# SOC – The overlooked nutrient

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## **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

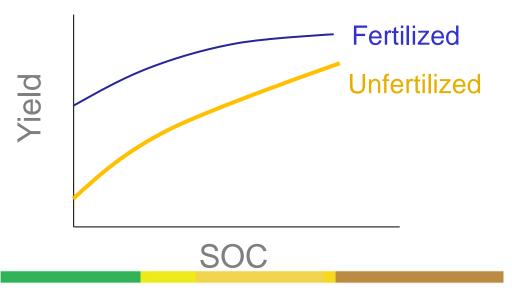
- Increases soil CEC allowing better retention of ammonium-N, K, Ca and Mg
- Chelates other micronutrients
- Keeps P available at high and low Ph
- Buffers soil, preventing rapid pH change
- Reduces bulk density and thus compaction and runoff
- Improves soil water-holding capacity



## Impact of SOC on yield

Yield increases as SOC increases

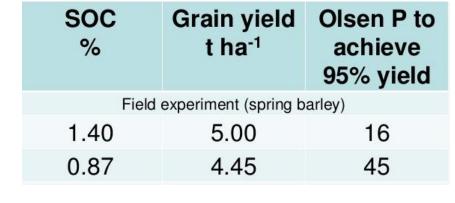
Yield differential between fertilised and unfertilised decreases with SOC



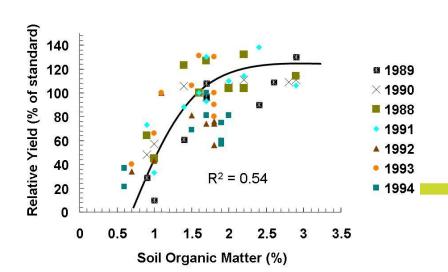
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Johnston et al. 2009 Adv. Agron. 101: 1-57



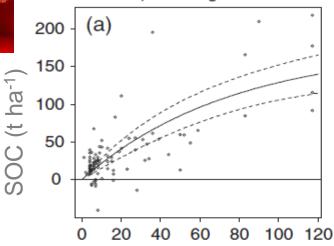
## **Land-use Change – C Equilibrium**

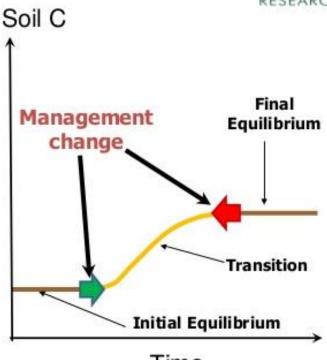
- Sequestration is finite move towards a new equilibrium
- Its reversible depends on maintaining change in management practice
- When grassland/forestry is converted to arable
  C in lost quite rapidly and reaches a new equilibrium after 20-30 years
- Measures that increase SOC tend to take much longer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



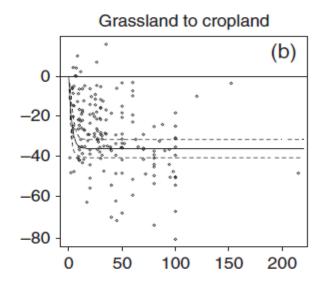
Poeplau et al. 2011 GCB

Cropland to grassland





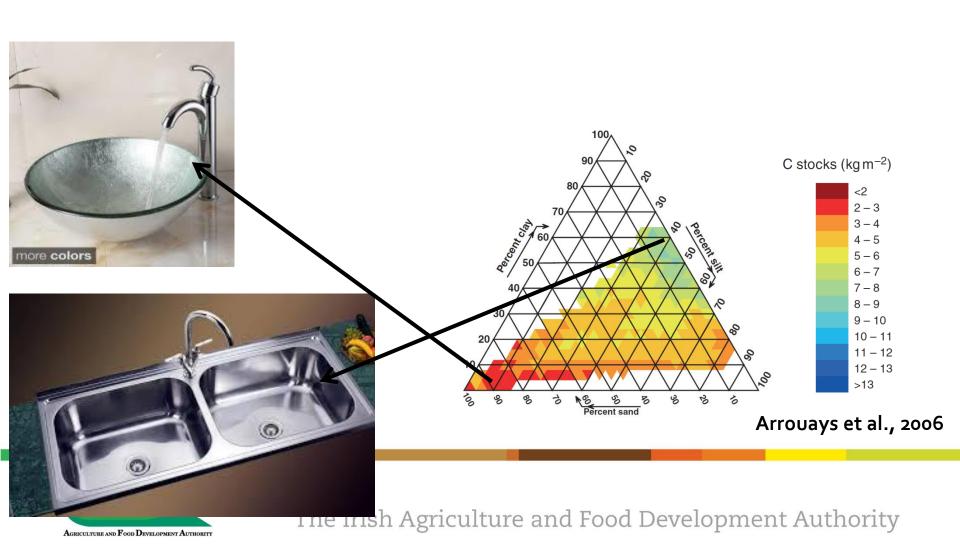
Time



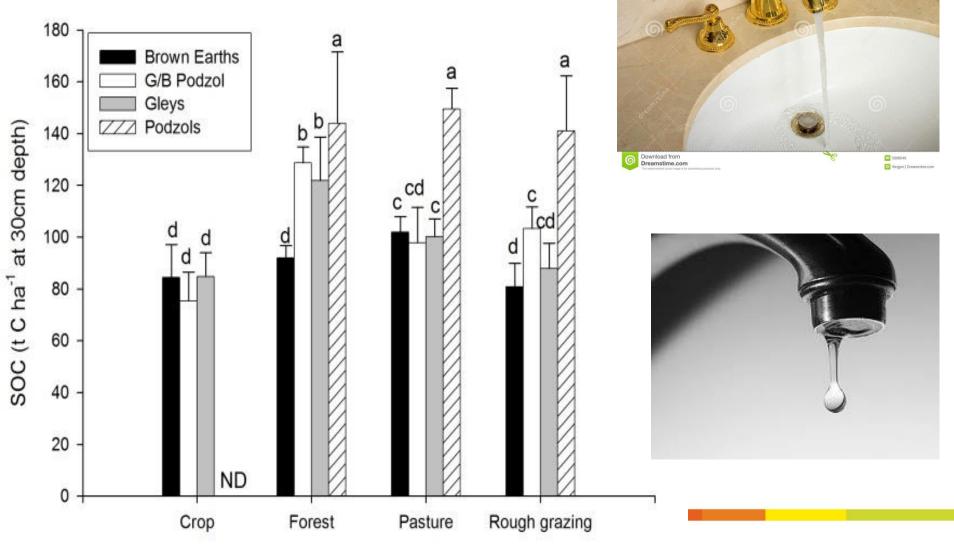


## Influence of Soil Type

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



## Impact of soil type and land use

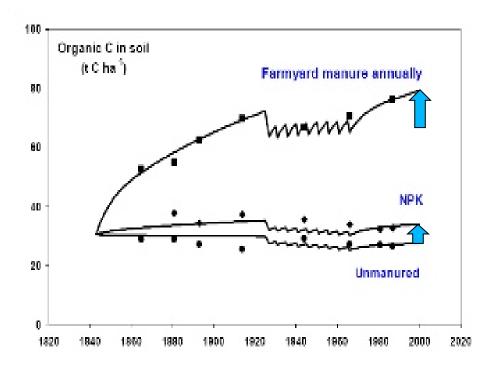




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#### **Manure and fertilizer Addition**

- 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



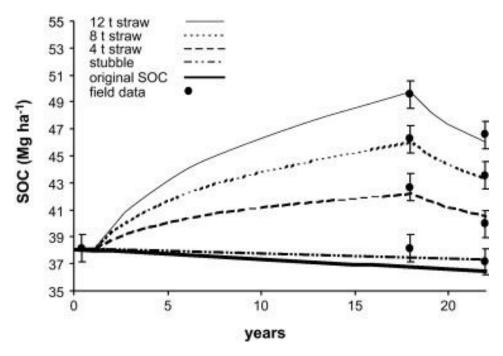
Manure type	% DM	Application rate*	Carbon addition (t/ha)
Cattle slurry	6	25 m³/haª	0.6
Pig slurry	4	25 m³/ha	0.4
FYM	25	25 t/ha	2.5
Poultry (layers manure)	55	5 t/ha	1.1
Spent Mushroom Compost	32	20 t/ha	2.6



<sup>\*</sup> 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



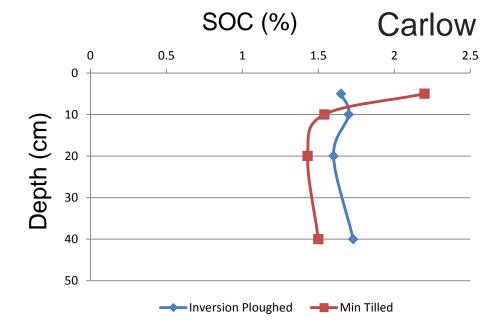
Van Groenigen et al. 2011

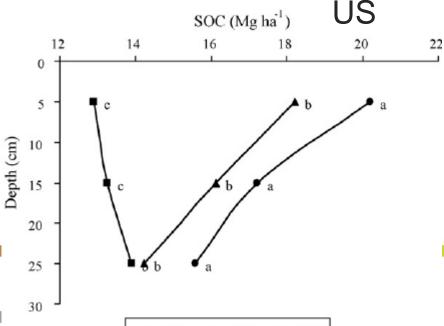


## **Minimum Tillage**

- Minimum tillage leads to a buildup 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

	_	Soil C (T C ha-1)			
Straw	Tillage	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	
	СР	27.5	29.9	30.1	



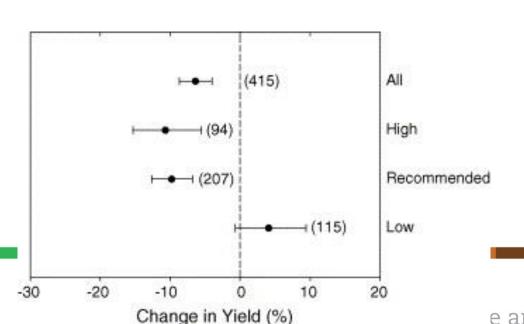




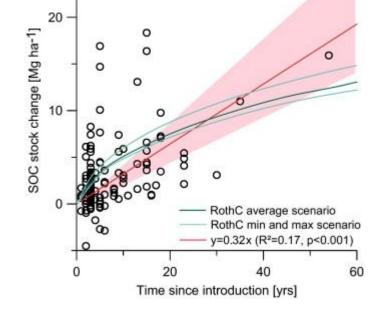
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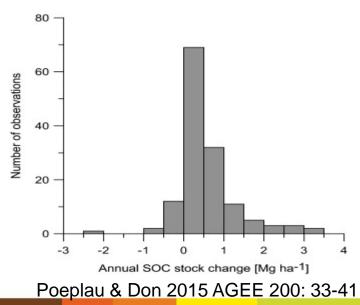
## Impacts of cover crops

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



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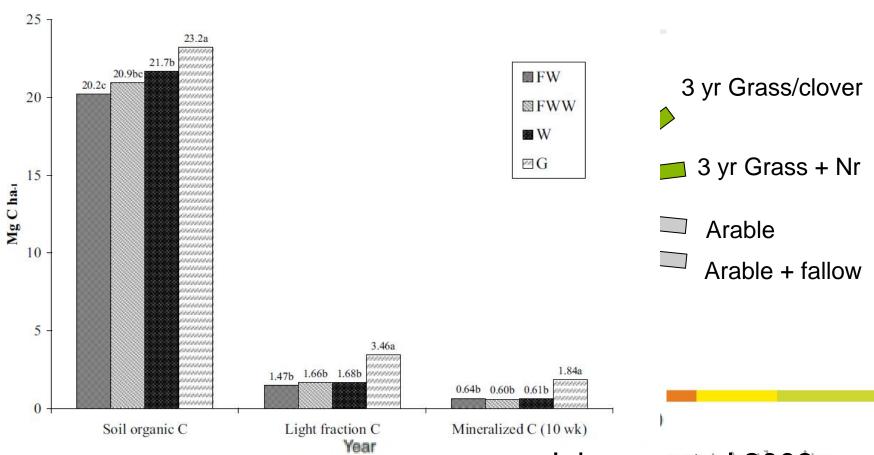


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Tonitto et al. 2006 AGEE 112: 58-72

## **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

