Long-term effects of land use on soil organic matter fractions and carbon mineralisation

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Organic matter fractionation can provide deeper insights into the dynamics of soil C (and N) than is possible based on measurements of the total stock of organic matter. In this study we examined how organic matter associated with different particle-size fractions responds to changes in land use. The soils were from the Ley-Arable trials at Rothamsted, which were initiated in 1949. One trial site (Highfield) had been under grass for centuries and some plots were converted to arable cropping while others been continuously fallowed since 1949. The second site (Fosters) had been under long-term arable cropping and, on this site, some plots were converted to permanent grassland while others remained under arable cropping. In 2012, samples were collected (0-10 and 10-23 cm) from both trials. Archived samples (0-23 cm depth) that have been collected at intervals over the course of the trials were also included in the fractionation study.
Sixty years after conversion from permanent grass at the Highfield site, C mineralisation in the top 10 cm (measured in a 14-week laboratory incubation at 25^{o}C) had declined by 67% under arable cropping and by ~90% under bare fallow. Carbon was lost from all of the measured fractions. Clay-associated C, the most stable C fraction, declined by 52% under arable cropping and by 70% under fallow (0-10 cm). Largest decreases were in the particulate organic matter (POM; >50 µm fraction); POM-C in the fallow treatment was only ~10% of that in soil under permanent grass.
At the Fosters site, C in all fractions was substantially increased by conversion from arable cropping to permanent grass. However, even after 60 years, stable C had not increased to the level found in the Highfield long-term grass treatment, confirming that C stabilisation can be slow, even under grassland where C inputs are large.