



## Discussion

## Soil carbon sequestration is a climate stabilization wedge: Comments on Sommer and Bossio (2014)

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## ABSTRACT

Sommer and Bossio (2014) model the potential soil organic carbon (SOC) sequestration in agricultural soils (croplands and grasslands) during the next 87 years, concluding that this process cannot be considered as a climate stabilization wedge. We argue, however, that the amounts of SOC potentially sequestered in both scenarios (pessimistic and optimistic) fulfil the requirements for being considered as wedge because in both cases at least 25 GtC would be sequestered during the next 50 years. We consider that it is precisely in the near future, and meanwhile other solutions are developed, when this stabilization effort is most urgent even if after some decades the sequestration rate is significantly reduced. Indirect effects of SOC sequestration on mitigation could reinforce the potential of this solution. We conclude that the sequestration of organic carbon in agricultural soils as a climate change mitigation tool still deserves important attention for scientists, managers and policy makers.

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## 1. Discussion letter

Sommer and Bossio (2014) present an interesting paper showing how the potential of soil organic carbon (SOC) sequestration in agricultural land for mitigating climate change in the next 87 years is very limited at the global scale. We consider that, while the contribution of carbon sequestration in agricultural land could have been overestimated (Smith, 2012), the message of this paper is disproportionately pessimistic, even accepting the estimations made in the study as they are. We argue that carbon sequestration is still a fundamental tool for climate change mitigation (and also adaptation) and the interpretation of the data by Sommer and Bossio is excessively negative because:

- 1) The main conclusion of this short communication is that SOC cannot be considered as an “stabilization wedge” as defined by Pacala and Socolow (2004). However this definition includes two acceptations: “Strategies available to reduce the carbon emission rate in 2054 by 1 GtC/year or to reduce carbon emissions from 2004 to 2054 by 25 GtC”. The scenario 2 (optimistic) proposed by Sommer and Bossio largely fulfil the second

conditions with 50.6 GtC sequestered in the next 50 years (2014–2064 period) and the most pessimistic is very close (24.8 GtC). These numbers also represent a significant fraction of the 100 GtC drawdown through reforestation and increase of soil carbon proposed by Hansen et al. (2013) to contribute to the goal of keeping global temperature within the Holocene range.

- 2) Authors have used one of the most pessimistic IPCC scenarios (SRES-A2) of future global emissions. This scenario is unrealistic in terms of population projections, as it assumes that population will reach 15.1 billion in 2100. By contrast, the most recent UN projection establishes an 80%-probability range of 9.6–12.3 billion by 2100 (Gerland et al., 2014). The relative contribution of carbon sequestration to mitigation would be higher if it is compared to scenarios with lower emission levels. For example, cumulative 1990–2100 fossil fuel emissions estimated in B2 scenario are 1160 GtC, as compared to 1773 GtC in A2 scenario. Therefore, the 2014–2100 contribution to mitigation of the optimistic and pessimistic scenarios proposed by Sommer and Bossio (2014) would rise, respectively, from 3.9% and 1.9% in the A2 scenario to 6.5% and 3.3% in the B2 scenario. It is true, however, that the wedges needed to stabilize the climate in the Pacala and Socolow (2004) approach where based on a “business as usual” emission rate growth that has been considered too low looking at the recent increasing contribution of some fossil fuels such as coal (Hoffert, 2010). This implies, however,

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that there is a need to add more wedges to the mitigation strategy, besides maintaining the wedges already identified.

- 3) Even if the peak sequestration timing arrives in about 20 years, as estimated by Sommer and Bossio (2014), it is nowadays when climate change mitigation is most important in order to avoid the onset of slow climate feedbacks that could lead to dangerous warming and potentially to irreversible climate change (Hansen et al., 2013). In this context, avoiding higher cumulative emissions along the whole century is not as important as to avoid trespassing critical atmospheric CO<sub>2</sub> concentration thresholds that might be reached in very few years unless large mitigation efforts are urgently made. Therefore, an intensification of mitigation practices in the next decades is crucial.
- 4) In particular, positive feedbacks between climate and soil carbon, through enhanced soil respiration driven by increased temperature (Bellamy et al., 2005; Davidson and Janssens, 2006; Dieleman et al., 2012), may turn the soil into a source of CO<sub>2</sub>. On the other hand, enhanced plant production driven by increased atmospheric CO<sub>2</sub> concentration (Polley et al., 2012; Dieleman et al., 2012) implies that potentially more C sources might be available for soil application. CO<sub>2</sub>-enhanced vegetation growth has already contributed significantly to lower the atmospheric CO<sub>2</sub> concentration (Shevliakova et al., 2013). Agricultural management should promote this negative feedback in order to counteract the effect of increased decomposition rates and associated carbon emissions.
- 5) Mitigation efforts should be done in all economic sectors, so comparisons of measures in individual sectors with the totality of anthropogenic emissions may be misleading. With the progressive inclusion of carbon sequestration in the life cycle assessment of crop product carbon footprints, an increasing number of studies is showing how a good management of organic carbon in agroecosystems can completely off-set all other life cycle emissions of crop production systems, potentially leading to carbon neutral crop products. For example, this has been observed in apples (Venkat, 2012), vineyards (Bosco et al., 2013) and olives (Aguilera et al., 2014).
- 6) The organic matter management practices that lead to carbon sequestration can also reduce N<sub>2</sub>O emissions in some regions of the world such as Mediterranean (Aguilera et al., 2013a), as well as contributing to the reduction of synthetic fertilizer use and its associated emissions. In this and other regions where the soil organic matter is very low, the mitigation of climate change achieved by carbon sequestration is not only high but can also have many benefits regarding climate change adaptation (Aguilera et al., 2013b; Kahiluoto et al., 2014). In addition, as Sommer and Bossio (2014) point out, other potential positive side effects of carbon sequestration could be expected regarding agroecosystems functioning and productivity (e.g. Montanaro et al., 2009, 2012; Lal et al., 2011; Srinivasarao et al., 2012; Kahiluoto et al., 2014). These effects should be studied in conjunction with carbon sequestration when estimating the mitigation potential. For example, productivity gains may affect the greenhouse gas balance both directly, through the fixation of more carbon that improves the ecosystem carbon balance and can be applied to the soil to increase carbon sequestration, and indirectly, reducing land requirements and associated land use changes (Burney et al., 2010; Lobell et al., 2013).

We therefore conclude that soil carbon sequestration can be still considered as a “stabilization wedge” among many other mitigation options and that this subject still deserves important attention for

scientists, managers and policy makers.

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