

Guide to the SOILS OF THE SWAZILAND SUGARCANE INDUSTRY

by David J. Nixon



**Produced by the Swaziland Sugar Association and
the South African Sugarcane Research Institute**

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A correlation of the Swaziland Soil Classification System, which
was originally devised by the Late George Murdoch, with the
South African Binomial System

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Soils on the cover (left to right):

- T Set/Tambankulu series (Tambankulu Form)
- W Set/Winn series (Hutton Form)
- Z Set/Zwide series (Sterkspruit Form)

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INTRODUCTION

The Swaziland soil classification, consisting of sets and series, was originally formulated in the late 1950's and early 1960's, during which time a nationwide soil survey was conducted. Soil sets are groupings of soil series with similar profile morphologies and land use potential. This is an excellent concept on which to base a soil classification, as the groups produced are ready-made management units. At the series level, the differentiating criteria used include the texture, colour, structure and depth of the horizons present.

In neighbouring South Africa, the Binomial System of soil classification has been developed, and recent work has fully incorporated the system for identification and management of soils in the sugar industry. In order to allow easy adaptation of management recommendations to the Swaziland industry, it therefore makes sense to apply the Binomial System's diagnostic horizons to the Swaziland soil series, thereby providing a correlation between the two classifications.

The accompanying key and descriptions give details of the revised method of classification for soils of the Swaziland sugar industry. The sets and series have remained largely unchanged, but in some cases the criteria have been amended, and new series (five in total) have been created only where absolutely necessary. In this way, some gaps in the original classification have been filled. More than one diagnostic topsoil or subsoil may occur in the same set and series in order to maintain the range of the original description, and therefore retain an emphasis on management potential. The most commonly correlated soil forms are given for each soil series.

It is recommended that this soil classification be used alongside the South African Sugar Experiment Station Bulletin 19, 'Identification and Management of the Soils of the South African Sugar Industry' (1999). This Bulletin provides information on the management features of the soils, and includes colour photos which can assist in identifying diagnostic horizons, and also contains an excellent glossary of terms used in soil identification.

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GUIDELINES FOR USING THE CLASSIFICATION

PROCEDURE:

The procedure is the same whether the soil is to be identified from a pit or from an auger sample.

1. IDENTIFY THE TOPSOIL.

In the sugar industry, you will only find Orthic, Melanic or Vertic topsoils; the majority will be orthic. In some cases the topsoil may be undeveloped or degraded.

2. IDENTIFY THE SUBSOIL HORIZON/S AND THEIR TEXTURE, COLOUR AND MORPHOLOGY.

Firstly define the diagnostic horizon, then assess its texture, colour and structure.

3. MEASURE SOIL DEPTH TO WEATHERING ROCK, AND DEPTH TO EACH HORIZON.

Total depth is used to identify the set, and horizon depth is used for series identification in some cases.

4. From the above information, use the Key to locate the set/s into which the soil is likely to fall.

5. Go to the set/s, and its series descriptions, and determine the soil series using all the information available to you from the soil profile. Comparisons between sets are made to help you with classification.

Descriptions of all the diagnostic topsoils and subsoils that occur in the Swaziland sugar industry are given on the following pages.

NOTE: Some soil sets are designated as occurring in the Lowveld (LV) or Middleveld (MV) areas of the industry only, and in one case (J Set) the letter is repeated in both areas. For further information, refer to Murdoch (1974).

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DESCRIPTION OF THE DIAGNOSTIC HORIZONS

1: TOPSOIL HORIZONS

Vertic A

Black, brown or dark red blocky swelling clay, which has one or more of the following features:

- 1) Cracks of >25 mm width when dry.
 - 2) Clearly visible slickensides or polished surfaces due to soil movement (swelling and shrinking) on wetting and drying.
 - 3) A granular, self-mulching layer at the surface.
- ❑ Clay content is invariably high (>30%), being mainly swelling clay minerals.
 - ❑ Structure has an angular morphology (with a long vertical axis) and may be blocky or wedge-shaped.
 - ❑ Hard consistency when dry, but plastic and sticky when wet.
 - ❑ Surfaces may have a shiny appearance and clay coatings.
 - ❑ In the field, self-mulching is often the only visible qualifying feature.
 - ❑ Generally occur on basic parent materials or colluvium.

Melanic A

Non-swelling, dark coloured clay with medium to high organic content.

- ❑ Colour is usually black or very dark grey/brown. Reddish hues of 5YR or redder are not permitted.
- ❑ There are no vertic features; the structure is blocky.
- ❑ Clay content is usually >15%, being mainly non-swelling clay minerals.
- ❑ Found on basic or intermediate rocks, colluvium from mixed parent material or heavy alluvial deposits.

Orthic A

A mineral topsoil, often <400 mm deep, which does not qualify as vertic or melanic, although it may have been darkened by organic matter. The majority of topsoils in the sugar industry fall into this category, and are characterised in two main groups:

- 1) Brown or grey sandy textures with low organic matter content and weak structure. Occur on sandstones, granites, mixed colluvium or recent alluvial deposits.
- 2) Brown or red clayey textures with moderate structure, found on basic parent materials or alluvial deposits.

2. SUBSOIL HORIZONS

A. POORLY DRAINING

G Horizon

Strongly gleyed horizon which is saturated with water for long periods of time due to high groundwater levels or poor internal drainage.

- ❑ Firm, plastic consistency when wet, but very dense and hard when dry; usually >15% clay.
- ❑ Contains strong grey and/or olive colours, and may have red, yellow or orange mottling.
- ❑ Structure may be weak to strong; often blocky in nature.
- ❑ In some cases soil profiles may qualify as G right to the surface.

E Horizon

Grayish horizon, which is paler in colour than the overlying topsoil. The texture is usually sandy (<15% clay). Formation is due to a periodic build-up of water-logging conditions on top of an underlying poorly draining layer, causing the reduction and removal of clay, iron and other constituents, to leave a bleached appearance.

- ❑ Directly underlies a topsoil horizon.
- ❑ Consistency is non-plastic when wet, hard when dry.
- ❑ The overall colour is usually grey, but may also be strongly mottled with red, yellow and orange colours in some cases.
- ❑ Usually overlies a G, soft or hard plinthic horizons.

Soft plinthic B

- ❑ Soft and hard concretions of iron and manganese which are red, yellow and black, in a grey, yellow or olive clay matrix.
- ❑ Formation is due to periodic saturation with iron-rich water, the horizon boundaries coinciding with the upper and lower limits of water table fluctuation.
- ❑ Many soft plinthic horizons were formed in previous, wetter climates and so are relic features. The strong gleying features usually associated with these horizons may therefore be weakly developed.
- ❑ Can be cut with a spade when wet.
- ❑ May merge with a G horizon or weathering rock at depth.

Hard plinthic B

- ❑ An indurated zone of iron and manganese oxide accumulation.
- ❑ Cannot be cut with a spade when wet.
- ❑ Usually formed in a previous, wetter climate, and now occurs well above present water table levels.

B. UNIFORMLY COLOURED**Red structured B**

- ❑ Uniform red colour throughout, of 2.5 YR or redder.
- ❑ Moderate to strong blocky structure.
- ❑ Directly underlies an orthic topsoil, with a gradual transition in structure and texture from A to B.
- ❑ Topsoil is usually red or reddish brown, and clayey in nature.
- ❑ The strong red colours indicate good internal drainage and aeration.
- ❑ Forms over basic rocks such as dolerite and basalt.
- ❑ Clay content is usually >35%.

Red apedal B

- ❑ Uniform red colour of 2.5 YR or redder.
- ❑ Structure ranges from weak apedal to weak blocky.
- ❑ May have a very hard dry consistency.
- ❑ Usually underlies an orthic topsoil.
- ❑ Clay content is usually in the range 15-35%.
- ❑ Forms on basic parent materials and alluvium.

Yellow-brown apedal B

- ❑ Yellowish to brownish in colour.
- ❑ Structure is weak apedal to weak blocky.
- ❑ Forms in moist (but non-gleying) environments.
- ❑ May contain mottles and iron concretions which are not sufficiently developed to qualify as soft plinthic or gleyed horizon.
- ❑ Directly underlies a topsoil horizon.

C. NON-UNIFORMLY COLOURED**Neocutanic B**

- ❑ Formed on recent sediments or other unconsolidated material (colluvial or alluvial in origin), or where a dark coloured horizon has overlain a material that would otherwise have been red apedal.
- ❑ Structure ranges from weak apedal to weak blocky.
- ❑ Directly underlies a topsoil horizon, and usually has a more clay than the horizon above.
- ❑ Has darkly coloured clay skins in the channels and pores, giving a variegated, non-uniform colour.
- ❑ Matrix colours range from dark to brown to orangey red.
- ❑ Lacks features of gleying and wetness.

Lithocutanic B

- ❑ Directly underlies a topsoil horizon and merges into weathering rock beneath.
- ❑ Consists of well developed soil material present as tongues or pockets in and around saprolite and rock fragments in various stages of decomposition (usually about 50% or more of the latter).
- ❑ Clay skins and coatings are presenting channels and on the weathering rock fragments.

Pedocutanic B

- ❑ Underlies a diagnostic topsoil horizon; often the boundary is merged.
- ❑ Structure is moderate blocky or stronger (but not strongly prismatic).
- ❑ Matrix colours may range from dark red to dark brown.

- ❑ Prominent clay skins in the channels and pores cause marked colour variegation.
- ❑ Lacks features of gleying and wetness.
- ❑ Clay content is usually >35%.

Prismacutanic B

- ❑ Occurs below an A or E horizon; Topsoil is often thin or absent.
- ❑ Upper boundary is marked by an abrupt change in texture, structure or consistency.
- ❑ Has coarse blocky, prismatic or columnar structure.
- ❑ Clay skins and coatings are restricted to the outer faces of the prisms, whose interiors have a fairly uniform dark colour (usually grey).
- ❑ May well be high in exchangeable sodium.
- ❑ If the structure is primarily prismatic, weakly developed hydromorphic features (mottling) are permitted.

D. OTHER SUBSOIL MATERIALS

Stratified alluvium

- ❑ Unconsolidated material, occurring adjacent to present river courses.
- ❑ Coarsely textured, containing layers of coarser and finer material and/or clay lenses.
- ❑ Directly underlies a topsoil horizon or occurs at the surface.

Soft rock

- ❑ Consists of partly decomposed rock (saprolite).
- ❑ May have a powdery consistency and/or contain rock fragments in different stages of decomposition. Rock structure may still be visible.
- ❑ Development of soil minerals is minimal, although may contain significant quantities of unstructured clay materials.

Hard rock

- ❑ Solid, massive un-decomposed mineral rocks.
- ❑ Thick stone lines have a similar effect to hard rock, and so these are grouped together.

KEY TO THE SOIL SETS USING THE CORRELATION WITH DIAGNOSTIC HORIZONS FROM THE BINOMIAL SYSTEM

<u>TOPSOIL</u>		<u>ORTHIC</u>		<u>MELANIC</u>		<u>VERTIC</u>		<u>UNDEVELOPED OR DEGRADED</u>
<i>DEPTH OF WHOLE SOIL</i>		<i><35 cm</i>	<i>>35 cm</i>	<i><35 cm</i>	<i>>35 cm</i>	<i><35 cm</i>	<i>>35 cm</i>	<i>All depths</i>
SUBSOIL	Texture							
HARD ROCK	LS to SCL	O	J/P					J/U
	CL to C	S	C/R	S	C	S	K/V	
SOFT ROCK	LS to SCL	O	J/P					J/U
	CL to C	S	C/R	S	C	S	K/V	
LITHOCUTANIC	LS to SCL	O	J/P					J/U
	CL to C	S	C/R	S	C	S	K/V	
STRATIFIED ALLUVIUM			B					X
NEO- CUTANIC	RED	SL to SCL	L/W					
		CL to C	N					
	BROWN	SL to SCL	B					
		CL to C	C					
RED APEDAL	SL to SCL		F/L/W					
	CL to C		M/N/R					
RED STRUCTURED	SL to SCL		L					
	CL to C		N/R					
PEDOCUTANIC	RED		M/N/R					
	BROWN		C/P		C			
YELLOW-BROWN APEDAL			A/D					
SOFT PLINTHIC	HARD CONCS.	SC	H					
		CL to C	T		T			
	SOFT CONCS	SC	H					
		SL to CL	D					
		C	T		T			
G HORIZON	SC		H					I/Q/Y
	SL to CL		D					
	C		T		T		K/V	
E HORIZON/G HORIZON			E					
PRISMACUTANIC			Z					
HARD PLINTHIC		G	G					
E HORIZON/HARD PLINTHIC		G	E/G					

TEXTURES: LS = loamy sand; SL = sandy loam; SCL = sandy clay loam; CL = clay loam; SC = sandy clay; C = clay.

A SET (MV)

GENERAL DESCRIPTION	Deep yellow or yellowish brown soils with imperfect drainage.
PARENT MATERIAL	Acid/intermediate rocks.

SOIL SERIES1. **Alicedale** **(Al)** (AVALON form)

A	ORTHIC	Yellow or yellowish brown loam.
B ₁	YELLOW-BROWN APEDAL	Yellow brown loam, often to >100 cm.
B ₂	SOFT PLINTHIC	Soft iron pan below 100 cm.

2. **Amuke** **(Am)** (CLOVELLY form)

A	ORTHIC	As Alicedale.
B	YELLOW-BROWN APEDAL	Deep yellow-brown loam, >100 cm to weathering rock.

3. **Atondozi** **(At)** (AVALON form)

A	ORTHIC	Greyish yellow sandy loam.
B ₁	YELLOW-BROWN APEDAL	Thick yellow brown loam.
B ₂	SOFT PLINTHIC	Soft iron pan below 100 cm.

COMPARISON WITH OTHER SERIES

A Set occurs only in the Middleveld area, whereas D set occurs only in the Lowveld.

B SET

GENERAL DESCRIPTION	Deep brown juvenile soils occurring on lower river terraces.
PARENT MATERIAL	Alluvium.

SOIL SERIES1. **Betusile** (**Be**) (DUNDEE or OAKLEAF forms)

A	ORTHIC	Weak to moderate structured brown sandy or silty loam.
B	STRATIFIED ALLUVIUM or NEOCUTANIC	Brown loamy sand to sandy clay loam. May show layering, or have weak structure and colour variations sufficiently developed to qualify as neocutanic.

2. **Bushbaby** (**Bu**) (DUNDEE form)

A	ORTHIC	Yellowish brown loamy fine sand to fine sandy loam with only very weakly developed structure.
B	STRATIFIED ALLUVIUM	Lenses of medium and fine sand clearly visible.

3. **Bona** (**Bo**) (DUNDEE form)

A	ORTHIC	Brown coarse sand with little soil development apart from an increase in organic matter content.
B	STRATIFIED ALLUVIUM	High content of medium to coarse sand.

COMPARISON WITH OTHER SERIES

These soils are generally brown in colour and occur on lower river terraces. Betusile series has reasonably developed soil properties as compared to Bushbaby and Bona series, which are relatively undeveloped. These latter two series are different from X Set, which occurs on the flood plain of the present river rather than its terraces. Alluvial soils that are red in colour (as defined for 'red apedal' in the Horizon Key) are W Set, whose soils are more developed and tend to occur on higher terraces than B Set.

C SET (LV)

GENERAL DESCRIPTION	Deep, brown well structured clays occurring in mid to lower slope positions. Colour of 5 YR or browner.
PARENT MATERIAL	Basalt, dolerite or unconsolidated sediments.

SOIL SERIES

1. **Canterbury** (Ca) (BONHEIM, SWARTLAND or VALSRIVIER forms)

A	ORTHIC or MELANIC	Brown to dark brown clay loam to clay (may be sandy due alluvial deposition in some cases). Well structured; may be calcareous.
B	PEDOCUTANIC or NEOCUTANIC	Brown to dark brown structured or blocky clay. Horizon is calcareous. >90 cm to weathering rock or partly decomposed sediments.

2. **Cuba** (Cu) (BONHEIM, SWARTLAND or VALSRIVIER forms)

As for Canterbury, but the whole profile is non-calcareous.

3. **Croydon** (Cr) (BONHEIM, SWARTLAND or VALSRIVIER forms)

As for Canterbury, but the profile is <90 cm deep to weathering rock or partly decomposed sediments. In some cases the B horizon may be absent.

4. **Chateau** (Ch) (BONHEIM, SWARTLAND or VALSRIVIER forms)

As for Cuba, but the profile is <90 cm deep to weathering rock or partly decomposed sediments. In some cases the B horizon may be absent.

COMPARISON WITH OTHER SERIES

C Sets have a brown structured orthic or melanic A. If the topsoil is vertic, then the soil is K Set. R Sets are differentiated on their red colour (having hues 2.5 YR or redder). If shallower than 35cm, it is an S Set. C Sets usually occur in a catenary sequence between R Set upslope and K Sets downslope. C Sets may also occur on old river sediments.

D SET (LV)

GENERAL DESCRIPTION	Deep fine sandy loam to clay loams, with distinctive friable texture and a layer of mottling and soft iron concretions at depth. Usually occur in mid-slope positions as discontinuous patches.
PARENT MATERIAL	Mixed parent materials, typically where dolerite is intruded into Ecca sandstones, but may also occur on weathering basalt or mixed colluvium.

SOIL SERIES1. **Delcor** (**De**) (WESTLEIGH form)

A	ORTHIC	Dark grey to yellowish brown well structured sandy loam to clay loam.
B	SOFT PLINTHIC	Red, yellow and grey mottled and gleyed clay loam or fine sandy clay loam with a very friable texture. Usually contains soft iron concretions and may qualify as soft plinthic. May be calcareous.

2. **Daputi** (**Dt**) (AVALON form)

A	ORTHIC	Yellowish brown sandy loam or loam.
B ₁	YELLOW-BROWN APEDAL	Yellow brown sandy loam or loam, merging into soft plinthic horizon below.
B ₂	SOFT PLINTHIC	Gleyed horizon, with soft iron concretions at depth.

3. **Duma** (**Du**) (KATSPRUIT form)

A	ORTHIC	Dark grey to yellowish brown well structured sandy loam to clay loam.
B	G HORIZON	Dark grey to olive brown friable clay loam or fine sandy clay loam with no strong red colours. May be calcareous. Merges at depth with an olive yellow friable calcareous silty clay loam layer.

Continued overleaf...

D SET (continued)

COMPARISON WITH OTHER SERIES

All D Set soils have a characteristic friable clay loam texture in the subsoil (Daputi is sandy loam). If iron concretions are present, they must be soft only; if the subsoil is clay, or has hard iron concretions, the soil is a T Set. If the texture is sandy clay, the soil is an H or Z Set. Duma series does not have the strong mottling colours or soft plinthic layer, but is included in D Set due to its friable clay loam subsoil. Its colours are similar to those of Z Set, with which it is often associated.

E SET

GENERAL DESCRIPTION	Deep (>60 cm) coarse sandy topsoil, overlying a sandy clay horizon or iron pan. The zone above the pan is bleached (E horizon). Found on gently sloping areas in mid to lower slope positions.
PARENT MATERIAL	Sandstones or granite.

SOIL SERIES

1. **Enkulunyo** (**Ek**) (KROONSTAD or LONGLANDS forms)

A	ORTHIC	Weakly structured coarse loamy sand to sandy loam with low organic matter content.
B ₁	E HORIZON	Layer of light grey bleached sand with no red or yellow mottling colours.
B ₂	G HORIZON or SOFT PLINTHIC	Dense mottled and gleyed coarse sandy clay or soft iron pan, which is fairly impermeable.

2. **Emphali** (**Em**) (KROONSTAD or LONGLANDS forms)

As for Enkulunyo, but the E horizon contains red and yellow mottling colours.

3. **Ebede** (**Eb**) (KROONSTAD or LONGLANDS forms)

As for Enkulunyo, but the profile has a significant stone and gravel content.

COMPARISON WITH OTHER SERIES

E Set has a deep (>60 cm) coarse sandy upper profile (consisting of A and E horizons) over a relatively impermeable layer. If this depth is <60cm, then the soil will be an H or G Set, depending on the nature of the B horizon. If the subsoil is hard plinthic, then the soil is always G Set. In I Set, the whole profile is gleyed, and generally lacks horizonation (but may have depositional layering).

F SET

GENERAL DESCRIPTION	Deep red or yellowish red sandy loam to sandy clay loam. May have a zone of iron concretions or soft iron pan in the subsoil. Occurs in mid to lower slope positions.
PARENT MATERIAL	Colluvium from intermediate or mixed parent materials.

SOIL SERIES1. **Frazer** (Fr) (BAINSVLEI form)

A	ORTHIC	Weakly structured red sandy loam.
B ₁	RED APEDAL	Red sandy loam weak or moderate structure.
B ₂	SOFT PLINTHIC	Layer of soft and hard iron concretions. Depth to weathering rock is <100 cm.

2. **Felwako** (Fe) (BAINSVLEI form)

As for Frazer, but the depth to weathering rock is >100 cm.

COMPARISON WITH OTHER SERIES

F Set does not occur widely, and is found as discontinuous patches. F Set is morphologically similar to D Set, but has predominantly red rather than yellow colours. W and L Sets have similar upper profiles but lack the plinthic later, and are generally associated with alluvial environments. Frazer and Felwako series are differentiated on depth only, although Felwako series may have a slightly heavier texture (sandy clay loam) and better structure than Frazer.

G SET

GENERAL DESCRIPTION	Grey sandy topsoil, over a hard iron pan. Occurs on gently sloping land, usually above present water tables.
PARENT MATERIAL	Acid–intermediate crystalline rocks and sandstones.

SOIL SERIES1. **Gocuka** (Gc) (DRESDEN or WASBANK forms)

A	ORTHIC	Grey coarse loamy sand or sandy loam with little structure and very low organic matter content.
B ₁	(E HORIZON)	There may be a light grey bleached zone over the pan.
B ₂	HARD PLINTHIC	Hard iron pan which is usually dark red in colour.

2. **Gudenzi** (Gz) (GLENCOE form)

A	ORTHIC	Red or reddish yellow sandy loam or sandy clay loam, may be quite deep.
B ₂	HARD PLINTHIC	Hard iron pan.

3. **Gongola** (Gn) (DRESDEN form)

A	(ORTHIC)	Topsoil is very thin or absent.
B	HARD PLINTHIC	Massive indurated iron pan exposed at the surface.

4. **Gubane** (Gb) (DRESDEN form)

A	ORTHIC	Grey gravelly sand.
B	HARD PLINTHIC	Massive or fragmented iron pan

COMPARISON WITH OTHER SERIES

The set is distinguished by a sandy topsoil over a hard iron pan. E Set can be similar to Gocuka series, but depth to the pan is >60cm and does not qualify as hard plinthic.

H SET

GENERAL DESCRIPTION	Two-deck soil with sandy topsoil over a gleyed sandy clay subsoil with massive or blocky structure and hard dry consistency. At depth the subsoil may be an olive friable calcareous sandy or silty clay. Occurs in mid-slope positions on gentle slopes.
PARENT MATERIAL	Sandstones and shales.

SOIL SERIES1. **Habelo** (**Ha**) (KATSPRUIT form)

A	ORTHIC	Grey coarse loamy sand to sandy loam. Poorly structured and low in organic matter. Often <30 cm deep, and with an abrupt lower boundary.
B	G HORIZON	Strongly mottled and gleyed sandy clay, with grey orange and red colours. May contain scattered iron concretions and stones. Very poorly structured.

2. **Habelo-gravel phase** (**Ha-g**) (WESTLEIGH form)

A	ORTHIC	As for Habelo.
B	SOFT PLINTHIC	Contains abundant concretions and stones (>50%) in a mottled and gleyed sandy clay matrix.

3. **Hlunya** (**Hi**) (KATSPRUIT form)

A	ORTHIC	Yellowish grey fine sandy loam. Usually deeper than for Habelo, and has abrupt lower boundary.
B	G HORIZON	As for Habelo.

4. **Homestead** (**Ho**) (KATSPRUIT form)

A	ORTHIC	Brownish grey sandy loam to sandy clay loam with weak to medium structure and higher organic matter content than Habelo. Lower boundary is transitional.
B	G HORIZON	Strong blocky structure. Mottling and gleying mainly of drab olive and yellow, without the strong red and grey colours of Habelo. Usually is calcareous.

Continued overleaf...

H SET (continued)5. **Herzov** (He) (KATSPRUIT form)

A	ORTHIC	Pinkish grey sandy loam.
B	G HORIZON	Sandy clay with prominent red mottles in a grey matrix. Lower subsoil is similar to Habelo.

COMPARISON WITH OTHER SERIES

Habelo and Hlunya series are differentiated from Homestead by their more marked duplex profile and strong red colours in the G horizon, whereas Homestead series has a drab olive subsoil. Homestead is distinguished from Z Set in that the latter has a prismatic B horizon, giving Z Sets a more uniform dark grey colour with only limited mottling. T and D Sets are distinguished from H on texture. E Set has >60cm of sandy material and an E horizon.

I SET

GENERAL DESCRIPTION	Heavy textured hydromorphic soils with gleying and mottling colours right to the surface. Occur in water holes and small depressions where drainage is extremely poor.
PARENT MATERIAL	Colluvial deposits.

SOIL SERIES1. **Idukathole** (Id) (KATSPRUIT form)

A	ORTHIC	Grey mottled and gleyed loamy sand or sandy loam to at least 60 cm.
B	G HORIZON	Sandy clay loam to clay. Very strongly gleyed and permanently wet.

2. **Ingoje** (In)

A/B	G HORIZON	Sandy clay loam to clay right to the top, with strong mottling and gleying colours and high organic content.
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3. **Imbojane** (Im)

A/B	G HORIZON	Structureless clays in waterholes and depressions.
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COMPARISON WITH OTHER SERIES

The profiles of I Set are largely created by depositional processes in small depressions, and have little soil development. Permanently waterlogged conditions to the soil surface make these soils unsuitable for agricultural use.

J SET (LV)

GENERAL DESCRIPTION	Brownish or reddish grey coarse loamy sand or sandy loam at least 60 cm (but usually deeper), overlying weathering rock. Occur in upper to mid-slope positions often along major river valleys.
PARENT MATERIAL	Colluvium derived from acid or intermediate crystalline rocks.

SOIL SERIES1. **Jovane** (**Jv**) (GLENROSA form)

A	ORTHIC	Pinkish or reddish grey gravelly coarse sand. Depth to weathering rock is >60 cm.
B	SOFT ROCK or LITHOCUTANIC	Soil profile transitions into well weathered rock.

2. **Jekhi** (**Jk**) (GLENROSA form)

A	ORTHIC	Greyish brown coarse sandy loam, which may become yellowish red at depth. Depth to weathering rock is >60cm.
B	SOFT ROCK or LITHOCUTANIC	As for Jovane

COMPARISON WITH OTHER SERIES

J Set is differentiated from P Set on depth. In the Lowveld this set is usually found on granite, whilst O and P Sets occur on either granite or sandstone.

J SET (MV)

GENERAL DESCRIPTION	Dark compact topsoil overlying a thick stone line.
PARENT MATERIAL	Acid/intermediate rocks.

SOIL SERIES1. **Juweel** (Jw) (MISPAH form)

A	ORTHIC	Dark brown sandy clay loam.
B	STONELINE (HARD ROCK)	Thick (>30 cm) stone line which acts as a barrier to rooting, over weathering material.

2. **Jolobela** (Jb) (MISPAH form)

A	ORTHIC	Grey gravelly loam
B	STONELINE (HARD ROCK)	Very thick stone line to depth.

3. **Johannesloop** (Jh) (MISPAH form)

A	ORTHIC	Dark brown loam.
B	STONELINE (HARD ROCK)	Shale-like stone line over clay layer.

COMPARISON WITH OTHER SERIES

J Sets are very distinct in the middleveld. U Sets have no continuous soil horizon above the rock layer.

K SET

GENERAL DESCRIPTION	Black blocky cracking clay over a heavy clay subsoil which may be gleyed and/or calcareous. Occurs in lower slope positions and bottomlands, or in areas of impeded drainage. The vertic horizon is 35-90 cm deep.
PARENT MATERIAL	Basalt and dolerite.

SOIL SERIES

1. **Kwezi** (Kz) (RENSBURG form)

A	VERTIC	Granular surface over a black blocky clay, which is calcareous and may contain lime concretions towards its base. <90 cm thick.
B	G HORIZON	Olive brown calcareous gleyed clay.

2. **King** (Kn) (RENSBURG form)

As for Kwezi, but the vertic A horizon is non-calcareous.

3. **Kwamtusse** (Kt) (ARCADIA form)

A	VERTIC	Red, brown or black blocky clay, calcareous.
B	SOFT ROCK	Weathering rock material.

COMPARISON WITH OTHER SERIES

K Set must have a vertic A horizon 35-90 cm in thickness. Kwezi and King series occur in bottomland locations or areas of impeded drainage, whilst Kwamtusse occurs on upper to mid-slope positions. If the vertic A horizon is >90 cm thick the soil is a V Set. If the whole soil depth is less than 35cm, the soil is Shebani series.

L SET

GENERAL DESCRIPTION	Deep red sandy loam or sandy clay loam with moderate structure and very hard dry consistency. Occurs on gently sloping valley sides or on ancient river terraces.
PARENT MATERIAL	Alluvium or colluvium from acid-intermediate rocks.

SOIL SERIES

1. **Lesibovu** (**Le**) (HUTTON, SHORTLANDS OR OAKLEAF form)

A	ORTHIC	Red sandy loam or sandy clay loam with weak to moderate structure.
B	RED APEDAL, RED STRUCTURED or NEOCUTANIC	Red sandy clay loam to sandy clay with strong apedal to moderate blocky structure and hard dry consistency.

2. **Ludomba** (**Ld**) (HUTTON, SHORTLANDS OR OAKLEAF form)

A	ORTHIC	Brown or yellowish brown loamy sand to sandy clay loam.
B	RED APEDAL, RED STRUCTURED or NEOCUTANIC	As Lesibovu

3. **Lutzi** (**Lz**) (HUTTON, SHORTLANDS OR OAKLEAF form)

As for Lesibovu, but both the topsoil and subsoil have a fairly high stone and gravel content.

3. **Lomahasheni** (**Lo**) (HUTTON, SHORTLANDS OR OAKLEAF form)

As for Lesibovu, but with a layer containing powdery or concretionary lime at depth.

COMPARISON WITH OTHER SERIES

L Sets are found on upper or ancient river terraces, and have a more developed structure and harder dry consistency than W Set, which usually occurs on middle to lower terraces and has a friable consistency, even when dry. R Sets have clay loam to clay textures (i.e. not sandy).

M SET (MV)

GENERAL DESCRIPTION	Deep red medium textured soils occurring on upper and mid-slopes.
PARENT MATERIAL	Intermediate colluvium.

SOIL SERIES1. **Malkerns** (**Ma**) (HUTTON form)

A	ORTHIC	Red sandy clay loam, usually up to 30 cm thick.
B	RED APEDAL	Red sandy clay loam or clay loam; may have a more structured layer between 30-80 cm, but generally the structure is weak. Depth to weathering rock >150 cm.

2. **Mtilane** (**Mt**) (HUTTON form)

As for Malkerns, but with a marked stone line in the top 90 cm.

3. **Mooihoek** (**Mo**) (HUTTON form)

A	ORTHIC	Pale red sandy loam.
B	RED APEDAL	Red sandy loam, >150 cm to weathering rock.

4. **Mdushane** (**Md**) (HUTTON form)

A	ORTHIC	Red/orange sandy loam.
B	RED APEDAL	Red/orange loam, >150 cm to weathering rock.

5. **Mbeli** (**Mb**) (HUTTON form)

A	ORTHIC	Orange clay loam.
B	RED APEDAL	Red/orange friable clay loam.

6. **Madevu** (**Mv**) (HUTTON form)

As Malkerns, but with >15% boulders and rock fragments within the soil profile.

Continued overleaf...

M SET (continued)7. **Mzawo** (Mz) (HUTTON form)

A	ORTHIC	Grey sandy loam.
B	RED APEDAL	As Malkerns or Mtilane.

8. **Munali** (Mu) (SWARTLAND form)

A	ORTHIC	Dark red/brown loam.
B ₁	PEDOCUTANIC	Compact blocky structure, usually between 20 and 40 cm thick.
B ₂	RED APEDAL	Deep friable red loam.

COMPARISON WITH OTHER SERIES

M Set soils only occur in the Middleveld areas, whereas R Sets occur mainly in the Lowveld and have heavier texture and stronger structure. L and W Sets are sandier soils formed mainly in alluvial environments.

N SET (LV)

GENERAL DESCRIPTION	Brown sandy loam overlying a red clay loam to clay. Occurs on gentle lower slopes adjacent to river terraces.
PARENT MATERIAL	Basalt, dolerite or ancient alluvium.

SOIL SERIES

1. **Nhloya** (**Nh**) (HUTTON, SHORTLANDS, OAKLEAF, SWARTLAND or OAKLEAF form)

A	ORTHIC	Brown or yellowish brown loamy sand to sandy loam with weak to moderate structure. Colour and texture are distinctly different to the underlying material, with an abrupt lower boundary.
B	RED STRUCTURED RED APEDAL NEOCUTANIC or PEDOCUTANIC	Red or brownish red clay loam or clay with moderate structure. Depth to weathering rock is >90cm.

2. **Nsoko** (**Ns**) (HUTTON, SHORTLANDS, OAKLEAF, SWARTLAND or OAKLEAF form)

As for Nhloya, but the depth to weathering rock is <90 cm

COMPARISON WITH OTHER SERIES

N Set is a distinctly two-deck soil, with a colluvial or alluvial top deposited over a heavier-textured red subsoil. Occurs in riverine environments. Effectively, the soil is an R Set with an alluvial layer deposited on top of the profile.

O SET

GENERAL DESCRIPTION	Shallow sandy soils with weak structure. Less than 35 cm deep, overlying soft or hard rock. Found on upper to mid-slopes and the margins of rocky areas.
PARENT MATERIAL	Acid to intermediate rocks.

SOIL SERIES1. **Otandweni** (**Ot**) (MISPAH form)

A	ORTHIC	Grey coarse loamy sand to sandy loam, with weak structure and low organic matter content < 35 cm thick.
B	HARD ROCK	Topsoil lies directly on hard rock material.

2. **Orrin** (**Or**) (GLENROSA form)

A	ORTHIC	As for Otandweni.
B	SOFT ROCK or LITHOCUTANIC	Depth to hard rock may be up to 90 cm.

3. **Omhlandlu** (**Om**) (GLENROSA form)

A	ORTHIC	Greyish yellow or pink fine sandy loam to loamy fine sand.
B	SOFT ROCK or LITHOCUTANIC	Underlying rock is Cave Sandstone (Upper Ecca). This series in the Lowveld only.

4. **Osaguleni** (**Os**) (MISPAH or GLENROSA form)

A	ORTHIC	Red or reddish grey coarse loamy sand or sandy loam.
B	HARD/SOFT ROCK or LITHOCUTANIC	Unspecified weathering material or hard rock.

COMPARISON WITH OTHER SERIES

O Set is differentiated from P Set on depth, and from S Set on texture, the latter being a clay loam or clay. Otandweni is the predominant series found in the Lowveld sugarcane areas.

P SET

GENERAL DESCRIPTION	Grey sandy loam, which is 35-60cm deep with weak structure, overlying weathering rock. Found in upper to mid-slope positions on and steeper ground.
PARENT MATERIAL	Acid to intermediate rocks.

SOIL SERIES1. **Pofane** (**Po**) (GLENROSA form)

A	ORTHIC	Grey coarse sandy loam with weak structure and low organic matter content, 35-60 cm in depth.
B	SOFT ROCK or LITHOCUTANIC	Poorly draining horizon, containing mottles and/or iron concretions.

2. **Petronella** (**Pt**) (SWARTLAND form)

A	ORTHIC	As Pofane.
B ₁	PEDOCUTANIC	Clay loam to clay, variegated colours.
B ₂	SOFT ROCK or LITHOCUTANIC	Poorly draining horizon, containing mottles and/or iron concretions.

3. **Peebles** (**Pe**) (SWARTLAND form)

As Petronella, but with a quartz stone line in the profile.

COMPARISON WITH OTHER SERIES

P Sets are differentiated from O Sets on depth. Pofane and Peebles will be found in upslope sites, whereas Petronella occurs in mid-positions on more moderate slopes. Pofane is differentiated from J Set on depth, but Petronella and Peebles are usually deeper soils.

Q SET (LV)

GENERAL DESCRIPTION	Sandy topsoil overlying an olive yellow poorly structured calcareous sandy clay. Occurs in bottom land positions and in drainage lines.
PARENT MATERIAL	Sandstones, shales or colluvium.

SOIL SERIES1. **Qualm** (Qu) (KATSPRUIT form)

A	ORTHIC	Poorly structured yellowish grey loamy fine sand to sandy loam. Abrupt lower boundary.
B	G HORIZON	Olive yellow calcareous and saline sandy clay, with massive structure.

COMPARISON WITH OTHER SERIES

Q Sets are poor quality soils which may have been degraded due to irrigation. The highly calcareous and alkaline subsoil has a friable and silty feel when wet, but is extremely hard when dry. H and Z Sets have better structure in the B horizon.

R SET

GENERAL DESCRIPTION	Moderate to well structured red or reddish brown clay loam to clay soils with moderate organic matter content. Usually occur in mid-slope positions on well draining gentle slopes.
PARENT MATERIAL	Basalt and dolerite.

SOIL SERIES

1. **Rathbone** (**Rt**) (HUTTON or SHORTLANDS form)

A	ORTHIC	Red to reddish brown well structured loam or clay.
B	RED APEDAL or RED STRUCTURED	Dark red to reddish brown clay loam or clay with moderate structure. Deep subsoil maybe compact and slightly mottled. Depth to weathering rock is >90 cm.

2. **Rondspring** (**Ro**) (HUTTON or SHORTLANDS form)

As Rathbone, but the depth to weathering rock is <90 cm. In some cases the B horizon may be absent.

3. **Rhebok** (**Rk**) (BAINSVLEI form)

A	ORTHIC	As for Rathbone.
B	RED APEDAL or RED STRUCTURED over SOFT PLINTIC	Dark red to reddish brown clay loam to clay with a characteristic layer of soft iron concretions at depth, is sufficiently developed to qualify as soft plinthic.

4. **Rasheni** (**Rs**) (VALSRIVIER form)

A	ORTHIC	Dark red to reddish brown clay loam to with weak to moderate structure.
B	PEDOCUTANIC	Dark red to reddish brown blocky clay to clay. Lower subsoil is a yellowish red calcareous friable clay loam to clay, usually <90 cm to weathering rock.

Continued overleaf...

R SET (continued)

5. **Redbuilt** **(Re)** (VALSRIVIER form)

As Rasheni, but much deeper soil >100 cm to weathering rock.

COMPARISON WITH OTHER SERIES

R Sets are red to reddish brown in colour and clayey in texture. W,L and F Sets have sandy textures. C Set is brown rather than red.

S SET (LV)

GENERAL DESCRIPTION	Shallow (<35cm to weathering rock) dark red, brown or black clay loam to clay. Occurs in upper or mid-slope positions.
PARENT MATERIAL	Basalt and dolerite.

SOIL SERIES1. **Somerling** **(So)** (MAYO form)

A	MELANIC	Dark brown clay loam to clay with blocky structure.
B	SOFT ROCK	The depth to hard rock can be considerable.

2. **Sibaya** **(Si)** (GLENROSA form)

A	ORTHIC	Brown to dark grayish brown clay loam to clay.
B	SOFT ROCK	The depth to hard rock can be considerable.

3. **Sikutwane** **(Sk)** (SHORTLANDS or HUTTON form)

A	ORTHIC	Red to reddish brown blocky clay loam or clay.
B	SOFT ROCK	This soil is a truncated R Set.

4. **Shebane** **(Sh)** (ARCADIA form)

A	VERTIC	Black cracking blocky calcareous clay.
B	SOFT ROCK or LITHOCUTANIC	Abrupt upper boundary.

COMPARISON WITH OTHER SERIES

S Sets are characterized by their shallow profile and clay loam to clay textures, and as such are shallow phases of C, R and K Sets. All other shallow soils have sandy textures. The overall depth to weathering rock is <35 cm.

T SET (LV)

GENERAL DESCRIPTION	Dark grayish brown sandy clay loam to clay loam topsoil, overlying a mottled and gleyed clay, which may contain soft and hard iron concretions. Occurs in mid-slope positions where drainage is impeded.
PARENT MATERIAL	Dolerite and Basalt.

SOIL SERIES1. **Tambankulu** **(Tm)** (TAMBANKULU or WESTLEIGH form)

A	ORTHIC or MELANIC	Dark grey or grayish brown sandy clay loam to clay loam, with moderate to well developed structure.
B	SOFT PLINTHIC	Clay loam or clay with strong red colours, containing soft and hard iron concretions.

2. **Tshaneni** **(Ts)** (TAMBANKULU or WESTLEIGH form)

A	ORTHIC or MELANIC	As for Tambankulu.
B	SOFT PLINTHIC	Clay loam or clay with strong grey and olive colours, containing soft and hard iron concretions.

Gravel and clay phases: Both Tambankulu and Tshaneni series have significant areas of gravel phase (designated Tm-g or Ts-g) containing >50% hard concretions/stones, and clay phase (Tm-c/Ts-c) where hard concretions are absent.

3. **Thorburn** **(Th)** (KATSPRUIT or WILLOWBROOK form)

A	ORTHIC or MELANIC	Dark grey to grayish brown blocky sandy clay loam to clay loam.
B	G HORIZON	Olive brown clay with only scattered mottles and concretions. Depth to weathering rock >90cm.

COMPARISON WITH OTHER SERIES

T Sets are clay loam to clay soils, whereas H Sets have a sandy clay subsoil. T Set topsoils tend to be better structured and more melanic in character than those of H Set. D Sets having a friable clay loam or fine sandy clay loam subsoil, containing few hard concretions.

U SET

GENERAL DESCRIPTION	Rocky land with large boulders or bedrock covering >15% of the surface. Non-agricultural areas.
PARENT MATERIAL	All parent rocks.

SOIL SERIES

1. **Ungabolima** **(Un)** (No equivalent soil form)

Massive hard rocks covering >15% of the surface.

2. **Upcountry** **(Up)** (MISPAH form)

Unconsolidated debris with patches of soil materials, which may be of considerable depth.

COMPARISON WITH OTHER SERIES

These areas of non-agricultural land are very distinct.

V SET

GENERAL DESCRIPTION	Very deep brown, grey or black cracking clays, with granular self-mulching surface and strong blocky structure, over a heavy clay subsoil, which may be calcareous and/or gleyed. Occurs in lower slope positions and bottomlands.
PARENT MATERIAL	Basalt, dolerite or basic colluvium.

SOIL SERIES1. **Valumgwaco** (**Va**) (RENSBERG form)

A	VERTIC	Deep black or very dark grey cracking clay >90cm deep.
B	G HORIZON	Olive calcareous clay, with free lime in the profile. Depth of whole soil is usually 150 cm to weathering rock.

2. **Vuso** (**Vu**) (RENSBERG form)

As for Valumgwaco, but the Vertic A is non-calcareous.

3. **Vimy** (**Vm**) (RENSBERG form)

A	VERTIC	Deep brown, grey or black blocky calcareous clay, >90cm deep, overlying a brown or red uniform calcareous clay, which may be saline.
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COMPARISON WITH OTHER SERIES

V Sets are differentiated from K Sets on depth of the vertic A horizon (>90 cm). Zikane series has a sandy texture and prismatic structure. Valumgwaco and Vuso series occur in drainage lines or areas of impeded drainage, whilst Vimy series occurs on very gentle mid- to lower slopes.

W SET

GENERAL DESCRIPTION	Deep (usually >150 cm) red or yellowish red sandy loam to sandy clay loam with weak structure. Found on alluvial river terraces.
PARENT MATERIAL	Alluvium.

SOIL SERIES

1. **Winn** (**Wn**) (HUTTON or OAKLEAF form)

A	ORTHIC	Red to reddish brown loamy fine sand to sandy loam.
B	RED APEDAL or NEOCUTANIC	Red or yellowish red sandy loam to sandy clay loam with weak apedal structure.

2. **Waspageni** (**Wa**) (HUTTON or OAKLEAF form)

As for Winn, but with a stone line in the top 100 cm of the profile.

3. **Whiterock** (**Wh**) (HUTTON or OAKLEAF form)

As for Winn, but with a powdery calcareous horizon at depth, which may be cemented into a lime pan.

4. **Wisteria** (**Wt**) (HUTTON or OAKLEAF form)

A	ORTHIC	Brown to yellowish brown loamy fine sand to silty loam (alluvial top).
B	RED APEDAL or NEOCUTANIC	As Winn.

COMPARISON WITH OTHER SERIES

W Set occurs on lower alluvial river terraces, whilst L Sets are found on upper terraces or ancient terrace deposits, and have a stronger structure and hard dry consistency; W Sets are fairly friable, even when dry. F Sets may have a similar profile, but are not alluvial soils (derived from acid/intermediate rocks). R Sets do not have sandy textures. B Sets are brown rather than red. Previous Wisselrode series now falls into K or V Set.

X SET

GENERAL DESCRIPTION	Sands and gravels of river beds and low sand banks. Found on present river flood plains.
PARENT MATERIAL	Alluvium

SOIL SERIES1. **Xulwane** (**Xu**) (DUNDEE form)

A	ORTHIC	Loamy sand, Thin or absent.
B	STRATIFIED ALLUVIUM	Deep layer of sand deposit.

COMPARISON WITH OTHER SERIES

X Sets are subject to frequent flooding and so have little or no profile development, as compared with B Sets which occur on river terraces and will only be subject to very infrequent flooding.

Y SET

GENERAL DESCRIPTION	Dark grey brown or black saline/alkaline and calcareous clays, which may have patches of salt inflorescence. Occur in bottomlands, often caused by irrigation.
PARENT MATERIAL	Basic colluvium.

SOIL SERIES

1. **Youngsvlei (Yo)** (KATSPRUIT form)

A	ORTHIC	Dark brown/black saline layer, thin or absent.
B	G HORIZON	Dark brown or black calcareous clay with grey or white saline patches. Very strongly gleyed.

2. **Yakeni (Yk)** (KATSPRUIT form)

As Youngsvlei, but the top 90 cm of the profile is acid/non-calcareous

COMPARISON WITH OTHER SERIES

Y Set is produced by over-irrigation of poorly draining saline/sodic soils, and are very difficult to reclaim.

Z SET (LV)

GENERAL DESCRIPTION	Distinctly two-deck soil. Grey coarse sandy topsoil over compact gleyed sandy clay. Found on gentle slopes in lowland areas.
PARENT MATERIAL	Ecce sandstones and shales.

SOIL SERIES1. **Zwide** (Zd) (STERKSPRUIT form)

A	ORTHIC	Grey coarse sandy loam or sandy clay loam, often thin or missing. Abrupt lower boundary.
B ₁	PRISMACUTANIC	Dark grey sandy clay with coarse prismatic structure which may extend nearly to the surface. May have strong secondary blocky structure and red mottling.
B ₂	G HORIZON	Olive brown calcareous friable sandy or silty clay, merging into dark yellow calcareous weathering rock at <150 cm.

2. **Zwakela** (Zi) (STERKSPRUIT form)

As Zwide, but <90 cm to weathering rock.

3. **Zebra** (Ze) (STERKSPRUIT form)

As for Zwide, but the orthic A is a pale brown fine sandy loam. Often found adjacent to river terraces.

4. **Zikane** (Zn) (STERKSPRUIT form)

As for Zwide, but depth to the base of the prismatic B is >150 cm and the whole soil may be >2 m deep.

COMPARISON WITH OTHER SERIES

Z have a prismatic structure and overall grey colour, whereas H Set is brown/gleyed, with strong mottling colours in the B horizon and blocky rather than prismatic structure. Zikane differs from V Set by having a sandy clay rather than clay texture, and lacks any of the qualifying vertic features.