Biochar and circular agricultural systems: an application to Viticulture production system

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Abstract

Biochar is a carbon-rich product resulting from the pyrolysis combustion of biomass, which has the ability of both trapping soil carbon and improving its properties, mainly by preventing erosion and water draining. It has also the ability to restore essential organic matter lost with the removal of biomass from agricultural systems. Biochar has been experienced from a long time by Amazonian communities, allowing to preserve their soil by the " terra preta " ancestral practices. Moreover, as it can be produced by burning biomass wastes, it can contribute to the promote circular agroeconomic systems. It can also give another source of income to the agricultural sector by providing a supplementary energy source and soil amendment through its production of heat and of bio-oil by- products.

Biochar techniques have been experienced in various contexts, using different pyrolysis techniques and biomass inputs (mainly, waste and agricultural residues), on different soils and in different agricultural contexts. The aim of this paper is (i) to evaluate the economic feasibility of Biochar and its different advantages, which go far beyond its direct valuation through current techno-economic

analysis, (ii) to assess its ability to promote circular economy at different farm levels (iii) to present a project, the REVIVFI project, launched in the French Centre Val de Loire region, which proposes to implement Biochar production and use in vineyard, in order to remediate long term soil pollution by the Bordeaux mixture.

- A literature survey on Biochar exhibits a huge diversity of results, related to the production technique of biochar, the nature of the soils on which it is used, and the different technical configurations implemented, slow pyrolysis being the most widely used.

For the use of Biochar as an agricultural soil improver, its benefits are highly dependent on the nature of the soils concerned: while Biochar's ability to improve the soil's capacity to retain moisture and nutrients is undeniable, this capacity mainly concerns degraded soils.

The benefits of adopting Biochar as a soil amendment go farther than its only direct agricultural gains. They have to be calculated over a long-term scale, as its ability to sequester carbon in the soil persists over a long time. This property allows it to be considered as a powerful Carbon Dioxid Removal (CDR) technique. Another benefit lies in its ability to

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prevent water erosion, pollutant infiltration (mainly, Nitrogen) and fertilizer persistence in the soil. Biochar appears as a powerful tool to improve soil quality at a low cost, jointly with improved seed varieties and SWC (Soil and Water Conservation) techniques.,All these benefits are difficult to evaluate, but are necessary to realize a comprehensive cost/benefits analysis of biochar.

(ii)The economic and environmental benefits of Biochar are mainly depending on whether it is produced locally, on a scale that can vary, or purchased from external suppliers. Their economic valuation needs also to take account of its contribution to a circular economy scheme, at various scale, from farm small production units to large-scale industrial units using urban wastes. The economic balance of different projects depends highly on their ability to be included in local circular economy networks. A large number of studies are devoted to various configurations where biochar is produced locally, mainly from agricultural waste, in units of varying size, with recovery of the heat produced by combustion to meet the needs of the farm, and optimization of the fertilizers and biochar composition. More specific uses for biochar have also to be considered, notably for the polluted or degraded land remediation as the REVIVIFI case study. Then considering a circular economy approach improves the cost/benefit balance of biochar and will make it a decisive factor in the search for new agro-ecological practices. (iii)The REVIVIFI regional project lies in a case study on the implementation of biochar production using vineyard wastes (vine shoots, grape marc, other wastes). Biochar will be incorporated in the soil and then will fix copper residues incorporated in the soil after years of Bordeaux mixture use. Moreover, the biochar pyrolysis burning produces bio-oil by-products, which can be used as soil amendment, improving its ability to fix copper. The REVIVFI Project will assess the gains linked to the use of Biochar use in vineyard, in different soils and landscape contexts, from an agronomic and an economic point of view.

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