



Soil Quality: What is it & how do you improve it?

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SAC Consulting is a division of SRUC

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Soil Quality: What is it?



- More productive ?
 - Nutrient status
 - pH
 - Drainage
 - Structure
- More biodiversity ?
 - Organic content
 - Amount and type
 - Plant (crop) diversity
- More sustainable ?
 - Storing carbon
 - Minimum tillage



Soil Quality: My definition



A quality soil is one that is managed in a such away that it meets the needs of today without impacting the needs of the future

- Todays need is profitable crop production
- Tomorrows need ?
- Key characteristics to protect
 - Long Term “Humic” organic fraction
 - Topsoil layer



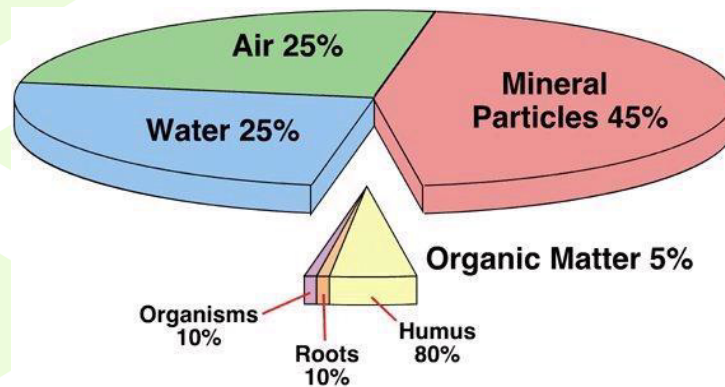
Soil Organic Matter (SOM)



- Fraction of the soil that included living microorganisms, fresh and partially decomposed organic material and humus.



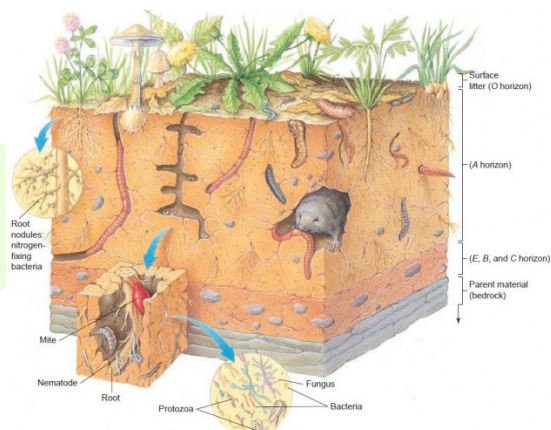
Soil Composition



Soil Biota



- Fauna: 1-5 T/ha
- Fungi: 3.5 T/ha
- Bacteria: 1.5 T/ha



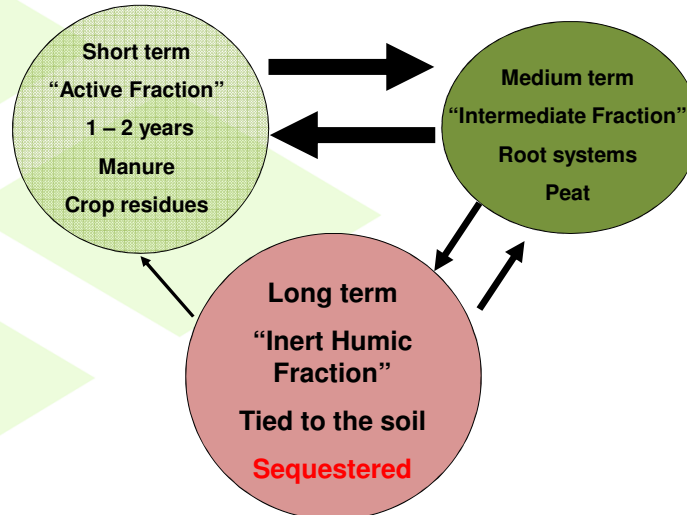
10.15 Soil organisms

The diversity of life in fertile soil includes plants, algae, fungi, earthworms, flatworms, roundworms, insects, spiders and mites, bacteria, and burrowing animals such as moles and groundhogs. Soil horizons are not drawn to scale.

SOM pools



- Fraction of the soil that included living microorganisms, fresh and partially decomposed organic material and humus.



Soil Organic Pools



Fraction	Amount (t/ha)	Turnover time (years)
Readily Decomposed plant material (crop residues – manure)	0.1 (<1%)	0.2
Resistant plant material	0.6 (2%)	3.3
Microbial biomass	0.3 (<1%)	2.4
Physically protected organic matter	13.6 (47%)	71
Chemically stabilized organic matter (Humus)	14.6 (50%)	2900

– Jenkinson (1981)

SOM pools



- Short term
 - Stable in most grazing systems
 - Mainly act as fertilisers
 - Prevents pressure on other pools
 - Manure back on silage land
- Medium term
 - Stable in most grass systems
 - Linked to well established root systems
 - Quickly lost after cultivation
- Long term (Black gold)
 - Fundamental aspect of a good quality soil
 - Fed by the medium term pool
 - Main threat is erosion
 - Gives soil its colour and structure

SOM pools



Soil erosion is the #1 concern – lose both the soil and the humic fraction



Measuring SOM – Minimum Targets



- Loss on ignition test

Soil	SOM levels (%)
Old Pasture	9
New pasture	7
Arable soil	6

Soil Quality



- What is the “bury by undershirt” trying to show ?



Soil Quality



- Presence of an active biological fraction
 - Diverse and active biological fraction improves
 - Nutrient cycling
 - Soil structure
 - Resistance to diseases and pests
- Variability in how efficient this fraction is at “cycling” nutrients in the short term pool
- What factors will impact this test?

Soil Quality



- What factors will impact this test?
- Fixed factors
 - Temperature
 - Moisture
 - Excess water
 - Lack of water
 - Soil type and texture
 - SOM types and amounts
 - Rooting potential
 - Drainage potential

Soil Quality



- Managed Factors
 - Presence of soil biota
 - Continues mono cropping (no diversity in feedstock for the soil)
 - SOM inputs (manure)
 - Excess water
 - Poor drainage
 - Soil compaction
 - Oxygen levels
 - Poor drainage
 - Soil compaction
 - Cropping system
 - Rotation
 - Sward Age
 - Rooting depth

Soil Quality



- Other Factors
 - pH ?
 - Nutrient status (N,P,K)?
 - Micronutrients ?

Soil Structure

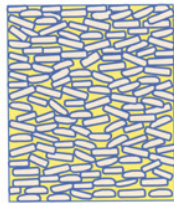


- All biological and chemical reactions occur on surfaces
 - Root uptake
 - Decomposition
 - Storage and Exchange of nutrients (cation exchange capacity)
- Most biological activates and organisms that are beneficial to soil quality require oxygen (anaerobic)

Compaction – The Problem



- Soil compaction
 - Mechanical or naturally occurring compression of soil resulting in
 - Reduction in pore space (reduced surface area)
 - Breakdown of soil structure
 - **Water Air and Roots cannot get through**



Types of Compaction



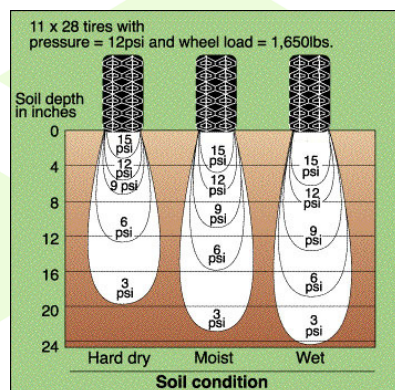
1. Cow Pan (poaching, grazing pan) 5 – 10 cm depth
 - Consequence of livestock traffic
 - Stocking density
 - Drainage
 - Always happens and many soils can recover



Types of Compaction



2. Machinery Pans 10 – 15 cm
 - Drainage
 - Equipment weight
 - Tyres



Types of Compaction



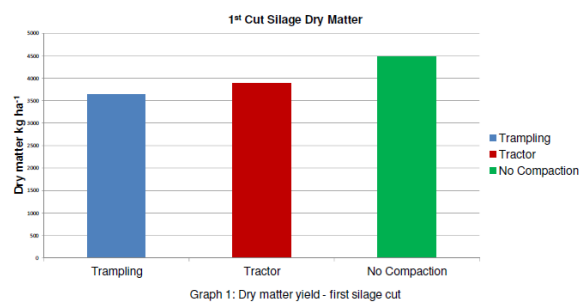
- Pans (10 – 30 cm)
 - Wheeling pans (10 – 15 cm)
 - Plow Pans (20 – 40 cm)
- Caused by soil smearing – differs from compression
- Serious issue due to the nature of the damage



Impact of Compaction



- Reduced Yield
 - Major concern but hard to measure in grassland systems
 - Systematic compaction (full field) will likely reduce yields by ~ 20%
 - Long term build up of a compaction layer in the upper profile
 - First cut impacted the most – Why?



Source : Dairy Co.

Impact of Compaction



- Reduced growing season
 - More water hanging around for longer
 - Reduced drainage
 - Lose two weeks of the growing season
 - Lower temperature
- Impaired root growth
 - Shallower and denser
 - Less efficient nutrient uptake
- Environmental
 - Nitrous oxide emissions are high from compacted soils
 - Increased surface runoff and soil erosion



Lifters vs Sub-Soilers



- Lifters work within the topsoil and are designed specifically to do so
 - Target depth no greater than 30 cm
 - At least 4 legs
 - Cutting discs
 - Rollers to control heave
 - Smaller tines (variable)





Soil Quality



- What can you manage ?



Testing Soil Quality



- Organic content
- Carbon Content
- pH
- P, K, Mg
- Micro nutrients
- Ca
- Cation Exchange Capacity (CEH)
- Soil respiration
- Sorption Capacity

Testing Soil Quality



- **Endless number of factors but only one will be a limiting factor at any one**
- The basics must be addressed first
 - pH
 - Drainage
 - Soil Structure
 - P, K, Mg
 - Nutrient management

Magnesium (Mg)



- Key plant nutrient but not a commonly deficient in Scottish soils
- Excessive Mg can cause a breakdown in soil structure
 - Primarily a concern for clay and silty soils
 - Mainly the result of naturally high levels
- Can impact plant uptake of Potash (K)
- Possible concern if Mg results are > 1000 mg/l based on SAC testing
- Unlikely an issue unless shown to be present at high levels

Calcium (Ca)



- Micro nutrient for plant growth
- Commonly found in many fertilisers formulations
- Not a common deficiency

Fertiliser versus soil improver

- Ca can improve sodic soils or those that have been flooded with sea water
- Little evidence for other benefits as a soil improver beyond this

Scottish soil online (<http://map.environment.gov.scot>)

