Results of the soil treatments at the Kirklands' farm

May 2012 update

The South East Natural Resources Management Board (SE NRM Board) has been implementing an Enhancing Soil Health project during 2010 - 2013, with funding provided by the Australian Government Caring for our Country program and the SE NRM Board.

As part of this project, the SE NRM Board is supporting demonstration sites on the Kirkland family's property at Conmurra. A demonstration farm is not a scientific trial; rather it aims to measure things that are happening in working farm situations.

The Kirkland family has been applying a lot of different treatments to the soil on their farm over the last decade. These treatment sites are being used by the Enhancing Soil Health project to test soil conditions such as carbon content and acidity levels following the treatments.

THE LANDSCAPE

The soils identified at the site were all shallow over calcrete. Some soils were as shallow as 15cm, while others presented almost a meter of root zone, albeit with substantial calcrete rubble below about 20cm. In addition, a number of the soils were weakly structured loamy soils over brown clay. Other soils were strong and finely structured black clay.

The high inherent fertility of the soils indicates that the clay minerals are dominated by smectites, which are highly fertile clays that shrink and swell significantly. Most of the soils are neutral to alkaline, becoming strongly alkaline at depth. Some of the loam over clay soils can be strongly acidic; with the 3 loam soils measured having surface pHca below 5.

WHAT ARE WE MEASURING?

A variety of treatments on the farm that can potentially influence soil pH, soil hardness and/or soil fertility are being measured. These treatments include:

- No till cropping,
- Various grazing regimes,
- A range of fertiliser treatments

SUMMARY OF PREVIOUS INFORMATION

10 paddocks/sites investigated

1. The physical qualities of the black clay soils are excellent. They are friable, with a high volume of pore spaces to facilitate root growth and air movement. Their high organic matter content, high calcium saturation and shrink swell properties give them significant resistance to compaction and other physical degradation processes. However, compaction from stock and other traffic when the soil is wet still has an impact. The reduced traffic of the cropping paddock has around 10% lower density than those carrying sheep. This can be interpreted as having 10% more soil volume for holding water, which can be quite influential in a soil that is only 15cm deep. Managing these soils to reduce traffic when they are waterlogged will enable them to quite quickly self-repair as the clay minerals shrink and swell.
2. A relationship between total **phosphorus (P)** and Colwell P has been developed, which could be used to determine how much extra P is required to get to a certain target level of P. With good management it may be possible to achieve nearly 100% efficiency from applied phosphorus fertilisers, once the threshold is reached. Note that the black flats soils hold onto phosphorus more tightly than many other soils. This is due in part to their high organic carbon and calcium contents.
3. The black clay soils have high organic carbon (OC) content, often around 5% OC in the surface. High carbon levels are common in soils that have formed while being seasonally inundated by a shallow water table. It is likely that modern agricultural practices, in particular cultivation and landscape drainage, will cause the carbon content to decrease with time. This decrease will be partly due to improvements in the

biological activity of the soil, leading to increased decomposition and turnover of carbon. For all its benefits to soil structure, high carbon comes with a cost and ties up much of the nitrogen and phosphorus. Some of this will be released over time, but much will remain unavailable to plants in the medium term.

4. On this farm the "never fertilised" treatment achieved pasture growth of 3.5 tonnes/ha between the break of season and November, which is about a half the growth of the other pasture paddocks with a phosphorus fertiliser history.

NEW INFORMATION

Further investigation was undertaken into 3 paddocks/ treatments during 2011/12. This included paddocks that had the following treatments:

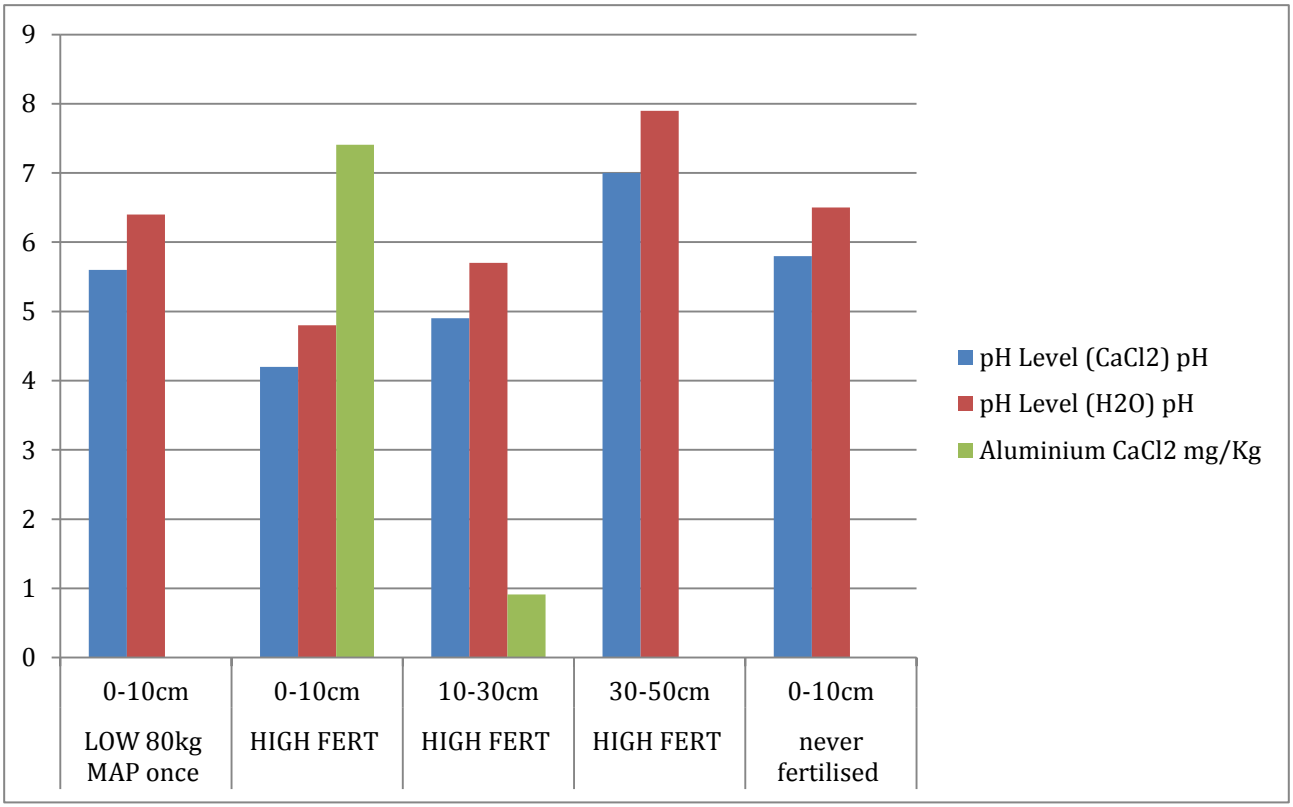
- Never fertilised (an area never fertilised)
- 80kg/ha MAP once (low nutrient applied)
- High fertility bean paddock (high nutrient applied)

Investigations included soil analysis and bulk densities of soil layers. Soil analysis was undertaken in late 2011 and early 2012 for deep nitrogen (N).

Acidity an issue on perceived "alkaline" flats

Even though the general soil type is black clay, the three areas sampled in 2011 all had acidic surface soils. This is consistent with last year's analysis where surface soils varied from 4.5 to 7.0, although in this comparison area Richard Kirkland believes the soils maybe even more acidic possibly due to a geological fault in this area changing the surface soils.

Toxic levels of aluminium can affect sensitive plants when levels are greater than 2 mg/kg, which is the case in the surface soil on the high fertiliser site. At this site he pHCa was 4.2 and aluminium 7.4, which will affect the yield of most crops and pastures. As discussed above acidity was also detected in some of last year's surface soils so pH needs investigation in this landscape. Of interest is the high fertiliser and high yielding area being more acidic than the non- and low fertilised areas. This is consistent with the causes of agricultural soils where they become more acidic when removing large amounts of product, such as growing legumes and using high rates of some nitrogen fertilisers.



NUTRITION

Nitrogen

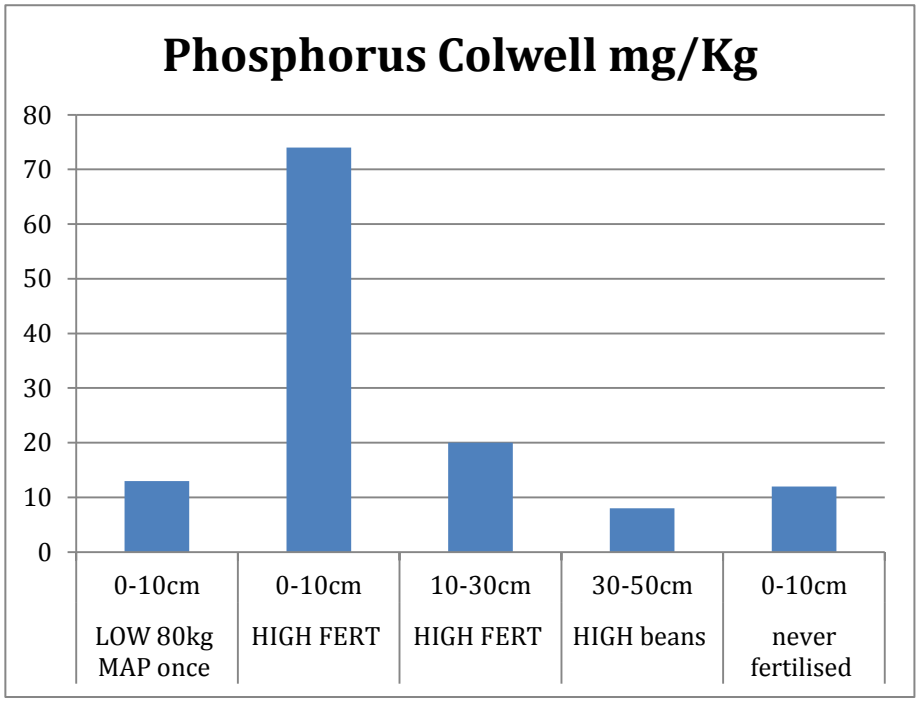
The high fertilised paddock was examined to 50cms in depth and found to have 85 kgs/ha of stored available nitrogen (Nitrate + Ammonium).

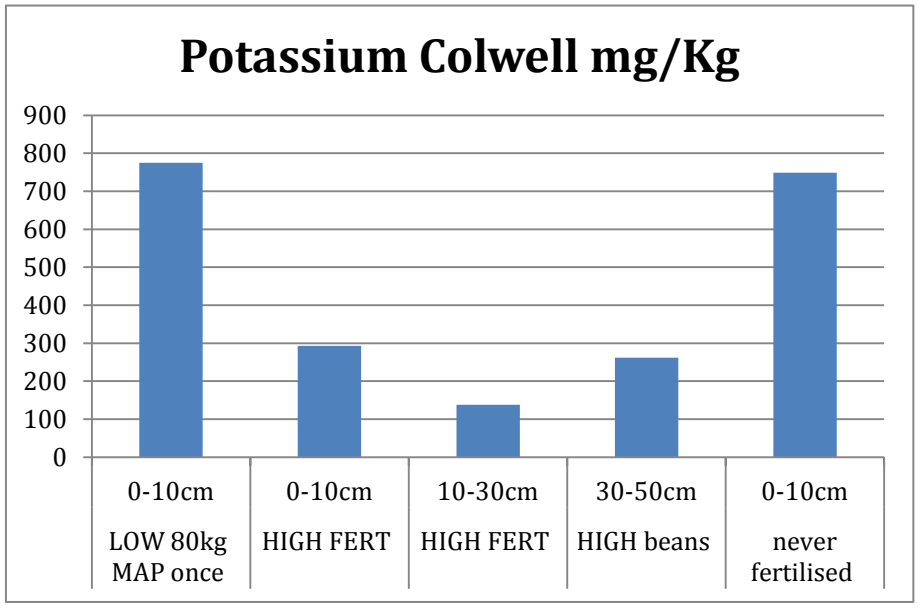
Phosphorus

Colwell P reflects the different histories of these paddocks with the high fertiliser topsoil, where even 10-30cms in depth has a much higher P than the non- and low fertilised areas. A natural level of around 12 mg/kg exists for this soil which is much higher than many other soils in the South East. Critical levels for Colwell P are around 30 – 40 mg/kg on this soil type.

Potassium and other cations

In a similar fashion other nutrients have been examined and interestingly, potassium levels are much lower in the heavily fertilised and farmed areas. While part of this maybe due to greater nutrient removal it is also linked to a more acid pH, lower cation exchange capacity (CEC) and lower levels of calcium and magnesium in this paddock. The lower levels of potassium are still above critical levels for all crops but they do raise the possibility of potassium issues in the future if the soil continues to acidify and nutrients are removed.





Trace elements

Trace elements were examined using the EDTA extraction technique. No plant testing was undertaken on Richard's farm during 2011, even though this is considered a more accurate method. Soil trace elements are poorly calibrated and critical levels will vary with soil types. Even so the table below indicates zinc to be much higher in fertilised paddocks probably due to fertiliser and low in the non-fertilised area. Marginal levels of copper and manganese are identified in the areas with more fertiliser and boron is identified at good levels in all topsoils.

At the field day in March 2012 Richard outlined his approach to trace elements including making his own stock licks and incorporating liquid trace element soil sprays in his seeding operation.

		boron Hot CaCl2	EDTA copper	EDTA manganese	EDTA zinc	EDTA iron
		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
LOW 80kg MAP once	0-10cm	1.83	1.75	70.09	0.49	408.24
HIGH FERT	0-10cm	0.78	1.07	8.86	1.75	736.32
HIGH FERT	10-30cm	1.9	0.78	4.81	0.48	364.52
HIGH beans	30-50cm	3.99	0.58	18.12	0.19	72.64
Never fertilised	0-10cm	1.89	1.62	50.79	0.55	368.7
Ball park Critical Level Heavy soils	0-10cm	1.0	1.0	10.0	1.2	N/A

PHYSICAL

Bulk Density

Bulk Density is a measure of soil hardness and density in grams/cm^3. Soil density is weight by a standard volume- therefore, higher the figure the more dense the soil. Generally in soils normal density is about 1.3-1.4 grams/cm^3, where at > 1.6 grams/ cm^3 root growth issues can occur.

For those paddocks examined, bulk densities came out between 1.2 and 1.3 grams/ cm^3. The good natural structure of these soils indicates there are no compaction issues.

Shallow black clay over fractured calcrete

Summary of Paddocks and Treatment evaluated in 2012

1. loamy surfaced soil- long term crop rotations
2. loamy surfaced soil- long term pasture
3. clayey surfaced soil- pasture cropped
4. clayey surfaced soil- long term crop rotations
5. clayey surfaced soil- long term pasture
6. No mineral fertiliser ever- road reserve.
7. liquid P- district average rate for liquids (located 0-30m from E fence line)
8. No P this year (located 30-60m from E fence line)

If you are interested in finding out more about the Enhancing Soil Health Project please contact Natural Resources South East by phone on 08 8735 1177 or by visiting the South East Natural Resources Management Board's website www.senrm.sa.gov.au