Soil Carbon in Grazing Systems

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BIGG Conference 2021

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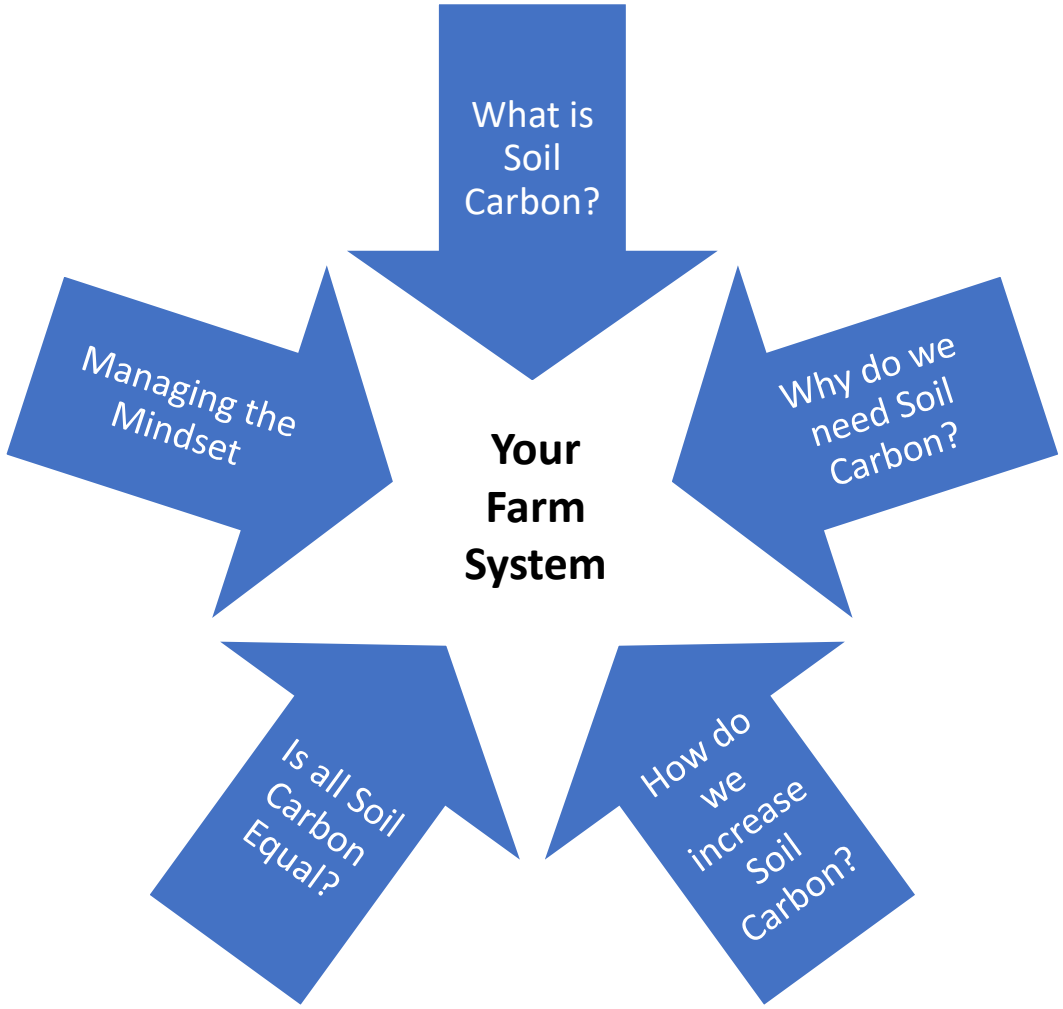
Soil Carbon in your system



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What is Soil Carbon

- Soil Carbon vs Soil Organic Matter
  - Soil Carbon is the measurable component of SOM (<2mm)
- Soil Organic Carbon x 1.72 = Soil Organic Matter

- Soil Carbon is influenced by

Climate, Rainfall, Soil type and management

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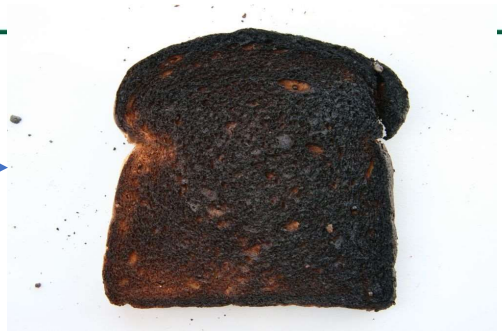
Not all Soil Carbon is Stored Equal

Particulate organic carbon Fresh residues, living organisms	Humus organic carbon 'Resistant' residues, physically protected	Resistant organic carbon Protected humus, charcoal
Labile (*POC*) SOM 1-5 y	Slow (*HOC*) SOM 20-40 y	Stable (*ROC*) SOM 500-1000 y



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Getting Carbon into Context

- What does 1% Carbon even mean?
- SOC = SOC% x Depth (cm) x Bulk Density
- SOC 0-10cm = 1% x 10cm x 1.3 = **13t/ha**
- SOC 0-30cm = 1% x 30cm x 1.3 = **39t/ha**

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Soil Carbon & Soil Function

Soil Carbon is the Destination

Soil Function is the Journey

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Focus on the Cycle

Focus on the cycle – not just the volume

How is your Carbon stored

% → tSOC/ha

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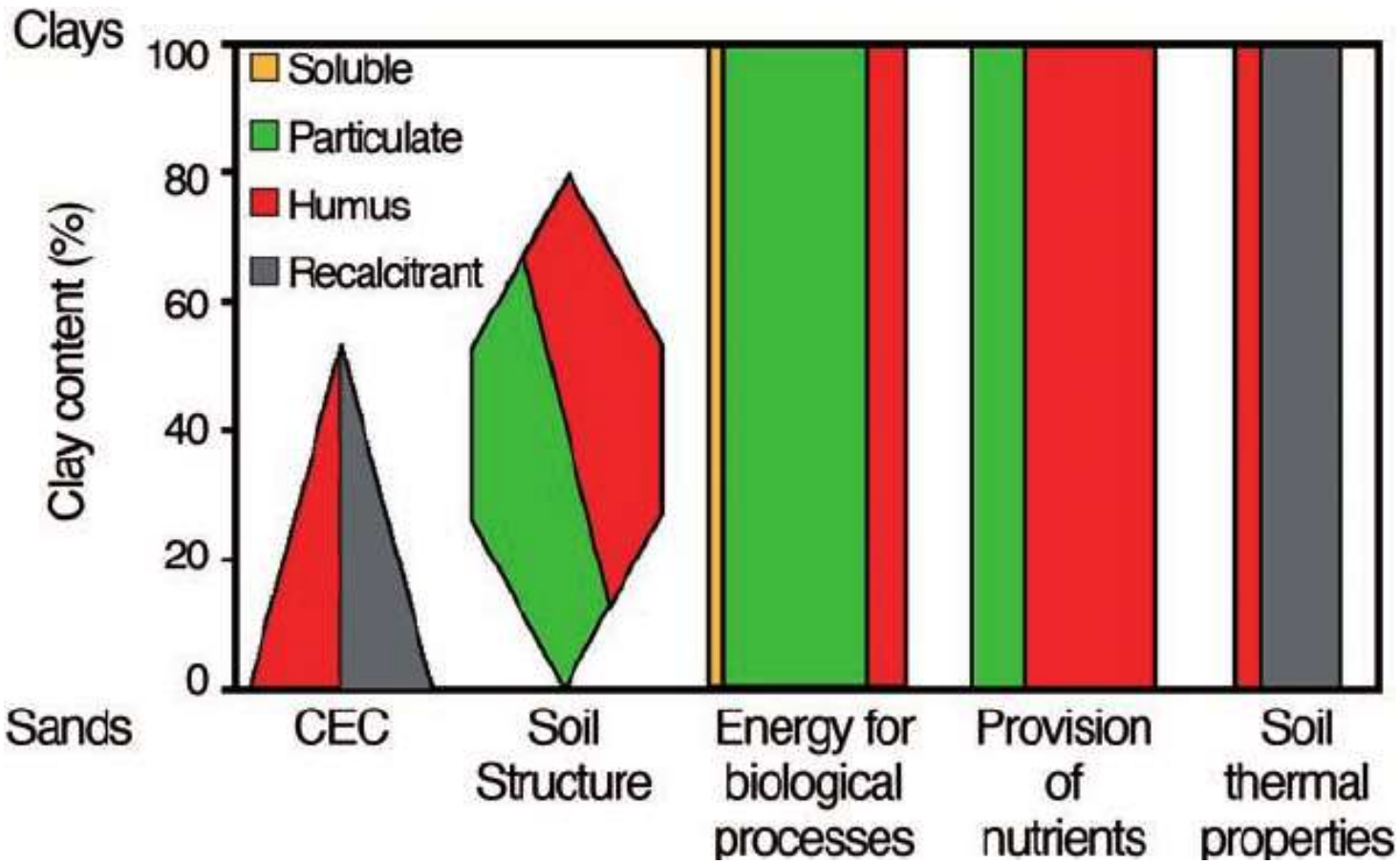
What is the Role in the System



Krull et all 2004

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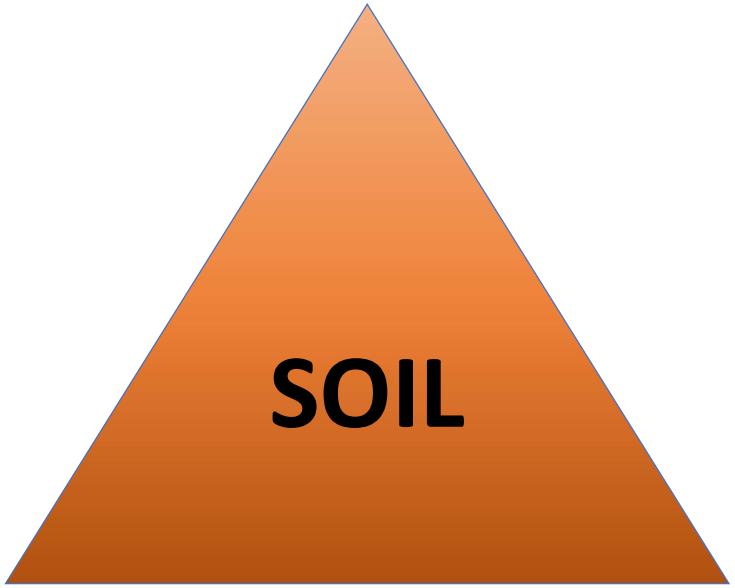
Physical



Chemical

Biological

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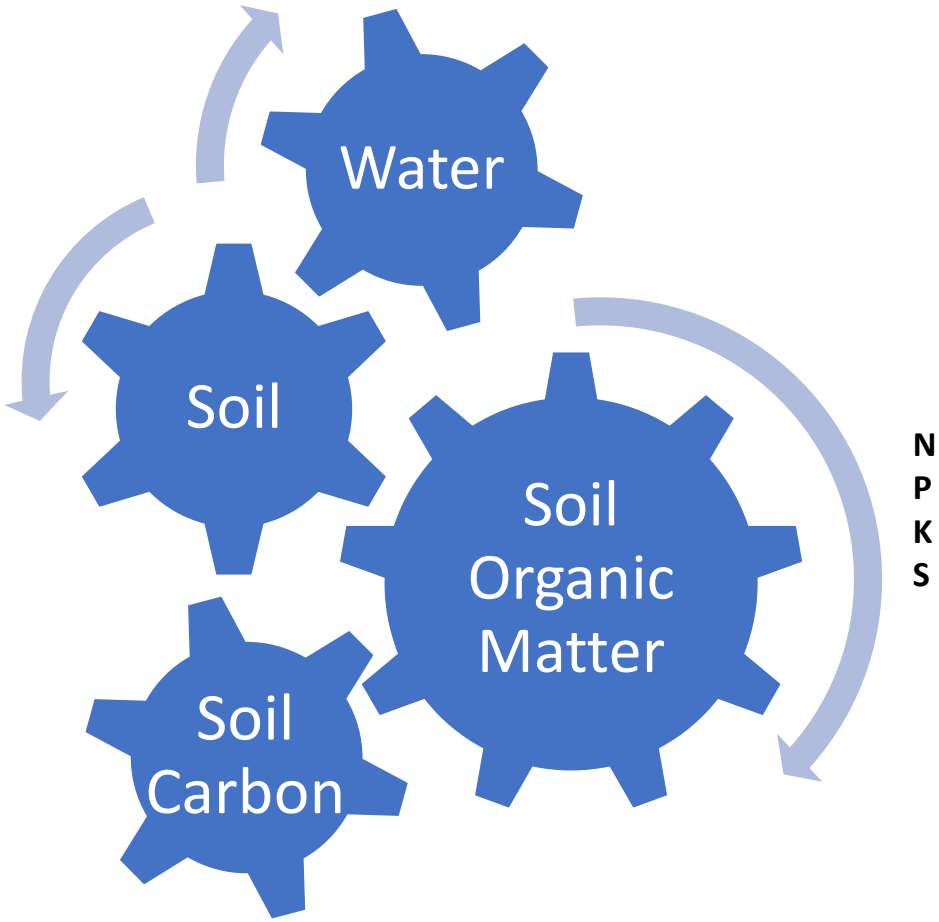
Carbon's role in the Soil Gearbox

- Carbon doesn't exist alone
- Nutrients are required
- Increasing the Cog Size



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How do we build Soil Carbon

- Humus consists of remains of soil microbes
- Plant residue is high in carbon therefore nutrients are required to stabilise carbon as humus

	C	N	P	S
Humus	1000	90	19	14
Wheat	1000	17	2	3
Fungi	1000	103	11	9
Bacteria	1000	250	49	26

Kirby et al. (2011) Geoderma

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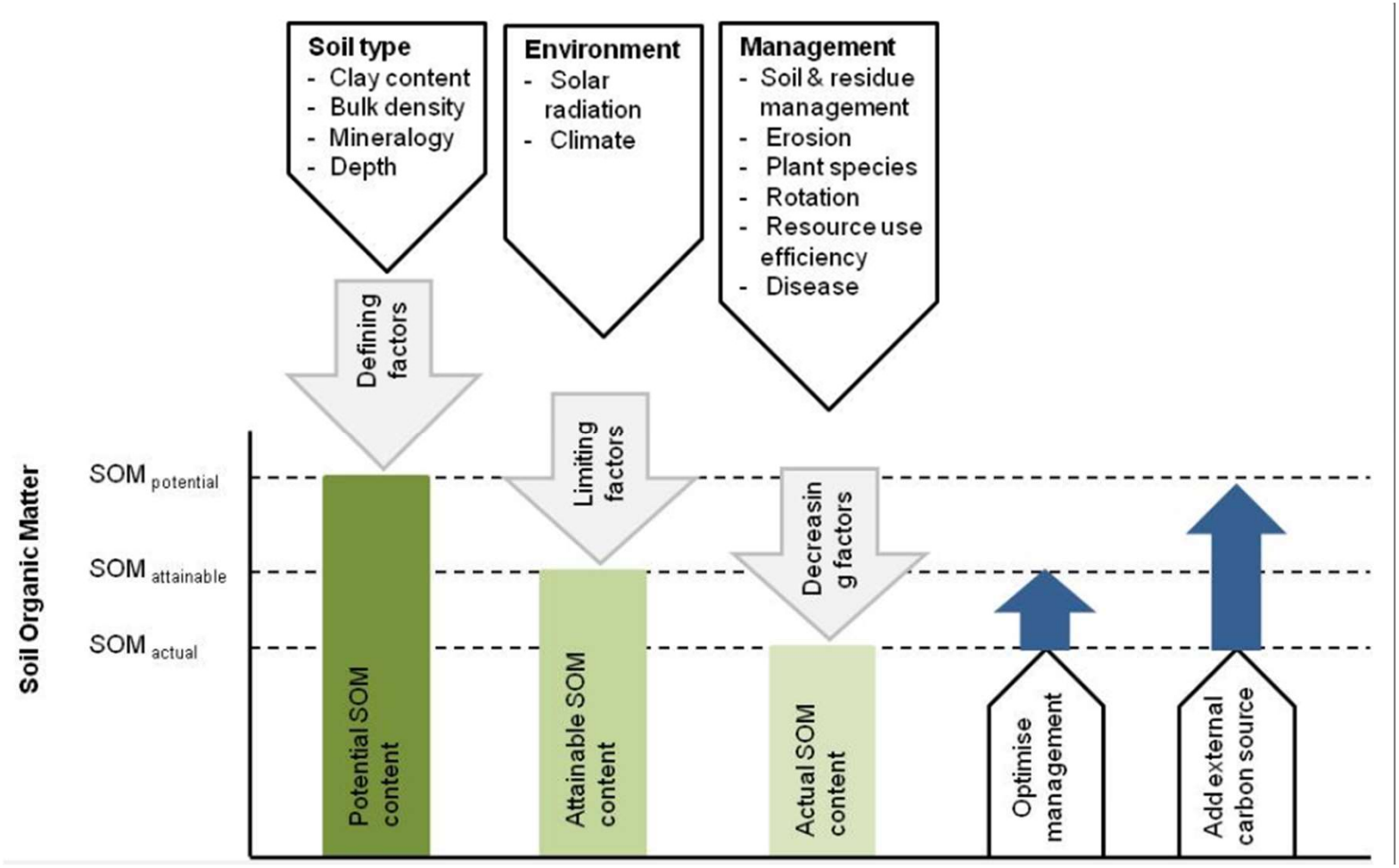
Identify the loss pathways



The influence of soil type, climate and management factors on the retention of soil organic matter in soils (Source: Ingram & Fernandes 2001)

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Soil Carbon in Grazing Systems

Management	C seq rate (t C/ha/yr 0-30cm)	Years averaged over	Reference
Pasture and crop management - NSW			
Liming	0.46 to 0.55	18 yrs	(Chan et al., 2011)
Pasture rotations	0.22 to 0.40	18 yrs	(Helyar et al., 1997; Chan et al., 2011)
Nutrient management	0.30	10 yrs	(Chan et al., 2010; Orgill et al., 2014; Orgill et al., 2017)
Rotational grazing	0.35	10 yrs	(Chan et al., 2010)
Legume in pasture	0.75	10 yrs	(Chan et al., 2010)
Grazing management (strategic and rotational)	1.04 to 1.46	5 to 8 yrs	(Orgill et al., 2016; Orgill et al., 2017)
Cultivated crop to pasture	0. 50 to 0.70	8 to 18 yrs	(Young et al., 2009; Chan et al., 2011; Conyers et al., 2015)
Introduced perennial pastures - Australia	0.50	Ave meta-analysis	(Gifford et al., 1992)
Pasture and crop management - Australia		Ave meta-analysis	(Sanderman et al., 2010)
Nutrient management	0.29		
Pasture improvement (irrigation, legumes)	0.11		
Cultivated crop to pasture	0.33		

Orgill et al. (2018)

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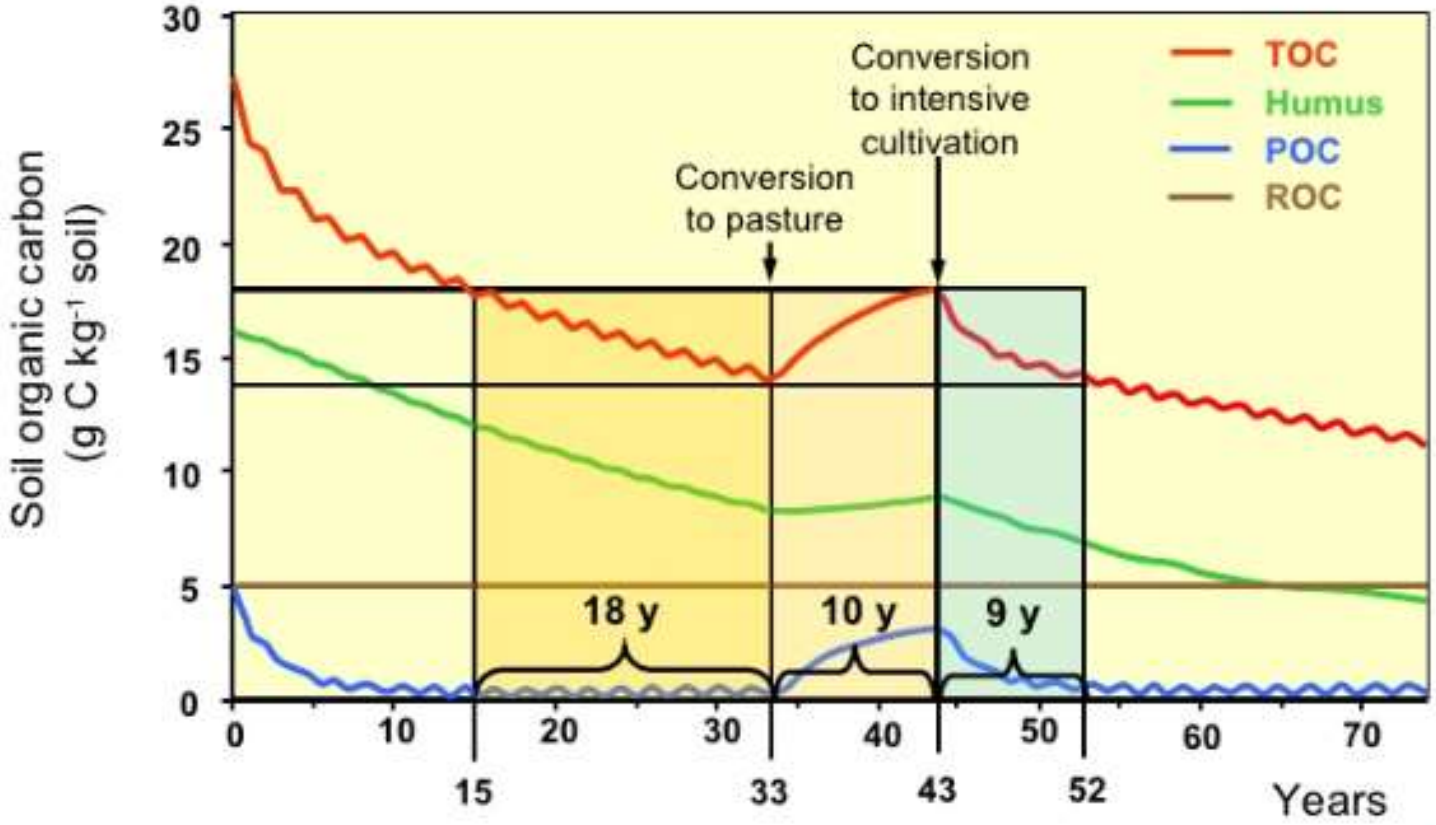
Impact of Practice Change



Baldock et al (2008)

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Soil Management for Positive Carbon Outcomes

Soil Organic Carbon

- Moisture
  - Build and Cycle the carbon
- Nutrient Availability
  - Stabilise the Carbon
- pH
  - Microbial activity
  - Nutrient availability
- Soil Structure
  - Air + Water Movement
  - Habitat

Livestock

- Shelter
- Water
- Food on Offer
- Supplementary feed

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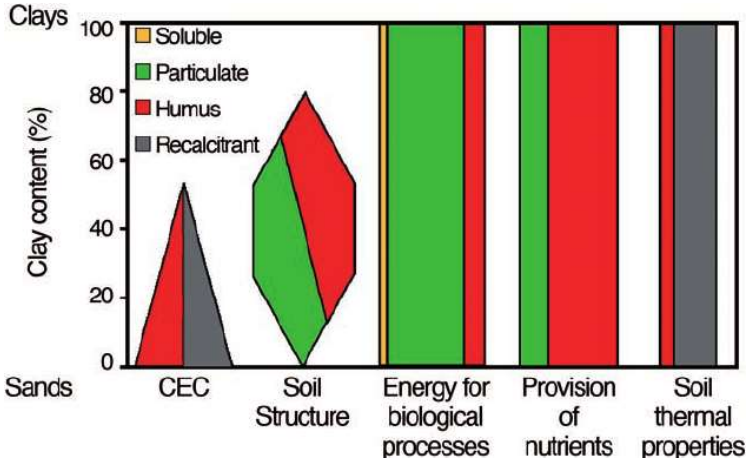
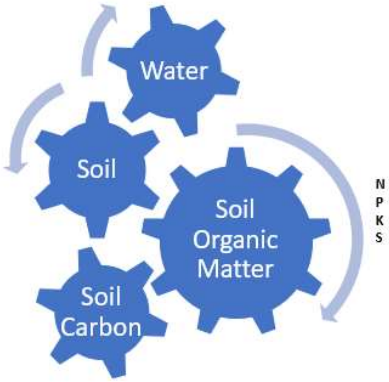

Clays
Sands
Clay content (%)
100
80
60
40
20
0
Soluble
Particulate
Humus
Recalcitrant
CEC
Soil Structure
Energy for biological processes
Provision of nutrients
Soil thermal properties


Water
Soil
Soil Organic Matter
Soil Carbon
N
P
K
S

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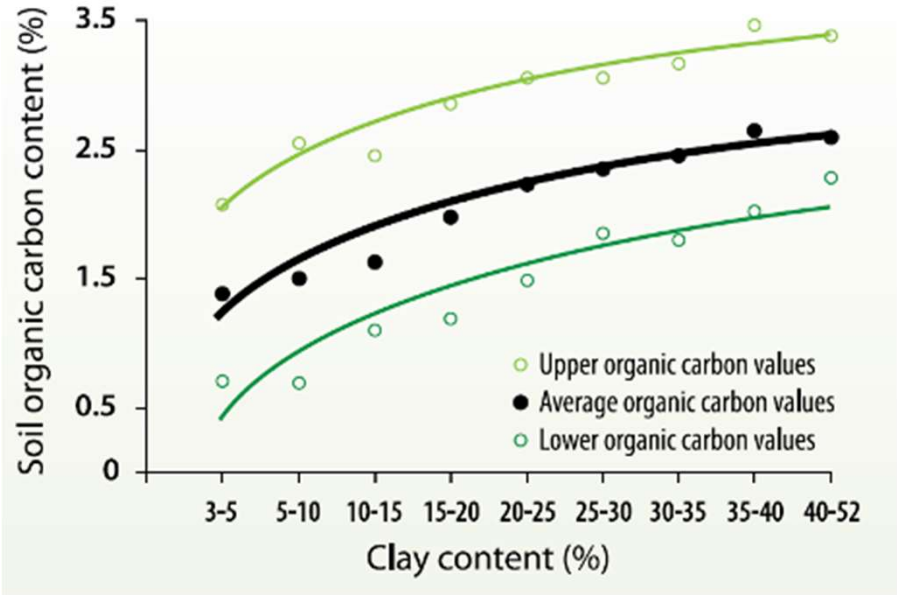
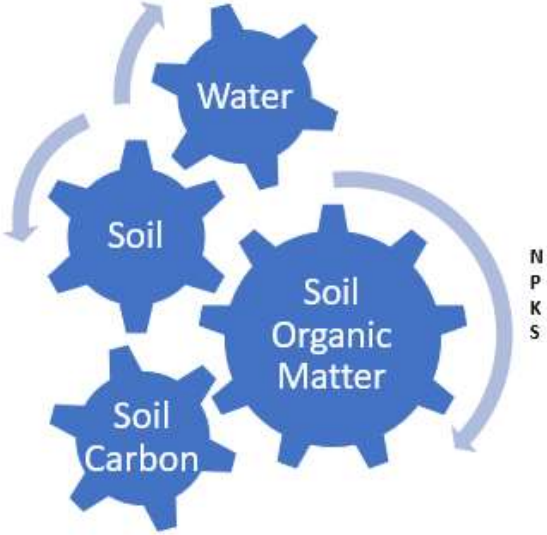

Soil organic carbon content (%)
3.5
2.5
1.5
0.5
0
3-5
5-10
10-15
15-20
20-25
25-30
30-35
35-40
40-52
Clay content (%)
Upper organic carbon values
Average organic carbon values
Lower organic carbon values


Water
Soil
Soil Organic Matter
Soil Carbon
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Understand your variability

Select some reference sites

On varying soil types & or management types

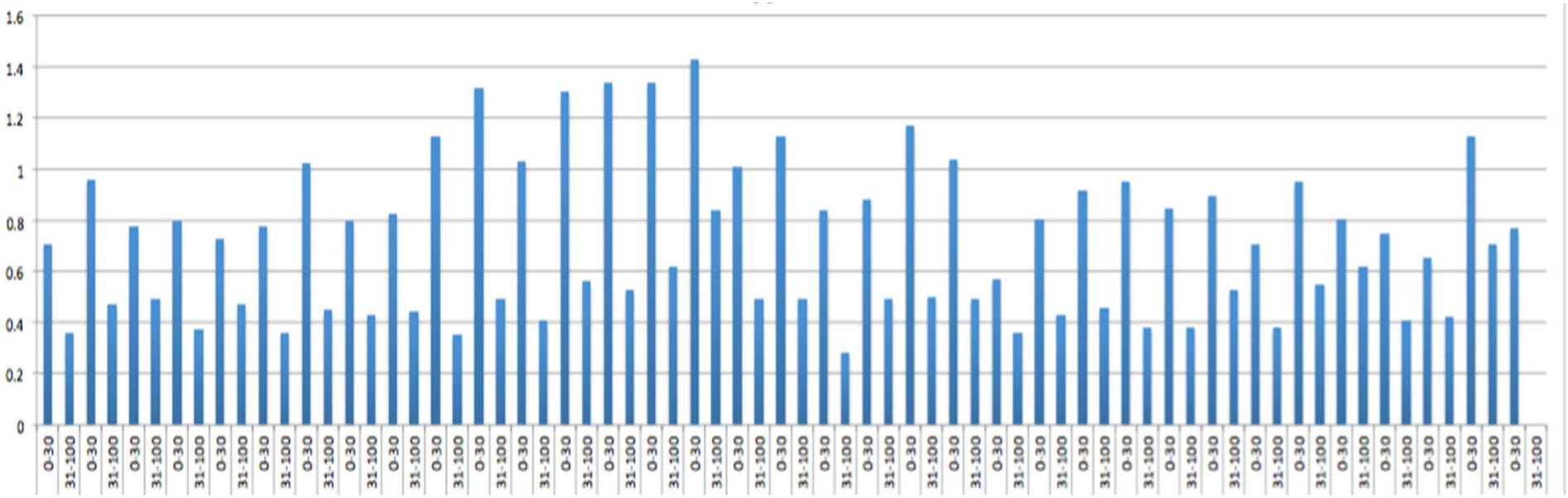
Understand your soils to depth

Where is the potential in your profile

0-10cm

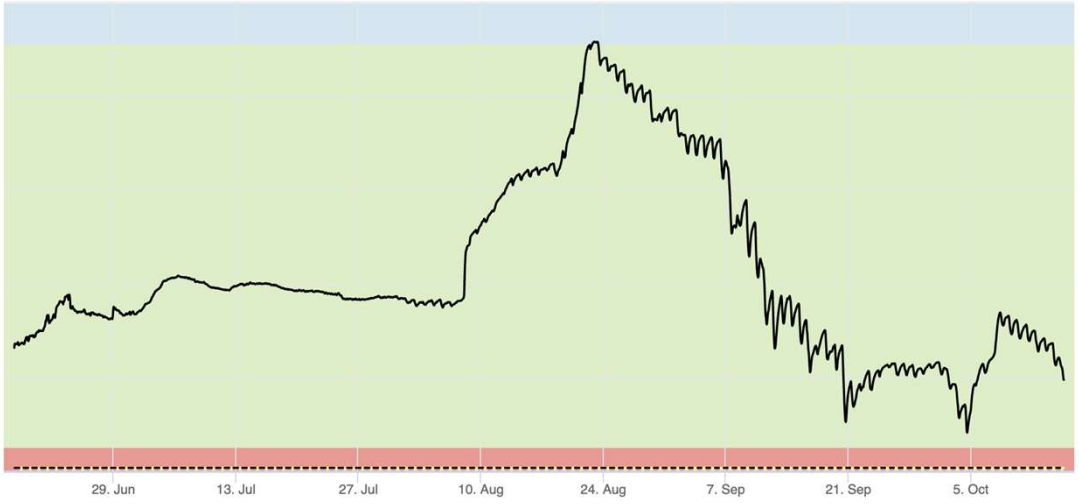
10-30cm

Identify the barriers or constraints in the system



Knowledge and insights

- Understand your moisture and its distribution through the year and through the profile
  - What is our bucket and how are we using it
  - If you have on farm weather and soil moisture data, start using it



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Know when, where and how much

- Understand your nutrient cycling and how you can compliment
  - C:N:P:S – Critical piece of the puzzle
  - Strength of a Pasture system
  - Soil Constraints: pH, Sodicity, Salinity
  - Inputs & Outputs

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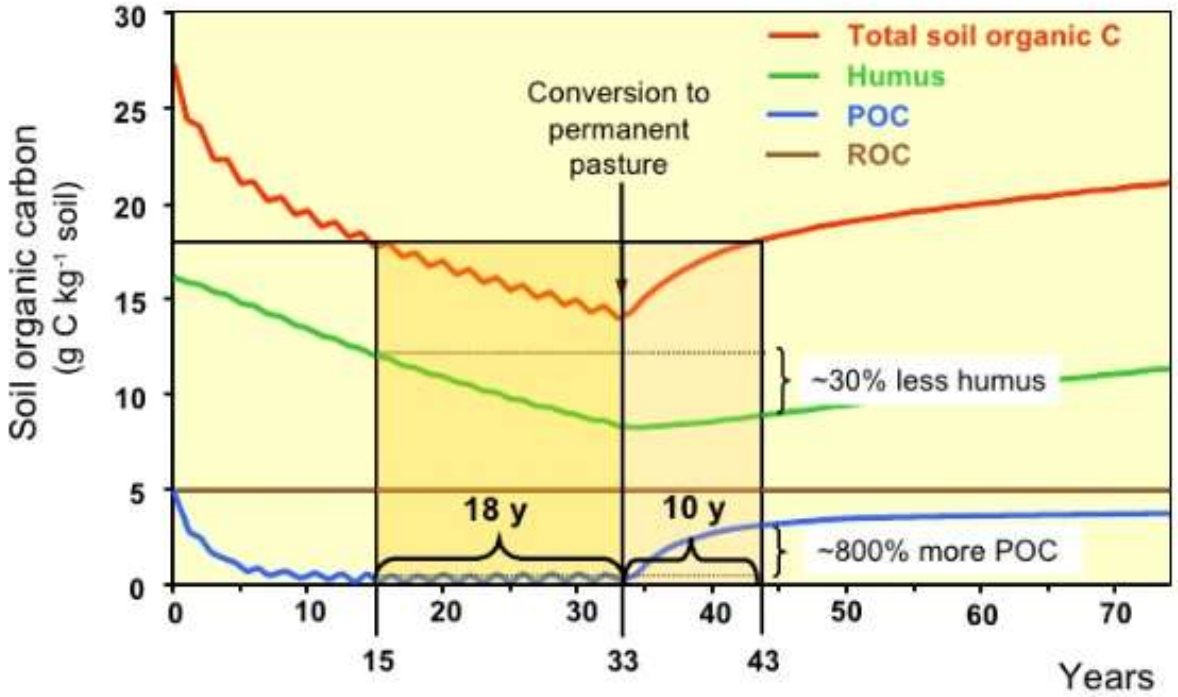
Apply the fundamentals and stick to it

- Consistency is key – what takes time to build can be lost in an instant



Baldock et al (2008)

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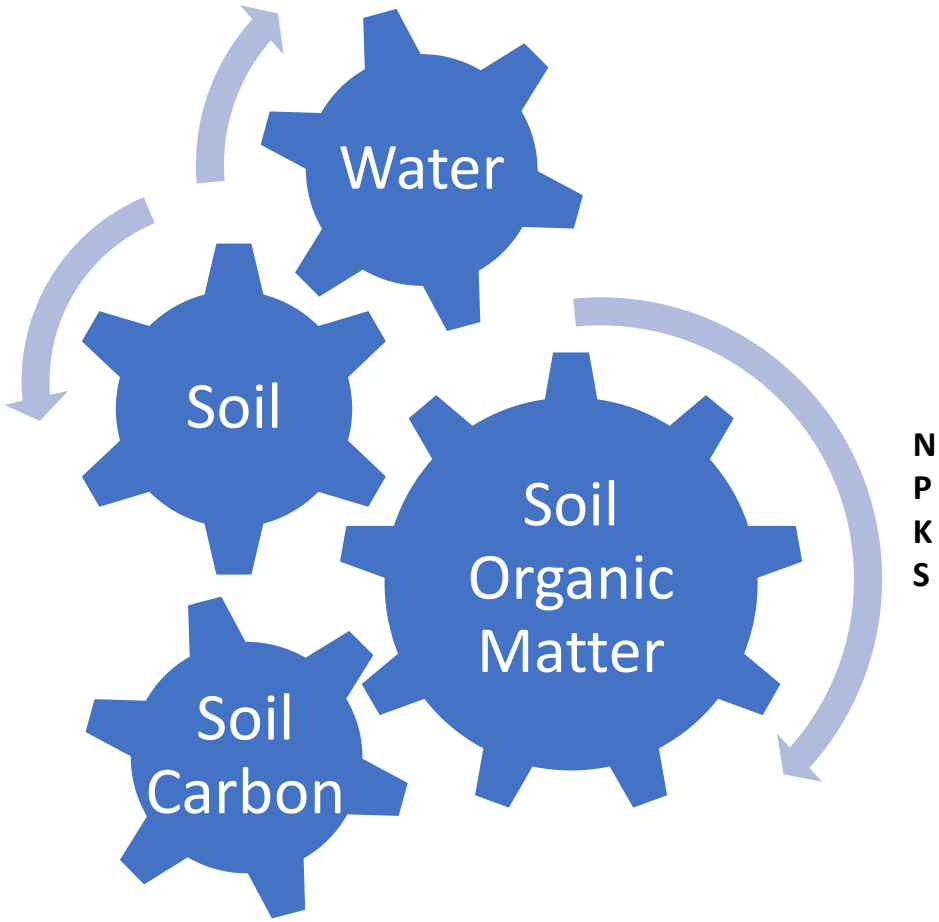
Kick your soils into Gear

- **Building Functional Soils**
- **Managing constraints and minimising loses**
- **Know your soils to grow your soils**



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