

# How do Lachlan Valley cotton soils compare to northern NSW?

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A soil survey project was recently carried out in the lower Lachlan Valley around Hillston with the aim of identifying current and potential soil limitations to cotton production. Three main soil classes were identified — each with distinct features which influence cotton production.

Soil features were also compared with other cotton-growing valleys in northern NSW, and it was found that subsoil sodicity and structural instability pose the greatest potential threat to cotton production in the lower Lachlan. Other potential soil limitations to cotton production include subsoil alkalinity and deficiencies in organic carbon and subsoil phosphorus.

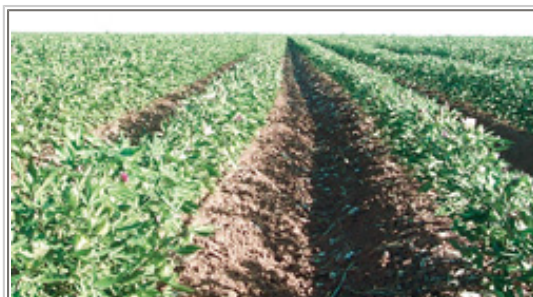
In recent years, the cotton industry has expanded from the more traditional cotton-growing regions of northern NSW and southern Queensland into new river plain areas such as the lower Lachlan Valley in southern NSW. Some distinct differences exist between southern and northern growing regions of NSW — particularly climatic conditions.

Management techniques that have been developed in northern NSW must be modified and adapted to southern NSW.

## Soil survey of the lower Lachlan River Valley

The soil survey area covered most of the cotton-growing properties in the Hillston region and involved the sampling of 114 soil cores to a depth of 1.5 metres.

Sampling focused on the alluvial plains where cotton production is based, but also included areas of sandy soil (wind-blown origin) which exist in locations adjacent to the Lachlan River and its associated streams. Soil was sampled



A Red Vertosol landscape used for cotton production in the Hillston district.

**TABLE 1: Attributes of three soil classes of cotton-growing soils in the lower Lachlan Valley**

	Grey Vertosol			Brown Vertosol			Red Vertosol		
	Topsoil		Subsoil	Topsoil		Subsoil	Topsoil		Subsoil
	Cotton	Natural		Cotton	Natural		Cotton	Natural	
pH	7.7	7.2	<b>8.8</b>	8.2	7.3	<b>9.0</b>	8.0	7.9	<b>9.2</b>
Clay (%)	56	50	53	52	46	49	52	43	53
CEC (cmol/kg)	34	24	31	31	24	28	30	22	28
ESP	3	1	<b>11</b>	2	2	<b>11</b>	3	4	<b>15</b>
ESI	0.18	0.17	<b>0.04</b>	0.11	0.07	<b>0.02</b>	0.09	0.09	<b>0.04</b>
Ca/Mg	1.8	1.6	1.6	2.1	1.9	1.7	1.7	1.9	1.3
P (mg/kg)	32	25	<b>11</b>	24	28	<b>12</b>	26	20	<b>8</b>
OC (%)	0.7	0.8		0.6	0.9		0.7	0.8	

Mean topsoil (0-20 cm) and subsoil (80-90 cm) results are shown, with topsoil results displayed for cotton and natural sites. Data indicating a potential limitation to cotton production are highlighted.

from the topsoil (0–20 cm depth) and the subsoil (80–90 cm depth) and analysed for various physical and chemical attributes.

### Soil types

As discussed in the recent article in The Australian Cottongrower by Cay and Cattle, three main soil types can be distinguished within the alluvial plains of the lower Lachlan Valley. These soil types can be differentiated primarily on colour and their proximity to active streams and waterways.

- Soil profiles closest to active streams and waterways are the most recently deposited in the landscape and are generally uniform in characteristics with depth. These soils are generally darker in colour and are classified under the Australian Soil Classification system (ASC) as Grey Vertosols.
- Secondly, a group of soil profiles are slightly more removed from active streams, but still within the alluvial floodplain. These soils are less grey and more brown in colour, and are classified as Brown Vertosols.
- The third and most dominant soil group in terms of area covered, also falls within the alluvial landscape, but is further from the active waterways. This group is redder with a lighter (sandier) textured topsoil layer in undisturbed areas. Most of these soils are classified as Red Vertosols, although those with lighter textured topsoil may be classified as Red Chromosols/ Sodosols.

Outside these alluvial riverine plains there is another class of soils which are of wind-blown origin. Generally, these soils have a significantly lighter texture throughout the profile and are mainly red in colour.

### Soil analysis

Soil samples were analysed from both cotton-growing and uncleared (natural) sites, but the subsoil results presented are a combination of both landuse types due to the small variation in attributes at depth in the profile.

Table 1 illustrates that although there are many

**TABLE 2: Comparison of some soil attributes at cotton sites in the lower Lachlan Valley with the lower Namoi and Gwydir Valleys**

	Lower Lachlan		Lower Namoi		Gwydir	
	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil
pH	8.0	<b>9.2</b>	8.4	<b>8.9</b>	7.5	8.5
Clay (%)	53	53	56	57	55	56
CEC (cmol/kg)	31	30	39	44	35	40
ESP	3	<b>15</b>	4	<b>8</b>	1	<b>10</b>
ESI	0.12	<b>0.04</b>	0.06	0.07	0.2	<b>0.04</b>
Ca/Mg	1.8	1.3	1.8	1.7	2.4	1.7
P (mg/kg)	29		34		24	
OC (%)	<b>0.8</b>		1.5		1.3	

\*With the exception of OC% which is taken from natural sites.  
Data indicating a potential limitation to cotton production are highlighted.

similar characteristics between these three soil types, there are also subtle differences which are important in relation to cotton production.

## pH

The pH values measured throughout the topsoil and subsoil of all soil classes are higher (more alkaline) than the optimum range preferred by cotton. The pH also increases significantly from the topsoil to the subsoil. This trend is most pronounced in the Red Vertosols.

For all soil types, the natural sites display a lower pH in the topsoil than the cotton production sites. This is thought to be largely due to the homogenisation of the top soil layers within cotton sites by landforming and cultivation, which serve to mix higher pH soil from the subsoil in with the topsoil.

## Clay content

The Grey Vertosols have slightly higher clay contents throughout the profile than the other two soil classes. The undisturbed (natural) Red Vertosols have a distinctly lower clay content in the topsoil than the Red Vertosols used for cotton production.

Again this may be attributed to the practise of cultivation homogenising the upper layers of the profile, and mixing the heavier clay lower layers with the lighter-textured topsoil. The cation exchange capacity (CEC) variation between the soil classes closely mirrors the trends observed in the clay content.

## Structural instability

Soil structural instability is usually correlated with comparatively large amounts of sodium associated with clay particles. A sodic soil is often dispersive upon wetting, leading to the breakdown of soil aggregates and an undesirable massive structure, which also increases erosion risk. The two structural instability indicators examined here — exchangeable sodium percentage (ESP) and electro-chemical stability index (ESI) — are especially relevant when considering current and potential limitations to cotton production in the lower Lachlan Valley.

As indicated in Table 1, all three soil classes have ESP values in the topsoil below the critical value of five (as defined by SOILpak), with the Brown Vertosols having the lowest ESP values. But the subsoils display very high ESPs for all soil classes, especially the Red Vertosols, with mean ESP values of 15, indicating a very high sodicity risk.

The Red Vertosols rise above the ESP critical value of five much closer to the soil surface than the other soil classes. This suggests that the Red Vertosols, with a significant sodicity risk high in the soil profile, require careful management for sustainable cotton production.

The electro-chemical stability index (ESI) incorporates ESP and electrical conductivity (EC), and indicates whether a high electrolyte concentration will suppress dispersive behaviour caused by high sodium contents. SOILpak suggests a critical value of 0.05 for ESI, where any value below this cut-off indicates a potentially dispersive soil.

Like the ESP results, the ESI values for the lower Lachlan soils suggest that the topsoils of all classes are structurally stable, but that all subsoils fall below the critical value of 0.05, indicating potential structural problems. Interestingly, it is the Brown Vertosols which are projected by the ESI to be at the greatest risk of structural instability, with a mean value of 0.02.

### Ca/Mg ratio

The exchangeable calcium:magnesium ratio (Ca/Mg) data also indicates a tendency in the soils of the lower Lachlan Valley toward dispersion and structural instability. SOILpak suggests that soil with a Ca/Mg less than two show an inclination toward clay dispersion. Only the topsoil of Brown Vertosols is above this critical value.

### Phosphorus

Topsoil phosphorus (P) levels are quite similar throughout the three soil classes, with no obvious trends between cotton and natural sites. A large reduction in P levels from topsoils to subsoils is evident in all three soil classes.

A suggested critical value for Vertosol P content

for cotton production is 10 mg/kg, with cotton likely to show a response to P fertiliser application if soil P levels are less than this value. All three soil types are well above this critical value in the topsoil, and so P is unlikely to be a current limitation to cotton production.

But the subsoil P values are significantly less and are all close to the critical P value, especially the Red Vertosols. Although these subsoil samples were taken from beneath the root zone, these low values may become relevant in areas where the subsoil has been brought to the surface by land levelling for furrow irrigation.

The other consideration regarding soil phosphorus content is that there is a net deficit of P from the soil due to uptake and removal during cotton production. So phosphorus deficiency is a potential limitation to cotton production in the future and soil phosphorus testing should continue.

### Organic carbon

Soil organic carbon (OC) contents are uniformly low throughout the lower Lachlan cotton-growing region, which in turn may have a limiting influence on other soil properties such as soil stability and CEC. It is important to note that there is a general increase in organic carbon in natural sites compared to cotton sites, due to the presence of natural vegetation decomposing in these topsoils.

### Comparison with northern cotton-growing regions

The Lachlan Valley results were compared with recent soil surveys in the lower Namoi and Gwydir valleys.

Cotton farms in all three regions lie in the alluvial plains of their associated river systems. But the geological origin of this alluvial material differs between the northern and southern valleys. This in turn leads to different clay minerals in the soil, greatly contributing to distinctive soil characteristics.

The main differences between the soils of the different valleys were:

- All three regions had alkaline (pH > 8.5) subsoils, with the lower Lachlan Valley subsoils the most alkaline (mean subsoil pH of 9.2). This increased pH in the southern valley may be due to increased salt and carbonate deposits blown in from the arid interior. Excessive alkalinity is related to reduced availability of certain plant nutrients such as nitrogen, calcium and magnesium, and micronutrients zinc, manganese and iron, and is a potential limitation to cotton production.
- Average clay contents are high throughout the profile for all three valleys, with many sites containing over 50 per cent clay. But Lachlan Valley soils have significantly lower topsoil CECs than the other valleys. The Lachlan soils have a slightly reduced ability to supply cations that are used by plants as nutrients, but the 'chemical fertility' can still be regarded as moderate to high.
- While all three cotton growing valleys have similar topsoil ESP values (less than the critical value of five), the average subsoil ESPs increase to levels well above the critical value in all valleys — particularly the lower Lachlan Valley. The average subsoil ESP of 15 in this region is extremely high. Electro-chemical stability index (ESI) data also indicates reasonable topsoil structural stability throughout all three valleys. But average subsoil ESIs for both the lower Lachlan and Gwydir Valleys fall below this critical value.
- Exchangeable calcium magnesium ratio (Ca/Mg) results are consistent with the ESP and ESI results. Only the topsoil of the Gwydir Valley showed results within the optimum range. For both the topsoil and subsoil, the Lachlan Valley had the lowest Ca/Mg ratios, indicating an increased tendency toward dispersion compared to the northern valleys.
- Phosphorus (P) levels throughout the three valleys are reasonably similar and are well above the critical value of 10 mg/kg, indicating that cotton production is generally not suffering from P deficiencies at present.
- Soil organic carbon (OC) contents in the topsoil of natural sites are also significantly less in the lower Lachlan Valley than in the north. This is

likely to be a function of the lower rainfall in the Lachlan, contributing to a reduced growth of biomass that can decompose into organic carbon.

The reduced organic carbon levels could place a potential limit to current and future production.

## Summary

The greatest potential limitation to cotton production in the lower Lachlan is the threat of soil sodicity and structural instability, most particularly in the subsoils. Other limitations compared to the northern valleys are increased soil alkalinity, low organic carbon levels and subsoil phosphorus deficiencies.

It is important that future production management decisions recognise the soil variation and the current and potential limitations that various soil attributes impose on cotton production.

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