Results of the soil treatments at the Prices' farm

The South East Natural Resources Management Board (SE NRM Board) has been implementing an Enhancing Soil Health project from 2010 to 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 and paddock scale investigations on the Price family's property at Glencoe. A demonstration farm is not a scientific trial; rather it tries to measure things that are happening in working farm situations.

The Price farm has a range of soils, all under similar grazing management, and this project aims to determine what makes some more productive and resilient than others. Soil conditions such as carbon content, fertility and acidity levels will be examined to see whether they are the factor's involved.

THE LANDSCAPE

The Price farm is situated mostly in the Young land system. It consists of a poorly drained sand plain. There are extensive swamps with peats or organic clays and sand over clay soils on elevated parts of plain. On the western part of the property the Mt Burr land System occurs where the landscape has been topped with volcanic ash over sandy and loamy soils and calcarenite.

Key soils include: Wet highly leached sand, thick sand over clay, highly leached sand, peaty soil, sand over acidic clay, bleached sand over sandy clay, loam over

brown clay.

Prices' at Glencoe

SUMMARY

The main limiting factors for land use in this land system are poor drainage and low fertility of the sands. The low landscape position of this land system makes external drainage difficult. Some areas have acid soils which have low production and require amelioration with lime.

The soils/ paddocks described at the site included

1. Clay spreading trial of a soil with a bleached sandy surface
2. Black clay flats
3. Better quality sandy soil
4. High productivity fertile loam
5. Wet loam

WHAT ARE WE MEASURING

Soil pH, salinity, soil hardness and / or soil fertility are being measured. A small treatment area examining clay spreading with a black clay is also being monitored.

Various measurements have been taken over a 12 month period at the demonstration sites and these have included:

1. Soil sampling at different depths (0-10cm, 10-30cm and 30-40cm) to test for pH, aluminium (AL), total organic carbon (TOC), cation exchange capacity (CEC), phosphorus (P), potassium (K) and nitrogen (N) and trace elements
2. Soil properties (texture, colour, pH, horizon depth)
3. Penetrometer and bulk density tests
4. Yields from demonstration areas

THE RESULTS TO DATE (FROM 2012)

Physical

The physical qualities of the range of soil were assessed by measuring the bulk density of soil down to 30cms. Generally, sandy soils are more prone to the development of dense layers, while clays which shrink and swell themselves are less prone. Compaction from stock and other traffic when the soil is wet can have an impact on any soil. The bulk densities of the soils shown in Figure 1 below are low to moderate (soils are generally not considered to be dense until they are over about 1.5-1.6g/cm3). The 10-20 cm and 20-30 cm layers on the sandy soils and the wet loam have the highest readings and are the most vulnerable layers. Root growth can be restricted around the 1.6 g/cm^3. Managing these soils to reduce traffic and livestock pressure when they are waterlogged will help prevent compaction.

Penetrometer resistance was also measured as a measure of soil strength with the results in Figure 2 below. Generally a resistance of around 2500 kPa on a soil at field capacity is where roots struggle to grow through soil layers. This was only evident in the leached sandy soil at about 35 to 45 cms.

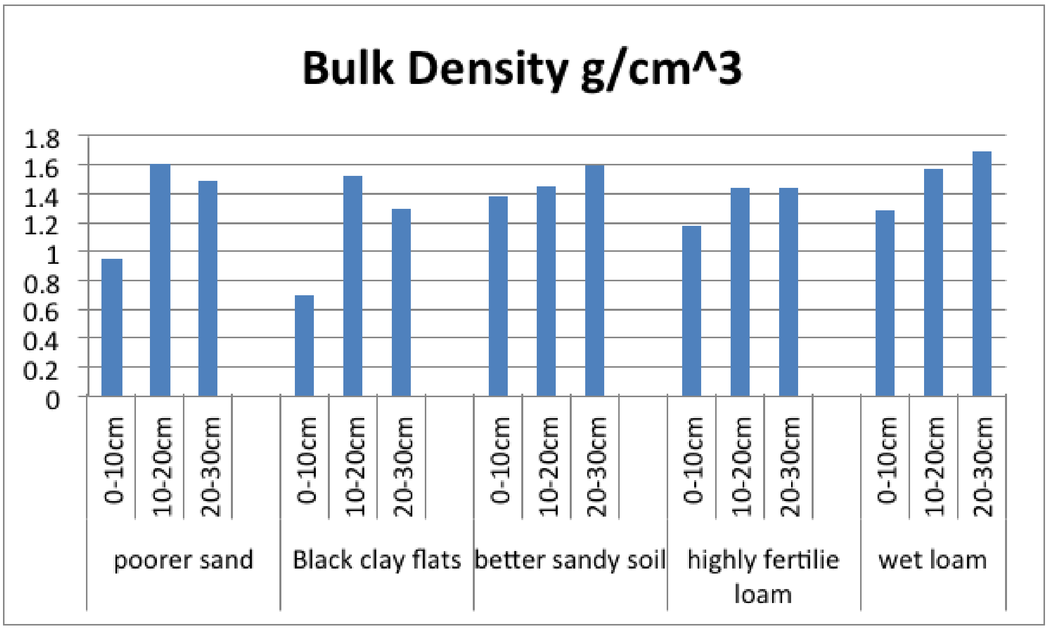

Fig 1 – bulk density of different sampling areas/ paddocks

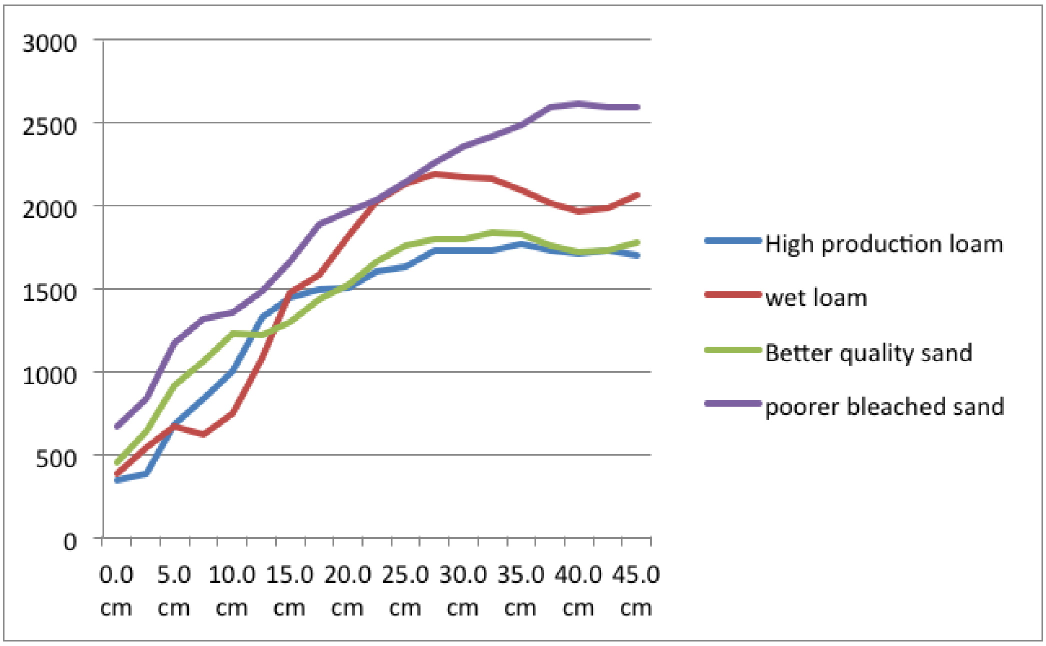

Fig 2 – Penetrometer Resistance in kPa

CHEMICAL

Some useful chemical relationships have been observed on the Glencoe Demonstration farm.

Acidity

Acidity showed up as a marginal issue in most paddocks, with the fertile loam having the worst pH down to 30cms. The low pH continued down the soil profile in most soils and was generally more pronounced in the 10-20cm layer. This may be due to recent liming of some paddocks.

pHCa and Exchangeable aluminium (Al) are shown in Figure 4 below for all data. Soluble aluminium is toxic to plants and affects fine root hair development, resulting in short and stubbly root growth. Soil layers with high soluble aluminium are sometimes referred to as chemical hardpans due to the way that they block root growth. Al increases sharply when soil pH falls below pHCa 5.0. Below this is the criteria used for liming in South Australia based on trial responses and the prevention of acidity.

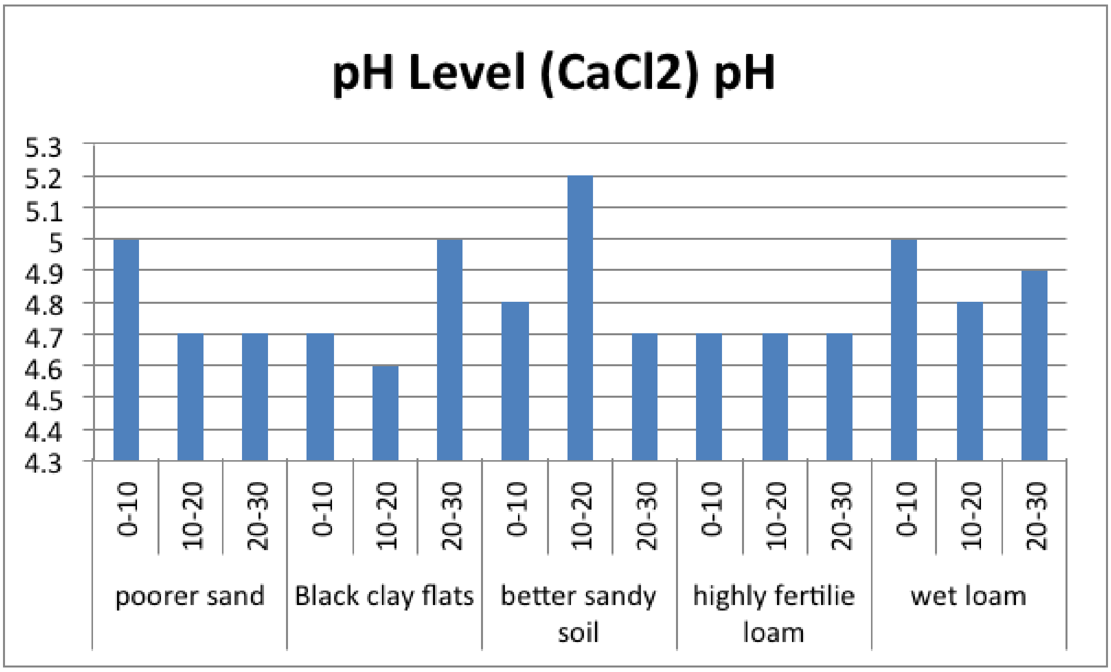

Fig 3 – pHCa across paddocks and depths

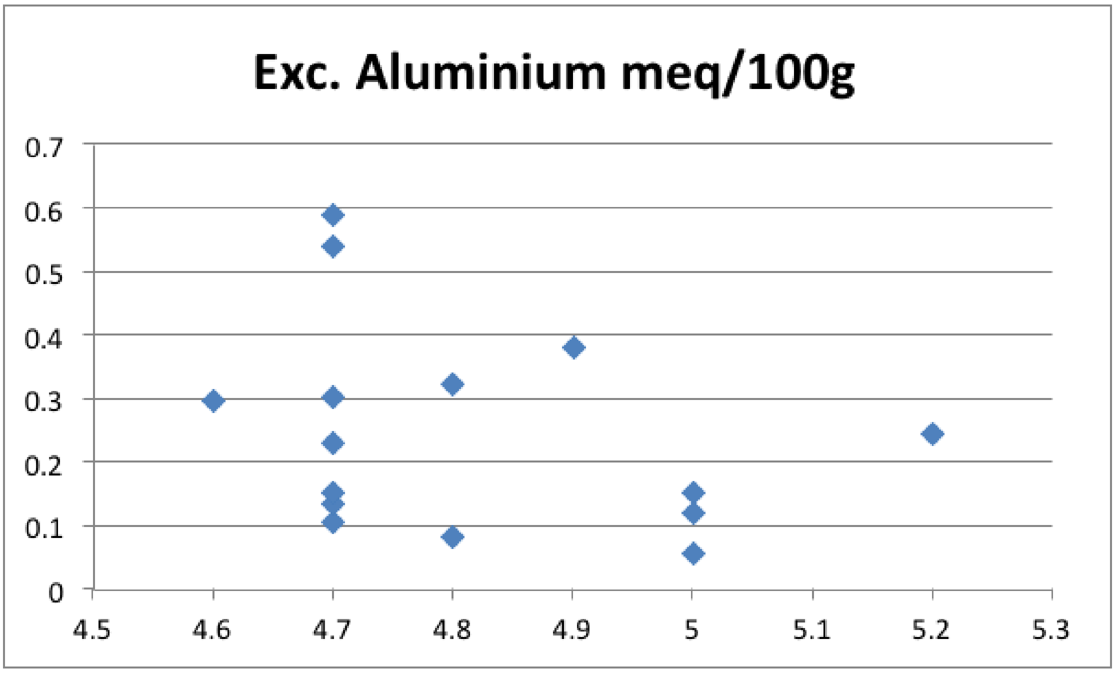

Fig 4 – Relationship between Al and pH

Criteria for liming– using pH (Calcium Chloride) for acid soils

pH Ca	Interpretation	Lime requirement for pastures or dryland crops
<4.8	Strongly acidic	Lime or equivalent required ASAP
4.8-5.2	Moderately high acidic	Lime or equivalent required in near future
5.2-5.5	Moderately acidic	Consider liming as preventative strategy or for highly sensitive crops

Phosphorus (P)

Soils were tested for Colwell P (available) and total P, and a Phosphorus Buffering Index (PBI) was undertaken. PBI gives a measure of the fixation potential of a soil or, where it is very low, the leaching ability of a soil. In Figure 5 below, there was quite a range of P levels in different paddocks from low to adequate using the Colwell test – if just considering the topsoil layer all were marginal to adequate. The PBI indicated the sandy soils to have an extremely low level indicating the potential for P leaching. The movement of P down the profile is also observed by the high total P and Colwell P down the profiles, particularly on the sandier soils.

A new method of P assessment is undertaken using the critical Colwell P assessment, which simply means having a different critical level based on the PBI. Under this assessment some of the soils move from being considered adequate to low when the PBI was taken into account.

Treatment	Phosphorus Colwell	Total Phosphorus	PBI	Assessment Colwell P	Assessment PBI	Critical Colwell assessment	Leaching Using total P levels
cm	mg/Kg	mg/Kg					
poorer sand 0-10	22	82.4	11.3	marginal	EL	marginal	high
10-20	19	62.3	11.3				
20-30	23	404.0	21.5				
Black clay flats 0-10	37	133.5	79.5	adequate	L	adequate	moderate
10-20	16	90.5	55.7				
20-30	12	180.4	64.9				
better sandy soil 0-10	30	133.8	12.3	adequate	EL	adequate	high
10-20	25	118.8	15.2				
20-30	34	533.7	14.0				
highly fertile loam 0-10	41	486.6	153.4	adequate	M	marginal	moderate
10-20	30	397.8	138.9		L		
20-30	27	468.9	158.9		M		
wet loam 0-10	27	281.5	112.1	adequate	L	low	low
10-20	17	182.0	127.0		L		
20-30	12	142.9	148.5		M		

Fig 5 – Phosphorus status using different tests and methods **– in blue is the best assessment!**

Potassium (K)

Surface potassium varied from 63 to 298ppm. With a critical level around 100-120ppm this indicated some soils potentially have low potash. The high production fertile loam was the lowest K level possibly induced by regular hay cutting. The poorer sand, wet loam and black clay flats were all marginal for K so this is emerging as another nutrient required in a fertiliser program.

Organic Carbon

Organic Carbon % was measured down to 30cms and presented as mean levels to this depth in Figure 6 below.

This highlights the inherent properties of the sandy soils which have a much lower ability to build and hold organic matter compared with the loamy and clayey soils. Clay spreading and increasing the texture of the soil may allow an increase in the soil's ability to hold organic matter.

Sulphur (S) and Nitrogen (N)

Sulphur and available nitrogen were measured down to 80cms with the results presented in Figure 7 below. Nitrogen included both the nitrate and ammonium forms. The poorer sand paddock is much lower for N and extremely low for S when compared with other paddocks. The ammonium forms of N were relatively higher in the wetter soil such as the black clay flats and wetter loams due to waterlogging and less oxidation.

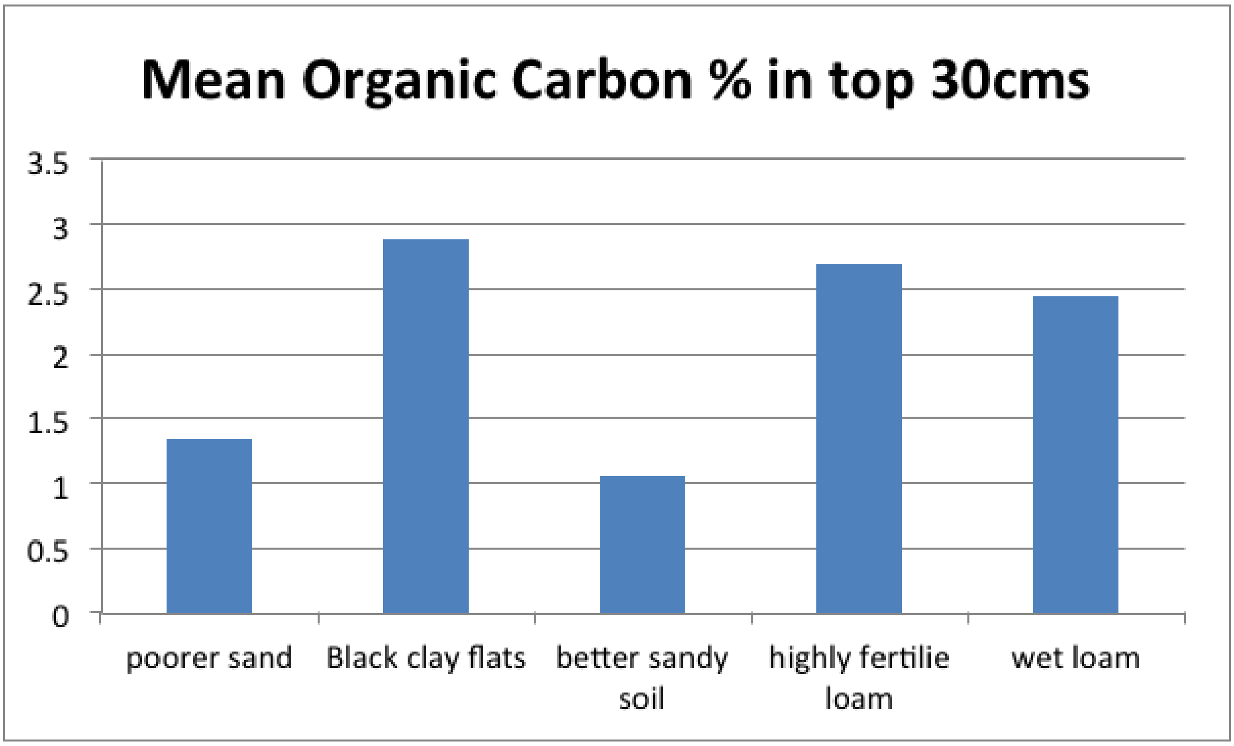

Fig 6 – The mean organic carbon in the top 30ms by paddock

Other Elements

Soil testing was undertaken for trace elements using the EDTA method. While noting soil testing for trace elements is unreliable and lacks established critical values, using ball park levels there were low levels observed for copper (Cu) in the two sandy paddocks. Zinc (Zn), iron (Fe) and manganese (Mn) levels generally looked good while boron (B) was inconclusive. Plant analysis should be undertaken to confirm any trace element issues.

Salinity was an issue with the black clay flat with elevated chloride and ECe when sampled during March 2012. This resulted in elevated sulphur as well on this soil.

Use of chicken manure

The Prices have been experimenting with the use of chicken manure as a fertiliser. Ball park analysis of chicken and pig manure is presented in the table below from Glendinning.

Typical available nutrient content (%) of various manures at 50% moisture, double figures for dry weight (from Glendinning, J S (2000))

Source	N	P	K	Organic Matter
Chicken	0.8-2.6	0.6-2.0	0.4-1.2	30-35
Pig	0.6-1.2	0.5-0.8	0.4-1.0	15-20

Using a product at 1.5% P would need about 600kg/ha to get same P as single super at 100kg/ha and this would give you up to 15-20 kg of N and 6 kg of K, although significant amounts of N in manures (up to 50%) can be volatised.

The analysis provided from the supplier suggests their source has either: 1.35%N, 1.36%P and 1.25%K or 10X these amounts. Chicken manure has some level of other nutrients and is a slow release product which suits the sandier soils in this environment.

Use of black clay area for clay spreading on poor sand

A small trial/demonstration has been established to examine the use of black clay from a nearby swamp to possibly improve the performance of the deep leached poorer sandy soils. There was some evidence of improved production even when the clay was placed over the sand but some long term monitoring is required. An analysis of the black clay material indicated it is only about 16-21% clay (genuine clay layers have around 35-50% clay) but has reasonable amounts of organic matter (around 2%), some phosphorus (total P 60-100 mg/kg) although available is low and elevated levels of chloride (680-700 mg/kg). pHCa was quite low in the low 5.0s. In comparison the clay under the better sandy soil nearby has a much lower level of P and organic matter but better levels of chloride (lower) and a higher pH (around 6.0)

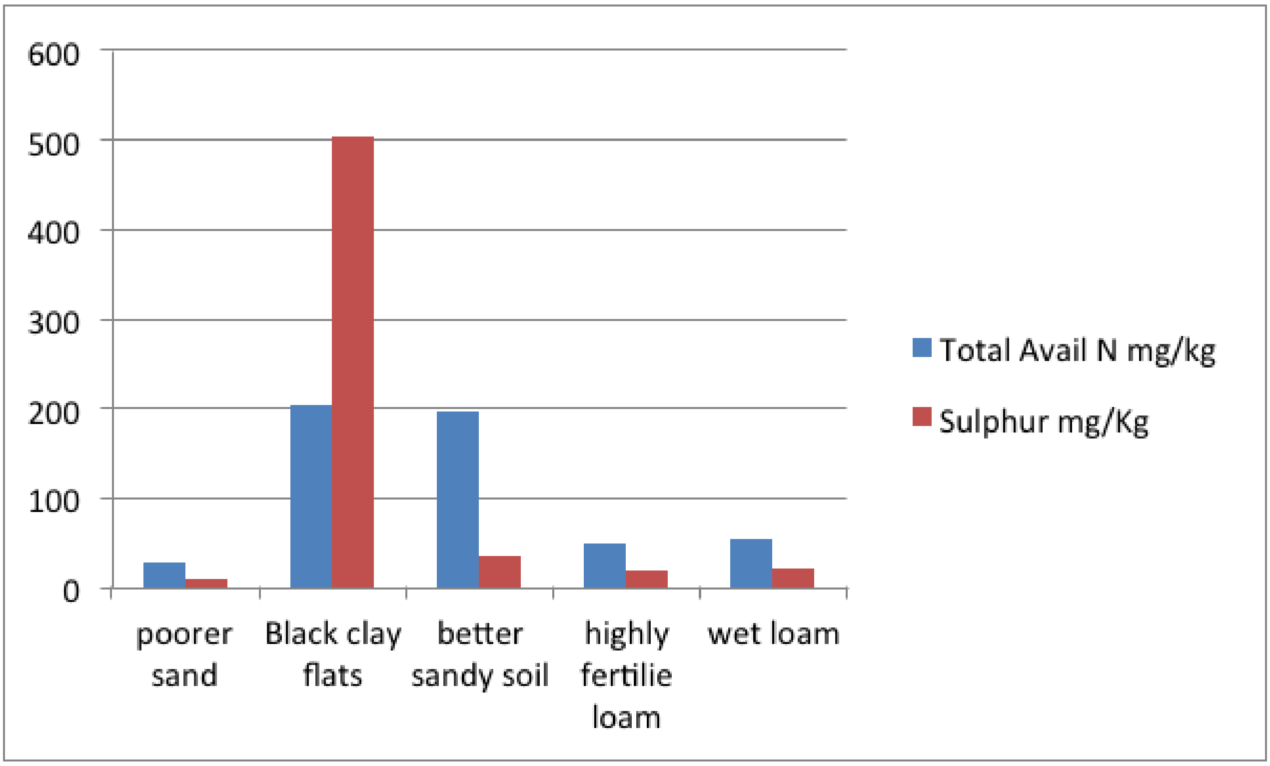

Fig 7 – Available nitrogen and sulphur to 70cms by paddock

So what are the Key Limiting Factors by Soil/Paddock?

Paddock	Key Limiting Factors	Possible Improvements
Low performance sand	Physical – moderate density at 10-20cm, high penetrometer readings at 30-45cm Chemical – low PBI, CEC,K, S, Cu all low Marginal pH and available P	Avoid compacting consider the use of deep ripping? Improve nutrient holding capacity Slower release fertiliser
Black clay flats	Physical – no hard pans however waterlogging an issue at times Chemical – low PBI, CEC,K, S, Cu all low Marginal pH and available P Toxic salt at times	Wet tolerant spps/ drainage Correction of low nutrients Salt tolerant spps
Better quality sandy soil	Physical – moderate density at 20-30cm, high penetrometer readings OK Chemical – low pH, PBI, CEC, Cu all low	Correction of pH and nutrients Improve nutrient holding capacity?
High productivity fertile loam.	Physical – no issues Chemical – low pH, and very low K possibly from hay cutting	Correction of pH and nutrient
Wet loam	Physical – Moderate density at 20-30cms, penetrometer readings OK however waterlogging an issue at times Marginal pH and lowish K	Wet tolerant spps Correction of pH and nutrient

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**