• CLIMATE • ACTION • FARMING •

- Stories from the land -

- The magic number-

- Improving production through increasing clay content of soils -

FARMER PROFILE

Name: Rohan and Rachel Murdoch
Location: Boxwood Hills, WA
Rainfall annual average: 500 mm
Enterprise mix: 50 % livestock (sheep) and 50 % cropping
Property size: 4000 hectares
Soil type: Duplex sandy gravel, South coast sandplain.

NUTS & BOLTS:

- For sandy, non-wetting soils Moore and Blackwell (2004) recommend to increase the clay content of the top 50 mm to about 5 %.
- Claying water repellent sands results in significant increases (>50 %) in crop yields over 15 years (David Hall *et al*. 2015).
- Claying of sandy, non-wetting soils can lead to improved water and nutrient holding capacity (DAFWA, 2015).
- Claying improves crop and pasture establishment resulting in better ground cover and reducing soil erosion through wind and water events.

Example of light sandy soil at the Murdoch's Boxwood Hill Property

FARMING ON THE SANDPLAINS OF THE SOUTH COAST

Soil erosion is a major form of land degradation in the dry land farming areas of south-western Australia with severe erosion events recurring every few years (Harper *et al.*, 2010). These events significantly impact productivity and contribute to loss of the extremely valuable fertile top soil including soil carbon.

In south-west Australia, about 5 million ha of land are either water repellent or susceptible to developing repellence with particularly susceptible soils being the 'sandplains' across the south coast from Albany to Esperance (Moore *et al.* 2004).

Rohan and Rachel Murdoch have been farming on the 'sandplains' of south-western Australia at their Boxwood Hills property since 2004. This farm has experienced severe land degradation through a number of different influencing factors.

"In addition to severe soil erosion due to wind and water around here, I have been struggling with reduced production because of water repellent soils and the damage caused by rabbits. We needed something to restore the land for enhancing production and ensuring we don't lose our top soil in the next severe rain or wind event." Rohan Murdoch said.

Rohan and Rachel have been working on ways to restore the degraded land, improve soil quality and increase production.

Rohan explained "A key issue we have is getting early ground cover on these sandy non wetting soils. Trying to get anything to grow on these parts of the farm was the tricky part. After looking into several options we decided to investigate soil amelioration using clay."

Gully formed by water erosion

Sandy soils produce limited crop production

IMPROVING NON-WETTING SANDY SOILS

Claying is the process of incorporating clay into light, often non-wetting, sandy soils. Applying clay helps to increase soil moisture, retain nutrients and overcome repellence (Brockman, 2013). This practice is expected to improve soil quality by enhancing organic carbon storage potential, improving microbial activity leading to stabilisation of fragile top soil and ultimately increasing agricultural production potential. The overall aim is to increase the clay content of the top 50 mm to about 5 % (Moore *et al.* 2004).

Claying is generally an expensive practice because of the volume required, transport cost and the mechanical methods used to ensure careful incorporation (Brockman, 2013). However the benefits of claying into non-wetting soils have been observed for up to 30 years or more, without having to repeat the process (DAFWA, 2015).

For the Murdoch family, claying is a fundamental option in preventing erosion. They have also been able to access clay from several existing dam catchments that greatly reduced the expense. The next hurdle was working out the best way to spread and incorporate the clay at depth into the soil.

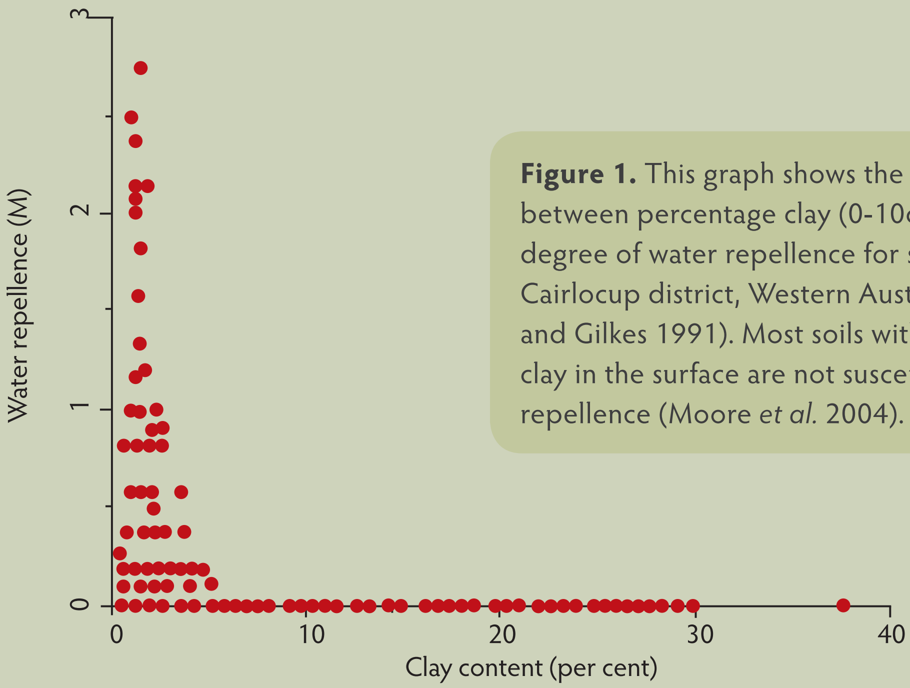

Figure 1. This graph shows the relationship between percentage clay (0-10cm) and the degree of water repellence for soils in the Lake Cairlocup district, Western Australia (Harper and Gilkes 1991). Most soils with more than 5% clay in the surface are not susceptible to water repellence (Moore *et al.* 2004).

TIPS AND TRICKS LEARNT ALONG THE WAY

Rohan explained "Our aim is to incorporate about 180 to 200 tonnes per hectare ideally into the top 30 cm of the soil profile. If I can get the clay content to around 5%, the magic number, I won't need to worry about non-wetting soils anymore. There has been some trial and error along the way working out the best method to spread the clay and how best to incorporate it evenly into the soil profile deeper than 10 cm. But with a bit of patience and perseverance, our methods have improved over the years".

"While claying into deep sand does improve germination, in the years with dry spring conditions the production from clayed deep sands can be disappointing. Yields are generally poorer when you don't have duplex soils to retain moisture within reach of the crops roots, which is needed to finish off the crop. But, we've also found if the clay is at a greater depth than 700 mm the production in dry spring conditions is still disappointing. This has led us to prioritising claying those areas with clay closer than 700 mm and planting kikuyu and serradella in deeper sands."

"A big tip is spreading the clay when it is dry and friable rather than wet and in large clumps. Large clumps of clay are difficult to incorporate, particularly evenly and if left they can form a hard impervious layer which can be difficult for plants to grow in. Adding to this you can spend a lot of extra time trying to break the clay up once it has dried out which adds to labour costs."

The Murdoch's were interested to find out what the clay content was in the soils that were clayed and at what depth. South Coast NRM in conjunction with the University of Western Australia worked with the Murdochs to find out more.

Rohan Murdoch (centre) shows WA's Minister for Agriculture Mark Lewis MLC (left) the increase in stubble and production post clay spreading on this previously bare paddock.

In 2006, a contractor's road scraper was used to spread clay but the clay wasn't spread evenly and wasn't worked or incorporated before it got wet. As a result, in patches, the clay formed a hard impervious layer which was much more difficult to spread with a smudge bar.

The 2009 site showed a higher clay content in the top 10 cm however more clay was put out on the site resulting in the higher clay content. The clay was spread evenly through the top 10 cm of the soil profile however not at depth. In 2013 Rohan reincorporated the clay at depth, using a spader. Rohan describes it as "the ultimate tool to get a mix through to soil profile. " The results indicate a far better incorporation of clay in the top 20 cm. However, soils that have been spaded may be more prone to wind erosion in the first year so Rohan recommends following up with a cereal crop rather than canola as cereal crops are more resilient to wind blow.

In 2012 the Murdoch's used a Lehmann Scraper to spread the clay and used a smudge bar to incorporate it. This resulted in a more even spread of the clay over the paddock, however the Lehmann spreader is slow resulting in reduced efficiency.

"These results are great because they add rigour to our trials and we can gauge if we are getting to that magical 5% clay content and at what depth. Using this type of information we can decide if we need more or less clay and the best method for incorporation," said Rohan.

Clay application				**Clay in soil depth (%)**		
Year	**Clay (t/ha)**	**Claying method**	**Incorporation**	**0-10 cm**	**10-20 cm**	**20-30 cm**
2006	180	Road scraper	Offset disks	7	3	3
2009	> 180	Road scraper	Offset disks	11	11	3
2012	180	Lehmann Scraper	---	5	3	3
untreated	---	---	---	2	2	3

Table 1 lists four sites that were tested for clay content at incremental depths of 10 cm. Three of the sites were clayed in 2006, 2009 and 2012 and an annual pasture non clayed (untreated) site was tested as a comparison. Approximately 180 t/ha of clay was applied and incorporated into the soil profile mainly to a depth of 0-10 cm.

IMPROVING PRODUCTION FOR THE LONG TERM

Increasing the clay content of soil can increase soil carbon because the clay protects the organic matter from degradation. The soil can then support higher concentrations of organic carbon, improving microbial activity and leading to a more fertile farming system (Brockman, 2013). Coupled with higher inputs, increasing clay content can increase organic carbon levels and improve productivity, although this will take many years (DAFWA, 2015).

RESEARCH

South Coast NRM and the University of Western Australia worked with the Murdoch's to find out if claying was changing their soil quality and carbon storage potential.

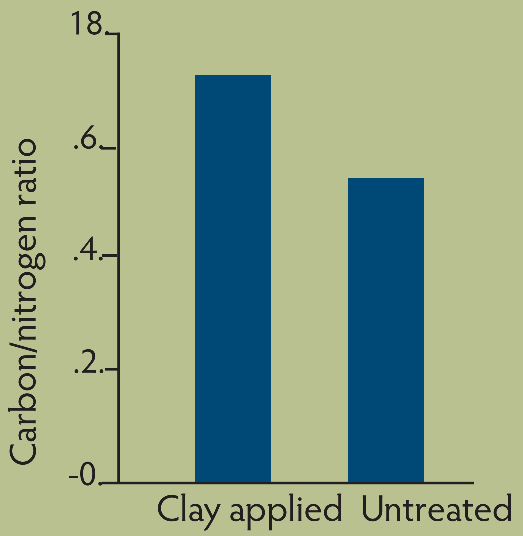

FIGURE 1. Mean value of Carbon/Nitrogen ratio in 0-30 cm soil depth

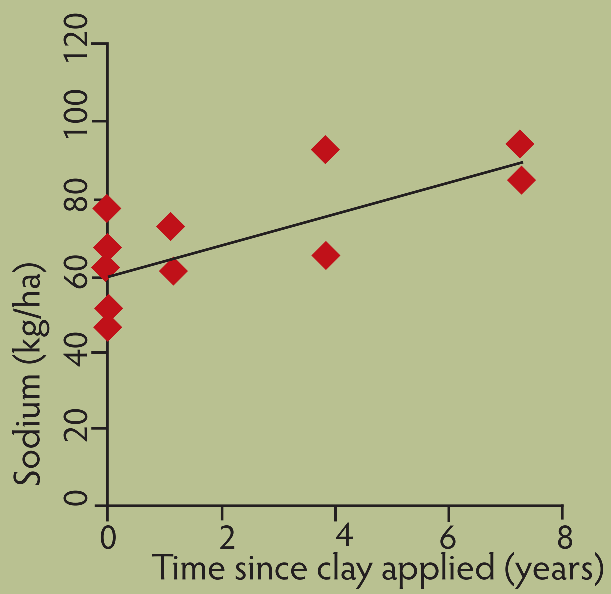

FIGURE 2. Relationship between time since clay applied (year) and Sodium (kg/ha) in 0-10cm soil.

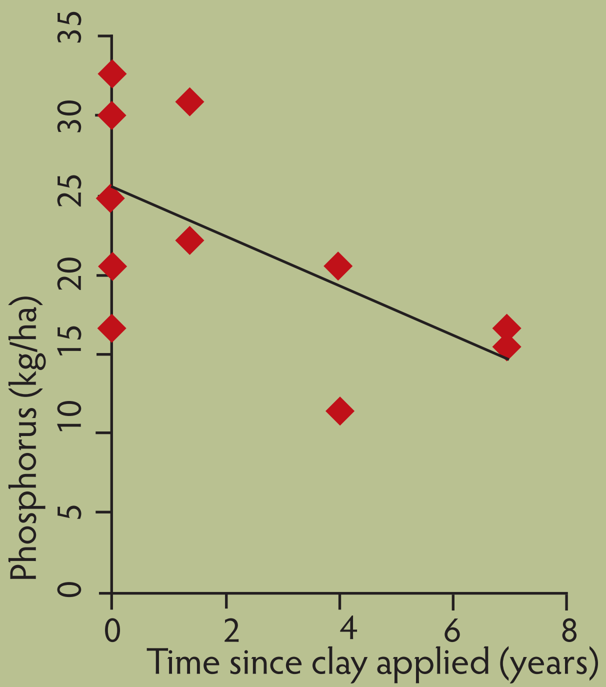

FIGURE 3. Relationship between time since clay applied (year) and Phosphorus (kg/ha) in 0-10cm soil.

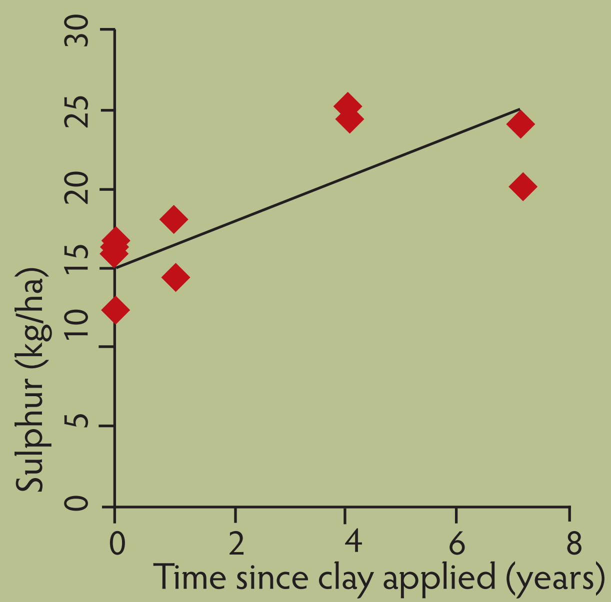

FIGURE 4. Relationship between time since clay applied (year) and Sulphur (kg/ha) in 0-10cm soil.

THE RESULTS

The Carbon/Nitrogen ratio was significantly higher in clay applied sites suggesting decomposition by microorganisms is slower and has potential to maintain or increase more organic carbon. Soil carbon and nitrogen showed no significant difference between clay applied in 2012 and untreated sites.

The concentration of macronutrients such as soluble phosphorus and sulphur and exchangeable sodium were correlated with time since clay applied (years) which infers claying has a long term influence on soil quality.

Sulphur and sodium increased with the time since clay applied. Phosphorus showed a negative relationship with time, probably because clay has adsorbed and fixed soluble phosphorus. These results suggest that nutrients and water were effectively retained in the clay applied sites. However availability of some nutrients to plants may vary depending on different factors.

Rohan stated that "areas which were clayed that once grew mainly weeds of little value are now productive and easier to manage. In pastures there is earlier germination of desired species, and in crops there is better control of weeds and better germination due to increased availability of water and nutrients. This along with rabbit proof fencing means these areas are less prone to erosion from wind, water and excess grazing pressure. The results backed up these observations".

The Murdoch's are establishing perennial pastures on the deeper sands not priorities for claying for further soil quality improvement including prospective soil carbon sequestration.

Soil carbon assessment was consistent with the CSIRO's Soil Carbon Research Program (SCRP) methodology measured by elemental analysis as described in the soil carbon analysis protocol of Sanderman et al. (2011).

This paddock was improved using a combination of claying for moisture retention and the perennial pasture species Kikuyu to stabilise and hold the soil.

"The minute you can get the clay content above 5% you don't have non wetting soils anymore. That 5% is the magical number we are aiming for."

– Rohan Murdoch, Boxwood Hill, WA – 2015.

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