

SOC – The overlooked nutrient

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Soil Fertility Conference
19/10/2016

Soil Organic Carbon

Soil Organic Matter Fraction	Particle Size (mm)	Turnover Time (years)	Description
plant residues	≥ 2.0	< 5	recognizable plant shoots and roots
particulate organic matter	0.06 – 2.0	< 100	partially decomposed plant material, hyphae, seeds, etc
soil microbial biomass	variable	< 3	living pool of soil organic matter, particularly bacteria and fungi
humus	≤ 0.0053	$< 100 - 5000$	ultimate stage of decomposition, dominated by stable compounds

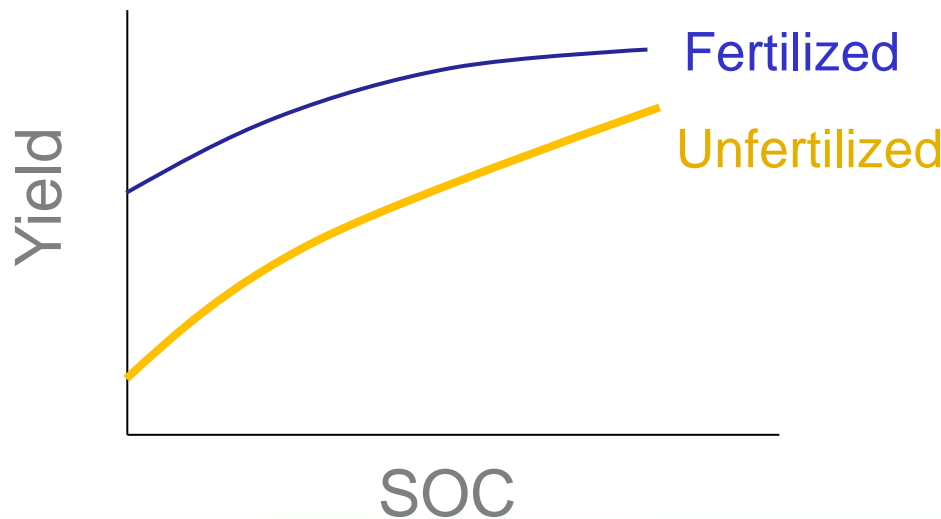
Impacts of organic matter on soil fertility

- Increases soil CEC allowing better retention of ammonium-N, K, Ca and Mg
- Chelates other micronutrients
- Keeps P available at high and low Ph
- Buffers soil, preventing rapid pH change
- Reduces bulk density and thus compaction and runoff
- Improves soil water-holding capacity

Impact of SOC on yield

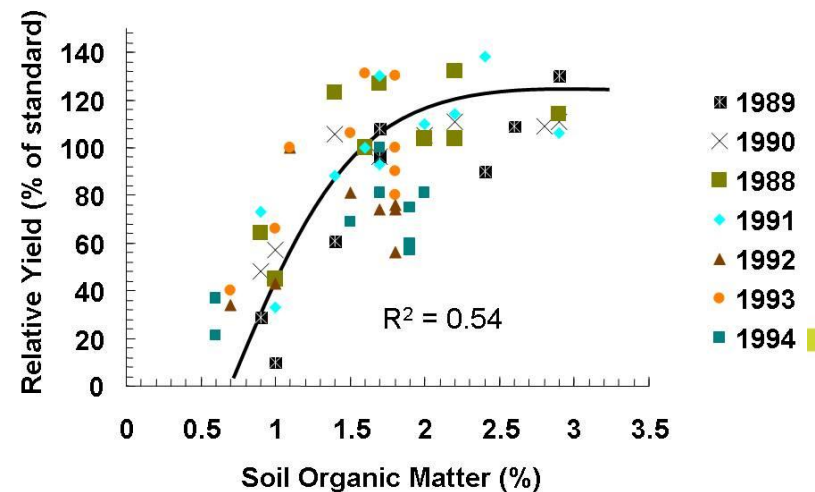
Yield increases as SOC increases

Yield differential between fertilised and unfertilised decreases with SOC



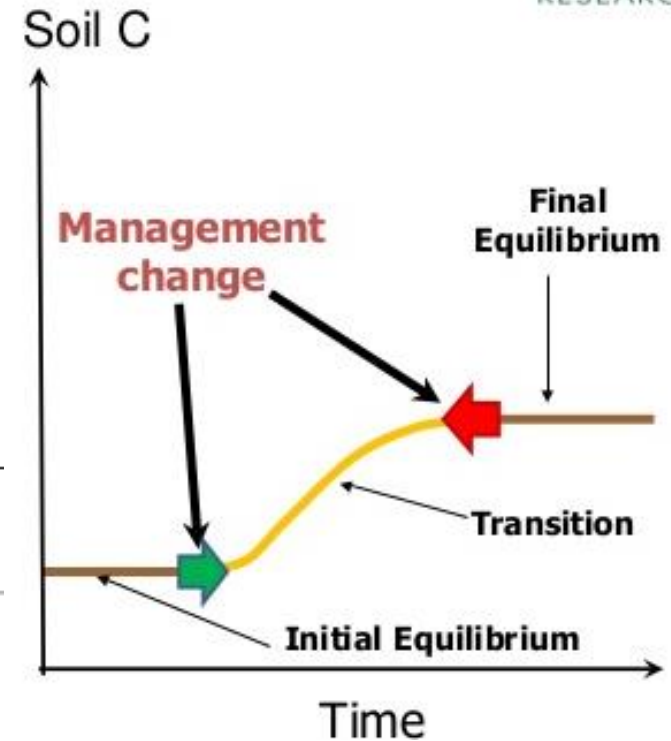
SOC %	Grain yield t ha ⁻¹	Olsen P to achieve 95% yield
Field experiment (spring barley)		
1.40	5.00	16
0.87	4.45	45

Johnston et al. 2009 Adv. Agron. 101: 1-57

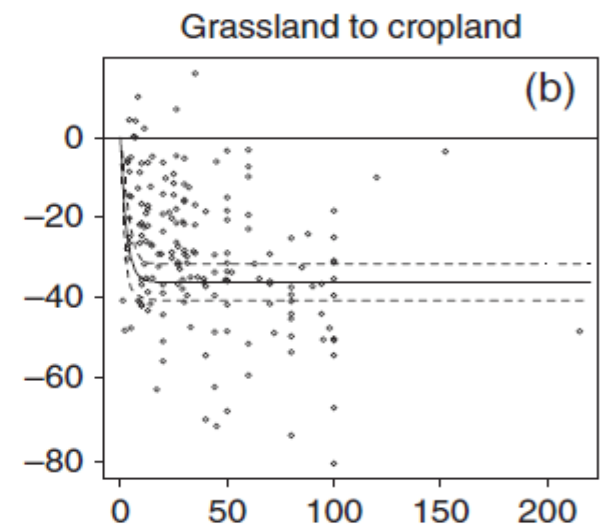
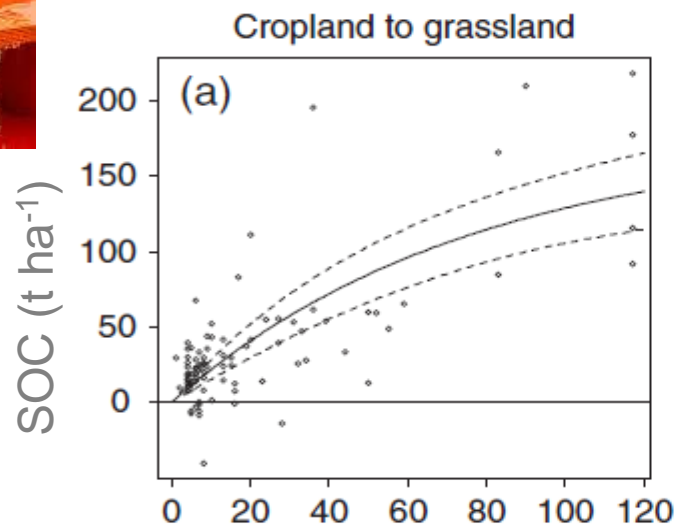


Land-use Change – C Equilibrium

- Sequestration is finite – move towards a new equilibrium
- Its reversible – depends on maintaining change in management practice
- When grassland/forestry is converted to arable – C is lost quite rapidly and reaches a new equilibrium after 20-30 years
- Measures that increase SOC tend to take much longer to build stocks up

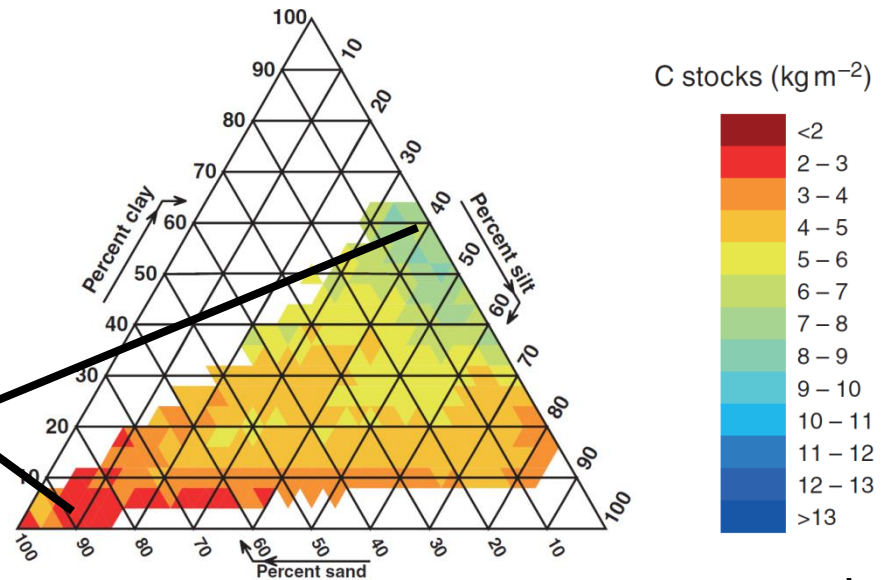


Poepplau et al. 2011 GCB



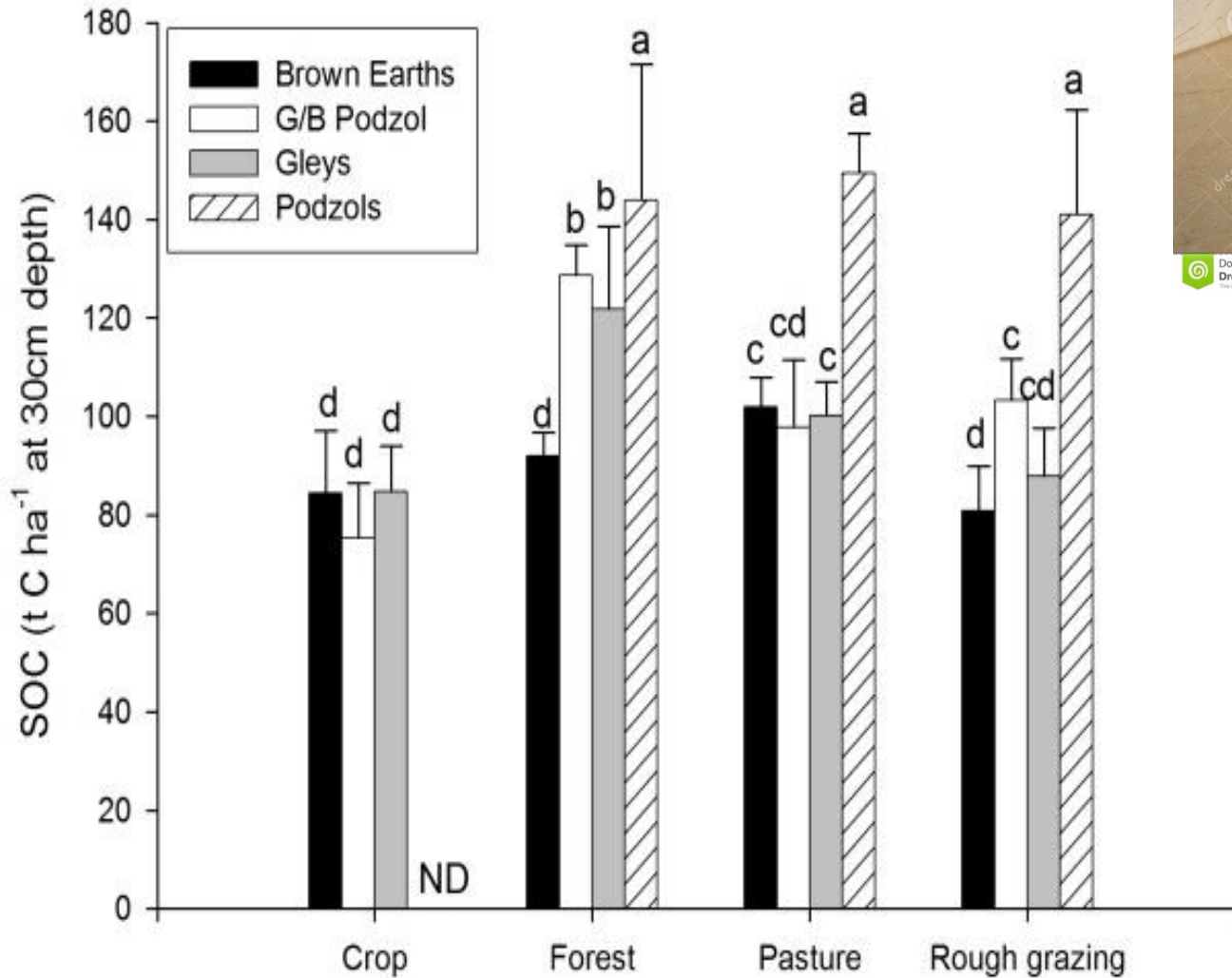
Influence of Soil Type

Soil type has a large impact on the size of the sink
More clay = more permanent sequestration



Arrouays et al., 2006

Impact of soil type and land use



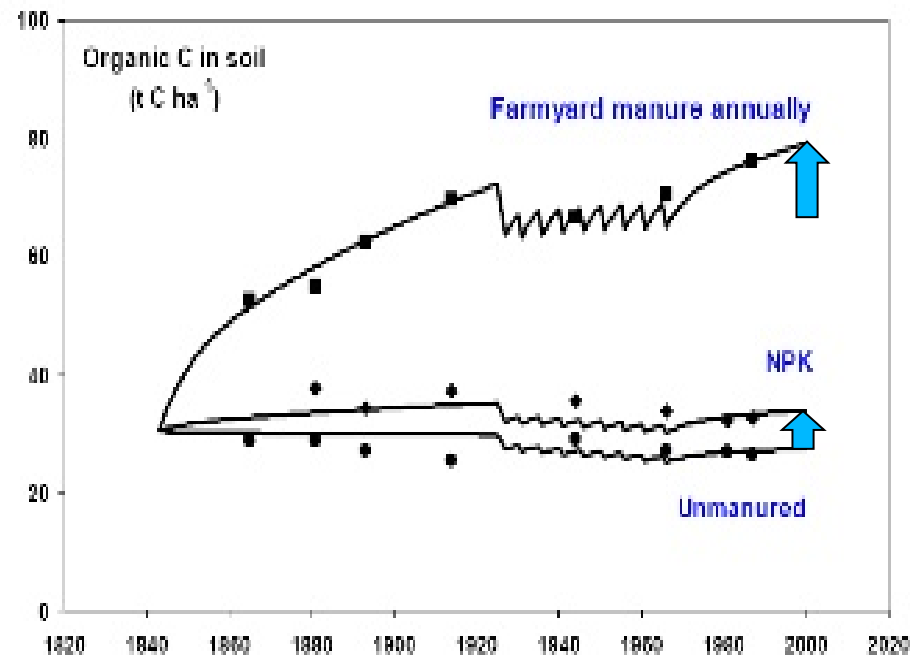
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Manure and fertilizer Addition

- Manure can increase SOC as 25% of applied manure C is retained
- Fertilisation increases crop yield and also increases root and residue C input into soil

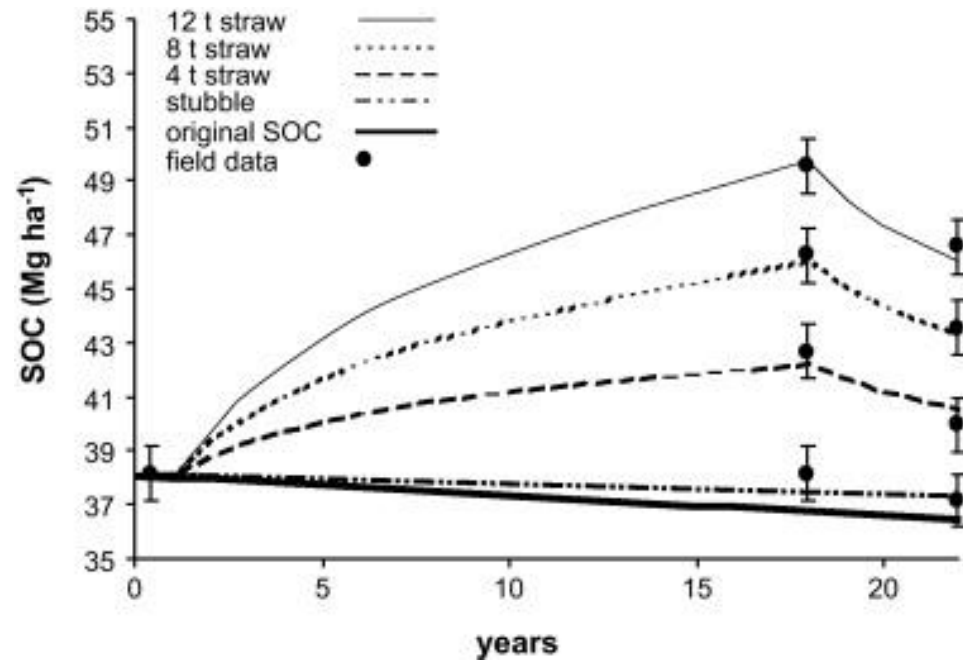


Manure type	% DM	Application rate*	Carbon addition (t/ha)
Cattle slurry	6	25 m ³ /ha ^a	0.6
Pig slurry	4	25 m ³ /ha	0.4
FYM	25	25 t/ha	2.5
Poultry (layers manure)	55	5 t/ha	1.1
Spent Mushroom Compost	32	20 t/ha	2.6

* Application rates are governed by SI 101 2009 and these rates may not be allowed in all circumstances.

Straw incorporation

- Estimated that 20% of straw C remains in the soil
- 8% increase in soil C @ 4t straw over 20 years or 22% @ 12 tonnes
- Can get 40% increase in microbial biomass even under low levels of incorporation

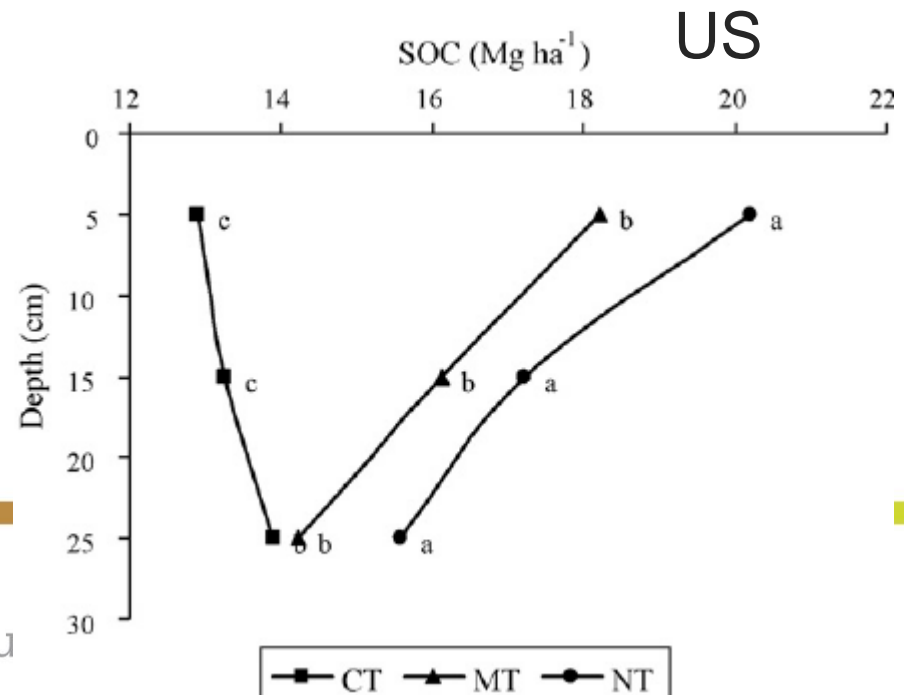
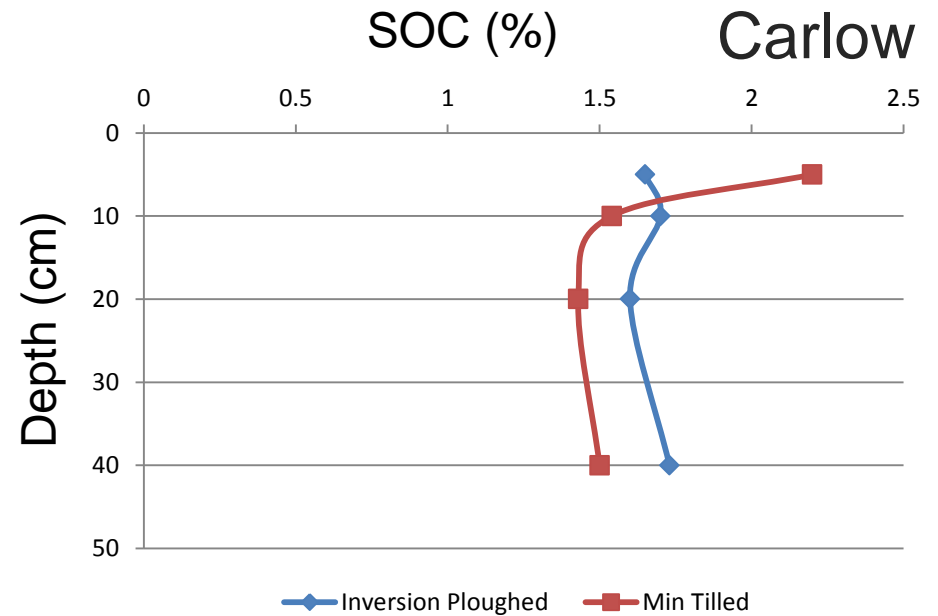


Van Groenigen et al. 2011

Minimum Tillage

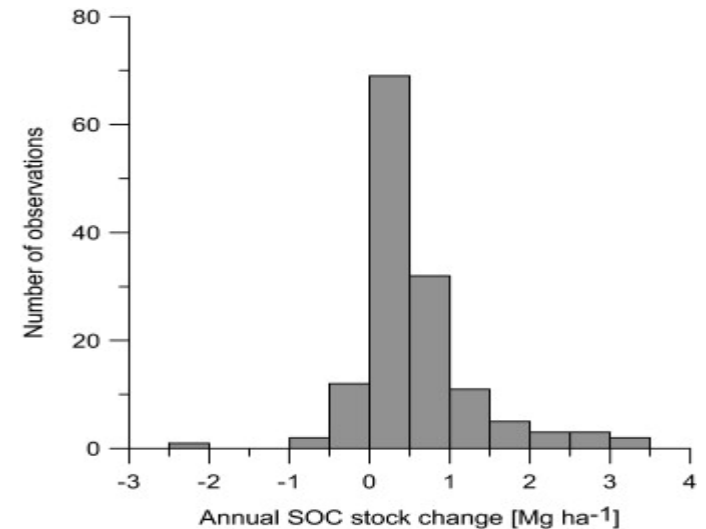
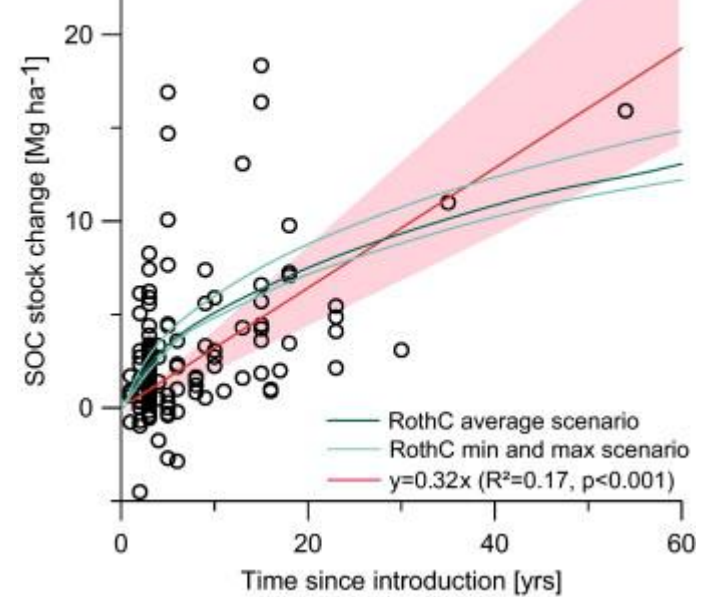
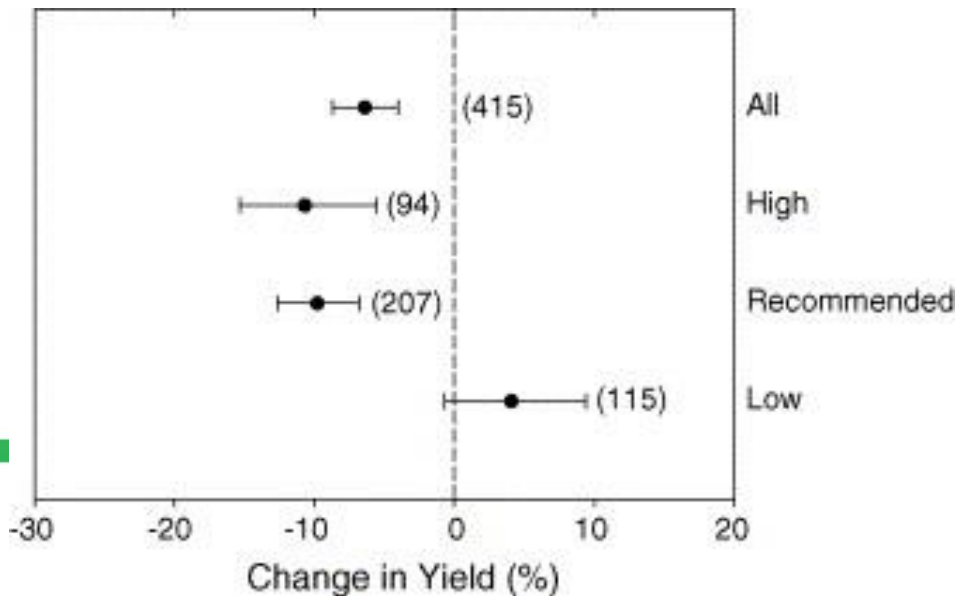
- Minimum tillage leads to a build-up in C in the topsoil.
- However no significant gains when you average down through the profile
- There are gains in drier regions with large field sizes
- Evidence that soil structure improves with more C in macroaggregates and light fraction

Straw	Tillage	Soil C (T C ha ⁻¹)		
		0-15	15-30	30-60
Incorporated	RT	34.6*	34.3	34.8
	CP	27.7	33.7	33.3
Removed	RT	32.4	32.4	38.3
	CP	27.5	29.9	30.1



Impacts of cover crops

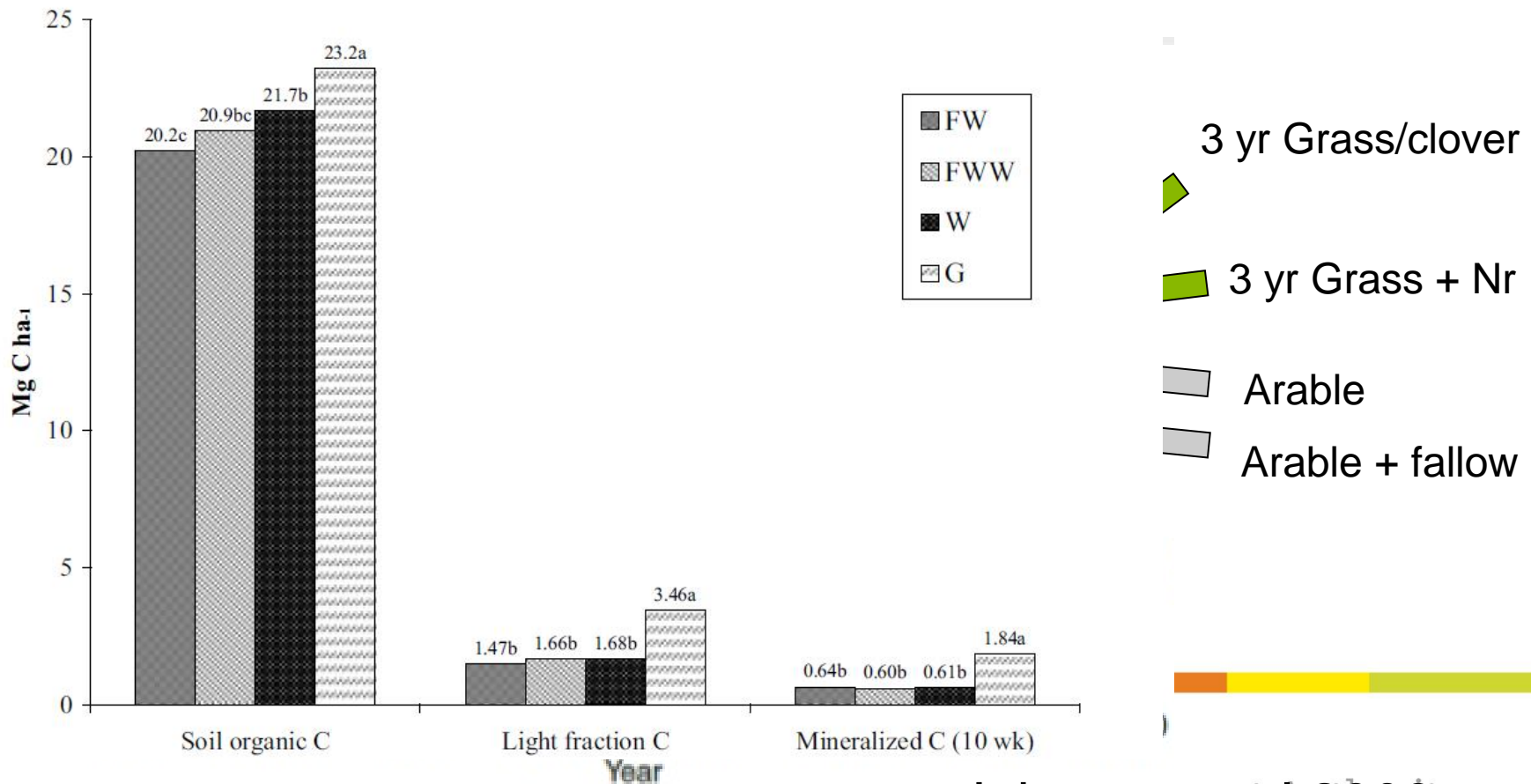
- SOC increases by 10-15 t C ha⁻¹ over a 20-40 year period
- Use of legume CC compared to winter fallow systems = improved yield



Poeplau & Don 2015 AGEE 200: 33-41

Rotations and grass leys

Introducing rotations esp with grass leys can increase SOC by 20% after 20-30 years



Summary

- SOC is important for increasing soil quality and maintaining yield
- Minimum tillage increases C in topsoil but not down through the profile
- Straw incorporation leads increase in SOC at slow rate
- Rotations, cover crops and grass leys are effective at increasing SOC in tillage systems
- Sequestration does not last forever and is reversible