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Assessment of soil mechanical preparation works during plantation phase in managed forests: impacts on soil organic carbon stocks at soil profile and stand level.

Edouard Quibel (1), Yoann Copard (2), Claudine Richter (3), François Elie (1), Lauric Cecillon (1,4), Catherine Collet (5), Michaël Aubert (1), and Fabrice Bureau (1)

(1) Ecodiv, University of Rouen, Rouen, France, (2) Morphodynamique Continentale et Côtière, University of Rouen, Rouen, France, (3) Office National des Forets, Fontainebleau, France, (4) Irstea, Grenoble, France, (5) LERFOB, INRA, Champenoux, France

Forest plantation is a major tool to implement adaptation strategies in response to climate change and wood production demand. Planting may be used to change tree species in order to produce Green House Gas-intensive materials with high substitution effects, implant tree species adapted to future climatic conditions. Plantation involves specific silvicultural operations, including soil preparation to enhance tree seedling establishment, especially by eliminating herbaceous competition. A first impact of soil preparation as tillage in cultivated soils is an immediate disturbance of soil structure and consecutively impact soil organic matter mineralization. Recently, innovative methods for soil preparation have been developed in managed French forests and are currently being evaluated. These methods use light-weighted, mechanical tools based on mini-excavator that perform soil preparation on a limited surface area at the forest stand level. These tools are the reversible scarifier® (SR) or the multifunction subsoiler® (SSM) working respectively up to 30 cm and 60 cm of depth. Soil preparation such as tillage in cultivated soils is known to be an unfavorable practice for soil carbon storage and increases risks of soil erosion (Carling et al., 2001). Managed forests are efficient ecosystems to store organic carbon (Lal, 2005).Soil Organic Carbon (SOC) stocks in managed forests are particularly affected when renewing stands, at clear-cut logging and after deep soil cultivation (Egnell et al.,2015).
The objective is to evaluate the consequences of soil mechanical preparation work (SR, SR+SSM) during the planting phase on SOC. This assessment takes into account the quantity and quality of SOC up to 60 cm deep in the mineral soil without neglecting the litter horizons. This project relies on the ALTER national experimental network, for ALTernative to hERbicides. This work presents the results obtained on the Alter site of Bord-Louviers (Normandy) characterized by a podzolic soil on silty-sandy alluvium with medium pebble load.
SOC stock up to 60 cm deep at the planting line is significantly different between SR and SSM treatments and the control. This difference cannot be interpreted only as a destocking by mineralization of SOC. Indeed, the use of the SR tool leads to the creation of non-worked inter-row but also to the elimination of the root systems of competing herbaceous vegetation by tearing in planting line, then to displacement of the collected roots to create windrows. This leads to a heterogeneity in spatial organization of the soil horizons at the stand level after mechanical work. Windrows have a superficial SOC stock's (O and mineral horizons until 10cm depth) significantly higher than inter-row or planting line. At this plot scale, taking account this spatial heterogeneity, superficial SOC stocks are not significantly difference between treatments and control. SOC quality was measured using Rock-Eval6 pyrolysis indices, Water Extractable Organic Carbon, KMnO4 extractable SOC. These parameters indicated a new distribution of labile and stable fractions within the soil profile in the worked area. In conclusion, it seems essential to take account the spatial heterogeneity induced by mechanical soil preparation to understand SOC stocks level and their quality at the stand level.