

# The science of soil health

Jenni Clausen DPIRD



GOVERNMENT OF  
WESTERN AUSTRALIA

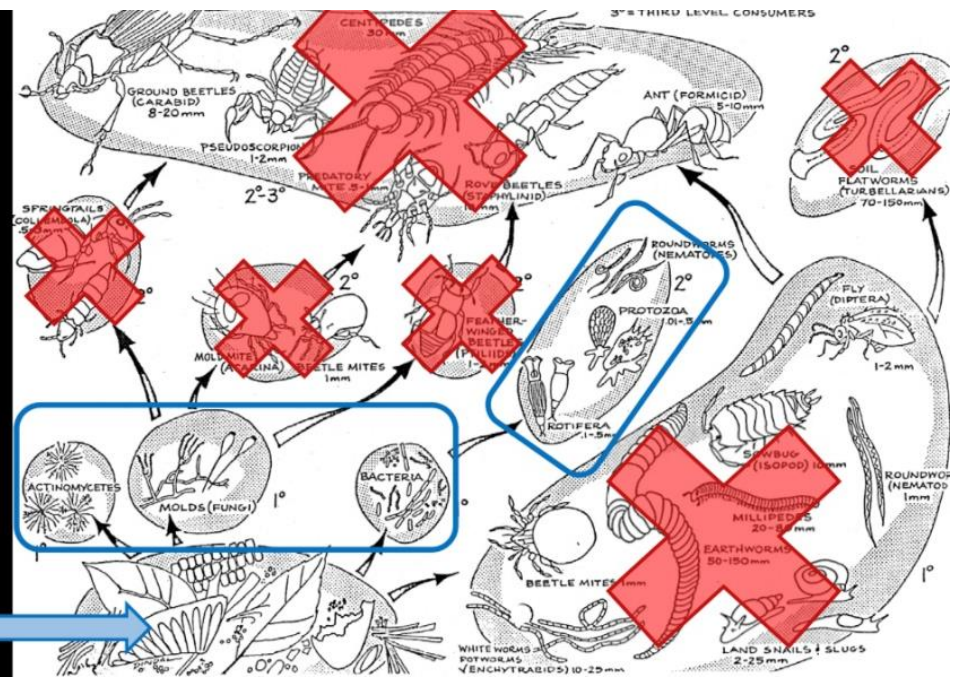
Department of  
Primary Industries and  
Regional Development

# Underpants experiments are taking place in Australian paddocks and gardens — all in the name of soil health

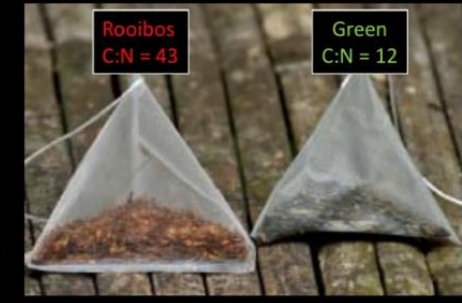
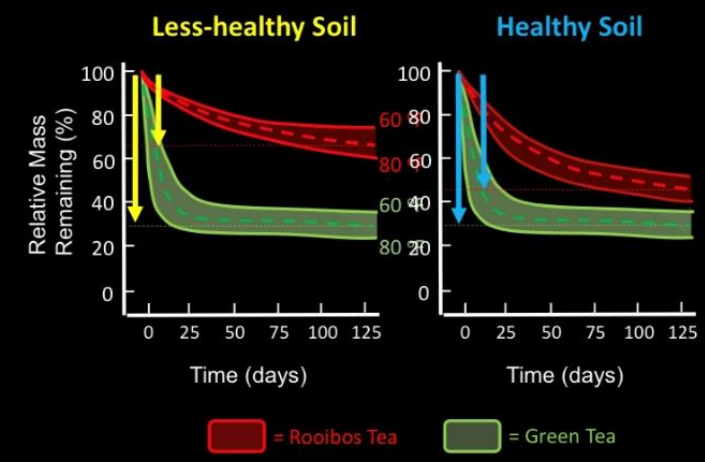
ABC Rural / By Megan Hughes



Can we bury tea to get at their health?



## Soil Decomposition Index (SDI) with two tea bags to measure Soil Health



Data adapted from Keuskamp et al. (2013)

The Intergovernmental Technical Panel on Soils (ITPS) defines soil health as

**“the ability of the soil to sustain the productivity, diversity, and environmental services of terrestrial ecosystems”.**

In managed systems, soil health can be maintained, promoted or recovered through the implementation of sustainable soil management practices.

As with human health, there is no single measure that captures all aspect of soil health.

**The preservation of these soil services requires avoiding and/or combating all types of soil degradation.**

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3	BD	Soil bulk density
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19	Leaching	Soil nutrient leaching

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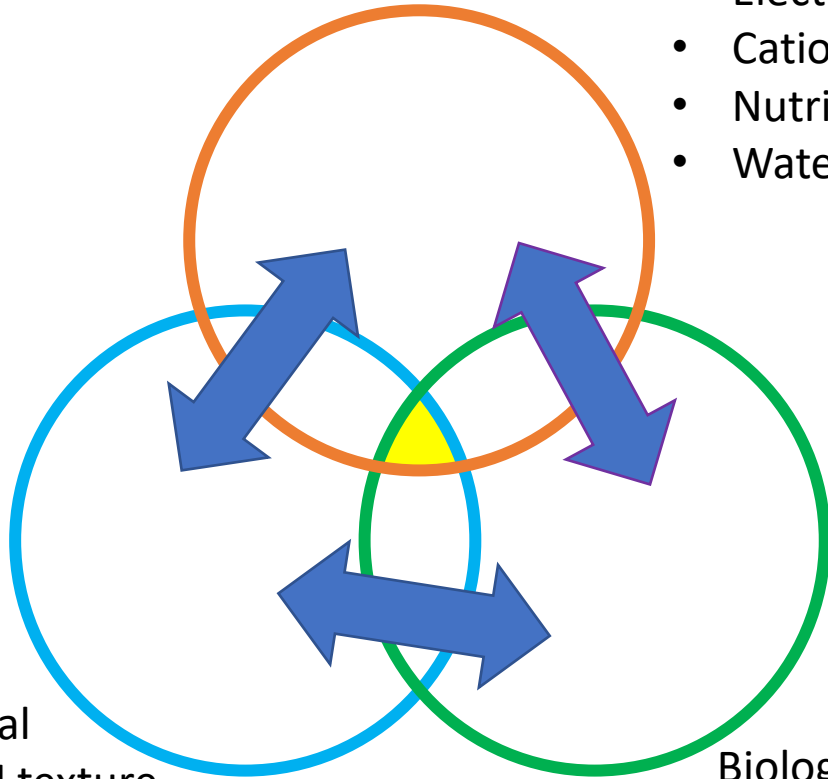
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## Chemical

- pH
- Electrical conductivity
- Cation exchange capacity
- Nutrients
- Water repellency

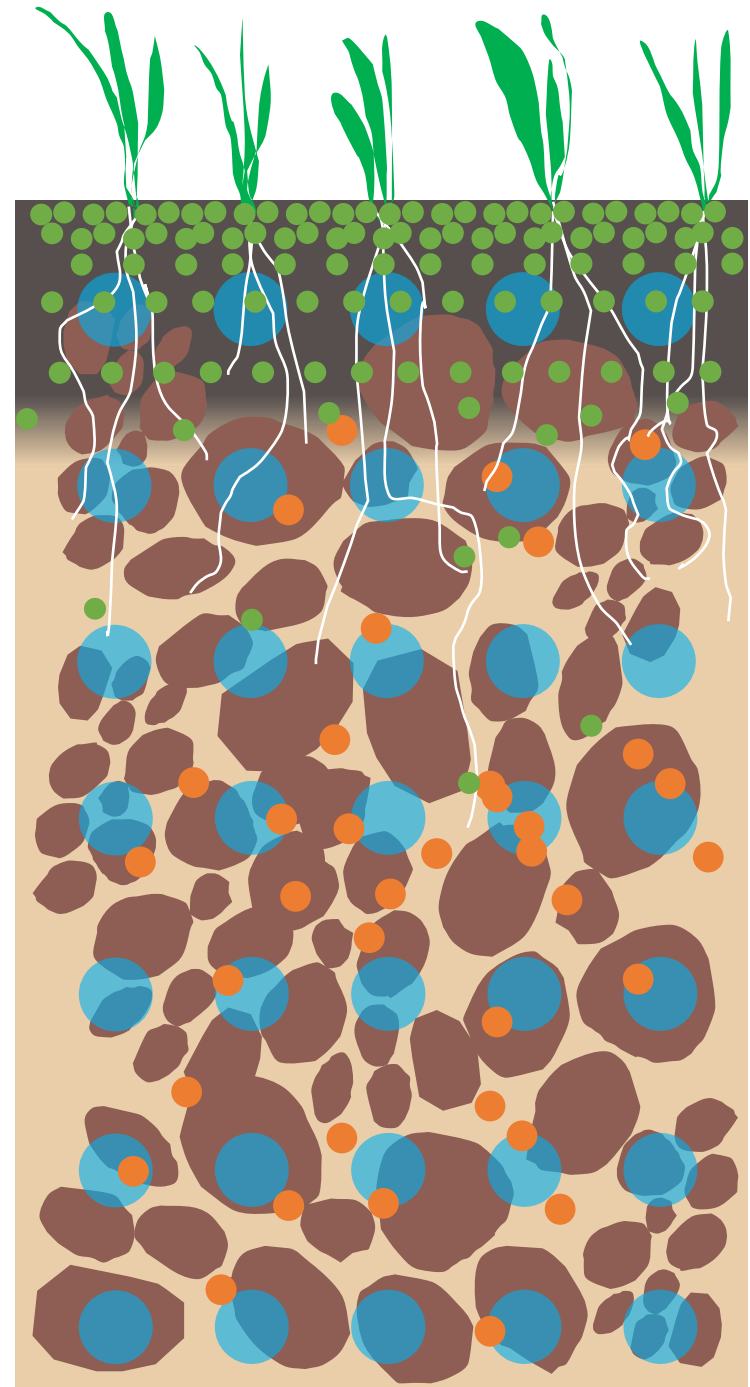


## Physical

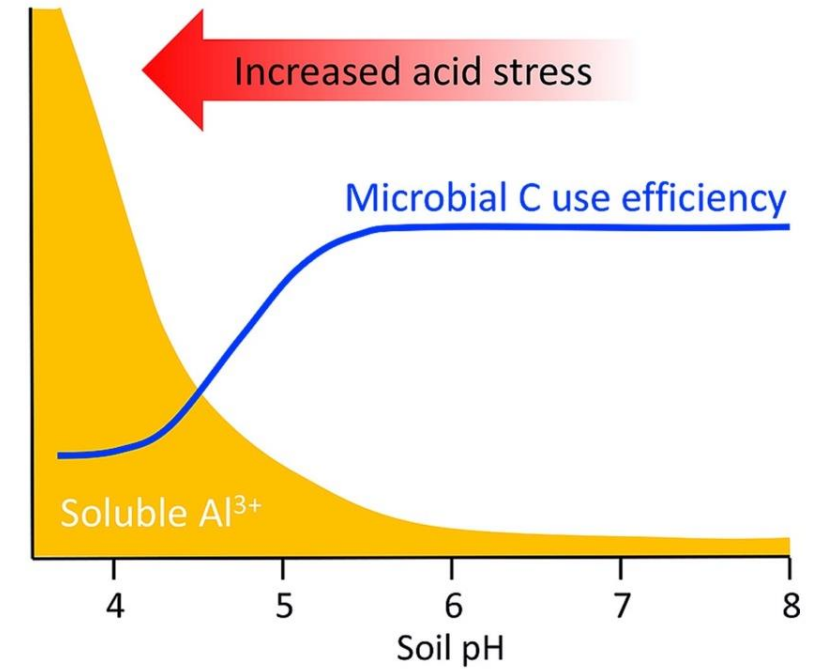
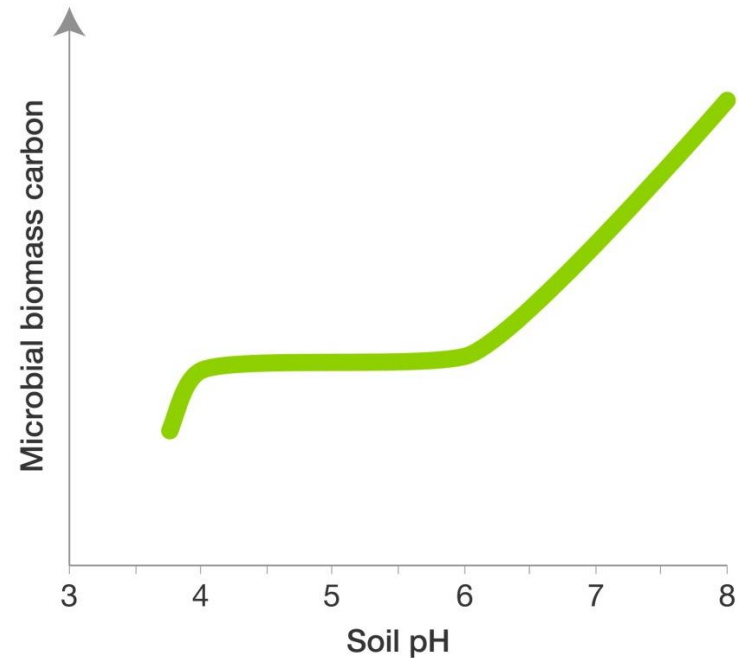
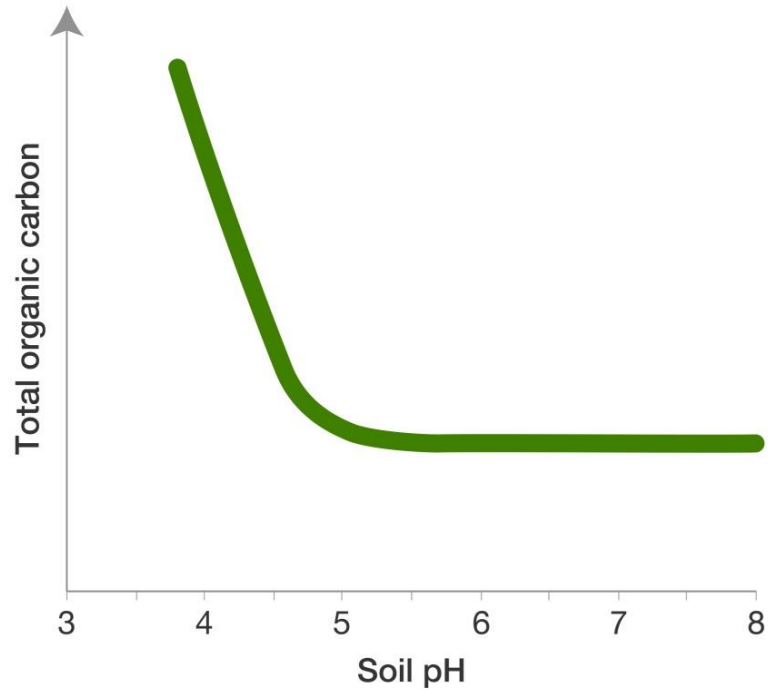
- Soil texture
- Bulk density
- Gravel content
- Water holding capacity
- Subsurface compaction

## Biological

- Total organic matter
- Labile organic matter
- Microbial biomass
- Microbial activity
- Soil N supply
- Diseases



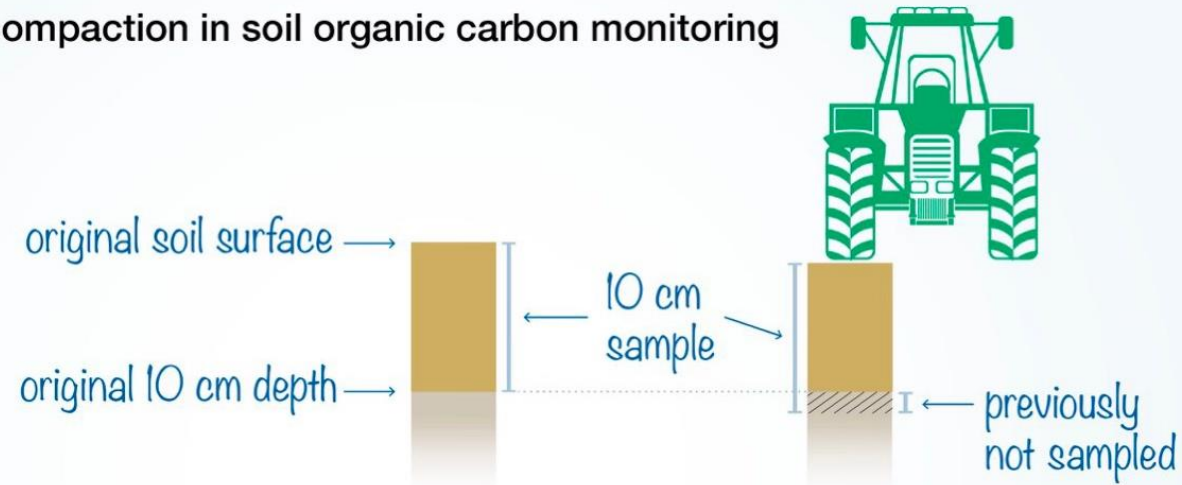
# Influence of soil pH on microbial functioning



# Soil carbon snapshot

- Carbon is one component of soil organic matter ( $OC\% \times 1.72 = SOM\%$ )
- Assumes 58% carbon
- Other parts include nitrogen, phosphorus, sulphur (hydrogen, oxygen)
  
- Soil is a sink and source
- Small changes incrementally to build

## Accounting for compaction in soil organic carbon monitoring



Bulk density (g/m <sup>3</sup> )		1.2	1.4
Mass soil 0–10 cm (t/ha)		1200	1400
Organic carbon (%)		1	1
Organic carbon (t/ha)	no adjustment	<b>12</b> (1200 × 1 %)	<b>14</b> (1400 × 1 %)
	adjusted for equivalent soil mass	<b>12</b> (1200 × 1 %)	<b>12</b> (1400 × 1 % × (1200 ÷ 1400))

~0.08% increase  
in OC% = 1 t C/ha

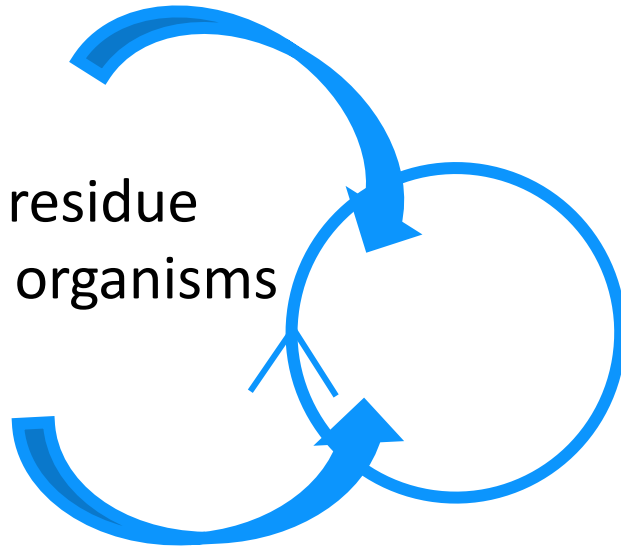
**Adjustment of organic carbon content for an equivalent soil mass associated with changes in bulk density and sampling depth.**

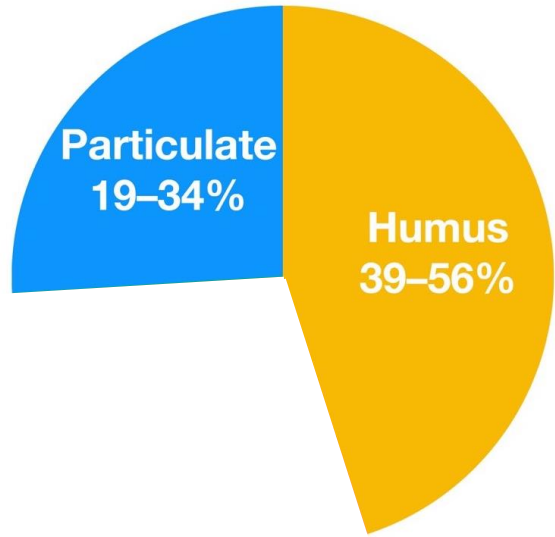
Compaction also occurs in subsurface layers so it is important to calculate the stock for any given depth using the same approach.

Particulate  
19–34%

Fresh residue  
Particulate labile  
2-5 years

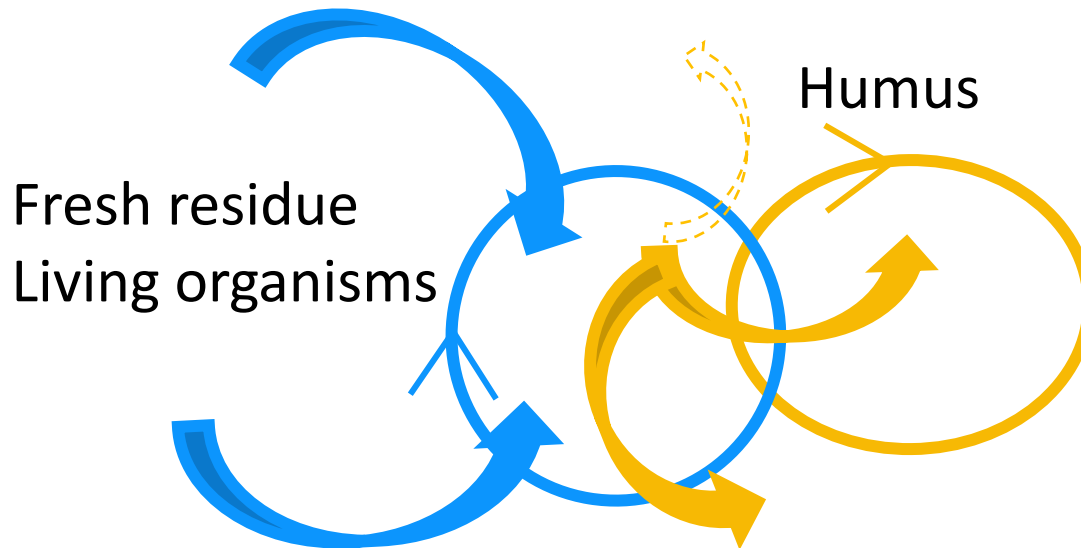
Fresh residue  
Living organisms



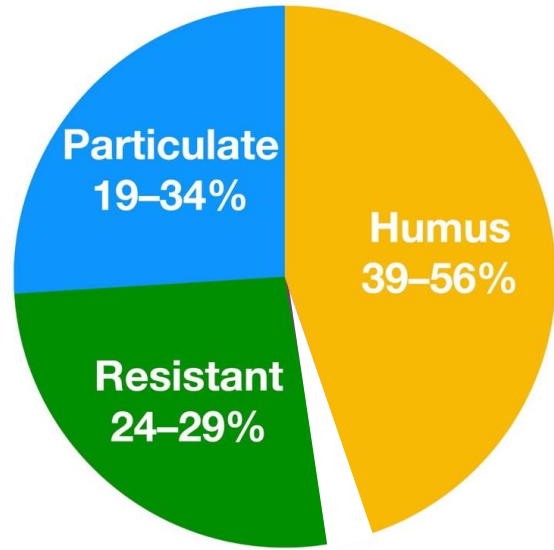


Fresh residue  
Particulate labile  
2-5 years

Humus slow  
20-40 years



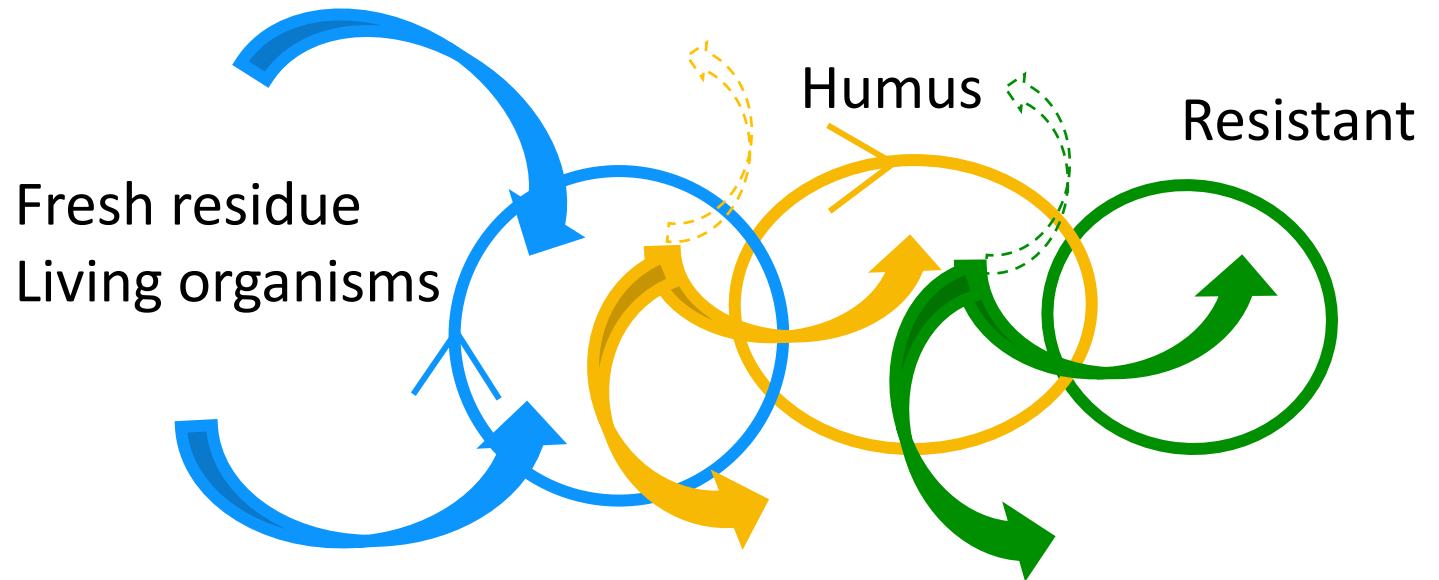


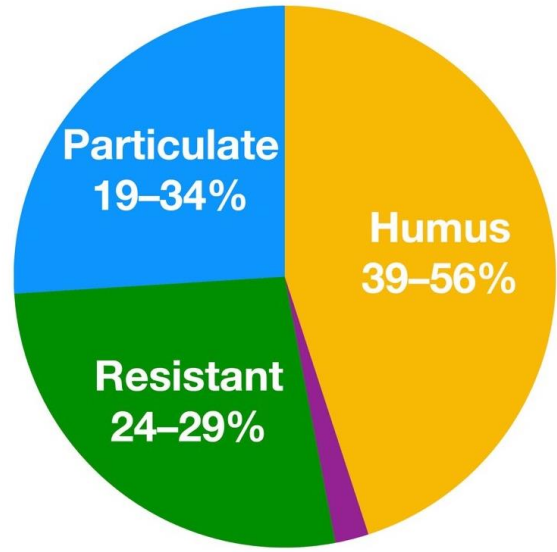


Fresh residue  
Particulate labile  
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Humus slow  
20-40 years

Resistant stable  
500-1000 years





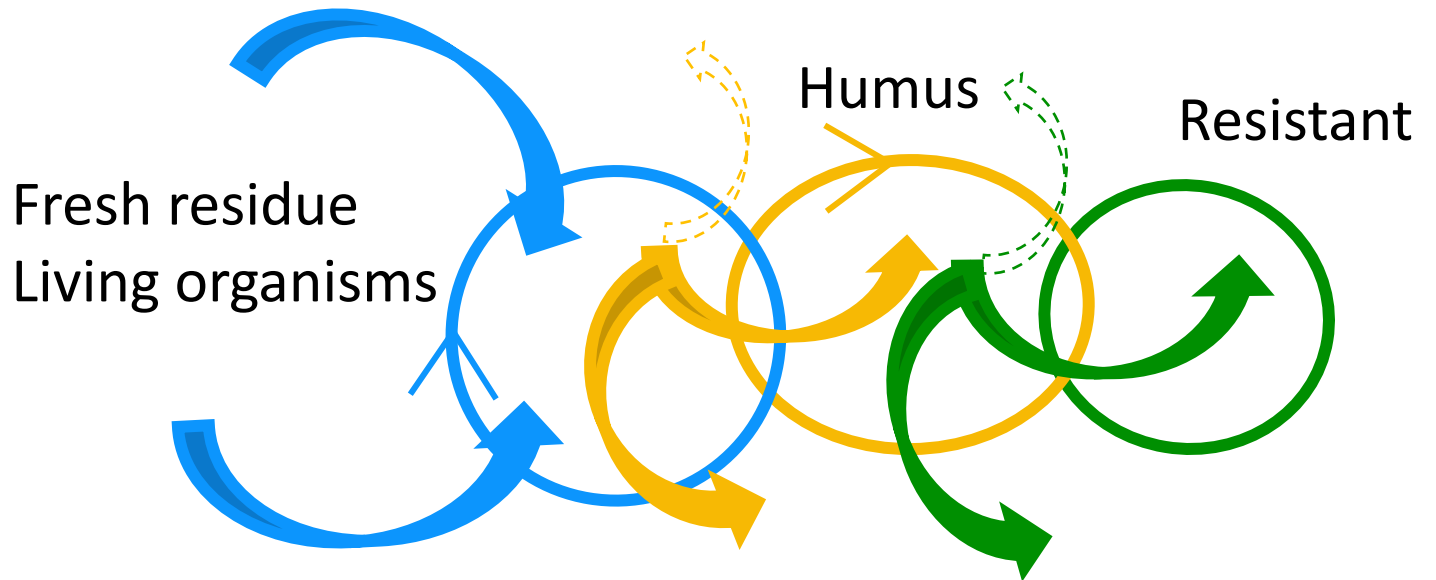
**Dissolved**  
less than 5%

Minutes-days

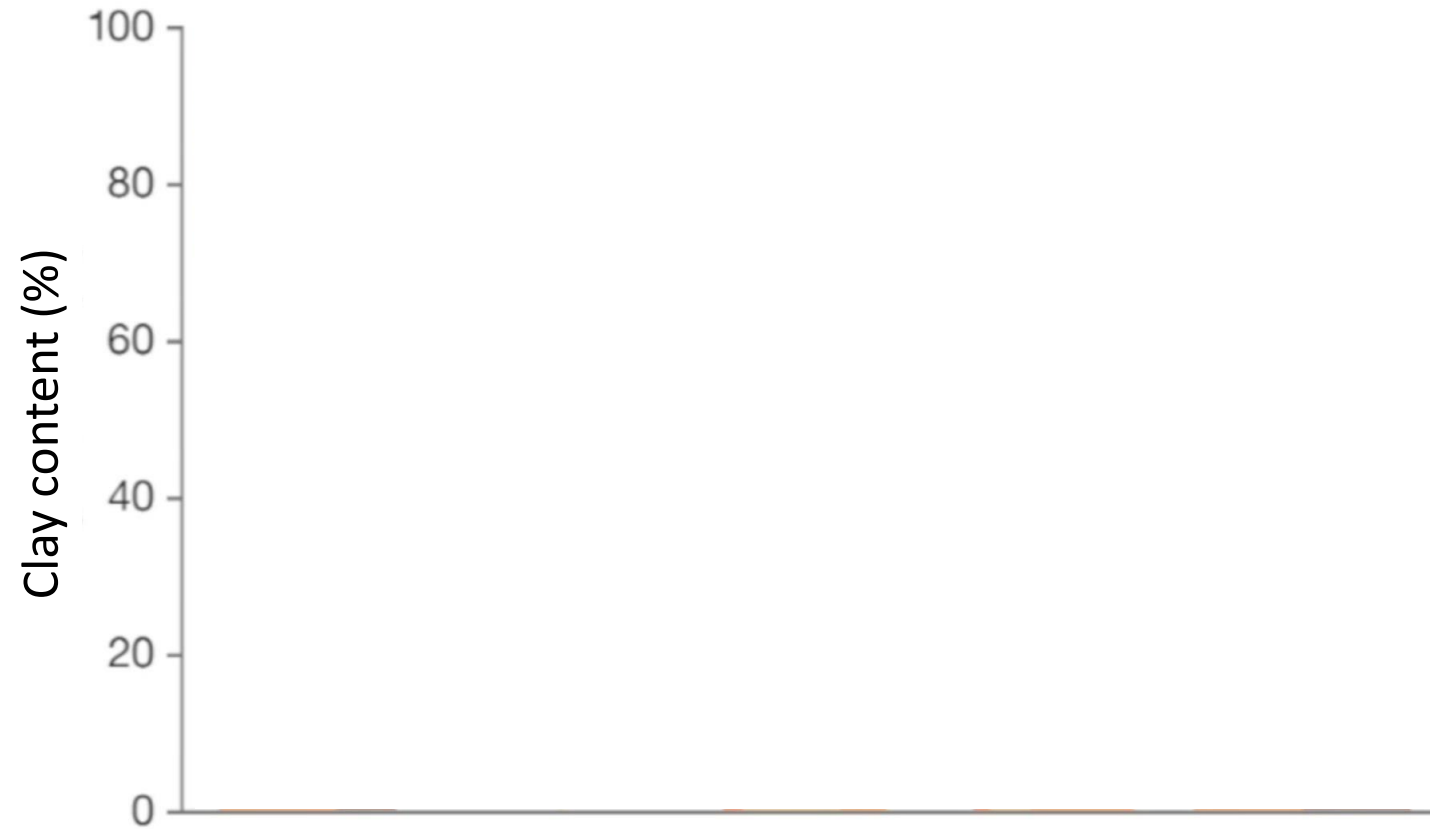
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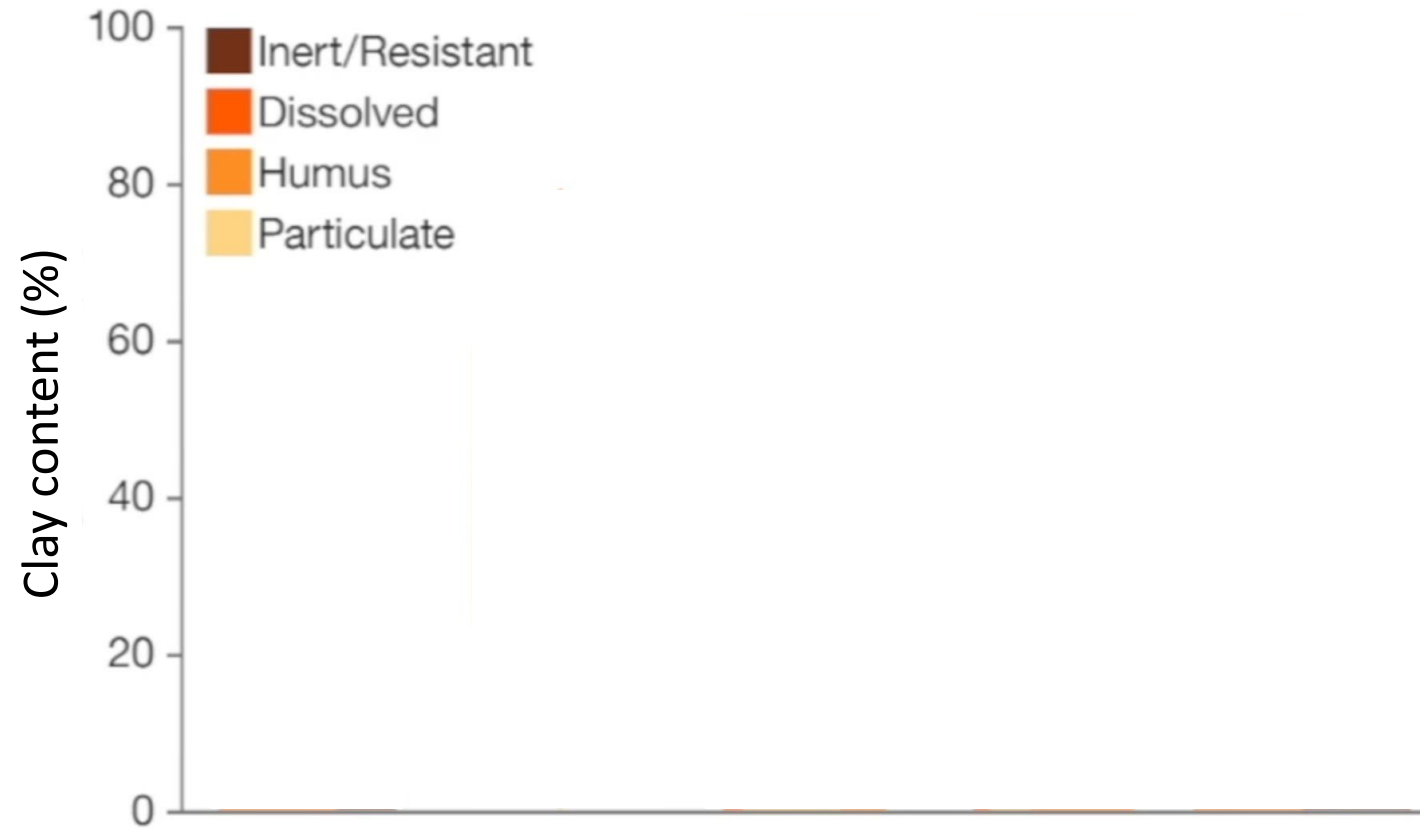
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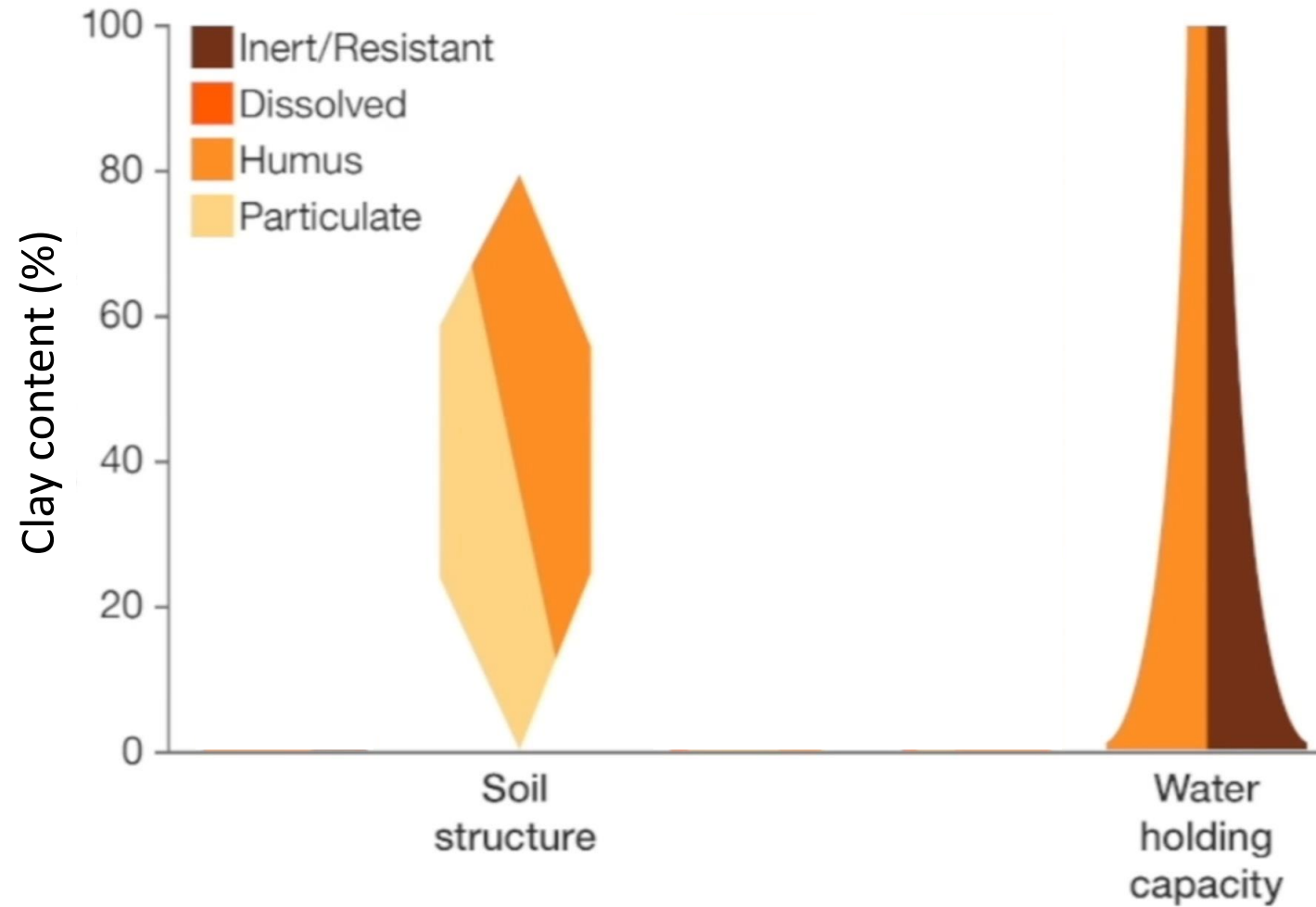
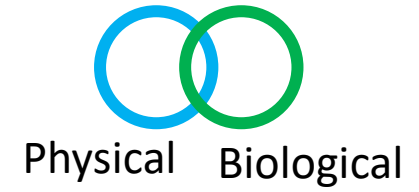
# Organic matter fractions on soil function



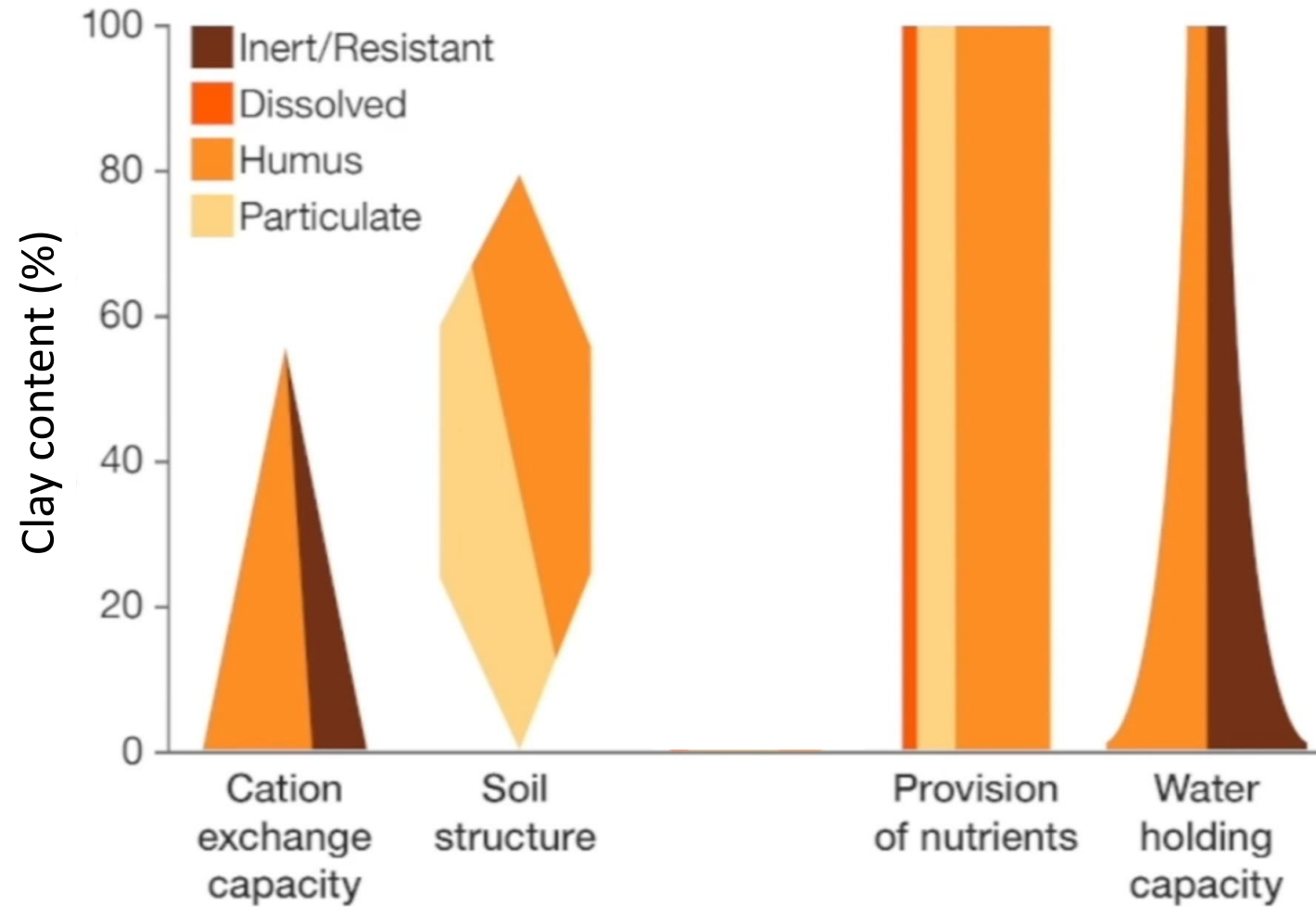
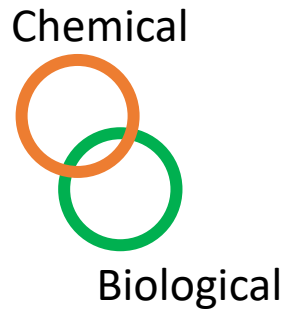
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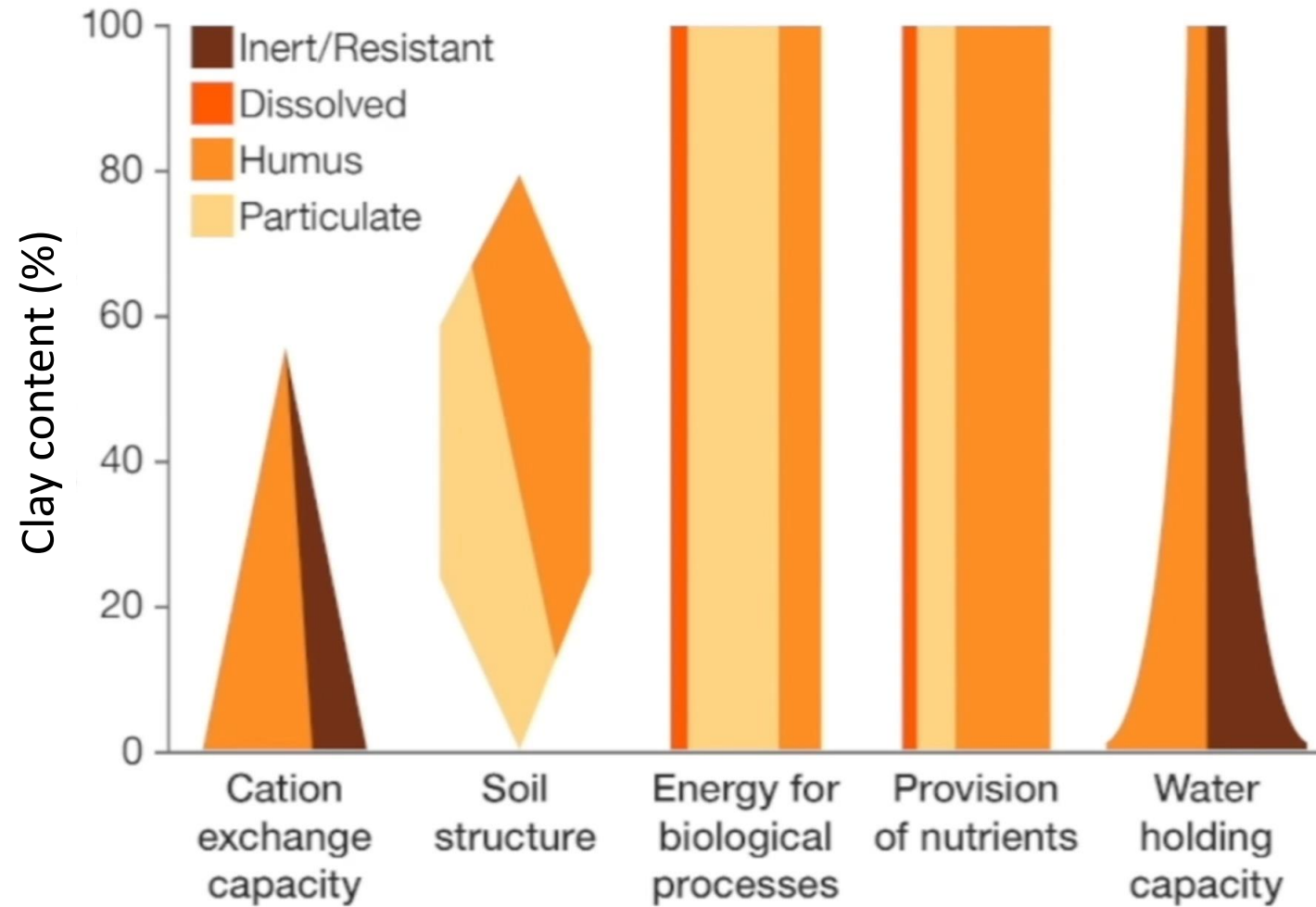
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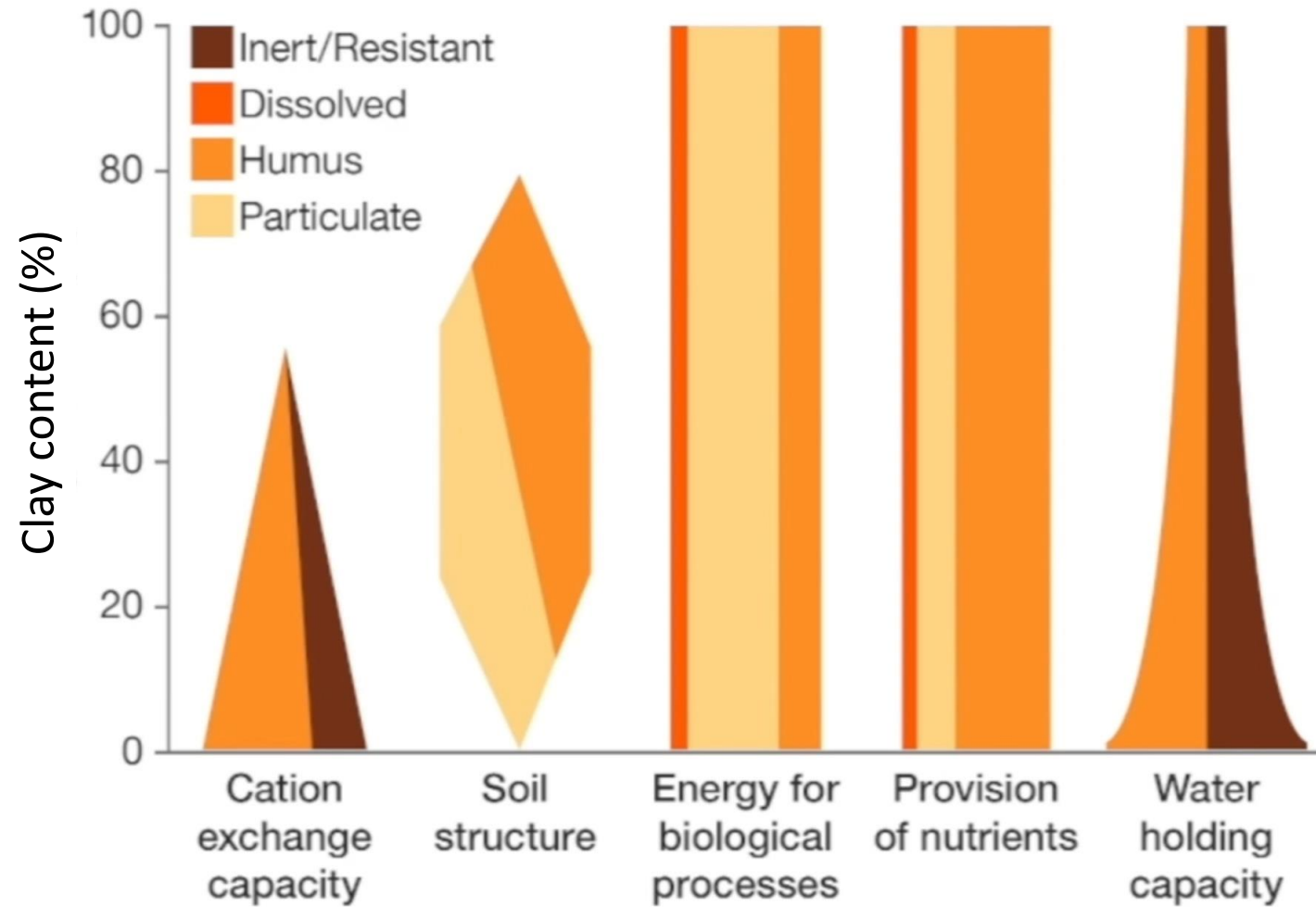
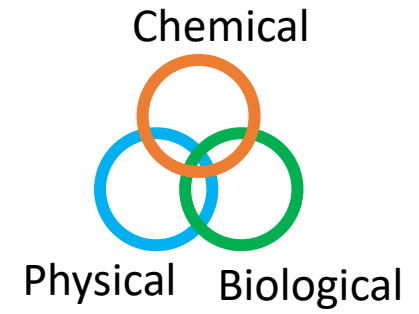
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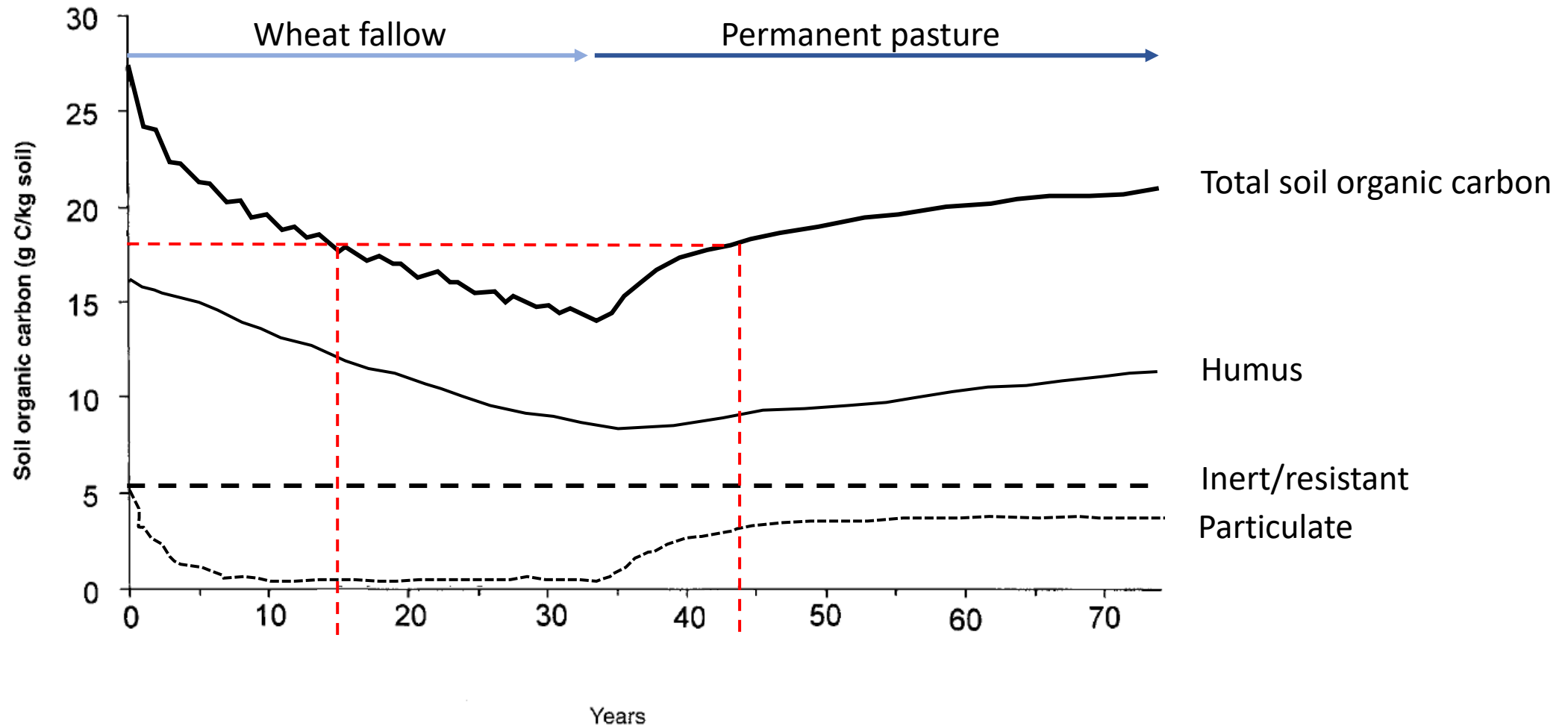


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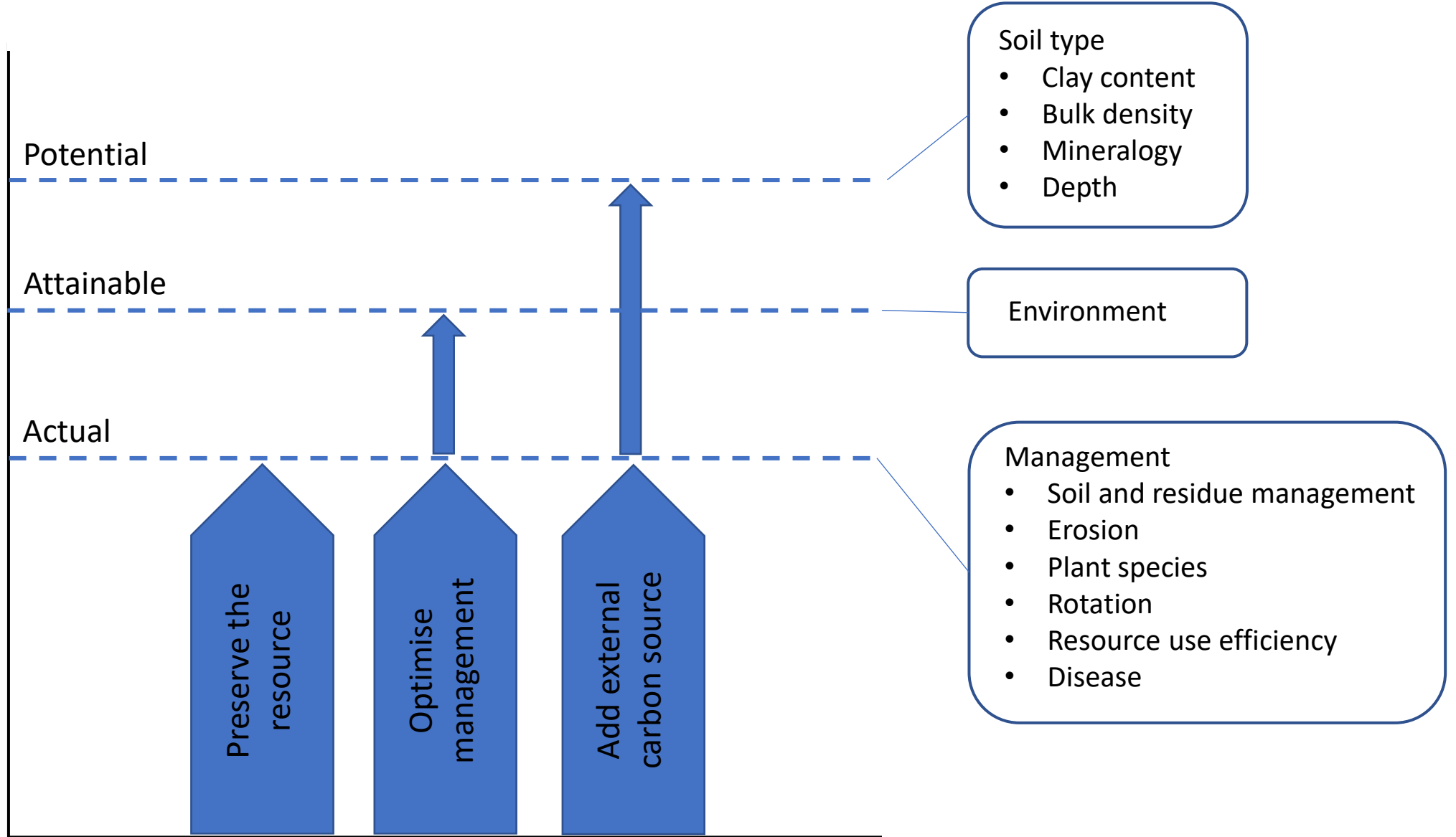


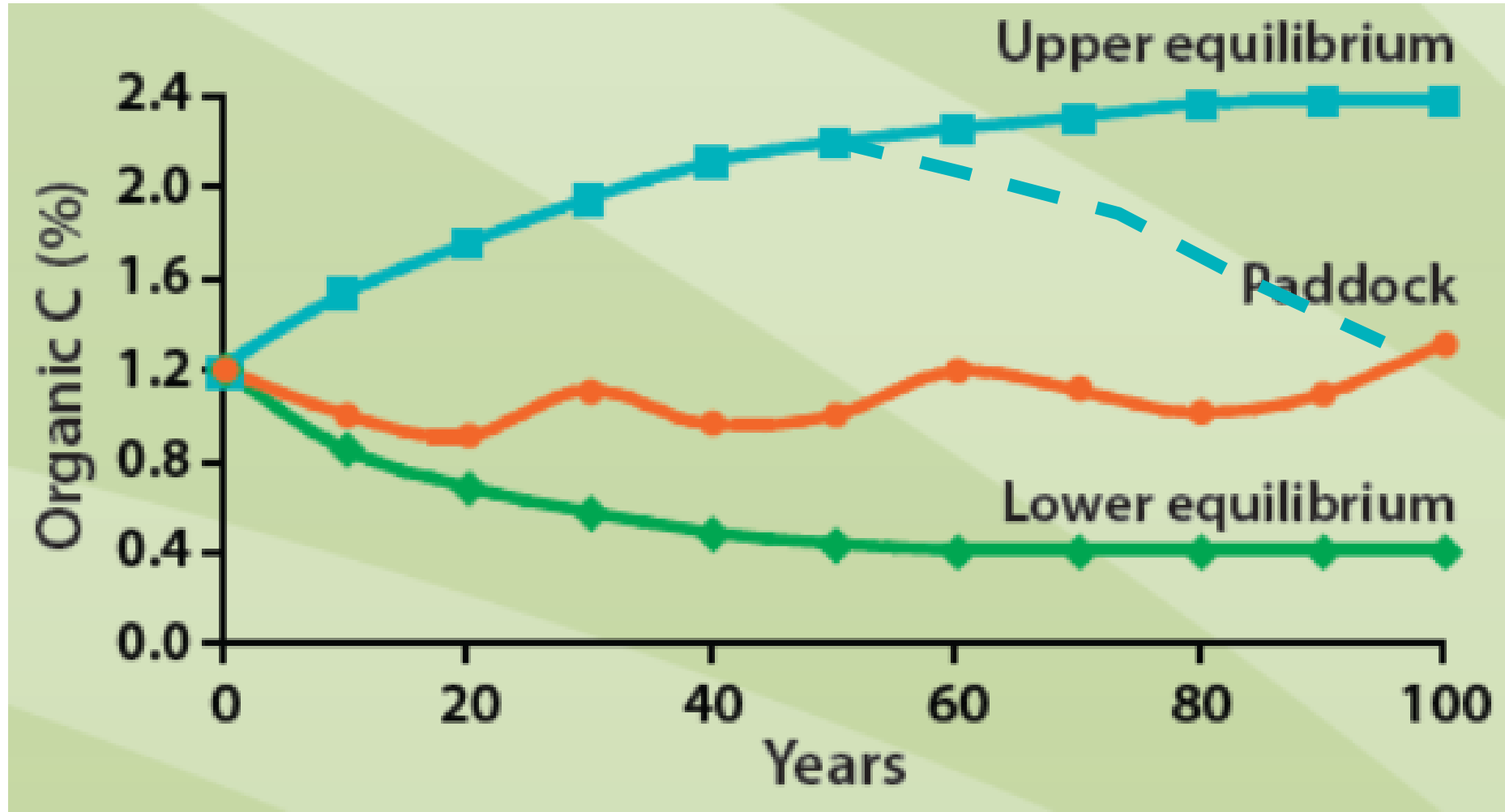


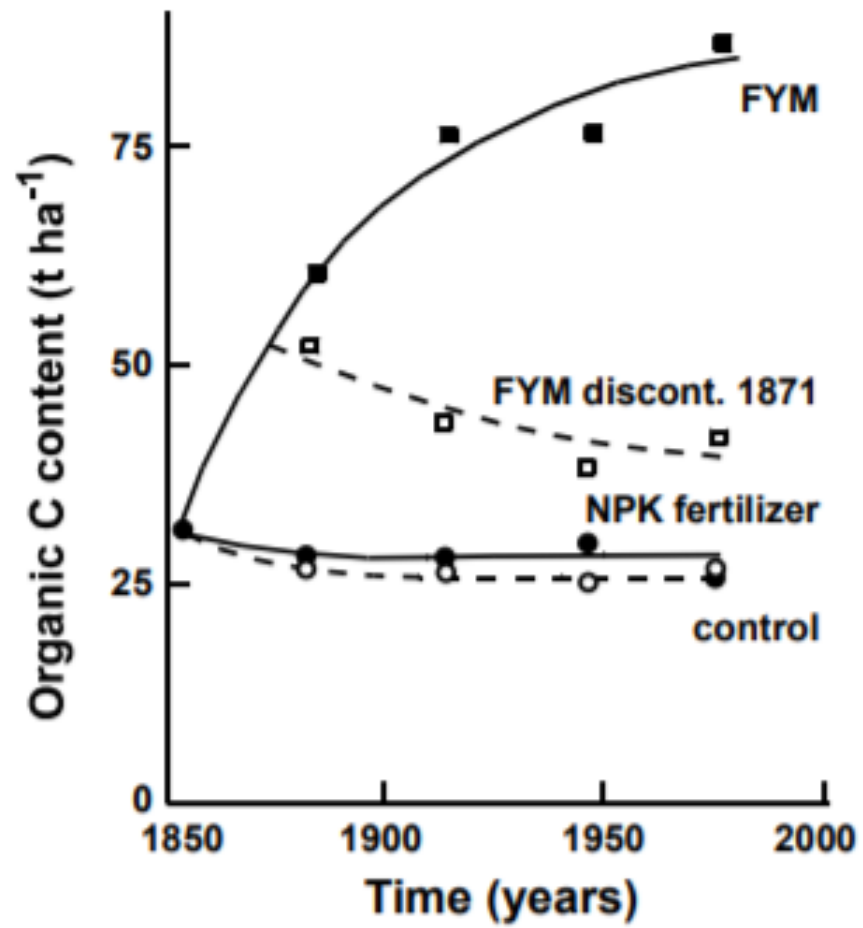
# Modelled example of change in rotation

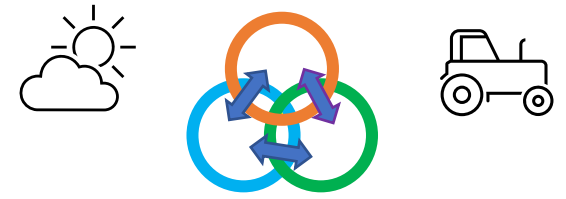
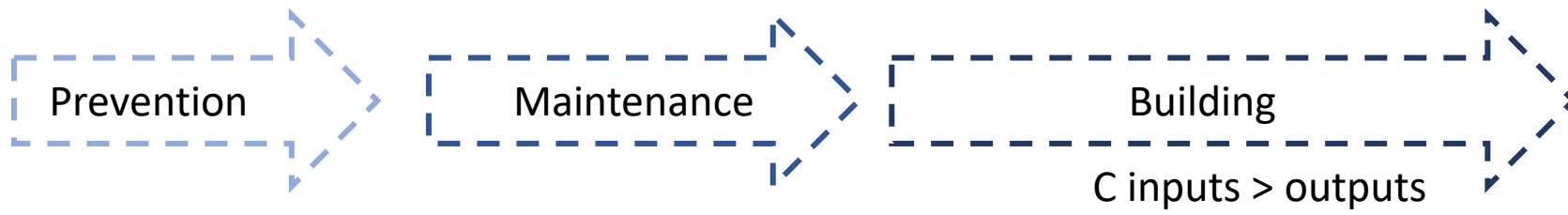


Soil organic matter



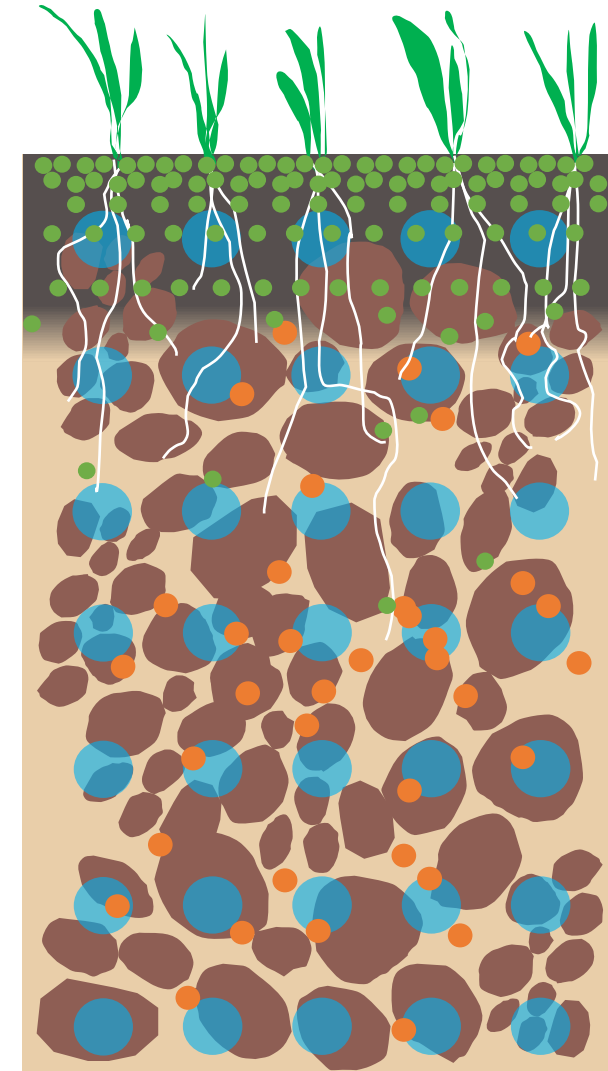






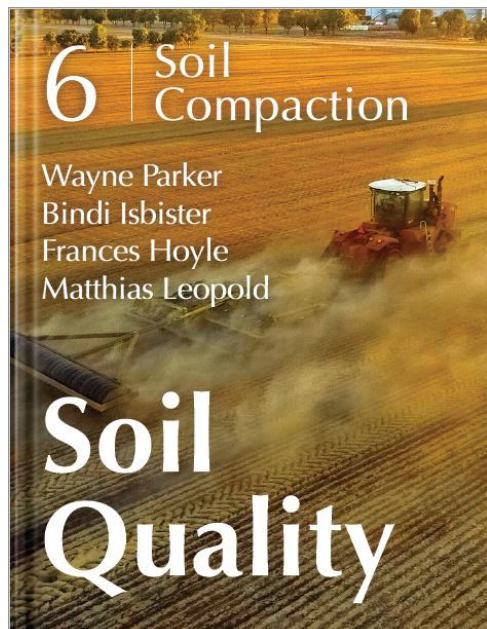
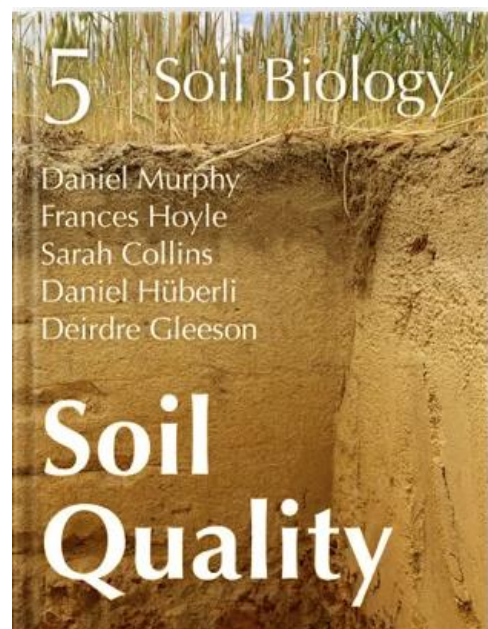
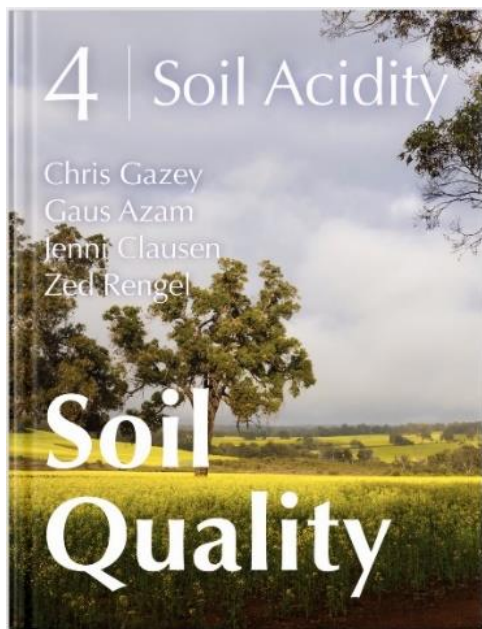
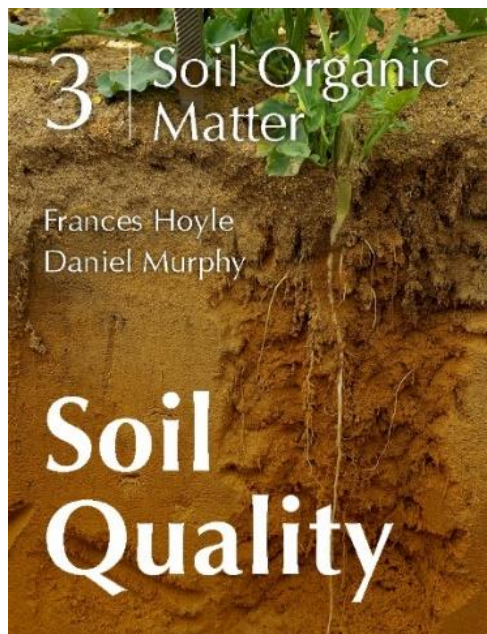
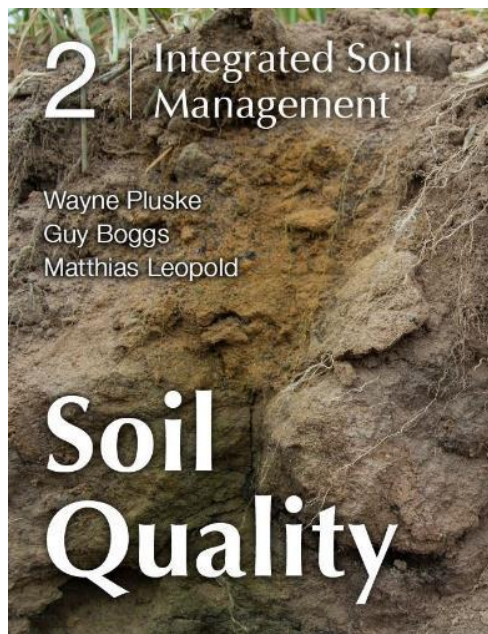
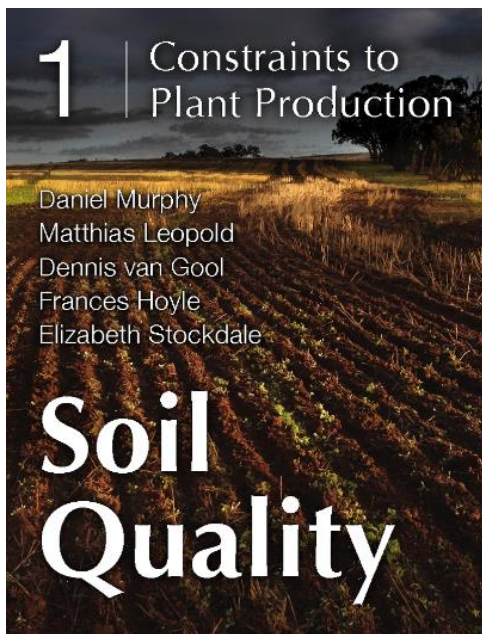
- Protect topsoil
- Minimising erosion
- Stubble management
- Sustainable grazing
- Minimise tillage

- Soil constraints management, CTF
- Improve WUE
- Diversity
- Fertility
- Alternatives to fallow
- Addition of carbon sources
- Conversion



# Summary

- Focus on the function for your system for soil health definition
- Biological, physical and chemical interact continuously
- Biology is affected by most limiting factor
- Small steps toward maintaining and growing your organic matter levels provides long term resilience to the system



## The Soil Quality ebook series

- 1 Constraints to Plant Production
- 2 Integrated Soil Management
- 3 Soil Organic Matter
- 4 Soil Acidity
- 5 Soil Biology
- 6 Soil Compaction
- 7 Soil Water Repellence
- 8 Sodic & Alkaline Soil
- 9 Soil Nutrition
- 10 Gravel Soil



# Thank you

Visit [dpird.wa.gov.au](http://dpird.wa.gov.au)

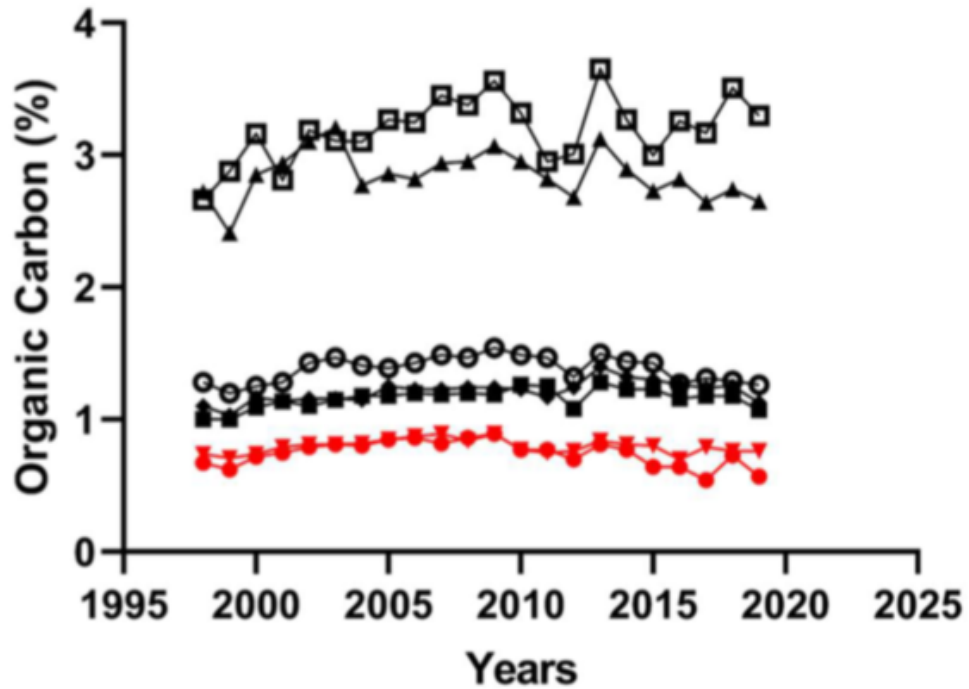
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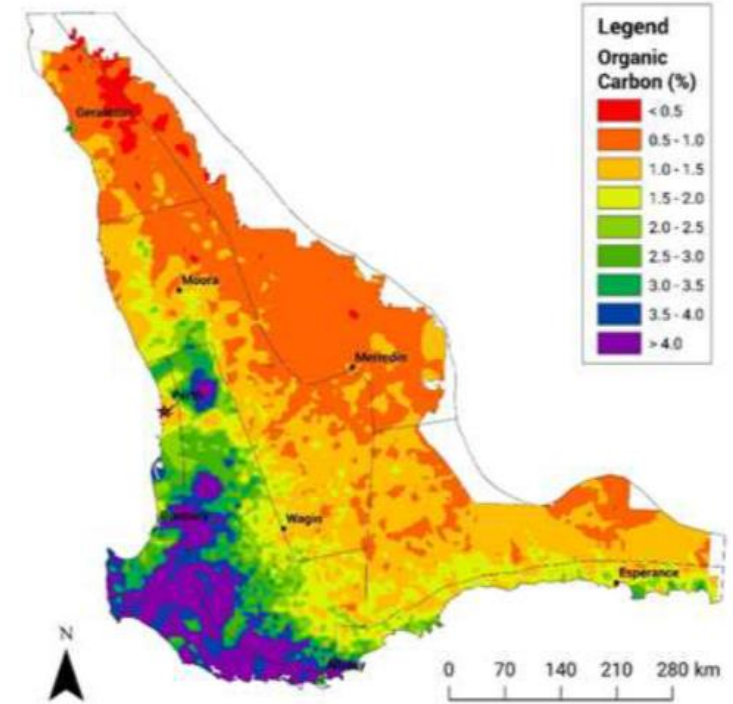
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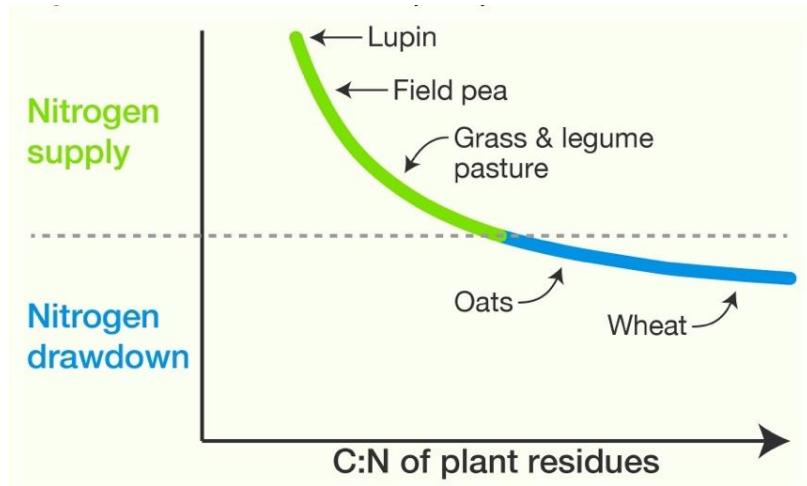


### Long-term median OC trends for topsoils



- Agzone 1
- Agzone 2
- ▲ Agzone 3
- ▼ Agzone 4
- ◆ Agzone 5
- Agzone 6
- VHR zone





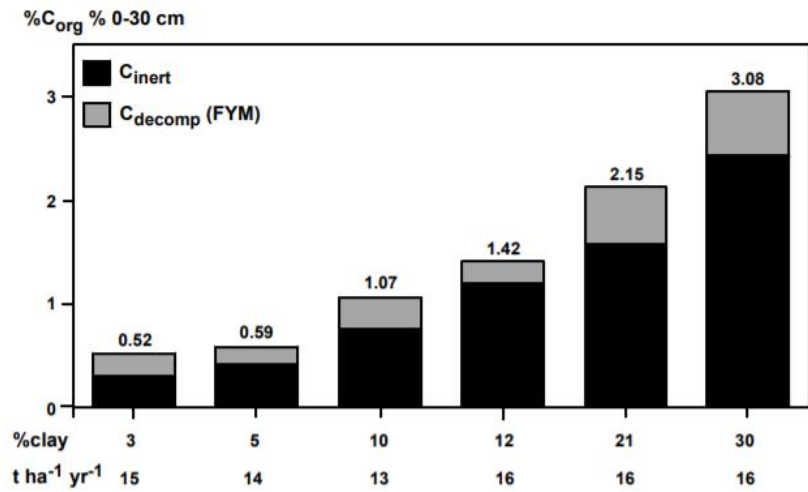


Figure 10: Influence of clay content and farmyard manure application on the inert and decomposable organic carbon content in selected long-term field experiments (from Körschens et al., 1998).

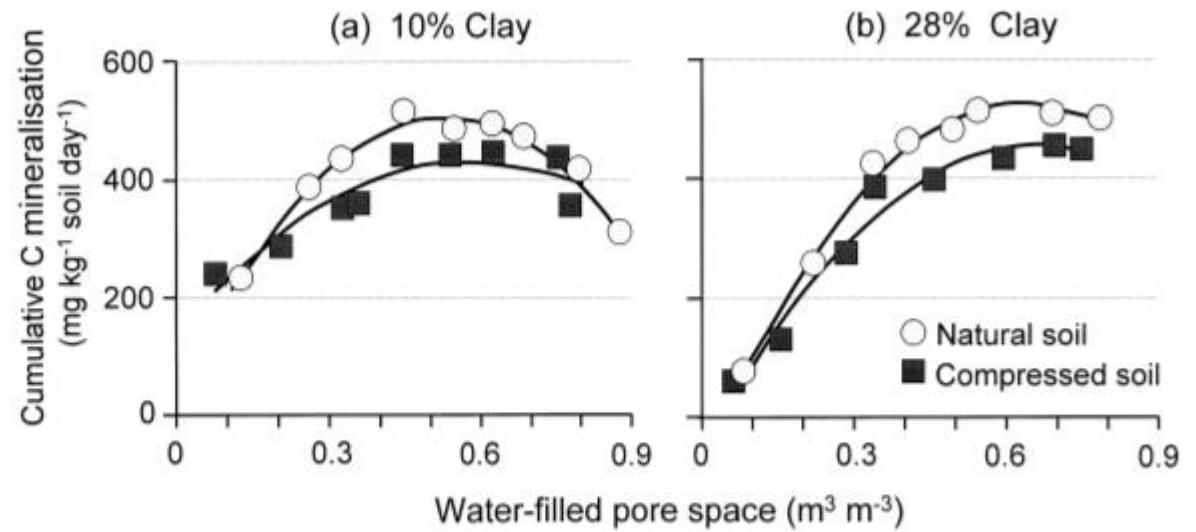


Figure 8: Changes in mineralisation of C with changes in air-filled porosity and for uncompressed and compressed soils with (a) 10% and (b) 28% clay (modified from Franzluebbers, 1999).