GOVERNMENT OF WESTERN AUSTRALIA

Department of **Agriculture and Food**
Department of **Regional Development and Lands**

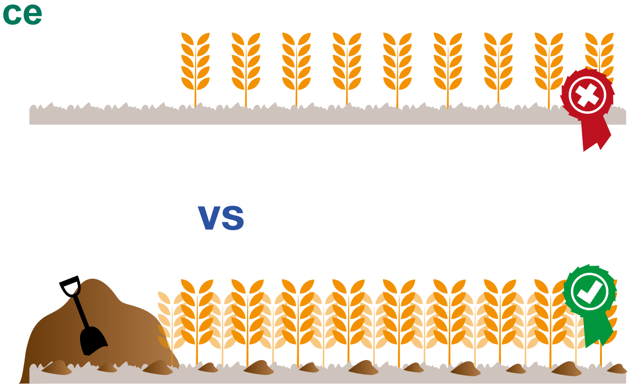
ROYALTIES FOR REGIONS

Carbon Farming in WA

Fact sheet No. 6

PRACTICE: **Claying as a method of increasing soil carbon content**

Description of practice



Spreading clay on light, sandy soils helps to increase soil moisture, retain nutrients and overcome water repellence. The risks associated with water repellence in agricultural regions are high. They include poor or uneven crop and pasture germination, soil loss through wind erosion, waterlogging, and leaching of fertilisers. In the pursuit of high quality soil, the practice of adding clay to non-wetting sands increases soil organic carbon storage (Hall 2012; Hoyle 2011). Claying helps to break down the small amounts of particulate organic matter covering the surface of sands that cause repellence, clearing the way for water to infiltrate the soil.

Outline of procedure

Clay is applied to the topsoil by spreading and ‘smudging’ it to the sandy soil surface (mechanical ‘top-dressing’). The soil can then support higher concentrations of organic carbon, improving microbial activity and leading to a more fertile farming system. The starting level of soil organic carbon (SOC) will determine the magnitude of the response. Degraded land offers greater potential to maximise the increase in carbon to the attainable limit. Soil disturbance through tillage will encourage the loss of SOC; minimum tillage and no-till practices are already conducted throughout much of the cropping areas of Western Australia.

Although claying is very effective on non-wetting soils, the high cost and potential risks associated with the practice limits its adoption in pasture-based systems and in lower to medium rainfall cropping areas. Spreading clay is expensive ($300 to $1000/ ha) because of the volume required, transport costs and the need for careful incorporation into the topsoil. However, the practice is effective, providing long-term amelioration of up to 15 years or more, without having to repeat the process.

The Department of Agriculture and Food is the lead agency and is working with the Department of Regional Development and Lands to deliver this Royalties for Regions funded project.

For more information please refer to agric.wa.gov.au

More Information

Contact
Henry Brockman
Department of Agriculture and Food

Telephone
(+618) 9892 8435

Email
henry.brockman@agric.wa.gov.au

The alternatives are annual use of detergent-type wetting agents (or banded surfactants) or farming system methods such as furrow sowing. Delving clay in situ is often less expensive, although the clay material still needs to be incorporated into the topsoil. 'Rotary spading' assists with the incorporation of delved clay (Saunders 2012), although wear on the discs and tines is significant.

The aim of claying is to increase the clay content in the surface of the soil to greater than 5 per cent, so that the soil surface area allows water to penetrate or pass through the hydrophobic organic molecules. Applications of between 100 t/ha and 300 t/ha clay are general. However, in recent years high rainfall cropping areas are increasingly using higher volumes of clay (in some cases up to 600 t/ha clay). In higher rates of clay application, the spread clay material must be well incorporated into the soil surface, which requires mechanical rotary spading tools.

Work done to date

Clay was first spread on water-repellent soils by South Australian growers in the late 1960s. These growers and numerous researchers since have found that using moderate application rates of 75 to 150 t/ha of dispersive clay-rich subsoil (25 per cent or more clay) can be easily incorporated and is effective at overcoming soil water repellence. Recent research has shown that a topsoil clay content of 3 per cent is sufficient to overcome topsoil water repellence where the organic carbon content is 1 per cent but higher clay contents of 5 to 7 per cent are required where the organic carbon content is higher at 1.5 per cent Department of Agriculture and Food (DAFWA Bulletin 4773 2009).

SOC concentrations in the top 10 cm in Western Australian cropping areas is low, between about 0.5 and 4 per cent with a mean of about 2 per cent (ASRIS 2007). Research in the Esperance (Dalyup) area found that claying (increasing clay content from 0.5 per cent to 6 per cent clay) increased soil carbon levels by 0.2 per cent organic carbon, which equates to about 3 tonnes of additional carbon (assuming all of the increase is in the 0 to 10 cm layer). The carbon content of the clay alone could not account for the increase (Hall et al. 2010). Much of the increase is assumed the result of increased productivity (for example, about 30 per cent increase in biomass and yield).

Recent trials in Western Australia (Hall et al. 2010) measured an increase of approximately 2 t C/ha in SOC through the practice of claying on various trial sites. Other research on the use of 'red mud' or 'alka-loam' has returned high values (R. Bell, personal communication 2010).

The Kondinin Group, the Western Australian No-Tillage Farmers Association (WANTFA) and the Grower Group Alliance WA (GGA) promote farmer experiences and conduct research and field demonstration trials.

The significant impact of water-repellent soils on crop yields, soil condition and farm profit has resulted in extensive development of practices and tools. The successful practice of claying water-repellent soils has extended to key locations across Australian over the years.

Current level of adoption

Claying and delving on water-repellent soils has led to production gains through more efficient water use and wind erosion controls. Clay spreading is widely used on water-repellent sandplain soils across much of Western Australia, although more prevalent in the higher rainfall cropping regions. There is no known adoption of this practice for the specific purpose or sole benefit of sequestering soil organic carbon.

The practice could be more widely adopted as increasing SOC in some areas improves soil quality, which in turn has economic benefit, without the need to sell carbon credits. Adoption solely for carbon credits probably is not viable, but it could become a component of the overall farming system, as modelling demonstrates that claying can increase carbon levels even when the increase in clay content is comparatively small.

Industry activity

Private investment in the practice of claying water-repellent soils is significant. As noted above, some farmers are prepared to pay up to $1000/ha to see a longer term benefit of higher crop yields.

There is limited research funding to directly investigate the amelioration of water-repellent soil by claying for the specific benefit or impact on soil organic carbon. However, the reinterpretation of data from related projects on this practice will provide useful information.

Carbon benefits

None and unlikely to become one due to the additionality rule.

Co-benefits

- Improved ability of the soil to capture and store water.
- Soils of higher clay content have a greater capacity to stabilise organic carbon.
- Increased crop production.
- Clayed soil wets up evenly allowing even light rains to penetrate over the whole surface.
- Weeds germinate evenly as opposed to the staggered germination associated with water-repellent soils. This allows better herbicide activity and weed kill.
- Nutrient retention is improved, making phosphorus and potassium available to the plants.

Opportunities

- Up to 5 million hectares of Western Australia is affected or has the potential to be affected by water repellency or non-wetting. These are mainly sandy soils with less than 5 per cent clay content in the West Midlands, the Swan coastal plain and the south coast sandplain (Blackwell 2003).
- Although still in its infancy, both endemic and introduced wax degrading bacteria have been used in broadacre farming to degrade organic waxes associated with water repellence. Research may increase the potential for these methods, but low economic returns and variable success rates limit their current use.
- Research findings indicate that claying increases soil carbon in the top 30 cm by 2 to 3 t/ha. (GRDC 2009). Claying is easily integrated into current farm systems but the economics of the practice need to be considered.

Risks

- Claying would probably not qualify under the additionality rule of the carbon credits scheme.
- High clay rates at the surface can result in surface sealing or water being held in the topsoil where it is subject to evaporation. It also can reduce root development into the subsoil.
- Farmers and researchers have often found that crops on clayed paddocks grow large biomass but are prone to haying off and poor yields. Poor incorporation and recent drier seasons or environments are two issues.
- Claying works on most sandy soils but may have low returns for warm, shorter season environments as early water use and increased evaporation may limit water availability at grain filling. It still has benefits for livestock feed and groundcovers.
- It is important to assess the potential to increase production and profitability of claying on a case by case basis. Some clay may provide additional nutrients or lime but others can fix nutrients, be excessively acid or alkaline, or salty. Before adopting this practice, clay should be tested for particle size, soil pH, salinity, sodicity and other limiting soil properties.
- Ameliorating water-repellent soils through the practice of clay spreading will usually incur significant costs.
- There may be a revenue loss by creating soil conditions not favourable to plant growth (such as surface nutrient retention, soil compaction, waterlogging). This may be offset in future years by improved mixing of the clay material into the soil and corresponding improvements in soil quality, increasing the performance of subsequent crops.

- Rapid turnover of organic material occurs in soils with little or no clay content. It can be difficult to increase organic carbon in coarse textured sandy soils.
- Increased soil organic matter reflects greater storage (sequestration) of carbon. While this generally reflects a greater level of organic inputs, it does not necessarily reflect a decrease in total greenhouse gas emissions.
- Soil amelioration through claying water-repellent sands is likely to be part of rotational cropping management for the paddock. This makes it difficult to isolate the component(s) of the farming system that are influencing soil organic carbon levels.
- A better understanding of the attainable limits and ability to maintain an increase in organic carbon is required.

Case studies

- A demonstration site in the North Stirling–Pallinup area in 2010/11 proposed to show farmers successful techniques for ameliorating water-repellent sands in cropping areas (Derk Bakker and the North Stirling-Pallinup grower group).
- Funding through the Department of Agriculture, Fisheries and Forestry's Action on the Ground soil carbon projects will develop other case studies to extend GRDC research trial work.
- The Northern Agricultural Region (NAR) grower group conducted research into the benefits of claying water-repellent soils with trials at Binnu, supported by the GRDC Agribusiness Trial Extension Network (GRDC 2009).
- Data from an eight-year trial in Western Australia demonstrated that yield responses to the application of clay (100 t/ha in subsoil with a 30 per cent clay content mixed into the top 100 mm) were typically positive in different rainfall years (Carter & Herington, 2006).

Key contacts – Australia

- Western Australian Grower Group Alliance (in particular, the South East Premium Wheat Growers Association, North Stirling Pallinup, Stirlings to Coast, Facey, Liebe and Mingenew–Irwin grower groups)
- Stephen Davies, Jeremy Lemon, David Hall, Derk Bakker and Fran Hoyle (DAFWA)
- Murdoch University
- Western Australian No-Tillage Farmers Association (WANTFA)
- Private agronomy consultants

National work

- Grains Research and Development Corporation: the GRDC has been researching the amelioration of water-repellent soils since 2009. Western Australia secured GRDC funding to further investigate the amelioration of water-repellent soils in the southern and northern agricultural regions.
- Other regions in Australia that have undertaken considerable research into practices such as claying include South Australia (Eyre and York Peninsula) and Victoria (Western Mallee region). Many of the recent research investigations have included soil analysis for SOC.

International work

None at this stage relevant to Australian conditions. Claying is more often researched for benefits other than quantifying SOC increases and soil sequestration for carbon farming.

Stakeholders

- Department of Agriculture and Food, Western Australia (DAFWA)
- Industry groups, such as WANTFA
- Grower groups and farmers
- Farm enterprises that will benefit from carbon credits

Next steps

- None specific to claying water-repellent soils and carbon.

- The GRDC is carrying out a number of research projects on water-repellent soils.
- The University of Western Australia (Dr Dan Murphy) in partnership with the CRC Polymers is assessing water repellence sites across Western Australia for the potential use of polymer additives to reduce water repellence.

Key references

Carter, DJ & Hetherington, RE 2006, 'Claying of water repellent soils', Department of Agriculture and Food, Western Australia, agric.wa.gov.au/PC_92461.html

Department of Agriculture and Food, Western Australia 2009, 'Managing south coast sandplain soils to yield potential', Bulletin 4773, agric.wa.gov.au/objtwr/imported_assets/content/lwe/land/bn_scsandplain.pdf

Davies, S, Blackwell, P, Bakker, D, Scanlan, C, Roper, M & Ward, P 2012, 'Developing and assessing agronomic strategies for water repellent soils', in *Proceedings 2012 Crop Updates*, Department of Agriculture and Food, Western Australia, www.agric.wa.gov.au/objtwr/imported_assets/content/fcp/cu2012_davies_water_repellence_paper.pdf

GRDC 2009, 'Store carbon for healthy soils and better yields, grdc.com.au/uploads/documents/GRDC_CarbonFarming_4pp.pdf

Hall, DJ, Jones, HR, Crabtree, WL & Daniels TL 2010, 'Claying and deep ripping can increase crop yields and profits on water repellent sands with marginal fertility in southern Western Australia', *Australian Journal of Soil Research*, no. 48, pp. 178–187, CSIRO Publishing

Hoyle F, Baldock J, Murphy D 2011, 'Soil organic carbon – role in rainfed farming systems: with particular reference to Australian conditions', in *Rainfed Farming Systems*, Springer, Netherlands

Moore, G & Blackwell, P 2004, 'Water Repellence' in *Soil Guide: A handbook for understanding and managing agricultural soils*, Bulletin 4343, ch. 3.1, Department of Agriculture and Food, Western Australia

Saunders, M 2012, 'Mixing it up in the soil', in *Ag in Focus*, Autumn edn, Department of Agriculture and Food, Western Australia, Kondinin Group

Skjemstad, JO, Clarke, P, Taylor, JA, Oades, JM & McClure, SG 1996, 'The chemistry and nature of protected carbon in soil', *Australian Journal of Soil Research,* vol. 34, pp. 251–271