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Impact of tillage intensity on carbon and nitrogen pools in surface and subsurface soils of three long-term field experiments

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Management options such as the intensity of tillage are known to influence amount and turnover of soil organic matter. However, less information is available about the influence of the tillage intensity on individual soil organic matter pools of different turnover dynamics analyzed for surface and subsurface soils. We took surface (0-5 cm) and subsurface (5-25 cm) soil samples from no tillage (NT), reduced tillage (RT), and conventional tillage (CT) systems of three long-term field experiments in Germany. The labile, intermediate and stable C and N pool sizes were determined based on the combined application of a decomposition experiment and a physical-chemical separation procedure. For the surface soils, we found higher stocks of the labile C and N pool under NT and RT compared to CT. In case of a change from conventional to no-tillage systems, our results indicate an increase of labile C and N pools for the analyzed agricultural surface soils from 8 to 18% of the organic C and from 10% to 21% of the total N after 19 to 21 years. This timespan should be taken into consideration within the evaluation of potential benefits from an increase in labile OM for nutrient supply and productivity especially within the development of more sustainably managed agro-ecosystems. The reverse effect was observed for the labile C pool in subsurface soils where an increase from 6 to 10% of the organic C with increasing tillage intensity was observed. Such increase might contribute to an improved nutrient supply in subsurface soils under intensive tillage systems. The intermediate C and N pools in the surface and the subsurface soils are with 76 to 84% of the organic C and with 75 to 83% of the total N quantitatively much more important for the OM dynamics than the stable or labile pools. However, only for the surface soils were the stocks of the intermediate N and C pools distinctly larger for NT than for CT. The stocks of the stable C and N pools were not affected by the tillage intensity but were positively correlated to the stocks of the clay-size fraction and oxalate soluble Al, indicating a strong influence of site specific mineral characteristics on the size of these pools. Our results imply soil depth-specific variations in the response of organic matter pools to tillage of different intensity. This indicates that the potential benefits of decreasing tillage intensity with respect to soil functions that are closely related to organic matter dynamics have to be evaluated separately for surface and subsurface soils.