of between 400 and 6000°C. The biomass is held at these temperatures for over 30 minutes. Slow pyrolysis yields two key products, biochar and syn gas. The syn gas is a high energy mixture of methane, hydrogen and carbon monoxide which is combusted to generate the heat required to dry and pyrolyse the biomass, with surplus gas being available to generate renewable energy, such as electricity.

What can be used to make biochar?

- Forestry and crop residues
- Poultry litter wastes
- Animal feedlot wastes and some biosolids
- Food and food processing wastes
- Some industrial wastes such as timber and papermill residues, and,
- Urban green waste

Are all biochars the same?

All biochars are different. The choice of feedstock and processing conditions play a major role in determining the qualities of the biochar (Table 1). For example, higher temperatures during production will give biochars with increased structure and higher stability in soil, but higher temperatures also lower the yield of biochar.

Table 1 Chemical analysis of three biochars

Feedstock	Poultry litter	Green waste	Papermill
N (%)	2.2	0.25	0.44
P (%)	2.4	0.049	0.11
K (%)	2.1	0.0072	0.047
Lime equivalency ($CaCO_3$ (%))	14	0.90	7.50
Total C (%)	35	66	37

produced at 550^{0}C

Some research findings from I&I NSW

Set-up November 2007

Sweet corn 2007/08

Faba bean 2008

Sweet corn 2008/09

Assessing the impact of biochar: establishing a randomised trial of different applications of biochar on crop yields of corn and faba bean.

Treatment (all plus fertiliser)	**Sweet corn2007/08** weight of cobs (t/ha)	**Faba bean 2008** dry bean (t/ha)	**Sweet corn 2008/09** weight of cobs (t/ha)
Poultry biochar (10t/ha*)	23.7	3.9	23.3
Papermill biochar (10t/ha)	25.7	3.9	27.3
Nil amendment	20.5	2.1	19.4

Table 2. Results from field trials at Wollongbar research station (red ferrosoil)

* Note: Single application of biochar incorporated into 0-10cm profile in November 2007. Fertiliser amendment to all plots upon sowing of sweet corn (400 kg/ha urea, 300 kg/ha single super, 140 kg/ha muriate of potash).

I&I NSW has over 160 field plots testing the impacts of biochar. Our work is in collaboration with Richmond Landcare, with funding from I&I NSW, Caring for our Country and NSW Climate Action Grants. Research plots include a range of cropping and horticultural enterprises: sub-tropical pasture, sweet corn/ legume rotation, sugarcane, macadamia and coffee.

Some biochars have been shown to increase soil pH in acidic soils, reduce toxic aluminium, improve water holding characteristics, reduce tensile strength of soil and improve nutrient availability. Biochar application has also been shown to significantly increase soil carbon stocks.

Biochar and greenhouse gas emissions

Tests using in-field chambers, field static chambers and laboratory studies are showing the potential of some biochars to reduce emissions of the potent greenhouse gas nitrous oxide. This gas can be produced when nitrogen fertilisers are applied to soil. Its loss to the atmosphere also means it is not available to the crop.

I&I NSW is working with a range of collaborators to determine the specific mechanisms driving nitrous oxide emissions and quantifying reductions in several farming systems.

Incubation studies by I&I NSW also show that biochar is stable when applied to soil. While this varies depending on the type of material used and the pyrolysis process, most biochars remain intact for between hundreds to thousands of years providing a very stable carbon sink.

A note of caution

If not produced using an appropriate pyrolysis process, biochar can contain contaminants. Producers should insist on an analysis of any biochar they obtain before applying it.

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