Geophysical Research Abstracts
Vol. 20, EGU2018-1233, 2018
EGU General Assembly 2018

Assessing the importance of perennial crops for agricultural biogeochemical cycles

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Perennial crops represent 30% of the global cropland area. However, the positive effect of biomass storage on net GHG emissions has largely been ignored. Agriculture is one of the main sources of greenhouse gas (GHG) emissions, but is also the only sector which has significant potential for negative emissions through offsetting via the supply of feedstock for energy and sequestration in biomass and soils. Indeed, perennial crops, including trees, are the main candidates to fulfil that function. The term perennial crops is an umbrella term that includes food corps, bioenergy, bio-products, animal feed crops and short rotation coppice. In every case, perennial crops impact directly on the global carbon (C) and nitrogen (N) cycles mainly by four processes: a) storing biomass, b) potentially reducing the use of fertilizers, c) adding below-ground carbon to the soil and d) avoiding annual soil disturbance. Additionally, bioenergy crops have an important role in substituting fossil fuel products for energy generation, an important indirect impact on C and N cycles. One reason that the positive effects of perennial crops are under-represented in the literature may be the inconsistency in methods of accounting for C and N dynamics in the plant and soil, and their interactions with the atmosphere. This is exacerbated by the lack of modelling approaches for perennial crops. Recent developments have provided calculators for C and N biomass accumulation, soil dynamics, and tools to assess the impact of bioenergy as an energy source substituting fossil fuels. Most of these tools incorporate different management options to allow the effect of perennials on the C and N cycles under different managements and scenarios for climate change mitigation to be examined.

In this study, we will first summarise the effects of perennial crops on the C and N cycles, then, using examples, we describe a set of available tools to analyse the impact of perennials, not only on the C and N cycles, but also on agricultural GHG emissions. Finally, we quantify the potential of perennial crops and trees present and planted in agricultural lands as a climate change mitigation option.