

Can soil organic carbon content be increased by sowing rotation crops?

Soil organic carbon (SOC) is a key indicator of soil quality and fertility. In many cotton farms SOC has decreased from 11-12 kg/m² in the surface 0.6m to values of 5-7 kg/m², and continues to decline 0.22-0.35 kg/m² per year. In some instances this decline is despite frequent rotation crops. The major causes for this appear to be:

- **Insufficient amounts of crop residues being returned to the soil** – to maintain or increase SOC, approximately 2-3kg/m² of dry matter needs to be returned to the soil. A typical cotton-based cropping system will return 0.8-1.2 kg/m². Some crop sequences that will return high amounts of dry matter to the soil are cotton-wheat-sorghum, & cotton-corn, & cotton-vetch & cotton-wheat-vetch sequences on permanent beds, all of which return above-ground crop residues in amounts ranging from 1.5 to 2.5kg/m². Sowing a wheat rotation crop alone, has been found to slow the rate of SOC decrease, particularly when stubble is not incorporated but is retained as standing stubble.
- **Management practices** - Modification of existing management practices is one approach by which SOC decline can be minimised.

Frequent and deep tillage operations can rapidly increase the rate of SOC decomposition, even if cotton is sown in rotation with cereal crops which produce significant amounts of crop residues.

As an alternative to intensive tillage, permanent beds have been used by many cotton growers. Unlike experiments conducted at ACRI, research on farm has not been able to demonstrate that permanent beds were able to reverse declines in SOC. This may be related to management with respect to stubble, N and irrigation, with on farm N and irrigation rates higher.

Burning cotton stubble in Vertosols, as in other soil types, results in degradation of their physical and chemical properties. Significant declines in yield, profitability and N fertiliser recovery have been found from cotton stubble removal in comparison with incorporating it. There has been limited research into the effect of burning rotation crop stubble in cotton based farming systems, however given the role played by rotation crop stubble in soil physical & chemical fertility, nutrient recycling, soil fauna & flora conservation & water conservation, the negative consequences of burning are likely to be significant.

Managing rotation and cotton crop stubble in permanent bed systems usually involves either slashing & incorporating stubble into the beds with shallow cultivation equipment or burning of crop stubble in combination with centre-busting.

In irrigated systems, retention of rotation crop stubble is constrained due to issues with establishment & fertilising, increased water logging & inability to incorporate residual herbicides. In addition, planting into standing wheat stubble can accelerate deep drainage and nutrient leaching. Planting into standing wheat stubble can however, result in increasing SOC and exchangeable K, and reduction in ESP (Exchangeable Sodium Percentage). This decrease in ESP, through an increase in deep drainage and leaching is especially advantageous in sodic soils.

- **Seasonal climatic conditions and climatic extremes** – Wet soil under warm to hot conditions facilitate SOC mineralisation, especially during the cotton growing season. It has been observed that intensive flooding results in a sharp and very rapid decrease in SOC, even under permanent beds, while extended drought conditions led to a steady decline in SOC.

Thanks to Susan Maas for this article (summarised from N Hulugalle & F. Scott, (2008) 'A review of the changes in soil quality & profitability accomplished by sowing rotation crops after cotton in Australian Vertosols from 1970 to 2006')

Are you interested in investigating the rates of carbon sequestration under different cotton farming systems on your farm?

Nilantha Hulugalle (Cotton CRC/NSW DPI) is looking to continue his work on maintaining profitability and soil quality in cotton farming systems. The aim of this project is to investigate the effect of selected crop and soil management practices on carbon sequestration, soil quality, drainage and nutrient leaching; and growth, yield and profitability. Ultimately, it is intended that a set of qualitative indicators will be developed that can be used as indices of carbon sequestration, N and WUE.

I am currently looking for interested growers to take part in this trial. The trial protocol is reasonably flexible and can be tailored to suit your particular farming system.

Please give me call if you are interested in taking part in this trial. This is a great opportunity to research some locally based information on carbon sequestration in irrigated cotton farming systems.