Fact sheet

Can grazing management improve soil organic carbon?

Key takeaways

- There is little conclusive evidence that grazing management (intensity or method) directly influences soil carbon in Australia.
- This may be a result of the influence of climate, soil type and pasture composition, which play a major role in changes to soil carbon. Research on soil carbon is complex due to these influences but studies in Australia are ongoing.
- However, grazing intensity and method can impact **key drivers of carbon sequestration**, such as above and below ground biomass, groundcover, soil structure and soil nitrogen.
- The other benefits that flow from manipulating grazing, such as improved pasture productivity, groundcover or soil nitrogen, may be significant for producers.

Grazing management and soil carbon

Grazing management involves manipulating the intensity and timing, frequency and duration (method) of grazing, and is associated with improvements in soil health, ecosystem services, and economic benefits.

Grazing management may increase soil organic carbon by increasing pasture productivity and root allocation, changing pasture composition (promoting deep-rooted perennial species or promoting nitrogen input from legumes), altering soil physical and chemical properties, and reducing loss of carbon (via erosion) by maintaining ground cover (Figure 1).

In Australia, the majority of scientific research reports no significant impact of grazing intensity or method on soil organic carbon (Figure 2), but research shows there is potential for grazing management to influence key *drivers* of soil carbon sequestration in grazing systems.

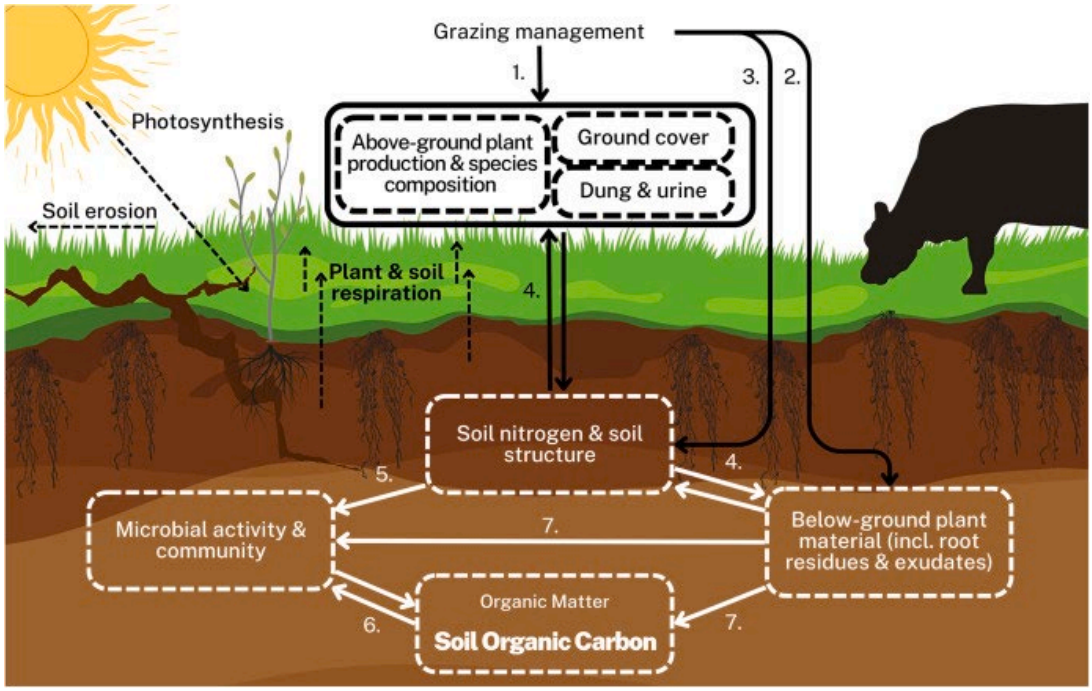

Figure 1 Key drivers and processes of soil organic carbon accumulation in grazing systems.

Pasture productivity and root allocation

Research shows lower grazing intensity and grazing systems that incorporate periods of rest are among the factors that can increase herbage mass and ground cover and influence pasture composition, but overall does not have a significant impact on plant growth rate (Figure 2).

- Grazing management that promotes increased pasture productivity and root allocation, and supports C4 grasses, perennial species or nitrogen-fixing legumes has potential to increase soil organic carbon.
- Under higher grazing intensity, more plants are consumed, reducing the amount of plant material contributing to soil organic matter, and productivity can decrease. This in turn reduces CO2 fixation and below-ground carbon inputs.
- When the interval between grazing events is too short to allow plants to replenish reserves, plant regrowth may be suppressed and over time herbage mass and persistence may decline.
- High grazing intensity reduces desirable perennials, some of which have fast growing, deep fibrous roots capable of exploring a large volume of soil, with significant potential to increase soil organic carbon.
- Overseas studies show that below-ground net productivity can be influenced by stocking rate and grazing management, with flow-on effects on soil organic carbon.
- Grazing management that leaves sufficient herbage mass to support desirable species is important for SOC accumulation and sustaining production.

Soil structure and chemistry

Trampling by livestock can degrade physical and chemical soil properties, including structure, infiltration, soil moisture, macroporosity and nutrients, with flow-on affects for root growth and plant productivity. These impacts are greater under higher grazing pressures.

One indicator of soil compaction is bulk density. At a global level, both continuous grazing and higher grazing pressure lead to higher bulk density, with potential negative impacts for productivity and soil carbon.

The accumulation of soil organic carbon is closely linked with soil nitrogen availability. Nitrogen availability has a positive effect on soil organic carbon accumulation by:

- increasing plant productivity (carbon inputs to soil)
- reducing soil respiration (carbon outputs from soil)
- increasing stabilisation of soil carbon.

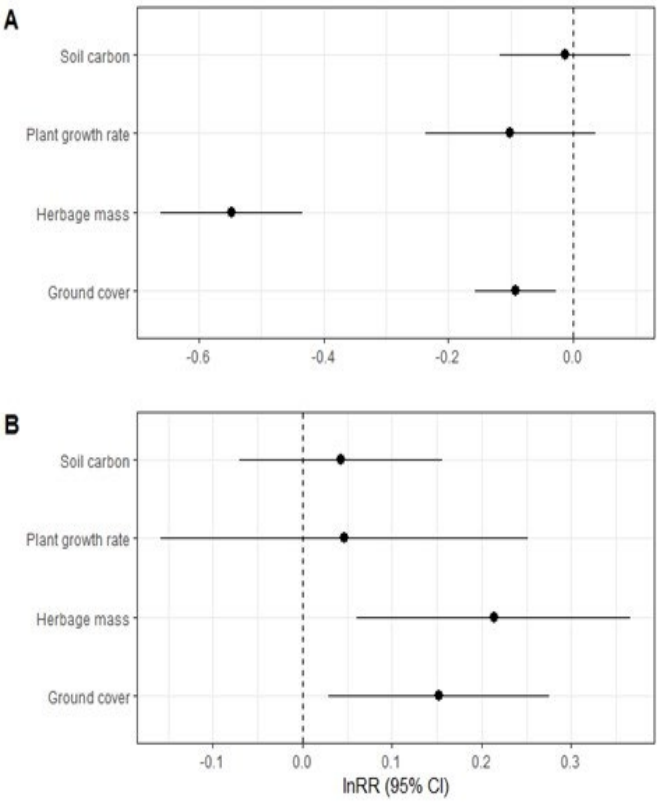

Figure 2 Results (mean effect size and 95% confidence interval) of a meta-analysis of Australian studies comparing (A) low vs high grazing intensity, and (B) grazing method (continuous versus non-continuous) for soil carbon, pasture growth rate, herbage mass, and ground cover. Where the confidence interval (horizontal line) overlaps 0, there is no clear evidence that grazing management has an impact.

Mineralisation of soil organic matter, derived from above and below ground organic material, and atmospheric nitrogen fixation via legumes is an important source of nitrogen in unfertilised pasture systems. Reductions in pasture growth or in the legume component of pasture (often with preferential grazing or where high biomass limits legume establishment) as a result of grazing management can create negative feedback loops for total nitrogen, as with soil organic carbon.

Groundcover

In most agricultural systems, maintaining adequate levels of ground cover, both litter and herbaceous plants, can considerably reduce soil erosion. Erosion influences soil organic carbon through soil loss and deposition and the decomposition of organic material in eroded soil.

Ground cover increases in grazing systems incorporating periods of rest, and under low compared to high grazing intensities (Figure 2).

Reference: McDonald, S.E. *et al,* Grazing management for soil carbon in Australia: A review, Journal of Environmental Management, Volume 347, 2023, 119146, https://doi.org/10.1016/j.jenvman.2023.119146

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