IDENTIFICATION OF THE SOILS OF THE SUGAR INDUSTRY

BULLETIN No. 19 (Revised) 1984

THE EXPERIMENT STATION OF THE SOUTH AFRICAN SUGAR ASSOCIATION

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Contents

South African Sugar Association Experiment Station
Mount Edgecombe, Natal 4300
Republic of South Africa
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Introduction

This is the second edition of the Experiment Station's Soils Bulletin. It differs from the first in that it introduces the national binomial system of classifying the soils of South Africa whilst retaining the old system of classification based on parent material.

Most of the area under sugarcane has fortunately been surveyed on a geological basis and in most instances the soil type may be identified by using the soil parent material key. For the sake of uniformity however, and because the parent material in some of the newer cane growing areas is not always easily identifiable, it is important that the binomial system for South Africa should also be understood.

Systems of identifying soils

A wide spectrum of soils occurs within the South African sugar industry and the soils differ greatly in their properties. The main types of soil include one or more of the following:

- red and grey medium-grained sands
- black, heaving clays which are occasionally saline
- shallow, grey sandy loams on steeply sloping land in parts of the coast hinterland
- dark alluvial soils
- neutral red clays
- wet gley soils, both clayey and sandy
- moderate to very acid, porous, red and yellow soils, some aluminous and/or humic.

Differences between these types of soils can be attributed to the parent materials from which they have formed and the environmental conditions (rainfall, temperature, topography, drainage), and biological conditions under which they have developed. The length of time that the parent materials have been exposed to the combined actions of these environmental factors or weathering processes is also important.

The soil parent material system

In the past, a soil was characterised by referring only to its parent material and geographical locality. This was because soil scientists who first worked on soils of the South African sugarbelt found a very strong relationship between the parent rocks and the soils derived from them. Dolerite always weathered to form heavy, deep red or shallow black clays. Shales and Dwyka tillite produced shallow soils, while granite yielded coarse, abrasive, sandy soils. The soils were therefore classified according to the underlying parent material and nearly the whole industry has been surveyed in this way to a scale of 1:6000. The type and extent of soil parent materials that have been mapped in the South African sugar industry are shown in Appendix 1. Individual soil series were also described and named after the farm or locality where they were first found.

The binomial system

The introduction of the binomial system of classification by the Department of Agriculture and Fisheries in 1977, provided a means of classifying soils without reference to the soil parent material. In this system, there are two categories; a general one of soil forms and a more specific one of soil series. The general category comprises 41 soil forms, each made up of a vertical sequence of diagnostic top and subsoil horizons. There are five topsoil and 15 subsoil horizons each clearly defined in terms of soil properties which are discussed on page 24. A thorough understanding of the definitions of these horizons is required for their identification. Each form is in turn subdivided into a number of series which have in common the prescribed horizon sequence of that particular form. They differ in some of their properties, mainly texture and base status. Of the 41 soil forms and more than 500 soil series that are classified in the binomial system, 33 soil forms and about 130 soil series are known to occur in the sugar industry.

In many ways the binomial system of classifying soils is analogous to that used by botanists and zoologists to classify plants and animals according to their genus and species. Thus soils are classified by allocating them first to the appropriate soil form and then to the series. Reference to a particular soil is made by means of a soil form and series name. The name of the soil series can be likened to the first name of a person, while the soil form would be equivalent to the surname. A number of soil series belonging to the same soil form are therefore like a family of soils.

Series are given their names according to some geographical location and the form usually takes its name from the series most commonly distributed within that form. For example, a heavy, black, shallow, clay soil derived from Lower Ecca shale is called the Milkwood series because it was first described and identified on Milkwood Estate on the north coast. Soils which are very similar in appearance to the Milkwood series but are heavier in texture are called the Dansland series because the soil was first identified on Dansland Estate on the south coast. In South Africa the Milkwood series is more widespread than the Dansland series and they therefore both belong to the Milkwood form.

The integrated system

Although the soil parent material and binomial systems of identifying soils are treated separately in this bulletin, there is considerable merit in using both systems to identify soils. The soil parent material key provides a short list of the most likely soil forms, and the soil series associated with each form may subsequently be identified from tables. A detailed examination of the soil profile in terms of the binomial system criteria will enable identification of the soil form, and very often also the appropriate soil series, to be made.

The parent material system

Procedure

If you have a soil parent material map of your farm from the Experiment Station proceed as follows:

Step 1: Identify the parent material of the soil that you wish to identify, using the colour code index on the farm map.

Step 2: Identify the soil system of your farm from the maps shown on pages 9 to 15.

Step 3: Obtain a simple profile description either by augering or from a freshly exposed face in a test pit, trench or road cutting. (See Appendix 3.)

Step 4: Having identified the soil parent material and the soil system, now select the appropriate soil form from the short list in the 'parent material key to the soil forms' (see page 16) that most closely matches the profile description you have prepared.

Step 5: Turn to the page containing the colour plate of the soil form that you have identified and, using various criteria such as soil system, texture, grade of sand and colour, select the appropriate series name from the table.

Examples

Soils in two cane fields (101, 102) of the farm XYZ situated in the Stanger area require identification. The soil parent material map (see overleaf) shows both fields to be colour coded mainly green.

Field 101

Step 1:	Parent material	: dolerite
Step 2:	Soil system	: Umzinto
Step 3:	Profile description	: deep, red, structured clay
Step 4:	From parent material key	: Shortlands form
Step 5:	From soil series table	: Shortlands series

Field 102

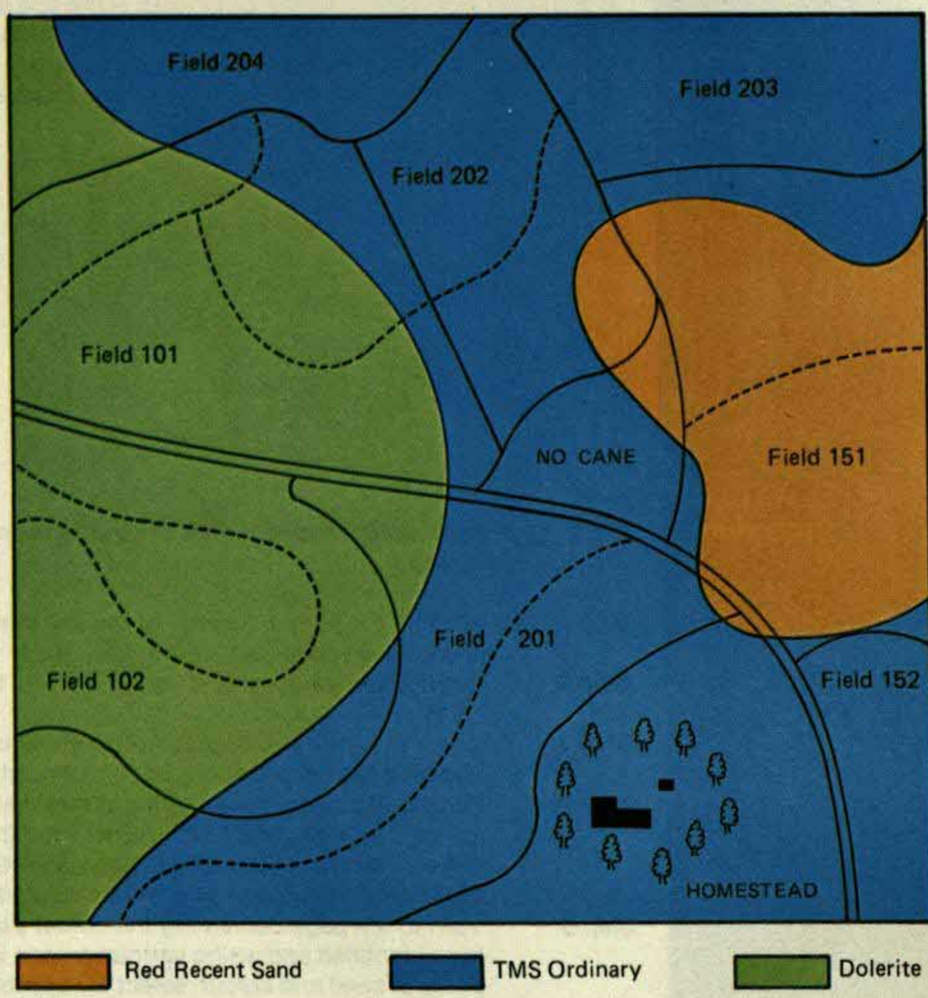
Steps 1 & 2:	As above	
Step 3:	Profile description	: shallow, black, cracking, blocky clay on rock
Step 4:	From parent material key	: Arcadia form
Step 5:	From soil series table	: Rydalvale series

Each step is explained more fully in the sections which follow.

Identifying the soil parent material

Step 1:

Most farms in the sugar industry have been surveyed to a 1 : 6 000 scale and each parent material has a different colour coding on the farm map. The maps are housed at the Experiment Station and copies are available for a nominal fee. A replica of a typical soil parent material map is shown below. To identify the parent material of a particular field, it must first be located on the farm map and the main colour identified. For example, from the map shown here, fields 101 and 102 would be classified as being mainly dolerite, whereas 151 is Red Recent Sand and 201 TMS (ordinary). The colour codes that represent each parent material are listed in Appendix 1.



Identifying the soil system of your farm

Step 2:

The distribution of soils in the sugar industry is not related to soil parent material alone but also to other factors. A soil system refers to an association of soils that coincide with geographical areas of similar climate, topography and age of the land surface. Five systems and three additional subdivisions have been described. These are:

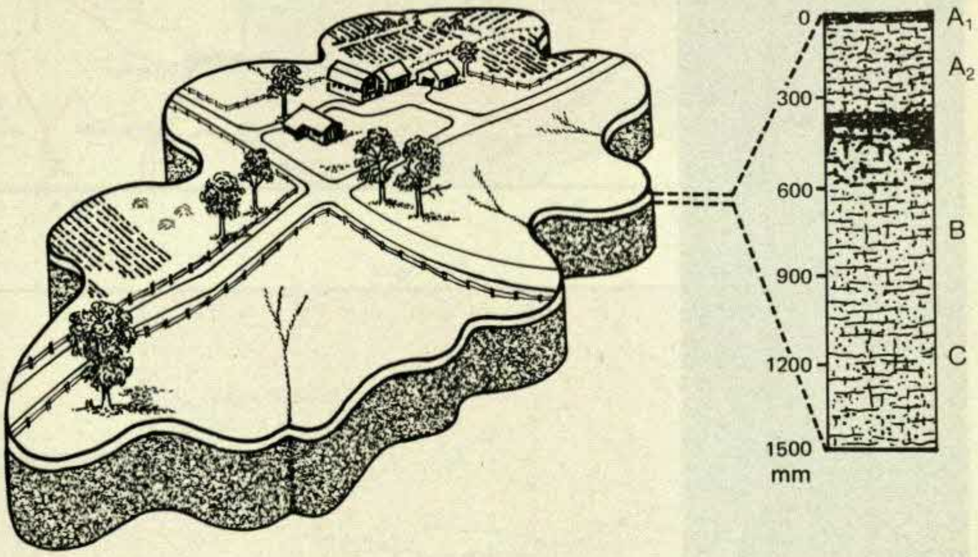
- Nottingham
- Umzinto
  - (i) Coast lowlands
  - (ii) Midlands
  - (iii) River valleys
- Komatipoort
- Nelspruit
- Berea

The distribution of these soil systems is shown in the accompanying set of coloured maps which facilitate easy identification of the system for any farm. In general the northern irrigated lowveld areas comprise mainly the Komatipoort and Nelspruit systems, while the rainfed areas of Natal fall in the other three systems. The main features of each system in terms of climate, altitude and soil physical properties are summarised in Appendix 2.

Obtáining a simple soil profile description

Step 3:

When the soil parent material and the soil system have been identified the next step is to determine the nature of the soil on the site. This means determining important properties such as colour, depth, texture and structure which is best carried out by exposing the soil profile either by digging a pit or clearing a soil face in an adjacent road cutting or ditch. Usually two or more distinct layers will be observed and these are referred to as horizons.



It is standard practice to refer to these layers as master horizons, each of which has been given a symbol. This is illustrated in the preceding diagram. The A horizon includes a surface layer (A1), darkened by organic matter. The weathered rock at the bottom of the profile is the C horizon. Between them is the B horizon. The following may be used as a guide to describe a soil profile:

1. Record the depth of each horizon.
2. Note the colour of each horizon and whether the colour is uniform.
3. Determine the texture of the A and B horizons.
4. Determine the structure of the B horizon.
5. Note the presence of a watertable which may be indicated by mottling, caused by chemical reduction or anaerobic conditions.

A guide to describing soil colour, texture, structure and consistency is given in Appendix 3.

Selecting the soil form

Step 4:

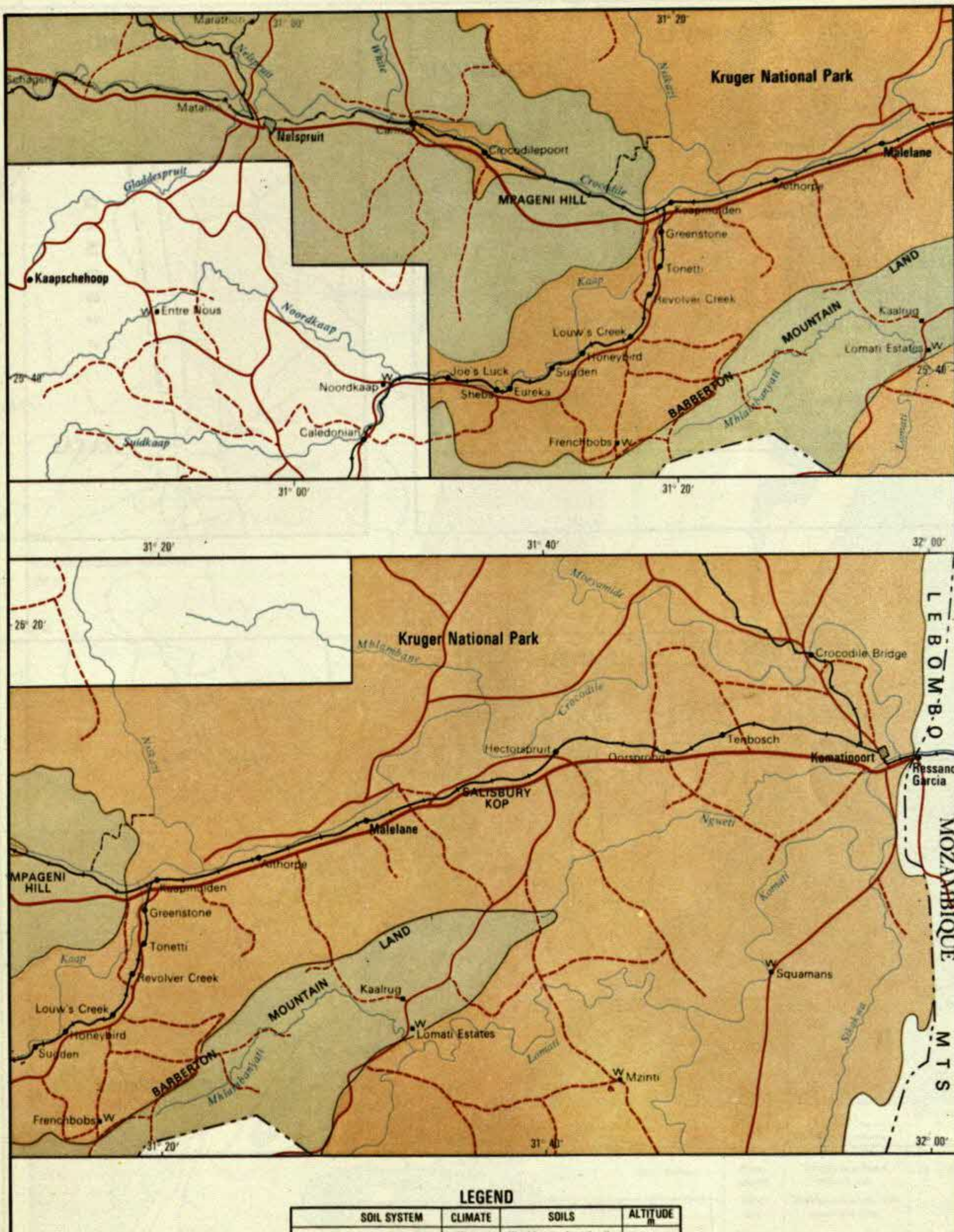
Once the parent material, soil system and appearance of the soil profile have been established, the soil form that best matches the description of the profile can be selected from the short list in the parent material key that follows.

Selecting the soil series

Step 5:

Turn to the page containing the relevant form and select the appropriate soil series from the table which appears below the colour plate. Useful information on the physical and chemical characteristics of the identified soil series can be obtained from the two tables on the page facing the soil form colour plate. For example, the Sprinz series in the Inanda form (see page 35) has a very high available moisture capacity, good drainage and high N mineralizing capacity but is very strongly P-fixing. A general guide on how to interpret these properties is given in Appendix 4.

Eastern Transvaal



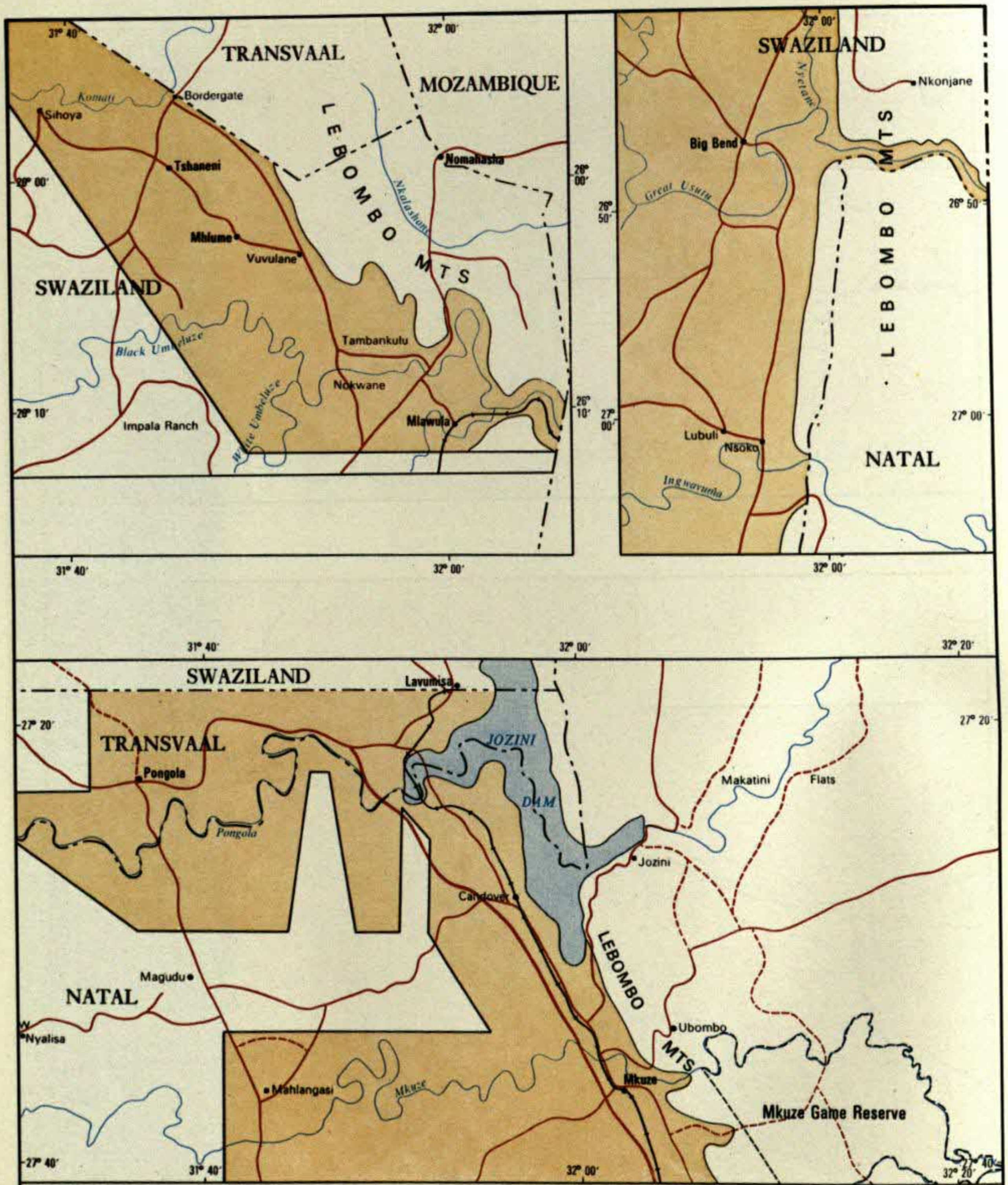
LEGEND

SOIL SYSTEM	CLIMATE	SOILS	ALTITUDE m
KOMATIPOORT	Warm, arid	Weakly weathered soils, some with lime	< 380
NELSPRUIT	Warm, subhumid	Moderately weathered, without lime	> 300

Km 10 5 0 10 Km

1: 500000

Swaziland — Pongola — Mkuze



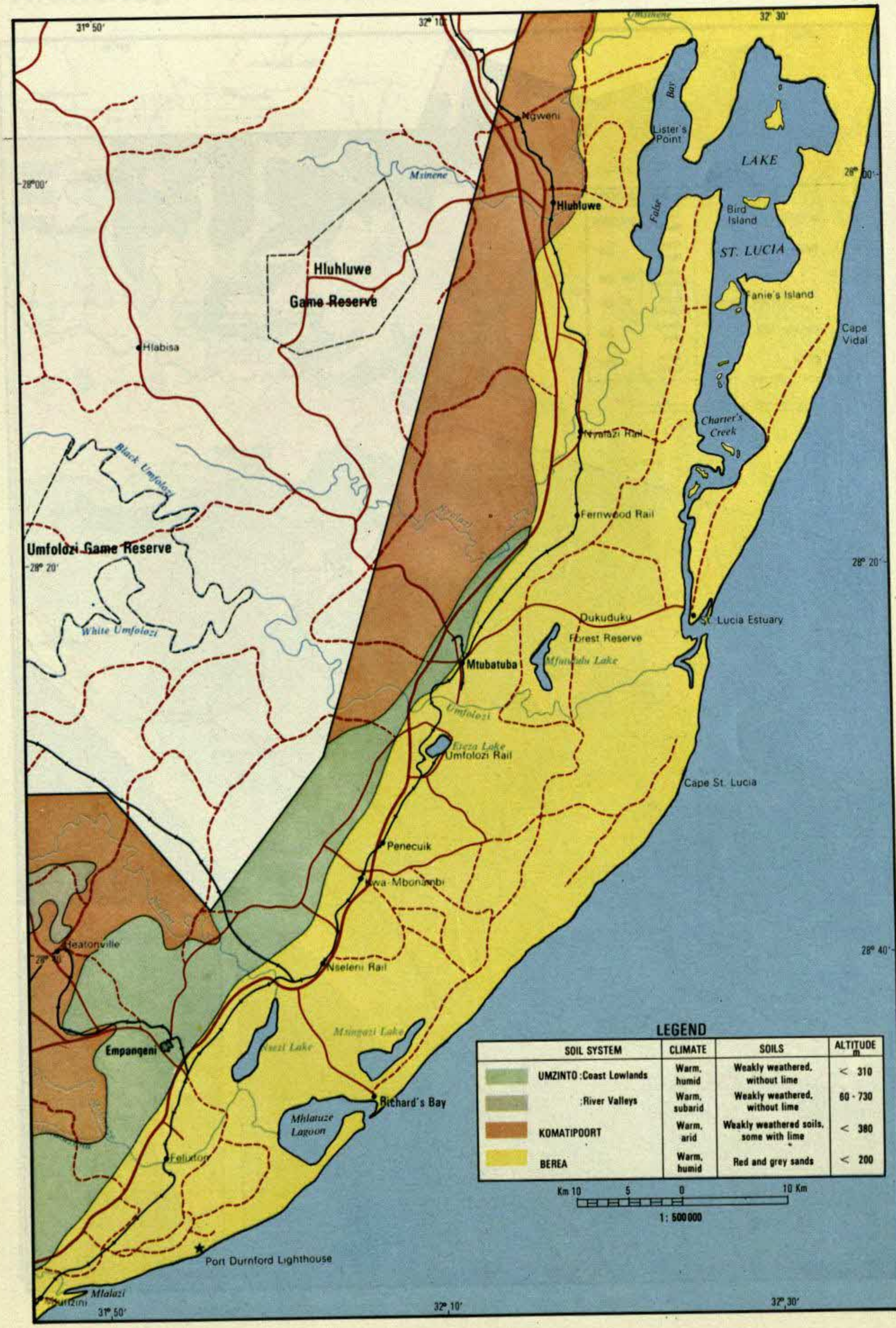
LEGEND

SOIL SYSTEM	CLIMATE	SOILS	ALTITUDE m
KOMATIPOORT	Warm, arid	Weakly weathered soils, some with lime	< 380

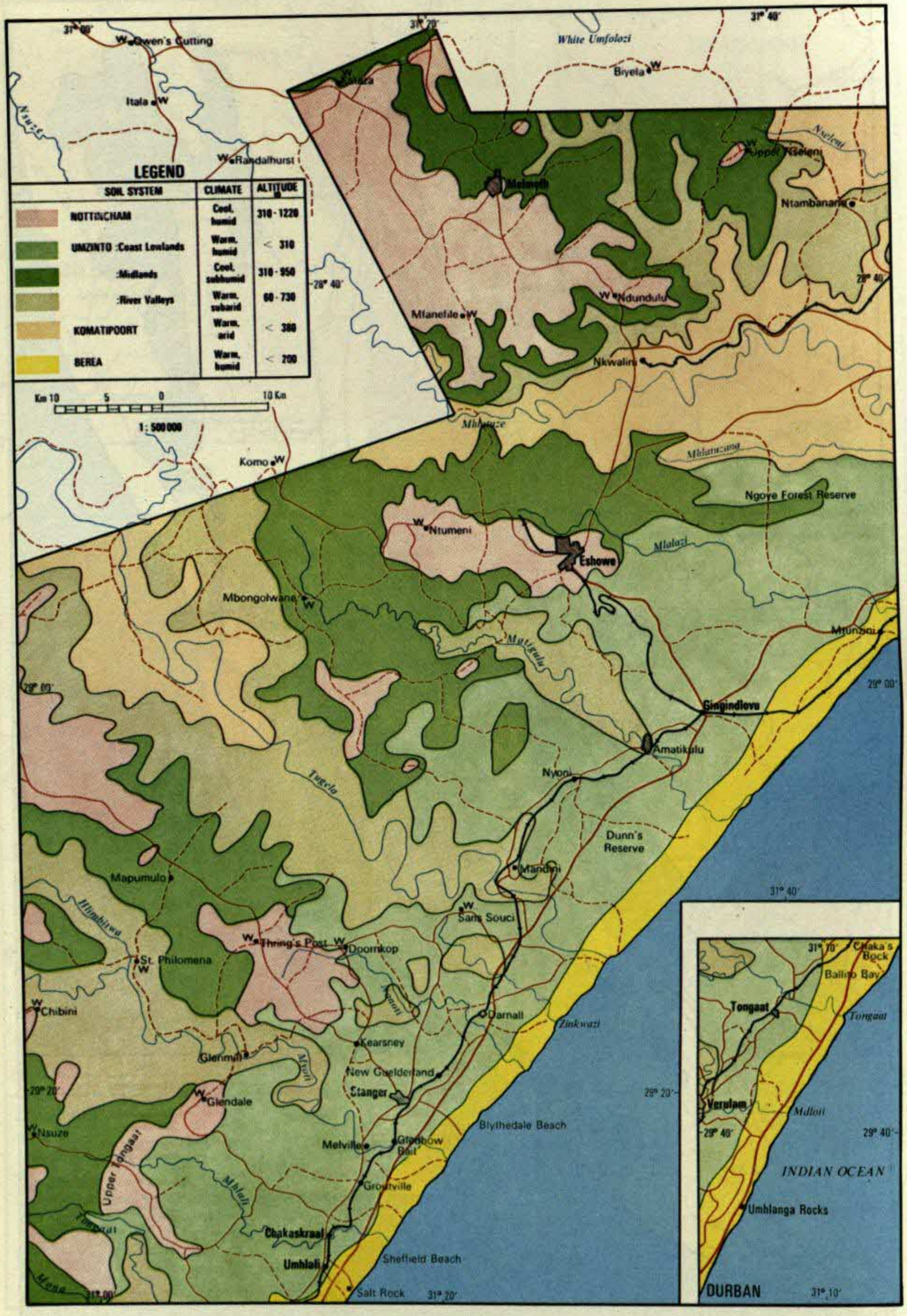
Km 10 5 0 10 Km

1: 500000

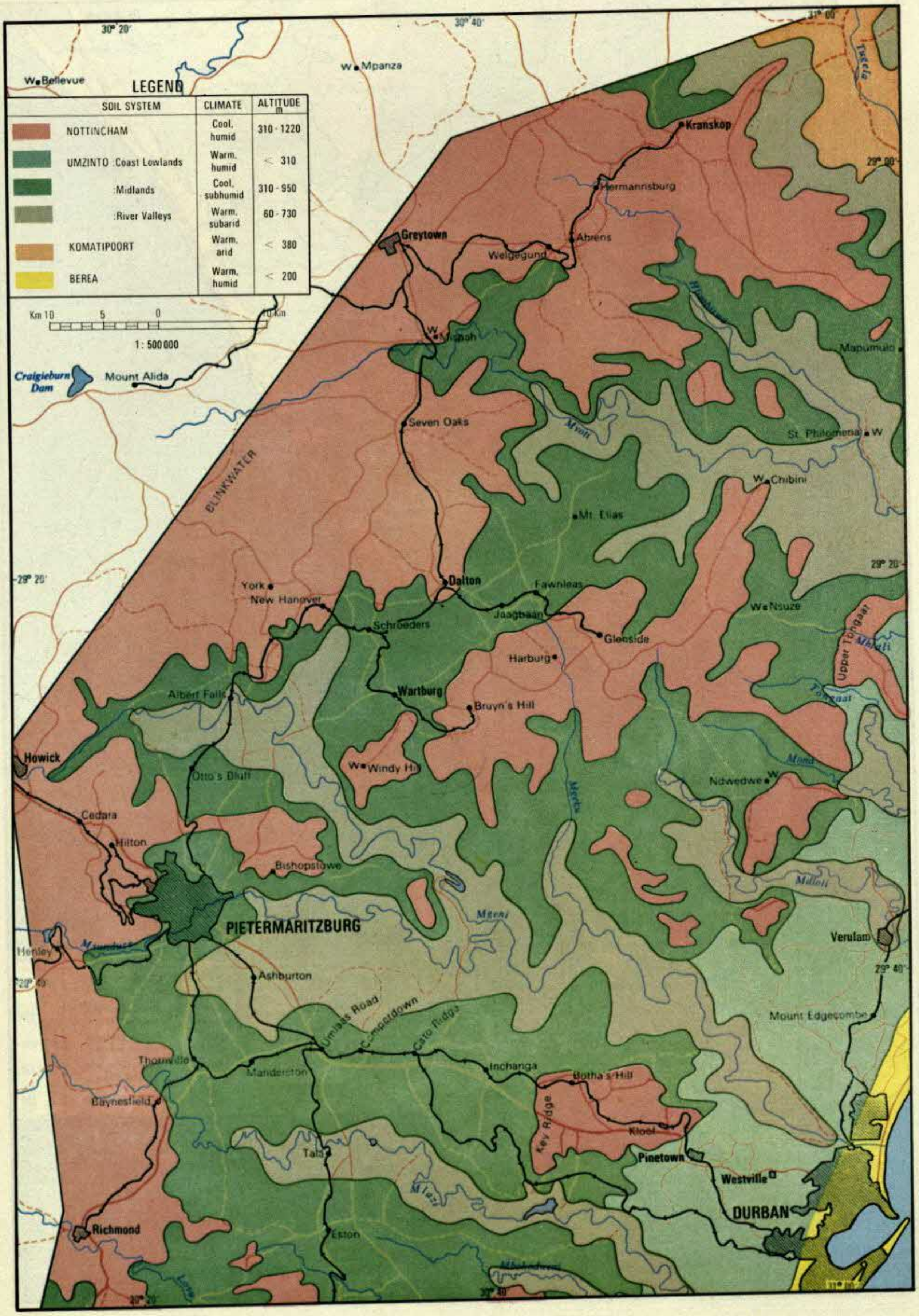
Hluhluwe — Empangeni



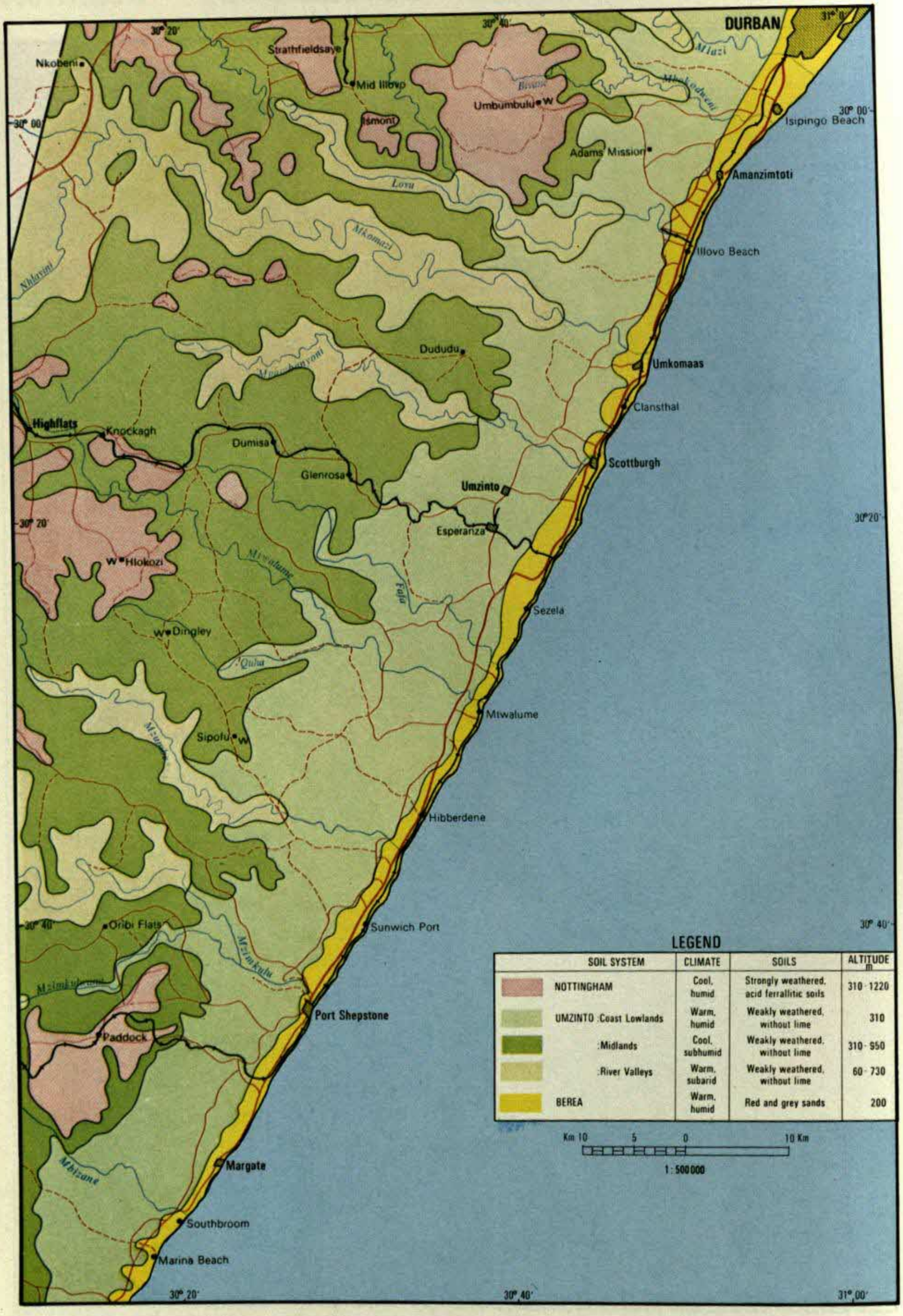
Melmoth — Tongaat



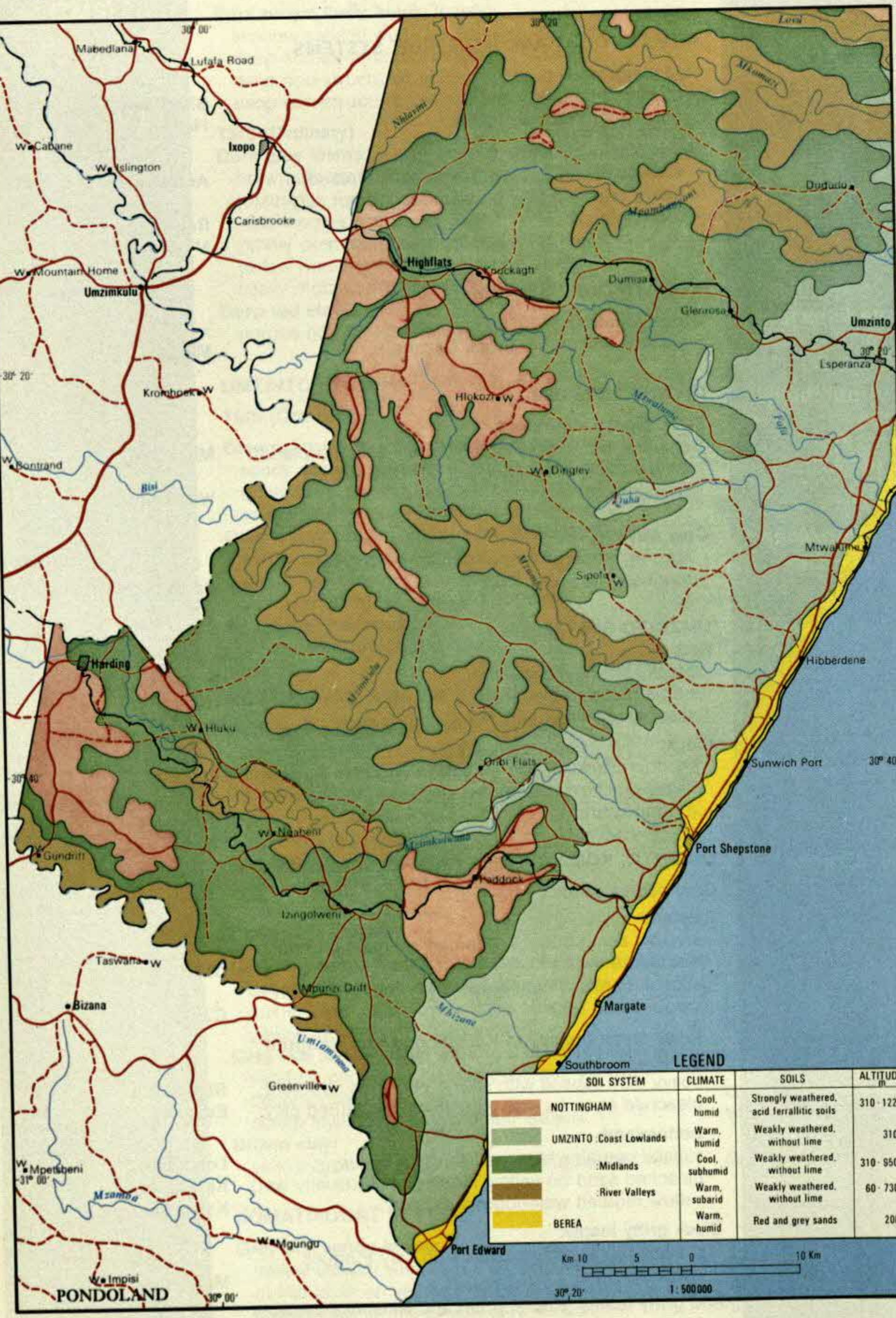
Kranskop — Richmond — Durban



Durban — Mid-Illovo — Margate



Highflats — Harding



Parent material key to the soil forms

			Page
1. Swaziland basic rocks	**KOMATIPOORT AND NELSPRUIT SYSTEMS**		
	Red clays:		
	blocky structured clay:	**Shortlands**	81
	non-structured clay loam:	**Hutton**	83
	Black blocky structured:		
	shallow cracking clay on soft rock (upland):	**Arcadia**	43
	heavy cracking clay on waterlogged pot clay (bottomland):	**Rensburg**	45
	non-cracking clay on hard rock (upland):	**Milkwood**	47
2. Swaziland shale/limestone	**KOMATIPOORT SYSTEM**		
	Brown loams:		
	shallow soil on hard rock (upland):	**Mispah**	59
3. Amphibolite	**UMZINTO SYSTEM**		
	Black blocky structured:		
	shallow, non-cracking clay on hard rock (upland):	**Milkwood**	47
	yellow mottled waterlogged pot clay subsoil (bottomland):	**Willowbrook**	55
4. Pre-granite quartzite	**Grey sand:**		
	subsoil contains light bleached horizon with clay tongues into rock:	**Cartref**	63
5. Tugela schist	**UMZINTO SYSTEM**		
	Red:		
	blocky structured clay:	**Shortlands**	81
	non-structured clay loam:	**Hutton**	83
	shallow red-brown cracking clay on rock:	**Arcadia**	43
	Black:		
	shallow cracking clay on soft rock (upland):	**Arcadia**	43
	heavy cracking clay on waterlogged pot clay (bottomland):	**Rensburg**	45
6. Granite	**UMZINTO, KOMATIPOORT AND NELSPRUIT SYSTEMS**		
	Grey coarse sands:		
	upland		
	shallow sandy subsoil with clay tongues into deep weathered rock:	**Glenrosa**	61
	subsoil contains light bleached horizon with clay tongues into rock:	**Cartref**	63
	lower slope (mainly in Komatipoort and Nelspruit Systems)		
	heavy clay subsoil with strong prismatic structure:	**Sterkspruit**	69
	bleached sand on heavy prismatic structured clay:	**Estcourt**	71
	bottomland		
	subsoil contains bleached sand on ouklip:	**Longlands**	75
	bleached sand on yellow mottled clay (usually wet):	**Kroonstad**	77
	yellow mottled waterlogged pot clay:	**Katspruit**	79
	Black gritty loams:		
	shallow blocky clay subsoil with clay tongues into rock:	**Mayo**	49
	.Red gritty loams (Komatipoort and Nelspruit Systems only)		
	non-structured porous loam:	**Hutton**	83

Parent material	Soil description	Soil form	Page
7. Table Mountain Sandstone (TMS)	**NOTTINGHAM SYSTEM**		
	TMS (Mistbelt)		
	Dark brown fluffy humic loams:		
	shallow subsoil with clay tongues into rock:	**Nomanci**	33
	deep non-structured orange/red subsoil:	**Inanda**	35
	deep non-structured yellow over red subsoil:	**Kranskop**	37
	deep non-structured yellow subsoil:	**Magwa**	39
	TMS (Ordinary)		
	Dark grey loams:		
	brown clayey subsoil with clay tongues into rock (upland):	**Glenrosa**	61
	yellow non-structured subsoil:	**Clovelly**	85
	yellow over red non-structured subsoil:	**Griffin**	87
	yellow non-structured subsoil on ouklip:	**Avalon**	89
	heavy mottled pot clay (bottomland):	**Katspruit**	79
	Deep red clays:		
	porous non-structured subsoil:	**Hutton**	83
	UMZINTO SYSTEM		
	TMS (Ordinary)		
	Grey sands with a bleached sandy horizon:		
	sandy subsoil with clay tongues into rock:	**Cartref**	63
	ouklip layer on mottled subsoil:	**Longlands**	75
	yellow mottled clay (bottomland)	**Kroonstad**	77
	Grey loamy sands without a bleached layer:		
	sandy subsoil with clay tongues into rock:	**Glenrosa**	61
	ouklip layer in grey subsoil:	**Westleigh**	73
	yellow mottled waterlogged pot clay:	**Katspruit**	79
	Red loams (midlands):		
	deep non-structured subsoil:	**Hutton**	83
8. Dwyka tillite	**NOTTINGHAM SYSTEM**		
	Dark brown humic loams:		
	yellow over red non-structured subsoil:	**Kranskop**	37
	Brown non-structured clays:		
	yellow above red subsoil on rock:	**Griffin**	87
	yellow subsoil on rock:	**Clovelly**	85
	yellow-brown subsoil with clay tongues into rock:	**Glenrosa**	61
	Red loams:		
	deep non-structured subsoil:	**Hutton**	83
	UMZINTO SYSTEM		
	Grey fine sandy loams with a bleached sandy horizon:		
	sandy subsoil with clay tongues into rock:	**Cartref**	63
	ouklip layer on yellow mottled subsoil:	**Longlands**	75
	yellow mottled clay (bottomland):	**Kroonstad**	77
	Grey fine sandy loams without a bleached horizon:		
	sandy subsoil with clay tongues into yellow decomposed rock:	**Glenrosa**	61
	ouklip layer on yellow mottled subsoil:	**Westleigh**	73
	Brown clay:		
	yellow-brown subsoil with clay tongues into rock:	**Glenrosa**	61
	KOMATIPOORT SYSTEM		
	Grey fine sandy loams:		
	yellow subsoil with dark clay tongues into rock:	**Glenrosa**	61
	ouklip layer on yellow mottled subsoil:	**Westleigh**	73
	olive-brown strong blocky clay subsoil:	**Sterkspruit**	69
	bleached sandy horizon on blocky clay subsoil:	**Estcourt**	71
	yellow mottled waterlogged pot clay:	**Katspruit**	79

9. Lower Ecca shale	**NOTTINGHAM SYSTEM**		
	Brown clays:		
	shallow clay on shale:	**Mispah**	59
	yellow non-structured subsoil on rock:	**Clovelly**	85
	yellow above red non-structured subsoil:	**Griffin**	87
	UMZINTO SYSTEM		
	Coast lowlands and river valleys		
	Dark grey to black blocky clays:		
	shallow rubbly clay on shale:	**Milkwood**	47
	yellow-brown blocky clay subsoil:	**Bonheim**	51
	yellow heavy mottled waterlogged pot clay:	**Willowbrook**	55
	heavy cracking yellow mottled water-logged pot clay:	**Rensburg**	45
	Midlands		
	Grey brown clays:		
	shallow stony clay on shale:	**Mispah**	59
10. Middle Ecca sediments (sandstones and shales)	**NOTTINGHAM SYSTEM**		
	Dark brown fluffy humic loams:		
	yellow above red non-structured subsoil:	**Kranskop**	37
	Brown clays on shale and grey loams on sandstone:		
	very shallow shaly subsoil:	**Mispah**	59
	yellow non-structured subsoil:	**Clovelly**	85
	yellow above red non-structured subsoil:	**Griffin**	87
	Red clays:		
	porous non-structured subsoil:	**Hutton**	83
	UMZINTO SYSTEM		
	Grey sands to fine sandy loams:		
	shallow shaly subsoil:	**Mispah**	59
	shallow blocky clay subsoil:	**Swartland**	65
	ouklip layer on yellow mottled subsoil:	**Westleigh**	73
	bleached sandy horizon on ouklip:	**Longlands**	75
	bleached sand on yellow mottled clay (usually wet):	**Kroonstad**	77
	yellow heavy mottled waterlogged pot clay:	**Katspruit**	79
	Dark blocky clays on shale:		
	(Coast lowlands and river valleys)		
	shallow rubbly clay on rock:	**Milkwood**	47
	yellow-brown blocky clay subsoil:	**Bonheim**	51
	yellow heavy mottled waterlogged pot clay:	**Willowbrook**	55
	heavy cracking waterlogged pot clay:	**Rensburg**	45
	KOMATIPOORT SYSTEM		
	Grey sands to loams:		
	shallow shaly or rocky subsoil:	**Mispah**	59
	shallow blocky clay subsoil:	**Swartland**	65
	yellow subsoil on ouklip:	**Avalon**	89
	strong blocky brown clayey subsoil:	**Sterkspruit**	69
	bleached sandy horizon on brown blocky clay subsoil:	**Estcourt**	71
	bleached sandy horizon on ouklip:	**Longlands**	75
	bleached sand on yellow mottled clay subsoil (usually wet):	**Kroonstad**	77
	yellow mottled waterlogged pot clay:	**Katspruit**	79
	Black blocky clays:		
	shallow non-cracking clay on shale:	**Milkwood**	47
	yellow-brown blocky clay subsoil:	**Bonheim**	51
	yellow mottled waterlogged pot clay:	**Willowbrook**	55
	heavy cracking waterlogged pot clay:	**Rensburg**	45

Parent material	Soil system / description	Soil form	Page
11. Beaufort sediments	**KOMATIPOORT AND UMZINTO SYSTEMS**		
	Grey loams on sandstone:		
	very shallow loam on rock:	**Mispah**	59
	bleached sand layer on blocky clay subsoil:	**Estcourt**	71
	Dark loams and clays on shale:		
	shallow brown blocky clay subsoil:	**Swartland**	65
	black blocky clay subsoil:	**Milkwood**	47
	yellow mottled waterlogged pot clay subsoil:	**Willowbrook**	55
12. Cave sandstone	**KOMATIPOORT SYSTEM**		
	Grey loamy sands:		
	very shallow soil on rock:	**Mispah**	59
	Red loams:		
	deep non-structured subsoil:	**Hutton**	83
13. Dolerite-basalt-diabase	**NOTTINGHAM SYSTEM**		
	Deep red non-structured clays:		
	thick dark brown fluffy topsoil (more than 450 mm):	**Inanda**	35
	brown shallow topsoil (less than 450 mm):	**Hutton**	83
	UMZINTO AND KOMATIPOORT SYSTEMS		
	Red blocky structured clays:		
	deep porous non-cracking clay on weathered rock:	**Shortlands**	81
	shallow red-brown cracking clay on rock:	**Arcadia**	43
	Black blocky structured clays:		
	shallow cracking clay on rock (upland):	**Arcadia**	43
	yellow-brown blocky clay subsoil (lower slope):	**Bonheim**	51
	heavy cracking waterlogged pot clay (bottomland):	**Rensburg**	45
	Red non-structured clays (Umzinto Midlands only):		
	deep porous subsoil on weathered rock:	**Hutton**	83
14. Cretaceous sediments	**UMZINTO AND KOMATIPOORT SYSTEMS**		
	Black blocky structured clays:		
	shallow cracking clay on rock (upland):	**Arcadia**	43
	yellow-brown blocky clay subsoil (lower slope):	**Bonheim**	51
	Dark grey loams:		
	shallow brown blocky clay subsoil:	**Valsrivier**	67
15. Recent sands	**BEREA SYSTEM**		
	Red sands to sandy loams:		
	deep non-structured subsoil:	**Hutton**	83
	bleached grey sand on red subsoil:	**Shepstone**	93
	Grey sands (no watertable):		
	deep loose sandy subsoil:	**Fernwood**	95
	yellow sandy subsoil:	**Clovelly**	85
	Grey sands (wet and low-lying areas):		
	sandy subsoil with abundant mottling:	**Fernwood**	95
	sandy subsoil with ouklip layer:	**Westleigh**	73
	bleached sandy subsoil with ouklip layer:	**Longlands**	75
	bleached sandy subsoil on mottled clay:	**Kroonstad**	77
	Dark peat:		
	humus-rich topsoil on sand:	**Champagne**	41
16. Alluvium	**ALL SYSTEMS**		
	Grey sands:		
	alternating layers of sand and clay:	**Dundee**	97
	deep loose sandy subsoil:	**Fernwood**	95

Alluvium

NOTTINGHAM SYSTEM

Grey sands:		
reddish structureless clay subsoil with dark clayskins:	**Oakleaf**	91
yellow mottled waterlogged pot clay:	**Katspruit**	79
Black peat:		
humus-rich topsoil on mottled pot clay:	**Champagne**	41

UMZINTO AND KOMATIPOORT SYSTEMS

Red soils:		
deep porous non-structured:	**Hutton**	83
red blocky structured:	**Shortlands**	81
Grey soils with yellow-brown subsoils:		
deep sandy subsoil:	**Clovelly**	85
non-structured subsoil with dark clayskins:	**Oakleaf**	91
blocky structured clay subsoil:	**Valsrivier**	67
Grey soils with a bleached sandy horizon:		
on ouklip:	**Longlands**	75
heavy blocky clay subsoil:	**Estcourt**	71
yellow mottled clay:	**Kroonstad**	77
Grey soils without bleached sandy horizon:		
yellow mottled waterlogged pot clay:	**Katspruit**	79
Black blocky structured clays:		
yellow-brown blocky clay subsoil:	**Bonheim**	51
clayey subsoil with ouklip layer:	**Tambankulu**	53
alternating layers of sand and clay in subsoil:	**Inhoek**	57
non-cracking yellow mottled pot clay:	**Willowbrook**	55
cracking yellow mottled pot clay:	**Rensburg**	45
Black peat:		
humus-rich topsoil on yellow mottled waterlogged pot clay:	**Champagne**	41

NELSPRUIT SYSTEM

Red loams:		
deep non-structured subsoil:	**Hutton**	83
Black clays:		
blocky structured on yellow mottled pot clay:	**Willowbrook**	55
Grey soil:		
bleached sand on wet mottled clay:	**Kroonstad**	77

The binomial system

Procedure

If you do not possess a soil parent material map then the binomial system of classification must be used to obtain the soil form and series as described on the following pages.

The procedure is as follows:

Step 1: Expose a profile of the soil to be identified by digging a pit and mark off the master horizons (see page 22).

Step 2: Identify the horizons that are diagnostic and name each appropriately (see page 23)

Step 3: Name the soil form by consulting the soil form key (see page 27).

Step 4: Use the page number shown in brackets next to the soil form to locate the colour plate of the identified form.

Step 5: Select the appropriate soil series from the soil series table below the colour plate using criteria such as texture, grade of sand, colour, or soil system. (In some instances it will be necessary to have the base status of the soil confirmed by laboratory analysis before the correct series can be chosen.)

Examples

Use fields 101 and 102 on the farm XYZ shown on page 6

Field 101

Step 1: Shallow dark brown clay loam topsoil (A horizon) over a red blocky subsoil (B horizon).

Step 2: A horizon diagnosed as orthic A
B horizon diagnosed as red structured B.

Step 3: Shortlands form (from page 27).

Steps 4 & 5: Shortlands series (clay, from page 81).

Field 102

Step 1: Black cracking clay A horizon (less than 500 mm deep) on weathering rock. No evidence of a B horizon.

Step 2: A horizon diagnosed as vertic A.

Step 3: Arcadia form (from page 27).

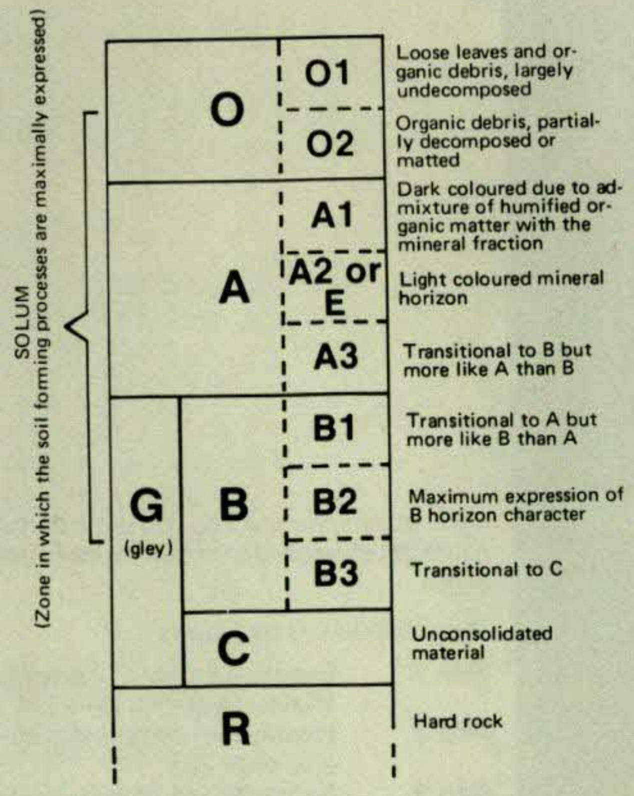
Steps 4 & 5: Rydalvale series (black, from page 43).

Each step is explained more fully in the sections which follow.

Step 1:

Expose a soil profile in a pit and demarcate the master horizons that are present.

The recognition of master horizons in a soil profile is probably the most important step in the whole procedure as these horizons can differ widely in their properties and appearance. A very careful examination of the soil profile is necessary to observe changes in colour, texture, structure and other features that are needed to demarcate master horizons and to differentiate these into the various diagnostic horizons that are described in Step 2. In the binomial system, six master horizons are recognised and their arrangement or relative positions are illustrated in the following diagram. These horizons are not present in all profiles and in most cases only two or three horizons are present.



Arrangement of master horizons

It is important to ensure that pits are well-sited and that the faces are clean. Guidelines for siting pits are given in Appendix 3. The following sequence should be followed when carrying out this step:

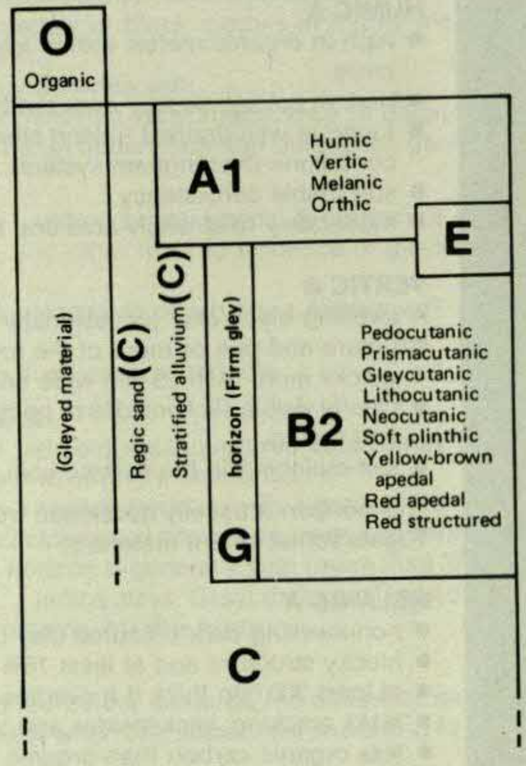
1. Start at the top of the profile and, using differences in colour and structure, mark off each master horizon down the profile.
2. Record the depths of the identified horizons.
3. Determine the colour, structure and texture of the A horizon. In the case of black clays note whether there is any sign of cracking, self-mulching or slickensides.
4. Note the colour of the B horizon and establish whether or not it is uniform.
5. Determine whether there are signs of periodic waterlogging as indicated by grey or greyish-brown colours, yellowish-red mottling, a bleached sandy layer (E horizon), a layer of ironstone concretions (ouklip) or a firm gley at depth (G horizon).

A guide to describing properties such as colour, texture and structure, is given in Appendix 3.

Step 2:

Identify and name each diagnostic horizon.

Once the master horizons have been marked off and their appearance described, the next step is to select from the list of five diagnostic topsoil and thirteen subsoil horizons of the binomial system, those that match your profile description. The names of these horizons and their relative positions in the soil profile are illustrated in the following diagram while a brief description of each topsoil and subsoil follows. A thorough understanding of these descriptions is required to ensure that the correct diagnostic horizon is selected. This can be checked by comparing your description with the specifications listed in the descriptions. In the case of subsoil horizons, these should occur within 1 200 mm of the surface.



Diagnostic horizons

Poorly drained

Description of diagnostic horizons.

TOPSOIL HORIZONS

ORGANIC O

- rich in organic matter with at least 10% organic carbon throughout a depth of 300 mm,
- overlies gleyed material,
- normally black or dark brown in colour,
- partly decomposed plant material may be seen in this horizon,
- also known as peat.

HUMIC A

- high in organic matter with at least 2% organic carbon to a depth of 450 mm or more,
- dark in colour, usually dark reddish brown,
- found in well drained upland sites on old land surfaces in humid, cool mistbelt conditions (Nottingham system),
- soft friable consistency,
- moderately to strongly acid and highly leached.

VERTIC A

A swelling black clay (occasionally the clay may be brown or red) with a blocky structure and one or more of the following properties:

- cracks more than 25 mm wide on drying,
- clearly visible slickensides or polished surfaces due to soil movement on wetting and drying,
- self-mulching in the surface soil.

This horizon is usually developed from dolerite, basalt, Swaziland basic rocks and Tugela schist parent materials.

MELANIC A

- non-swelling dark coloured clay usually black,
- blocky structure and at least 15% clay,
- at least 300 mm thick if it overlies a red or yellow coloured B horizon,
- lacks cracking, slickensides and self-mulching,
- less organic carbon than organic (0) horizon.

This horizon is commonly associated with soils derived from Lower Ecca shale, amphibolite, biotite granite and heavy alluvial parent materials.

ORTHIC A

- ordinary mineral topsoil which is not humic, melanic, vertic or organic,
- usually grey to brown in colour and less than 400 mm thick,
- covers a wide textural range (usually 0 to 30% clay),
- usually structureless to weakly structured.

The majority of soils in the sugarbelt have this topsoil diagnostic horizon (approximately 70%). An orthic A horizon can develop under almost any soil forming conditions but it tends to be associated with soils derived from Table Mountain Sandstone, Dwyka tillite, Recent Sands, Middle Ecca sandstone, granite, pre-granite quartzite and recent alluvium.

SUBSOIL HORIZONS

E HORIZON

- directly underlies a diagnostic topsoil horizon,
- a bleached, greyish or whitish coloured horizon which frequently results from the eluviation (removal) of clay, iron oxide and humic material by a watertable,
- lies within 1 200 mm of the soil surface over a gleycutanic, prismacutanic, lithocutanic, neocutanic or plinthic B horizon,
- may be mottled or streaked,
- non-plastic and frequently sets very hard on drying.

G HORIZON

This is a strong, firm gley developed where conditions are waterlogged for the greater part of the year.

- underlies a topsoil horizon,
- has shades of grey with blue or green tints and various coloured mottles. Can also be yellowish brown, olive brown, red or even black,
- has a firm plastic consistency,
- at least 250 mm thick,
- does not overlie any of the cutanic horizons,
- generally occurs in valley bottom soils.

SOFT PLINTHIC B

- sometimes known as ouklip, gravel, laterite or ngubane
- results from the accumulation and localisation of iron and manganese oxides which form red, yellow or black mottles in a grey matrix sometimes causing concretions to form
- can be cut by a spade when wet,
- occurs second or third in a vertical sequence of diagnostic horizons,
- usually merges into an impervious non-diagnostic gley with depth.

GLEYCUTANIC B

- directly underlies a yellow-brown apedal B horizon or an E horizon,
- has dark mottles and other marked evidence of gleying superimposed on the cutans,
- any degree of development of structure except well developed prismatic or columnar,
- associated with a fluctuating watertable.

Uniformly coloured sub-soil horizons

RED STRUCTURED B

- mainly a uniform red colour although red cutans may be present,
- structure moderate to strongly developed,
- directly underlies a topsoil horizon, with a gradual transition.

This horizon also indicates good internal drainage and aeration. In the sugarbelt the clay content of this horizon is generally high (more than 35%) and is characterised by both 1 : 1 and 2 : 1 lattice clays. Basic rocks such as dolerite, basalt and schists provide the parent material for this horizon.

RED APEDAL B

- mainly a uniform red colour although red cutans or mottles may be present,
- may be structureless when dry, sometimes improving to weakly structured when moist,
- directly underlies a diagnostic topsoil horizon, a yellow-brown apedal B horizon or sometimes an E horizon.

This horizon indicates a well drained and aerated soil dominated by non-swelling 1:1 clay minerals. Developed under a wide range of climatic conditions from basic parent materials (eg basalt, schist, diabase, dolerite) or siliceous parent materials (eg granite, gneiss, quartzite, sandstone, alluvium, wind blown sands).

YELLOW BROWN APEDAL B

- yellowish to brownish in colour,
- structure is weaker than moderate,
- directly underlies a topsoil or E horizon.

This horizon is similar to the red apedal B differing mainly in colour. It is also developed under a wide range of climatic conditions and derived mainly from siliceous parent materials (eg sandstone, wind blown sands).

Non-uniform coloured sub-soil horizons

Cutanic B horizons have developed clayskins illuviated from the overlying A horizon and may have developed prominent colour variations due to iron and manganese oxides or organic matter. These easily recognised clayskins are present in four different types of cutanic B horizons which can vary considerably in their other properties.

NEOCUTANIC B

- uniform dark brown colour except when cutans are present,
- underlies a topsoil or E horizon,
- generally occurs in recently deposited material,
- structural development is weaker than moderate and cutanic character in the form of clayskins, is still in an early stage of development,

Other subsoil horizons:

- typically found in floodplains or when recent alluvial deposits have occurred and soil forming processes have not had sufficient time to develop to any marked extent.

LITHOCUTANIC B

- underlies a topsoil or an E horizon and merges into weathering rock
- occurs in saprolite (unconsolidated material). This includes profiles in a variable but early stage of development,
- weathered soils often having tongues into or being interspersed with weathered rock,
- the cutans are coatings of iron and manganese oxides or organic matter on ped surfaces or surrounding root channels.

PEDOCUTANIC B

- underlies a diagnostic topsoil horizon either directly or via a stone line,
- the transition into the overlying A horizon is usually not abrupt,
- structure is stronger than defined for red apedal horizons,
- clayskins on the ped surfaces or tongues into the C horizon are diagnostic,
- colour contrast between clayskins and ped surfaces,
- does not qualify as a G horizon because it lacks wetness; nor as a gleycutanic or prismacutanic B horizon because it lacks an abrupt transition; nor as a red structured B horizon because of non-uniform colour.

The lithocutanic B frequently merges into a pedocutanic B down a slope. The structure of the soil comprising the pedocutanic horizon is fairly well developed and is dominant over the saprolite. In the lithocutanic horizon the saprolite is dominant and soil structure is weakly developed.

PRISMACUTANIC B

- has an abrupt transition with an overlying E or A horizon in terms of at least two of the following three properties:
  - i) texture
  - ii) structure
  - iii) consistency
- has a prismatic or columnar structure,
- usually no evidence of wetness or if it has signs of wetness then the vertical faces of the prisms have continuous clay coatings of uniform colour,
- colour contrast between clayskins and ped interiors.

REGIC SAND

- has a light texture (sand or loamy sand) and lacks structure,
- is at least 250 mm thick
- has a consistency that is softer than firm,
- may have clay fibres or lamellae,
- usually has the same colours as defined for the E horizon but does not have reddish or yellow colours,
- directly underlies a diagnostic topsoil horizon but may occur at the surface
- does not overlie any other diagnostic horizon within a depth of 1 200 mm of the soil surface but may overlie hard rock
- commonly found in soils derived from the grey Recent Sands.

STRATIFIED ALLUVIUM

- unconsolidated material and contains fine stratifications due to alluvial deposition
- directly underlies a diagnostic topsoil horizon.

Step 3:

Name the soil form by consulting the soil form key

By determining the presence or absence, sequence and depth of the diagnostic horizons the appropriate soil form can be determined by referring to the following soil form key. Form names are arranged in terms of the defined topsoil and subsoil horizons. For example, a soil with an orthic A over a red apedal B horizon will be classified as the Hutton form. Another soil profile with the same topsoil but a red structured B subsoil will be classified as the Shortlands form.

KEY TO THE SOIL FORMS
(page reference in brackets)

Subsoil diagnostic horizons	Topsoil diagnostic horizons				
	Organic	Humic	Vertic	Melanic	Orthic
Hard rock				Milkwood (47)	Mispah (59)
Soft rock (saprolite)			Arcadia (43)		
Lithocutanic B		Nomanci (33)		Mayo (49)	Glenrosa (61)
Pedocutanic B/saprolite				Bonheim (51)	Swartland (65)
Pedocutanic B/ unconsolidated material					Valsrivier (67)
Prismacutanic B					Sterkspruit (69)
Soft plinthic B				Tambankulu(53)	Westleigh (73)
E horizon/red apedal B					Shepstone (93)
E horizon/lithocutanic B					Cartref (63)
E horizon/soft plinthic B					Longlands (75)
E horizon/prismacutanic B					Estcourt (71)
E horizon/gleycutanic B					Kroonstad (77)
G horizon (firm gley)	Champagne(41)		Rensburg (45)	Willowbrook (55)	Katspruit (79)
Red structured B					Shortlands (81)
Red apedal B		Inanda (35)			Hutton (83)
Yellow apedal B		Magwa (39)			Clovelly (85)
Yellow apedal B/ red apedal B		Kranskop (37)			Griffin (87)
Yellow apedal B/ soft plinthic B					Avalon (89)
Neocutanic B				Inhoek (57)	Oakleaf (91)
Regic sand	Champagne(41)				Fernwood (95)
Stratified alluvium				Inhoek (57)	Dundee (97)

Step 4:

Use the page number given in brackets next to the soil form to locate the colour plate of the form.

The 33 soil forms contained in this bulletin have been arranged into groups based on similar topsoil or subsoil horizons. Where applicable, forms have been arranged in relation to their position in the landscape, from the highest (crest) to the lowest (bottomland) level. In practice, the soil forms in any toposequence will depend on the soil system and nature of the underlying parent material.

		Page
Forms with humic A or organic O horizons		
1. Humic A over hard rock	**Nomanci**	33
2. Humic A over red apedal B	**Inanda**	35
3. Humic A over yellow-brown apedal B over red apedal B	**Kranskop**	37
4. Humic A over yellow-brown apedal B	**Magwa**	39
5. Organic O over regic sand or G horizon	**Champagne**	41
Forms with vertic A horizons (crest to valley bottom)		
6. Vertic A on soft rock (saprolite)	**Arcadia**	43
7. Vertic A over G (firm gley)	**Rensburg**	45
Forms with melanic A horizons (crest to valley bottom)		
8. Melanic A over hard rock	**Milkwood**	47
9. Melanic A over lithocutanic B	**Mayo**	49
10. Melanic A over pedocutanic B	**Bonheim**	51

11. Melanic A over soft plinthic B	**Tambankulu**	53
12. Melanic A over G (firm gley)	**Willowbrook**	55
13. Melanic A over neocutanic B or stratified alluvium	**Inhoek**	57

Forms with orthic A horizons over rock or lithocutanic B (mainly crest or upland)

14. Orthic A over hard rock	**Mispah**	59
15. Orthic A over lithocutanic B	**Glenrosa**	61
16. Orthic A over E over lithocutanic B	**Cartref**	63

Forms with orthic A horizons over pedocutanic or prismacutanic B horizons (mid-slope to bottomland)

17. Orthic A over pedocutanic B on saprolite	**Swartland**	65
18. Orthic A over pedocutanic B on unconsolidated material	**Valsrivier**	67
19. Orthic A over prismacutanic B	**Sterkspruit**	69
20. Orthic A over E over prismacutanic B	**Estcourt**	71

Forms with the orthic A horizons over E and/or soft plinthic B or G horizons

21. Orthic A over soft plinthic B	**Westleigh**	73
22. Orthic A over E over soft plinthic B	**Longlands**	75
23. Orthic A over E over gleycutanic B	**Kroonstad**	77
24. Orthic A over G (firm gley)	**Katspruit**	79

Forms with orthic A horizons over red or yellow B horizons (mainly upland to foot-slope)

25. Orthic A over red structured B	**Shortlands**	81
26. Orthic A over red apedal B	**Hutton**	83
27. Orthic A over yellow-brown apedal B	**Clovelly**	85
28. Orthic A over yellow-brown apedal B over red apedal B	**Griffin**	87
29. Orthic A over yellow-brown apedal B over soft plinthic B	**Avalon**	89

Forms with orthic A horizons over recently formed subsoil material (footslope to valley bottom)

30. Orthic A over neocutanic B	**Oakleaf**	91
31. Orthic A over E over red apedal B	**Shepstone**	93
32. Orthic A over regic sand	**Fernwood**	95
33. Orthic A over stratified alluvium	**Dundee**	97

Step 5:

Identify the soil series

The final step is to identify the appropriate soil series from the table below the colour plate. Various criteria such as texture, grade of sand, colour, base status and soil system, may be used. In most cases these properties may be determined in the field. The soil system in which your farm is situated (refer to soil system maps), is generally a good indicator of base status:

e.g. Nottingham and Umzinto midlands	—	low base status
Umzinto coast lowlands and Berea	—	medium base status
Umzinto river valley, Komatipoort and Nelspruit	—	high base status

Where textural and chemical analyses of the diagnostic horizon have been carried out, the soil series can be identified more accurately from the two tables facing the soil form colour plate. The correct soil series will be the one with a clay content closest to that of the diagnostic horizon. In the case of the Hutton, Clovelly, Griffin and Avalon forms, the series is identified from the clay content and base status of the B horizon.

Key to Groups of Soil Forms having Common Diagnostic Horizons

SOIL FORMS WITH HUMIC A OR ORGANIC O HORIZONS

Horizon	Soil form				
	Nomanci	Inanda	Kranskop	Magwa	Champagne
A/O	Humic	Humic	Humic	Humic	Organic O
B	Lithocutanic	Red apedal	Yellow-brown apedal / Red apedal	Yellow-brown apedal	Gleyed material
C/R	Rock	Rock	Rock	Rock	
Series determined by	Clay content (A)*	Clay content (B)	Clay content (B)	Clay content (B)	Clay content (O) pH (O)
Representative soil series	Nomanci Lusiki	Fountainhill Inanda Sprinz	Kipipiri Kranskop Umbumbulu	Milford Magwa Frazer	Mposa Stratford Champagne Ivanhoe
See page	33	35	37	39	41

* refers to a particular diagnostic horizon

SOIL FORMS WITH VERTIC A HORIZONS (CREST TO BOTTOMLAND)

Horizon	Soil form	
	Arcadia	Rensburg
A	Vertic	Vertic
C/G	Saprolite or rock	Firm gley
Series determined by	Self-mulching/crust formation Carbonate content (A) Colour (A)	Carbonate content (G)
Representative soil series	Rydalvale, Rooidraai Arcadia, Eensaam	Phoenix Rensburg
See page	43	45

SOIL FORMS WITH MELANIC A HORIZONS (CREST TO BOTTOMLAND)

Horizon	Soil form					
	Milkwood	Mayo	Bonheim	Tambankulu	Willowbrook	Inhoek
A	Melanic	Melanic	Melanic	Melanic	Melanic	Melanic
B/G	Rock on ferricrete or calcrete or silcrete	Lithocutanic	Pedocutanic	Soft plinthite	Firm gley	Neocutanic or stratified alluvium
C/R			Saprolite	Saprolite or sedimentary rock (usually gleyed)		
Series determined by	Clay content (A) Carbonate content (A)	Clay content (A) Carbonate content (B)	Clay content (B) Colour (B) Carbonate content (B)	Clay content (A) Carbonate content (B)	Clay content (A) Carbonate content (B)	Clay content (A) Carbonate content (C)
Representative soil series	Dansland Milkwood Sunday Graythorne	Mayo Msinsini Tshipise Pafuri	Kiora Stanger Rasheni Glengazi Bonheim	Fenfield Tambankulu Loshoek Masala	Emfuleni Willowbrook Sarasdale Chinyika	Cromley Coniston Inhoek Drydale
See page	47	49	51	53	55	57

SOIL FORMS WITH MAINLY ROCK AND/OR LITHOCUTANIC B HORIZON (CREST TO MIDSLOPE)

Horizon	Soil form		
	Mispah	Glenrosa	Cartref
A	Orthic	Orthic	Orthic
B	Rock on hardened ferricrete or lime crete or silcrete	Lithocutanic	E Horizon
C/R			Lithocutanic
Series determined by	Material (C/R) Carbonate content (A)	Clay content (A) Colour (A) Carbonate content (B) Sand grade (A)	Clay content (E) Sand grade (E)
Representative soil series	Mispah Muden	Platt, Glenrosa Williamson Trevanian, Robmore Saintfaiths, Achterdam	Cartref Arrochar Grovedale Kusasa
See page	59	61	63

SOIL FORMS WITH PEDOCUTANIC OR PRISMACUTANIC B HORIZONS

Horizon	Soil form			
	Swartland	Valsrivier	Sterkspruit	Estcourt
A	Orthic	Orthic	Orthic	Orthic
B	Pedocutanic	Pedocutanic	Prismacutanic	E horizon Prismacutanic
C/R	Saprolite	Unconsolidated material	Saprolite or rock	Saprolite or sedimentary rock
Series determined by	Clay content (B) Colour (B) Carbonate content (B)	Clay content (B) Colour (B) Carbonate content (B)	Clay content (A) Sand grade (A) Colour (B)	Clay content (E) Sand grade (E) Colour (B)
Representative soil series	Rosehill Swartland Skilderkrans Malakata, Nyoka Broekspruit	Valsrivier Lindley Sheppardvale Arniston Waterval	Graafwater Hartbees Sterkspruit	Elim Uitvlugt Estcourt Rosemead
See page	65	67	69	71

SOIL FORMS WITH E AND/OR SOFT PLINTHITE OR G HORIZON

Horizon	Soil form			
	Westleigh	Longlands	Kroonstad	Katspruit
A	Orthic	Orthic	Orthic	Orthic
E	Soft plinthic	E horizon	E horizon	Firm gley (G)
B		Soft plinthic	Gleycutanic	
C/R	Gleyed saprolite	Gleyed saprolite	Gleyed saprolite	
Series determined by	Clay content (B) Sand grade (B)	Clay content (E) Sand grade (E)	Clay content (E) Clay content (B) Sand grade (E)	pH(G)
Representative soil series	Kosi Witsand Rietvlei Sibasa	Waaisand Longlands Waldene Albany, Vaalsand	Kroonstad Mkambati Katarra Avoca, Bluebank	Katspruit Killarney
See page	73	75	77	79

SOIL FORMS WITH RED AND/OR YELLOW B HORIZONS

Horizon	Soil Form				
	Shortlands	Hutton	Clovelly	Griffin	Avalon
A	Orthic	Orthic	Orthic	Orthic	Orthic
B	Red structured	Red apedal	Yellow-brown apedal	Yellow-brown apedal Red apedal	Yellow-brown apedal Soft plinthic
C/R	Saprolite or rock	Saprolite or rock	Saprolite or rock	Saprolite or rock	Gleyed saprolite
Series determined by	Clay content (B) Base status (B) Carbonate content (B)	Clay content (B) Sand grade (B) Base status (B) Carbonate content (B)	Clay content (B) Sand grade (B) Base status (B) Carbonate content (B)	Clay content (B) Base status (B)	Clay content (B) Sand grade (B) Base status (B)
Representative soil series	Glendale Shortlands Argent Sunvalley	Joubertina Clansthal Shorrocks Makatini Doveton Vimy Msinga Farningham Balmoral	Sandspruit Denhere Springfield Oatsdale Clovelly Balgowan	Burnside Cleveland Griffin Farmhill	Kanhym Ruston Bezuidenhout
See page	81	83	85	87	89

SOIL FORMS ON RECENT ALLUVIUM AND REGIC SAND

Horizon	Soil form			
	Oakleaf	Shepstone	Fernwood	Dundee
A	Orthic	Orthic	Orthic	Orthic
B	Neocutanic	E horizon	Regic sand	Stratified alluvium
C/R	Neocutanic	Red apedal	Regic sand	Stratified alluvium
Series determined by	Clay content (B) Sand grade (B) Colour (B) Carbonate content (B)	Clay content (E) Clay content (B) Sand grade (E)	Sand grade (Regic sand) Acidity Signs of moisture	Only one series
Representative soil series	Sezela Levubu Jozini Koedoesvlei Limpopo Leeufontein Highflats	Bitou Shepstone Robberg Portobello	Maputa Fernwood Langebaan Sandveld Warrington Trafalgar	Dundee
See Page	91	93	95	97

SELECTED PROPERTIES OF NOMANCI FORM SOIL SERIES

Soil series	Physical†					
	Clay % A horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Nomanci 10*	Less than 35	Moderate to high	Good	Good	Moderate	Slight (t)
Lusiki 11	More than 35	High	Good	Good	Moderate to low	Slight (t)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity hazard
Nomanci 10	4,5 to 5,5	Very low	Moderate to severe	Moderate	High	Low	Low	Nil
Lusiki 11	5,0 to 5,5	Low	Moderate	High	High	Low	Low	Nil

*Series code number

†See Appendix 4 for explanations of soil properties

Nomanci Form - No*

Humic A

Lithocutanic B

Thick brown humic powdery clay loam to clay

Clay tongues into weathering rock

MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Nottingham	TMS† (Mistbelt)	Nomanci	Clay loam	Less than 700
		Lusiki	Clay	

†Table Mountain Sandstone

FEATURES TO NOTE

- excellent physical properties but some nutritional problems
- lime, phosphorus or zinc : commonly required to correct serious deficiencies
- potassium : requirement may be higher than average
- nitrogen : requirement should be below average
- soil sampling : thorough sampling before planting is essential

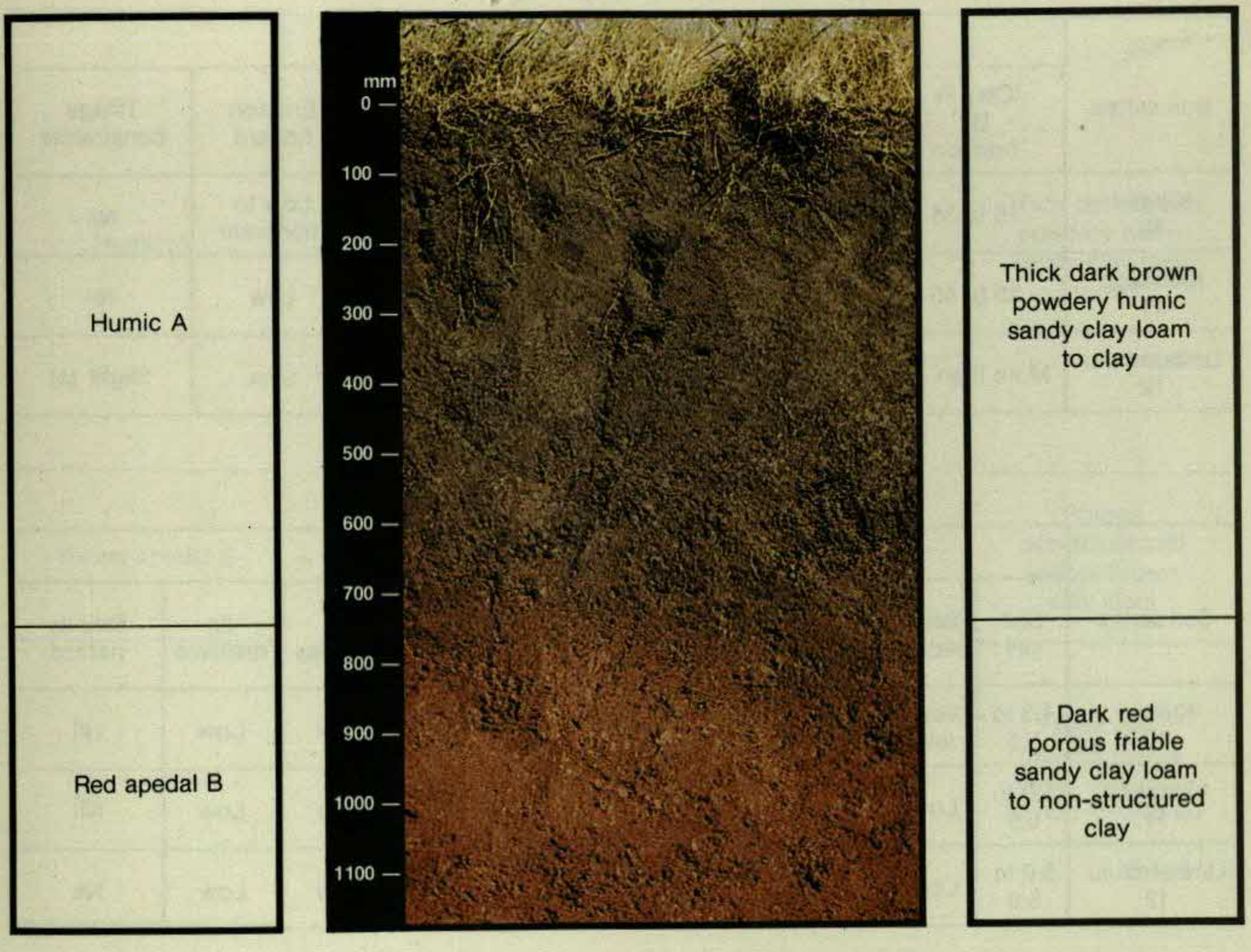
*Standard abbreviation

SELECTED PROPERTIES OF INANDA FORM SOIL SERIES

Soil series	Physical					
	Clay % B2 horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Fountainhill 10	15 to 35	Moderate to high	Good	Good	Low to moderate	Nil
Inanda 11	35 to 55	High	Good	Good	Low	Nil
Sprinz 12	More than 55	Very high	Medium to good	Good	Very low	Slight (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity hazard
Fountainhill 10	4,5 to 5,5	Very low	Moderate to severe	Moderate	High	Low	Low	Nil
Inanda 11	5,0 to 5,5	Low	Moderate	High	High	Low	Low	Nil
Sprinz 12	5,0 to 5,5	Low	Moderate to low	Very high	High	Low	Low	Nil

Inanda Form - Ia



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Nottingham	TMS (Mistbelt)	Fountainhill	Sandy clay loam	More than 1 000
		Inanda	Clay loam	
	Dolerite	Sprinz	Clay	

FEATURES TO NOTE

- excellent physical properties but some nutritional problems
- lime, phosphorus or zinc : commonly required to correct serious deficiencies
- potassium : requirement may be higher than average
- nitrogen : requirement should be lower than average
- soil sampling : thorough sampling before planting is essential

SELECTED PROPERTIES OF KRANSKOP FORM SOIL SERIES

Soil series	Physical					
	Clay % B2 horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Kipipiri 10	15 to 35	Moderate to high	Good	Good	Low to moderate	Nil
Kranskop 11	35 to 55	High	Good	Good	Low	Nil
Umbumbulu 12	More than 55	Very high	Medium to good	Moderate	Low	Slight (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity hazard
Kipipiri 10	4,5 to 5,5	Very low	Moderate to severe	Moderate	High	Low	Low	Nil
Kranskop 11	5,0 to 5,5	Low	Moderate	High	High	Low	Low	Nil
Umbumbulu 12	5,0 to 5,5	Low	Moderate to low	Very high	High	Low	Low	Nil

Kranskop Form - Kp

Humic A	Thick dark brown powdery humic sandy clay loam to clay
Yellow apedal B	Porous non-structured yellow-brown clay loam
Red apedal B	Dark red porous friable sandy clay loam to non-structured clay

MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Nottingham	TMS (mistbelt) Middle Ecca sediments and Dwyka tillite	Kipipiri	Sandy clay loam	More than 1 000
		Kranskop	Clay loam	
		Umbumbulu	Clay	

FEATURES TO NOTE

- excellent physical properties but some nutritional problems
- lime, phosphorus or zinc : commonly required to correct serious deficiencies
- potassium : requirement may be higher than average
- nitrogen : requirement should be below average
- soil sampling : thorough sampling before planting is essential

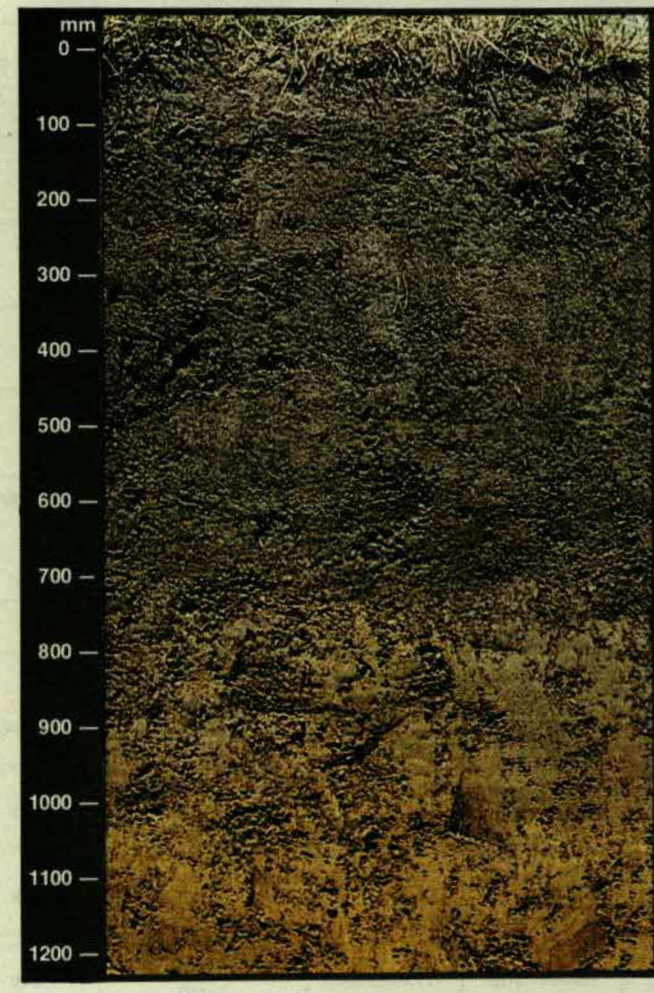
SELECTED PROPERTIES OF MAGWA FORM SOIL SERIES

Soil series	Physical					
	Clay % B2 horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Milford 10	15 to 35	Moderate to high	Good	Good	Low to moderate	Nil
Magwa 11	35 to 55	High	Good	Good	Low	Nil
Frazer 12	More than 55	Very high	Medium to good	Good	Very low	Slight (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity hazard
Milford 10	4,5 to 5,5	Very low	Moderate to severe	Moderate	High	Low	Low	Nil
Magwa 11	4,5 to 5,5	Low	Moderate	High	High	Low	Low	Nil
Frazer 12	4,5 to 5,5	Low	Moderate to low	Very high	High	Low	Low	Nil

Magwa Form - Ma

Humic A	Thick dark brown powdery humic sandy clay loam to clay
Yellow apedal B	Yellow-brown porous friable clay loam to non-structured clay



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Nottingham	TMS (Mistbelt)	Milford	Sandy clay loam	700 to 1 200
		Magwa	Clay loam	
		Frazer	Clay	

FEATURES TO NOTE

- excellent physical properties but some nutritional problems
- lime, phosphorus or zinc : commonly required to correct serious deficiencies
- potassium : requirement may be higher than average
- nitrogen : requirement should be below average
- soil sampling : thorough sampling before planting is essential

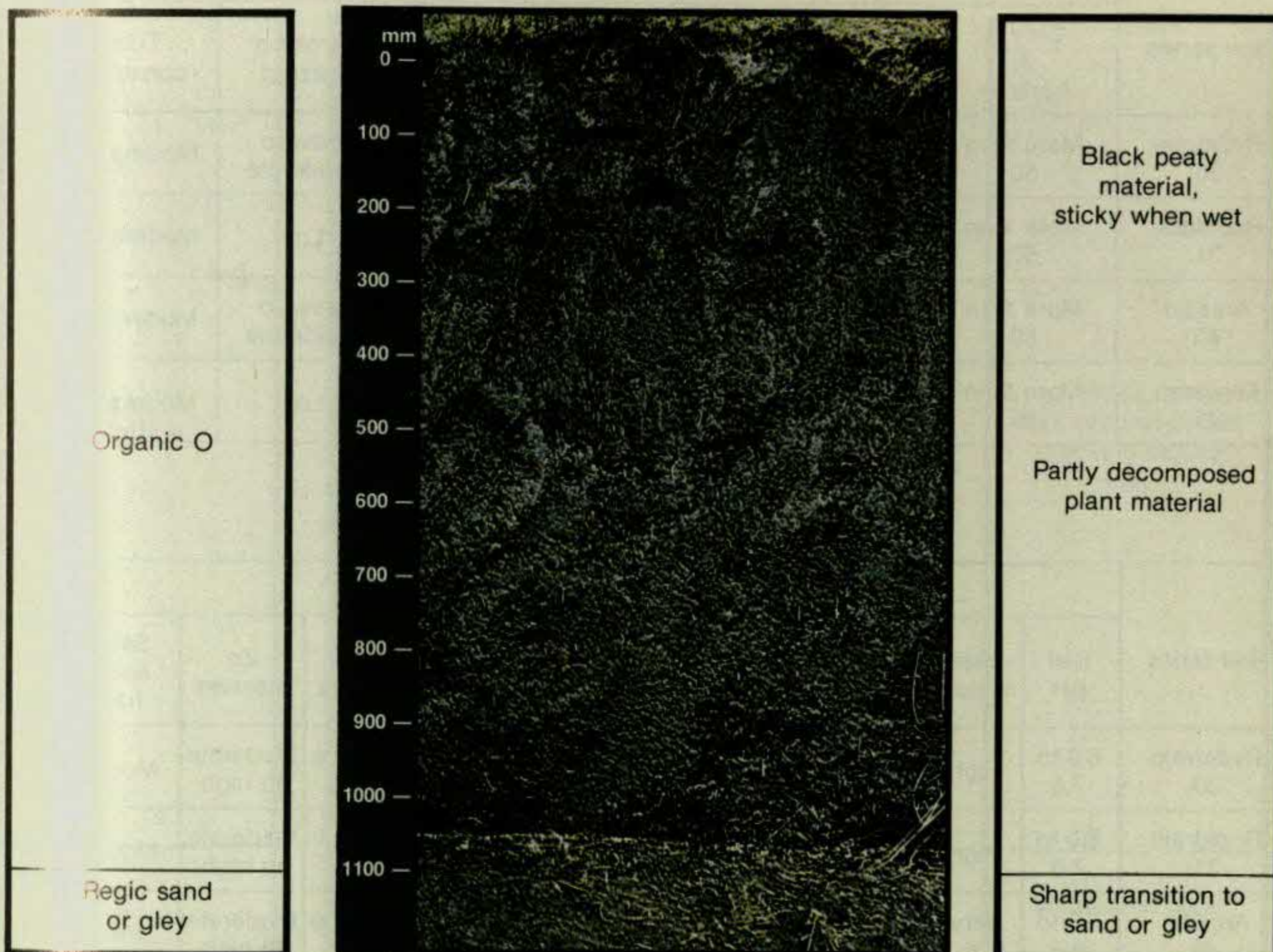
SELECTED PROPERTIES OF CHAMPAGNE FORM SOIL SERIES

Soil series	Physical					
	Clay % O horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Mposa 10	Less than 20	High to very high	Medium to poor	Poor to moderate*	Low	Slight to moderate (c)
Stratford 20	More than 20	High to very high	Medium to poor	Poor to moderate*	Low	Slight to moderate (c)
Champagne 11	Less than 20	High to very high	Medium to poor	Poor to moderate*	Low	Slight to moderate (c)
Ivanhoe 21	More than 20	High to very high	Medium to poor	Poor to moderate*	Low	Slight to moderate (c)

*Moderate drainage where underlying alluvium is regic sand

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Mposa 10	Below 4,0	Low to mod.	Moderate to severe	Moderate	Very high	Low	Medium	Low
Stratford 20	Below 4,0	Low to mod.	Moderate to severe	Moderate	Very high	Low	Medium	Low
Champagne 11	Above 4,0	Low to mod.	Moderate	Moderate	Very high	Low	Medium	Low
Ivanhoe 21	Above 4,0	Low to mod.	Moderate	Moderate	Very high	Low	Medium	Low

Champagne Form - Ch



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil (clay %)	Soil pH*	Effective rooting depth (mm)
Berea	Recent Sands	Mposa	Less than 20	Below 4	600 to 1 500
Umzinto	Alluvium	Stratford	More than 20		600 to 1 200
Nottingham	Alluvium	Champagne	Less than 20	Above 4	600 to 1 200
		Ivanhoe	More than 20		

*measured in IN KC*l*

FEATURES TO NOTE

- water table : generally present as the soils are found in vleis and old swamp land. An overall drainage scheme is essential for removing excess water
- nutrient status : large quantities of soil nitrogen are available so applied nitrogen should be markedly less than average. Agricultural limestone may be required and potassium and zinc are often low so soil sampling is essential and leaf analysis a useful guide
- month of harvest : flooding may be a problem in the summer months so annual cutting in August/September should be considered

SELECTED PROPERTIES OF ARCADIA FORM SOIL SERIES

Soil series	Physical					
	Clay % A horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Rydalvale 30	More than 50	Moderate	Medium to poor	Moderate	Low to moderate	Moderate (c)
Rooidraai 31	More than 50	Moderate	Medium to poor	Moderate	Low	Moderate (c)
Arcadia 40	More than 50	Moderate	Poor	Poor	Low to moderate	Moderate (c)
Eensaam 41	More than 50	Moderate	Poor	Poor	Low	Moderate (c)

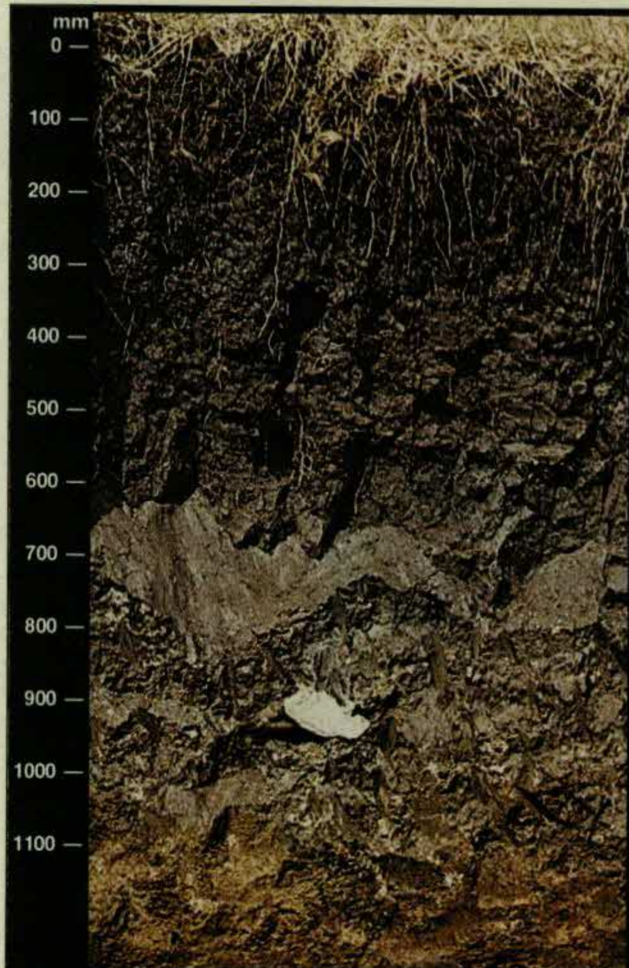
Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Rydalvale 30	6,0 to 7,5	High	Absent	Low to moderate	Moderate	Moderate to high	Moderate to high	Moderate
Rooidraai 31	6,0 to 7,5	High	Absent	Low to moderate	Moderate	Moderate to high	Moderate to high	Moderate
Arcadia 40	7,0 to 8,5	Very high*	Absent	Low to moderate	Moderate	Moderate to high	Moderate to high	Severe
Eensaam 41	7,0 to 8,5	Very high*	Absent	Low to moderate	Moderate	Moderate to high	Moderate to high	Severe

*Free lime present

Arcadia Form - Ar

Vertic A

C
Soft rock



Black or dark reddish-brown cracking blocky clay

Weathered rock

MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Umzinto	Dolerite Tugela schist and Cretaceous sediments	Rydalvale Rooidraai	Black clay Red clay	300
Nelspruit & Komatipoort	Swaziland basic rocks	Rydalvale	Black clay	to
Komatipoort	Dolerite-basalt Cretaceous sediments	Arcadia* Eensaam (calcareous)	Black clay Red clay	1 100

*Kwezi in Swaziland

FEATURES TO NOTE

- a heavy cracking clay : should not be worked when too wet or dry as hard clods will form
- salinity/sodicity hazard : a problem only in the Komatipoort system where adequate drainage and careful irrigation with good quality water are necessary.
- good nutrient status : only potassium is required in amounts greater than normal; economies may be made with nitrogen fertilizer as moderate quantities are mineralised
- trash blanket : under rainfed conditions the response to trashing is substantial
- irrigation problems : water intake rates decline rapidly when Arcadia and Eensaam soils are moistened, hence furrow irrigation is usually preferable

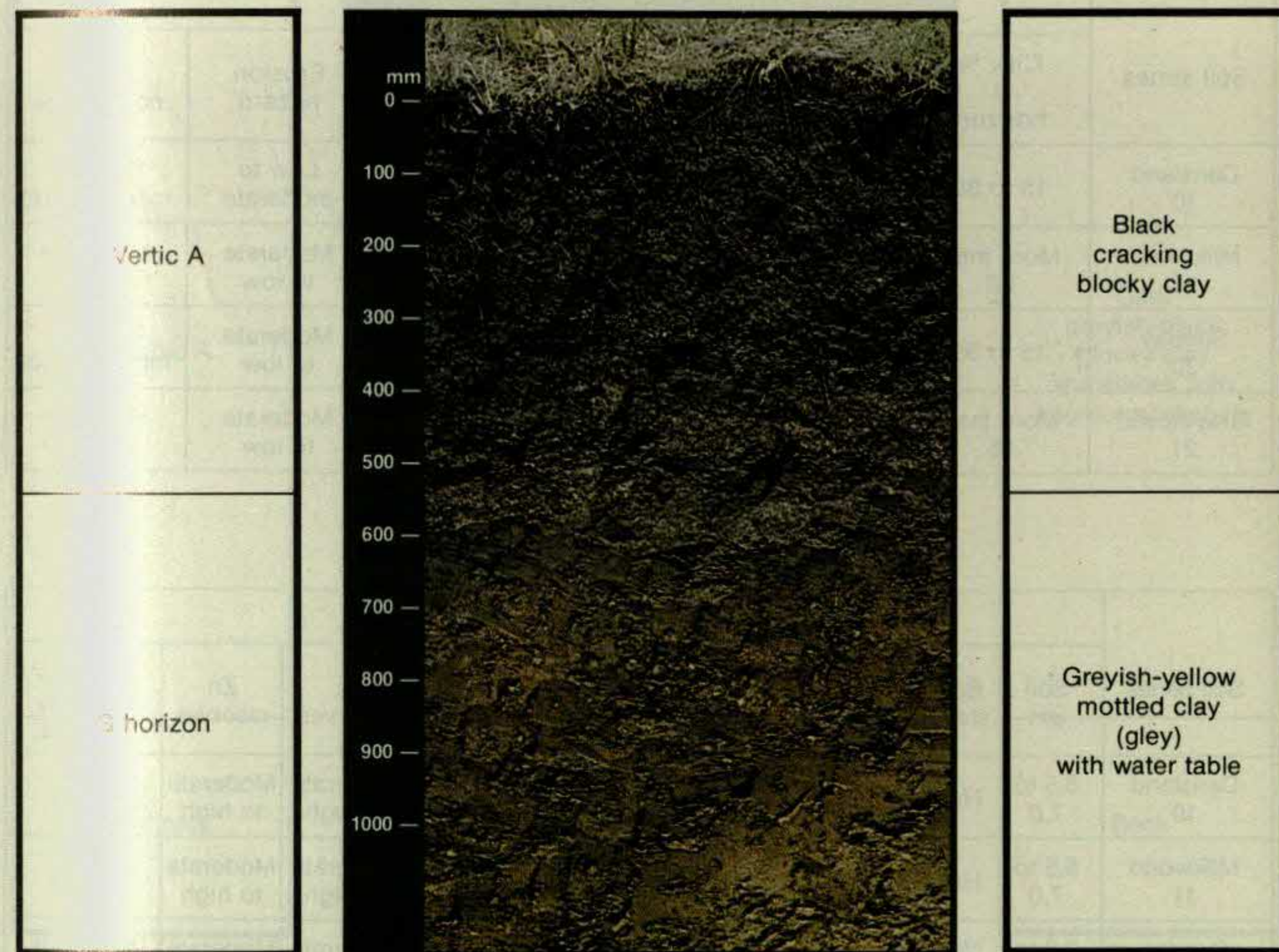
SELECTED PROPERTIES OF RENSBURG FORM SOIL SERIES

Soil series	Physical					
	Clay % B2 horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Phoenix 10	More than 40	Moderate	Poor	Poor to very poor	Moderate	Moderate (c)
Rensburg 20	More than 40	Moderate	Poor	Poor to very poor	Moderate	Moderate to severe (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Phoenix 10	6,0 to 7,5	High	Absent	Low to moderate	Moderate	Moderate to high	Moderate to high	Moderate to severe
Rensburg 20	7,0 to 8,5	Very high*	Absent	Low to moderate	Moderate	Moderate to high	Moderate to high	Severe

*Free lime present

Rensburg Form - Rg



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Umzinto	Alluvium Ecca sediments Dolerite-basalt Tugela schist	Phoenix	Clay	400 to 800
Komatipoort	Alluvium Dolerite-basalt Swaziland basic rocks	Rensburg* (calcareous)	Clay	

*Youngsvlei in Swaziland

FEATURES TO NOTE

- poorly drained : close drain spacing required
- salt problems : a high probability in the Rensburg series
- irrigation : must be carefully controlled and only good quality water used
- timing : soil seals rapidly on wetting; should only be worked in the dry winter months
- burn at harvest : a trash blanket will aggravate the wetness problem
- erosion hazard : banks of open drains need protection from erosion

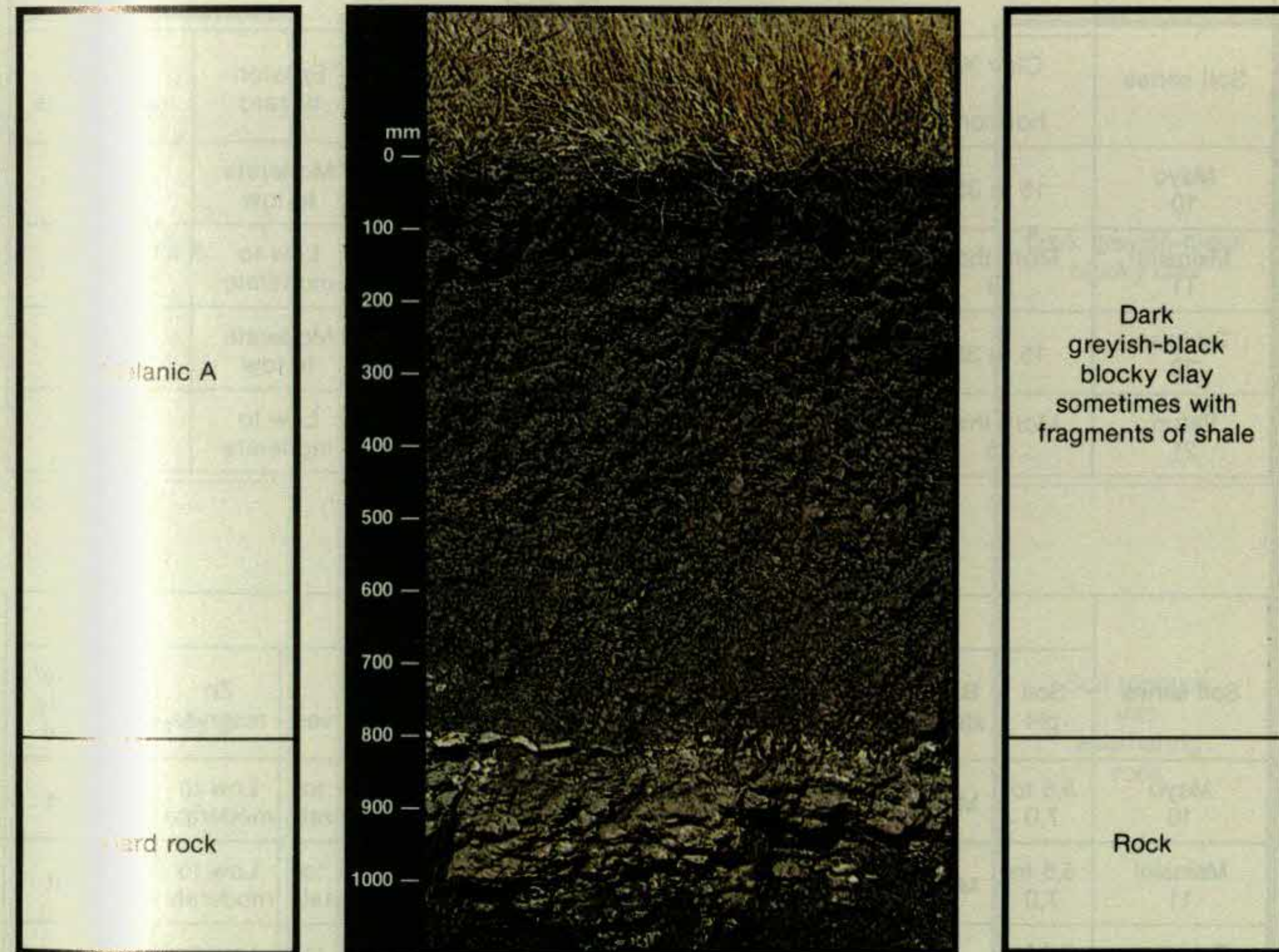
SELECTED PROPERTIES OF MILKWOOD FORM SOIL SERIES

Soil series	Physical					
	Clay % A horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Dansland 10	15 to 35	Moderate to high	Medium	Moderate	Low to moderate	Slight to moderate (c)
Milkwood 11	More than 35	Moderate	Medium	Moderate	Moderate to low	Moderate (c, t)
Sunday 20	15 to 35	Moderate	Medium to poor	Moderate to poor	Moderate to low	Slight to moderate (c)
Graythorne 21	More than 35	Moderate	Medium to poor	Moderate to poor	Moderate to low	Moderate (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Dansland 10	5,5 to 7,0	High	Absent	Low	Moderate	Moderate to high	Moderate to high	Slight
Milkwood 11	5,5 to 7,0	High	Absent	Low	Moderate	Moderate to high	Moderate to high	Slight
Sunday 20	7,0 to 8,5	Very high*	Absent	Low	Moderate	Moderate to high	Moderate to high	Moderate to severe
Graythorne 21	7,0 to 8,5	Very high*	Absent	Low	Moderate	Moderate to high	Moderate to high	Moderate to severe

*Free lime present

Milkwood Form - Mw



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Umzinto	Amphibolite Ecca and Beaufort shale	Dansland Milkwood	Clay loam Clay	300 to 700
Komatipoort	Swaziland basic rocks Ecca shale Basalt	Sunday Graythorne (calcareous)	Clay loam Clay	

FEATURES TO NOTE

- drought problems : because of the relatively shallow and variable depth of the A horizon and the heavy texture, cane is frequently droughted
- response to water : a good response to irrigation and a trash blanket under rainfed conditions can be obtained
- soil tilth : soil should not be worked when too wet or dry
- salt hazard : exists only in the Graythorne and Sunday series

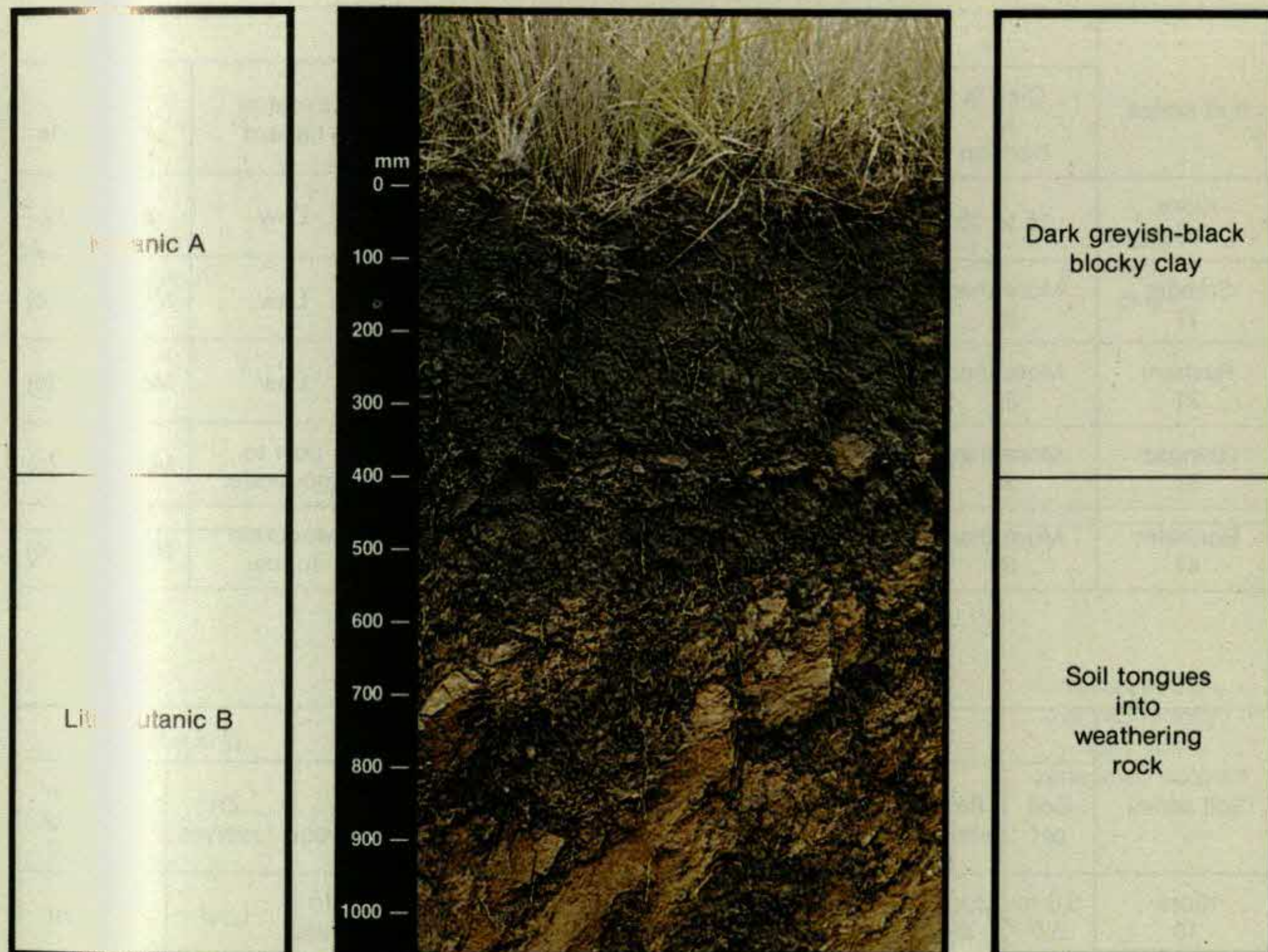
SELECTED PROPERTIES OF MAYO FORM SOIL SERIES

Soil series	Physical					
	Clay % A horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Mayo 10	15 to 35	Moderate to high	Medium to good	Moderate to good	Moderate to low	Slight (c)
Msinsini 11	More than 35	Moderate to high	Medium	Moderate	Low to moderate	Slight (c)
Tshipise 20	15 to 35	Moderate to high	Medium	Moderate	Moderate to low	Slight (c)
Pafuri 21	More than 35	Moderate to high	Medium	Moderate	Low to moderate	Slight (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Mayo 10	5,5 to 7,0	Mod.	Absent	Low	Moderate to high	Low to moderate	Low to moderate	Slight
Msinsini 11	5,5 to 7,0	Mod.	Absent	Low	Moderate to high	Low to moderate	Low to moderate	Slight
Tshipise 20	7,0 to 8,5	High*	Absent	Low	Moderate	Low to moderate	Low to moderate	Moderate
Pafuri 21	7,0 to 8,5	High*	Absent	Low	Moderate	Low to moderate	Low to moderate	Moderate

*Free lime present

Mayo Form - My



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Umzinto	Granite	Mayo* Msinsini	Gritty to coarse sandy clay loam Sandy clay	300 to 1 200
Komatipoort	Granite	Tshipise† Pafuri (calcareous)	Coarse sandy clay loam Sandy Clay	

*Stegi in Swaziland †Somerling in Swaziland

FEATURES TO NOTE

- good physical properties : roots penetrate via the clay tongues well into the weathering rock
- moderate nutrient status : average quantities of phosphorus and potassium are generally required but economies may be made with nitrogen fertilizer as moderate quantities are mineralised
- trash blanket : under rainfed conditions a good response to a trash blanket can be obtained
- soil tilth : should not be worked when too wet or dry
- salt hazard : exists only in the Tshipise and Pafuri series

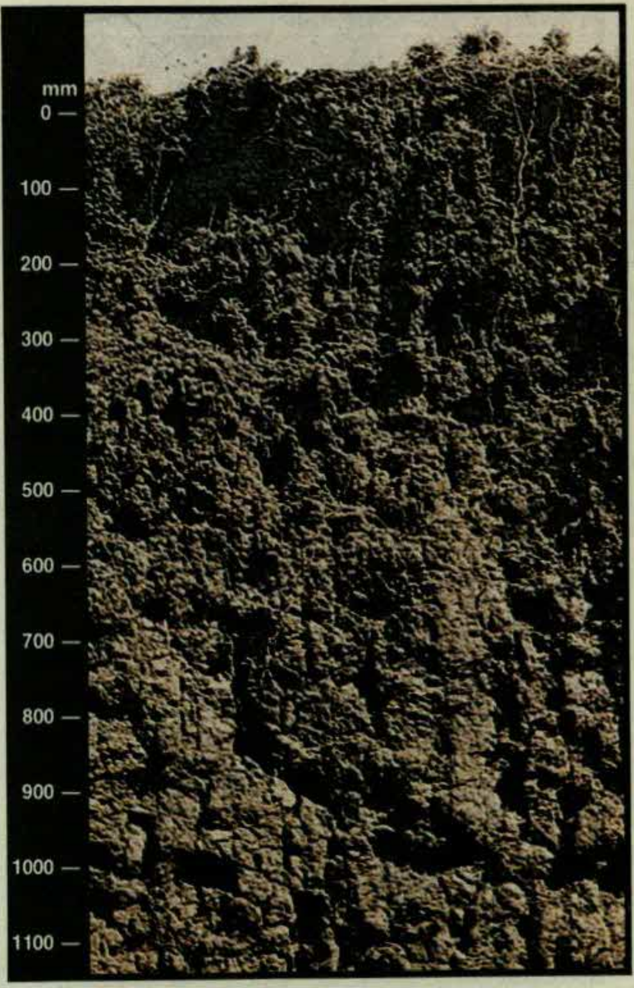
SELECTED PROPERTIES OF BONHEIM FORM SOIL SERIES

Soil series	Physical					
	Clay % A horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Kiora 10	15 to 35	Moderate	Medium to good	Moderate to good	Low	Slight (c)
Stanger 11	More than 35	Moderate	Medium	Moderate	Low	Moderate (c)
Rasheni 21	More than 35	Moderate	Medium	Moderate to poor	Low	Moderate (c)
Glengazi 31	More than 35	Moderate	Medium to poor	Moderate to poor	Low to moderate	Moderate (c)
Bonheim 41	More than 35	Moderate	Medium to poor	Moderate to poor	Moderate to low	Moderate (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Kiora 10	5,0 to 6,0	Moder-ate	Slight	Moderate	Moderate	Low to moderate	Low	Absent
Stanger 11	5,5 to 7,5	High	Absent	Low to moderate	Moderate	Moderate	Moderate	Slight
Rasheni 21	7,0 to 8,5	High to very high*	Absent	Low to moderate	Moderate	Moderate	Moderate	Moderate to severe
Glengazi 31	5,5 to 7,5	High to very high	Absent	Low to moderate	Moderate	Moderate	Moderate	Moderate to severe
Bonheim 41	7,0 to 8,5	High to very high*	Absent	Low to moderate	Moderate	Moderate	Moderate	Moderate to severe

*Free lime present

Bonheim Form - Bo

Melanic A		Black blocky clay
Pedocutanic B		Yellow-brown or red blocky clay with variegated colours

MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Colour (subsoil)	Effective rooting depth (mm)
Umzinto Komatipoort	Dolerite-basalt	Kiora Stanger Rasheni* (calcareous)	Sandy clay loam Clay Clay	Red	800 to 1 200
Umzinto	Alluvium Ecca and Cretaceous sediments	Glengazi†	Clay	Yellow-brown	400 to 800
Komatipoort	Alluvium Dolerite-basalt Cretaceous and Middle Ecca sediments	Bonheim†† (calcareous)	Clay		

*Vimy in Swaziland †Cuba in Swaziland ††Canterbury or Valumgwaco in Swaziland

FEATURES TO NOTE

- salt problems : in the profiles with yellow-brown subsoil, drainage is poor and the salinity/sodicity hazard high; subsurface drainage is necessary and good irrigation control essential
- timing : all operations should preferably be done in the dry period on the Glengazi and Bonheim soils
- subsoil colour : the red subsoil indicates a good free-draining soil with no management problems
- trash blanket : good responses can be obtained from trashing on the Stanger and Kiora series

SELECTED PROPERTIES OF TAMBANKULU FORM SOIL SERIES

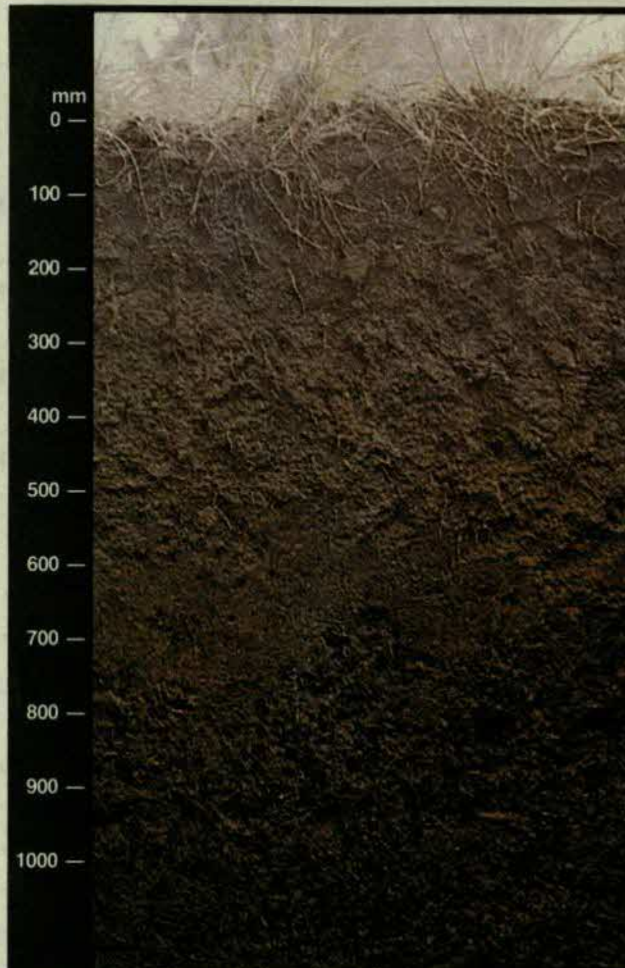
Soil series	Physical					
	Clay % A horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Fenfield 10	15 to 35	Moderate	Medium to poor	Poor	Low	Slight (c)
Tambankulu 11	More than 35	Moderate	Medium to poor	Poor	Low	Moderate (c)
Loshoek 20	15 to 35	Moderate	Medium to poor	Poor	Moderate to low	Slight (c)
Masala 21	More than 35	Moderate	Medium to poor	Poor	Low	Moderate (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Fenfield 10	6,0 to 7,0	High	Absent	Low	Moderate to low	Moderate to high	Moderate to high	Slight to moderate
Tambankulu 11	6,0 to 7,0	High	Absent	Low	Moderate to low	Moderate to high	Moderate to high	Slight to moderate
Loshoek 20	7,0 to 8,5	Very high*	Absent	Low to moderate	Moderate to low	Moderate to high	Moderate to high	Moderate to severe
Masala 21	7,0 to 8,5	Very high*	Absent	Low to moderate	Moderate to low	Moderate to high	Moderate to high	Moderate to severe

*Free lime present

Tambankulu Form - Tk

Melanic A	Dark grey to black blocky clay
Soft plinthic B	Mottled and gleyed with ironstone concretions; intermittent water table



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth *(mm)
Umzinto	Alluvium	Fenfield Tambankulu	Clay loam Clay	300 to 400
Komatipoort	Dolerite-basalt Alluvium	Loshoek Masala (calcareous)	Clay loam Clay	

FEATURES TO NOTE

- shallow with drainage problems : irrigation control must be good with provision of subsurface drains
- salt problem : in the Masala and Loshoek series, soil sampling for salinity/sodicity is necessary
- soil tilth : should not be worked when too wet or dry
- nitrogen requirements : optimum levels are higher than average

SELECTED PROPERTIES OF WILLOWBROOK FORM SOIL SERIES

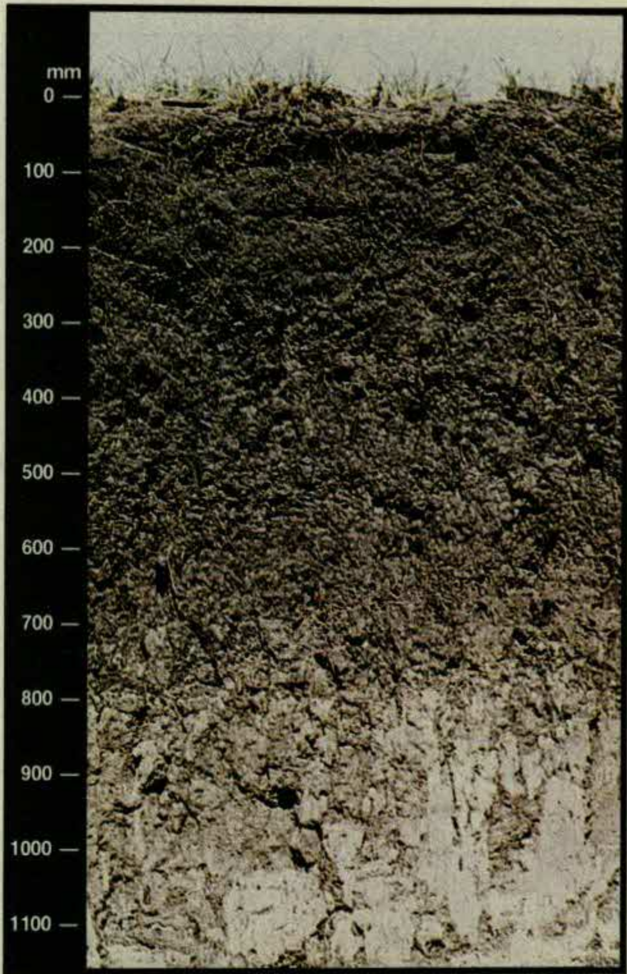
Soil series	Physical					
	Clay % A horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Emfuleni 10	15 to 35	Moderate	Medium to poor	Poor	Moderate to low	Moderate (c)
Willowbrook 11	More than 35	Moderate	Medium to poor	Poor	Moderate to low	Moderate (c)
Sarasdale 20	15 to 35	Moderate	Medium to poor	Poor	Moderate to low	Moderate (c)
Chinyika 21	More than 35	Moderate	Medium to poor	Poor	Moderate to low	Moderate (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineralisation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Emfuleni 10	5,5 to 7,0	High	Absent	Low	Moderate	Moderate	Moderate to high	Moderate
Willowbrook 11	5,5 to 7,0	High	Absent	Low	Moderate	Moderate	Moderate to high	Moderate
Sarasdale 20	7,0 to 8,5	Very high*	Absent	Low	Moderate	Moderate	Moderate to high	Moderate to severe
Chinyika 21	7,0 to 8,5	Very high*	Absent	Low	Moderate	Moderate	Moderate to high	Moderate to severe

*Free lime present

Willowbrook Form - Wo

Melanic A	Black blocky clay
G horizon	Dark grey or yellow mottled clay (gley) with water table



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Umzinto and Nelspruit	Ecca and Beaufort sediments	Emfuleni	Clay loam	400 to 700
	Amphibolite Alluvium	Willowbrook	Clay	
Komatipoort	Ecca and Beaufort sediments	Sarasdale	Clay loam	
	Alluvium	Chinyika (calcareous)	Clay	

FEATURES TO NOTE

- poorly drained : the impervious gley horizon indicates the need for subsurface drains
- irrigation problem : careful scheduling is necessary; soils seal rapidly on wetting
- salt hazard : salinity/sodicity problems are likely in the Sarasdale and Chinyika series so thorough soil sampling to depth is recommended
- timing : field operations should take place in winter only
- burn at harvest : a trash blanket can aggravate the wetness problem

SELECTED PROPERTIES OF INHOEK FORM SOIL SERIES

Soil series	Physical					
	Clay % A horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Cromley 10	Less than 35	Moderate	Medium	Moderate to good	Moderate to low	Slight (c)
Coniston 11	More than 35	High	Medium	Moderate	Moderate to low	Moderate (c)
Inhoek 20	Less than 35	Moderate	Medium	Moderate	Moderate to low	Slight (c)
Drydale 21	More than 35	High	Medium	Moderate to poor	Moderate to low	Moderate (c)

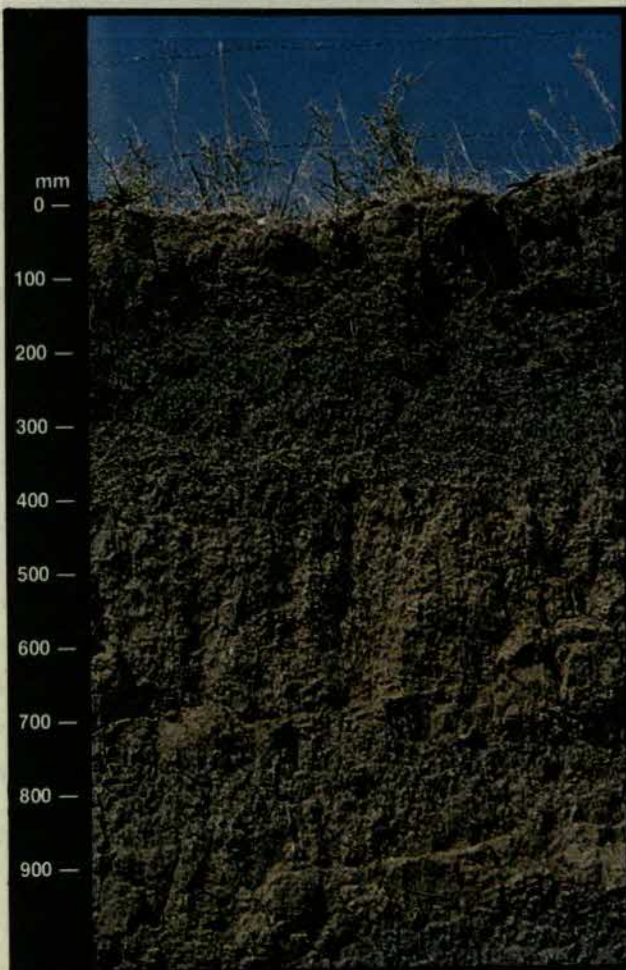
Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Cromley 10	6,0 to 7,0	High	Absent	Low	Moderate	Moderate to high	Moderate to high	Slight
Coniston 11	6,0 to 7,0	High	Absent	Low	Moderate to high	Moderate to high	Moderate to high	Slight
Inhoek 20	7,0 to 8,5	Very high*	Absent	Low to moderate	Moderate	Moderate to high	Moderate to high	Slight to moderate
Drydale 21	7,0 to 8,5	Very high*	Absent	Low to moderate	Moderate to high	Moderate to high	Moderate to high	Moderate

*Free lime present

Inhoek Form - Ik

M anic A

ratified
luvium
or
Ne cutanic B



Dark grey
to black
blocky clay

Recent stratified
alluvium or
olive-brown
weakly
structured clay

MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Umzinto	Alluvium	Cromley Coniston	Clay loam Clay	More than 1 000
Komatipoort	Alluvium	Inhoek Drydale (calcareous)	Clay loam Clay	

FEATURES TO NOTE

- highly productive : a good soil in every sense and should be planted to a high yielding disease resistant variety to last for many ratoons
- good nutrient status : economies may be made in respect of nitrogen fertilizer as moderate levels of nitrogen are mineralised
- soil tilth : soil should not be worked when too wet or dry
- salt hazard : exists only in Drydale series

SELECTED PROPERTIES OF MISPAH FORM SOIL SERIES

Soil series	Physical					
	Clay % A horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Mispah 10	6 to 35	Low to very low	Medium	Moderate	Moderate to high	Severe (t, p)
Muden 20	15 to 35	Low to very low	Medium	Moderate	Moderate to high	Severe (t, p)

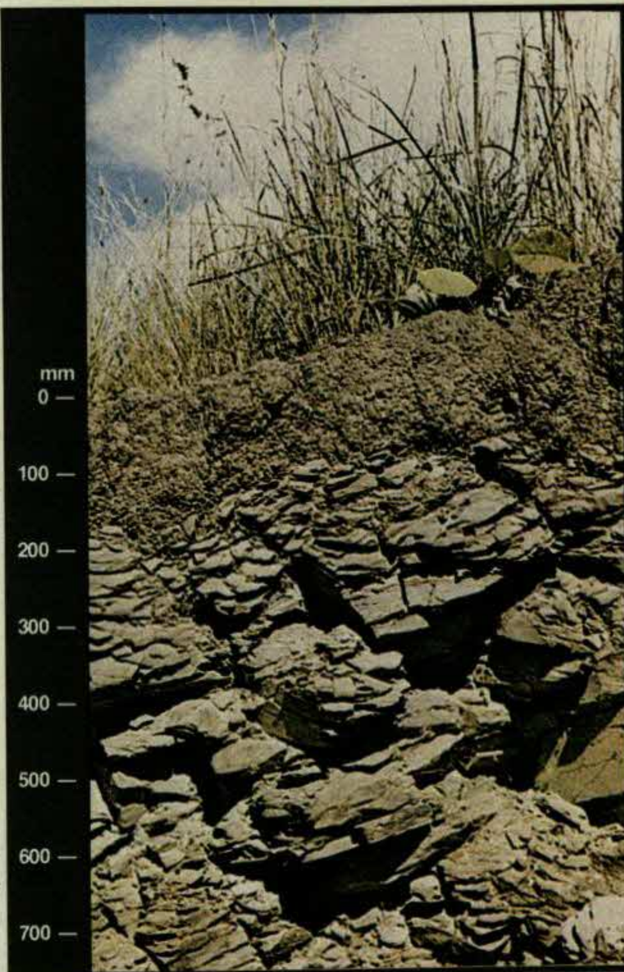
Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity sodicity hazard
Mispah 10	4,5 to 7,0	Low to mod.	Slight to moderate*	Low to moderate*	Low	Low	Low	Low to moderate†
Muden 20	7,0 to 8,5	High††	Absent	Low	Low	Low	Low	Low to moderate†

*Moderate in Nottingham system only †Moderate in Komtipoort system only ††Free lime present

Mispah Form - Ms

Orthic A

Hard rock



Very shallow grey to brown sand to sandy clay loam

MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
All systems (except Berea)	Cave sandstone	Mispah	Fine sandy loam	150 to 500
	Beaufort sediments		Clay loam	
	Swaziland quartzite and Middle Ecca sediments		Sandy loam to sandy clay loam	
Komatipoort	Swaziland shales and limestone	Muden (calcareous)	Sandy clay loam	

FEATURES TO NOTE

- shallow profile : soil moisture retention is limited
- erodible : protect soils with a trash blanket or scattered tops and use minimum tillage
- low nutrient status : high fertilizer rates would not generally be warranted because of the over-riding limitations of soil depth and available moisture

SELECTED PROPERTIES OF GLENROSA FORM SOIL SERIES

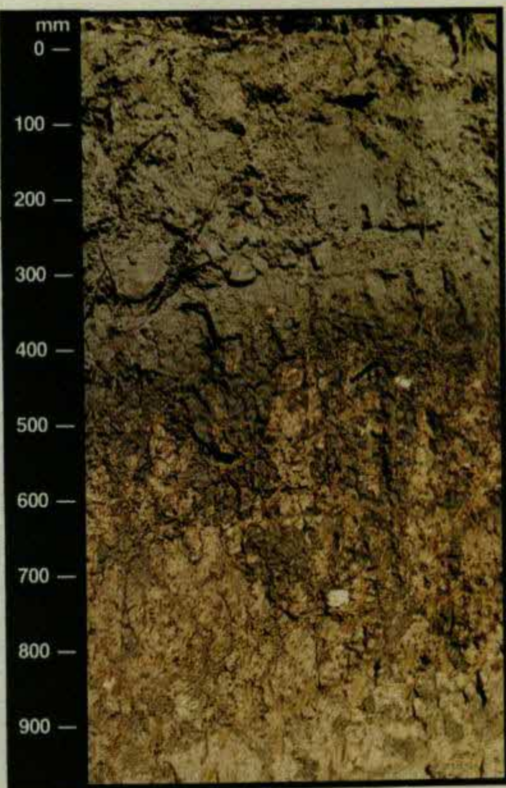
Soil series	Physical					
	Clay % A horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Platt 14	6 to 15 (medium sand)	Low	Good	Good	High	Moderate (w, t)
Glenrosa 15	6 to 15 (coarse sand)	Low	Good	Good	High	Moderate (w, t)
Williamson 16	15 to 35 (fine sand)	Moderate	Medium	Moderate to good	High	Moderate (co, p, t)
Trevanian 17	15 to 35 (medium sand)	Moderate to high	Good	Good	Low to moderate	Slight (t)
Robmore 18	15 to 35 (coarse sand)	Moderate	Medium	Moderate	Low to moderate	Slight (p, co)
Saintfaiths 19	More than 35 (undiffer-entiated)	Moderate	Medium	Moderate	Low	Moderate (p, co)
Achterdam 28	15 to 35 (coarse sand)	Moderate	Medium	Moderate	Low to moderate	Moderate (p, t)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Platt 14	5,0 to 6,0	Low	Slight	Low	Low	Low	Medium	Low
Glenrosa 15	5,0 to 6,0	Low	Slight	Low	Low	Low	Medium	Low
Williamson 16	5,0 to 6,5	Low	Slight	Low	Low	Low	Medium	Low
Trevanian 17	5,0 to 6,0	Low to mod.	Slight to moderate	Low	Moderate to high	Low	Low	Low
Robmore 18	6,0 to 7,0	Mod.	Absent	Low	Moderate	Moderate	High	Low
Saintfaiths 19	6,0 to 7,0	Mod. to high	Absent	Low to moderate	Low to moderate	Moderate	High	Low
Achterdam 28	7,0 to 8,5	High*	Absent	Low to moderate	Low	Moderate	Medium	Moderate

*Free lime present

Glenrosa Form - Gs

Orthic A
Lithocutanic B



Shallow grey or dark grey loamy sand to clay
Soil tongues into weathering rock

MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Umzinto	TMS (Ordinary)	Platt	Medium loamy sand	300 to 500
	Granite	Glenrosa	Coarse loamy sand	
	Dwyka tillite	Williamson	Fine sandy clay loam	
Umzinto/ Nottingham	TMS (Ordinary)	Trevanian	Medium sandy loam	500 to 700
Umzinto	Granite	Robmore	Coarse sandy loam	
Umzinto/ Nottingham	Dwyka tillite	Saintfaiths	Clay	400 to 500
Komatipoort	Granite	Williamson	Fine sandy clay loam	300 to 500
		Achterdam (calcareous)	Coarse sandy clay loam	
		Glenrosa	Coarse loamy sand	

FEATURES TO NOTE

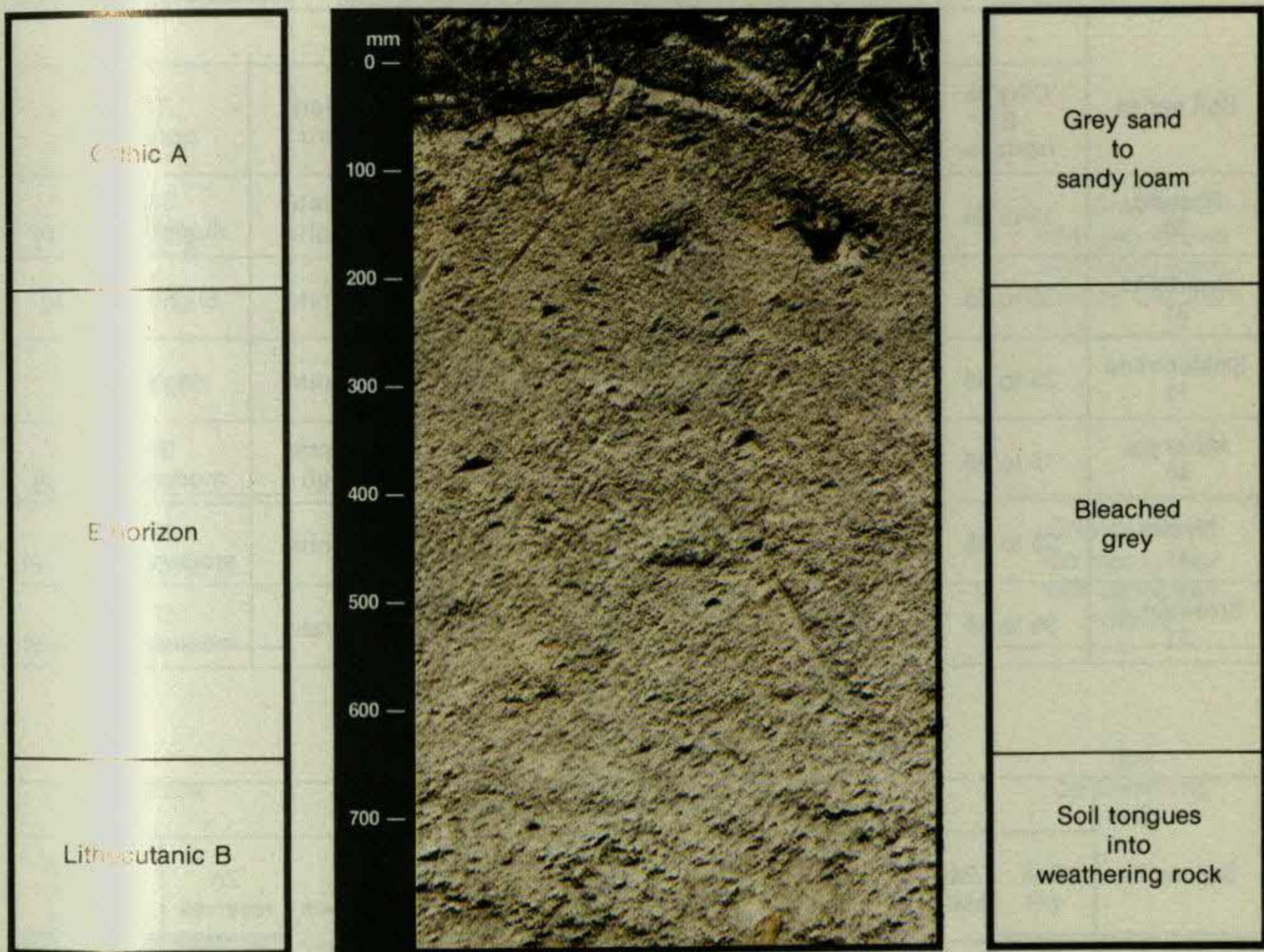
- erodible : needs a protective cover such as a trash blanket or burnt tops; use minimum tillage
- moderate nutrient status : above average levels of nutrients are generally required for the Platt, Glenrosa and Williamson series, but lower than average amounts of nitrogen are required for the Trevanian series; leaf sampling strongly recommended
- irrigation : because of relatively shallow profiles rainfall efficiency is low and careful irrigation scheduling is essential

SELECTED PROPERTIES OF CARTREF FORM SOIL SERIES

Soil series	Physical					
	Clay % E horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Cartref 21	6 to 15 (medium sand)	Low	Medium to good	Moderate	High	Slight (p, w)
Arrochar 12	15 to 35 (fine sand)	Moderate	Medium	Moderate to poor	High	Moderate (p, co, w)
Grovedale 30	0 to 6 (coarse sand)	Very low	Good	Moderate	High	Moderate (w)
Kusasa 31	6 to 15 (coarse sand)	Low to very low	Medium to good	Moderate	High	Slight (w)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Cartref 21	5,0 to 7,0	Low	Moderate	Low	Low	Low	Low to medium	Low
Arrochar 12	6,0 to 7,0	Mod.	Slight	Low	Low	Low	Medium	Low
Grovedale 30	6,0 to 8,0	Low	Absent	Low	Low	Low	Low to medium	Low to moderate
Kusasa 31	6,0 to 8,0	Mod.	Absent	Low	Low	Low	Low	Low to moderate

Cartref Form - Cf



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Umzinto	TMS (Ordinary)	Cartref	Loamy medium sand	500 to 1 200
	Dwyka tillite	Arrochar	Fine sandy loam	
Komatipoort and Nelspruit	Granite	Grovedale	Coarse sand	400 to 1 000
	Granite	Kusasa	Coarse sandy loam	

FEATURES TO NOTE

- highly erodible : protect with a trash blanket or burnt tops and use minimum tillage; do not cultivate
- low nutrient status : commonly deficient in calcium and magnesium; potassium is always low, nitrogen requirements are higher than average and zinc may be deficient. Soil and leaf sampling are important. Split applications of fertilizer are recommended for Grovedale and Kusasa soils
- nematodes : a response to nematicide may occur in soils where clay content is less than 6%
- low available moisture capacity : exceptionally good surface water management is necessary
- irrigation : good irrigation control and short cycles are essential for the Grovedale and Kusasa soils

SELECTED PROPERTIES OF SWARTLAND FORM SOIL SERIES

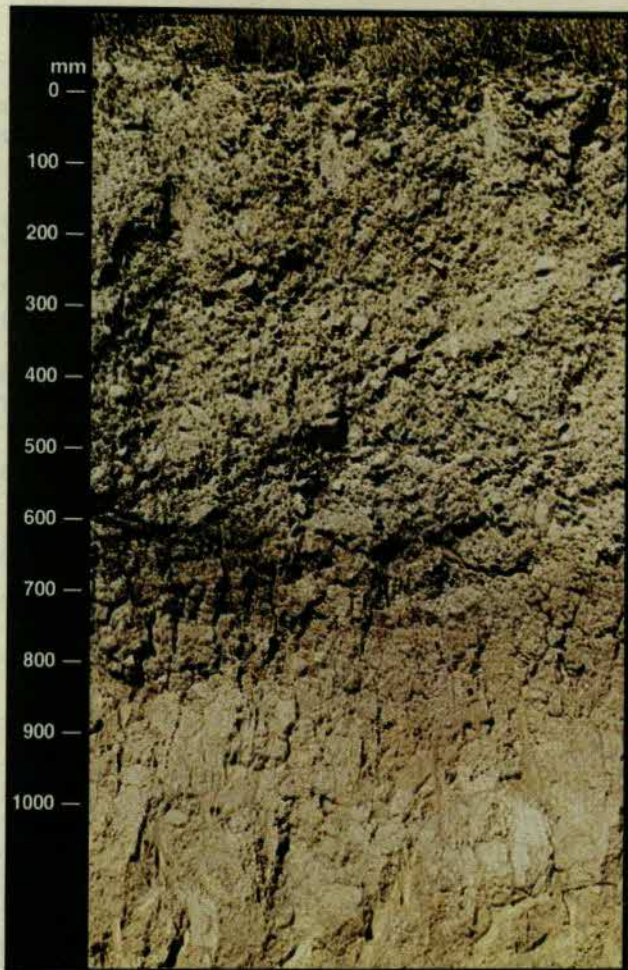
Soil series	Physical					
	Clay % B horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Rosehill 30	15 to 35	Low to moderate	Medium to poor	Moderate	Moderate to high	Slight to moderate (co, p)
Swartland 31	35 to 55	Moderate	Medium	Moderate	Moderate	Slight (co, c, p)
Skilderkrans 11	35 to 55	Moderate	Medium	Moderate	Moderate	Slight (co, p)
Malakata 40	15 to 35	Low to moderate	Medium to poor	Moderate to poor	Moderate to high	Slight to moderate (co, p)
Nyoka 41	35 to 55	Moderate	Medium to poor	Moderate to poor	Moderate	Slight to moderate (co, c, p)
Broekspruit 21	35 to 55	Moderate	Medium to poor	Moderate	Moderate	Slight to moderate (co, c, p)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Rosehill 30	5,0 to 6,0	Mod.	Very rare	Low to moderate	Low	Medium	Moderate	Slight
Swartland 31	5,0 to 6,0	Mod. to high	Absent	Low to moderate	Moderate	Medium to high	Moderate to high	Slight
Skilderkrans 11	5,0 to 6,0	Mod. to high	Absent	Low to moderate	Moderate	Medium to high	Moderate to high	Slight
Malakata 40	7,0 to 9,0	High*	Absent	Low to moderate	Low	Medium	Moderate	Moderate
Nyoka 41	7,0 to 9,0	High*	Absent	Low to moderate	Low	Medium to high	Moderate to high	Moderate
Broekspruit 21	7,0 to 9,0	High*	Absent	Low to moderate	Moderate	Medium to high	Moderate to high	Moderate to severe

*Free lime present

Swartland Form - Sw

Orthic A	Grey to dark grey-brown fine sandy loam to sandy clay loam
Pedocutanic B	Grey-brown or red blocky clay with variegated colours
Saprolite	Soft decomposing rock



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Colour (subsoil)	Effective rooting depth (mm)
Umzinto	Middle Ecca sandstone and Beaufort sediments	Rosehill	Fine sandy loam	Grey-brown	500 to 700
		Swartland	Fine sandy clay loam		700 to 1 200
		Skilderkrans	Fine sandy clay loam	Red	500 to 700
Umzinto (river valley) and Komatipoort	Middle Ecca Cretaceous and Beaufort sediments	Malakata (calcareous)	Fine sandy clay loam	Grey-brown	500 to 700
		Nyoka (calcareous)	Fine sandy clay loam		300 to 500
		Broekspruit (calcareous)	Fine sandy clay loam	Red	300 to 500

FEATURES TO NOTE

- irrigation : cane becomes severely stressed under dry conditions so a good response will be obtained with irrigation
- trash blanket : strongly recommended on the well drained soils
- salinity : drainage and careful irrigation management invariably required for the Malakata, Nyoka and Broekspruit series
- timing : because of vulnerability to capping and compaction, soils should not be worked when wet

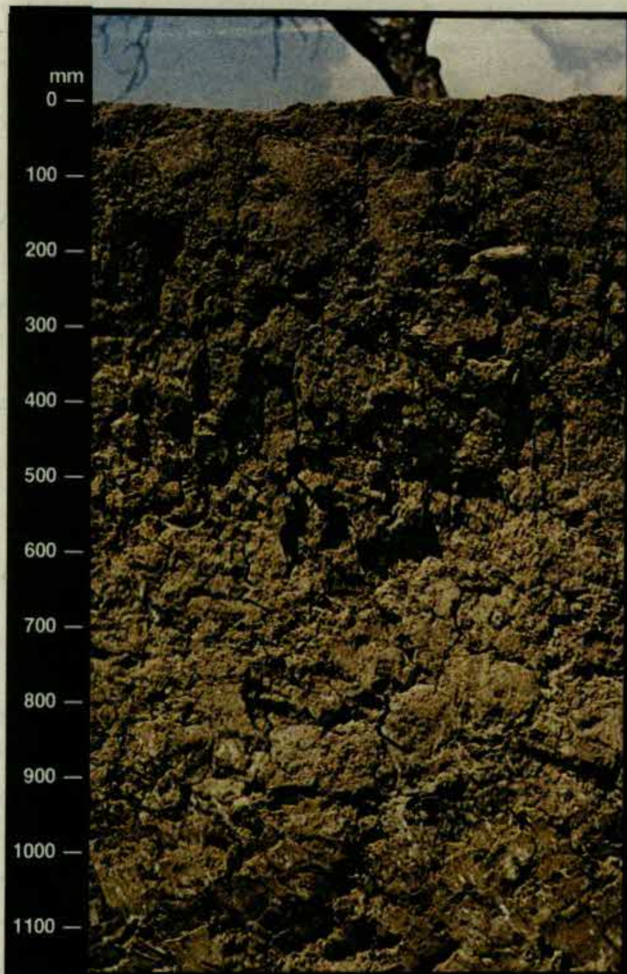
SELECTED PROPERTIES OF VALSRIVIER FORM SOIL SERIES

Soil series	Physical					
	Clay % B horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Valsrivier 40	15 to 35	Moderate	Medium	Moderate	Very high	Slight to moderate (co, p)
Lindley 41	35 to 55	Moderate	Medium to poor	Moderate to poor	Moderate to high	Moderate (co, p)
Sheppardvale 42	More than 55	Moderate to high	Poor	Moderate to poor	Moderate to high	Moderate (co, c, p)
Arniston 31	35 to 55	Moderate	Medium	Moderate	Moderate	Moderate (co, p)
Waterval 11	35 to 55	Moderate	Medium	Moderate	Moderate	Moderate (co, p)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Valsrivier 40	6,0 to 9,0	Mod. to high*	Absent	Low to moderate	Low to moderate	Low to moderate	Moderate	Moderate to severe
Lindley 41	6,0 to 9,0	Mod. to high*	Absent	Low to moderate	Low to moderate	Low to moderate	Moderate	Moderate to severe
Sheppardvale 42	6,0 to 9,0	Mod. to high*	Absent	Low to moderate	Low to moderate	Low to moderate	Moderate	Moderate to severe
Arniston 31	6,0 to 7,0	Mod.	Absent	Low to moderate	Moderate	Low to moderate	Moderate	Slight to moderate
Waterval 11	6,0 to 7,0	Mod.	Absent	Low to moderate	Moderate	Low to moderate	Moderate	Slight to moderate

*Free lime present

Valsrivier Form - Va



Orthic A	Dark grey to brown medium sandy loam to sandy clay loam
Pedocutanic B	Blocky yellow-brown or red clay with variegated colours
Unconsolidated material	Partly decomposed sediments

MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Colour (subsoil)	Effective rooting depth (mm)
Komatipoort	Cretaceous sediments and Alluvium	Valsrivier	Sandy loam	Yellow-brown	400 to 1 000
Komatipoort	Cretaceous sediments and Alluvium	Lindley	Sandy clay loam	Yellow-brown	400 to 1 000
Komatipoort	Cretaceous sediments and Alluvium	Sheppardvale (all calcareous)	Clay	Yellow-brown	400 to 1 000
Umzinto	Cretaceous sediments and Alluvium	Arniston	Sandy clay loam	Yellow-brown	400 to 1 000
Umzinto	Cretaceous sediments and Alluvium	Waterval	Sandy clay loam	Red	400 to 1 000

FEATURES TO NOTE

- salinity hazard : problems may develop in the Sheppardvale, Valsrivier and Lindley series
- irrigation : exceptionally good surface water management and irrigation scheduling are required
- timing : these soils compact when wet and cap when dry so planting and harvesting should preferably take place in spring or early summer

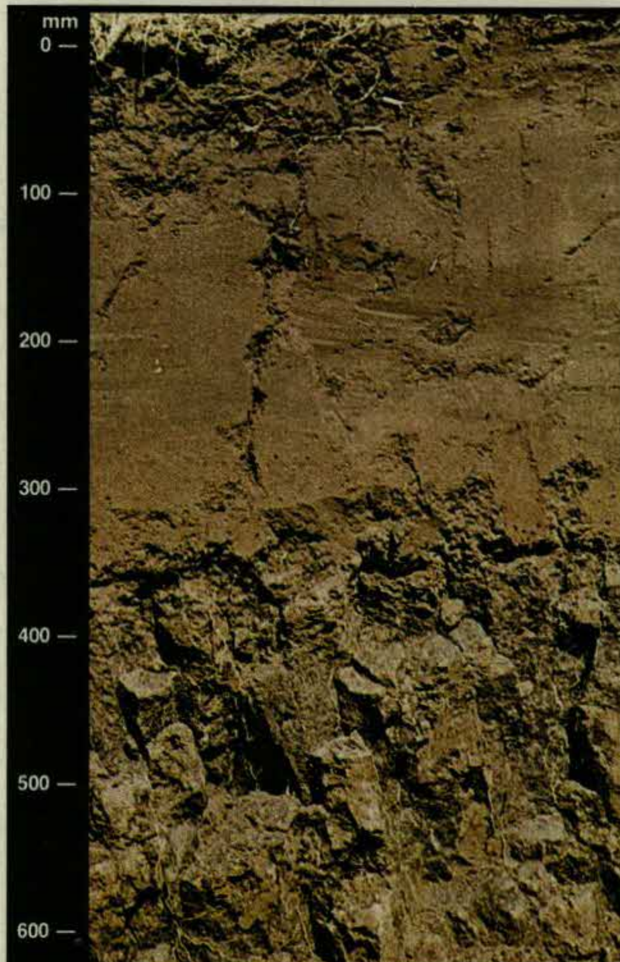
SELECTED PROPERTIES OF STERKSPRUIT FORM SOIL SERIES

Soil series	Physical					
	Clay % A horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Graafwater 21	0 to 6 (medium sand)	Very low	Medium	Poor	Very high	Moderate (co, p)
Hartbees 24	6 to 15 (medium sand)	Low	Medium to poor	Poor	Very high	Moderate (co, p)
Sterkspruit 26	15 to 35 (undifferentiated)	Low	Poor	Very poor	Very high	Moderate (co, p, t)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineralisation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Graafwater 21	6,0 to 9,0	Low	Absent	Low	Low	Low	Low	Severe
Hartbees 24	6,0 to 9,0	Low to mod.	Absent	Low	Low	Low	Low	Severe
Sterkspruit 26	6,0 to 9,0	Mod. to high	Absent	Low	Low	Low	Low	Severe

Sterkspruit Form - Ss

hic A	Grey to brown sand to sandy loam
Pris cutanic B	Slowly permeable, olive-brown prismatic clay with lime concretions



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Komatipoort and Umzinto (river valley)	Granite	Graafwater	Medium sand	450 to 600
	Middle Ecca sediments	Hartbees	Loamy medium sand	
	Dwyka tillite	Sterkspruit*	Fine sandy loam	

*Zwide in Swaziland

FEATURES TO NOTE

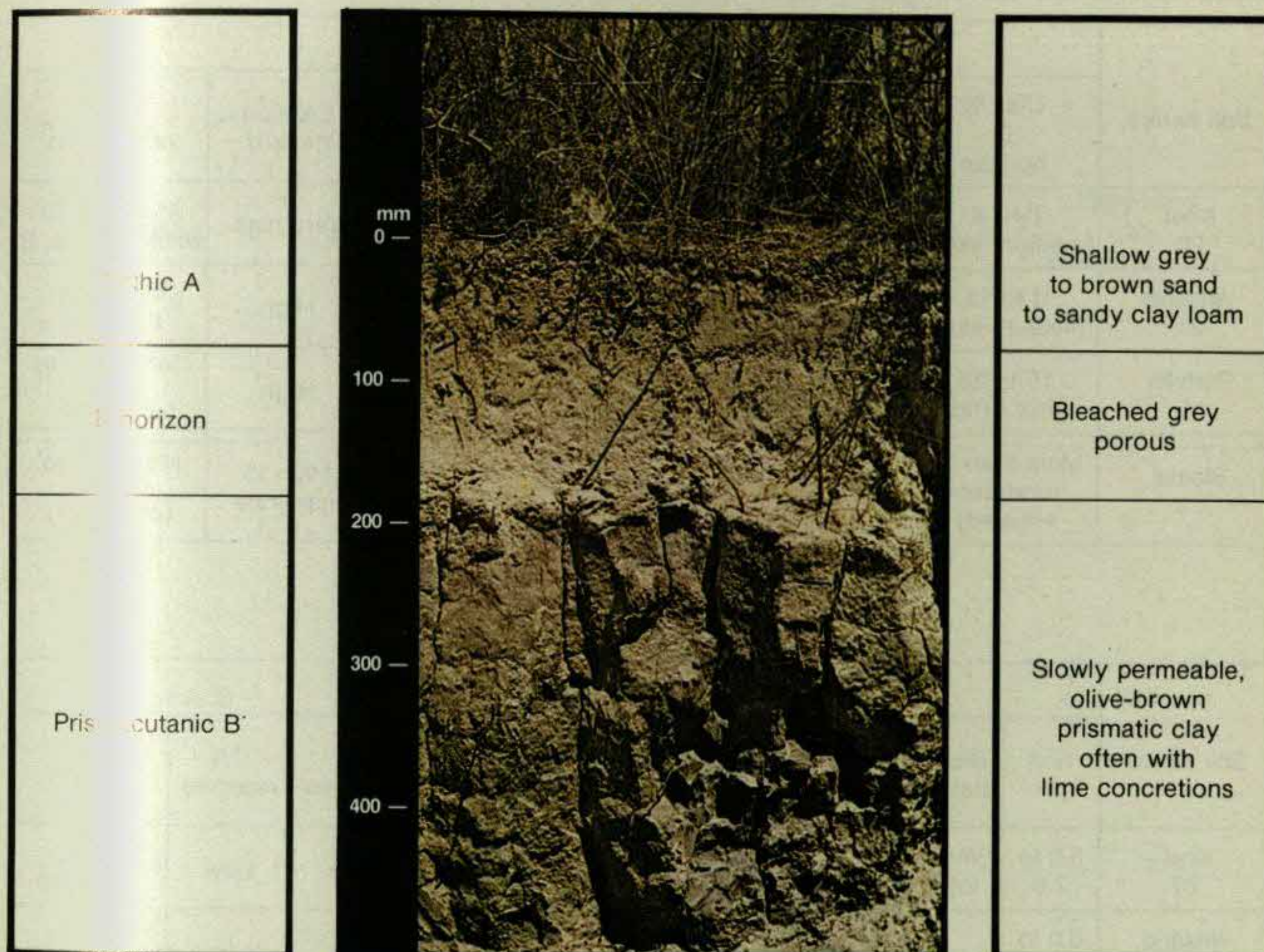
- poorly drained : installation of drains is often essential to avoid wetness and salinity development
- irrigation problems : a low available moisture capacity, shallow depth, low intake rate and poor drainage make good irrigation control and short cycles essential
- land smoothing : surface water management is very important
- highly erodible : the easily dispersed topsoil is highly erodible so lands should be well protected and minimum tillage practised once lands have been levelled and drained
- winter harvest : infield traffic will compact and damage this soil when wet so plan to harvest in winter
- nematodes : nematicides may be effective in the sandy Graafwater series.

SELECTED PROPERTIES OF ESTCOURT FORM SOIL SERIES

Soil series	Physical					
	Clay % E horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Elim 31	0 to 6 (medium sand)	Very low	Medium to poor	Poor	Very high	Moderate (co, p)
Uitvlugt 34	6 to 15 (medium sand)	Low	Medium to poor	Poor	Very high	Moderate (co, p)
Estcourt 36	15 to 35 (undiffer-entiated)	Low	Poor	Very poor	Very high	Moderate (co, p, t)
Rosemead 16	15 to 35 (undiffer-entiated)	Low	Medium to poor	Poor	High	Moderate (co, p)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Elim 31	6,0 to 9,0	Low to mod.	Absent	Low	Low	Low	Low	Severe
Uitvlugt 34	6,0 to 9,0	Mod.	Absent	Low	Low	Low	Low	Severe
Estcourt 36	6,0 to 9,0	Mod. to high	Absent	Low	Low	Low	Low	Severe
Rosemead 16	5,0 to 7,0	Mod. to high	Absent	Low	Low	Low	Medium	Moderate to low

Estcourt Form - Es



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Komatipoort	Granite	Elim	Sand	450 to 600
	Middle Ecca Dwyka tillite Beaufort sediments	Uitvlugt	Loamy sand	
		Estcourt*	Sandy loam	
Umzinto (coast lowlands)	Dwyka tillite	Rosemead (non calcareous)	Fine sandy clay loam	450 to 1 000

*Zwide in Swaziland

FEATURES TO NOTE

- irrigation problems : a low available moisture capacity, shallow depth, low intake rate and poor drainage make good irrigation scheduling essential
- poorly drained : installation of drains is essential to avoid a salinity hazard
- land smoothing : surface water management is very important
- highly erodible : the easily dispersed topsoil is highly erodible so lands must be well protected and minimum tillage is recommended once lands have been levelled and smoothed
- timing : these soils compact easily when wet and become capped when dry so planting should take place in spring or early summer. This ensures that the soil is well protected by the cane canopy in the wet season. Harvesting should be planned for the dry winter months
- low nutrient status : inherently low in phosphorus and potassium so soil and leaf sampling are particularly important. Higher than average levels of nitrogen are generally required
- nematodes : nematicides may be effective in the Elim series only

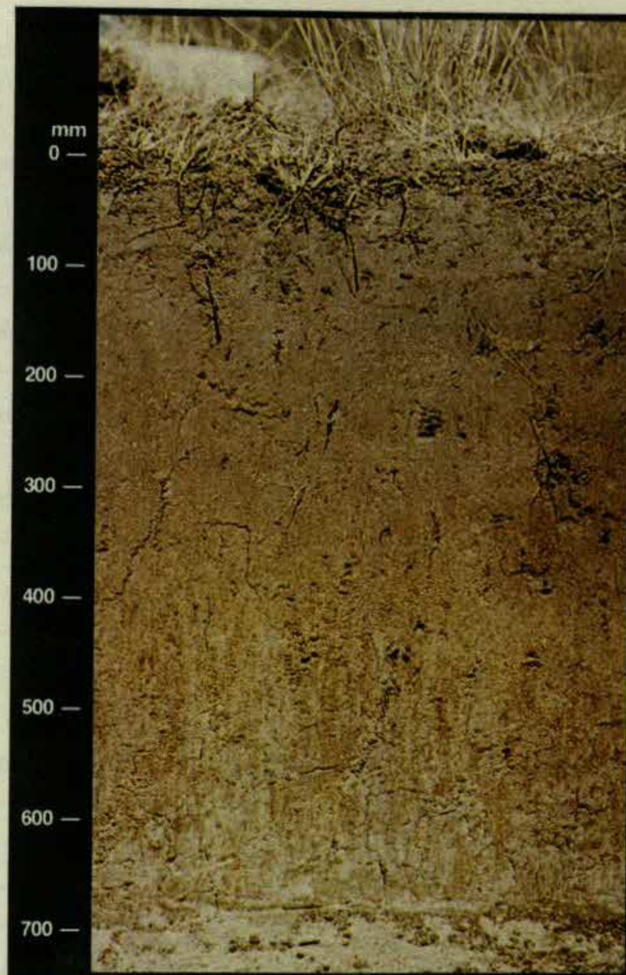
SELECTED PROPERTIES OF WESTLEIGH FORM SOIL SERIES

Soil series	Physical					
	Clay % B horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Kosi 20	0 to 6 (medium sand)	Low	Medium to poor	Poor to very poor	Very high	Moderate to severe (co, p, t)
Witsand 21	6 to 15 (medium sand)	Low	Medium to poor	Poor to very poor	High	Moderate (co, p, t)
Rietvlei 12	15 to 35 (fine sand)	Moderate	Medium to poor	Poor to very poor	High	Moderate to severe (co, p, t)
Sibasa 13	More than 35 (undiffer-entiated)	Moderate	Medium to poor	Poor to very poor	High to moderate	Moderate to severe (co, c, p, t)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Kosi 20	5,0 to 7,0	Very low	Slight	Low	Low	Low	Low	Low to moderate
Witsand 21	6,0 to 8,0	Low	Slight	Low	Low	Low	Low	Low to moderate
Rietvlei 12	6,0 to 8,0	Low to mod.	Absent	Low	Low	Low	Medium	Moderte
Sibasa 13	6,0 to 8,0	Mod.	Absent	Low	Low	Low to moderate	Medium	Moderate

Westleigh Form - We

Orthic A	Grey sand to sandy clay loam
Soft plinthic B	Mottled and gleyed with soft iron concretions



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Berea	Recent Sands	Kosi	Medium sand	300 to 500
Umzinto and Komatipoort	TMS (ordinary)	Witsand	Loamy medium sand	
	Middle Ecca sediments	Rietvlei	Fine sandy loam	
	Dwyka tillite	Sibasa	Fine/medium sandy clay loam	

FEATURES TO NOTE

- highly erodible : the easily dispersed topsoil is highly erodible so lands should be well protected; use minimum tillage and protect with trash or scattered tops
- poorly drained : this may lead to salinity problems in the Rietvlei and Sibasa series in the Komatipoort system
- low available moisture capacity : exceptionally good surface water management and irrigation scheduling are required
- nematodes : nematicides are likely to be effective in the sandy Kosi series only
- low nutrient status : nutrients are inherently low including calcium, magnesium and zinc. Higher than average fertilizer levels are required and split applications of nitrogen and potassium are recommended. Leaf sampling is strongly recommended.
- timing : because of wetness, compaction and capping problems it is preferable to harvest in winter

SELECTED PROPERTIES OF LONGLANDS FORM SOIL SERIES

Soil series	Physical					
	Clay % E horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Waaisand 11	6 to 15 (fine sand)	Low	Medium to poor	Poor	Very high	Moderate (co, p)
Longlands 21	6 to 15 (medium sand)	Low	Medium to poor	Poor	Very high	Moderate (co, p)
Waldene 12	15 to 35 (fine sand)	Low	Poor	Very poor	Very high	Moderate to severe (co, p, t)
Albany 22	15 to 35 (medium sand)	Low	Poor	Very poor	High	Moderate to severe (co, p)
Vaalsand 31	6 to 15 (coarse sand)	Very low	Medium	Poor	High	Moderate (co, t)

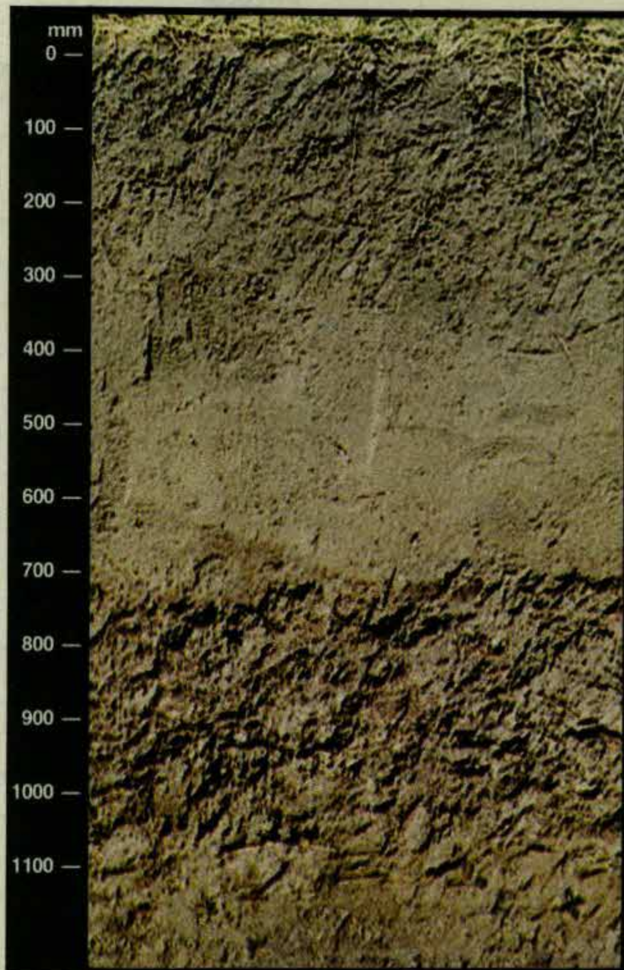
Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Waaisand 11	5,0 to 6,0	Very low	Slight	Low	Low	Low	Low	Low to moderate
Longlands 21	5,0 to 6,0	Low	Slight	Low	Low	Low	Low	Low to moderate
Waldene 12	5,0 to 7,0	Low to mod.	Absent	Low	Low	Low	Medium	Moderate
Albany 22	6,0 to 7,0	Low to mod.	Absent	Low	Low	Low	Medium	Moderate
Vaalsand 31	6,0 to 8,0	Mod.	Absent	Low	Low	Low	Low	Moderate

FEATURES TO NOTE

- highly erodible : use minimum tillage; protect with a trash blanket or leave burnt tops scattered; do not cultivate
- poorly drained : drainage is poor in the bottomland areas and unless rectified, salinity problems may develop in the Albany and Vaalsand series
- low available moisture capacity : exceptionally good surface water management and irrigation scheduling are required
- timing : the sandy clay loam soils compact easily when wet and become capped when dry so planting should take place in spring or early summer. This ensures that the soil is well protected by the cane canopy in the rainy season. Harvesting should be planned for the dry winter months.
- low nutrient status : inherently low in nitrogen, phosphorus and potassium and possibly zinc; split applications of nitrogen and potassium are advisable; high levels of nitrogen may be required to balance nitrogen losses due to denitrification and leaching particularly in wet years; leaf sampling is strongly recommended
- nematodes : nematicides may be effective in the sandy Waaisand series only

Longlands Form - Lo

Orthic A	Grey sandy loam to clay loam
E horizon	Bleached grey
Soft plinthic B	Mottled and gleyed with iron concretions
	Gleyed mottled clay or rock



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Berea	Recent Sands	Waaisand	Fine sandy loam	More than 1 000
Umzinto	Middle Ecca sandstone TMS (ordinary) Alluvium	Longlands	Medium sandy loam	600 to 1 200
	Middle Ecca sandstone Dwyka tillite	Waldene	Fine sandy clay loam	450 to 1 000
Komatipoort	Alluvium	Albany	Medium sandy clay loam	800 to 1 200
Nelspruit	Granite	Vaalsand	Coarse sandy loam	400 to 800

SELECTED PROPERTIES OF KROONSTAD FORM SOIL SERIES

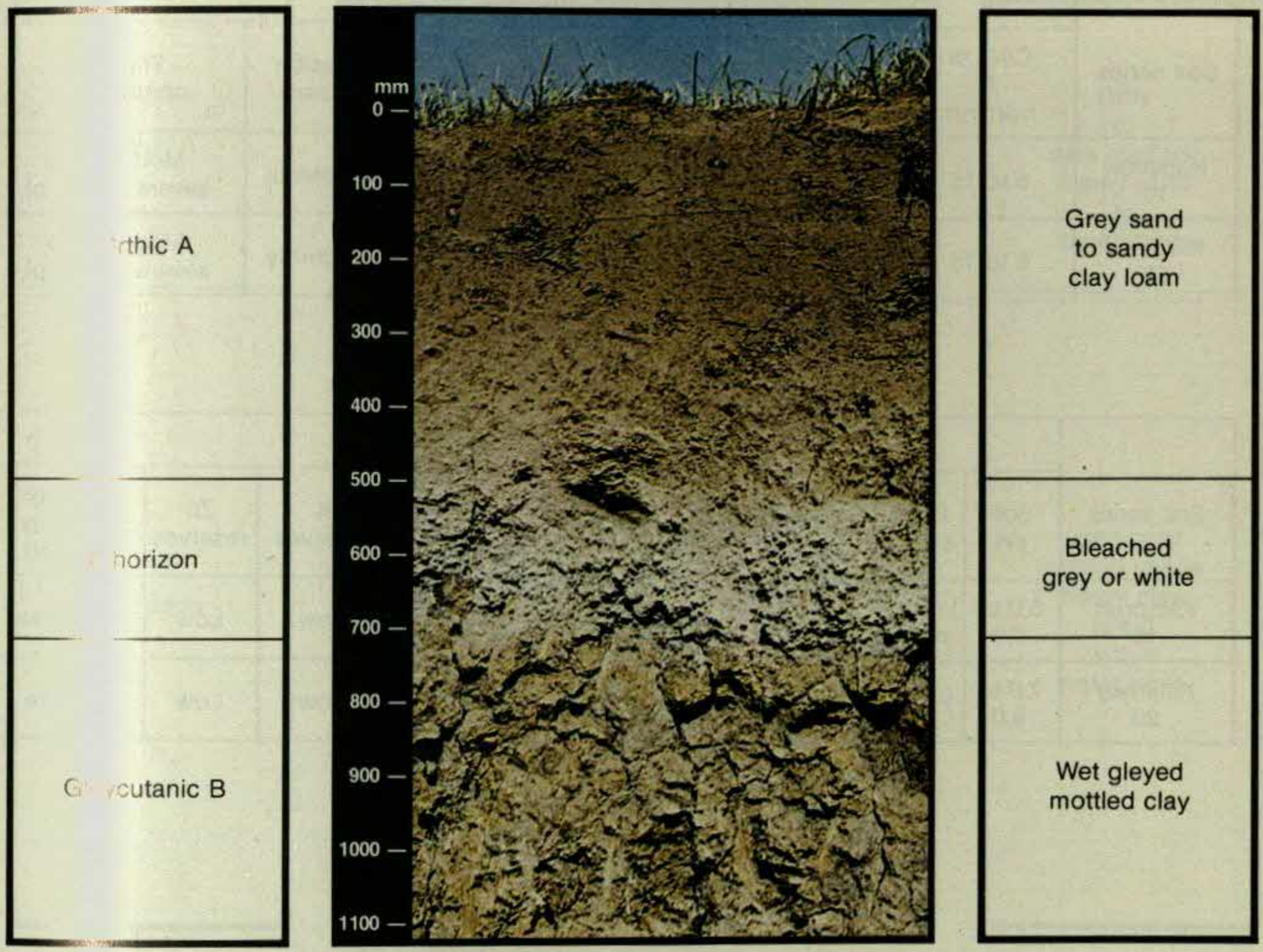
Soil series	Physical					
	Clay % E horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Kroonstad 13	6 to 15 (fine sand)	Very low	Medium	Poor	Very high	Moderate (co, p)
Mkambati 14	6 to 15 (medium sand)	Low	Medium	Poor	Very high	Moderate (co, p)
Katarra 22	0 to 6 (coarse sand)	Very low	Medium	Poor	Very high	Slight (co)
Avoca 17	15 to 35 (medium sand)	Moderate	Medium to poor	Poor	Very high	Moderate to severe (co, p)
Bluebank 16	15 to 35 (fine sand)	Moderate	Poor	Poor	Very high	Moderate to severe (co, p)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Kroonstad 13	5,5 to 7,0	Low	Slight	Low	Low	Low	Low	Low to moderate
Mkambati 14	5,5 to 7,0	Low	Slight	Low	Low	Low	Low	Low to moderate
Katarra 22	6,0 to 8,0	Low	Absent	Low	Low	Low	Low	Moderate
Avoca 17	5,5 to 7,0	Mod.	Absent	Low	Low	Low	Medium	Moderate
Bluebank 16	5,5 to 7,0	Mod.	Absent	Low	Low	Low	Medium	Moderate

FEATURES TO NOTE

- highly erodible : use minimum tillage; protect with a trash blanket or leave burnt tops scattered; do not cultivate. Banks of open drains need protection against erosion
- poorly drained : drainage is a problem in bottomland areas and salinity may develop in the Bluebank, Katarra and Avoca series in the Komatipoort system
- timing : the sandy clay loam soils compact easily when wet and become capped when dry so planting and harvesting should take place in spring or early summer. This ensures that the soil is well protected by the cane canopy in the rainy season
- low nutrient status : inherently low in nitrogen, phosphorus and potassium and possibly zinc; split applications of nitrogen and potassium are advisable: high levels of nitrogen may be required to balance nitrogen losses due to denitrification and leaching particularly in wet years; leaf sampling is strongly recommended
- low available moisture capacity : exceptionally good surface water management and irrigation scheduling are required
- nematodes : may be a problem where A horizon is very sandy

Kroonstad Form - Kd



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Berea	Recent Sands	Kroonstad	Fine sand	450 to 1 200
Umzinto	TMS (ordinary)	Mkambati*	Medium sand	600 to 800
Komatipoort Nelspruit	Granite	Katarra	Coarse sand	400 to 600
Umzinto	Middle Ecca sandstone, Alluvium	Avoca	Medium sandy loam	600 to 800
Umzinto	Dwyka tillite Middle Ecca sandstone	Bluebank	Fine sandy clay loam	400 to 600

*Habelo in Swaziland

SELECTED PROPERTIES OF KATSPRUIT FORM SOIL SERIES

Soil series	Physical					
	Clay % A horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Katspruit 10	6 to 15	Moderate to high	Poor	Very poor	Moderate	Moderate to severe (co, c, p)
Killarney 20	6 to 15	Moderate to high	Poor	Very poor	Moderate	Moderate to severe (co, c, p)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Katspruit 10	5,0 to 7,0	Low to mod.	Absent	Low	Low	Low	Low	Moderate
Killarney 20	7,0 to 9,0	High*	Absent	Low	Low	Low	Low	Severe

*Free lime present

Katspruit Form - Ka

rthic A	Grey to dark medium loamy sand to sandy loam
horizon	Deep grey mottled yellow heavy clay (gley) with a water table

MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
All systems except Komatipoort	TMS (ordinary) Middle Ecca sediments Alluvium	Katspruit	Loamy sand to sandy loam	300 to 500
Komatipoort	Granite Dwyka tillite Middle Ecca sediments	Killarney (calcareous)	Loamy sand to sandy loam	

FEATURES TO NOTE

- poorly drained : subsurface pipe and mole drains are invariably required in this valley-bottom soil, particularly in the Killarney series where there is a salinity hazard
- irrigation : poor intake rate and drainage coupled with a salinity hazard makes good irrigation scheduling essential
- land smoothing : surface water management must be good as intake rate and drainage are poor
- timing : all operations should be carried out in the dry winter period; minimum tillage is recommended
- low nutrient status : higher than normal amounts of nutrients are required, particularly nitrogen and potassium, which are likely to be lost because of wetness. Frequent leaf sampling is essential
- burn at harvest : a trash blanket will aggravate the wetness problem

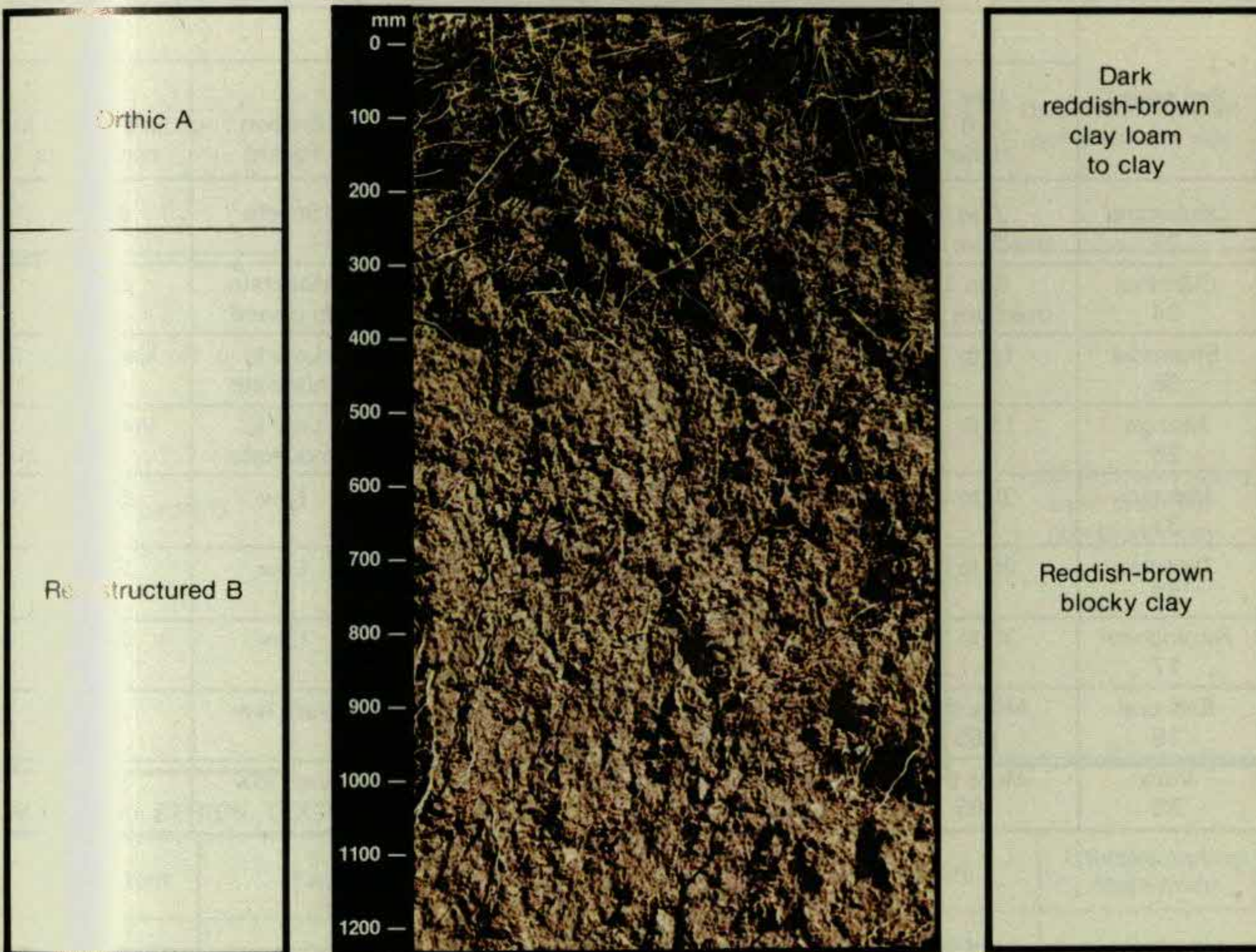
SELECTED PROPERTIES OF SHORTLANDS FORM SOIL SERIES

Soil series	Physical					
	Clay % B horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Argent 11	35 to 55	Moderate to high	Medium	Good	Very low	Slight to moderate (c
Glendale 21	35 to 55	Moderate to high	Medium	Good	Very low	Slight to moderate (c
Sunvalley 31	35 to 55	Moderate to high	Medium	Good to moderate	Very low	Slight to moderate (c
Shortlands 22	More than 55	High	Medium	Good	Very low	Moderate (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Argent 11	5,0 to 6,0	Mod.	Absent	Moderate	Moderate to high	Moderate	Moderate to high	Low
Glendale 21	6,0 to 7,0	High	Absent	Low to moderate	Moderate to high	Moderate to high	Moderate to high	Low
Sunvalley 31	7,0 to 8,5	Very high*	Absent	Low to moderate	Moderate to high	Moderate to high	Moderate	Moderate
Shortlands 22	6,0 to 7,0	High	Absent	Low to moderate	Moderate to high	Moderate to high	Moderate to high	Low

*Free lime present

Shortlands Form - Sd



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Umzinto and Komatipoort	Tugela schist Dolerite-basalt	Glendale Shortlands*	Clay loam Clay	900 to 1 200
Nelspruit	Swaziland basic rocks	Argent	Sandy clay loam	
Komatipoort	Swaziland basic rocks Alluvium	Glendale†	Clay loam	
	Swaziland basic rocks Dolerite-basalt	Sunvalley (calcareous)	Clay loam	

*Rathbone in Swaziland †Rondspring in Swaziland

FEATURES TO NOTE

- **nutrient status** : well supplied with calcium and magnesium; mineralises considerable quantities of nitrogen with no leaching or denitrification problems so applied nitrogen levels may be below average. Higher than average potassium may be required on the high clay soils; phosphorus fixation may be a problem in the Argent, Shortlands and Sunvalley series
- **salinity** : low quality irrigation water may cause saline conditions along drainage lines only in the Sunvalley series
- **trashing** : a good response to trashing can be expected
- **soil tilth** : Shortlands series should not be worked when too wet or dry

SELECTED PROPERTIES OF HUTTON FORM SOIL SERIES

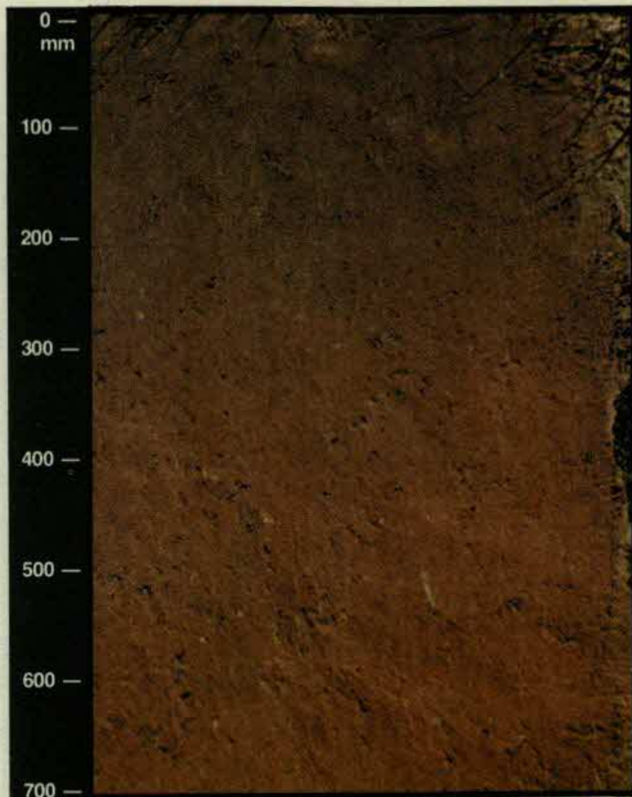
Soil series	Physical					
	Clay % B horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Joubertina 21	0 to 6 (medium sand)	Low to very low	Good	Very good	Severe	Slight (w)
Clansthal 24	6 to 15 (medium sand)	Low to moderate	Good	Very good	Moderate to severe	Slight (w)
Shorrocks 36	15 to 35	Moderate to high	Good	Good	Low to moderate	Very slight
Msinga 26	15 to 35	Moderate to high	Good	Good	Low to moderate	Very slight
Makatini 37	35 to 55	High	Medium to good	Good	Low	Slight (c)
Doveton 27	35 to 55	High	Medium to good	Good	Low	Slight (c)
Farningham 17	35 to 55	High	Medium to good	Good	Low	Slight (c)
Balmoral 18	More than 55	Very high	Medium	Good	Very low	Slight (c)
Vimy 28	More than 55	Very high	Medium	Good	Very low	Slight (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/sodicity hazard
Joubertina 21	5,0 to 8,5*	Low	Slight	Low	Low to moderate	Low	Low	Very low
Clansthal 24	5,0 to 8,5*	Low	Slight	Low	Low to moderate	Low	Low	Very low
Shorrocks 36	6,0 to 8,0	Mod. to high	Absent	Low to moderate	Low to moderate	Moderate	Low to moderate	Low
Msinga 26	5,0 to 6,5	Mod.	Slight	Low to moderate	Low to moderate	Moderate	Low to moderate	Very low
Makatini 37	6,0 to 7,0	High	Absent	Low to moderate	Moderate to high	Moderate to high	Moderate	Low
Doveton 27	5,0 to 6,0	Mod.	Absent	Moderate to high	Moderate to high	Moderate	Moderate	Absent
Farningham 17	4,5 to 5,5	Low to mod.	Slight to moderate	Moderate to high	Moderate to high	Low to moderate	Low	Absent
Balmoral 18	4,5 to 5,5	Low to mod.	Slight to moderate	Moderate to high	Moderate to high	Low to moderate	Low	Absent
Vimy 28	6,0 to 7,0	Mod. to high	Absent	Moderate	Moderate	Moderate	Moderate	Low

* pH values in excess of 7,5 generally indicate the previous use of filtercake containing lime

Hutton Form - Hu

Orthic A	Dark reddish-brown loamy sand to clay
Red apedal B	Reddish-brown loamy sand to porous non-blocky clay



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent materials	Soil series	Topsoil texture	Effective rooting depth (mm)
Berea	Recent Sands	Joubertina	Medium sand	More than 1200
		Clansthal	Loamy medium sand	
Komatipoort	Cave sandstone Granite (granodiorite)	Shorrocks*	Sandy loam	300 to 500
Komatipoort Umzinto (river valley)	Alluvium Swaziland basic rocks	Makatini	Sandy clay loam	More than 1200
Nelspruit	Alluvium Granite (granodiorite) Swaziland basic rocks	Msinga	Sandy loam	300 to 500
Umzinto (midlands)	Tugela schist	Doveton†	Clay loam to clay	700 to 1000
	Dolerite	Vimy	Clay	
	TMS (ordinary)	Msinga	Sandy loam	500 to 1000
Nottingham	TMS (ordinary) Middle Ecca sediments	Farningham	Clay loam	700 to 1200
	Dolerite	Balmoral	Clay	

* Winn; † Malkerns in Swaziland

FEATURES TO NOTE

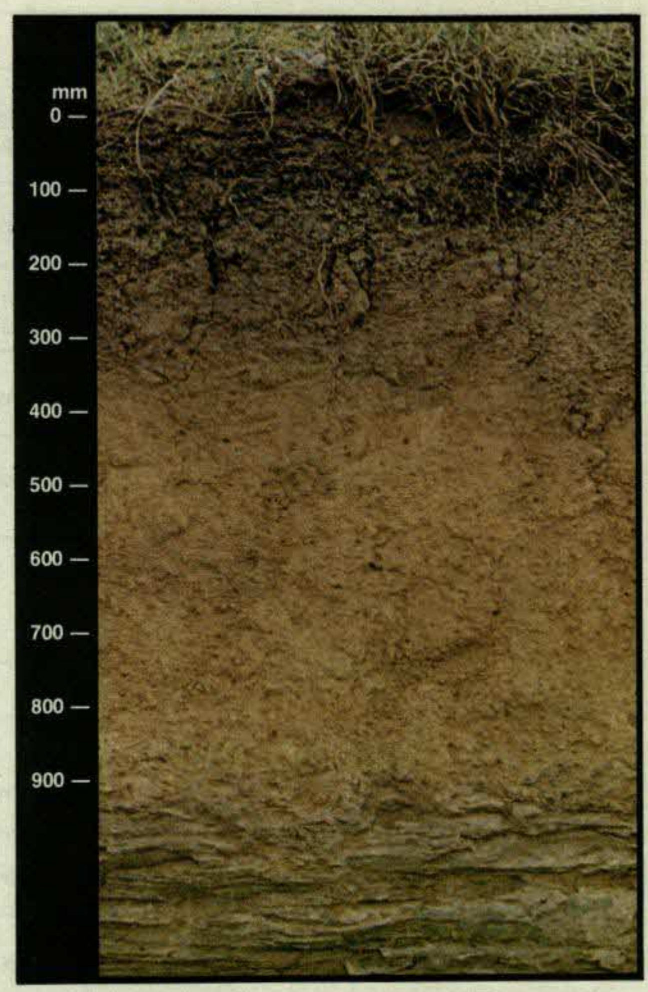
- agricultural limestone : commonly required on the highly weathered Farningham and Balmoral series and occasionally on the Joubertina and Clansthal series.
- phosphorus fixation : the Farningham and Balmoral series are commonly high phosphorus fixing.
- stool eradication : re-establishment should be infrequent; minimum tillage is recommended on the Clansthal and Joubertina series and shallow ploughing on the remainder.

SELECTED PROPERTIES OF CLOVELLY FORM SOIL SERIES

Soil series	Physical					
	Clay % B horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Sandspruit 31	0 to 6 (medium sand)	Very low	Good	Very good	High	Moderate (w)
Denhere 35	6 to 15 (coarse sand)	Very low	Good	Very good	High	Slight (w)
Springfield 24	6 to 15 (medium sand)	Low	Good	Very Good	High	Slight (w)
Oatsdale 16	15 to 35 (undiffer-entiated)	Moderate	Good	Good	Moderate to low	Slight (w)
Clovelly 17	35 to 55 (undiffer-entiated)	Moderate to high	Good to medium	Good	Low	Moderate (c)
Balgowan 18	More than 55 (undiffer-entiated)	High	Good to medium	Good	Low	Moderate (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Sandspruit 31	6,0 to 7,0	Mod. to low	Low to moderate	Low	Low	Low	Medium	Low
Denhere 35	6,0 to 7,0	Mod.	Low to moderate	Low	Low	Low	Medium	Low
Springfield 24	6,0 to 7,0	Mod. to low	Low to moderate	Low	Low	Low	Medium	Low
Oatsdale 16	4,0 to 6,0	Low	Moderate	Moderate	Moderate	Low	Low	Absent
Clovelly 17	4,0 to 6,0	Low	Severe	High	Moderate to high	Low	Low	Absent
Balgowan 18	4,0 to 6,0	Low	Severe	Very high	Moderate to high	Low	Low	Absent

Clovelly Form - Cv

Orthic A		Dark greyish-brown sand to clay
Yellow-brown apedal B		Yellow-brown sand to friable non-structured clay
C or rock		Weathering rock

MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Berea	Recent Sands	Sandspruit	Medium sand	More than 1 000
		Denhere	Coarse loamy sand	
Umzinto	Alluvium	Springfield	Loamy medium sand	
Nottingham	TMS (ordinary) Middle Ecca sandstone	Oatsdale	Sandy loam	500 to 800
	Dwyka tillite	Clovelly	Sandy clay loam	
	Lower and Middle Ecca shale	Balgowan	Clay	700 to 1 000

FEATURES TO NOTE

- low nutrient status — lime, phosphorus and zinc requirements likely to be high in soils of the Nottingham system. Comprehensive soil sampling is essential
- nematodes : may be a problem in the Sandspruit and Denhere series
- stool eradication : a problem in the sandy soils where a rotary hoe or minimum tillage is recommended

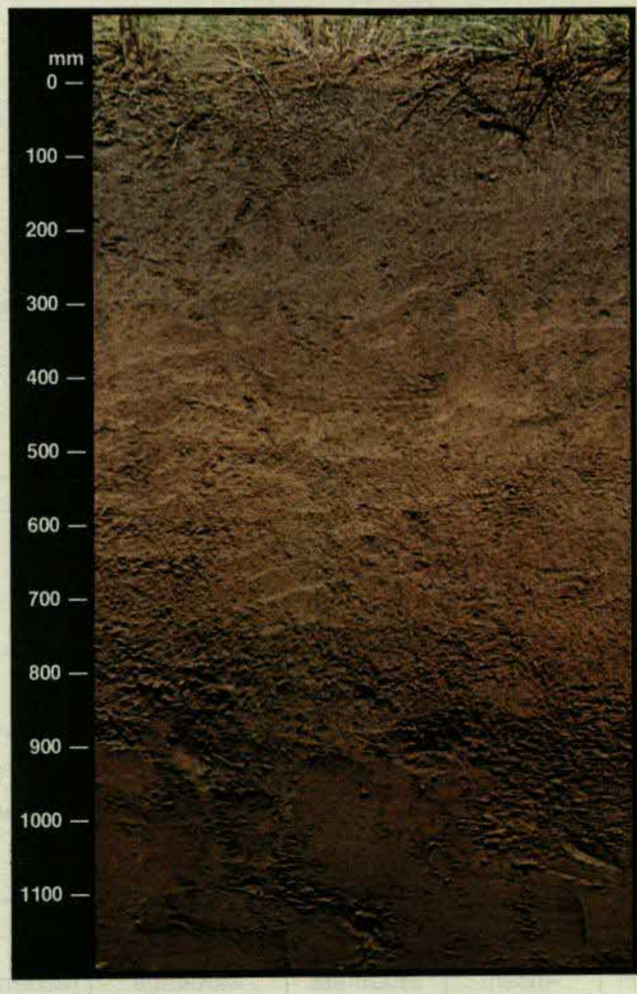
SELECTED PROPERTIES OF GRIFFIN FORM SOIL SERIES

Soil series	Physical					
	Clay % B horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Burnside 10	6 to 15	Very low to low	Good	Very good	High	Slight (w)
Cleveland 11	15 to 35	Moderate	Good	Good	Moderate to low	Slight (w)
Griffin 12	35 to 55	Moderate to high	Medium	Good	Low	Moderate (c)
Farmhill 13	More than 55	High	Medium	Good	Low	Moderate (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Burnside 10	6,0 to 7,0	Low	Moderate to severe	Low	Low	Low	Medium	Absent
Cleveland 11	4,0 to 6,0	Low	Severe	Moderate	Moderate	Low	Low	Absent
Griffin 12	4,0 to 6,0	Low	Severe	High	Moderate to high	Low	Low	Absent
Farmhill 13	4,0 to 6,0	Low	Severe	Very high	Moderate to high	Low	Low	Absent

Griffin Form - Gf

Orthic A	Dark grey to brown loamy sand to clay
Yellow-brown apedal B	Yellow-brown loamy sand to friable clay
Red apedal B	Red loamy sand to friable non-structured clay



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Nottingham	TMS (ordinary)	Burnside	Loamy sand to sandy loam	700 to 1 000
	TMS (ordinary) Middle Ecca sandstone	Cleveland	Sandy loam to sandy clay loam	
	Dwyka tillite	Griffin	Clay loam	
	Lower and Middle Ecca shale	Farmhill	Clay	

FEATURES TO NOTE

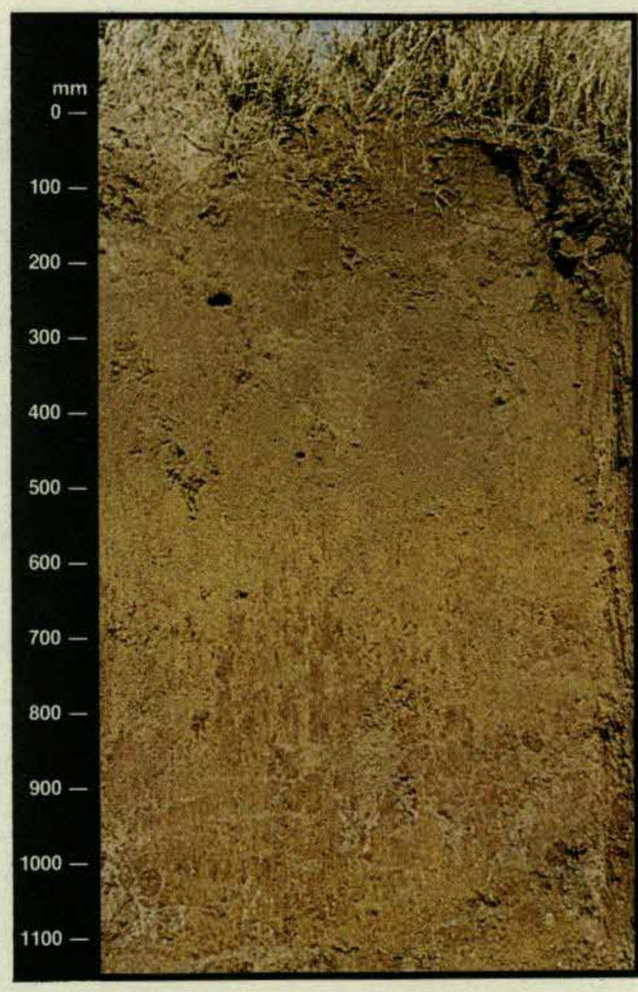
- good physical properties but has some nutrient deficiencies
- lime requirement : generally widespread because of aluminium toxicity and low calcium and magnesium status
- phosphorus requirement : generally high because of phosphorus fixation
- potassium availability : may be a problem so soil and leaf sampling required
- zinc : zinc at planting is advisable
- nitrogen : requirements are lower than normal in the Griffin and Farmhill series

SELECTED PROPERTIES OF AVALON FORM SOIL SERIES

Soil series	Physical					
	Clay % B horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Kanhym 14	6 to 15 (medium sand)	Low	Medium	Moderate	High	Slight (w)
Ruston 16	15 to 35 (undiffer-entiated)	Moderate	Medium	Moderate	Moderate	Slight (w)
Bezuidenhout 37	More than 35 (undiffer-entiated)	Moderate to high	Medium to poor	Moderate to poor	Low	Moderate (c)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Kanhym 14	5,0 to 6,0	Very low	Moderate	Moderate	Low to moderate	Low	Low	Absent
Ruston 16	5,0 to 6,0	Low	Moderate	Moderate to high	Moderate	Low	Low	Absent
Bezuidenhout 37	6,0 to 7,0	High	Absent	Moderate	Moderate	Moderate	Medium	Moderate to high

Avalon Form - Av



Orthic A	Dark grey-brown sandy loam to clay loam
Yellow-brown apedal B	Yellow-brown friable loamy sand to non-structured clay
Soft plinthic B	Soft iron concretions

Main soil series, texture and depth

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
Umzinto (midlands)	TMS (ordinary)	Kanhym	Medium sandy loam	600 to 800
Nottingham		Ruston	Sandy clay loam	800 to 1 000
Komatipoort	Middle Ecca sediments	Bezuidenhout*	Clay loam	600 to 800

*Delcor in Swaziland

FEATURES TO NOTE

- low nutrient status : Kanhym and Ruston series commonly require agricultural lime due to calcium or magnesium deficiency or aluminium toxicity; phosphorus fixation may be a problem, potassium is inherently low and nitrogen mineralisation is low to moderate. Comprehensive soil sampling is essential
- erodibility : the same two series need protection with careful field layouts and limited cultivation
- drainage : despite the soft plinthite, the depth of A and B horizons is generally good and drainage is unlikely to be a problem in the Kanhym and Ruston series but it could be a problem in the Bezuidenhout series
- irrigation : good irrigation control is required in the Bezuidenhout series

SELECTED PROPERTIES OF OAKLEAF FORM SOIL SERIES

Soil series	Physical					
	Clay % B horizon	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Sezela 32	0 to 6 (coarse sand)	Low	Good	Very good	High	Moderate (w)
Levubu 34	6 to 15 (medium sand)	Low	Good	Very good	Moderate	Moderate to slight (w)
Jozini 36	15 to 35 (undiffer-entiated)	Moderate to high	Good	Good	Low	Slight (p)
Koedoesvlei 37	More than 35 (undiffer-entiated)	High	Good	Moderate to good	Low	Slight (p)
Leeufontein 16	15 to 35 (undiffer-entiated)	Moderate to high	Good	Moderate to good	Low	Slight (p)
Limpopo 46	15 to 35 (undiffer-entiated)	Moderate to high	Good	Good	Low	Slight (p)
Highflats 17	More than 35 (undiffer-entiated)	High	Good	Good	Low	Very slight

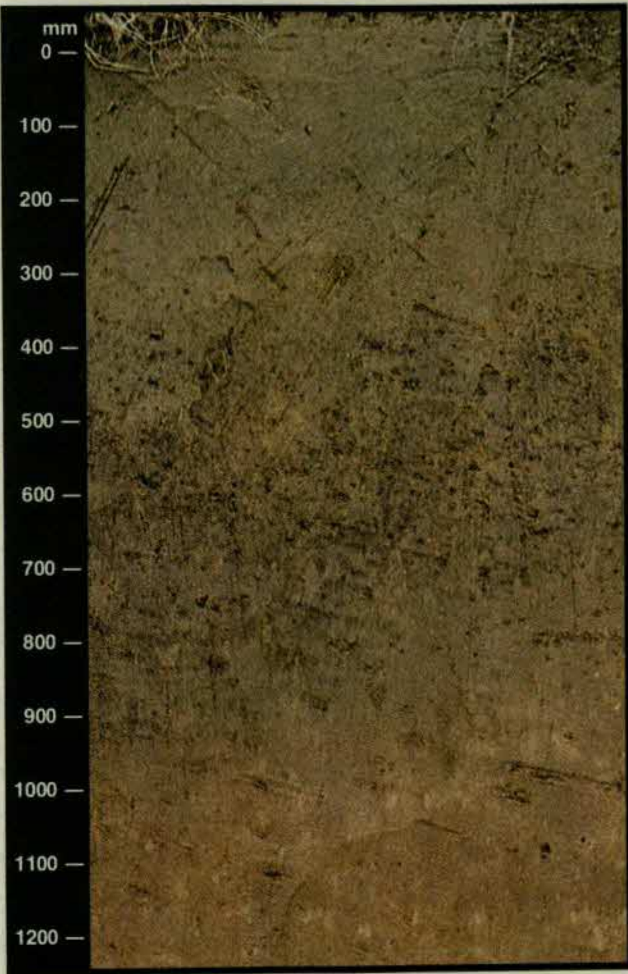
Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Sezela 32	6,0 to 7,0	Very low	Absent	Low to moderate	Low	Low	Low	Absent
Levubu 34	6,0 to 7,0	Low	Absent	Low to moderate	Low to moderate	Low to medium	Low	Low
Jozini 36	6,0 to 7,0	Low to mod.	Absent	Low to moderate	Low to moderate	Low to medium	Low to medium	Low
Koedoesvlei 37	6,0 to 7,0	Low to mod.	Absent	Low to moderate	Low to moderate	Low to medium	Low to medium	Low
Leeufontein 16	6,0 to 7,0	Low to mod.	Absent	Low to moderate	Low to moderate	Low to medium	Low to medium	Low
Limpopo 46	7,0 to 8,5	High*	Absent	Low	Moderate	Medium	Medium	Moderate to high
Highflats 17	4,5 to 6,0	Low to mod.	Moderate	Moderate	Moderate to high	Low	Low	Absent

*Free lime present

Oakleaf Form - Oa

Orthic A

Neocutanic B



Dark grey-brown sand to sandy clay loam

Weakly structured dark brown or red sandy loam to clay

MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Colour (subsoil)	Effective rooting depth (mm)
Umzinto and Komatipoort	Alluvium	Sezela	Coarse sand	Dark brown	More than 1 000
		Levubu	Loamy medium sand		
		Jozini	Sandy loam		
		Koedoesvlei	Sandy clay loam		
Komatipoort	Alluvium	Limpopo (calcareous)	Sandy loam		
		Leeufontein	Sandy loam	Red	
Nottingham	Alluvium	Highflats	Sandy clay loam		

FEATURES TO NOTE

- physical and chemical properties : good
- nematodes : only in the sandy Sezela series is the need for nematicides likely

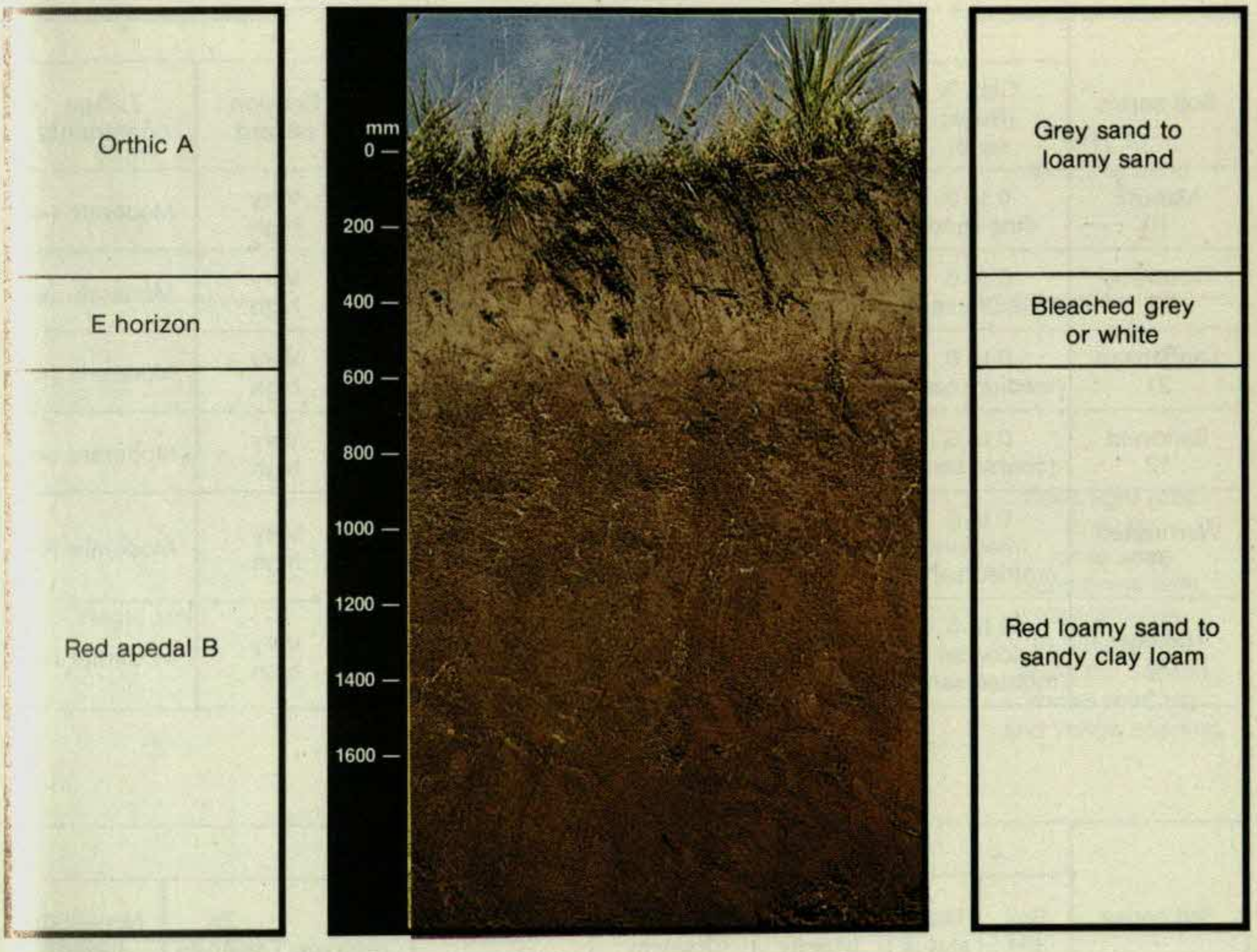
SELECTED PROPERTIES OF SHEPSTONE FORM SOIL SERIES

Soil series	Physical						
	Clay %		Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
	E * horizon	B horizon					
Bitou 11	0 to 6	Less than 15	Very low to low	Good	Good	Very high	Moderate (w)
Shepstone 21	0 to 6	More than 15	Low to moderate	Good	Good to moderate	Very high	Moderate (w)
Robberg 14	6 to 15	Less than 15	Very low to low	Good	Good	High	Slight (w)
Portobello 24	6 to 15	More than 15	Low to moderate	Good	Good to moderate	High	Slight (w)

*Medium sand predominant in all four soil series

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Nematode hazard
Bitou 11	5,0 to 7,0	Low	Moderate	Low	Low	Low	Low	Moderate to severe
Shepstone 21	5,0 to 7,0	Low to mod.	Slight	Low	Low	Low	Low	Moderate to severe
Robberg 14	5,0 to 7,0	Low to mod.	Slight	Low	Low	Low	Low	Moderate
Portobello 24	5,0 to 7,0	Mod. to low	Slight	Low	Low to moderate	Low	Low	Moderate

Shepstone Form - Sp



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Subsoil (red)	Effective rooting depth (mm)
Berea	Recent Sands	Bitou	Medium sand	Loamy sand	700 to more than 1 000
		Shepstone		Sandy clay loam	
		Robberg	Loamy medium sand	Loamy sand	
		Portobello		Sandy clay loam	

FEATURES TO NOTE

- nematodes : in the very sandy topsoils nematicides should be used
- low nutrient status : higher than average amounts of fertilizer are needed as the soil nutrient status is inherently low. Thorough soil sampling is recommended
- stool eradication : minimum tillage or alternatively a rotary hoe should be used in these sandy soils
- variety : where topsoils are very sandy select varieties best suited to sandy soils but where clay in topsoil is greater than 8% select high yielding varieties

SELECTED PROPERTIES OF FERNWOOD FORM SOIL SERIES

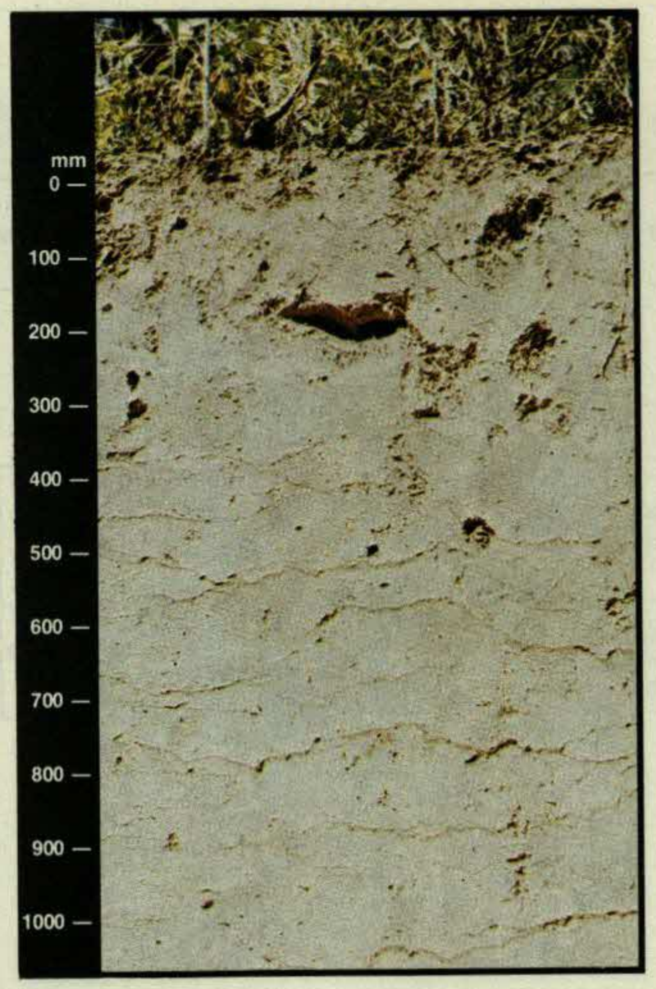
Soil series	Physical					
	Clay % (Regic sand)	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Maputa 10	0 to 6 (fine sand)	Low to very low	Good	Very good	Very high	Moderate (w)
Fernwood 11	0 to 6 (medium sand)	Low to very low	Good	Very good	Very high	Moderate (w)
Langebaan 21	0 to 6 (medium sand)	Low to very low	Good	Very good	Very high	Moderate (w)
Sandveld 12	0 to 6 (coarse sand)	Low to very low	Good	Very good	Very high	Moderate (w)
Warrington 31	0 to 6 (medium mottled sand)	Low	Good	Moderate to poor	Very high	Moderate (w)
Trafalgar 32	0 to 6 (coarse mottled sand)	Low	Good	Moderate to poor	Very high	Moderate (w)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Nematode hazard
Maputa 10	5,0 to 6,5	Low to very low	Slight to moderate	Low	Low	Low	Low	Severe
Fernwood 11	5,0 to 6,5	Low to very low	Slight to moderate	Low	Low	Low	Low	Severe
Langebaan 21	7,0 to 8,5	Low to very low	Absent	Low	Low	Low	Low	Severe
Sandveld 12	5,0 to 6,5	Low to very low	Slight	Low	Low	Low	Low	Severe
Warrington 31	5,0 to 6,0	Low	Slight to moderate	Low	Low	Low	Low	Moderate to severe
Trafalgar 32	5,0 to 6,0	Low	Slight to moderate	Low	Low	Low	Low	Moderate to severe

Fernwood Form - Fw

Orthic A

Regic sand



Grey to dark grey sand

Deep light grey to white loose sand sometimes with clay lamellae. In bottomland areas the subsoil shows mottling and yellow staining

MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
All systems (mainly Berea)	Grey Recent Sands and Recent alluvium	Maputa	Fine sand	More than 1 200
		Fernwood	Medium sand	
		Langebaan (calcareous)	Medium sand	
		Sandveld	Coarse sand	
		Warrington	Medium sand	800 to 1 200
		Trafalgar (bottomland soils)	Coarse sand	

FEATURES TO NOTE

- nematodes : are a serious problem and without a nematicide good yields will not generally be obtained
- burn at harvest : this facilitates nematicide application
- low nutrient status : thorough soil sampling is required as agricultural lime and zinc may be needed in addition to high levels of nitrogen, potassium and possibly phosphorus
- narrow row spacing : because cane growth is slow weeds are a problem and close row spacing will help
- stool eradication : the conventional plough is relatively ineffective so chemical eradication or minimum tillage is recommended; this will also combat wind erosion
- variety : choose those best suited to sandy soils

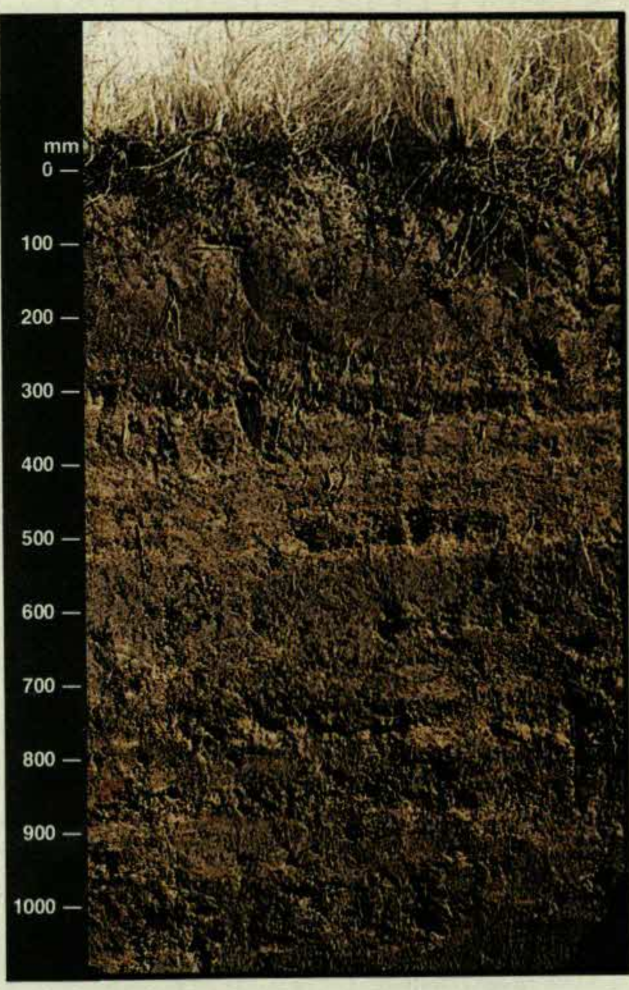
SELECTED PROPERTIES OF DUNDEE FORM SOIL SERIES

Soil Series	Physical					
	Clay %	Available moisture capacity	Intake rate	Drainage	Erosion hazard	Tillage constraints
Dundee 10	Variable	Moderate	Good	Moderate	Moderate	Slight (w)

Soil series	Chemical							
	Soil pH	Base status	Al toxicity	P fixation	N mineral-isation capacity	K reserves	Zn reserves	Salinity/ sodicity hazard
Dundee 10	5,0 to 7,0	High to very high	Absent	Low	Moderate	Moderate to high	High	Low

Dundee Form - Du

Orthic A	Dark grey-brown loamy sand to sandy clay loam
Stratified alluvium	Alternating layers of sand and clay sometimes merging into heavy gley



MAIN SOIL SERIES, TEXTURE AND DEPTH

Soil system	Parent material	Soil series	Topsoil texture	Effective rooting depth (mm)
All systems	Alluvium (recent)	Dundee*	Variable	More than 1 000

*Betusile and Bushbaby in Swaziland

FEATURES TO NOTE

- physical and chemical characteristics are good
- nutrient status : generally high so fertilizer requirements usually low; soil sampling important
- nematodes : some sandy alluvial soils benefit from the use of a nematicide
- flooding : a likely hazard in summer so plan field operations for winter and spring

APPENDIX 1: The nature and extent of soil parent materials in the South African sugar industry

Soil parent material	Map colour guide	Percentage distribution of total area surveyed						
		Overall	South Coast	Midlands	North Coast	Zululand	Pongola	Eastern Transvaal
Amphibolite	Red cross hatched	0,21	0,21	—	—	—	—	—
Pre-granite quartzite	Red dotted	0,07	0,03	—	—	0,04	—	—
Tugela schist	Red hatched	2,31	0,73	0,16	0,15	1,25	0,02	—
Swaziland basic rocks	Red hatched	0,65	—	—	—	—	—	0,65
Granite	Red	9,62	7,54	0,19	0,36	1,19	—	0,34
Table Mountain Sandstone (TMS) — Mistbelt	Blue with white dots	4,96	0,71	1,37	2,74	0,14	—	—
Table Mountain Sandstone (TMS) — Ordinary	Blue	24,90	7,10	8,76	7,59	1,45	—	—
Dwyka tillite	Red-brown	9,35	3,68	1,89	3,29	0,50	—	—
Lower Ecca shale	Dark brown	6,19	0,98	1,86	2,42	0,93	—	—
Middle Ecca shales and sandstones	Yellow-brown	6,62	0,03	1,30	1,67	3,22	0,40	—
Beaufort shales and sandstones	Grey	2,01	—	—	—	2,01	—	—
Cave sandstone	Pink	0,06	—	—	—	0,06	—	—
Dolerite-Basalt-Diabase	Light green	12,22	0,72	4,89	2,69	3,19	0,26	0,47
Cretaceous sediments	Yellow hatched	0,29	—	—	—	0,29	—	—
Recent Sands — Red	Orange	4,58	0,28	—	1,66	2,64	—	—
Recent Sands — Grey	Yellow	5,61	0,32	—	0,89	4,40	—	—
Alluvium	Dark green	10,42	0,53	3,51	1,29	4,05	0,83	0,21
Total		100,00	22,86	23,93	24,75	25,36	1,51	1,67

Note: The area under cane in the South African sugar industry was about 392 000 ha in 1982.
Total area surveyed was 587 865 ha.

APPENDIX 2: EXPLANATORY NOTES ON SOIL SYSTEMS

1. NOTTINGHAM SYSTEM

Identification

(i) Well weathered red or yellow acid soils
(ii) Found in moist climatic zones and on old land surfaces in the midlands (300 to 1 200 m elevation)
(iii) Topography is undulating, but steeper (rolling) in parts
(iv) Towns situated in this system are Paddock, Richmond, Seven Oaks, Greytown, Kranskop, Eshowe and Melmoth.

Rainfall

Mean annual rainfall range is 925 to 1 250 mm, but usually is between 950 and 1 175 mm. Mist is common but the system does not coincide with the 'mistbelt' as defined by ecologists. The good rainfall, together with cool temperatures and deep soils, ensure that moisture is not as severe a limiting factor as on the coast.

Temperature

Summers are warm and the winters cool in the east, but conditions become progressively cooler in a westerly direction. For example, the climate at Upper Tongaat is mild and it becomes cooler through Bruyns Hill to Seven Oaks and Greytown. At Greytown and on most parts of the highter plateau, conditions are too cold for sugarcane. The incidence of frost follows a similar trend.

Soil physical properties

(i) Soils are porous loams and clays with yellow or red subsoils (sometimes both, eg **Farmhill** series). Topsoils are dark brown and usually rich in organic matter. Although some of these soils are clays, they have physical properties more commonly associated with loams
(ii) Upland soils do not have watertables
(iii) Soils are deep except on shale when depth is often less than 1 m
(iv) Physically the soils are excellent for agriculture.

Soil chemical properties

(i) Strongly to moderately acid (pH 4,0 to 5,5)
(ii) Low reserves of potash and moderate to low reserves of calcium and magnesium
(iii) Aluminium toxicity is commonly encountered in yellow soils and ~~less frequently on red~~
(iv) Phosphate fixation is often a problem.

Soil nomenclature

(i) As a group, the well-weathered upland soils are known as 'latosols', 'oxisols' or 'ferralitic' soils. Kaolinite, amorphous compounds and chlorite dominate the clay fraction of the red soils, while the yellow and grey soils often contain illite as well
(ii) Common soil forms are **Hutton, Inanda Nomanci, Griffin** and **Clovelly.** At shallow sites the **Mispah** form is common. In vleis, **Katspruit** is most common and **Champagne** series is sometimes found.

2. UMZINTO SYSTEM

Identification

(i) The soils are not well-weathered because they occur on young land surfaces
(ii) Calcium carbonate (lime) in the form of nodules is rarely found in these soils
(iii) The soils tend to be shallow
(iv) Soils tend to be well supplied with calcium, magnesium and weatherable minerals, neutral to moderately acid, and contain illite and montmorillonite in addition to kaolinite
(v) Climate varies considerably according to the three divisions of the system described as follows.

Three divisions of the system:

A UMZINTO SYSTEM: Coast lowlands

(i) This is the area where sugarcane was first grown in Natal and it lies below an altitude of 300 m
(ii) Mean annual rainfall ranges from 925 to 1 300 mm, but is seldom more than 1 150 mm
(iii) Summers are hot and the winters are mild and frost-free
(iv) Topography is rolling.

B UMZINTO SYSTEM: Midlands

(i) This region lies at altitudes of 300 to 950 m
(ii) Mean annual rainfall is in the range 730 to 1 000 mm. Rainfall tends to increase towards the Nottingham system and the coast lowlands, and to decrease towards the river valleys. Mist is fairly frequent, particularly in the vicinity of the Nottingham system
(iii) In the east, temperatures are only slightly lower than those of the coast lowlands, but conditions become progressively cooler in a westerly direction. The incidence of frost follows ~~a similar~~ trend
(iv) Topography is undulating, but steeper (rolling) in parts
(v) In contrast with the dark clays on shale at the coast **(Milkwood** series), grey clays are found on shale **(Mispah** series) in the midlands divison.

C UMZINTO: River valleys

(i) The region lies 60 to 730 m above sea level

(ii) Mean annual rainfall ranges from 650 to 800 mm and in consequence moisture is severely limiting for dryland cane production

(iii) Frost is not common except in the west

(iv) Red soils (**Glendale** series), often with grey topsoils, are fairly common on Dwyka tillite, whereas they do not occur elsewhere in this system on Dwyka

(v) Topography tends to be steep with moderately level valley floors

(vi) A few parts of the area shown in the maps as river valleys belong in the Komatipoort system because of the presence of lime nodules in the soils.

3. KOMATIPOORT SYSTEM

Presence of lime

Unlike the other systems, the Komatipoort system has soils which contain calcium carbonate (lime) as nodules. This phenomenon is related to the low rainfall, and is indicative of reserves of soluble salts which pose a salinity hazard when the land is irrigated. However, not all the soils contain these nodules.

Lowveld cane

Most of the lowveld cane is grown in this system. The remainder is in the Nelspruit and Berea systems.

Topography

Cane is grown on undulating land less than 380 m above sea level.

Climate

Mean annual rainfall is 590 to 730 mm, but usually less than 700 mm, which is too low for the production of non-irrigated cane. Winters are mild and the summers hot.

Soils

(i) Red blocky clays with and without free lime (**Shortlands** form) dominate on basic rocks such as dolerite, basalt and schist. These tend to be less porous than their counterparts in wetter regions. Less frequent on these rock types are black clays (eg — **Arcadia** and **Bonheim** forms). Montmorillonite, illite and kaolinite are common clay minerals.

(ii) Shallow duplex soils (**Estcourt** form) with free lime in the subsoil are a regular feature on sedimentary rocks such as sandstones. They also occur on granite and are sometimes found on alluvium. However, **Longlands, Kroonstad** and other forms are also found on these materials. Illite and montmorillonite are the predominant clay minerals in the clay subsoils.

(iii) Red loams such as the **Shorrocks** series are common on alluvial terraces and granodiorite.

4. NELSPRUIT SYSTEM

Climate

(i) The wetter cane growing areas of the Eastern Transvaal are in this system

(ii) Mean annual rainfall ranges from 760 mm to more than 900 mm, being 785 mm at Nelspruit, 830 mm at Alkmaar and 880 mm at Kaalrug; it tends to be highest at high altitudes on southern slopes

(iii) Summers are warm and the winters mild.

Topography

This hilly region is generally more than 300 m above sea level.

Soils

(i) Soils containing calcium carbonate (lime) as nodules are absent

(ii) Common soils are grey sands (**Grovedale, Longlands** and **Katarra** series) on granite, porous red loams (**Msinga** series) on granodiorite, red clays (**Argent** series) on schists, and red loams (**Shorrocks** series) on alluvial terraces. Kaolinite and illite are common clay minerals.

(iii) Phosphate fixation may be a feature on **Msinga** and **Argent** series.

5. BEREA SYSTEM

Identification

(i) Known locally as Recent Sands this system is a belt of sands along the coast, wide in the north and narrow in the south, eventually disappearing altogether in the Transkei.

(ii) In the south, the belt is discontinuous because rivers entering the sea have removed the sand to expose the underlying rock

(iii) Red **Clansthal** and grey **Fernwood** sands, both deep, are the dominant soils. In a given locality, one may be present more or less to the exclusion of the other. Kaolinite and montmorillonite are the dominant clay minerals.

Climate

(i) Summers are hot and the winters mild and frost-free

(ii) Except in the north, the mean annual rainfall is 1 020 to 1 340 mm, and is highest at Port Durnford (1 340 mm) and St Lucia estuary (1 270 mm). A line running from Nyalazi railway station northwards between False Bay and Lake St Lucia, roughly separates the moist part of this system which lies along the coast, from the drier inland part.

Soils

(i) A sandstone was formed in beach deposits left behind after the sea level dropped during recent geological times

(ii) The immediate weathering product of this sandstone is a red sandy clay loam (**Shorrocks** series), occasionally a blocky sandy clay (**Glendale** series)

(iii) Further development in this red loam has given rise either to deep, red sands (**Clansthal** series) due to leaching out of the clay, or to deep, grey sands (**Fernwood** series) in situations where very slight wetness occurs. Thin horizontally-bedded sheets of red loamy soil, known as lamellae, are common in these soil series; in a profile they appear as thin horizontal bands

(iv) Where the grey **Fernwood** type sand is shallow, the red sandy clay loam subsoil is known as **Shepstone** series

(v) When the **Shepstone** series is subjected to marked wetness as it is near Penecuik in Zululand, then the red subsoil either becomes a mottled dark grey sandy clay (**Kroonstad** series), or a layer of iron concretions and mottles develop (**Waaisand** series)

(vi) In vleis where conditions are very wet, mottled grey sands, often with dark grey sandy topsoils (**Warrington** series) occur.

(vii) In swampy conditions, found mainly in parts of Zululand, very acid peats (**Mposa** series) are sometimes found.

Agriculture

(i) The deeper sands (mainly **Fernwood** and **Clansthal**) do not always produce good crops. This may be due in part to the effects of nematodes which damage cane roots

(ii) Nutrients, particularly nitrogen, are easily leached out of the root zone.

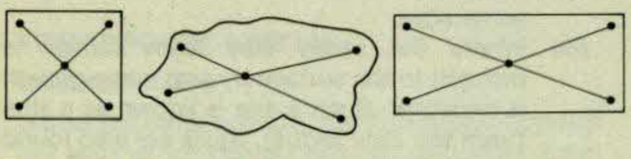
(iii) Aluminium is present in toxic amounts at some sites

(iv) Where the sandy clay loam subsoil is brought to the surface by ants, cane growth is excellent. Such a site is known as a stuli (from the Zulu *isiduli*). Stulis are also found in other kinds of sandy soils.

APPENDIX 3: NOTES ON DESCRIBING SOIL PROPERTIES

Because soils tend to vary within a field, it is important to ensure that a pit is correctly sited so that it represents the predominant soil type. The following points should be noted when siting a pit:

i) as a general rule of thumb, one pit to every 4 hectares
ii) depth of pit should be about 1,2m or to the weathering rock or impervious layer
iii) in small fields (less than 10 hectares) site pits towards the centre
iv) in large fields (more than 10 hectares) on flat ground good coverage may be obtained by siting the pits along the diagonals across the field as illustrated in the following examples:



v) pits should not be sited in areas where isidulis (antheaps), rock outcrops, or old roads are found
vi) if two or more soil parent materials occur in a field (usually indicated by change in topsoil colour) separate pits should be sited in each parent material
vii) on slopes greater than 15%, pits should be sited in the crest, midslope and bottomland positions in the landscape.

Properties used to describe soil

The important properties used to describe a particular horizon include:

Colour

The most important colours are black, dark grey, light grey, red, yellow, brown and blue. When describing the colour of a horizon it is important to state whether it has a single, uniform colour or whether it is variegated or mottled.

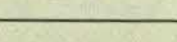
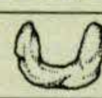
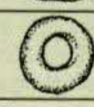
- black and dark colours signify either the presence of organic matter or darkly coloured clay particles
- light greys and bleached colours indicate strongly eluviated horizons
- red and brown colours indicate well aerated and well drained conditions, and are usually found in upland positions. The colour usually comes from the soil particles being coated with iron and aluminium oxides.
- yellow and yellow-brown colours indicate slightly less well drained, shallower profiles or dystrophic conditions. The colour usually comes from the soil particles being coated with hydrated iron and aluminium oxides
- grey and blue-grey colours are associated mainly with poorly drained bottomlands, strong reduction reactions and waterlogging
- mottled colours usually indicate anaerobic or waterlogged conditions with strong reduction of iron and aluminium oxide except along the root runs and air passages
- variegated colours usually indicate the presence of clayskins, individual aggregates of soil or recent weathering (soil and weathering rock)
- uniform colours indicate conditions that have persisted for a long time.

Texture

The texture of a soil is determined by the relative proportions of sand, silt and clay with the grade of sand also being used as a criterion. For example, there are such textural classes as sands, loamy sands, sandy loams, loams, sandy clay loams, clay loams and clays. Some idea of the textural class can be determined in the field by taking a handful of **moist** soil, kneading and rolling it between the palms of the hands to form a 'spindle' or 'sausage';

- if no 'sausage' can be rolled, the soil is sandy (less than 10% clay)
- if a 'sausage' can just be formed but it cracks upon bending, it is a loamy sand (10 to 15% clay)
- if it will bend a little, it is a sandy loam (15 to 20% clay)
- if it will bend readily before cracking, it is a sandy clay loam (20 to 25% clay)
- if it will bend around nearly into a circle, it is a sandy clay (35 to 55% clay)
- if it will bend into a circle it is a clay soil (more than 55% clay).

The following table illustrates this relationship:

NO 'SAUSAGE'	SAND
	LOAMY SAND
	SANDY LOAM
	SANDY CLAY LOAM
	SANDY CLAY
	CLAY

Structure

This refers to the natural aggregation of primary soil particles into compound units or peds which are separated from one another by planes or surfaces of weakness. Cohesion within peds is greater than adhesion between them.

The structured particles are categorised according to their nature (degree, size and shape), ie

Type : prismatic, columnar, blocky, angular, granular, crumb
Size : fine, medium, coarse
Degree: structureless, weak, moderate, strong

For the majority of purposes, structured soils can be regarded as having either a **blocky** or a **prismatic** structure. The blocks may vary in size from a few millimetres to 40 or 50 mm in cross-section. Prisms are normally 30 to 60 mm across and at least 100 mm long. A **strong structure** is one with spaces between clearly defined peds (blocks or prisms); in a **weakly structured** material, it is difficult to see boundaries between peds. Prismatic structures are usually strong.

Consistency

This term is used to describe the physical state of a soil in relation to how it changes with moisture content and its effect on mechanical cultivation in particular. As the moisture content changes from very dry to very wet, the following descriptive terms may be used for different conditions:

Moisture status		
Very dry ↓	—	harsh, hard, cloddy, powdery
	—	firm
	—	friable, soft
	—	plastic
Very wet	—	sticky or saturated

Both the texture and structure have a marked effect on soil consistency; sands need only little water to become soft, friable and easily worked, while clays need more. Strongly structured soils have to be worked when their moisture contents lie between close limits. They are frequently either too firm or too plastic or sticky for cultivation.

Slickensides

These are polished or grooved surfaces within the soil resulting from its movement and occurring in clay materials. Alternate shrinking and swelling caused by differences in moisture content result in polished faces being formed.

APPENDIX 4: INTERPRETING THE RATING OF SOIL PROPERTIES

The physical and chemical characteristics of the various soil series in each soil form have been rated in the following way:

PHYSICAL CHARACTERISTICS

Available moisture capacity (AMC)

Five ranges of available moisture capacity have been chosen:

very high	: more than 180 mm/m	: More than 55%
high	: 140 to 180 mm/m	: 35 to 55%
moderate	: 100 to 140 mm/m	: 15 to 35%
low	: 80 to 100 mm/m	: 6 to 15%
very low	: less than 80 mm/m	: less than 6%

These AMC values correspond only approximately with the clay percentages shown above.

Intake rate

Also known as the infiltration capacity. The rate will vary between and within forms. Three ranges have been chosen:

good	— more than 13 mm/h
medium	— 6 to 13 mm/h
poor	— less than 6 mm/h

Drainage

This term describes the ease with which water moves through the soil profile and is also referred to as internal drainage or permeability. Five categories of drainage have been chosen:

Category	Rate of water movement (m/day)
very good —	more than 0,60
good —	0,30 to 0,60
moderate —	0,15 to 0,30
poor —	0,05 to 0,15
very poor —	less than 0,05

Accurate information on internal drainage is not available for the majority of soil forms and the limits for the above ranges are tentative.

Erosion hazard

Includes potential soil loss through rainfall and wind erosion. The ratings vary from very low to very high and are largely related to soil texture and organic matter content. Soil depth has an important effect on soil erodibility. The deeper the soil the less severe erosion is likely to be.

Tillage constraints

The constraints range from slight to severe and the actual rating is determined by one or more of the following soil factors:

i) **cloddy consistency (c):** soils in this category tend to be very slippery when wet and hard and cloddy when dry making it extremely difficult to get a good tilth

ii) **crusting and capping hazard (p):** soils that crust tend to be soft to slightly plastic when wet and cemented when dry

iii) **compaction hazard (co):** applies to soils that are prone to physical damage (puddling and smearing) by infield traffic under wet conditions

iv) **machine wear (w):** refers to wear caused by abrasion in sandy soils

v) **sub-surface hindrance (t):** refers mainly to shallow soils on hard rock or ouklip.

CHEMICAL CHARACTERISTICS

Soil pH: unless otherwise indicated all pH values are measured in water.

Base status: refers to the sum of the exchangeable cations or bases in a soil (ie calcium, magnesium, potassium and sodium). Depending on the degree of leaching soils may be rated as having low, moderate or high base status as follows:

Base status	Degree of leaching	Sum of bases (me/100 g clay)
low	marked (dystrophic)	less than 5
moderate	moderate (mesotrophic)	5 to 15
high	negligible (eutrophic)	more than 15

Aluminium toxicity hazard: refers to the harmful effect on cane growth due to toxic levels of exchangeable aluminium in acid soils (pH below 5,3). The ratings and interpretations are as follows:

Rating	Interpretation
absent	: not a problem
slight	: unlikely to be a problem
moderate	: toxic levels of aluminium may be present; submit soil samples to the Fertilizer Advisory Service
severe	: strong likelihood of aluminium toxicity which will require amelioration with lime; submit soil samples to the Fertilizer Advisory Service

P-fixation: refers to the process by which soluble phosphorus fertilizers are converted into forms which are less available to plants. The ranges of the various ratings and corresponding phosphate desorption index (PDI) values are:

Rating	PDI	
low	: above 0,40	no supplementary phosphorus fertilizer is necessary
moderate	: 0,20 to 0,40	as soil phosphorus fixing capacity increases from moderate to very high, the need for supplementary broadcast phosphorus fertilizer application increases. Submit soil samples to the Fertilizer Advisory Service for checking.
high	: 0,10 to 0,20	
very high	: below 0,10	

Salinity/sodicity hazard:

- **Salinity ratings:** sugarcane growth is affected when the electrical conductivity (EC) from the saturation extract exceeds 200 mS/m. The salinity ratings are:

Rating	EC (mS/m)	Effect on cane growth
nil/absent	less than 200	none
low	200 to 400	slight
moderate	400 to 600	marked
severe	more than 600	serious

- **Sodicity ratings:** a high sodium level in a soil has an adverse effect on its physical properties such as structure and internal drainage. The mean sodium adsorption ratio (SAR) value from the saturation extract is used as the index of sodicity. Soil forms vary in their sensitivity to sodium and are therefore assigned different critical SAR values. The sodicity ratings and corresponding SAR values are:

N mineralisation: substantial differences exist between soil forms and soil series in the amounts of nitrogen that are mineralized. Soils have been broadly grouped into the following categories:

N mineralising capacity	mineral N release* (kg/ha)
low	less than 70
medium	70 to 140
high	more than 140

* based on a standard incubation period of two weeks

K reserves: marked differences occur between soil forms in their capacity to supply potassium to growing plants in both the exchangeable and non-exchangeable forms. Soils have been classified into low, moderate or high potassium supplying power.

Zinc reserves: these are rated as low, moderate or high. In general, the light textured soil series and soil series with humic A horizons contain low reserves of zinc.

Rating	Grey soils restricted drainage	Black clays slow to moderate drainage	Red and brown soils free drainage
Slight Moderate Severe	SAR less than 4 4 to 6 more than 6	SAR less than 6 6 to 10 more than 10	SAR less than 10 10 to 15 more than 15
Representative soil forms	Estcourt Kroonstad Sterkspruit Katspruit Longlands Westleigh Swartland	Arcadia Bonheim Mayo Tambankulu Milkwood Champagne Rensburg Willowbrook Inhoek	Shortlands Hutton Inanda Kranskop Nomanci Magwa Griffin Clovelly

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Capping
See crust.
Cartref form and series, 63
Catena
A sequence of soils of about the same age derived from similar parent material and occurring under similar climatic conditions but having different characteristics due to variation in relief and drainage.
Cation exchange capacity (CEC)
The total exchangeable cations that a soil or clay can adsorb.
Cations
Positively charged ions.
Cemented
Having a hard, brittle consistency because the soil particles are held together by cementing substances such as humus, calcium carbonate, or oxides of silicon, iron and aluminium. The hardness and brittleness persist even when wet.
Champagne form and series, 41
Chinyika series, 55
Chlorite, 99
Non-swelling clay mineral usually confined to acid soils.
Clansthal series, 83
Clay
Soil separate consisting of particles less than 0,002 mm in diameter.
Clay minerals
Naturally occurring crystalline compounds of iron, aluminium and silicon less than 0,002 mm in diameter.
Claypan
A horizon or layer that is considerably less permeable and more clayey than the material overlying it.
Clay soil
Soil with more than 40% clay.
Cleveland series, 87
Clovelly form and series, 85
Coarse sand
A soil separate consisting of particles 0,5 to 2,0 mm in diameter.
Coast lowlands, 99, *11-15*
Rolling terrain less than 300 m above sea level.
Colluvium
A deposit of transported soil and/or rock fragments accumulated at the base of steep slopes.
Colour, soil, 102
The colour of a soil reflects its characteristics, e.g. black and dark colours signify the presence of organic matter; red and brown soils are well aerated and well drained; mottled colours indicate anaerobic or waterlogged conditions.
Compaction
Increasing soil bulk density and decreasing porosity due to the application of mechanical forces to the soil.
Concretion
A local concentration of a chemical compound in the soil, such as calcium carbonate or iron oxide, in the form of a grain or nodule of varying size, shape, hardness and colour.
Coniston series, 57
Conservation
Practices designed to prevent soil erosion by reducing runoff and increasing the amount of water available to plants.
Consistency, 103
The degree of cohesion or adhesion within the soil mass.
Cromley series, 57
Crust
A surface layer of soil, up to 25 mm thick, which is much more compact, hard and brittle when dry, than the material immediately beneath it.
Cuba series, 51
The Swaziland classification for the Glengazi series.
Cultivation
A tillage operation used in preparing land for planting or later for weed control and for loosening the soil.
Cutans
Humus and clay which is washed into the soil and forms skins or coatings on the surfaces of peds or individual particles (sand grains, stones).

D

Dansland series, 47
Deflocculation
The breakdown of soil aggregates (granules, crumbs, etc) into their individual clay, silt and sand components.
Delcor series, 89
The Swaziland classification for the Bezuidenhout series.
Denhere series, 85
Denitrification
The biochemical reduction of nitrate or nitrite to gaseous nitrogen.
Dolomitic lime
See lime.
Doveton series, 83
Drydale series, 57
Dundee form and series, 97
Duplex soils
Soils with a relatively permeable topsoil (sand or sandy loam) abruptly overlying a very slowly permeable subsoil (heavy clay).
Dystrophic soil, 104
A soil that has undergone marked leaching.

E

E horizon, 22-24
A bleached subsoil horizon found beneath the A horizon resulting from the removal of clay and organic matter by a watertable (see subsoil diagnostic horizons).
Eensaam series, 43
Electrical conductivity (EC), 105
Conductivity expressed in millisiemens/m (mS/m) is a measure of the concentrations of salt in soil solutions and irrigation water.
Elim series, 71
Eluviation
The removal of soil in suspension (or in solution) from a part of or from the whole of the soil profile.
Emfuleni series, 55

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A

A horizon 7, *21-23*
A topsoil horizon consisting largely of mineral particles mixed with variable amounts of organic matter (see topsoil diagnostic horizons).

Acid soil
Soil with pH lower than 7.

Achterdam series, 61

Aeration of soil
The process by which air in the soil is replaced by air from the atmosphere.

Aerobic
Describes an organism or life process that utilises, or can only exist in the presence of oxygen.

Air-dry soil
The state of dryness of a soil at equilibrium with the moisture content of the surrounding atmosphere.

Albany series, 75

Alkaline soil
Soil with pH higher than 7.

Allophane
A series of naturally occurring amorphous minerals which are hydrous aluminium silicates of widely varying chemical composition.

Alluvium
Unconsolidated materials deposited by running water in close proximity to streams and rivers.

Aluminium toxicity, 103
Below pH 5,3 (water) in many soils, exchangeable aluminium occurs in quantities sufficient to harm plant growth.

Amendment (ameliorant), soil
Any substance used to alter the properties of soil to make it more suitable for plant growth. Examples are gypsum, lime, fertilizers.

Ammonification
The biochemical process whereby ammoniacal nitrogen is released from nitrogen-containing organic compounds in the soil.

Amorphous compounds, 99
Noncrystalline compounds of aluminium, silicon and iron, which are highly reactive and thought to be largely responsible for P-fixation, aluminium toxicity and for the fact that large amounts of lime are needed to alter the pH of soils in which they occur.

Anaerobic
Describes an organism or life process that does not utilize, or cannot exist in the presence of oxygen.

Anion exchange capacity (AEC)
The total exchangeable anions that a soil or clay can adsorb.

Anions
Negatively charged ions.

Apedal, 25
Having a weak structure or structureless.

Arcadia form and series, 43

Argent series, 81

Arniston series, 67

Arrochar series, 63

Available moisture capacity (AMC), 104
That part of the water held by a soil which can be absorbed by plant roots.

Available nutrient
That quantity of a nutrient element or compound in the soil that can be readily used by growing plants.

Avalon form and series, 89

Avoca series, 77

B

B horizon 7, *21-23*
A subsoil horizon lying between the A and C horizons, showing maximum accumulation of mineral matter, ie clay, iron and aluminium oxides (see subsoil diagnostic horizons).

Balgowan series, 85

Balmoral series, 83

Base saturation percentage
The extent to which the colloids in a soil are saturated with exchangeable cations (bases) other than hydrogen.

Base status, 104
The proportion of exchangeable cations (bases), Ca, Mg, K and Na in a soil.

Berea soil system, 100 - 101, *11-15*

Betusile series, 97
The Swaziland classification for the Dundee series.

Bezuidenhout series, 89

Bitou series, 93

Bleached horizon
Highly leached, whitish in colour (see E horizon).

Bluebank series, 77

Bonheim form and series, 51

Broekspruit series, 65

Buffer capacity
The capacity of a soil to resist an induced change in pH.

Bulk density, soil
The mass of dry soil per unit volume.

Burnside series, 87

Bushbaby series, 97
The Swaziland classification for the Dundee series.

C

C horizon 7, *21-23*
Mineral horizon of unweathered rock.

Calcareous soil, 100
Soil containing sufficient free calcium carbonate or calcium — magnesium carbonate to effervesce visibly when treated with dilute acid.

Calcium
The threshold for calcium in soils is 150 ppm (340 kg/ha) except in sandy soils (less than 15% clay), where it is 100 ppm (225 kg/ha) (see lime).

Calcrete
See hardpan.

Canterbury series, 51
The Swaziland classification for the Bonheim series.

Capillary zone or fringe
The zone above a watertable in which water is held by capillary force.

Capping
See crust.
Cartref form and series, 63
Catena
A sequence of soils of about the same age derived from similar parent material and occurring under similar climatic conditions but having different characteristics due to variation in relief and drainage.
Cation exchange capacity (CEC)
The total exchangeable cations that a soil or clay can adsorb.
Cations
Positively charged ions.
Cemented
Having a hard, brittle consistency because the soil particles are held together by cementing substances such as humus, calcium carbonate, or oxides of silicon, iron and aluminium. The hardness and brittleness persist even when wet.
Champagne form and series, 41
Chinyika series, 55
Chlorite, 99
Non-swelling clay mineral usually confined to acid soils.
Clansthal series, 83
Clay
Soil separate consisting of particles less than 0,002 mm in diameter.
Clay minerals
Naturally occurring crystalline compounds of iron, aluminium and silicon less than 0,002 mm in diameter.
Claypan
A horizon or layer that is considerably less permeable and more clayey than the material overlying it.
Clay soil
Soil with more than 40% clay.
Cleveland series, 87
Clovelly form and series, 85
Coarse sand
A soil separate consisting of particles 0,5 to 2,0 mm in diameter.
Coast lowlands, 99, *11-15*
Rolling terrain less than 300 m above sea level.
Colluvium
A deposit of transported soil and/or rock fragments accumulated at the base of steep slopes.
Colour, soil, 102
The colour of a soil reflects its characteristics, e.g. black and dark colours signify the presence of organic matter; red and brown soils are well aerated and well drained; mottled colours indicate anaerobic or waterlogged conditions.
Compaction
Increasing soil bulk density and decreasing porosity due to the application of mechanical forces to the soil.
Concretion
A local concentration of a chemical compound in the soil, such as calcium carbonate or iron oxide, in the form of a grain or nodule of varying size, shape, hardness and colour.
Coniston series, 57
Conservation
Practices designed to prevent soil erosion by reducing runoff and increasing the amount of water available to plants.
Consistency, 103
The degree of cohesion or adhesion within the soil mass.
Cromley series, 57
Crust
A surface layer of soil, up to 25 mm thick, which is much more compact, hard and brittle when dry, than the material immediately beneath it.
Cuba series, 51
The Swaziland classification for the Glengazi series.
Cultivation
A tillage operation used in preparing land for planting or later for weed control and for loosening the soil.
Cutans
Humus and clay which is washed into the soil and forms skins or coatings on the surfaces of peds or individual particles (sand grains, stones).

D

Dansland series, 47
Deflocculation
The breakdown of soil aggregates (granules, crumbs, etc) into their individual clay, silt and sand components.
Delcor series, 89
The Swaziland classification for the Bezuidenhout series.
Denhere series, 85
Denitrification
The biochemical reduction of nitrate or nitrite to gaseous nitrogen.
Dolomitic lime
See lime.
Doveton series, 83
Drydale series, 57
Dundee form and series, 97
Duplex soils
Soils with a relatively permeable topsoil (sand or sandy loam) abruptly overlying a very slowly permeable subsoil (heavy clay).
Dystrophic soil, 104
A soil that has undergone marked leaching.

E

E horizon, 22-24
A bleached subsoil horizon found beneath the A horizon resulting from the removal of clay and organic matter by a watertable (see subsoil diagnostic horizons).
Eensaam series, 43
Electrical conductivity (EC), 105
Conductivity expressed in millisiemens/m (mS/m) is a measure of the concentrations of salt in soil solutions and irrigation water.
Elim series, 71
Eluviation
The removal of soil in suspension (or in solution) from a part of or from the whole of the soil profile.
Emfuleni series, 55

Erosion, 104
The wearing away of the land surface by running water, wind, ice or other geological agents.
Estcourt form and series, 71
Eutrophic soil, 104
A soil that has undergone little or no leaching.

F

Farmhill series, 87
Farningham series, 83
Fenfield series, 53
Fernwood form and series, 95
Ferralitic soils, 99
See latosols.
Ferricrete
See hardpan.
Fertility, soil
The status of a soil with respect to its ability to supply the nutrients essential for plant growth.
Fertilizer requirement
The quantity of certain plant nutrient elements needed, in addition to the amount supplied by the soil to increase plant growth to an optimum level.
Field capacity
The water content of a freely draining soil that has been saturated with water in the field and allowed to drain for 2 to 3 days.
Fine sand
A soil separate consisting of particles 0,02 to 0,2 mm in diameter.
Fixation
The process of converting an element in the soil from a readily available to a less available form.
Form, soil, 3
A soil form consists of a number of soil series which, although not identical, have a general similarity.
Fountainhill series, 35
Frazer series, 39
Friable
Soils that easily crumble.

G

G horizon, 25
A subsoil horizon of bluish or greyish material that has developed due to prolonged waterlogging (see subsoil diagnostic horizons).
Geological (parent) materials, 98
See Appendix 1.
Glendale series, 81
Glengazi series, 51
Glenrosa form and series, 61
Gley
A soil developed under conditions of poor drainage.
Gleycutanic B horizon, 25
Graaffwater series, 69
Gravel
Consists of rock fragments each more than 2 mm and less than about 7,5 mm in diameter.
Graythorne series, 47
Griffin form and series, 87
Grovedale series, 63

H

Habelo series, 77
The Swaziland classification for the Mkambati series.
Hardpan
A hardened soil layer in the lower A or B horizon, which may be caused by the cementation of soil particles with organic matter or materials such as silica, sesquioxides (mainly iron oxides), or calcium carbonate.
Hartbees series, 69
Highflats series, 91
Horizon, soil, 21-23
A horizon is a layer of soil bounded by air, hard rock or by soil material that has different characteristics (see master horizons).
Humic A horizon, 24
A diagnostic topsoil horizon rich in organic matter (more than 4%) and more than 450 mm thick.
Hutton form and series, 83
Hydraulic conductivity, 104
A measure of the rate of flow of water through the soil.
Hydromorphic soils, 41, 45, 53, 55, 69, 71, 73, 75, 77, 79
Soils with features (gleying, mottling, concretionary horizons) resulting from the presence of permanent or intermittent watertables.

I

Illite, 99
A mixture of mica and its weathering product vermiculite.
Illuviation
Deposition of soil material removed by percolating water from one part of the soil profile to another; usually from an upper to a lower horizon.
Inanda form and series, 35
Induration
A brittle, hard consistency caused by cementing substances other than quartz and crystalline alumina-silicates.
Infiltration, 104
The entry of water into the soil.
Inhoek form and series, 57
Ironpan
See hardpan.
Isiduli, 101
Ivanhoe series, 41

J

Joubertina series, 83
Jozini series, 91

K

Kaolinite, 99
A non-swelling clay mineral with a 1:1 crystal structure.
Kanhym series, 89
Katarra series, 77
Katspruit form and series, 79
Killarney series, 79
Kiora series, 51

Kipipiri series, 37
Koedoesvlei series, 91
Komatipoort soil system, 100, *9-13*
Kosi series, 73
Kranskop form and series, 37
Kroonstad form and series, 77
Kusasa series, 63
Kwezi series, 43
The Swaziland classification for the Arcadia series.

L

Lateritic weathering
The process of soil formation which, in freely drained conditions, results in a loss of Ca, Mg, K, Na and silica and a relative accumulation of sesquioxides.
Latosols, 99
Soils that have reached an advanced stage of lateritic weathering.
Langebaan series, 95
Lamellae, clay, 26
Thin horizontal bands of clay found in Recent Sands.
Leaching
The removal of materials in solution from a part of or from the whole of the soil profile.
Leeufontein series, 91
Levubu series, 91
Lime
Calcium carbonate ($CaCO_3$) is often termed 'agricultural' or 'calcitic' lime to distinguish it from dolomitic lime.
Lime requirement
The amount of agricultural lime or the equivalent of other specified liming materials, required to raise the pH of the soil to a specified value under field conditions.
Limpopo series, 91
Lindley series, 67
Lithosols, 59
Shallow soils, often with weakly expressed morphology.
Lithocutanic B horizon, 26
Longlands form and series, 75
Loshoek series, 53
Lowveld, 100
Dry areas below 460 m elevation in Zululand, Swaziland and the Eastern Transvaal.
Lusiki series, 33

M

Magnesium
The critical or threshold value in the soil is 25 ppm Mg (60 kg/ha).
Magwa form and series, 39
Makatini series, 83
Malakata series, 65
Malkerns series, 83
The Swaziland classification for the Doveton series.
Maputa series, 95
Masala series, 53
Master horizons, 22
Mayo form and series, 49
Medium sand
A soil separate consisting of particles 0,2 to 0,5 mm in diameter.
Melanic A horizon, 24
me%
Concentration of a cation expressed in milligram equivalents per 100 grams.
Mesotrophic soil, 104
A soil that has undergone moderate leaching.
Midlands, 99, *12-15*
Undulating, and in places rolling terrain, inland from the coast and 300 to 1 200 metres above sea level.
Milford series, 39
Milkwood form and series, 47
Mineralisation
The conversion of an element from an organic form to an inorganic form as a result of microbial decomposition.
Minimum tillage
The minimum amount of soil disturbance necessary for crop production.
Mispah form and series, 59
Mistbelt, 99
Most of the Nottingham system and parts of the midlands division of the Umzinto system.
Mkambati series, 77
Montmorillonite, 100
A swelling clay mineral with a 2:1 crystal structure.
Mottling
Spots or blotches of different colour or shades of colour interspersed with the dominant colour in a soil profile.
Mposa series, 41
Msinga series, 83
Msinsini series, 49
Muden series, 59

N

Nelspruit soil system, 100, *9*
Nematicides
Chemicals which are used to control plant feeding nematodes.
Nematodes
Plant parasitic nematodes are worm-shaped animals ranging in size from 0,5 mm to over 5 mm in length.
Neocutanic B horizon, 25
Ngubane
See hardpan.
Nitrogen mineralisation, 104-105
The biochemical conversion of organic nitrogen to ammoniacal or nitrate nitrogen.
Nomanci form and series, 33
Nottingham soil system, 99, *12-15*
Nyoka series, 65

O

Oakleaf form and series, 91
Oatsdale series, 85
Organic matter, soil
The organic fraction of the soil.
Organic O horizon, 24
Orthic A horizon, 24

Ouklip
See hardpan.
Oxisols, 99
See latosols.

P

Pafuri series, 49
Parent material, 5-6, *16-20*
The unconsolidated, more or less chemically weathered material (mineral or organic matter) from which the soil is developed.
Peat, 24
Unconsolidated soil material consisting largely of non-or slightly decomposed organic matter accumulated under conditions of excessive moisture.
Ped, 102
A unit of soil structure such as an aggregate, crumb, prism, block or granule formed by natural processes.
Pedal
Having strong, or moderate to strong structure.
Pedocutanic B horizon, 26
Permeability, soil, 104
The ease with which gases, or more usually liquids penetrate or pass through a soil horizon.
pH, soil, 104
The degree of acidity or alkalinity of a soil.
Phoenix series, 45
Phosphate fixation, 104
The process whereby readily soluble phosphorus compounds, when added to the soil, are changed to less soluble forms not readily available to the plant.
Phosphorus
The critical or threshold value of P in the soil is 31 ppm plant cane and 11 ppm for ratoon cane in all but the midlands cane areas, especially the latosols in the Nottingham system.
Platt series, 61
Plinthite, 24
An iron accumulation in soil due to a watertable. It may be hard (ouklip) or soft.
Pore space
Total space not occupied by soil particles in a volume of soil.
Porosity
The percentage of the soil volume not occupied by solid particles.
Portobello series, 93
Potassium
The critical or threshold value of K in soils with a clay content of 30% and less is 112 ppm, while 150 ppm is the value for soils with a clay content greater than 30%.
Potassium reserves, 105
The capacity of the soil to supply potassium to growing plants forms both exchangeable and non-exchangeable forms.
ppm
Parts per million.
Prismacutanic B horizon, 26
Prismatic, 102
See structure.
Profile, soil, 7, *21*
A vertical section of the soil through all its horizons and extending into the parent material.

Q

Quartz
Inert crystalline silica (SiO_2).

R

Rasheni series, 51
The same series name is used in the Swaziland classification system.
Rathbone series, 81
The Swaziland classification for the Glendale series.
Regic sanαs, 26
Young sands that are chiefly, though not exclusively of aeolian origin (deposited by wind).
Rensburg form and series, 45
Rietvlei series, 73
River valleys, 100, *11-15*
Robberg series, 93
Robmore series, 61
Rondspring series, 81
The Swaziland classification for the Glendale series.
Rooidraai series, 43
Rosehill series, 65
Rosemead series, 71
Ruston series, 89
Rydalvale series, 43

S

Saintfaiths series, 61
Saline-sodic soil (Witbrak), 105
A soil with a high soluble salt content in which sodium is the dominant exchangeable cation, pH is less than 8,5.
Saline soil (Witbrak), 105
A soil with a high soluble salt content in which calcium and magnesium are dominant and sodium is not a major constituent, pH is less than 8,5.
Sand
A soil separate consisting of particles 0,02 to 2,0 mm in diameter.
Sandspruit series, 85
Sandveld series, 95
Saprolite
Weathering rock at various stages of decomposition.
Sarasdale series, 55
Saturated paste, 105
A mixture of soil and water such that all the voids between the soil particles are filled with water while at the same time there is no accumulation of free water on the surface.
Saturation extract, 105
The solution which is extracted under suction from a saturated paste.
Sediment
Deposited material varying from hard rock to recent unconsolidated material.
Self-mulching, soil, 24
A process of swelling and shrinking due to alternate wetting and drying which gives rise to a surface layer of well aggregated granules or fine blocks that do not crust or seal.

Series, soil, 3, 4, 8, 21, 28
The soil series is the basic unit of soil classification and may be likened to the species in botanical or zoological classifications.
Sesquioxide
A binary compound of a metal and oxygen in the proportion of 2 to 3 as in Al_2O_3 (aluminium oxide) or Fe_2O_3 (ferric oxide).
Sezela series, 91
Sheppardvale series, 67
Shepstone form and series, 93
Shorrocks series, 83
Shortlands form and series, 81
Sibasa series, 73
Silcrete
See hardpan.
Silica
Silicon dioxide (SiO_2). See clay minerals and quartz.
Silt
A soil separate consisting of particles 0,002 to 0,02 mm in diameter.
Slickensides, 24, *103*
Skilderkrans series, 65
Sodic soil (Swartbrak), 105
A soil with a low salt content but, unlike other soils, the ratio of sodium to other cations (ie SAR) is harmfully high; pH is more than 8,5 and soil structure is very poor.
Sodicity status, soil, 105
The mean SAR value of the soil saturation extract is used as an index of sodicity for soil depths from 0 to 0,3 m and 0,3 to 0,6 m separately.
Critical value SAR 6 — refers to poorly drained, highly dispersed grey soils.
Critical value SAR 10 — refers to slowly draining black swelling clays.
Critical value SAR 15 — refers mainly to well drained non-dispersive soils.
Sodium adsorption ratio (SAR), 105
A measure of the quality of salts in solution (e.g. in a soil saturation extract, or in irrigation water) and depends on the sodium content relative to the calcium plus magnesium content.
Soluble salts
Sodium salts, particularly sodium chloride, are the most common soluble salts.
Somerling series, 49
The Swaziland classification for the Tshipise series.
Springfield series, 85
Sprinz series, 35
Stanger series, 51
Stegi series, 49
The Swaziland classification for the Mayo series.
Sterkspruit form and series, 69
Stratford series, 41
Structure, soil, 102
The natural aggregation of primary soil particles into secondary units or peds.
S-value
The sum of the exchangeable bases, i.e. Ca, Mg, Na and K, expressed in milliequivalent/100 g soil (me%).
Subsoil diagnostic horizons, 24-26
Sunday series, 47
Sulphur
The critical or threshold value of extractable S is 15 ppm in the soil.
Sunvalley series, 81
Swartland form and series, 65
Swaziland soil series
Reference is made to the following series: Betusile, Bushbaby, Canterbury, Cuba, Delcor, Habelo, Kwezi, Malkerns, Rasheni, Rathbone, Rondspring, Somerling, Stegi, Tambankulu, Valumgwaco, Vimy, Winn, Youngsvlei and Zwide.
Swelling clays
Clay minerals such as montmorillonite which swell when wetted and shrink and crack when dried.
System, soil, 99-101, *9-15*
Refers to land which has a distinctive pattern.

T

Tambankulu form and series, 53
The same series name is used in the Swaziland classification system.
Texture, soil, 102
The relative proportions of sand, silt and clay in the soil.
Threshold value (critical value)
The minimum level of each nutrient that soils should contain to ensure that a deficiency does not exist.
Tillage, 104
Tilth
The physical condition of soil in relation to its suitability for crop production.
Tongues
In some soils, clay and organic matter leached from the topsoil are deposited in the subsoil as tongues darker in colour than the material into which they have been moved. See lithocutanic.
Toposequence
A sequence of related soils that differ from one to another, primarily because of topography as a soil formation factor.
Tops, cane
The burnt or singed cane tops which are commonly left as a mulch on the soil surface after harvest.
Topsoil diagnostic horizons, 24
Total available moisture capacity (TAM)
The capacity (expressed in mm water) of a soil to store water for use by the crop.
Trafalgar series, 95
Trash, cane
Dry leaves and sheaths of green cane commonly left as a mulch on the soil surface after harvest.
Trevanian series, 61
Tshipise series, 49

U

Uitvlugt series, 71
Umbumbulu series, 37
Umzinto soil system, 99, *11-15*

V

Vaalsand series, 75
Valsrivier form and series, 67
Valumgwaco series, 51
The Swaziland classification for the Bonheim series.
Vermiculite
A swelling clay with a 2:1 crystal structure.
Vertic A horizon, 24
Vimy series, 83
The Swaziland classification for the Rasheni and Bonheim series.

W

Waaisand series, 75
Waldene series, 75
Warrington series, 95
Water percentage
The water held by a soil, expressed as a percentage of the dry mass of soil.
Water quality, 105
See Sodium Adsorption Ratio (quality of salts) and electrical conductivity (quantity of salts).
Watertable
Free-standing water in the soil profile.
Waterval series, 67
Weathering
All physical and chemical changes produced in rocks at or near the earth's surface by atmospheric agents.
Westleigh form and series, 73
Williamson series, 61
Willowbrook form and series, 55
Wilting point
The point in the range of soil water content below which the majority of plants wilt permanently.
Winn series, 83
The Swaziland classification for the Shorrocks series.
Witsand series, 73

Y

Youngsvlei series, 45
The Swaziland classification for the Rensburg series.

Z

Zinc, 105
The critical threshold value of Zn in sandy soils (less than 15% clay) is 0,5 ppm and 1,00 ppm in all other soils, unless more than 3 tons lime/ha is to be applied, when a value of 1,5 ppm Zn is used.
Zwide series, 69, 71
The Swaziland classification for the Estcourt and Sterkspruit series.

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i) 'Soils of the Sugar Belt' Report numbers 3, 4 and 5 of the Natal Regional Survey 1957, 1959 and 1962.

ii) 'Soil Series of the Natal Sugar Belt' published by the South African Sugar Association in 1970.

The following maps were used as a base for preparing the maps of soil systems:

Government Printer, Pretoria:
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