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Biochar – Sustainability, Certification and Legislation

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Introduction

Biochar can be produced with a wide variety of physical and chemical characteristics, depending on the feedstock and operational conditions. Much progress has been achieved and substantial research is still ongoing on the way such factors determine the properties of the resulting biochar. Soil is also highly heterogeneous in nature and its properties can vary widely both in space and time. It is recognized that the effects of biochar on soils, as well as on the wider ecosystem/ecotope and socio-economic landscape may be positive, negative or not yet fully quantified [1]; see Table 1. This paper conceptually discusses how biochar properties may be matched to soil (and wider ecotope) properties as well as relevant socio-economic conditions, as part of a biochar certification procedure.

Results and Discussions

Sustainability

For biochar to be considered as a sustainable policy option, it is essential to extend R&D to cover all soil functions comprehensively and at several spatio-temporal scales. In addition, R&D needs to be representative of the natural and socio-economic conditions of any site (physical area) under consideration for policy development. Beyond representation of current conditions, true sustainability should be shown by preliminary modelling of expected changes in natural (i.e. climate change), land use (incl. soil/crop management) and socio-economic conditions of any site under consideration, for the same period as the expected functional lifetime of biochar in the different soils of that site.

Table 1 Potential interactions and effects of biochar on soil and the wider ecotope/system, for which a comprehensive evidence base is not available; adapted from [1]

Long-term effects of modern biochars in soils under modern arable management
C Negativity
Effects on N cycle
Biochar Loading Capacity (BLC)
Environmental behaviour mobility and fate
Distribution and availability of contaminants (e.g. heavy metals, PAHs) within biochar
Effect on soil organic matter dynamics
Pore size and connectivity
Soil water retention/availability
Soil compaction
Priming effects
Effects on soil megafauna
Hydrophobicity
Enhanced decomposition of biochar due to agricultural management
Soil Albedo

Certification/legislation

Certification should extend beyond a technical description of the biochar material, i.e. it should include the natural and social context that biochar would be applied in (Figure 1).

We should aim to get to a point where biochar certification reads (in simple term): This biochar:

- has properties A, B, C
- is appropriate for ecotopes with properties D, E, F
- to grow crops G, H, I
- at biochar application rates of J t ha^{-1} yr^{-1} every K years to L t ha^{-1} yr^{-1} every M years,
- up to a maximum biochar loading capacity of N gBiochar $kgSoil^{-1}$.
- Etc.

In addition, socio-economic impact assessments should be performed, as part of the certification procedure, for scenarios of possible combinations of the above-mentioned factors.

In many cases, it is expected that too few relevant primary soil data (i.e. measured directly, not inferred), will be available at the required spatial resolution. Therefore, in these cases, requirements for soil testing will have to be described as part of the certification procedure. The methodological design of soil testing should be informed by the range of potential biochar properties for a specific site.

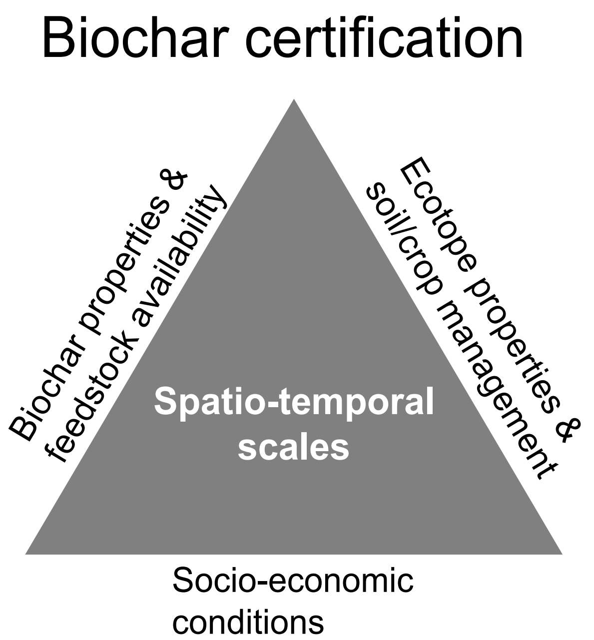

Figure 1. Conceptual diagram of factors that require integration ('critical matching') into a biochar certification procedure

Conclusions

Biochar certification should extend beyond characterizing biochar properties (the production process and subsequent biochar properties) to include suitable ecotope factors (e.g. soil physicochemical properties, geomorphology, hydrology and climate) as well as land management (crop type/rotation and soil management). Therefore, the definition of biochar certification should include the 'critical matching' of biochar properties to combinations of ecotope factors and land management options.

In a sense, the greatest strength of the biochar concept is also its greatest weakness.

Its relatively long mean residence times in soils (100s of years) make it a potential instrument of sequestering carbon (climate change mitigation). At the same time, it may improve one or more soil functions while avoiding deleterious effects (if managed appropriately and carefully, i.e. critical matching is achieved). However, that same long mean residence time sets biochar apart from more conventional soil amendments (i.e. fertilizers, lime, 'fresh' organic matter) that are considered as transient in the soil, with functional lifetimes of 1-10s of years. The functional lifetime of biochar in soils essentially moves biochar from the soil management box to the geoengineering box. While biochar may be considered as 'soft geoengineering' (i.e. ecosystem manipulation) in contrast to 'hard geoengineering' (e.g. putting mirrors in space to reflect sunlight away from the Earth), it can be considered 'hard' in terms of reverse-engineering. That is, it can be very difficult, or it takes a long time, to remove the biochar from the soils again if at any time that might become desirable.

Therefore, biochar deserves a sophisticated certification procedure, where biochar properties are matched to ecotope and socio-economic conditions at appropriate spatial scales, as well as modelled at temporal scales similar to the expected functional life time of biochar in soils at a particular site.

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[1] Verheijen, F.G.A., Jeffery, S., Bastos, A.C., van der Velde, M., and Diafas, I. (2010). Biochar Application to Soils - A Critical Scientific Review of Effects on Soil Properties, Processes and Functions. EUR 24099 EN, Office for the Official Publications of the European Communities, Luxembourg, 149pp. http://eusoils.jrc.ec.europa.eu/esdb_archive/eusoils_docs/other/EUR24099.pdf