LANDSCAPE SOUTH AUSTRALIA MURRAYLANDS AND RIVERLAND

Farm-Scale Biochar Production

Making and using biochar to improve soil performance

Biochar is stable, carbon-rich form of charcoal that can be used as a soil amendment to improve soil fertility while also providing an efficient way to sequester carbon. Produced by burning organic material at a high temperature with little or no oxygen present, the resulting biochar is added to the soil to help retain water in the soil profile, increase soil fertility and reduce the leaching of nitrogen from the root zone.

With many landholders looking towards a more regenerative approach to farming, the benefits offered by biochar provide many benefits. This webpage provides an introductory guide to landholders interested in learning more about biochar and how it can potentially benefit their farming system.

Biochar: An ancient fertiliser

Biochar dates back to more than 2,000 years ago when farmers in the Amazon delta used char-rich soils helped to support Mayan populations. The Mayan would slash and burn patches of forest with the resulting char buried with manure, food and fish waste. After a year, these plots would then be planted with crops or trees. Many other native cultures around the world have a history of making biochar including Africa, India, Asia and even in Australia on the banks of the River Murray.

Soil made from the incorporation of char, plant matter, human waste and pottery shards is called terra preta, the Portuguese term for black earth. These dark rich soils, manufactured up to 2,000 years ago, are still highly functional today, with a depth of 1 metre or more.

Uses for biochar

Biochar has the ability to improve crop yield and quality in agriculture systems by improving fertility, retaining nutrients in the soil root zone, and improving the water holding capacity of soil. It can be used as a feed additive for livestock and mixed with bedding to improve animal health problems and reduce odours.

A trial site shows increased biomass where biochar has been incorporated

A tonne of biochar removes 2.88 tonnes of carbon dioxide from the atmosphere. Additionally, the production of biochar can reduce the amount of carbon lost to the atmosphere by reducing the volume of organic waste decomposing or being burned.

Biochar has an incredibly porous structure. A piece of biochar the size of a golf ball has the same surface area as a tennis court. This allows biochar to hold 5-10 times its weight in water, provides storage for a high volume of microbes and retains a high level of nutrients. Biochar has similar physical attributes to charcoal - it is black in colour, brittle and very lightweight.

What is biochar made from?

Biochar can be made from any organic biomass including on-farm waste. Organic material includes woody waste, weeds, grasses, hay, spent grain, animal bones, municipal waste, animal manure and green waste.

Higher temperature biochar lasts with in the soil for a very long time and is resistant to microbial breakdown, whereas lower temperature biochar can be broken down easier by microbes and is not as porous as high temperature biochar.

How is biochar made?

While the manufacturing of biochar can range in format from simple to complex, the basic principle underpinning the process is the same. Biomass is heated in an oxygen-free environment ranging in temperature from 350^{o}C to 1,000^{o}C, a process known as pyrolysis. As the biomass is heated it becomes volatile, forming a flammable gas. This gas makes pathways in the material causing pores to be formed.

In the initial stages of the burn, moisture in the biomass is driven off in the form of steam. Once steam production has concluded, clear or a light blue smoke will form. This contains wood vinegar - the part of the smoke that burns your eyes. In more elaborate biochar production systems you can capture this wood vinegar, along with bio oil (liquid) and syngas (gas).

How to make biochar on-farm - char made in an open pit

Wear the appropriate safety gear including non-flammable clothing, gloves and eye protection.

For an economical way to make biochar, dig a hole to suit the size of the material you want to char. Add the material and start a small fire. Once coals are produced, rake the coals to level them, add more biomass and continue the process. Once the pit is full of char, quench the coals with water, animal urine or a slurry of manure.

Chars quenched with urine or animal manures are considered charged and won't require any additional additives before being used. Quenching is important to prevent char from re-igniting, so be sure to dig through the char with spade to make sure no embers remain.

Pit kiln char

Biochar can be made using the same method but using a kiln for better mobility

Kiln-made biochar after being quenched with water

Top-lit updraft gasifier

With a top-lit updraft kiln, biomass is loaded in and the fire is started from the top. Any biomass can be used as long as it has a moisture content of less than 20%.

A top-lit updraft gasifier

Large batch biochar systems

Large scale ring biochar maker.

Large batch systems can handle larger volumes of biomass, but still involve a lot of manual labour.

Full of biochar after quenching

Continuous biochar plants

Continuous biochar plants are generally in a fixed position, but some transportable formats are in use. Material is either chipped or shredded and fed into the machine via a hopper. At this scale, produced syn gas can be used to produce energy by using a combustion energy to power a generator. An additional benefit of closed-burn system is the ability to produce and capture wood vinegar which can be used as both a herbicide and early-stage fertiliser depending on the dilution

rate.

A transportable continuous biochar machine

Other resources include the waste heat which can also be captured and redirected, and hydrogen gas which can be used to power hydrogen gas engines.

Continuous biochar plants are able to be run by one person and allow farmers to convert farm waste into a suite of beneficial products. A tow-behind unit offers added flexibility, except where the system is hooked up to transfer electricity.

Using biochar on-farm

Before handling biochar, it is important to ensure you wear the appropriate personal protective equipment including gloves and a mask and avoid breathing in biochar dust. Biochar dust is combustible and should be handled only when damp to manage this risk. If the char is larger in size, it can be broken down by running it through a garden mulcher or a ball mill.

Uncharged biochar should be mixed with an organic source of biomass to turn it into biochar. An effective way to do this is to add the char to good quality compost. This will charge the char with nutrients and microbes and benefit the soil when added. Once combined, the char and compost should be left covered for a couple of weeks before being applied. Another way to charge the char is to quench the char with a diluted animal urine or a manure slurry. For soils that are significantly low in a certain nutrient, it can be beneficial to charge the char using liquid synthetic fertilisers or trace elements.

Raw biochar can also be used to capture and relocate excess nutrients. On dairy farms where manure and urine can be captured downstream of wash down areas, permeable bags of biochar can be used to capture nutrients. The resulting biochar can then be applied to a part of the farm

requiring a nutritional top-up, preventing off-farm loss of a valuable soil additive.

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More information

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