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Crop residue incorporation for increasing SOC stock. Is it worth it?

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In the last fifty years, soil organic carbon (SOC) in North-Eastern Italy decreased at rates ranging from 0.02 to 0.58 t ha/year as a consequence of the intensification and simplification of cropping systems. Most recently, the removal of crop residue for bioenergy production raises concerns about its potential impact on SOC evolution.
Crop residue incorporation has been included in the Recommended Management Practices (RMPs) for climate change mitigation, however, several doubts still remain on its actual effectiveness. Indeed, long term effects of residue incorporation on SOC stocks have been studied by many authors with apparently contrasting findings. Thus, given the pivotal role played by SOC on ecosystem services, investigating the effects of residues incorporation on soil quality constitutes a key step towards understanding soil processes and will help establish a rationale bioenergy production policy.
For this purpose, soil samples were taken from a long-term field experiment started in 1970, with three types of soil: sand, silt-loam and clay. The experiment design adopted implied a crop rotation including maize, wheat, and potatoes with only two types of residues management: incorporation and removal. The levels of nitrogen application were six (0, 50, 100, 200, 300, 400 kg ha-1) with a factorial combination with the residues management.
Residue incorporation affected significantly the carbon stock within the profile (0-70cm), with an average increase in carbon content from 60 to 67 t C ha-1 in 42 years (0.16 t C ha-1 y-1). In clay and silt-loam soils the C stock varied within the whole profile, with an increase in the upper layer (0-20 cm) ranging from 29% (silt-loam) to 60% (clay soil) of the total increment. Conversely, in sand soil the effect was found only in the upper horizon, where the incorporation of residues increased SOC of only 1.9 t ha-1. This indicates that in sand soil the increase of C is mainly attributable to the direct effect of residues input, while in the other two soils the accumulation depends both on direct effect and root-C input due to the enhancement of crop growth. The effectiveness of residue incorporation strongly depends on the type of soil, a factor which should be considered by the future bioenergy production policy.