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Deep-C Drilling: Carbon Sequestration at Depth under Vine Crops

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Management practices designed to increase carbon sequestration via perennial tree crops, are potential tools to mitigate the consequences of climate change. Changes in orchard management could enable growers to meet eco-verification market demands for products with a low carbon footprint, and potentially exploit the emerging business opportunity in carbon storage, whilst enhancing the delivery of ecosystem services that depend on soil carbon stocks. However, there is no standard methodology to verify any potential claims of carbon storage by perennial vine crops. We developed a robust methodology to quantify carbon storage in kiwifruit orchards. Soil carbon stocks (SCS) were determined in six depth increments to 1 m depth in two adjacent kiwifruit blocks, which had been established 10 ('young') and 25 ('old') years earlier. We used a 'space-for-time' analysis.
Our key results were:
• The 'young' and 'old' kiwifruit block stored about 139 and 145 t C/ha to 1 m depth. Between 80-90% of the SCS were stored in the top 0.5 m, and 89-95% in the top 0.7 m.
• There was no significant difference between the SCS in row and alley to a depth of 0.5 m.
• A CV of 5-15% indicates that 4-10 cores are needed for 80% confidence in the estimated SCS.
• We recommend separating each core into the depths 0-0.1, 0.1-0.3, 0.3-0.5 and 0.5-1 m to allow the assessment of SCS dynamics.
• We detected a weak spatial pattern of the SCS only for the 'old' kiwifruit block with a range of about 3 m. A sampling bay along a vine-row should have a maximum length of 3 m.
We then assessed SCS in over 60 kiwifruit orchards throughout New Zealand. They stored on average 174.9 $\pm$ 3 t C ha-1 to 1 m depth. On average, 51% of the SCS down to 1 m depth were stored in the top 0.3 m, which is the standard depth according to the Kyoto protocol. About 72% of the SCS to 1 m depth were captured when increasing the sampling depth to 0.5 m. These results underscore the necessity to analyze SCS in an orchard to at least 0.5 m depth. Using the same methodology to 1 m depth, we determined SCS in two wine grape vineyards on shallow, stony alluvial soils. We found a difference between vineyard and adjacent pasture SCS of nearly 16 t/ha. As the vines are 25 years old, this equates to carbon sequestration rates of 640kg/ha/year.
Our results of the 'space-for-time' analysis also showed that all sequestration had occurred below 0.5 m. Therefore, we decided to deep-C drill further. In a 30-year old kiwifruit orchard and an adjacent pasture, SCSs were measured to 9 m depth. In the kiwifruit orchard, we found a sequestration rate of 6.3 tonnes C per hectare per year greater than in the adjacent pasture that was the antecedent land use.
The carbon sequestered each year within the top 1 m of soil equates to about 4% of the emissions of kiwifruit grown in New Zealand and consumed in the United Kingdom. However, if the stock in the top 9 m of soil is included in this calculation, then the amount of SOC sequestered equates to about 42% of the respective emissions that would be calculated by life cycle assessment.