Accelerated soil C sequestration through targeted use of full inversion tillage when renewing permanent pastures

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The size of the soil organic carbon (SOC) pool is determined by the rates of C input (plant & animal residues) and decomposition. Many New Zealand pastoral top soils (e.g. 0-15 cm) are approaching SOC saturation, whereas subsurface soils (e.g. 15-30 cm) have a greater C saturation deficit and the potential to sequester additional SOC. Consequently, management practices that place soil organic matter in closer proximity to under-saturated mineral soils may increase the potential to sequester SOC.

Pasture renewal is actively promoted to farmers to improve pasture performance. Renewal represents an ideal point in the management of grassland systems to use full inversion tillage (FIT; mouldboard plough to 30-40 cm) as a one-off event to bury carbon-rich topsoil (slowing its decomposition) and bring under-saturated mineral soil to the surface where the high inputs of C from shallow, dense rooted pasture species can fill the SOC saturation deficit over time.

We applied a simple empirical model to predicting changes in soil C stocks following a one-off application of FIT (30 cm) during pasture renewal. The model accounts for the decomposition of SOC in buried topsoil and the accumulation of C in the new topsoil (inverted subsoil) and was used to derive national estimates of soil C sequestration under different scenarios of pasture renewal.

Our results suggest that pastures renewed with FIT could sequester an additional 3 -10 Mt C in NZ high production grassland (HPG) soils over 30 years (0.4 to 1.2 t C/ha/yr). This conservative estimate was based on 10-20% farmer adoption on flat and rolling land (<20o slope; 6-12% of HPG) and the recommended 10% annual renewal rate. The increase is significant in relation to the increase in NZ agricultural greenhouse gas (CH4 & N2O) emissions of 1.1 Mt CO2-C eq per annum (relative to 1990).