

Understanding your soils

*Zach Reilly and Eric Anderson
Thursday 19th February 2026*

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Course Overview

- Session 1: Soil texture and stability
- Session 2: pH and fundamentals of soil health
- Session 3: Soil pit – hand texturing and structure

Questions and discussion throughout!

The current situation

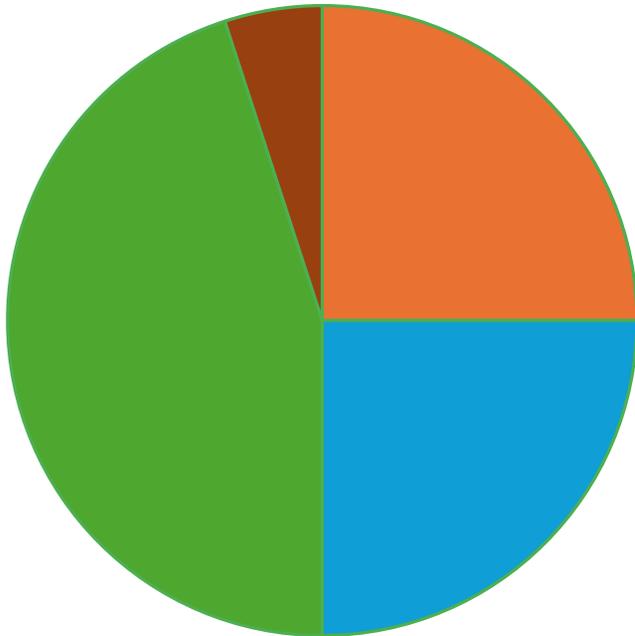
- Yield improvement in crops /grass has slowed – ‘yield plateau’
- ‘Chemical’ solutions are not a ‘one stop’ answer
- More frequent extreme weather events
- A more holistic approach is required
 - Soil health
 - Soil structure
- A **considered and appropriate** attitude to inputs is essential
- Inputs must be justified by a specific and identifiable requirement

Your soil is the fundamental resource you have!

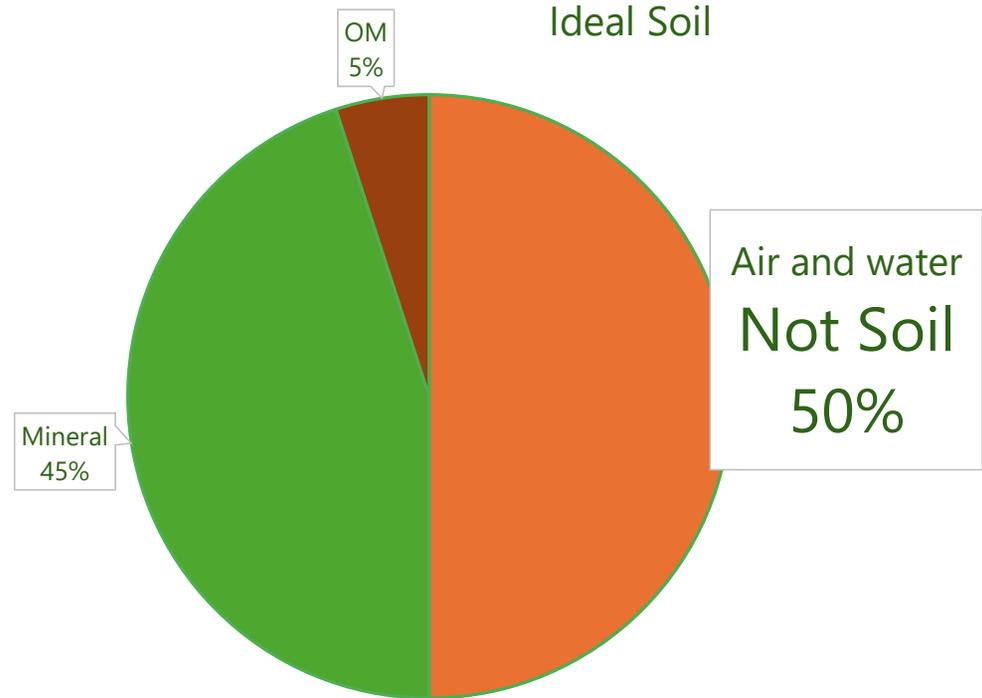


What is in soil?

Ideal Soil



Ideal Soil



■ Not Soil ■ Mineral ■ OGM

Choose your soil...

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Slake test:

Slake (wet aggregate stability) test



CaSTCo

Making sure that people count at the heart of rivers' recovery

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Based on Vidacycle's approach

Note: Choose a day when the soil is not waterlogged and has not been recently cultivated.

01

Locate your chosen sample site

If you have done the test previously, use the GPS mapping feature on Soilmentor to find the same spot.

02

Dig

Insert your spade to about 20 cm depth into the soil. Dig up the soil and gently break it apart to release pieces of soil.

03

Collect

Collect a fist-sized sample of soil put in small labelled bag to take home/to the office.

04

Dry overnight

Back at the office: select three 1-3mm sized lumps of soil from the bag and leave them to dry overnight. They may need another 2-3 days more drying if very wet – must be completely dry before testing.

05

Place in sieve

Once dry, arrange pieces of soil on the sieve and fully immerse into water until the lip of the sieve is reached. A light coloured water bowl (as a background) will make it easier to see how the soil is behaving.

06

Time for five minutes

Start timer for 5 minutes, & observe the pieces under water. Score the behaviour of the pieces in Soilmentor using the scores on the following page.

07

Optional: comparison

You may like to take another sample in an long-term uncultivated part of the farm, e.g. woodland, for a good comparison to assess the effect of field management on aggregate stability.

Equipment

During sampling



After sampling



Video of the process:



Photo/video credits:
Vidacycle

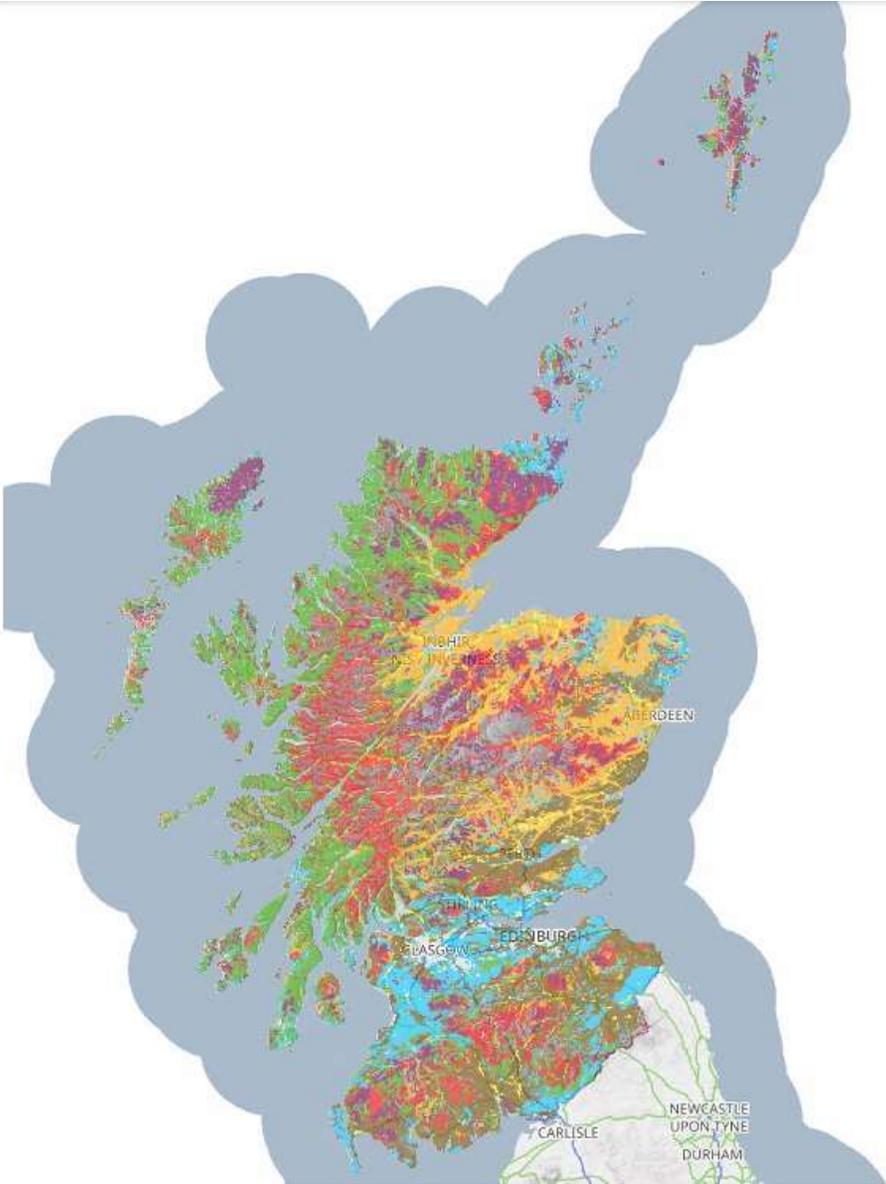
Don't forget to take photos of you doing your soil sampling and of the results!



The mineral component

National Soil Map of Scotland: Generalised Soil Type

- Alluvial soils
- Brown soils
- Calcareous soils
- Immature soils
- Mineral gleys
- Mineral podzols
- Montane soils
- Peat
- Peaty gleys
- Peaty podzols
- Lochs



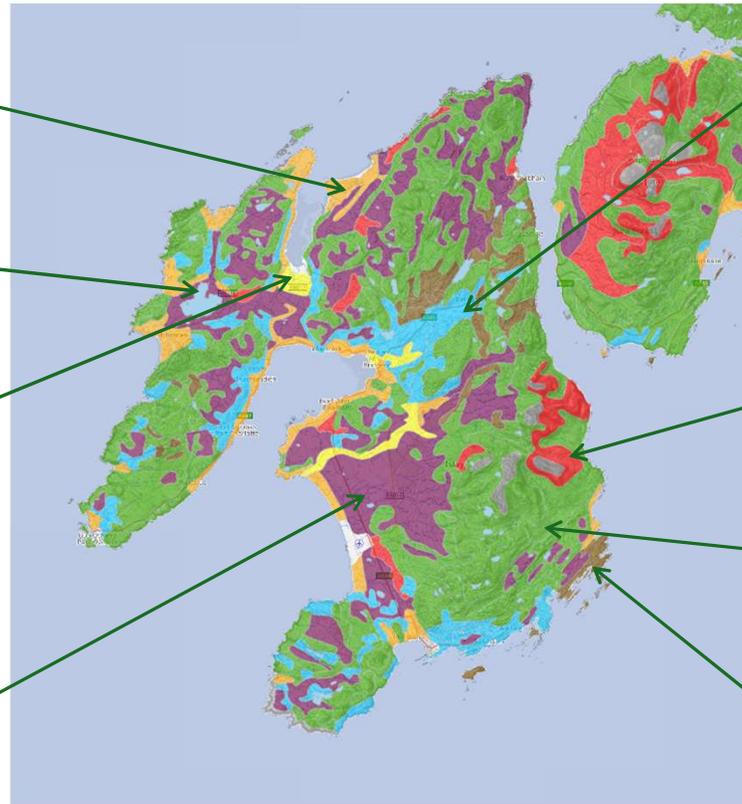
The mineral component - Islay

Corby – humus iron podzols

A loch!

Alluvial soil – mineral alluvial
with peaty alluvial soil

Organic soils – dystrophic
blanket peat



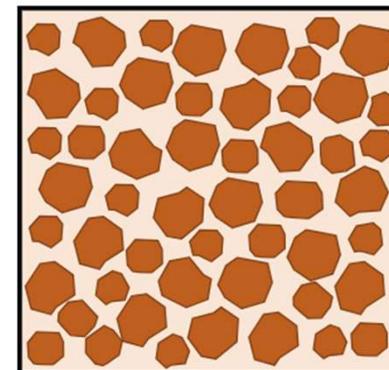
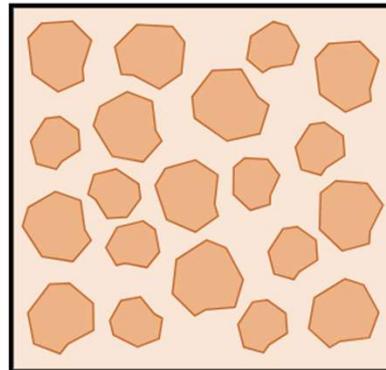
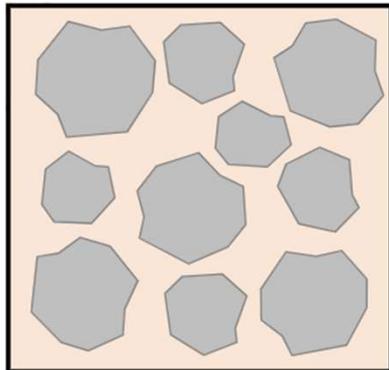
Foudland – noncalcareous
gleys with humic gleys

Durnhill – peaty gleyed
podzols

Durnhill – peaty gleys

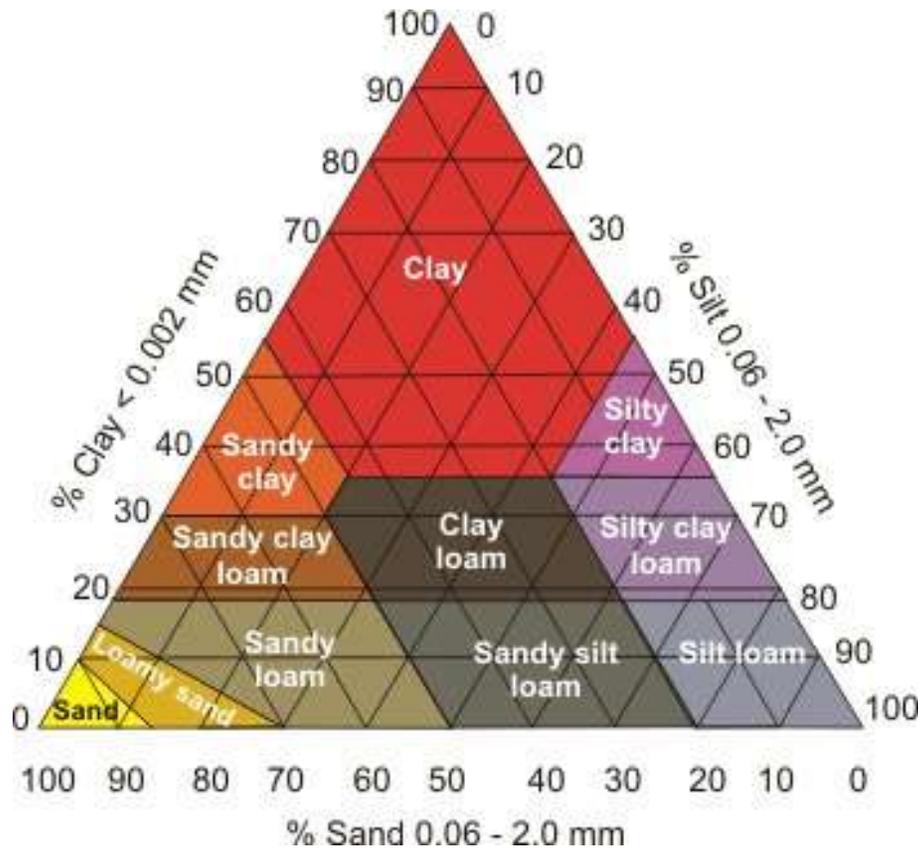
Organic soil – dystrophic
basin peat

Particle size



SAND	SILT	CLAY
Large, 2.00mm – 0.05mm	Medium, 0.05mm – 0.002mm	Small, less than 0.002mm
Poor structuring	Prone to capping	Tightly formed structure
Low nutrient retention	Good nutrient holding capacity	High nutrient holding capacity
High permeability, good drainage, poor water holding capacity	Medium permeability, high available water	Low permeability, poor drainage and prone to becoming sticky when wet
High bulk density	Medium bulk density	Low bulk density

The mineral component: sand / silt / clay



Where does your soil fit?

Residual or transported?

Sand / silt / clay?

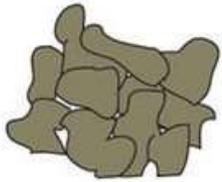
Structural forms



Granular (high permeability)



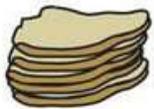
Aggregated (high permeability)



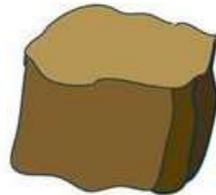
Blocky (moderate permeability)



Columnar/prismatic (moderate permeability)



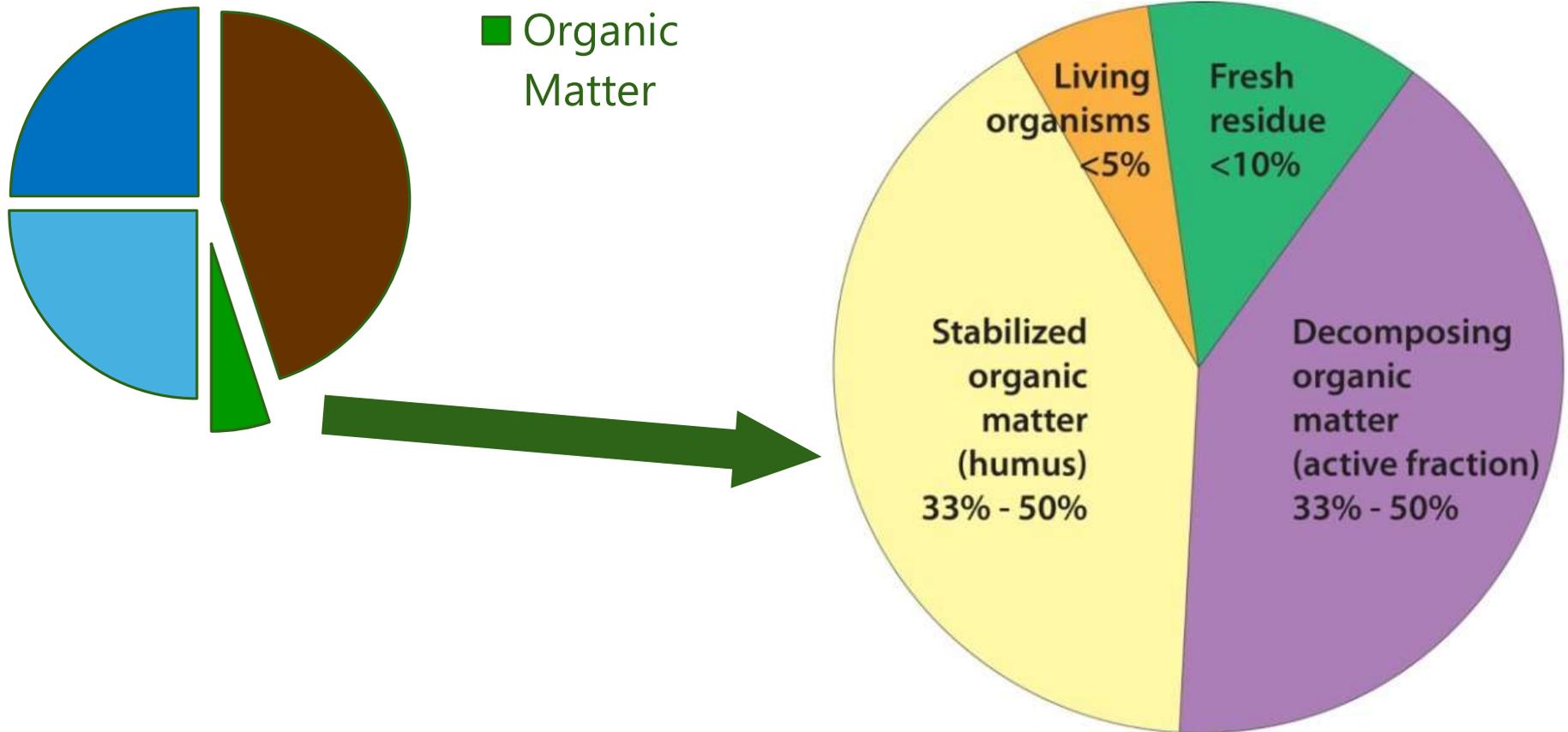
Platy (low permeability)



Massive (low permeability)



Organic matter



Organic matter

- Dead and decomposing remains of plants, animals and microorganisms
- Residues and waste products from plants, animals and microorganisms
- Dead and decomposing remains of decomposer organisms
- Potential new substances formed during decomposition



pH and the importance of lime

Liming History

Grant between 1939 and 1976 Under FHDS

- Paid 60% of cost of 2 ton /ac every 5 years
 - Paid 70% of cost for summer applications to rushy land
 - Peak use 7.5 m tons/annum
 - Current use 2.5 m tons
-
- 1991 Fertiliser Regulations still in place and define quality of Agricultural Lime.
-
- Descriptor of Lime use changed in 2018 BSFB tables.

CEC or soil type

Soil Type	CEC range	Calcium PPM range
Sand	3-5	400-665
Sandy Loam	8-12	1065-1600
Silty loam	15-20	2000-2650
Sandy Clay Loam	18-29	2395-3860
Clay	30+	3990+

What is the right pH and why?

% of maximum yield achieved at a range of pH levels

Crop	Mineral Soil pH					
	4.8	5.2	5.6	6.0	6.4	SE
Spring Barley	21.3%	59.4%	88.4%	91.3%	100%	3.85
Winter Wheat	74.2%	98.2%	100%	100%	95.5%	3.69
OSR	72.0%	84.8%	91.5%	93.8%	100%	2.14
Grass (3 cuts)	82.0%	92.9%	96.2%	100%	100%	2.56

Cresser, Edwards, Killham 1993

Stylised fertiliser efficiency calculations relative to that biologically achievable

A pH that is close to neutrality improves assimilation of NPK

Soil acidity	Nitrogen	Phosphate	Potash	% fertiliser wasted
4.5	30%	23%	33%	71.34
5.0	53%	34%	52%	53.67
5.5	77%	48%	77%	32.39
6.0	89%	52%	100%	19.67
7.0	100%	100	100%	Zero

Effectiveness factors of limestone fineness classes

Source: West Virginia University & University of Delaware USA

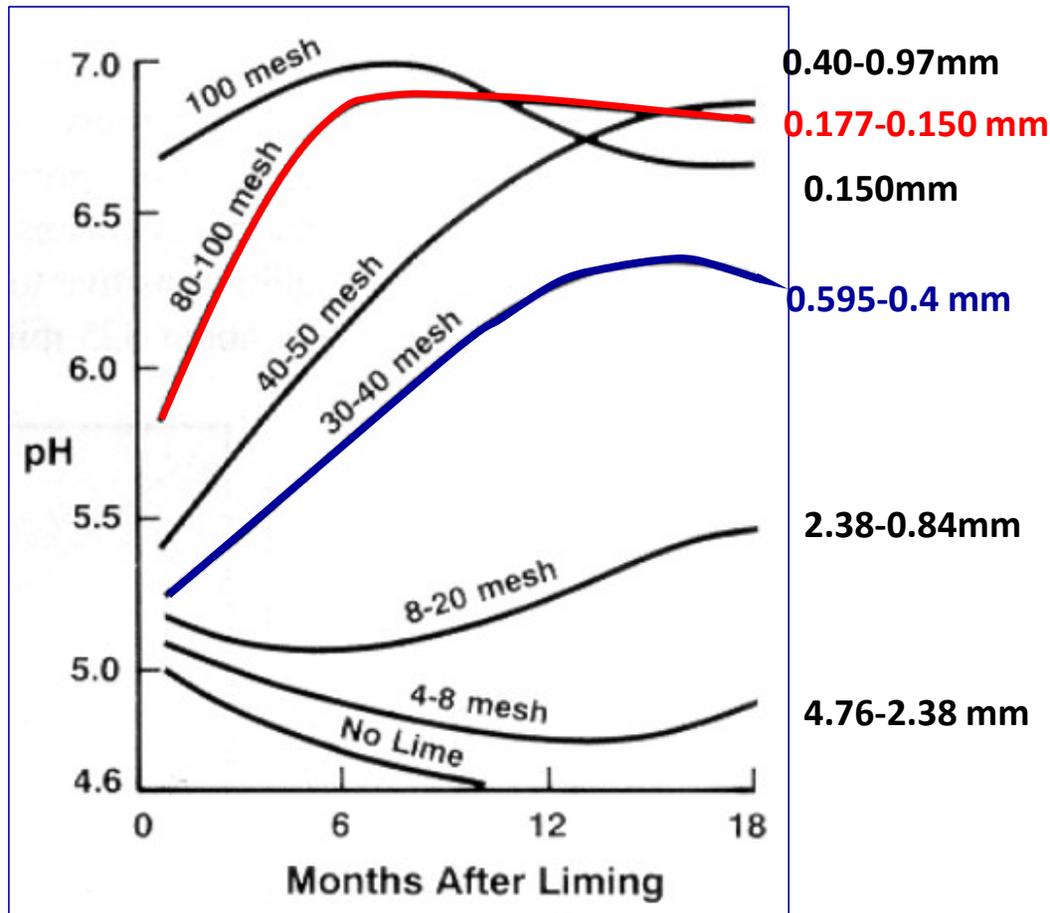
Limestone size fraction mesh	Limestone size fraction mm	Efficiency factor
Passing 100 mesh	0.15	100% in 6 months
Passing 60 mesh	0.25	100% in 12 months
Between 20 to 60 mesh	0.25-0.85	50% in 12 months
Retained on 20 mesh	>0.85	Between 5-10% and not generally credited when evaluating lime materials

Dunlossit Estate Quarry

ANALYSIS	RESULT
Neut. Val CaO (%)	39.1
Calcium Total (%)	29.6
Magnesium (%)	1.08
Fraction < 5mm (%)	100.0
Fraction < 3.15mm (%)	99.5
Fraction < 2mm (%)	86.2
Fraction < 1mm (%)	53.7
Fraction < 0.5mm (%)	35.0
Fraction < 0.315mm (%)	27.4
Fraction < 0.15mm (%)	18.9
Fraction < 0.1mm (%)	12.6

Speed of liming material activity

Source: Luke Gatiboni & David Hardy North Carolina University



Choice of calcium liming materials

Source of calcium lime	Neutralising value	Passing through 150 µm screen	True effective value
Biker - Burnby	48.6	11.9 %	5.8 %
Sherburn Quarries	49.1	12.0 %	5.9%
Leiths, Parkmore	40.0	24.0 %	9.6%
Breedon Boyne Bay	43.5	20.0%	9.7%
Breedon, Sheerglas Blair Athol	44.0	30.0 %	13.2%
Limehillocks, Blackhillocks (Keith)	49.8	32.0%	15.9%
Thompsons Greenwick East Yorks	56.3	45.0%	25.3%
			£46/t
Dunlossit Estate Quarry	39.1	18.9%	7.39%
Calciprill	52.0	90.0%	45.8%
Calcifert	54.3	90.0%	48.9%
			£46/t
Limex70	28.0	85%	23.8%

Soil acidification

- Leaching, passage of water through soil
- Cropping, this process varies with type of crop and fert used
- Fertilising, particularly high amounts of N and SO_3
- Microbial processes in soil, e.g. mineralisation (C cycling), N and S cycling.
- Root exudation.
- Pollution

Losses will be greatest on high pH sandy soils with high nitrogen fertiliser usage and high excess winter rainfall.

Apart from initial pH and nitrogen use, the main factor affecting lime loss is soil organic matter. The higher soil organic the lower the lime loss.

High CEC soils tend to be well-buffered, requiring more lime to change the pH; while sandy soils are poorly-buffered, requiring less lime per unit pH change.

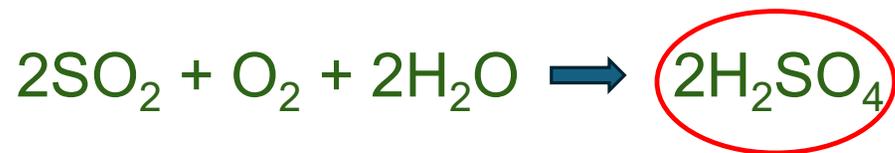
Acidification process

Causes:

- Nitrification of ammonium-N and nitrate leaching:



- S oxidation:



Urea soil processes

Initial hydrolysis of urea to ammonium and the accompanying increase in pH.

- Urea hydrolysis



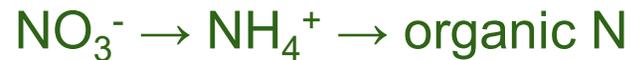
- Nitrification



- Denitrification



- Ammonification-immobilisation



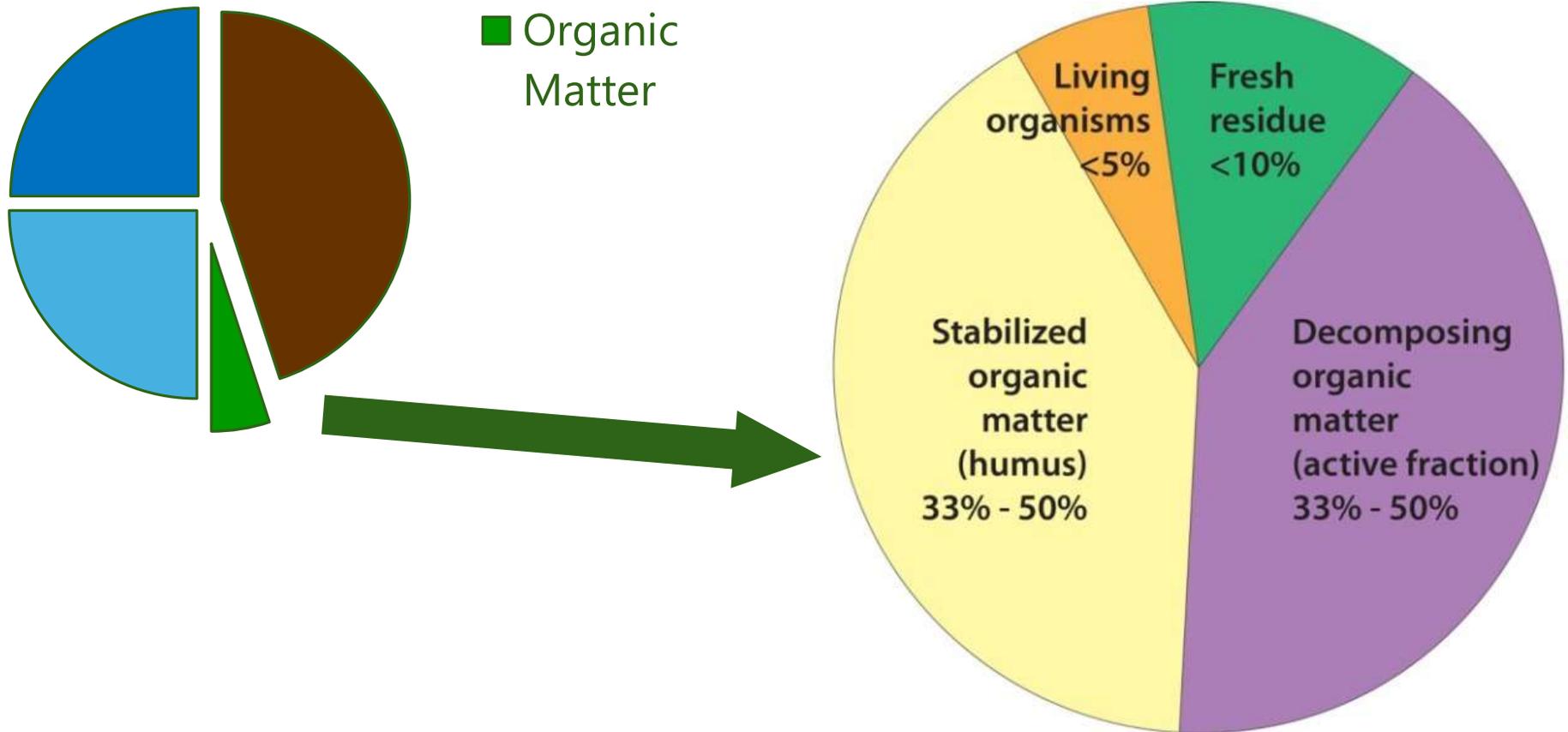
Amount of ground lime to neutralise the effects of nitrogen fertilisers

100 kg nitrogen per Ha	Ground limestone t/Ha
Ammonium sulphate (21% N)	0.5-0.7 (2.5 X AN)
Ammonium Nitrate (34% N)	0.2-0.3
Urea	0.2-0.3
Calcium Ammonium Nitrate 27% N	0.15-0.25 (0.75 x AN)
Calcium nitrate	0

Questions?

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Organic matter

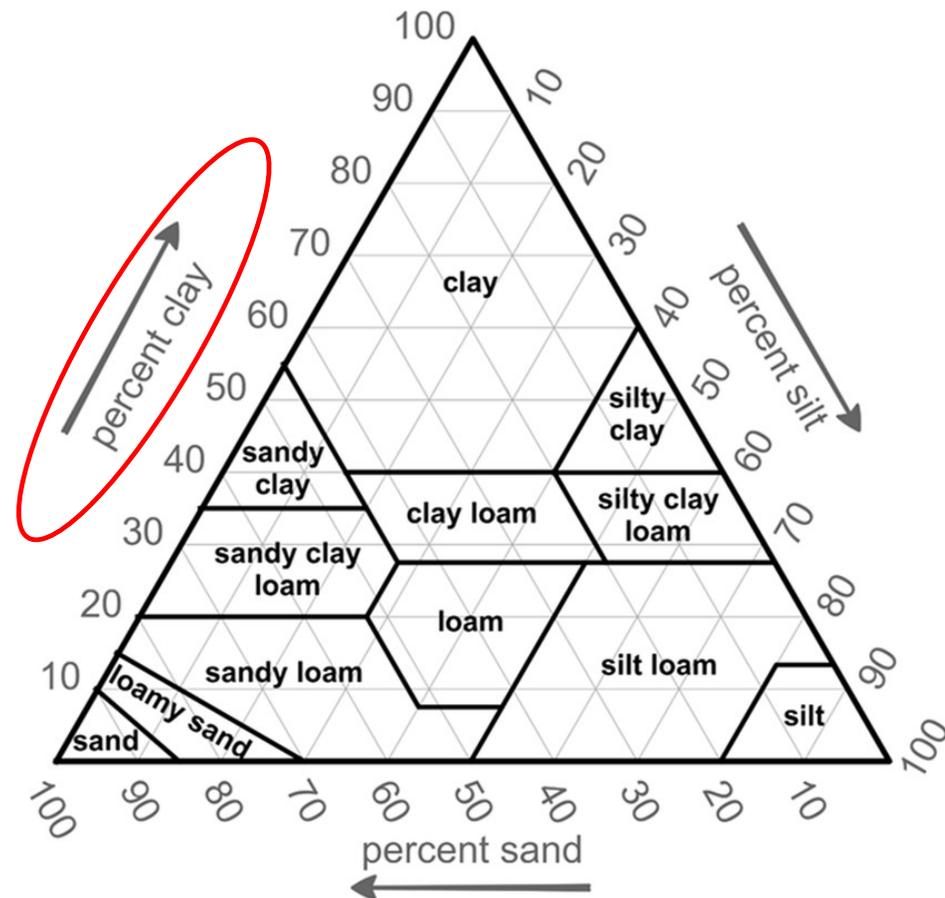


SOC : C

Soil Organic Carbon to Clay Ratio (SOC : C)

Soils are variable; therefore, soil targets must be flexible

SOC:C sets a realistic target which varies for different soil types by using the clay content



Starting point: SOC:C ratio

- **SOC** - is the amount of carbon in the organic compounds of soil. It's a key component of soil organic matter (SOM), which is the organic residue in soil that's in various stages of decay.
- **C** – is a soil particle (sand/silt/clay) which measures less than 0.002mm in size. Flat and plate like, they have undergone secondary weathering.

Why use SOC:C?

- Sets a realistic value for carbon sequestration
- Can be worked out from an organic matter (indirectly) and soil texture analysis ([Scotland's Soils](#))
- Links to a soils ability to retain nutrients and water
- Doesn't include any OM which will be cycled
- Closely correlated to a soils structure (which in turn links to its function)



SOC:C indictive targets

For agricultural soils:

Very good: 1:8

Moderate: 1:10

Poor/degraded: 1:13

The EU has set a threshold of 1:13 within the **EU Soil Monitoring Law's** framework, for use at member states digression

Target remedial action to the poorest SOC:C ratios for greatest impact



Soils with higher OM content have:

- Improved soil structure, & water holding capacity
- Improved biological activity, nutrient retention & turnover



- Improved rooting, nutrient and water capture
- Reduced run-off and erosion
- Reduced water logging



- Improved productivity
- Reduced flood risk
- Reduced emissions to environment
- Greater resilience

Organic matter and soil structure

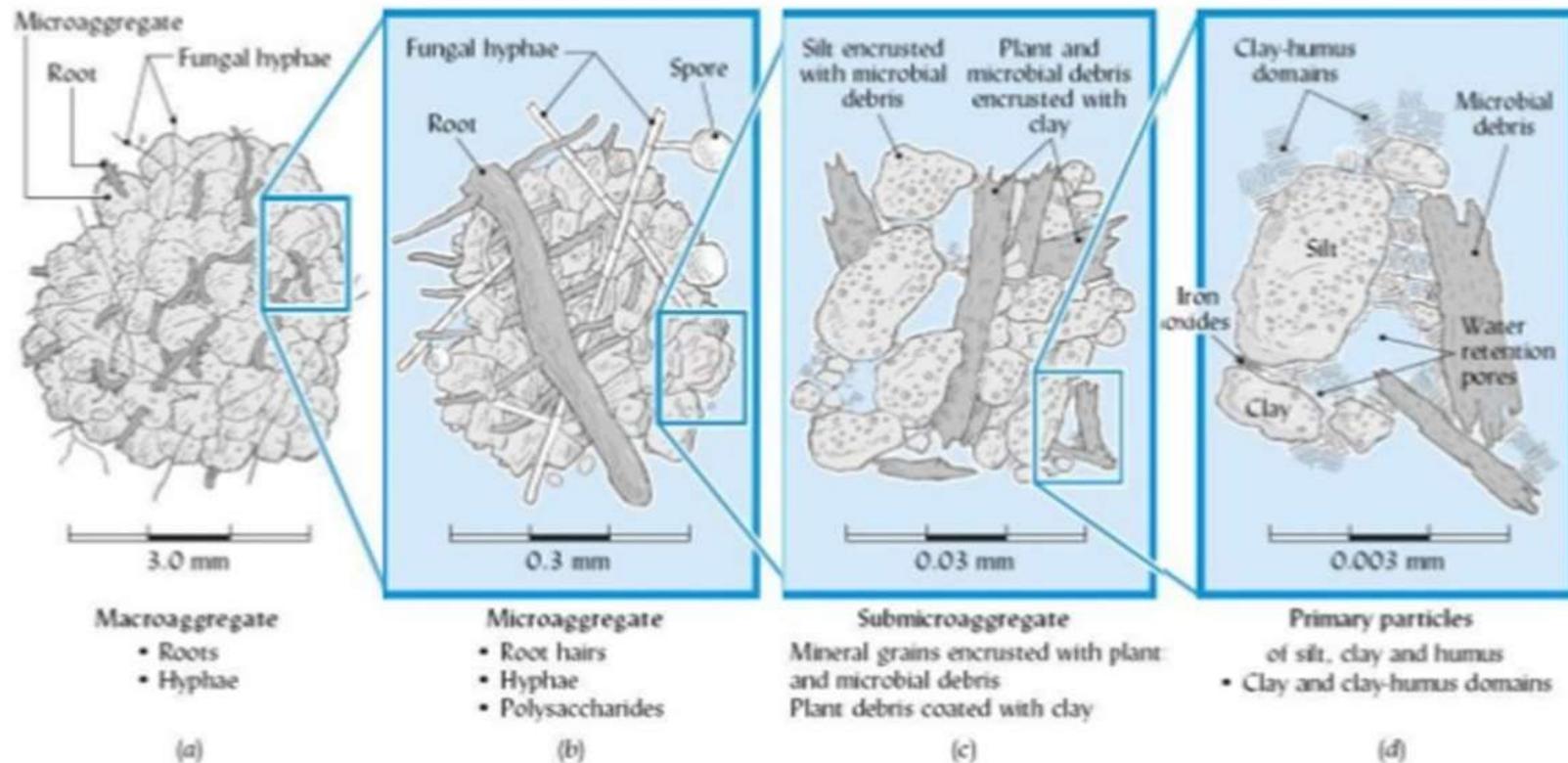


Figure from Brady and Weil

A hands-on approach

Hand texturing in field



Hand texturing

Take a small clump of moistened soil and knead it between your fingers, then follow the flow chart below to find out what type of soil you have...

