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Soil survey and Microsite assessment guidelines

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Sampling strategy

In a normal soil survey, a 150 - 200 m grid is used for large areas but for smaller farms such as small holders it may be necessary to adjust the sampling strategy to the terrain and environment encountered on the farm. **Table 1** is a suggested sampling intensity based on farm size.

Table 1: Relationship between farm size, observation intensity, distance between observations and are represented by one observation.

Farm size (ha)	Description	Observation intensity per ha	Distance between observations	Area represented by one observation (ha)
< 2	Very intensive/ Very detailed	1 – 4	50 - 100	0.25 – 1.00
2 – 5	Intensive/detailed	1 – 2	70 - 100	0.50 – 1.00
> 5 – 50	Intensive/detailed	0.44	150	2.25
50 - 500	Semi-detailed	0.10 - 0.25	200 - 300	4 - 10

Notes on sampling strategy

- A base map needs to be obtained preferably with Google Earth imagery at a scale of 1: 5 000 – 1: 10 000, together with the farm boundaries.
- The sampling strategy should be considered so that soil sampling points represent the major terrain types of the area.
- Locate observations to make them as representive as possible.
- Features such as wetlands, drainage lines, rocky areas that are obvious on the imagery need to drawn on the map before sampling starts as this will provide a framework for sensible sampling locations.
- Construct a grid on a base map. Adjust sample points to keep clear of obvious wetlands or man-made features such as houses etc

Augering procedure

1	Find an area at least 5 m away from a road, termite mound or disturbed area.
2	Before augering, clear the surface of vegetation i.e. grass, litter, leaves, branches etc. Keep away from tree roots by augering as far away as possible. If in a plantation auger between the rows.
3	Clear an area for laying the soil samples either with your foot or a small spade. For a hole 100 cm deep there will be about 10 piles of soil coming out of the auger depending on the soil type. **This should always be done in a straight line**. If one is close, laying the soil track, road or a footpath makes it easier to see the soil if there is dense undergrowth.
4	When the surface is clear turn the auger in a clockwise direction.
5	Because the surface often has small roots and/or a partially decomposed layer of vegetation for the FIRST sample it is better to half fill the auger bucket and empty.
6	Lay this sample at the top of the area cleared in (3) above.
7	Turn the auger until the bucket is overflowing but do not over-compact the sample in the bucket.
8	Empty the bucket by tamping the handle on the ground with the bucket about 50 cm above the ground so the soil falls neatly out of the TOP of the bucket**. DO NOT HIT THE BUCKET OF THE AUGER** to loosen the soil as it can be damaged.
9	Make sure that successive piles of soil are not contaminated by each other. Therefore, the emptying of the bucket must take place at right angles to the direction of the area cleared for the soil sample.
10	Mark with a stick when the soil piles reach 30, 60 & 90 cm so that the correct depths can be identified for each horizon.

Two soil profiles obtained using an auger. The one on the left has been laid on a mat, the one on the right on cleared ground adjacent to the auger hole

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Soil properties to measure and record

Soils can be classified in terms of a soil suitability classification and/or pedological classification. With respect to the soil suitability classification a revised system to the one currently being used is presented in **Table 2**. To assist in the assessment of soil suitability and in order for soil suitability to be checked, the full profile description should initially be recorded. For each depth increment (0 – 20; 20 – 50; 50 – 80 & 80 – 120 cm) the COLOUR, TEXTURE, GRAVEL CONTENT AND SOIL STRUCTURE, should be recorded. DEPTH & NATURE of LIMITING HORIZON should also be recorded. Then the checklist should be applied as before. Where a dark bar is indicated no entry should be made. Only grey

Table 2: A revised soil suitability worksheet

Observation number		**DATE**		**AREA/PLANTATION**	
Suitability classification		**Compartment**		**COMPANY**	MTP
Co-ordinate (X)		**Co-ordinate (Y)**			
SOIL DESCRIPTION					Limiting horizon
Soil depth (cm)	0 - 20	20 - 50	50 - 80	80 - 120	and depth (cm)
Colour					
Texture					
Structure					
Gravel (%)					
	Limitations and soil suitability class				
	None	**Slight/few**	**Moderate**	**Many**	**Severe**
Soil property	S1	S2	S3	S4	NS
Soil depth	> 120	80 - 120	50 - 80	20 - 50	< 20
Soil structure	Apedal/single grain	-	Moderate	Strong/massive	Very strong/cracking
(20 - 50 cm)					
Organic Carbon	Moderate/high	Low	Very low /no topsoil		n/a
content (topsoil)					
Soil texture (20 - 50 cm)	-	-	SL	S	
(Clay content %)	-	-	5 - 15	< 5	
Gravel content	< 10	10 - 25	25 - 50	50 - 75	75 - 100
(w hole soil depth)					
Waterlogging	-	-	Slight	Periodic	Permanent
Mottling	-	-	Slight	Distinct	Strong
(w ithin top 50 cm)					
COMMENTS					

boxes, where appropriate should be ticked. This was changed as some factors have less weighting than others. For example, the suitability classification has a heavy weighting on soil depth to limiting horizon. All other factors generally modify rather than override soil depth. A guide to the procedure is outlined in **Table 3**.

Gravel content is a difficult soil property to quantify particularly as it may vary within a soil profile. The suitability classification above can be used if gravel content is even throughout the profile but where it is not uniform throughout the profile the system outlined in **Figure 1** can be used where the whole soil depth is 120 cm. If a limiting horizon is present within 120 cm of the surface and gravel horizons exist above that, then the site suitability is reduced by one suitability category for each depth increment where gravel occurs. For example, if a soil has a depth to rock (the limiting horizon) of 80 cm it would be regarded as an S2. However, if the 50 – 80 cm depth has > 25% gravel in the soil matrix then the soil would be downgraded to S3.

Figure 1: A guide to establishing site suitability for soils with gravel horizons. A gravel horizon is defined as having more than 25% gravel. The red colour indicates soil present without gravel.

	Soil suitability							
	Depth (cm)	S1	S2	S3	S4	S3	S2	S3
Very shallow	0 - 20							
Shallow	20 - 50				GR	GR		GR
Moderately deep	50 - 80			GR	GR	GR	GR	
Deep	80 - 120		GR	GR	GR			
Very deep	> 120	GR	GR	GR	GR			

Table 3: A guide to field identification of soil properties for determining soil suitability.

	Soil suitability classification
1	**The total soil depth** to any impediment to root development such as; Rock (R), Hard plinthite/Laterite (P2), Weathering material (W), Soft plinthite (P1), Gley (G), Strongly structured horizons (K) Classify the soil depth as 0 – 20; 20 – 50, 50 – 80; 80 – 120; > 120 cm.
2	Record the **Organic carbon content classes** (when moist). As a rule of thumb this can be based on colour. **High**: Dark brown/black/fluffy friable topsoils > 1.8% (can also be reddish brown in some clayey soils) **Moderate:** Brown/grey brown/reddish-brown/yellow-brown 1.0 – 1.8% **Low:** Light grey/grey/very grey 0.5 – 1.0 **Very low**: Very grey/whitish grey (usually sands) < 0.5
3	**Soil texture** – in the suitability table only if the soil is sandy loam or coarser does it have an effect on suitability class. A method for determining soil texture in-field is presented in **Appendix 1**
4	**Soil structure** – use a sample from the B horizon at about 30 – 60 cm. This can be determined by ease with which individual soil aggregates break in your hand when dry or most **Apedal**: crumbles easily into very small particles so that it almost looks like sand **Weak**: Some aggregates or crumbs or blocky structured particles are still present after squeezing in the hand, sometimes with slightly shiny surfaces. Usually structured particles are less than is less than 5mm in diameter. **Moderate**: Larger aggregates or crumbs or blocky structured particles (> 5mm) and are resilient to break even when wet. **Strong**: Very large structural units > 5 cm and often bigger which are impossible to break in the hand. **Very strong:** When structure is strong *and coarse* in other words units are often bigger than 20 cm in diameter and longer in length as in Vertisols (Cracking clays). Large surface cracks are often present when the soils are dry (> 2cm).
5	Record the **Gravel content** of each horizon in terms of the categories in the SOIL SUITABILITY TABLE then use an average over the whole soil depth and record. If this is difficult to estimate use the diagram in **Figure 1**.
6	**Unless the waterlogging is indicated as a Gley (G) horizon) or a Soft Plinthite (P_1) horizon degree of waterlogging** should be recorded for the top 50 cm: *Slight waterlogging (W_1):* Slight Faint mottles/few: Usually small red/orange streaks (< 1mm) in old root channels often in the topsoil. Probably less than 10% of the soil volume *Periodic waterlogging (W_2):* Some/distinct mottles: Between 10 – 50 % of the total soil volume streaked with clear red/orange mottles on grey or brown background It is a limiting horizon if it has *Permanent waterlogging (W_3):* Strong mottles: Large orange/red mottles on a grey or black/grey background with or without black manganese concretions.

Classifying soil horizons pedologically

The most universally soil classification applicable in Africa is the old FAO system now known as the World Reference Base for Soil Resources (IUSS Working Group WRB, 2014). Its disadvantage is its cumbersome terminology and the need for soil analysis to differentiate between horizons. The South African soil classification system also works well in East Africa and is easy to apply (Soil classification working group, 1991). It is often useful to have the soils classified in terms of both soil suitability and given a name according to a pedological system. An example of some of the horizons that could be recorded is presented below for the South African system. It is useful to be able to recognize the following horizons as they may assist in describing limiting horizons for tree growth (**Table 3**)

Table 4: Features of principal horizons according to the South African system of soil classification (Soil classification working group, 1991)

	Identify the main soil horizons – usually by colour and structure. The main ones are as follows: A horizon – mineral horizon stained by organic matter (usually darker than horizons below) B horizon – yellow, brown, red = well drained, friable "good subsoils". When microaggregated (apedal) they are known as Yellow/brown and Red apedal B horizons E horizon - Bleached, grey or white horizon usually between a topsoil and overlying a poorly drained or structured B horizon G horizon - A waterlogged horizon with grey/black colours, sometimes "mottled" with yellow/red/orange colours. Is often massive and occurs in or close to wetlands P1 – Soft plinthite B – red/bright orange and red mottles on a grey background sometimes with black manganese concretions. Hard when dry soft when wet. P2 horizon – Hard plinthite B or laterite, usually impenetrable. Sometimes occurs at the surface. Vertic A – black or brown (can even be red) cracking clays. Extremely difficult to dig. Hard when dry, sticky when wet and has large surface cracks in the dry season. Melanic A – Similar to Vertic but not so strongly structured. More blocky, crumbly structure but often with black shiny surfaces. Humic A – A surface horizon high in organic carbon, stained a dark colour by organic matter, often has a "fluffy" feel to it. Common in grassland rather than forest soils. Pedocutanic B: A moderate to strongly structured subsoil horizon Prismacutanic B: Very strongly structured horizon having prismatic structure usually present in waterlogged or poorly drained soils

References

IUSS Working Group WRB (2014) World Reference Base for Soil Resources 2014. International soil classification system for naming soils and creating legends for soil maps. *World Soil Resources Reports No. 106.* FAO, Rome.

Soil Classification Working Group (1991). Soil classification - A Taxonomic system for South Africa. *Memoirs on the Agricultural Natural Resources of South Africa No 15*. Department of Agricultural Development. Pretoria, Republic of South Africa.

APPENDIX 1: A field method for determining soil texture in-field