



Information Sheet

14. SOIL SUSTAINABILITY

14.1 Soil quality and degradation

Monoculture of sugarcane has been practised for over 100 years in South Africa. Without crop rotation, the vigour and yield of most other crops will diminish. Although monoculture of sugarcane has been accepted as a viable practice, it has been reported in Australia that yield decline costs between A\$200-300 million annually. Recent research has linked yield decline to a number of biological factors of which soil-borne fungi, toxins and nematodes appear to be the greatest under adverse soil conditions. In Colombia, yield decline on mollisols has been positively linked to intensive mechanisation.

In South Africa, a yield plateau occurred between 1970 and 1995. Apart from the effects of droughts and eldana outbreaks, sugarcane monoculture may also have resulted in the degradation of soils. Recent research has shown that under continuous sugarcane production, soils degrade mainly from loss of organic matter, soil crusting, compaction, breakdown of soil structure and acidification. The loss of soil organic matter is now considered to be the most important aspect of soil degradation under cane production.

SOIL QUALITY

Soil quality is defined as the capacity of soils to accept, store and recycle nutrients and water, to maintain economic yields and sustain the environment. Soil quality indicators can be divided into the physical, chemical and biological properties of the soil. A comprehensive soil chemical database has been developed in the FAS laboratory using the results of over 200 000 soil tests, which include pH, organic matter, soil N mineralisation potential, exchangeable bases, and plant available P and Zn. Soil physical properties such as texture, bulk density

and available moisture limits are also measured in our current research programmes. Biological indicators for soil quality are now considered central to determining soil health and sustainable soil management practices.

FACTORS AFFECTING SOIL QUALITY

Soil organic matter loss

- Paired site investigations in which soils under cane were compared with undisturbed adjoining virgin land have demonstrated a significant reduction in soil organic matter content.
- Data from the long term burning/trashing trial at Mount Edgecombe has shown that, after 59 years, burning has caused a marked reduction in soil organic matter content when compared with surrounding virgin land. Soil microbial biomass and respiratory rate were also reduced through burning, where differences were most pronounced in the topsoil.



The result of a heavy downpour: soil deposition from a fallow field upslope.

- Soil organic matter is a key factor of soil quality, as a primary source of plant available nutrients through mineralisation. It is also important in the formation and maintenance of soil aggregates and aids the infiltration of air and water, promoting water retention and reduced erosion.
- Organic matter serves as a source of energy for bacteria, fungi and earthworms. These organisms are important in soil processes such as nutrient mineralisation, soil aggregation and the creation of macro-porosity.
- The numerous components of organic matter in these processes can be measured. Because they change, the pools of organic matter are effective indicators of overall soil quality.

Soil crusting and erosion

- Many soils in the sugar industry are subject to crusting.
- Physical disaggregation of soil particles occurs on impact from raindrops, which compact the surface layer and limit water movement into the soil.
- Soil crusting is a precursor of soil erosion. Erodibility ratings of some of our soils have been determined from trials. Results show that strong crusts do not form under a surface mulch such as trash. Results from five trials show that soil and water losses are reduced by 89 and 58% respectively, where burnt tops are spread over the soil after harvest.



The beginning of erosion caused by soil compaction.

- Ameliorants such as phosphogypsum, molasses meal, polyvinyl alcohol and various polymers are far more costly than a trash blanket and are less effective in reducing run-off and increasing rainfall use efficiency.

Compaction

- Harvesting and cane extraction during wet conditions is sometimes an unavoidable practice, but infield traffic will cause damage through compaction, sealing/capping and physical damage to cane stools. Yield losses as high as 40% have been recorded.
- Soils are most susceptible to compaction when their moisture content is near field capacity.
- Traffic over the cane row has a more severe effect on yield than traffic in the interrow.
- Amelioration through ripping is only slightly beneficial. Tines can have a detrimental effect due to root pruning, which inhibits growth of the subsequent crop.
- Compaction from traffic occurs mostly within a depth of 200 mm from the soil surface.

Soil acidification

- Toxic effects of exchangeable Al levels on cane growth are well known (see Information Sheets 7.5 and 7.7). In the past, soil acidity has been confined mainly to high altitude areas (such as the Midlands).

- More recently, an industry survey of soil fertility trends indicated that non-irrigated sandy soils have become more acidic during the past decade.
- Accelerated acidification of soils occurs from the combined effects of oxidation of ammoniacal fertilisers to nitric acid, mineralisation of organic matter and leaching of basic cations from the soil.

Salinity/sodicity

- A primary cause of soil salinisation is the development of high water tables, which allow

capillary rise of saline ground water into the rooting zone of the crop.

- Poor quality irrigation water is another source of salts.
- A serious decline in yield on estates in northern Zululand has been linked to the build-up of salts in the soil.
- At Mhlume in Swaziland, yield decline on duplex soils has been partly arrested by the installation of subsurface drainage.

PREVENTATIVE SOIL MANAGEMENT STRATEGIES

The adverse effects of monocropping can be reduced by practices which include green manuring, minimum tillage, strip cropping, nutrient recycling through

filtercake, green cane harvesting and spreading of crop residues. Results of research and observations show that these should be planned according to soil type, and include land preparation, selection of varieties, soil amendments, fertiliser rates, timing and placement, trash management, season of harvest and irrigation scheduling.

SOIL LOSS IN KZN

Ignorance of sound farming methods and the desire for a quick return despite the consequences, have been the main causes of veld deterioration and soil degradation. Every year, 100 million tons of soil are lost from KwaZulu-Natal alone. This can be calculated as being equivalent to 40 farms of 850 hectares each. KwaZulu-Natal is responsible for 25% of South Africa's run-off, and 45 of the province's 73 estuaries show deterioration.



Advanced soil erosion.

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