Carbon pool changes determine ‘permanence’ unlikely after long term amendment with plant residue inputs to a dryland agricultural system in a semiarid climate

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Soil organic matter (SOM) is intrinsically linked to a myriad of soil functions. High amounts of SOM generally denote better soil quality and resilience of agricultural soils. While management of SOM suggests potential agronomic benefits, inherent constraints associated with soil condition suggests these may not be realised. Transient changes in the amount or distribution of SOM are reported in agricultural systems but few have shown such changes to be meaningful in terms of productive capacity or ‘permanence’.
In this study, SOM was measured periodically over 13 years on a free-draining, continuously cropped sandy soil. The experimental design considered whether stubble retained and stubble burnt under minimum tillage, and two levels of OM additions (0 t ha-1 OM, 100 t ha-1 OM) under cultivation could generate measurable changes in SOC, which would match simulated changes in C storage for this soil type and climate. Secondly, we investigated changes in particulate (POC), humus (HOC) and resistant (ROC) fractions using mid-infrared (MIR) spectroscopy and determined the rate of C loss on cessation of treatments receiving higher inputs.

Repeated application of OM inputs (plant residue inputs) contributed to increasing SOM. However few differences were evident in SOM between burning or retaining stubble, or minimum tillage and cultivation. High plant residue amendment treatments demonstrated that increasing SOM to a simulated potential was possible, but that any gains in soil OM were likely short lived. This was reflected in changes to the POC fraction and the rapid transition of soil amended with plant residues to near control levels within 3 years. While possible to build SOM in dryland semi-arid agricultural systems on sandy a soil, this experiment highlights the difficulty in retaining it. It is doubtful that within current broadacre agricultural systems that significant increases in SOM are achievable that are both feasible and practical.