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Interactive comment on "Positive trends in organic carbon storage in Swedish agricultural soils due to unexpected socio-economic drivers" *by* C. Poeplau et al.

C. Poeplau et al.

christopher.poeplau@slu.se

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1. The methodology to determine SOC did not change over time. It has always been dry combustion using a LECO elemental analyser. To exclude a measurement bias, a sample from Inventory 1 was measured repeatedly over the years. The latter information was already included in the manuscript. We have added the following sentence: "Soil carbon concentrations of all inventories were measured in the same laboratory by dry combustion with an elemental analyser (LECO, St. Joseph, Michigan, USA)."

2. It is true that the increase in SOC concentration causes a decrease in bulk density. Referee 1 had a similar concern and we have added several sentences dealing with

that issue in the discussion. Generally, the following is true: A decrease in soil bulk density does not mean that less soil is present, it only means that sampling should be adjusted (deepened) to sample equivalent soil masses. This has not happened (sampling depth remained 20 cm), because bulk density was unfortunately not measured in any of the inventories. In fact, bulk density is a very variable soil property (intra-annually) and especially in agricultural soils. It is therefore always difficult if not impossible to resample the exact equal amount of soil (or layer of soil). But even if we would have to sample deeper in the less dense soil, it is likely that the concentration would not change, since the plough layer does often exceed 23 cm and it can be assumed that C concentration is more or less homogeneous in the plough layer. So how would we treat different bulk densities in our analysis to calculate stock changes: equivalent soil mass adjustment, which means that we would cut "theoretically" 1-2 cm of the "denser soil" to obtain the same masses. Then we would multiply the different bulk densities with different soil depth, which is completely equal (mathematically) with using the fixed depth and only one bulk density (the one of the less dense soil) (this is true when only one layer is investigated). Therefore, the stock change would not be different from the change in concentration, which means that the C stock change is real. However, estimating bulk density and stone content from the available information is quite uncertain, which is why we decided not to publish stock changes (which can become quite a political number) in this stage.

3. The results of this study will find their way into greenhouse gas reporting as a model validation. The modelling set up is currently renewed. This activity will lead to another scientific publication in which we would like to elaborate more the actual stock changes. In the moment, as discussed in the current version of the paper and the point above, we would not like to estimate SOC stock change just over the thumb, without considering any more detailed regional information about stoniness and bulk density. Here we rather attempted to show the existing positive trend (more relative) and link those to changes in agricultural management. We hope that the referee can follow us in this point.

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4. The observed situation (More horses=more ley=more soil carbon) is a very Swedish situation. In fact, most other European countries loose SOC, which is discussed in the paper. Reasons for that are: less perennial crops, less manure, climate change. In a global context, the increase in horses as driver for the expanding ley-area, as observed in Sweden, is probably rather exceptional. In other countries, there may be other drivers than horses for increasing the proportion of perennials in crop rotations. We added the following sentences to the manuscript: “In a global context, the explosion of the Swedish horse population may be exceptional and reflect the wealth of a rich country However, incentives for increasing the area of leys or other perennial crops may be also be provided elsewhere, e.g., by substituting annual crops grown for bioenergy by perennials. To cope with a steadily increasing food demand, the potential to increase the proportion of ley in global agriculture is limited. Other options, such as cover crop cultivation might be more realistic and were shown to have a comparable positive effect on SOC (Poeplau and Don, 2015).”

5. Heikkinen et al. (2013) report for the Finnish cropland soils a relative decrease of SOC by 0.4% yr-1 between 1974 and 2009. This is exactly the same change that Swedish agricultural soils observed in the other direction. As the first reason, Heikkinen et al. mention the conversion from permanent grasslands and crop rotation to cultivation of annual crops. Referee 1 has suggested being more quantitative in this aspect, so we compared the findings to other studies. On top of this discussion, we now added another sentence about the Finnish results. The whole section now reads: “The most likely explanation for the increasing trend observed for SOC is thus the increase in ley. When using the pedotransfer function reported by Kätterer et al. (2006) to estimate bulk density, the average SOC stock in the first Inventory was 66 Mg C ha-1 in 0-20 cm soil depth. The found annual increase of 0.38% would thus correspond to 0.25 Mg C ha-1. The proportion of ley and green fallow increased between 1991 and 2013 by 33%, so the expected change in SOC stock would be 0.17 Mg C ha-1, when the reported accumulation rate of Kätterer et al. (2013) (0.52 Mg ha-1) is considered. (Conant et al., 2001) reported an annual increase in SOC stock of 1

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Mg C ha-1after cropland to grassland conversion, which would account for 0.33 Mg C ha-1. The calculated accumulation of 0.25 Mg C ha-1 is the exact mean of those two estimates. Furthermore, Heikkinen et al. (2013) report an annual decrease in SOC of 0.4%, which corresponds to the annual increase of 0.38% found in our study. As the first reason for this decline, they mention significant changes from permanent grasslands and perennial crops to cultivation of annual crops. We conclude that attributing the increase in SOC to the increase in ley and green fallow area is reasonable."

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