Better Management Practice		
	• Soil types (forms) are mapped and classified in terms of their erodibility	**Mapping of Soils** **Soil types:** Soil types should be mapped and classified in terms of their erodability, and visible soil erosion should be mapped, measured and monitored over time, and addressed through specified measures (McCulloch and Stranack, 1995). Soil is a living, dynamic resource that supports plant life. It is made up of different sized mineral particles (sand, silt and clay), organic matter and numerous species of living organisms. A healthy soil should contain 1 000 kg/ha earthworms, 2 700 kg/ha fungi, 1 700 kg/ha bacteria, 150 kg/ha protozoa and 1000 kg/ha arthropods and small animals. The rate of soil loss should not exceed the rate of soil formation. To ensure this, adequate soil protection measures must be implemented. In addition, the soil's chemical and physical composition should not be altered to such an extent that it adversely affects the growth of crops, vegetation or animal life within the soil body. Soils should also be managed in such a way as to limit the effect that leachate from the soil has on the environment. **Soil identification:** Each soil has its own characteristic chemical, physical and morphological properties. Refer to SASRI Bulletin No. 19, 'The Identification and Management of the Soils of the South African Sugar Industry', Appendix 3, page 156. To make sound management decisions, it is important that a grower knows the major soil types found on the farm. Fertiliser and herbicide applications, drainage systems, tillage practices, irrigation, conservation planning and variety selection are all soil dependent. All farms should have a soil parent material map, and preferably a soil survey indicating soil form, depth and percentage clay of each field (see Module 1.1 – Land Use Planning).

Better Management Practice

Soil depth:
Soil depth can be categorised as follows:

Depth category	Depth mm
Shallow	<400
Moderate	400 – 1000
Deep	>1000

Soil moisture content:
The Available Water Content (AWC) of soil can be estimated from the percentage clay in the topsoil. Where the rooting depth is known, an estimation of Total Available Water (TAW) can be made.
TAW is calculated using the following formula:

TAW = AWC x effective rooting depth

(Refer to SASRI Bulletin No. 19, 'The Identification and Management of the Soils of the South African Sugar Industry', page 158 for the ranges of AWC according to clay%).

Soil erodibility:

Different soils have different erodibility potential and can be categorised accordingly. Well-structured soils with a high clay content tend to be more resistant to erosion than the sandy non-structured soils. For example, a Shortlands soil will be more resistant to erosion than a Cartref soil. It therefore follows that different soils will require different management practices according to their erodibility category (K factor).

Consideration must be given to the erodibility of the soil, particularly where cultivation takes place. Those soils falling into the erodible groups 3 and 4 (see below), require extra precautions and full use must be made of both biological and mechanical conservation measures.
(See SASRI Bulletin No. 19 'The Identification and Management of the Soils of the South African Sugar Industry', Table 2, page 142).

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Soils are categorised into four broad groups of increasing erodibility:

Group	Erodibility	Erosion hazard	K value
Group 1	LOW	1	K values <0.2
Group 2	MODERATE	2	K values 0.2 – 0.4
Group 3	HIGH	3	K values 0.4 – 0.6
Group 4	VERY HIGH	4	K values >0.6

Notes:

- **K value – Based on the soil erodibility nomograph developed by Wischmeier *et al.* (1974). From this nomograph the Universal Soil Loss Equation (USLE) K factor can be estimated for each soil. For the sugar industry, K ratings have been developed based on results from trials using runoff plots and the nomograph.**
  Refer to page 159 of the SASRI Bulletin No. 19 'The Identification and Management of the Soils of the South African Sugar Industry.'

Soil physical and chemical properties and limitations:

Soil physical and chemical properties have a major impact on irrigation, drainage and nutritional management. See SASRI Bulletin No. 19 'The Identification and Management of the Soils of the South African Sugar Industry', Table 9 on page 151, for information regarding the suitability of soils for irrigation.

Soil and leaf threshold levels for sugarcane:

Excessive applications of fertiliser and/or ameliorants must be avoided. To determine the exact nutrient requirements it is essential that regular and comprehensive soil and leaf sampling be undertaken. Soil test values and nutrient threshold levels are used to calculate the amount and type of nutrients required to attain optimum crop growth (see SASRI Information Sheet 7.16).
For further information on nutrition and soil amelioration see SASRI Information Sheets 7.1 to 7.18.

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Toxic levels of heavy metals
Concentrations (mg/l) at which common heavy metals can become toxic to living organisms are given below.

Organism	Heavy metals						
	Cu	Zn	Pb	Cd	Fe	Mn	Al
Toxicity in solutions to plants	0.02	1.3	1.7	2.1	9.3	0.06	0.93
Toxicity in solution to fish	0.02	1.3	1.7	2.1	250	100	1.5
Drinking water	1.5	15	0.1	0.01	1.0	0.5	-
Water for farm animals	0.5	25	0.1	0.05	-	-	5
Irrigation water	0.2	2	5	0.01	5	0.2	5.0

pH levels also have an effect on the toxicity levels of certain elements in the soil:
- Al is toxic at high and low pH
- Cu is toxic at pH 5 or below.

These measurements should be taken at replant and recorded spatially on a map.

Soil compaction: (refer to SASRI Information Sheet 6.2)
The use of infield transport and loaders can cause compaction, breaking down the soil structure, and can damage the cane stools. Loams are more compactable than clays or sands and compaction intensifies with increasing soil moisture. The use of infield transport and loading systems, and other heavy machinery, should be avoided when conditions are wet. It is also important to use the right tyres to minimise compaction.

Compaction can be identified by the following:
- ponding on a soil with a fine sandy texture
- observations using a penetrometer
- digging a pit and observing root growth, and looking for evidence of a ‘hardpan’
- crusting on the soil surface
- smeared, shiny soil surface
- lack of cracks, deep roots or earthworm holes
- a platey soil structure
- grey, anaerobic topsoil
- mottling caused by impeded drainage.

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For a given amount of compactive effort, the resulting soil bulk density will depend on the amount of moisture present in the soil, as shown below.

The following table shows critical values for bulk density and porosity for different soil types.

Soil texture	Bulk density (kg/m^3)		Porosity (%)	
	Normal range	Critical value	Normal range	Critical value
Clay soil (>35%)	1 100 to 1 300	1 500	58 to 51	43
Sandy soil (<20%)	1 500 to 1 700	1 800	43 to 36	32