ithakajournal

viticulture ecology climate-farming
1|2012

55 Uses of Biochar

by Hans-Peter Schmidt

55 Uses of Biochar
by Hans-Peter Schmidt

Please cite the article as follows:
Schmidt HP
55 Uses of Biochar
Ithaka Journal 1/2012: 286–289 (2012)
www.ithaka-journal.net
Editor: Delinat-Institute for Ecology and Climate-farming, CH-1974 Arbaz
www.delinat-institut.org, www.ithaka-journal.net.
ISSN 1663-0521

Initially only used in agriculture, the range of uses for biochar now covers a wide range of different fields, giving this plant-based raw material the chance to make the most of its positive properties. Wherever biochar is specifically used even for industrial purposes, the carbon taken from the atmosphere in the form of CO_2 can be stored for long periods or at least used to replace fossil carbon sources.

Biochar is much too valuable and expensive for any farmer to be able to afford to spread 10 tonnes or more per hectare on his fields. Whereas a hectare will normally provide an annual benefice of EUR 1000, the EUR 8000 needed to purchase and spread the biochar would need to be amortised over several decades. The CO_2 certificates favoured by so many outside the trade would be of no much help either.

Does it really make sense to work biochar into fields?

These economic considerations are not so different from what the natives in the Amazon delta and Australia had to face when they used biochar to improve their soils, and where you will still find some places with over 100 tonnes of biochar buried into just one hectare of soil. Even if no money existed back in those days, it would have made no economic sense to cut down some 300 to 400 huge rain forest trees and then use ancient charcoal kilns to make some 100 tonnes of biochar from 2000 tonnes of wood – just to bury the biochar in the soil. And don't forget: all this would have been done without any chainsaws or axes and no animals to pull the logs close to the field.

The idea of applying dozens of tonnes of biochar to fields can only come from scholars who, on the basis of a right observation (50 t biochar per hectare) have arrived at a false conclusion completely without any practical relevance – i.e. the massive one-time application of biochar. And this is quite apart from the fact that no soil becomes Terra Preta just because tonnes of char have been ploughed in.

Example of Terra Preta Cultures

The char used back then was probably created in the typical hearths of the natives, in which not just ash but also relatively large amounts of charcoal were produced at relatively low heat (Smith 1999). This char, basically a waste product, was then apparently used as a way of preventing infectious diseases. This was done by regularly adding char to faeces and other waste in the large jungle settlements, thus sterilising them (see Terra Preta – Model of a Cultural Technique, Schmidt 2011). Once the organic waste had been stabilised through composting or fermenting it with added char, it was then used as a fertiliser on the fields. These methods led to the char being loaded with nutrients and its surface achieving

greater binding capability through oxidisation, with the consequence that, once worked into the soil, the char was able to fully unfold its function as a nutrient store and humus stabiliser (through the creation of char-clay-humus complexes).
According to investigations carried out by Bruno Glaser and colleagues (Birk et al 2007), the amount of phosphor in Terra Preta soils compared to natural soils in the immediate vicinity can be up to 500 times higher. Different to carbon and nitrogen, phosphor can not be accumulated in the soil through plant growth, but mainly through the manual addition of excrement, (fish-)bones and ash. A rough estimate shows that the char- stabilised organic waste of some 500 people must have been worked into every hectare of soil over a period of 1000 years to gain such Terra Preta nutrient contents. Terra Preta has been created over centuries through the secondary use of biochar for recycling organic wastes. In other words, it took centuries to bring the biochar content of the soil up to over 100 tonnes per hectare.

The many uses of biochar

Biochar is much too valuable for it to be just worked into the soil without having it used at least once for more beneficial purposes – whether as storage for volatile nutrients, as an adsorber in functional clothing, as insulation in the building industry, as energy storage in batteries, as a filter in a sewage plant, as a silage agent or as a feed supplement. Such uses can be followed by use in a farmer's slurry pit or in a sewage plant, before being composted. It should only be worked into the soil at the end of this "cascade", helping to create Terra Preta.
The following list of 55 possible uses of biochar is by no means complete. In fact it has only just been started. In the medium term biochar will (or must) replace oil as the main raw material of our industrial society, insofar as mankind is willing to maintain living conditions on the planet in the long term (see: Biochar – a key technology for the planet, Schmidt 2012).
We will initially just comment shortly on each usage of the list, as we intend to devote in-depth articles to some of them, highlighting in particular the use of biochar in agriculture and cattle farming and supporting the articles with the latest research findings. Biochar is without doubt one of the decade's most exciting fields of research, with findings and their practical implementation increasing exponentially from year to year. Nevertheless, however much we enthuse over our field of research and the importance of our findings, it's the real world that decides about its success.

The cascaded use of biochar in animal farming

1. Silage agent, 2. Feed additive / supplement, 3. Litter additive, 4. Slurry treatment, 5. Manure composting, 6. Water treatment in fish farming

At present some 90% of the biochar used in Europe goes into animal farming. Different to its application to fields, a farmer will notice its effects within a few days. Whether used in feeding, litter or in slurry treatment, a farmer will quickly notice less smell. Used as a feed supplement, the incidence of diarrhoea rapidly decreases, feed intake is improved, allergies disappear, and the animals become calmer. For in-depth articles on the use of biochar in cattle and poultry farming, see: Treating liquid manure with biochar, Schmidt 2012; Biochar in poultry farming, Gerlach & Schmidt 2012; The use of biochar in cattle farming, Gerlach 2012. Over 80 farmers in Germany, Austria and Switzerland are currently being surveyed with the aim of creating a statistic on the effects of biochar in animal farm. First results are expected in Mai 2013.

Use as a soil conditioner

7. Carbon fertiliser, 8. Compost, 9. Substitute for peat in potting soil, 10. Plant protection, 11. Compensatory fertiliser for trace elements

In certain very poor soils (mainly in the tropics), positive effects on soil fertility were seen when applying untreated biochar. These include the higher capacity of the soil to store water, aeration of the soil and the release of nutrients through raising the soil's ph-value. In temperate climates, soils tend to have a humus content of over 1.5%, meaning that such effects only play a secondary role. Indeed the high adsorption of plant nutrients released in the soil can instead often have – at least in the short and medium term – a negative effect on plant growth. These are the reasons why in temperate climates biochar should only be used when first loaded with nutrients and when the char surfaces have been activated through microbial oxidation. The best method of loading nutrients is to co-compost the char. This involves adding 10–30% biochar to the biomass to be composted (see: Ways of Making Terra Preta: Biochar Activation, Schmidt 2012). The co-composting of biochar results not only in a valuable soil conditioner. The compost can be used as a highly efficient substitute for peat in potting soil, greenhouses, nurseries and other special cultures.
When biochar is used as a carrier for plant nutrients, efficient mineral and organic long-term fertilisers can be produced. Such fertilisers prevent the leaching of nutrients, a negative aspect of conventional fertilisers. The nutrients are available as and when the plants need them. Through the stimulation of microbial symbiosis, the plant takes up the nutrients from the porous carbon structure. Through mixing biochar with such organic waste as wool, molasses, ash, slurry and pomace, organic carbon-based fertilisers can be produced. These

are at least as efficient as conventional fertilizers, and have the advantage of not having the well-known adverse effects on the ecosystem.
The biochars contain all trace elements originally contained in the pyrolised biomass. During pyrolysis, the crucial trace elements (over 50 metals) become part of the carbon structure, thereby preventing them being leached out and making them available to plants via root exudates and microbial symbiosis. This feature can be used specifically when certain trace elements are missing in a certain regional soil or in soil-free intensive cultures such as "Dutch tomatoes".
A range of by-products are produced during pyrolysis. These remain stuck to the pores and surfaces of the biochar and in many cases have the ability to mobilise plant's internal immune systems, thereby increasing its resistance to pathogens (Elad et al. 2011). This potential use is however only just now being developed and still requires a lot of research effort.

Use in the building sector

12. Insulation, 13. Air decontamination, 14. Decontamination of earth foundations, 15. Humidity regulation, 16. Protection against electromagnetic radiation ("electrosmog")

Two of biochar's properties are its extremely low thermal conductivity and its ability to absorb water up to 6 times its weight. These properties mean that biochar is just the right material for insulating buildings and regulating humidity. In combination with clay, but also with lime and cement mortar, biochar can be added to sand at a ratio of up to 50%. This creates indoor plasters with excellent insulation and breathing properties, able to maintain humidity levels in a room at 45–70% in both summer and winter. This in turn prevents not just dry air, which can lead to respiratory disorders and allergies, but also dampness through air condensing on the outside walls, which can lead to mould developing (see Biochar as building material for an optimal indoor climate, Schmidt 2013).
Such biochar-mud plaster adsorbs smells and toxins, a property not just benefiting smokers. Alongside their use in housing, biochar-mud plasters are particularly good for warehouses, factory and agricultural buildings as well as in schools and other rooms frequented by people.
Biochar is a very efficient adsorber of electromagnetic radiation, meaning that biochar-mud plaster is very good at preventing "electrosmog".
Biochar can also be applied to the outside walls of a building by jet-spray technique mixing it with lime. Applied at thicknesses of up to 20 cm, it is a substitute for styrofoam. Houses insulated this way become carbon sinks, while at the same time having a more healthy indoor climate. Should such a house be demolished at a later date, the biochar-mud plaster can be recycled as a valuable compost additive.
Together with the German company Casadobe, the Delinat Institute is currently developing a range of biochar-mud plasters, expected to be available on the market in mid-2013.

Decontamination

17. Soil additive for soil remediation [for use in particular on former mine-works, military bases and landfill sites.]
18. Soil substrates [highly adsorbing, plantable soil substrates for use in cleaning waste water; in particular urban waste water contaminated by heavy metals]
19. A barrier preventing pesticides getting into surface water [Sides of field and ponds can be equipped with 30-50 cm deep barriers made of biochar for filtering out pesticides.]
20. Treating pond and lake water [Biochar is good for adsorbing pesticides and fertilizers, as well as for improving water aeration.]

Biogas production

21. Biomass additive, 22. Biogas slurry treatment

First tests show that, through adding biochar to a fermenter's biomass (especially heterogeneous biomasses), the methane and hydrogen yield is increased, while at the same time decreasing CO_2 and ammonia emissions (Inthapanya et al. 2012; Kumar et al. 1987).
Through treating biogas slurry with lacto-ferments and biochar, nutrients are better stored and emissions prevented (see (in German): The sustainable production of biogas through climate farming, Schmidt 2012)

The treatment of waste water

23. Active carbon filter, 24. Pre-rinsing additive, 25. Soil substrate for organic plant beds, 26. Composting toilets,

The treatment of drinking water

27. Micro-filters, 28. Macro-filters in developing countries

Divers other uses

Exhaust filters *(29. Controlling emissions, 30. Room air filters)*
Industrial materials *(31. carbon fibres, 32. plastics)*
Electronics *(33. semiconductors, 34. batteries)*
Metallurgy *(35. metal reduction)*
Cosmetics *(36. soaps, 37. skin-cream, 38. therapeutic bath additives)*
Paints and colouring *(39. food colorants, 40. industrial paints)*
Energy production *(41. pellets, 42. substitute for lignite)*
Medicines *(43. detoxification, 44. carrier for active pharmaceutical ingredients)*

Textiles

45. Fabric additive for functional underwear, 46. Thermal insulation for functional clothing, 47. Deodorant for shoe soles

In Japan and China bamboo-based biochars are already being woven into textiles (Lin et al. 2008) to gain better thermal and breathing properties and to reduce the development of odours through sweat. The same aim is pursued through the inclusion of biochar in inlay soles and socks.

Wellness

48. Filling for mattresses, 49. Filling for pillows

Biochar adsorbs perspiration and odours, shields against electromagnetic radiation (electrosmog), and removes negative ions from the skin. Moreover, it acts as a thermal insulator reflecting heat, thereby enabling comfortable sleep without any heat build-up in summer. In Japan, pillows have been filled with biochar for a long time. This is supposed to prevent insomnia and neck tension.

50. Shield against electromagnetic radiation

Biochar can be used in microwave ovens, television sets, power supplies, computers, power sockets, etc. to shield against electromagnetic radiation. This property can also be used in functional clothing as protection for parts of the body particularly sensitive to radiation.

All of the proposed biochar uses except nos. 35, 41, 42 are carbon sinks. After its initial or cascading use, the biochar can be recycled as a soil conditioner. Fully depreciated when finally returned to the soil, the black carbon will slowly build up in the soil – and over a few generations the soil's biochar content could easily reach 50 to 100 t per ha.

We have listed 50 possible uses of biochar. But the title refers to 55 uses … This is to be seen as an indication of our intention to keep on adding to the list over the coming weeks and years, as experience builds up. We can also be sure that the author has missed out a number of uses already available today (the first version of this article only contained 44 possible uses)

References

Birk J, Grosch H, Neves E, Teixeira W, Glaser B (2007): *Rekonstruktion von Besiedlungsmuster und -intensität einer Terra Preta anhand der kleinräumigen Nährstoffverteilung,* Mitteilungen der Deutschen Bodenkundlichen Gesellschaft 110:643–644

Elad, Y, D RDavid, Y M Harel, M Borenshtein, H B Kalifa, A Silber, and E R Graber. 2010. *Induction of systemic resistance in plants by biochar, a soil-applied carbon sequestering agent.* Phytopathology 100 (9): 913–921

Gerlach A: *The use of biochar in cattle farming.* Ithaka Journal 2012:281–285 (2012)

Gerlach H, Schmidt HP: *Biochar in poultry farming.* Ithaka Journal 2012: 262–264 (2012)

Inthapanya, Sangkhom, Preston T R, und Leng R A. 2012. *Biochar increases biogas production in a batch digester charged with cattle manure.* http://www.lrrd.org/lrrd24/12/sang24212.htm

Kumar, S., M. C. Jain, und P. K. Chhonkar. 1987. *A note on stimulation of biogas production from cattle dung by addition of charcoal.* Biological wastes 20 (3): 209–215.

Lin, C M, und C W Chang. 2008. *Production of thermal insulation composites containing bamboo charcoal.* Textile Research Journal 78 (7): 555–560

Schmidt HP: *Pflanzenkohle – eine Schlüsseltechnologie zur Schließung der Stoffkreisläufe,* Ithaka Journal 2012: 75–79 (2012)

Schmidt HP: *Treating liquid manure with biochar.* Ithaka Journal 2012, 273–276 (2012)

Schmidt HP: *Biogas durch Klimafarming nachhaltig produzieren,* Ithaka Journal 2012: 61–66 (2012)

Schmidt HP: *Ways of Making Terra Preta: Biochar Activation,* 2012, http://bit.ly/XlKA5I

Schmidt HP: *Terra Preta – Modell einer Kulturtechnik,* Ithaka Journal 2011: 117–121 (2011)

Schmidt HP: *Biochar as building material for an optimal indoor climate,* Ithaka Journal 2013: x–y (2013)

Smith NJH (1980) *Anthrosols and human carrying capacity in Amazonia.* Ann Assoc Am Geogr 70:553–566

Smith NJH (1999) *The Amazon River forest: a natural history of plants, animals, and people.* Oxford University Press, New York