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Modelling soil organic carbon changes in cropping and grazing systems

Dr De Li Liu and **Dr Mark Conyers** NSW DPI, Wagga Wagga; **Dr Garry O'Leary** Department of Economic Development, Jobs, Transport and Resources, Horsham; **Yuchun Ma** Visiting Scientist, Graham Centre, Wagga Wagga; **Dr Annette Cowie** NSW DPI, Armidale; **Dr Frank Yonghong** Inner Mongolia University, China; **Dr Malcolm McCaskill** and **Dr Fiona Robertson** Department of Economic Development, Jobs, Transport and Resources, Hamilton; **Dr Ram Dalal** Department of Science, Information Technology and Innovation, Brisbane; **Dr Warwick Dougherty** NSW DPI, Menangle

Key findings

- The difference in soil organic carbon (SOC) changes between nine sites across eastern Australia was largely characterised by mean temperature and rainfall.
- High temperature strongly interacted with management practices (stocking rate, nitrogen application and residue incorporation) to reduce carbon sequestration despite favourable rainfall.

Introduction

SOC levels in agricultural systems depend largely on rates of carbon input and decomposition under various agronomic practices such as stubble (crop residue) management and fertiliser application. This project explored the extent to which various crop and pasture management options effected changes in SOC, from sub-tropical to temperate environments.

Site details

The Agricultural Production Systems Simulator (APSIM)-Wheat and APSIM-Agpasture models were used to simulate changes in SOC in a range of crop and pasture management systems across nine locations in eastern Australia: central and southern New South Wales (Deniliquin and Wagga Wagga), northern NSW (Narrabri and Nyngan), south-western Queensland (Roma and Dalby), northern Victoria (Rutherglen) and western Victoria (Horsham and Hamilton).

Treatments

The effect of nitrogen fertilisation, stubble management and stocking rate on SOC, and what strategies growers might use to increase SOC sequestration across eastern Australia were investigated. A continuous cropping regime, continuously grazed pasture and mixed cropping and pasture rotation were all modelled.

Results

Continuous cropping

Under continuous cropping, higher nitrogen application and higher amounts of stubble incorporation increased the SOC levels at all locations. At Roma, the northern-most site, there was little additional gain in SOC from increasing nitrogen application above 70 kg N/ha, but most other sites showed benefits above 70 kg N/ha. The most influential factor for boosting SOC under cropping was the level of stubble incorporation.

Continuous grazing

At all but one site of continuously grazed pasture generally resulted in SOC increases over 60 years. However, increasing stocking rates decreased the rates of SOC change at all sites.

Mixed cropping and pasture rotation

In crop–pasture rotations, even four years of pasture is likely to be significant in reducing the decline in SOC levels at low nitrogen applications during cropping phases. Nitrogen fertilisation and stubble incorporation ameliorated the stocking rate effect seen in continuous grazing, thereby reducing the decline in SOC.

Summary

- The difference in SOC changes between nine sites across eastern Australia was largely characterised by mean temperature and rainfall.

» High temperature strongly interacted with management practices (stocking rate, nitrogen application and residue incorporation) to reduce carbon sequestration, despite favourable rainfall.
» A mean annual temperature higher than about 20 °C can switch a soil from net sink into a net source of atmospheric CO_2 if other factors affecting soil carbon changes such as stubble incorporation, stocking rate and site rainfall, are constant.

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