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SOILS OF THE CSIRO PASTURE RESEARCH STATION "LANSDOWN", TOWNSVILLE, QUEENSLAND

BY G. G. MURTHA AND B. J. CRACK

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C.S.I.R.O.
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I INTRODUCTION

The C.S.I.R.O. pasture research station “Lansdown” is situated 25 miles south of Townsville adjacent to the highway to Charters Towers. It was purchased in 1962 to be used primarily as an experimental station for the Townsville Pastoral Research Laboratory and comprises an area of almost 7,000 acres in the catchments of Double Barrel and Lansdowne Creeks. It occupies parts of Manton, Northcote, Leichhardt, and Dalbeg land systems of the Townsville-Bowen region (Christian *et al.* 1953).

The soils of the station have been examined to ascertain the nature, extent, and distribution of the major groups present. This has assisted in the selection of appropriate experimental sites and in the interpretation of results. Two levels of mapping were employed. Traverses were made on a 3 to 5 chain grid over the area planned for small plot experiments on the eastern side of the property and on the grazing trial area in Manton paddock. Over the remainder of the property traverses were made at 10 chain intervals with inspections along or adjacent to the traverse where necessary. Soil boundaries were plotted directly on to aerial photographs enlarged to 1” = 15 chains.

Although this has given a reliable picture of the kind and general distribution of the soils subsequent experience has shown that because of the complex soil pattern a much more detailed inspection is essential before designing any small plot experiments.

II ENVIRONMENT

(a) Landscape and Geology

The greater part of “Lansdown” is situated on an old alluvial system draining east to the Houghton river. This alluvial plain is flat to very gently undulating and lies within the 200 and 300 ft contours. Lansdowne Creek which runs through the north-western corner of the property now drains north to the Ross River but there is evidence to show that it once flowed east to the Houghton system. The flood plain exhibits a fairly complex pattern of old channel in-fills, relic back swamp deposits, and natural levees. Although these features are quite distinct, on close examination the air photo patterns are obscured by fairly uniform timber cover. Bore logs indicate that the soils of the alluvial plain are underlain by 20 to 30 ft of stratified sediments which in turn overlie deeply weathered granite. In several bores fresh granite was not encountered until 70-75 ft.

The hills forming the western boundary of the property have a fairly long 1-4° pediment slope, a short 4-7° talus slope with very steep rocky slopes to the crests at 600-1000 ft M.S.L. The small gullies draining these hills give rise to small colluvial fans at the base of the pediment slopes. Although fairly numerous most are of restricted area and consist of unsorted gravels, sands, and clay.

The major rock types of the hills are Palaeozoic metamorphics (schist, gneiss) quartzite, metamorphosed siltstone, sandstone and arkose), and the Devonian Fanning River group (greywacke, arkose, sandstone, shale, and limestone) intruded by Permian granite (Bureau of Mineral Resources, unpublished data). These rocks form the chief source of material for the alluvium of Double Barrel and Lansdowne Creeks. A small area of granodiorite forms the parent material of the soils on the undulating country north-west of Lansdowne Creek.

(b) Climate

Lansdown has a strongly seasonal rainfall pattern with approximately 75% of the mean annual rainfall falling in December to March inclusive, with slightly more than 50% in January and February. Table 1 gives the mean monthly and annual figures for Woodstock, 2 miles north of the property.

TABLE 1
Mean monthly and annual rainfall (in.), Woodstock* (61 year record)

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
8.98	8.48	5.83	1.63	1.17	1.11	.52	.48	.39	.58	1.77	3.5	34.23

* Data from Commonwealth Bureau of Meteorology

The rainfall is extremely variable, annual totals have ranged from 9 in. to 69 in. and the annua1 variability is 38% (mean deviation from the mean expressed as a percentage of the mean).

An assessment of rainfall reliability is given in Table 2 which lists the percentage chances of receiving specified amounts of rain or more each month.

TABLE 2

Rainfall Probability Woodstock*

(Percentage chance of receiving specified amounts of rain)

in.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
½	96	98	94	54	54	51	37	25	19	44	56	86
2	85	88	76	27	18	22	5	9	7	7	30	54
5	63	63	45	9	4	3	x	x	1	1	7	25
10	34	34	22	1	1	x	x	x	x	x	2	8
20	9	8	x	x	x	x	x	x	x	x	x	x

(x – Amount has not been recorded)

*Data from Commonwealth Bureau of Meteorology

Rainfall intensities are very high during the summer months due to the influence of tropical cyclones and thunderstorms. For the wettest months of January and February the amount of rain per wet day averages l inch.

The nearest temperature recording station is at Townsville. Table 3 gives the monthly mean maximum and minimum figures for that station. While Lansdown temperatures would be similar it is likely that maxima would be slightly higher and the minima slightly lower. Lansdown may experience an occasional light frost each year.

TABLE 3

Mean monthly temperatures, °F, Townsville*

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
maximum	87.0	87.1	86.3	84.3	80.6	76.6	75.5	77.0	79.9	82.7	84.6	86.5
minimum	75.8	75.1	73.5	69.9	64.5	61.0	58.8	60.7	65.6	70.6	73.6	75.6

*Data from Commonwealth Bureau of Meteorology

(c) Vegetation

Approximately one quarter of the property has been cleared for experimental use. The remainder is largely grassy eucalypt forest and low woodland which has been modified by fire, timber cutting, and ringbarking. Six broad communities are recognized; the major component species of these and their relationship to the soils of the area are listed in Table 4. Only a few of the communities are closely correlated with particular soils.

Evidence suggests that the ground cover was originally dominantly kangaroo grass (*Themeda australis*) with smaller areas of the blue grasses (*Bothriochloa* spp. and *Dichanthium* spp.) on the heavy clay soils. Due to the influence of grazing and burning black spear grass (*Heteropogon contortus*) together with the introduced annual legume Townsville lucerne (*Stylosanthes humilis*) is now dominant over much of the property.

III DESCRIPTION OF THE SOILS

Twenty-four soils approximating series level have been recognized and mapped as 27 units. As far as was practicable at this scale of mapping the units have been restricted to one soil; however this was not always possible so some are associations of two or more soils. For the convenience of map usage and easy reference each soil has been named. The mapping unit has been given the name of the dominant soil except where there is a gilgai microrelief or an association of two

TABLE 4

Plant Communities

Community	Tree Species	Ground Cover	Soils
Poplar gum - Bloodwood (grassy forest)	Euclayptus alba, E. polycarpa, E. tesselaris, E. crebra	Themeda australis, Heteropogon triticeus, H. contortus	Wyoming sandy loam, Glenoming sandy loam
Ironbark (grassy forest)	E. Crebra, E. alba, E. polycarpa	Heteropogon contortus, Themeda australis, Stylosanthes humilis	Woodridge sandy loam, Woodridge loam, Lansdown sandy loam
Poplar gum – Box (open grassy forest)	E. alba, E. brownii, E. tesselaris, E. crebra, Grevillea striata	Heteropogon contortus, Bothriochloa spp., Dichanthium spp., Stylosanthes humilis	Manton gilgai complex, Lansdown sandy loam
Ti tree (low woodland)	Melaleuca viridiflora, E. alba, Planchemia careya	Heteropogon contortus, H. triticeus, Stylosanthes humilis, Themeda australis	Stockyard sandy loam, Woodridge sandy loam, Glenoming sandy loam
Quinine – Ti tree (low woodland)	Petalostigma banksii, Melaleuca viridiflora, E. alba, Planchemia careya	Heteropogon triticeus, H. contortus, short annual Chloris spp., Stylosanthes humilis	Flagstone loamy sand, Miscellaneous 4
Sandalwood (low woodland)	Eremophilia mitchellii, Grevillia striata, E. brownii	Short annual Chloris spp., Stylosanthes humilis, Heteropogon contortus	Sandalwood sandy loam

soils of similar surface textures. These have been termed complexes and given the name only of the dominant soil present.

For the purpose of general discussion the soils have been grouped on the basis of the primary profile form (Northcote 1965). A brief outline of the soils and the occurrence of each mapping unit is given below with more detailed descriptions and analytical data for typical profiles presented in appendix I. The major characteristics of the soils and their classification are summarised in Table 5.

SOILS WITH UNIFORM TEXTURE PROFILES

These are soils which show very little if any texture differentiation throughout the profile. Horizon changes are very gradual to diffuse and are on the basis of colour, or presence of nodules or gravel. The textures may range from coarse sands to heavy clays.

Magenta Loamy Sand

Two or occasionally three terrace levels are clearly defined on the upper reaches of both Lansdowne and Double Barrel Creeks. This unit is restricted to the lowest terrace and to the alluvium of minor creeks and gullies. It consists almost entirely of the Magenta loamy sand but there are also some small areas of waterworn gravels and sand.

The typical profile is a uniform, dark grey-brown loamy sand showing little pedological development beyond the accumulation of organic matter in the surface 3-4 in. Weakly developed fine blocky structure may be evident in the Al horizon. Water worn gravels to 12 in. size are invariably found at a depth of less than 18 in.
Reaction trend is weakly acid to neutral.

Miscellaneous Unit 2.

The one small area of this unit is probably a deposit of sand and gravel associated with a prior course of Lansdowne Creek. It occurs as a low rise near the south west corner of Woodstock paddock. The soil has a thin grey-brown sandy Al horizon (3 in.) overlying a bleached very light grey- brown coarse sandy A2 horizon. Water worn gravels (1/4-2 in. size) are present in increasing quantities below 6 in. and are impenetrable below 18-24 in. Structure is apedal throughout and consistence is loose. The sands are normally weakly acid.
Small areas of water worn gravels also occur in this unit.

Miscellaneous Unit 4.

This unit includes some of the coarse sandy soils developed on the granodiorite north of Lansdowne Creek. It occupies fairly small areas on the ridge crests and includes numerous rock outcrops.

The typical profile has a grey-brown loamy sand Al horizon 4-5 in. thick overlying a very strongly bleached loamy sand A2 horizon. This often extends to 30 in. with then a gradual change to a light yellowish brown loamy or clayey sand. Weathered granite occurs at 42-48 in. The soils are normally weakly acid in reaction. Small areas of Flagstone loamy sand are also included in this unit.

Miscellaneous Unit 5.

The steep hilly country along the western boundary of the property is included in this unit. The lower colluvial slopes average 10-12° while some of the higher slopes are in excess of 50°. A wide range of soils are included as both metamorphics and limestones form the parent materials. Lithosols are dominant but some gravelly red and yellow earths occur on the lower colluvial slopes. The latter are similar to the Woodridge sandy loam but the A2 horizon is not as strongly developed and there are variable amounts of 1- 3 in. gravels present throughout the profile.

The lithosols have a thin (2-3 in.) dark grey-brown loam to clay loam surface over a grey-brown or reddish brown clay loam subsoil. There is normally much stone on the surface and throughout the profile which rarely exceeds 15 in. in depth. Reaction is slightly acid.

The major part of the limestone is exposed as bare rock outcrops but small areas of very shallow red soils are developed on benches and in minor depressions. These have a very dark grey-brown light clay Al horizon grading to a dark red light to medium clay B horizon. Structure is strong fine blocky throughout. Most profiles contain variable amounts of coarse limestone gravel and grade to weathered limestone at depths of less than 24 in.

Calman Clay

This unit is restricted to two small, very slightly depressed areas in Manton paddock. Calman clay is a black earth and in the past probably occurred extensively in the back swamps of the Double Barrel Creek flood plain. It has now been almost entirely covered by later deposits as shown by its presence as a buried layer beneath the solodics surrounding the areas delineated and as the puff profile in some areas of the Manton gilgai complex.

Calman clay has a thin ($\frac{1}{2}$ to $1\frac{1}{2}$ in.), massive surface horizon of light to medium clay overlying very dark grey or black heavy clay with a strong, coarse lenticular structure exhibiting highly polished surfaces. Below 18 in. there is a gradual change to a light grey or yellowish grey heavy clay with a strong coarse blocky structure. These clays are hard when dry and very plastic when moist. Below 30 in. texture gradually decreases to a light clay. Only traces of carbonate occur in the upper 20 in. but very high concentrations of both diffuse and nodular carbonate are found below this and continue to at least 5 ft. Reaction is weakly alkaline at the surface but becomes very strongly so at depth .

Gilliqan Clay

The Gilligan clay is a grey- brown soil of heavy texture with a dark grey- brown, light to medium clay surface horizon 4 to 5 in. thick grading to olive-brown heavy clay. Below 30 in. there is a very gradual change to a dark yellow- brown heavy clay which continues to at least 7 ft. The upper part of the profile is strongly structured; the surface has a fine (1/4-$\frac{1}{2}$ in.) blocky structure grading to coarse blocky and at 30 inches to very coarse lenticular units. Low to moderate amounts of hard carbonate nodules are present throughout with some soft diffuse carbonate at depth. Low amounts of fine (l/8-1/4 in.) ferromanganiferous nodules occur throughout the profile. Occasionally there is some coarse water worn gravel on the surface. Reaction is moderately alkaline throughout.

SOILS WITH GRADATIONAL TEXTURE PROFILES

These soils gradually increase in texture with depth. The texture increase between successive horizons occurs over a depth of at least 4 in.

Flagstone Loamy Sand

This unit is confined to the gently undulating granodiorite country north of Lansdowne Creek. Slopes range from 2 to 7 degrees and the ridge crests are gently rounded. Since settlement and stocking most of the minor drainage lines have been deeply dissected by gully-head erosion.

The major soil of this unit is Flagstone loamy sand but small areas of Miscellaneous 4 occur on and near the ridge crests and Miscellaneous 3 on the basal slopes.

The important morphological features of the Flagstone loamy sand are a light grey-brown apedal loamy sand A1 horizon 4-5 in. thick overlying a strongly bleached loamy sand A2 horizon. This is apedal, incoherent, and often contains low to moderate amounts of 1/4-$\frac{1}{2}$ in. ferromanganiferous nodules. At depths ranging from 15 to 24 in. there is a gradual change to mottled yellow-brown and dark red sandy clay loam. This has a weakly developed fine blocky structure and occasionally contains some soft red ironstone concretions. Below 30 in. texture gradually becomes coarser with increasing amounts of soft, white altered felspar. Weathered granite is usually encountered by 42 in. Reaction is acid throughout.

Wyoming Sandy Loam

This unit occupies a very low, broad, east-west rise 2-3 ft high and 10-25 chains wide in the southern half of Woodstock paddock. The presence of coarse water worn gravels at depths of 3 to 4 ft in the profile suggests it is probably an old infill channel of Lansdowne Creek. It is likely that Lansdowne Creek originally flowed due south after emerging from Dean's Gorge and connected with either 4 Mile or Double Barrel Creek.

Wyoming sandy loam is a red earth characterised by a dark brown or dark reddish brown sandy loam surface grading to yellowish red or red, sandy clay loam and then to sandy medium clay B horizons. Structure is massive throughout but fabric is earthy and porous. Consistence is very friable when moist and slightly hard when dry. In some areas a very weak A2 horizon has developed and there are normally some soft ferromanganiferous segregatio ns through the B horizon. Very coarse water worn gravels are invariably encountered at depths of 36 to 48 in.

Associated with Wyoming sandy loam are small areas of red podzolics which occur on the lower side slopes of the low rise. It is not possible to separate these at the level of mapping employed. This associated unnamed podzolic soil differs from the red earth in that it always has an A2 horizon (often sporadically bleached) and has strong fine (1/4-$\frac{1}{2}$ in.) blocky structure in a faintly mottled B2 horizon. This soil is transitional between the red earth and Glenoming sandy loam. The reaction of both the earths and the podzolics is weakly to moderately acid throughout.

Miscellaneous Unit 1

This unit contains a range of soils that have developed on small areas of relatively unsorted colluvium and fan deposits. They occur commonly where small creeks and gullies flow from the hills along the western boundary. Small areas in Manton and Windmill paddocks are associated with relict levees of prior streams.

The dominant soils are weakly developed red and yellow podzolics. They have grey-brown or brown sandy loam Al horizons overlying pale brown sandy loam A2 horizons. At 8 to 12 in. this grades into a yellow, brown or reddish brown sandy clay loam which is normally massive but occasionally has a very weakly developed fine blocky structure. Coarse gravels are encountered at depths of less than 4 ft. The reaction trend is weakly acid. Similar soils but with coarse gravels at 12-15 in. also occur, commonly on the higher fan slopes.

Double Barrel Sandy Loam

This unit is confined to the third or highest terrace of Double Barrel Creek, the second or highest terrace of Lansdowne Creek, and to an area of alluvium near the head of School Gully. Although there are some remnants of the high terrace still evident along Double Barrel Creek they are of very small extent and could not be delineated at the map scale.

The soils are well developed red podzolics with a dark grey-brown sandy loam Al horizon overlying a very pale brown or yellowish brown sandy loam A2 horizon, which occasionally may be sporadically bleached. At depths ranging from 8 to 15 in. there is a clear change to a red-brown or brown sandy medium clay B horizon with moderately developed coarse blocky structure and firm to hard consistence. Some soft ferromanganiferous segregations occur in the B horizon and coarse water-worn sands and gravels below 4 ft. Although most profiles are weakly acid to neutral in reaction carbonate is present in the B2 horizon of some.

Double Barrel Loam

Along the upper reaches of Double Barrel Creek this unit includes soils developed on the second or middle terrace but in the lower reaches where there is no terrace system evident it includes all the levee bank soils. Small areas of alluvium along minor streams are also included. Some of these have been delineated but many are too small to map, particularly those of the small gullies through Aerodrome Paddock.

The dominant soil is a red podzolic with a very dark grey-brown loamy Al horizon up to 8 in. thick and a grey-brown or dark brown A2 horizon. There is a gradual texture increase to a sandy clay loam through the A2 which may occasionally have a fine sporadic bleach. When moist the Aland A2 horizons are friable with a well developed fine blocky structure. At depths ranging from 10 to 18 in., most commonly about 14 in., there is a gradua1 change to dark brown or dark red-brown light to medium clay. This has a coarse blocky structure, is hard when dry and contains low amounts of soft 1/4-$\frac{1}{2}$ in. ferromanganiferous nodules. Some grit and very fine gravel are present throughout. Below 24 to 30 in. there is a gradual change to yellowish red sandy clay which grades to sandy clay loam and clayey coarse sand with depth. The texture decrease is accompanied by an increase in gravel which is often impenetrable below 42 inches. Most profiles are weakly acid to neutral in reaction but carbonate is present in occasional profiles.

Small areas of a reddish pra1r1e soil are also included in this unit. This is very similar to the Double Barrel loam but lacks an A2 horizon and has a very dark finely structured Al horizon of about 12 inches depth. There are also small areas of young alluvial soils which are often quite strongly stratified.

Woodridqe Sandy Loam

The soils of this unit are probably formed on relict levees of Double Barrel and Lansdowne Creeks. This is suggested by the elongate form of the units and their approximate parallel orientation to the present and prior stream channels.

Woodridge sandy loam has a grey-brown sandy loam Al horizon and a very pale brown sandy loam A2 horizon. These upper horizons are massive and porous, moderately hard when dry, and contain low amounts of fine ferromanganiferous nodules. At 9 in. there is a gradual change to light yellowish brown or pale brown sandy clay loam. This is normally massive and porous, occasionally with a fine red mottle but always with moderate to high amounts of hard red 1/4-$\frac{1}{2}$ in. ferromanganiferous nodules. At 24 to 30 in. there is a clear to sharp change to a very highly organized, mottled pale brown or yellow brown medium clay. This is most likely a D horizon as it is quite different from the materials above. It is much heavier textured, has a strongly developed structure and when texturing has the behaviour of a high sodium clay. Reaction also often shows a marked rise, in most profiles it is weakly acid in the A and B horizons but becomes strongly alkaline in the D horizon. Water worn gravels are encountered by about 6 ft. in most profiles and in others there may be an impenetrable hard pan beneath the D horizon.

Woodridge Sandy Loam sloping phase

This unit is restricted to the 1 to 4 degree piedmont hill slopes along the western boundary. The soils are very similar to those of the Woodridge sandy loam, having a grey-brown sandy loam Al horizon and a bleached sandy loam A2 horizon. Below 10 in. there is a gradual change to a yellow- brown sandy clay loam B2 horizon with a faint yellowish red mottle and variable amounts of 1/4-$\frac{1}{2}$ in. ferromanganiferous nodules. Structure is usually massive and earthy but very weak blocky units often accompany higher nodule concentrations. Most profiles grade into loose colluvial gravels by 42- 45 in. and only rarely is there a D horizon present. Reaction is weakly acid throughout.

Woodridge Loam

This is a yellow earth somewhat similar to the Woodridge sandy loam. The parent alluvium was probably deposited at the same time as that of the Woodridge sandy loam but represents the finer deposits of the back slope of the levee and hence the soils are of slightly heavier texture throughout. A characteristic feature of this unit is the occurrence of a prominent sink-hole microrelief. These depressions range from 3 to 12 in. in diameter and up to 30 in. deep.

Woodridge loam is characterised by a dark grey-brown loam surface grading to a faintly mottled, yellowish brown clay loam to light clay subsoil. The Al horizon is friable when moist with a moderate fine blocky structure but when dry consistence is hard and structure is less evident. An A2 horizon may be present but is only rarely sporadically bleached. There is a gradual texture increase from a clay loam A2 – B1 horizon to a light clay B2 horizon. This is normally yellow-brown with some fine yellowish red mottles and structure is massive and earthy with many fine pores and channels to 1/16 in. size. At depths ranging from 21 to 30 in. there is a clear change to a clay D horizon, which in most profiles is identical to that described for the Woodridge sandy loam. However, in other profiles it is more like the surface of the Gilligan clay. This is discussed further in the description of the Woodridge gilgai complex. Low amounts of 1/4-$\frac{1}{2}$ in. ferromanganiferous nodules are common throughout the A and B horizons. Surface horizons are moderately to strongly acid but free carbonate and high reaction values occur in the clay D horizon.

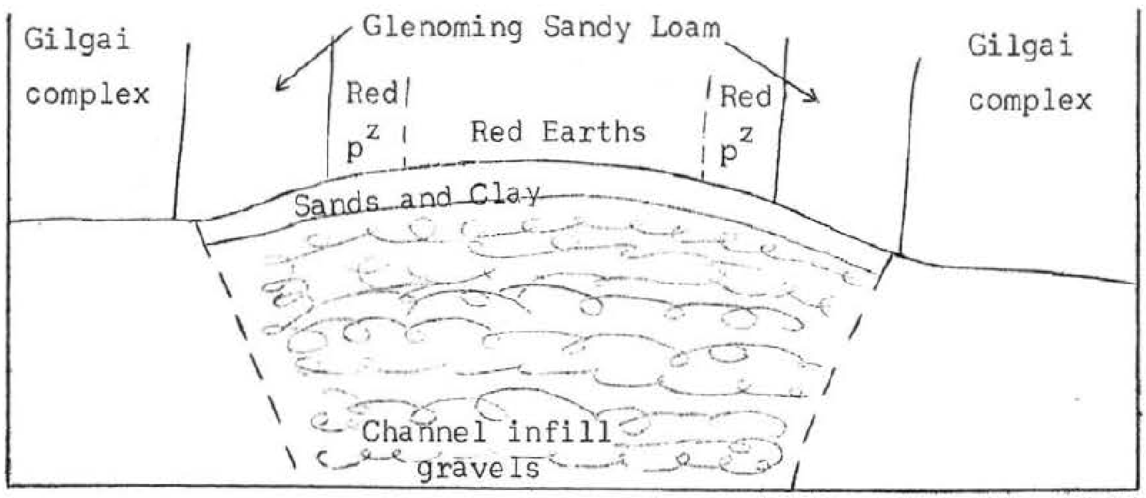
SOILS WITH STRONG TEXTURE CONTRAST

These are soils which have a very marked texture change between the A and B horizons. Commonly the increase is from sand or sandy loam to medium or heavy clay and occurs abruptly, often over a depth of less than $\frac{1}{2}$ in.

Glenoming Sandy Loam

The podzolic soils of this unit have developed along the margin of the low broad rise occupied by the Wyoming sandy loam. They are developed from the same alluvial channel infill as the Wyoming soils but due to landscape position experience somewhat wetter seasonal conditions which probably account for the stronger profile development.

The typical Glenoming sandy loam has a dark grey-brown sandy loam Al horizon and a bleached sandy loam A2 horizon. Both are massive and porous and contain low amounts of fine (1/8-$\frac{1}{2}$ in.) ferromanganiferous nodules. Below 9 inches there is a gradual change to a faintly mottled red medium clay with moderate to strong $\frac{1}{2}$ to 3/4 in. blocky structure and smooth ped faces. Low amounts of $\frac{1}{2}$ to 1 in. waterworn gravels occur throughout the B horizon but at 30-36 in. there is an abrupt change to very high amounts of coarse waterworn gravel in a red- brown sandy clay matrix. Reaction is weakly acid to neutral throughout the profile.



Miscellaneous Unit 3.

Two very small areas of this unit have been delineated, on the granodiorite north of Lansdowne Creek, and on granite at the southern boundary east of the highway. The soils are solodics and have developed on the lower 1 to 3 degree slopes of a gently undulating topography. They have a grey-brown loamy sand Al horizon up to 4 in. deep and a strongly bleached loamy sand A2 horizon. At 8-10 in. there is a sharp change to a mottled brown and yellow- brown sandy medium clay B horizon which has a moderately developed coarse blocky structure and contains low amounts of weathered felspar. At varying depths below 25 in. there is a gradual change to light yellowish brown soft decomposed granite. The A horizons are moderately acid but carbonate nodules are often present in the B2 and B-C horizons.

Sandalwood Sandy Loam

Small areas of this unit occur throughout the old flood plain system and are always characterised by a sandalwood (*Eremophila mitchellii*) dominant vegetation. The soils are all solodic to solonetzic in character with a very thin (1/4-$\frac{1}{2}$ in.) light grey-brown Al horizon and a very strongly bleached powdery A2 horizon. The total depth of the A horizons rarely exceeds 4 in. with then a very abrupt change to a grey-brown or olive-brown heavy clay B2 horizon. This occasionally has weak columnar structure but more commonly is prismatic breaking to coarse blocky units. With depth there is a gradual change to mottled, yellow-brown and red medium to heavy clay with well-developed coarse blocky structure and moderate amounts of hard carbonate nodules to 3 in. size. Below 40-48 in. texture gradually decreases and gravel becomes prominent. This is usually impenetrable by auger below 6 ft. Reaction is slightly acid at the surface but becomes strongly alkaline with depth.

There is very little variation from this general profile. A horizon textures may be a loam or light clay loam where the surface horizons are less than 1 in. deep and the colour of the B horizons is occasionally yellowish red.

Lansdown Sandy Loam

The dominant soil of this unit is a typical solonised soil common to much of the dry tropical coastal region. It has developed on the alluvium towards the back of the flood plains of both Double Barrel and Lansdowne creeks.

The most striking feature of this soil is the very strongly bleached, brittle, sandy loam A horizons. These range from 5 to 10 in. thick but commonly are 7- 8 in. A shallow ($\frac{1}{2}$ to 2 in.) slightly organic Al horizon overlies the almost white A2 horizon which normally contains low amounts of fine (1/8-l/4 in.) ferromanganiferous nodules. The A2 horizon is abruptly underlain by an olive-brown heavy clay B2 horizon. Columnar structure is occasionally evident but fairly coarse prisms which break to coarse blocky units are more common. When columns are present they range from 4 to 36 in. in diameter and the A horizons range from 5 to 15 in. in thickness. The clay is extremely hard when dry and contains low amounts of 1/4 in. ferromanganiferous nodules. Below 13-15 in. there is a gradual change to a finely mottled yellow- brown or yellow medium to heavy clay and at 36 in. this grades to mottled, light brownish grey sandy medium clay. This is massive, very hard when dry, and contains low amounts of $\frac{1}{2}$- 1 in. carbonate nodules and waterworn gravels. Texture further decreases with depth and gravel increases, augur penetration is not possible below 4- 8 ft. Reaction is weakly acid in the A horizons and is strongly alkaline in the deeper B horizon.

Lansdown Sandy Loam Gravelly Phase

This unit is restricted to small areas of alluvium associated with some of the minor creeks and gullies. The soils are identical to the Lansdown sandy loam except for the high concentrations of waterworn gravels to 6 in. size in the A horizons. These gravels have probably been locally derived.

Lansdown Fine Sandy Loam

This unit is confined to the l to 4 degree pediment slopes on the north west boundary. The soils are typical solodized solonetz with a thin (1-2 in.), slightly organic, light grey- brown Al horizon and a very strongly bleached fine sandy loam A2 horizon. Both are very hard and brittle when dry, but when disturbed become very powdery. (Although the depth of the A horizons averages about 10 inches there is a tendency for them to be deeper (12- 16 in.) on the higher piedmont slopes and shallower (8- 9 in.) on the lower slopes.)

At depths ranging from 8 to 16 in. there is a very abrupt change to mottled grey-brown and yellow- brown heavy clay, the upper part of the B2 horizon often having strongly developed columnar structure. The columns range from 3 to 6 in. in diameter with well rounded tops and break down to coarse blocky units. Hard carbonate nodules ($\frac{1}{2}$-1 in.) are present below 18 inches and low amounts of fine ferromanganiferous nodules occur throughout the B horizon. With depth the clay becomes more yellow in colour and at variable depths below 40 in. there is a fairly sharp texture decrease to sandy clay or sandy clay loam with increasing amounts of coarse gravels. These are impenetrable by auger below 48-60 in. Surface horizons are acid but subsoils are alkaline.

Stockyard Sandy Loam

This unit occurs sporadically over the property, its distribution probably being related to the depositional pattern of the old flood plain. The soils are again strongly solonised with a grey-brown sandy loam Al horizon and a strongly bleached loamy sand to sandy loam A2 horizon. The A horizons range from 15 to 24 in. in thickness but commonly average 16-18 in. In some profiles there is an A3 horizon of slightly heavier texture and pale yellow colour at the base of the A2. This is abruptly underlain by mottled yellow-brown and grey-brown sandy or gritty medium clay which occasionally has a weak columnar structure but more commonly is prismatic breaking to coarse blocky. The clay is very hard when dry, contains some ferromanganiferous nodules throughout and carbonate nodules below 30 in. With depth there is a gradual texture decrease to a sandy clay accompanied by an increase in gravel which is often impenetrable by auger below 40 in. In some areas beneath the gravels is a complexity of buried soils. These are usually strongly layered but are dominantly dark grey-brown or dark brown, medium or sandy clays with strongly developed fine polyhedral structure. Reaction is weakly acid in the A horizons alkaline throughout the B horizons, and normally weakly acid at the top of the D horizons.

Stockyard Loam

This unit is restricted to the eastern side of the highway where it occurs on the back slopes of the levees of Double Barrel creek. The dominant soil is a weakly developed solodic which is transitional between Lansdown sandy loam and Double Barrel loam.

A typical profile has a dark grey- brown Al horizon and an A2 horizon which is sporadically or occasionally conspicuously bleached. Both are friable when moist and have a weak fine blocky structure. At depths ranging from 12 to 20 in. (most commonly 14-15 in.) there is a very sharp change to mottled medium or heavy clay. The dominant colour of the clay ranges from the dark brown and red- brown characteristic of the Double Barrel loam to the olive and yellow- brown of the

Lansdown sandy loam. A weak prismatic structure is often evident in the top of the B horizon which breaks to a very coarse blocky unit with smooth ped faces. Carbonate nodules to 3 in. size are present below 24 in. and fine ferromanganiferous nodules and soft segregations occur throughout the profile. Water worn gravels are present below 30 in. and gradually increase in concentration with depth; in many profiles they are impenetrable by auger below 5 ft. Reaction is very weakly acid to neutral at the surface and alkaline at depth.

Manton Sandy Loam

Manton sandy loam is very similar to Lansdown sandy loam with a shallow slightly organic sandy loam Al horizon and a very strongly bleached sandy loam A2 horizon. Both are massive, hard setting, and usually contain some fine ferromanganiferous nodules. At 8-10 in. there is a very sharp change to mottled dark grey-brown and dark yellow-brown gritty medium to heavy clay with a weakly developed coarse blocky structure. Carbonate nodules are present below 15 or 18 in. and there are low amounts of soft ferromanganiferous nodules throughout the B horizon. At approximately 24 in. there is a gradual change to a brown or dark yellow-brown sandy medium clay. This is massive and has fine white felspathic flecking. With depth texture gradually decreases to a sandy clay, there is an increase in weathered felspar, and waterworn gravels increase and become impenetrable by auger below 4 ft. Reaction is weakly acid at the surface and strongly alkaline in the B horizons. The chief features which distinguish this soil from the Lansdown sandy loam are the dark brown colours, the sandy or gritty textures, and the white felspathic flecking of the B horizons.

Manton Loam

Only small areas of this unit have been individually mapped but Manton loam occurs extensively in the Manton gilgai complex. The dominant soil is a solodic with thin, medium-textured surface horizons. A dark grey-brown loam Al horizon overlies a sporadically bleached loam or clay loam A2 horizon. Near the centre of the depressions in the gilgai complex the bleach is often conspicuous. Fine water worn gravels are often present on the surface and throughout the A horizons. At depths ranging from 4 to 8 in. (commonly 4-5 in.) there is a very sharp change to dark grey-brown or dark brown heavy clay. This often has some weakly developed gley features or a faint yellowish brown mottling. Weakly developed columnar structure may occur but very coarse blocky units are more common. Low amounts of fine ferromanganiferous nodules are present throughout the B horizon and moderate amounts of hard carbonate nodules occur below 14-20 in. At 30 in. there is a very gradual change to a greyish-brown heavy clay with little structural development. Carbonate remains present and there is a trace of fine water worn gravel and grit. In some profiles the heavy clay grades into coarse water worn gravels by 4 ft but in the gilgaied areas the clay continues to at least 8 ft. Reaction is weakly acid at the surface and alkaline at depth.

Small areas of soils transitional to the Lansdown sandy loam are also included in this unit.

Manton Gilgai Complex

This unit has wide distribution over the property. The micro-relief consists of a series of puffs protruding above a flat surface. This is also a feature of the other gilgai complexes. The puffs average 4-6 ft in diameter, are up to 9 in. high, and occupy approximately 15-20% of the area.

On the western side of the highway Manton loam is the major soil component. This occupies all the interpuff areas while the Gilligan clay comprises all the puffs except for small areas adjacent to School Gully where the Calman clay black earths are exposed. On the eastern side of the highway the Calman clay occupies all the puffs and Lansdown sandy loam is common to the interpuff areas. Some Manton loam may occur where the clays of the puff grade into the solodics.

Manton Gilgai Complex Gravelly Phase

This is restricted to the western side of the highway and consists of Gilligan clay on the puffs and Manton loam in the interspaces. The gravels are largely restricted to the puffs, are slightly waterworn, and range to 6 in. in size and extend into the puff profile.

Woodridge Gilgai Complex

This unit occurs only in Woodstock paddock and is a complex of Woodridge loam and Gilligan clay. The latter is confined to the puffs which occupy less than 10% of the unit and range from 4 to 8 ft in diameter and 6-9 in. high. There are no well defined depressions but a series of large cracks in the interpuff area terminate in fairly prominent sink holes up to 12 in. wide and from 12-30 in. deep.

The Woodridge loam profile of the interpuff areas is usually identical to that described earlier. However, where the clay D horizon occurs within 18 in. of the surface there is a very weak A2 horizon beneath the organic Al horizon and a strongly bleached horizon at the base of the yellow earth profile, i.e. immediately above the clay D horizon. It appears from examination of a trench face dug from the top of a puff into a depression that the clay D horizon is continuous with the clay of the puffs and represents an older alluvial deposit.

Sandalwood Gilgai Complex

This unit is of a very limited occurrence. The gilgai is very weakly developed with puffs 4-6 ft across and 3-6 in. high. Both Gilligan and Calman clays are exposed on the puffs while Sandalwood sandy loam occupies the interpuff areas. There are often low to moderate amounts of fine waterworn gravel on the surface of the puffs.

Lansdown Complex

This complex of solodic soils occurs in Manton and surrounding paddocks. Lansdown and Manton sandy loams together occupy approximately 85 to 90% of the unit. Smaller areas of Stockyard sandy loam, Manton loam, and Sandalwood sandy loam are also included but individually occupy only a very small part of the unit.

TABLE 5

Major characteristics and classification of the soils

Soil Unit	% of total area	Major characteristics	Great Soil Group	Northcote Key
SOILS WITH UNIFORM TEXTURE PROFILES				
Magenta Loamy Sand	3.8	Shallow very dark grey-brown loamy sands showing little pedological development	Alluvial Soil	Uc1.21

Soil Unit	% of total area	Major characteristics	Great Soil Group	Northcote Key
Miscellaneous 2	0.3	Very gravelly bleached sands of old creek deposit	No provision	Uc2.21
Miscellaneous 4	0.4	Strongly bleached coarse sands derived from granite	No provision	Uc2.21
Miscellaneous 5	3.3	Shallow stony soils on steep slopes	Lithosol	Um1
Calman Clay	0.2	Uniform dark heavy clays overlying highly calcareous grey and yellowish grey heavy clay	Black Earth	Ug5.4
Gilligan Clay		Dark grey heavy clay overlying olive or yellow-brown heavy clay, carbonate throughout	G.S.H.T	Ug5.29
SOILS WITH GRADATIONAL TEXTURE PROFILES				
Flagstone Loamy Sand	4.0	Light grey-brown A1 and bleached A2 horizon overlying yellow and red mottled sandy loam - sandy clay loam subsoils	Yellow-earth-yellow podzolic intergrade	Gn2.94
Wyoming Sandy Loam	5.1	Dark reddish brown sandy loam grading to red sandy clay loam – sandy clay	Red Earth	Gn2.14

Soil Unit	% of total area	Major characteristics	Great Soil Group	Northcote Key
Miscellaneous 1	1.0	Grey-brown sandy loam A1 and weak A1 horizon overlying red or yellow sandy clay loam to sandy clay B horizons	Red and Yellow Podzolics	Gn2.14 .24
Double Barrel Sandy Loam	2.1	Shallow sandy loam A1 and sporadically bleached A2 horizon overlying red and red-brown sandy clays	Red Podzolic	Gn3.14 .31
Double Barrel Loam	3.2	Very dark loamy A1 horizon up to 10" deep, weakly developed A2 horizon grading to structured red or brown sandy clay subsoils	Red Podzolic	Gn3.15
Woodridge Sandy Loam	11.9	Light grey-brown sandy loam A1 and bleached A2 over yellow and red mottled sandy clay loam to sandy clay B horizons	Yellow earth – yellow podzolic intergrade	Gn2.94
Woodridge Sandy Loam sloping phase	5.9	As above on the 1-4 degree pediment slopes	Yellow earth – yellow podzolic intergrades	Gn2.94 .91

Soil Unit	% of total area	Major characteristics	Great Soil Group	Northcote Key
Woodridge Loam	10.5	Thin grey-brown loam A1 horizon overlying yellow and yellow-brown clay loam-light B horizons. Clay D horizon at depth	Yellow earth	Gn2.64
SOILS WITH STRONG TEXTURE CONTRAST				
Glenoming Sandy Loam	2.1	Grey-brown sandy loam A1 moderately bleached A2 over mottled yellow or red, structured medium clay subsoils	Red-Yellow Podzolic	Dr3.42 Dy3.42
Miscellaneous 3	0.2	Moderately bleached sandy loam A horizon overlying mottled yellow gritty clays	Solodic	Dy3.43
Sandalwood Sandy Loam	4.6	Very thin strongly bleached sandy loam A horizons over-lying olive or yellow-brown heavy clays. May or may not be mottled	Solodic-Solodized solonetz	Dy2/Dy3.43
Lansdown Sandy Loam	5.2	Very strongly bleached sandy loam A horizons over yellow or olive heavy clays. May be mottled. A1-A2 horizons up to 10 in. thick	Solodic-Solodized solonetz	Dy2/Dy3.43

Soil Unit	% of total area	Major characteristics	Great Soil Group	Northcote Key
Lansdown Sandy Loam Gravelly Phase	1.8	As above with high amounts of water-worn gravels in A horizon	Solodic-Solodized solonetz	Dy2/Dy3.43
Lansdown Fine Sandy Loam	3.5	Very strongly bleached A horizon overlying dense mottled yellow clay with strong columnar structure	Solodized solonetz	Dy3.43
Stockyard Sandy Loam	5.3	Deep sandy loam bleached A horizons overlying mottled gritty medium clay subsoils	Solodic-Solodized solonetz	Gn3.15
Stockyard Loam	1.6	Dark grey-brown loam A1 horizon, moderately bleached A2 horizon overlying mottled red or brown sandy clay or medium clay.	Solodic	Dy2/Dy3.43 .33
Manton Sandy Loam		Strongly bleached sandy loam A horizon overlying mottled grey brown and yellow sandy medium clay B horizons	Solodic-Solodized solonetz	Dy2.43 .33
Manton Loam	0.5	Dark grey-brown loam A1 horizon, bleached A2 horizon overlying grey-brown or olive heavy clays	Solodic	

SOIL COMPLEXES

Soil Unit	% of total area	Major components	Minor Components
Manton Gilgai Complex	5.2	Manton Loam Gilligan Clay	Lansdown Sandy Loam Calman Clay
Manton Gilgai Complex Gravelly Phase	2.9	Manton Loam Gilligan Clay	Lansdown Sandy Loam Calman Clay
Woodridge Gilgai Complex	5.2	Woodridge Loam Gilligan Clay	
Sandalwood Gilgai Complex	0.7	Sandalwood Sandy Loam Gilligan Clay	Calman Clay
Lansdown Complex	9.7	Lansdown Sandy Loam Manton Sandy Loam	Stockyard Sandy Loam Manton Loam

IV CHEMISTRY AND FERTILITY

Detailed analytical data for representative soils are presented in Appendix I. Additional analytical data are reported elsewhere (C.S.I.R.O. Division of Soils Tech. Memo. No. 28/66). Most of the soils described have a low level of fertility as evidenced particularly by phosphorus, nitrogen and organic carbon values for surface horizons.

Particle Size Analysis

A feature of the particle size distribution for the texture contrast and gradational profiles is the high proportion of fine sand in the A horizons. This is of some importance in the solodic soils where the surface horizons are hard setting and provide a poor physical environment for plant growth.

The solodic soils have a characteristic abrupt increase in clay content in the B2 horizon which decreases again gradually at depth. This is most marked in the solodized solonetz Lansdown profiles. Although these subsoils are classed as heavy clay on field texture, they are commonly less than 45% clay.

In the subsoils of the Woodridge series there is frequently a marked increase in clay content at depth coinciding with the morphologic clay D horizons.

Nitrogen and Organic Carbon

Total soil nitrogen and organic carbon contents are in general low. In most of the soils where the surface depth sampled exceeds 0-2 in. total soil nitrogen is <0.08% and organic carbon <1%. Slightly higher values are found in the clay surface soils and in soils formed on more recent alluvium where a loam surface texture occurs. In some of the data reported e.g. T.30, higher surface organic values will be noted but these are for shallow 0-1 in. or 0-1$\frac{1}{2}$ in. horizons. A number of surface samples were obtained at fixed depths from some of the more important soils and these data are reported in Table 6.

TABLE 6

Nitrogen and Organic Carbon Data

Soil	Depth in.	No. of samples	Total N %		Org. C %		C/N
			Mean	Range	Mean	Range	Mean
Lansdown							
sandy loam	0-3	10	0.07	0.06-0.11	0.7	0.4-1.0	11
Manton							
sandy loam	0-3	5	0.07	0.06-0.08	0.6	0.5-0.7	9
loam	0-3	5	0.07	0.06-0.08	0.9	0.7-1.1	13
Stockyard							
sandy loam	0-3	5	0.07	0.04-0.09	0.7	0.5-0.9	10
loam	0-3	5	0.09	0.07-0.1	1.0	0.8-1.4	12
Woodridge							
loam	0-3	10	0.06	0.05-0.08	0.6	0.4-1.0	11
Wyoming							
sandy loam	0-3	10	0.06	0.05-0.08	0.8	0.6-1.0	13
Double Barrel							
sandy loam	0-4	5	0.06	0.04-0.08	0.6	0.4-0.9	10
loam	0-4	5	0.09	0.06-0.12	1.1	0.9-1.3	13

C/N ratios do not generally exceed 10 for the sandy-textured soils except for the Wyoming series but a wider ratio is encountered in many of the loams. Field and laboratory studies of nitrogen mineralization in the solodic soils have shown the nitrifying capacity of these soils to be low.

Phosphorus

The low levels of 'available' and total phosphorus recorded for most soils represent a gross and consistent deficiency of this element for plant growth, the only exceptions being those soils formed on more recent alluvium. The Double Barrel and Magenta soils associated with current stream deposition show high but variable 'available' P and moderate total phosphorus content. The Stockyard loam which is possibly a levee of a prior stream and the Wyoming sandy loam which appears to be an infill of an older stream course show variable phosphorus levels with some medium and high values.

'Available' P data for a number of surface samples are reported in Table 7.

TABLE 7

Available Phosphorus Data

Soil	Depth in.	No. of samples	Total N %	
			Mean	Range
Lansdown fine sandy loam	0-3	5	3	2-5
Lansdown sandy loam	0-3	10	4	3-6
Sandalwood sandy loam	0-3	10	4	2-7
Manton sandy loam	0-3	5	3	2-5
Manton loam	0-3	5	4	3-4
Stockyard sandy loam	0-3	5	4	2-7
Stockyard loam	0-3	5	25	4-65
Woodridge sandy loam	0-3	10	4	3-5
Woodridge loam	0-3	10	4	3-7
Flagstone loamy sand	0-3	5	4	3-5
Wyoming sandy loam	0-3	10	22	4-63
Glenoming sandy loam	0-3	5	5	4-10
Double Barrel sandy loam	0-47	5	27	12-52
Double Barrel loam	0-4	5	48	16-80
Magenta sandy loam	0-4	5	160	86-300
Calman clay	0-4	5	10	5-19
Gilligan clay	0-4	5	4	3-7

With the exception of those soils mentioned above, total phosphorus (HCl extract) is low throughout the profile, particularly for the solodized and yellow earth soils. For the seven solodized soil profiles described the mean total phosphorus of surface horizons is 0.014% P and for six yellow earth soils it is 0.016% P. These values decrease in lower horizons and there is no concentration of phosphorus in the subsoil. Limited pot trials have shown marked responses on Lansdown and Woodridge soils to relatively low amounts of added phosphorus.

Soluble Salts

The total soluble salt content of surface horizons is low for all soils with the exception of Sandalwood sandy loam. The Sandalwood profiles show a medium amount of salt in the A horizons (0.1%) rising to high (O.8%) at depth. The salt content of this soil is of agronomic significance. Soluble salts reach a medium-high rating at depth in the Calman and Gilligan clays. In some soils of the Woodridge series, an appreciable salt content is found at depth associated with a clay D horizon but not in the yellow earth profile itself.

The solodized solonetz Lansdown soil has a high salt content in the B2 horizons but for the solodic Manton and Stockyard soils high salt values, where present, occur lower in the profile. Where total soluble salts are appreciable, chloride (calculated as NaCl) accounts for >50% and where higher salt contents occur, chloride accounts for a greater proportion of the increase.

Cations

The cation status of the various soils is quite well reflected in their morphology and is of particular interest in the solodized soils. In the Lansdown and Sandalwood profiles, change to the sodic B21 horizon is sharp with sodium between 20 and 40% of the exchange capacity and increasing with depth. However this B21 horizon is base unsaturated. The magnesium content of the subsoils is high and exceeds that of calcium in these soils.

In the Stockyard and Manton soils the change to high sodium is not so abrupt although sodic horizons are encountered at depth. Although magnesium levels are high, calcium remains dominant. Surface horizons of Calman and Gilligan clays are calcium dominant but sodium and magnesium increase in the subsoils to each account for up to 30% of the exchange capacity. In the Woodridge soils sodium and magnesium are not high in the yellow earth profile but an increase of these cations is noted in some of the lower clay D horizons.

Calcium is the dominant cation in Wyoming, Glenoming and Double Barrel soils and sodium is low throughout these profiles.

Exchangeable potassium values in general are not high but pot experiments have not revealed a deficiency. Considerable release of potassium from non-exchangeable forms has been observed.

Other elements

Limited pot trials have shown marked responses to molybdenum and sulphur but no evidence of other trace element deficiencies has been obtained to date.

V CONCLUSION

Lansdown is well situated as a pastoral experiment station for the drier coastal area of North Queensland. Although the pattern is quite complex many soils are common to this area, particularly the solodic-solodized-solonetz soils. The Lansdown sandy loam solodics are typical of large areas of essentially similar soils extending from Proserpine to near Ingham. Sandalwood sandy loam, although not occupying large areas, also occurs commonly in this region as small isolated units. Manton loam solodic, the uniform clay soils, and the gilgai complex of these two soils also have a fairly wide occurrence. Similar soils occur quite extensively in the Lower Burdekin valley where they have been mapped separately as the Oakey and Barratta series and as the Oakey-Barratta complex (Hubble and Thompson 1953).

Although yellow podzolics, yellow earths, and red earths of the Woodridge and Wyoming series are quite extensive on Lansdown they do not occupy large areas elsewhere on the drier coastal plain. Red and yellow earths do occur very extensively further inland but the Lansdown soils cannot be directly equated with these inland lateritic or laterite-derived soils. The more recent stream terrace soils as represented by the Double Barrel red podzolics also only occur in relatively small areas on the Proserpine- Ingham coastal plain. However they assume importance because of their higher inherent nutrient status and their good physical condition.

Most of Lansdown is suitable for experimental usage, due regard being taken to the level of mapping employed and the very complex pattern of soils present in certain areas. These are mainly the gilgai complexes where the soils may rapidly alternate from uniform clays to abrupt texture- contrast soils with very different physical and chemical properties.

It is now being recognized that in this lower-rainfall tropical region various soil factors will play an important part in the selection of suitable improved pasture species. This is particularly so in the case of the solodic soils. Experimental work to date on Lansdown by the Division of Tropical Pastures has indicated that Townsville lucerne is the only persistent and productive legume available for most of the solodic soils. It is also evident that on the Sandalwood solodic soils even Townsville lucerne is relatively unproductive in spite of fertilizer treatment.

Regional fertility survey work based on laboratory and glasshouse studies has shown the widespread occurrence of phosphorus, sulphur and molybdenum deficiencies and various field responses to these elements have also been obtained. These three deficiencies have been recognised at Lansdown which thus offers a valuable site for long term studies into such aspects as movement of fertilizer, residual value, seasonal variations in nutrient availability, and plant species requirements. Such results could be expected to be of extensive application in North Queensland.

Apart from the nutritional aspects, various physical parameters are of considerable importance. Total A horizon depth and texture of the solodic-solodized- solonetz soils has been seen to influence plant performance and also species suitability. Studies on such factors as bulk density and aeration, available soil moisture, and water penetration and runoff need to be made in relation to plant performance. The presence of a number of defined and differing soils on Lansdown offers an opportunity to study under the one climatic environment the importance of various edaphic factors in influencing pasture quality and quantity, species suitability and animal production.

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APPENDIX I

The soils have been grouped firstly on their primary profile form (Northcote 1965) and secondly on the great soil group classification of Stephens (1962) and the profile data are arranged in this order in the tables.

SOILS WITH UNIFORM TEXTURE PROFILES

(a) Black Earths

This soil has a uniform heavy clay texture profile and is very dark grey to black to depths of 2-3 ft. Beyond this there is a gradual lightening in colour to grey brown or yellow grey. The Calman clay is similar to the Barrunga series of the Burdekin region (Reeve, Hubble and Thompson 1960).

Calman clay	profile T.35	page

(b) Grey soil of Heavy Texture

This soil has a uniform heavy clay texture profile and is grey- grey-brown, or olive-brown in colour. Gilligan clay is similar to the Yalinga series of the Burdekin region (Reeve, Hubble, and Thompson 1960).

Gilligan clay	profile T.23	page

SOILS WITH GRADATIONAL TEXTURE PROFILES

(a) Yellow Earth-Yellow Podzolic Intergrades

Although similar in many respects to the yellow earths these soils have weak to moderately bleached A2 horizons and clear to gradual changes to mottled yellow subsoils. These are usually massive and earthy and do not have the fine blocky structured subsoils common to many podzolics.

Flagstone loamy sand	profile T.37	page
Woodridge sandy loam	profile T.22	page

(b) Red Earth

This soil is characterised by a gradational texture profile and a massive but friable and porous subsoil. The colour is normally a dark red throughout with only a slight organic darkening of the surface horizon.

Wyoming sandy loam profile T.25 page

(c) Minimal Red Podzolic

These are weakly differentiated profiles developed on the younger alluvium of Double Barrel Creek. There is normally a fairly well developed A2 horizon but it is only occasionally sporadically bleached. They have a well developed blocky structure throughout the B horizon.

Double Barrel loam profile T.33 page

(d) Yellow Earth

These soils have a gradational texture profile, a grey-brown loam surface grading to a bright yellow clay subsoil. The surface horizons are massive and the subsoils are normally earthy and porous with some fine ferramanganiferous nodules throughout.

Woodridge loam profile T .19 page

SOILS WITH STRONG TEXTURE CONTRAST

(a) Red Podzolic

These have similar morphology to the solonetzic soils but the textural change between the A and B horizons is clear or gradual and the clay subsoils are more friable with weak to moderately developed blocky structure.

Glenoming sandy loam profile T.26 page

(b) Solodized Solonetz-Solodic

These are soils with strong textural, structural, and consistence differences between the A and B horizons, the boundary being very abrupt. Most have very strongly bleached A2 horizons and moderate to strongly developed columnar structure in the top of the B horizon. Sodium and magnesium ions together usually dominate the exchange complex of the dense clay B horizons. The term solodic is used to designate those soils lacking columnar structure but with otherwise similar morphology.

Lansdown sandy loam, Sandalwood sandy loam, and Manton loam are similar to the Yoda, Dowie, and Oakey series, respectively, of the Burdekin region (Reeve, Hubble and Thompson 1960).

Sandalwood sandy loam	profile T.32	page
Lansdown sandy loam	profile T.30	page
Lansdown fine sandy loam	profile T.27	page
Stockyard sandy loam	profile T.29	page
Stockyard loam	profile T.18	page
Manton loam	profile T.24	page

LABORATORY METHODS

The plummet balance method of Hutton (1955) was used for particle size analysis but the 5% correction applied for silt and clay in this method was omitted.

pH was determined on a 1:5 soil/water suspension using glass and calomel electrodes and a Philips direct reading pH meter. Total soluble salt values were calculated from conductivity measurements on this 1:5 suspension at 25°C using a factor of 336 x conductivity. Chloride was determined by electrometric titration of the suspension with silver nitrate after the method of Best as described by Piper (1950).

Total nitrogen was determined by the Kjeldahl method. Readily oxidizable organic matter was determined by the method of Walkley and Black (1934) and organic carbon calculated using the factor of 1.30 derived by Little, Haydock and Reeve (1962).

'Available ' phosphorus was determined by the method of Kerr and van Stieglitz (1938) by extracting with .01 N H_2SO_4 for 16 hours. Total phosphorus was extracted by boiling for 4 hours with constant boiling HCl. The samples were previously ignited with magnesium acetate at 500-550°C as described by Beckwith and Little (1963).

Exchangeable cations were determined on the leachate from N.NH_4Cl (pH 8.4) in a closed system. Sodium values were corrected for soluble sodium by subtracting an amount equal to the soil chloride content. Sodium and potassium were measured with the Eel flame photometer. Calcium and magnesium were measured by an Atomic Absorption Spectrophotometer in a solution containing 1500 p.p.m. strontium as described by David (1960). Cation exchange capacity to pH 8.4 was determined by measuring NH_4 leached from NH_4 saturated soil by $NaNO_3$. NH_4 was corrected for NH_4Cl present by a value equivalent to Cl present in the leachate. Exchangeable hydrogen was calculated by subtracting the sum of the metal cations from C.E.C. Soils containing free carbonates were leached with alcoholic NH_4Cl in a closed system as described by Tucker (1950).

Carbonate was determined by treatment of the soil with dilute HCl containing stannous chloride and absorption of the co evolved in ‘Ascarite’.

All figures are expressed on an oven dry basis.

ABBREVIATIONS USED IN TABLES

T.S.S	= Total soluble salts by conductivity of 1:5 suspension
NaCl	= Chloride calculated as sodium chloride
CaCO3	= Carbonate calculated as calcium carbonate
Org. C	= Organic carbon by Walkley-Black
N	= Total nitrogen by Kjeldahl digestion
P	= Phosphorus. A.ppm. "Available phosphorus" by modified Truog acid extraction method. Tot. % "Total" phosphorus
CS	= Coarse sand
FS	= Fine sand
Si	= Silt
C	= Clay
Exchangeable cations	
Total	= Total exchange capacity
Ca	= Calcium
Mg	= Magnesium
K	= Potassium
Na	= Sodium
H	= Hydrogen
M	= moist

Note: Unless otherwise specified all horizon boundaries in the morphological descriptions are gradational.

GGM/BJC/VHR
17/8/66

Soil Series : Calman Clay
Great Soil Group : Black Earth - G.S.H.T. Intergrade
Principal Profile Form : Ug5.4

Sample No. & Depth (Ins.)	Horizon	Depth (Ins.)	Morphological Description			
T 35.1 (0-4)	A1	0-4	Very dark grey	(m.10 YR 3/1)	light - medium clay	strong blocky (½-1" units) low 1/8" CO_3 nodules
.2 (4-12) .3 (12-22)	B	4-22	Very dark grey	(m.10 YR 3/1)	heavy clay	moderate blocky (1-2" units) grading to coarse lenticular low 1/8" CO_3 nodules
.4 (22-28)	B	22-28	Grey-brown	(m.10 YR 5/2)	heavy clay	weak very coarse blocky, moderate-high soft CO_3
.5 (28-37) .6 (37-45)	B	28-45	Light grey with some faint brown mottles	(m.2.5 Y 6/1)	heavy clay grading to medium clay (sandy)	as above
.7 (45-53)		45-53	Mottled light grey and yellowish brown	(m.2.5 Y 6/1) (m.10 YR 5/8)	light clay (sandy)	weak coarse blocky, moderate to high 1" CO_3 - nodules

Location: On stock route 2 chain north of Cemetery reserve.

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P A.ppm.	P Tot. %	Particle Size CS %	FS %	Si %	C %	Exchangeable Cations m.e./100g Total	Ca	Mg	K	Na	H	Sat. %
.1	6.9	.03	.01	3.6		1.2	.088	7	.010	23	33	14	31	22	14.2	4.6	.27	.90	2.1	90
.2	7.3	.03	.01	5.3	.2			6		20	31	13	35	23	15.6	5.2	.12	1.0	1.1	95
.3	8.6	.10	.03	4.7					.012											
.4	9.4	.16	.06	4.2																
.5	9.3	.25	.14	3.4	14.4									19	6.2	7.0	.12	5.8	0	100
.6	9.1	.39	.23	4.4																
.7	9.0	.43	.24	4.7																

Soil Series : Gilligan Clay
Great Soil Group : Grey Soil of Heavy Texture
Principal Profile Form : Ug5.29

Sample No. & Depth (Ins.)	Horizon	Depth (Ins.)	Morphological Description				
T 23.1 (0-4)	A	0-4	Dark grey-brown	(m.2.5 Y 4/2)	medium clay	strong fine blocky on surface grading to coarse blocky	
.2 (4-14)	B21	4-36	Dark grey-brown	(m.2.5 Y 4/2)	heavy clay	strong coarse blocky	moderate 1/4-½" CO_3 trace FeMn nodules and some fine gravel
.3 (14-24)							
.4 (24-36)							
.5 (36-48)	B22	36-48	Dark olive-brown	(m.2.5 Y 4/3)	heavy clay	coarse lenticular	as above
.6 (48-60)		48-72	Dark yellowish brown	(m.10 YR 5/4)	heavy clay	coarse lenticular	as above
.7 (60-72)							
.8 (72-90)		72-102	As above $\overline{c}$ fine grey mottles	(m.2.5 Y 5/1)	heavy clay	coarse lenticular	low 1/8" CO_3 nodules few fine 1/8" FeMn nodules
.9 (90-102)							

Location: Near eastern fence line Woodstock Paddock.

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P A.ppm.	P Tot. %	Particle Size CS %	FS %	Si %	C %	Exchangeable Cations Total	Ca	Mg	K	Na	H	Sat. %
														m.e./100g						
.1	7.1	.03	<.01	3.1	.7	1.0	.099	9	.018	24	32	15	30	26	18.0	4.8	.37	.65	2.4	91
.2	8.6	.05	<.01	5.8				6												
.3	8.9	.11	.03	6.4	3.0				.008	9	27	17	47	21	11.2	6.6	.08	3.3	0	100
.4	8.7	.27	.12	6.1																
.5	8.7	.37	.20	5.0	2.9									24	9.0	8.2	.15	6.5	0	100
.6	8.9	.32	.18	5.4																
.7	8.9	.30	.15	5.5																
.8	8.6	.29	.16	5.3																
.9	8.1	.25	.15	5.3					.012											

Soil Series : Flagstone Sandy Loam
Great Soil Group : Yellow Earth - Yellow Podzolic Intergrade
Principal Profile Form : Dy4.41

Sample No.	Horizon	Depth (Ins.)	Morphological Description			
T 37.1	A1	$0-2\frac{1}{2}$	Dark grey-brown	(m.10 YR 4/2)	sandy loam	apedal, very friable and porous
.2	A21	$2\frac{1}{2}-9$	Brown	(m.10 YR 4/3)	sandy loam	massive, friable and porous conspicuous bleach
.3	A22	9-20	Yellowish brown	(m.10 YR 5/4)	sandy loam	massive, very porous, few fine FeMn nodules conspicuous bleach
.4	B21	20-26	Yellowish brown	(m.10 YR 5/6)	sandy clay loam	weak blocky ($1/4-\frac{1}{2}$" units) light $1/4-\frac{1}{2}$" FeMn nodules
.5	B22	26-36	Mottled yellowish brown and yellowish red	(m.10 YR 5/6) (m.5 YR 4/5)	sandy clay loam	as above
.6	B3	36-45	Mottled yellowish brown and grey-brown	(m.10 YR 5/6) (m.10 YR 5/2)	sandy clay loam	massive, very porous, low $1/4-\frac{1}{2}$" FeMn nodules
.7	C	45-54	Pale brown	(m.10 YR 6/3)	clayey grit	as above

Location: 5 mile north of Lansdowne Creek, Lansdown Paddock.

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P		Particle Size				Exchangeable Cations						Sat. %
								A.ppm.	Tot. %	CS	FS	Si	C	Total	Ca	Mg	K	Na	H	
														m.e./100g						
.1	5.5	.04	<.01	<1.0		.6	.046	4	.005	20	71	2	7	3	1.2	0.3	.20	.15	1.0	66
.2	5.2	.04	<.01	<1.0																
.3	5.1	<.01	<.01	<1.0					.008	46	44	5	6	2	0.2	0.2	.09	.14	1.7	25
.4	5.1	<.01	<.01	<1.0																
.5	4.9	<.01	<.01	3.6						36	27	8	30	5	1.0	0.9	.30	.20	2.5	50
.6	4.8	<.01	<.01	1.0					.008											
.7	4.9	<.01	<.01	1.0																

Soil Series : Woodstock Sandy Loam
Great Soil Group : Yellow Earth-Yellow Podzolic Intergrade/Clay D horizon
Principal Profile Form : Gn2.94

Sample No. & Depth (Ins.)	Horizon	Depth (Ins.)	Morphological Description			
T 22.1 (0-3)	A1	0-3	Very dark grey-brown	(m.10 YR 3/2)	sandy loam	massive, fine 1/8" FeMn nodules
.2 (3-9)	A2	3-9	Dark grey-brown	(m.10 YR 4/2)	sandy loam-loam	massive, earthy fine 1/8" FeMn nodules
.3 (9-17)	B1	9-17	Light yellowish brown	(m.10 YR 6/4)	sandy clay loam	earthy high 1/4" FeMn nodules
.4 (17-30)	B2	17-30	Pale brown $\bar{c}$ some red mottles	(m.10 YR 6/3) (m.5 YR 4/6)	clay loam	massive to weak as above polyhedral
.5 (30-36)	D1	30-36	As above		light medium clay	strong polyhedral some fine FeMn nodules
.6 (36-48)	D2	36-57	Yellow brown $\bar{c}$ some light grey mottles	(m.10 YR 5/8)	medium clay	as above as above
.7 (48-57)			Some light grey mottles	(m.2.5 Y 7/2)		
.8 (57-66)	D3	57-66	As above $\bar{c}$ some red mottles	(m.2.5 YR 4/6)	medium clay	moderate fine polyhedral trace fine Qz grit

Location: North west quarter of Woodstock paddock.

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P A.ppm.	P Tot. %	Particle Size CS %	FS %	Si %	C %	Exchangeable Cations Total	Ca	Mg	K	Na	H (m.e./100g)	Sat. %
.1	5.8	.02	<.01	1.3		1.0	.069	4	.016	35	40	14	12	10	2.0	0.7	.45	.10	6.3	33
.2	5.9	<.01	<.01	1.0				4												
.3	6.3	<.01	<.01	2.0					.018	34	31	8	26	7	2.4	1.4	.07	.10	2.5	62
.4	6.5	<.01	<.01	2.6						26	29	6	38	9	2.2	2.2	.12	.25	4.3	52
.5	6.5	<.01	<.01	3.6						23	20	5	52	11	2.0	4.0	.11	.80	4.1	63
.6	6.5	<.01	<.01	3.6					.009											
.7	6.2	.03	.02	3.1																
.8	6.3	.04	.02	2.8																

Soil Series : Wyoming Sandy Loam
Great Soil Group : Red Earth
Principal Profile Form : Gn2.14

Sample No.	Horizon	Depth (Ins.)	Morphological Description			
T 25.1	A1	0-3	Dark brown	(m.7.5 YR 3/2)	sandy loam	massive, clear change to
.2	A2	3-10	Reddish brown	(m.5 YR 4/4)	sandy loam	massive, earthy, low 1/8" FeMn nodules
.3	B1	10-18	Yellowish red	(m.5 YR 4/6)	sandy clay loam	as above with low fine gravel
.4	B2	18-28	Yellowish red	(m.5 YR 4/6)	light to medium clay	as above
.5		28-34	Yellowish red	(m.5 YR 4/6)	gritty clay	massive, earthy, much waterworn gravel
		34+	Unsorted waterworn gravels 1 to 6" size with gritty clay matrix			

Location:

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P		Particle Size				Exchangeable Cations						Sat. %
								A.ppm.	Tot. %	CS %	FS %	Si %	C %	Total	Ca	Mg	K	Na	H	
														m.e./100g						
.1	6.5	.02	<.01	1.2		1.1	.079	63	.050	18	59	14	11	9	5.0	1.0	.42	.10	2.2	74
.2	6.4	.01	<.01	3.0				42	.041	44	34	13	8	6	3.8	.9	.21	.10	.5	91
.3	6.2	.02	<.01	1.0																
.4	6.4	<.01	<.01	2.6						31	28	11	30	9	3.8	1.1	.34	.10	3.5	61
.5	6.3	<.01	<.01	1.3																

Soil Series : Double Barrel Loam
Great Soil Group : Red Podzolic
Principal Profile Form : Gn3.15

Sample No.	Horizon	Depth (Ins.)	Morphological Description			
T 33.1	A1	0-5	Very dark brown	(m.10 YR 2/2)	loam	weak blocky ($\frac{1}{2}$" units) vesicular, clear change to
.2	A2	5-12	Dark brown	(m.10 YR 3/3)	fine sandy clay loam	weak blocky ($1\frac{1}{2}$" units), clear change to
.3	B1	12-18	Dark brown	(m.7.5 YR 4/4)	light clay	moderate blocky ($1\frac{1}{2}$-2" units), vesicular
.4	B2	18-28	Reddish brown	(m.5 YR 4/4)	medium clay (sandy)	as above
.5	B2	28-36	Mottled reddish brown and brown	(m.5 YR 4/4) (m.10 YR 4/3)	medium clay (sandy)	moderate blocky (1-$1\frac{1}{2}$" units) low waterworn gravels to 3" few soft FeMn segregations
.6	BC	36-45	Yellowish red	(m.5 YR 4/6)	sandy clay	as above
.7	C	45-54	Yellowish red	(m.5 YR 4/6)	sandy clay loam grading to clayey sand	massive, low increasing 1-3" waterworn gravels

Location: Southern corner of Brolga and Mango Paddocks.

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P A.ppm.	P Tot. %	Particle Size CS %	FS %	Si %	C %	Exchangeable Cations Total	Ca	Mg	K	Na	H	Sat. %
														m.e./100g						
.1	6.3	.03	<.01	2.3		1.6	.118	100	.045	16	42	24	19	17	9.6	2.0	.70	.35	4.5	74
.2	6.3	.01	<.01	1.8		.7	.051	52												
.3	6.5	.01	<.01	1.6						18	36	23	23	12	6.4	2.0	.33	.42	2.6	78
.4	6.4	.01	<.01	3.1					.025	21	32	20	28	12	6.4	2.0	.30	.25	3.3	73
.5	6.5	.01	<.01	4.4																
.6	6.6	.01	<.01	2.8					.023											
.7	6.6	.01	<.01	1.8																

Soil Series : Woodstock Loam
Great Soil Group : Yellow Earth with clay D horizon
Principal Profile Form : Gn2.64

Sample No.	Horizon	Depth (Ins.)	Morphological Description			
T 19.1	A1	0-3	Dark grey-brown	(m.10 YR 4/2)	loam	massive, trace fine grit and gravel
.2	A2	3-8	Yellowish brown	(m.10 YR 5/6)	clay loam	massive, earthy, few 1/8" FeMn nodules
.3	B	8-14	Mottled yellowish brown and yellowish red	(m.10 YR 5/7)	clay loam-light clay	as above
.4	B	14-21	As above		light clay	mostly massive with few smooth ped faces
.5	D1	21-26	Mottled yellowish brown and pale brown	(m.10 YR 5/7) (m.10 YR 6/3)	medium clay	moderate polyhedral trace ½" gravel
.6	D2	26-36	As above		medium clay	strong coarse polyhedral trace CO_3
.7	D3	36-48	Yellowish brown	(m.10 YR 5/4)	heavy clay	strong coarse polyhedral low ½" CO_3 nodules
.8	DC	52-57	Yellowish brown		gritty clay	moderate fine gravel low CO_3

Location: Northern fence line Woodstock paddock.

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P A.ppm.	P Tot. %	Particle Size CS %	FS %	Si %	C %	Exchangeable Cations Total m.e./100g	Ca	Mg	K	Na	H	Sat. %
.1	6.0	.02	<.01	1.5		.88	.079	4	.019	18	53	13	18	9.4	2.2	1.6	.44	.10	5.1	46
.2	5.6	<.01	<.01	1.5				3												
.3	5.8	.01	<.01	3.0					.014	19	32	13	37							
.4	6.2	.01	<.01	2.6						17	27	11	44	10.9	2.6	2.5	.08	.60	5.1	53
.5	6.2	.02	<.01	3.2					.011	10	20	13	57	15.1	3.8	4.1	.10	1.6	5.5	64
.6	8.2	.12	.04	5.0	1.6					8	24	15	52	12.8	5.6	5.2	.10	1.9	0	100
.7	9.0	.20	.08	4.2																
.8	9.2	.18	.07	4.8																

Soil Series : Glenoming Sandy Loam
Great Soil Group : Red Podzolic
Principal Profile Form : Dr3.42

Sample No.	Horizon	Depth (Ins.)	Morphological Description			
T 26.1	A1	0-2½	Very dark grey-brown	(m.10 YR 3/2)	sandy loam	massive, clear change to
.2	A2	2½-9	Yellowish brown	(m.10 YR 5/4)	sandy loam	massive, fine 1/4" FeMn nodules
.3	A3	9-18	Yellowish brown	(m.10 YR 5/5)	sandy loam	massive, trace 1/4" gravel, conspicuous bleach
.4	B21	18-26	Mottled red and brown	(m.2.5 YR 4/5) (m.7.5 YR 5/6)	medium clay	weak coarse blocky, low 1" gravels
.5	B22	26-34	Mottled dark red and yellowish red	(m.2.5 YR 3/6) (m.5 YR 5/6)	medium clay	moderate fine blocky (1/4-½" units) low waterworn gravel to 2" size
		34+	Heavy waterworn gravels with a mottled red clay matrix			

Location: 15 chain west of windmill, Woodstock paddock.

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P A.ppm.	P Tot. %	Particle Size CS %	FS %	Si %	C %	Exchangeable Cations Total	Ca	Mg	K	Na	H	Sat. %
														m.e./100g						
.1	6.1	<.01	<.01	<1.0		.8	.059	10	.015	31	51	10	9	7	2.4	.8	.21	.15	3.6	50
.2	5.8	<.01	<.01	<1.0				7	.015	50	33	12	5	3	1.5	.4	.14	.10	.9	71
.3	6.0	<.01	<.01	<1.0																
.4	6.1	<.01	<.01	2.6					.016	21	31	11	38	9	4.4	1.5	.26	.15	2.5	72
.5	6.4	.01	<.01	2.8																

Soil Series : Sandalwood Sandy Loam
Great Soil Group : Solodic Solodized Solonetz
Principal Profile Form : Dy2.43

Sample No.	Horizon	Depth (Ins.)	Morphological Description			
T 32.1	A1-A2	0-3	Light brownish grey	(m.10 YR 6/2)	sandy loam	massive, very thin organic A1 strong bleach, abrupt change to
.2	B21	3-7	Dark grey-brown	(m.10 YR 4/2)	medium clay (sandy)	weak columnar breaking to coarse blocky, low $\frac{1}{2}$" gravel
.3	B22	7-17	Mottled brown and reddish brown	(m.1 Y 5/3) (m.5 YR 4/4)	medium clay (sandy)	moderate coarse blocky, low 1/4" CO_3 nodules and 1/8" FeMn nodules
.4		17-28	Mottled reddish brown and brown	(m.5 YR 4/5) (m.10 YR 4/3)	light medium clay	moderate blocky ($\frac{1}{2}$-3/4" units) low $\frac{1}{2}$-3" CO_3 nodules low $\frac{1}{2}$" gravel
.5		28-40	Yellowish red	(m.5 YR 4/6)	light medium clay	as above with moderate 1-3" CO_3 nodules
.6		40-46	Yellowish red	(m.5 YR 5/6)	sandy clay	as above

Location: North west corner of Spring Creek Paddock.

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P A.ppm.	P Tot. %	Particle Size CS %	FS %	Si %	C %	Exchangeable Cations Total	Ca	Mg	K	Na	H	Sat. %
														m.e./100g						
.1	5.8	.08	.04	1.0		.6	.051	5	.011	23	46	23	9	6	1.7	1.0	.30	.50	2.6	57
.2	7.7	.14	.09	3.1				4	.012	20	35	20	26	15	4.8	4.7	.21	4.8	0.8	95
.3	8.5	.37	.20	3.1	.3					13	47	10	31	15	3.6	5.0	.06	5.9	0	100
.4	8.7	.38	.24	4.2																
.5	9.3	.40	.22	3.9	2.5															
.6	9.4	.34	.19	3.1																

Soil Series : Lansdown Sandy Loam
Great Soil Group : Solodized Solonetz
Principal Profile Form : Dy2.43

Sample No. & Depth (Ins.)	Horizon	Depth (Ins.)	Morphological Description			
T 30.1 (0-1½)	A1	0-1½	Greyish brown	(m.10 YR 5/2)	sandy loam	massive, sporadic bleach
.2 (1½-8)	A2	1½-8	Pale brown	(m.10 YR 6/3)	sandy loam	massive, strong conspicuous bleach, abrupt change to
.3 (8-13)	B21	8-13	Olive-brown	(m.1 Y 5/4)	heavy clay	columnar breaking to strong coarse blocky
.4 (13-24)	B22	13-24	Yellowish brown	(m.10 YR 5/5)	medium clay (sandy)	moderate blocky (1-1½" units) few 1/8" FeMn nodules
.5 (24-35)	B	24-35	Mottled brownish yellow and light brownish grey	(m.10 YR 6/5) (m.10 YR 6/2)	medium clay (sandy)	weak coarse blocky, low 1" CO_3 nodules, few 1/4" FeMn nodules
.6 (35-48) .7 (48-56)	BC	35-56	Mottled light brownish grey and yellowish brown	(m.10 YR 6/2) (m.10 YR 5/6)	medium clay (sandy)	massive, low ½" CO_3 nodules, low ½" gravel and few ½" FeMn nodules
.8 (56-66) .9 (66-78)	C	56-78	Mottled yellowish brown and light brownish grey	(m.10 YR 5/8) (m.10 YR 6/3)	sandy clay	moderate fine polyhedral, low 1" CO_3 nodules

Location: Homestead 2.

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P A.ppm.	P Tot. %	Particle Size CS %	FS %	Si %	C %	Exchangeable Cations m.e./100g Total	Ca	Mg	K	Na	H	Sat. %
.1	5.4	.02	<.01	1.5		1.6	.126	8	.012	26	50	14	9	8	1.6	.8	.23	.20	4.7	37
.2	5.8	.01	<.01	<1.0		.3	.028	6	.006	27	52	17	4	3	.8	.5	.03	.15	1.9	42
.3	7.9	.22	.14	4.7					.010	15	29	12	44	19	2.4	6.0	.12	7.7	2.6	86
.4	8.6	.45	.31	5.8																
.5	8.7	.45	.28	4.7	1.5					22	30	13	36	11	1.6	4.6	.08	4.5	0	100
.6	8.6	.31	.20	3.4					.007											
.7	9.3	.25	.11	3.1																
.8	8.7	.22	.11	3.6	1.0				.006											
.9	8.9	.25	.11	3.4																

Soil Series : Lansdown Fine Sandy Loam
Great Soil Group : Solodized Solonetz
Principal Profile Form : Dy3.43

Sample No.	Horizon	Depth (Ins.)	Morphological Description			
T 27.1	A1	0-2½	Dark grey-brown	(m.10 YR 4/2)	fine sandy loam	massive, clear change to
.2	A2	2½-10	Light brownish grey	(m.10 YR 6/2)	fine sandy loam	massive, strong conspicuous bleach abrupt change to
.3	B2	10-17	Mottled grey-brown and	(m.10 YR 5/2)	heavy clay	strong columnar breaking to coarse blocky
			yellowish brown	(m.10 YR 5/5)		few 1/4" FeMn nodules
.4	B22	17-27	Mottled pale brown and yellowish brown	(m.10 YR 6/3)	heavy clay	moderate blocky (2-4" units) low ½" waterworn gravel and 1/4" FeMn nodules
.5	B2	27-37	Mottled yellowish brown and	(m.10 YR 5/6)	heavy clay	as above with low 1" CO_3 nodules
			pale brown	(m.10 YR 6/3)		
.6	BC	37-46	As above		medium-heavy clay	weak coarse blocky few FeMn nodules
.7		46-51	As above		sandy clay	massive, increasing amounts of 1-2" waterworn gravels

Location: Approximately 35 chains E.S.E. of mill, Lansdown Paddock.

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P A.ppm.	P Tot. %	Particle Size CS %	FS %	Si %	C %	Exchangeable Cations m.e./100g Total	Ca	Mg	K	Na	H	Sat. %
.1	5.2	.01	<.01	<1.0		.9	.076	7	.013	36	48	11	7	5	1.3	.5	.28	.10	2.7	45
.2	5.2	<.01	<.01	<1.0				5		16	71	10	4	4	.9	.4	.08	.45	2.1	46
.3	6.7	.05	.03	3.2					.007	10	45	8	37	17	4.0	6.0	.10	3.5	3.3	80
.4	8.0	.16	.08	3.6						18	37	18	28	15	3.0	5.8	.08	4.6	1.3	91
.5	8.8	.22	.15	3.4																
.6	8.3	.25	.10	3.1	1.0				.010					11	2.4	4.1	.06	3.9	0	100
.7	8.5	.19	.10	3.1																

Soil Series : Stockyard Sandy Loam
Great Soil Group : Solodic - Solodized Solonetz
Principal Profile Form : Dy3.43

Sample No. & Depth (Ins.)	Horizon	Depth (Ins.)	Morphological Description			
T 29.1	A1	0-2½	Very dark grey-brown	(m.10 YR 3/2)	sandy loam	massive, clear change to
.2 (2½-8) .3 (8-15) .4 (15-21)	A2	2½-21	Yellowish brown	(m.10 YR 5/4)	sandy loam	massive, porous, few 1/4" FeMn nodules, very strong conspicuous bleach. Very abrupt change to.
.5 (21-27)	B21	21-27	Mottled grey-brown and yellowish brown	(m.10 YR 5/2) (m.10 YR 5/6)	sandy medium clay	moderate prismatic 2-4" diam. breaking to coarse blocky, trace ½" gravel, fine FeMn nodules
.6 (27-33)	B22	27-33	Mottled yellowish brown and grey brown	(m.10 YR 5/6) (m.10 YR 5/2)	sandy medium clay	weak coarse blocky, few FeMn nodules
.7 (33-40)	B	33-40	As above		sandy medium clay	low CO_3 nodules
.8 (40-46)	C	40-46	Dark grey-brown	(m.10 YR 4/2)	gritty clay	low CO_3 nodules, clear change to
.9 (46-52)	D	46-52	Very dark grey-brown	(m.10 YR 3/1.5)	medium clay	moderate fine polyhedral, low soft CO_3

Location: 5 chains N.E. of yards, Manton Paddock.

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P A.ppm.	P Tot. %	Particle Size CS %	FS %	Si %	C %	Exchangeable Cations m.e./100g Total	Ca	Mg	K	Na	H	Sat. %
.1	5.6	.01	<.01	1.0		.9	.078	7	.015	40	41	10	7	7	2.0	.7	.23	.05	4.2	41
.2	5.7	.01	<.01	1.1				4		39	41	14	7	5	1.6	.7	.12	.10	2.3	52
.3	6.1	.01	<.01	1.0																
.4	6.6	.01	<.01	1.4						36	40	12	13	6	2.2	1.5	.06	.30	2.0	66
.5	7.2	.03	<.01	3.6					.012	25	34	12	30	13	5.8	4.1	.13	1.7	1.6	88
.6	7.6	.04	<.01	2.6																
.7	8.3	.05	.01	2.6																
.8	8.5	.07	.03	2.6	.5									14	6.5	3.8	.10	3.3	0	100
.9	8.8	.11	.03																	

Soil Series : Stockyard Loam
Great Soil Group : Solodic
Principal Profile Form : Dy3.43

Sample No.	Horizon	Depth (Ins.)	Morphological Description			
T 18.1	A1	0-5	Dark grey-brown	(m.10 YR 4/2)	loam	massive, friable and porous
.2	A2	5-15	Brown	(m.10 YR 5/3)	sandy loam	massive, very porous, clear change to
.3	B21	15-24	Yellow-brown	(m.10 YR 5/4)	medium-heavy clay	moderate blocky (1-1½" units)
.4	B22	24-36	Mottled yellow-brown	(m.10 YR 5/4)	medium-heavy clay	very coarse prismatic grading to coarse blocky (1½-2" units) trace CO_3
.5		36-48	Mottled brown and reddish brown	(m.10 YR 4/3) (m.5 YR 4/4)	medium-heavy clay	as above
.6		48-60	As above		medium-heavy clay	moderate blocky (1-2" units) low CO_3
.7		60-80	Mottled reddish brown and dark grey-brown	(m.5 YR 4/4) (m.10 YR 4/2)	sandy clay	moderate blocky (½-1½" units) low CO_3

Location: Homestead Paddock.

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P A.ppm.	P Tot. %	Particle Size CS %	FS %	Si %	C %	Exchangeable Cations m.e./100g Total	Ca	Mg	K	Na	H	Sat. %
.1	5.9	.03	<.01	1.1		1.2	.103	8	.008	15	54	18	14	12.0	5.4	1.8	.60	.15	4.0	66
.2	6.2	.02	<.01	1.3				4												
.3	6.5	.02	<.01	3.2						19	35	11	34	14.4	6.6	3.6	.30	.10	3.8	74
.4	6.7	.01	<.01	2.6																
.5	7.3	.03	<.01	1.8																
.6	8.2	.02	<.01	2.8	.7				.005					14.0	7.4	4.7	.27	1.05	0.6	96
.7	8.6	.05	<.01	2.3					.006											

Soil Series : Manton Loam
Great Soil Group : Solodic
Principal Profile Form : Dy3.43

Sample No.	Horizon	Depth (Ins.)	Morphological Description			
T 24.1	A1	0-2½	Very dark grey-brown	(m.10 YR 3/2)	loam	massive low gravels to 2" size
.2	A2	2½-7	Dark grey-brown	(m.10 YR 4/2)	loam	massive sporadic bleach abrupt change to
.3	B21	7-12	Mottled dark grey-brown and yellowish brown	(m.10 YR 4/2) (m.10 YR 5/4)	heavy clay	moderate columnar (4" diam.) breaking to coarse blocky, few 1/8" FeMn nodules
.4	B22	12-20	Dark grey-brown	(m.1 Y 4/2)	heavy clay	moderate blocky (1-2" units) few 1/8" FeMn nodules
.5	B	20-30	Dark grey-brown	(m.2.5 Y 4/2)	heavy clay	weak coarse blocky moderate 1/4-½" CO_3 nodules
.6		30-42	Dark greyish brown	(m.1 Y 4/3)	heavy clay	as above

Location:

No.	pH	T.S.S. %	NaCl %	H_2O %	$CaCO_3$ %	Org. C %	N %	P A.ppm.	P Tot. %	Particle Size CS %	FS %	Si %	C %	Exchangeable Cations Total (m.e./100g)	Ca	Mg	K	Na	H	Sat. %
.1	5.9	.01	<.01	1.5		1.1	.083	4	.016	18	39	24	19	13	4.4	2.6	.20	.45	5.3	59
.2	6.0	.02	<.01	1.0				3		20	43	20	16	8	2.5	1.5	.08	.40	3.0	60
.3	6.9	.04	.02	5.3					.011	12	25	16	49	21	8.2	6.9	.11	3.2	2.9	86
.4	7.3	.08	.05	5.0																
.5	8.4	.29	.18	5.8	.9					14	29	18	40	19	8.0	7.6	.08	3.4	0	100
.6	8.9	.29	.17						.013											