A meta-analysis on terrestrial bio-pumps – sequestering carbon in soils while producing sustainable biomass streams for the bioeconomy

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Healthy and productive soils are a pre-condition to succeed in the global challenge of sustainably feeding a growing population[1], a challenge reflected by the Sustainable development Goal #2[2]. Because of the well-acknowledged importance of soil organic carbon to soil fertility[3,4], the emergency of stabilizing global temperature increases to 1.5°C (from pre-industrial levels)[5] and the ambition to replace part of the fossil carbon by biogenic carbon[6,7], the ability of some terrestrial biomass to induce a net carbon transfer towards the soil carbon pool must be better understood. These are herein referred to as bio-pumps. Albeit several individual field experiment data and simulation models quantifying the carbon sequestration over time of some bio-pumps (e.g. tall *Festuca* species, specific *Miscanthus* species, alfalfa, deep-root species such as *Brachiaria*) do exist, no clear insights on their performance parameters are available, in the perspective of their role into the future European bioeconomy (in terms of both carbon sequestration and biomass production, but also environmental including biodiversity, land & water use). This knowledge gap restricts soil carbon management policy and limits the development of a potentially important climate mitigation solution.

In an endeavour to bridge this gap, our work presents a state-of-the-art meta-analysis investigating the key parameters upon which the performance of these bio-pumps is dependent. Through a stringent protocol involving seven selection criteria, we searched the literature on studies reporting the yield and soil carbon changes of any bio-pump species that have been reported to grow under Western European conditions. Three search engines were used (Web of Sciences Core Collection, Scopus and Google Scholar), including peer-reviewed articles as well as gray literature, following the best practices described by[8] in order to cover a maximum of the relevant literature without a priori judgements on study quality.

The key research questions to be answered by this work in progress are as follows: (i) What are the biomass species that could allow inducing a net carbon sink in European soils, what sequestration ranges could be expected towards 2050 and what would these mainly depend upon?; (ii) What biomass yield could be obtained and what biomass composition could be expected at harvest?; and finally (iii) Are there any environmental risks that can be foreseen from the broad deployment of the bio-pumps identified in (i), what are their extent and how could these be limited?

We expect this work to have a major impact on the development of local and national bioeconomy strategies over Europe. The vision is that its findings can be, in subsequent work, translated into detailed geo-localized analyses for France and Denmark (among others), allowing to propose which bio-pump specie should be cultivated and where, and a quantification of the net resulting carbon sink over time.

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