



Department of  
Primary Industries

You want to have your carbon  
cake and eat it too???  
For nitrogens sake!

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# Sacred benefits of pasture rotations

- Fix N and build soil C (= Soil Organic Matter)
- Improve soil structure
- Enhance retention of soil nutrients
- Sequester C

## But

- Good crops need lots of N
- This comes from the soil N pool and fertiliser

It is inevitable that soil N mineralises



# Dilemma

- Soil C:N varies only ~10:1 to 14:1 in surface soil
- The provision of soil N comes with a loss of soil C
- Therefore you cannot sequester C and have cheap N too

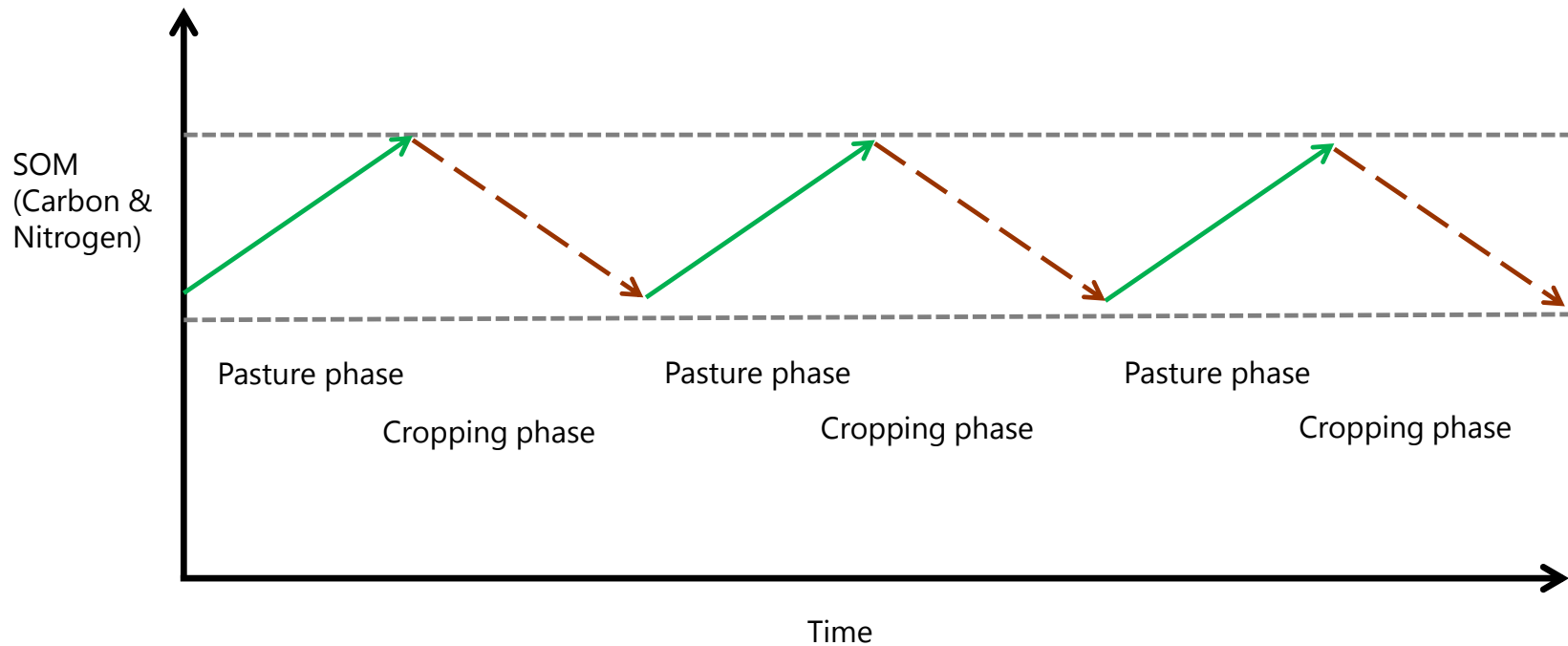
# Solution

There is a build up of C&N during the pasture phase and a run down in the cropping phase.

Best we can do is:

1. Avoid a net rundown in SOM (C&N) overtime
2. Build enough C&N to minimise the need for N fertiliser during the cropping phase

# Lets look at some examples

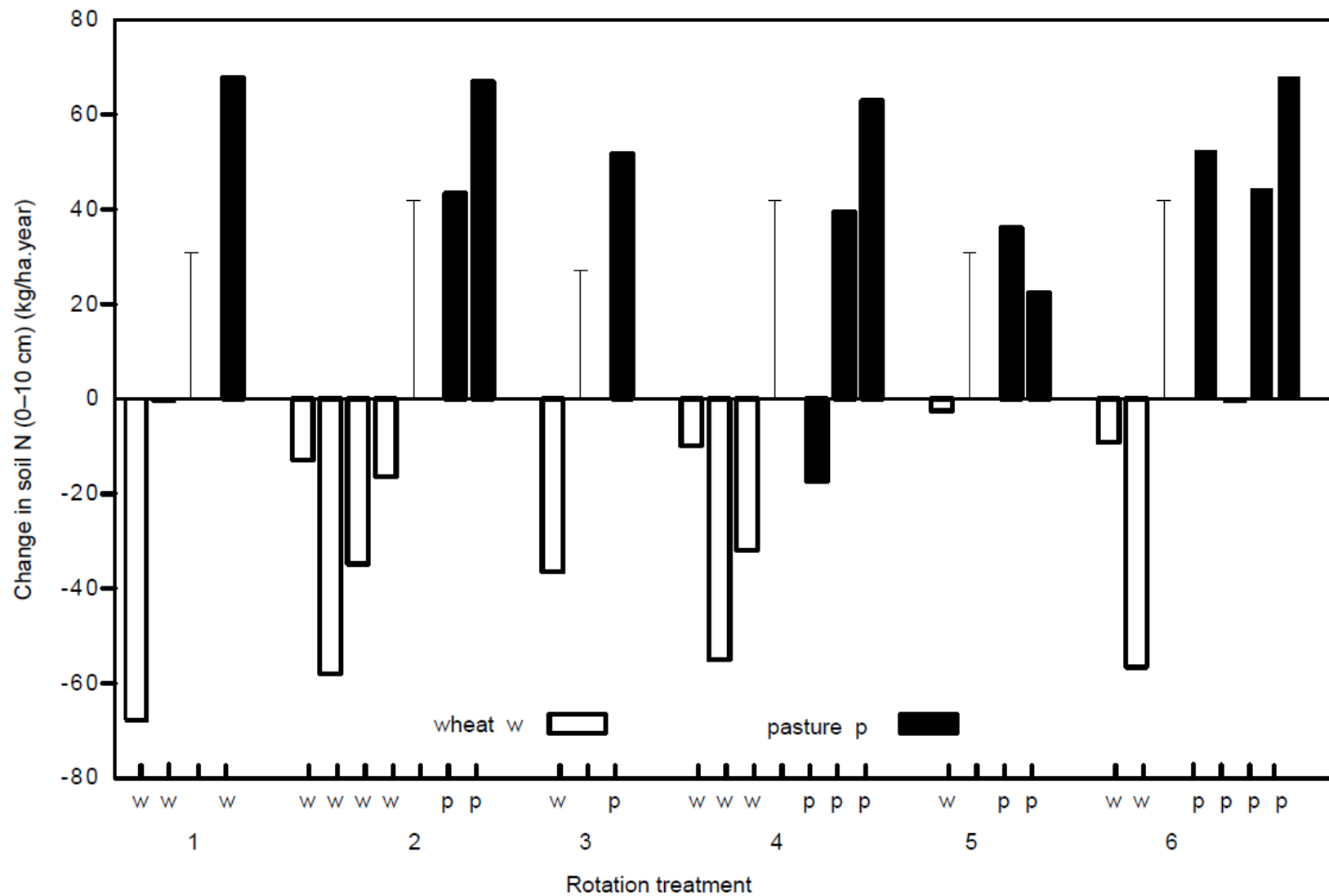


## KohnRot 1963-1980 (0-30 cm depth; 540 mm)

- WWAI, Kandosol
- Initial SOC was low 0.8% (0–10 cm W&B)
- Pastures dominated by subclover and annual ryegrass
- Long (6 years) or short (2 or 3 years) rotations
- Short-fallow cultivation (multiple passes), stubble burnt in autumn
- P was applied, 12 kg/ha/yr

## KohnRot 1963-1980 (0-30 cm depth; 540 mm)

Rotation		C kg/ha/yr
33% pasture	67%wheat	+216
50%	50%	+253
67%	33%	+403
(100%)	(0%)	(+570)



Source: Helyar et al AJAR 1997

# SATWAGL 1979-2004

(Sustainable Ag Through Wheat and Grain Legumes)

0-30 cm depth (540 mm)

- WWAI, Kandosol, 'high' initial SOC
- 3 rotations i.e. 1:1 lupin/wheat (L/W), 1:1 subclover/wheat (S/W) and continuous wheat (W/W)
- Treatments:
  - Stubble retained (SR) / burnt (SB)
  - No-till (NT) and conventional cultivation (CC; 3 passes)
- Each plot received P at a sowing at rate of 20 kg/ha/year



# SATWAGL 1979-2004

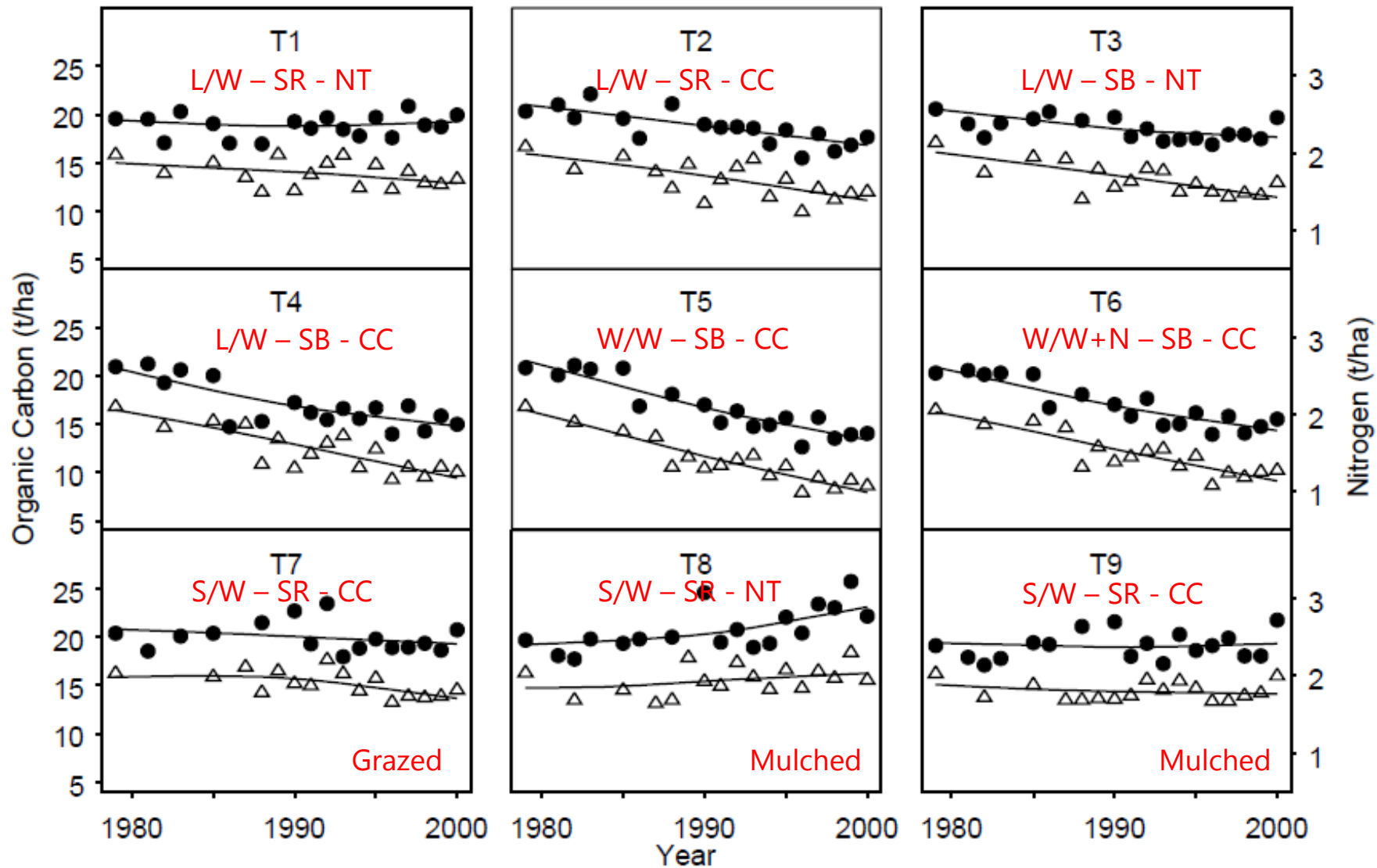
(Sustainable Ag Through Wheat and Grain Legumes)

**0-30 cm depth (540 mm)**

Rotation	Stubble	Tillage	C kg/ha/yr
L W	Retain	nil	-52
L W	Burn	nil	-98
LW	Retain	CC	-174
LW	Burn	CC	-176
WW +N	Burn	CC	-193
WW	Burn	CC	-278
S W	Retain	nil	+257

Circles: Carbon

Triangles: Nitrogen



Source: Heenan et al Soil & Tillage Research 2004

# C run down...

Treatment	C kg /ha/yr.30cm	Standard error	t-value
L/W – SR - NT	- 8	50	ns
L/W – SR - CC	- 199	50	***
L/W – SB - NT	- 138	50	**
L/W – SB - CC	- 284	49	***
W/W – SB - CC	- 389	48	***
W/W+N – SB - CC	- 311	49	***
S/W – SR – CC (G)	-72	51	ns
S/W – SR – NT (M)	185	50	***
S/W – SR – CC (M)	- 4	50	ns

Source: Heenan et al Soil & Tillage Research 2004

## And the N run down...

Treatment	N kg /ha/yr.30cm	Standard error	t-value
L/W – SR - NT	- 13	7.3	ns
L/W – SR - CC	- 29	7.3	***
L/W – SB - NT	- 28	7.3	***
L/W – SB - CC	- 42	7.3	***
W/W – SB - CC	- 51	7.2	***
W/W+N – SB - CC	- 42	7.3	***
S/W – SR – CC (G)	-13	7.4	ns
S/W – SR – NT (M)	9	7.3	ns
S/W – SR – CC (M)	- 6	7.3	ns

Source: Heenan et al Soil & Tillage Research 2004

# MASTER 1992-2010

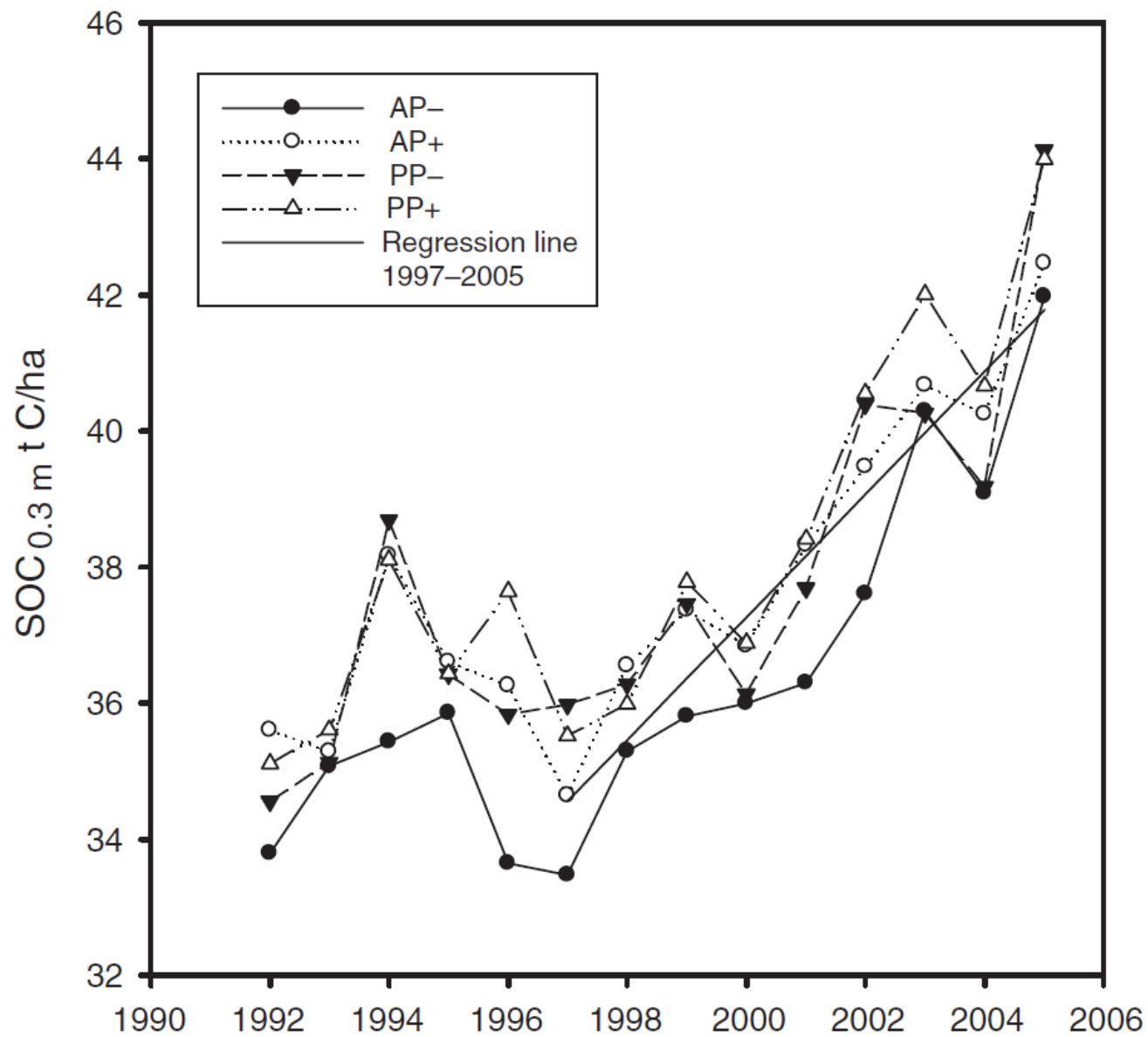
(Managing Acid Soils through Efficient Rotations)

## 0-30 cm depth

- Book Book, Acidic Sodosol
- Pastures estab 1992; perennial (phalaris and cocksfoot) and annual (annual rye and subclover)
- With (incorporated) or without lime
- Plots limed 6-yearly (target pH<sub>Ca</sub> 5.5, 0-10cm)
- Maintenance lime top-dressed
- Fertiliser applied annually
- Site was grazed

**MASTER 1992-2010**  
**0-30 cm depth**

Rotation	C kg/ha/yr
Perennial pasture - no lime	+499
Annual pasture - no lime	+496
Perennials - limed	+552
Annuals - limed	+462

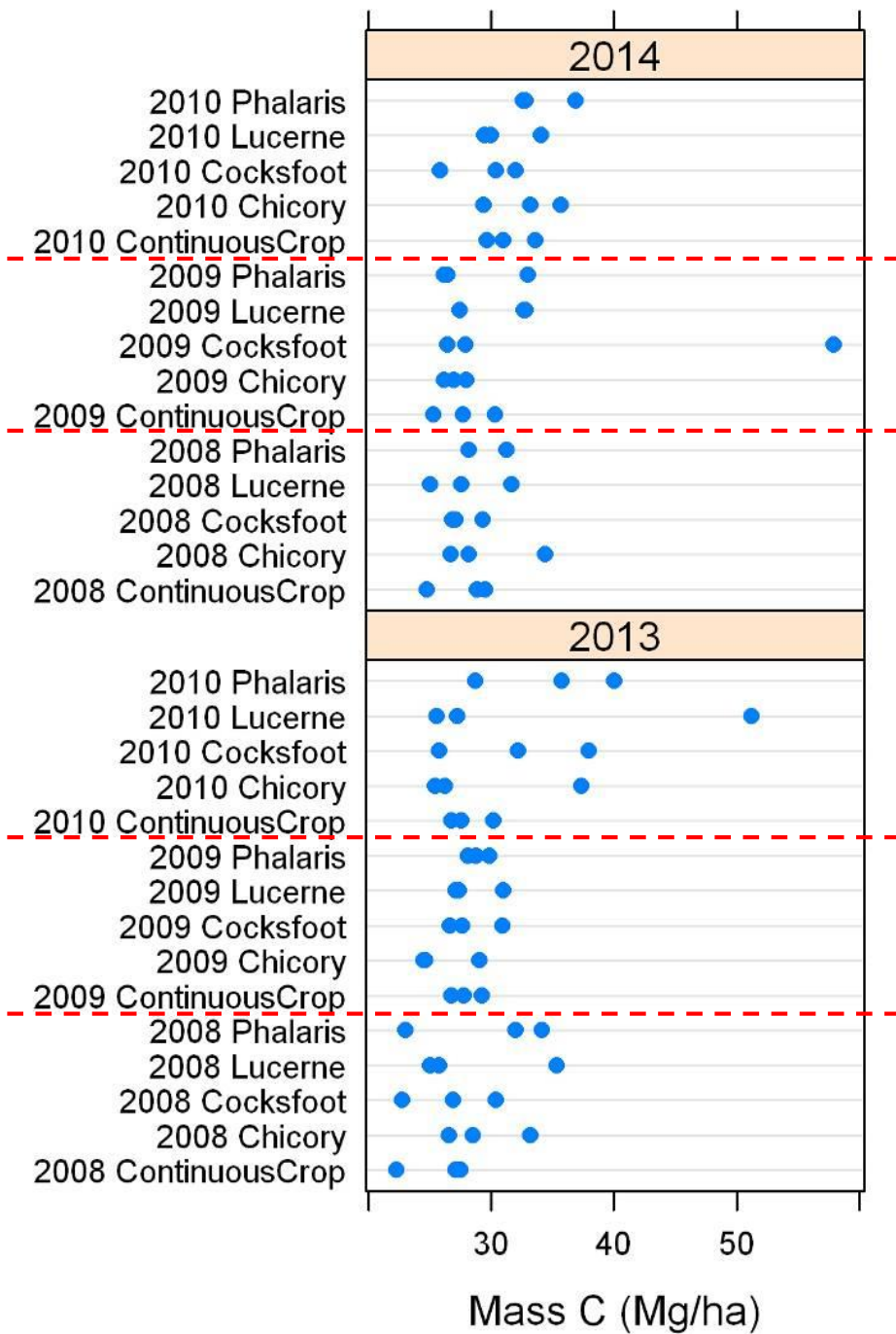


Source: Chan et al Soil Research 2011

# EverCrop Carbon Plus

- Yerong Creek, Red Kandosol
- Treatments:
  - Rotation: 3yrs pasture phase then 3yrs crop (wheat, canola, barley)
  - Pasture type: Phalaris/subclover, Cocksfoot/subclover, Lucerne/subclover and Chicory/subclover *vs* continuous crop
  - Sowing year: 2008, 2009 and 2010





P - 2 year crop

CC - 6 years crop

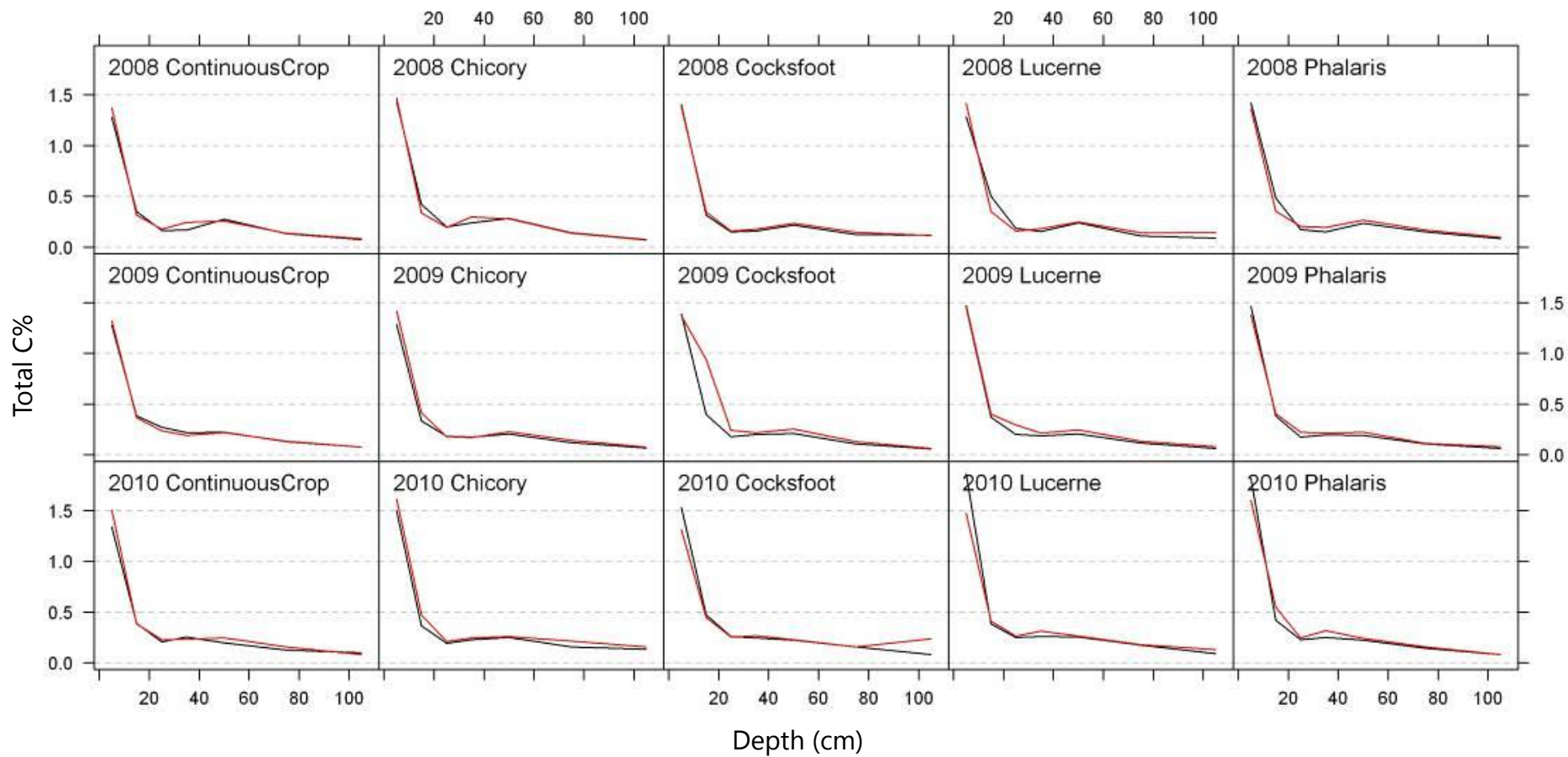
P - 3 years crop

CC - 6 years crop

P - 4 years crop

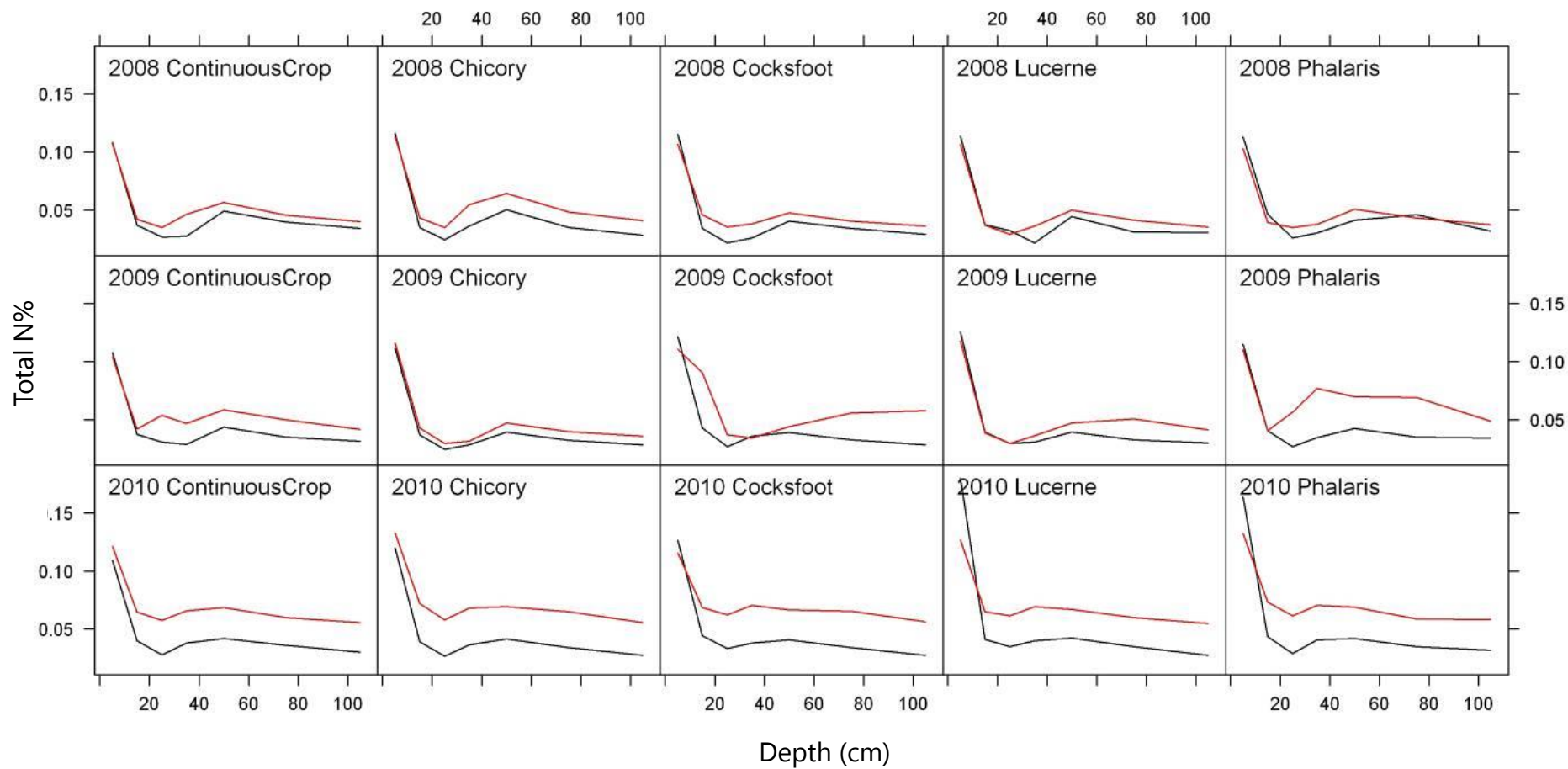
CC - 7 years crop

EverCrop Carbon  
Plus



Carbon

Black: 2013; Red: 2014



Nitrogen

Black: 2013; Red: 2014

# Take home messages

- C sequestration is slow in our soils (-300 to +550 kg C/ha.30cm/yr)
- Where soil is already at >1% SOC, max rates under cropping are about *zero* kg C/ha.30cm/yr
- Crop residue retention does not provide increases in SOM (C&N) in such soils (but pastures may)
- Productivity and environmental benefits from SOM accumulation are sacred
- But benefits to soil fertility stem from SOM being *dynamic* in the soil, not from continuously accumulating.
- Need to either use SOM-N during the cropping phase or use fertiliser-N

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