

MFS Soil Carbon Project Update

*Monaro Farm Management
Strategies and Soil Carbon Project
AotG R1*

Susan Orgill

Research Officer - Soil Carbon
Wagga Wagga Agricultural Institute
NSW Department of Primary Industries

MFS
MONARO FARMING SYSTEMS



The **focus** of the Monaro Farm Management strategies and Soil Carbon Project

- Can land management increase soil organic carbon in the Monaro region?
- What we know:
 - Parent material influences soil C
 - Nutrients *can* influence soil C
 - Grazing *can* influence soil C
 - Perennial pastures *may* represent maximum sequestration potential



Activity 1:

Survey 20 sites for soil C under different land use/management

Including:

Within site-sampling grid variability, C stocks to 50cm, two sampling times 2012 and 2014.

Output:

- C stocks under different management and soil type scenarios
- Changes in soil C over time

Soil-related project activities

Activity 2:

Construct soil C variograms at selected sites

Including:

Carbon and phosphorus variability at the paddock scale.

Output:

- Protocols for sampling grid size and number of cores
- Information on the main attributes influencing soil C at the paddock scale

Activity 3:

Model changes in soil C fractions for a subset of these sites

Including :

RothC modelling with local climate, production and management inputs.

Output:

- Understand the vulnerability of C to changes in management and climate

Activity 1: Sites and sampling

- Demonstrations based on local management
 - Liming
 - Aspect
 - Cropping
 - Pasture type
 - Pasture age
 - Phosphorus
- Comparisons selected to be same soil type, landscape position, within close proximity



To increase soil carbon: OM inputs need to be more than losses

That is, OM supply (grown on site or grown elsewhere and brought to the paddock) needs to be more than losses via decomposition and erosion.



Why might there be a difference with these activities?

- What can increase OM **supply**? Anything that promotes plant growth (e.g. nutrients, plant type etc)
- What can accelerate OM **loss**? Bare ground, altering wetting and drying cycles
- Lime: can increase biomass, but can also increase microbial activity
- Aspect: influences microclimate and the soil environment. Managing to aspect can maximise groundcover and biomass production
- Cropping: can increase OM supply but can also create more favourable conditions for decomposition
- Pasture age: literature suggests an exponential increase in soil C for first 5 years and then increases at a declining rate for up to 40yrs
- Nutrients: help produce more biomass and can increase humification (slowing overall decomposition)

- Liming
- Aspect
- Cropping
- Pasture age
- Phosphorus



The challenge is pasture systems already have high
soil carbon

OM supply (or biomass grown) is often limited by
climate and soil nutrients

Activity 1: Surveying paddocks for soil C

Comparison

Description

Granite

NPP: High vs Low P

High P site: P management plan since 2005. Low P; nil P.

IPP: Unlimed vs Limed

2.5t/ha lime broadcast in 2002. IPP sown 1970.

NPP vs <5 yr IPP vs Crop

New IPP sown 2012 (cropped 2009-12). Wheat crop (cropped since 2011, previously IPP).

Sedimentary

IPP: Aspect SE vs NW

IPP originally sown 1989.

IPP: <10 yr vs >35 yr

Old IPP sown 1974. New IPP sown 2003.

>35 yr IPP vs Crop vs Pines

IPP sown 1960. Oat crop (cropped since 1998). Pines 2002.

NPP vs <5 yr IPP vs Crop

Wheat crop (cropped since 2009). New IPP sown 2010 (cropped 2004-09).

Basalt

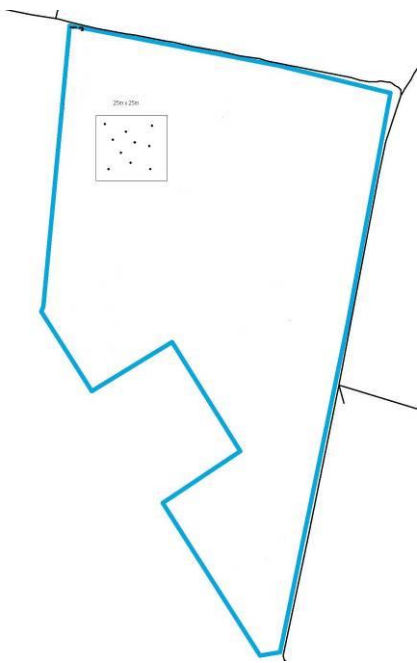
NPP vs Crop

Barley crop (first year, previously NPP).

High P vs Low P

High P site: P management plan since 2005. Low P; nil P.

From the paddock to the lab...



Land management comparisons (granite)

Treatment	C stock (Mg.C.ha)		Comparison (Mg.C.ha)	
	0 - 30cm	0 – 50cm	30cm	50cm
NPP Low P	32.9	40.4		
NPP High P	36.3	46.1	(+) 3.4	(+) 5.6
Unlimed	52.8	66.7		
Limed	46.9	62.8	(-) 5.9	(-) 3.9
NPP	41.4	58.5		
IPP <5 yr old	39.5	51.5	(-) 1.9	(-) 7.0
Crop	41.4	58.1	0.0	(-) 0.4

Land management comparisons (sedimentary)

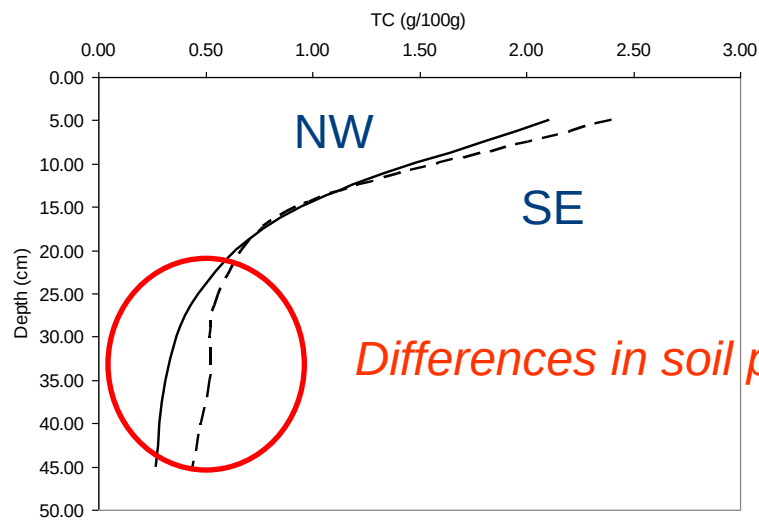
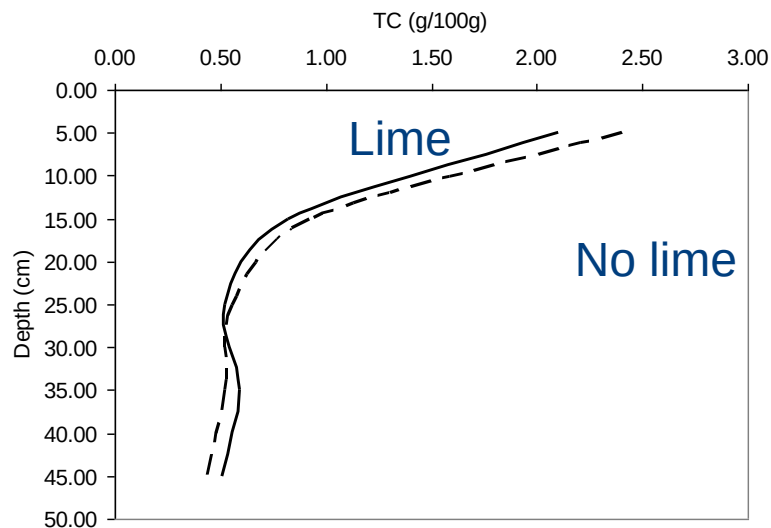
Treatment	C stock (Mg.C.ha)		Comparison (Mg.C.ha)	
	0 – 30cm	0 – 50cm	30cm	50cm
NW Aspect	47.3	56.4		
SE Aspect	45.7	55.6	(-) 1.6	(-) 0.8
IPP <10 yr old	75.2	92.7		
IPP >35 yr old	73.6	96.6	(+) 1.5	(-) 3.9
IPP >35 yr old	45.2	60.2		
Crop	42.7	54.6	(-) 2.5	(-) 5.6
Pines (10 yr old)	67.2	85.7	(+) 22.0	(+) 25.4
NPP	46.5	60.6		
IPP <5 yr old	70.3	90.1	(+) 23.8	(+) 29.5
Crop	52.1	68.0	(+) 5.7	(+) 7.4

Land management comparisons (basalt)

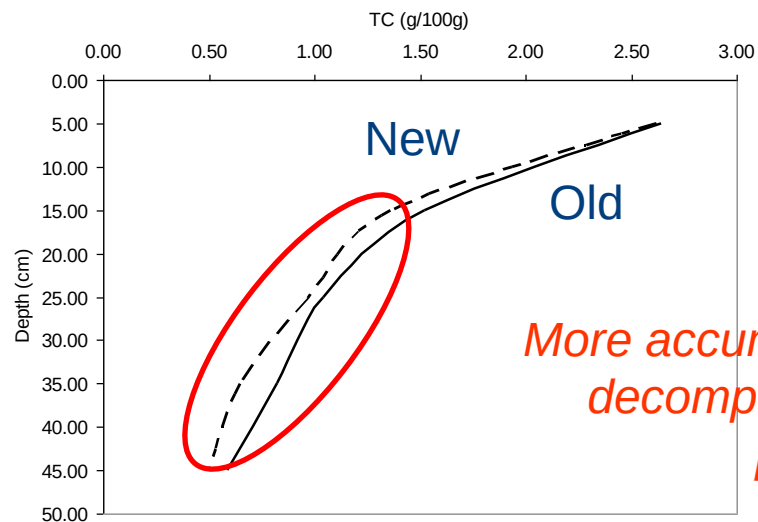
Treatment	C stock (Mg.C.ha)		Comparison (Mg.C.ha)	
	0 – 30cm	0 – 50cm	30cm	50cm
NPP	61.3	82.5		
Crop	46.8	72.4	(-) 14.5	(-) 10.1

Now, to look at how C changes with depth ...

Soil carbon profiles (C concentration)

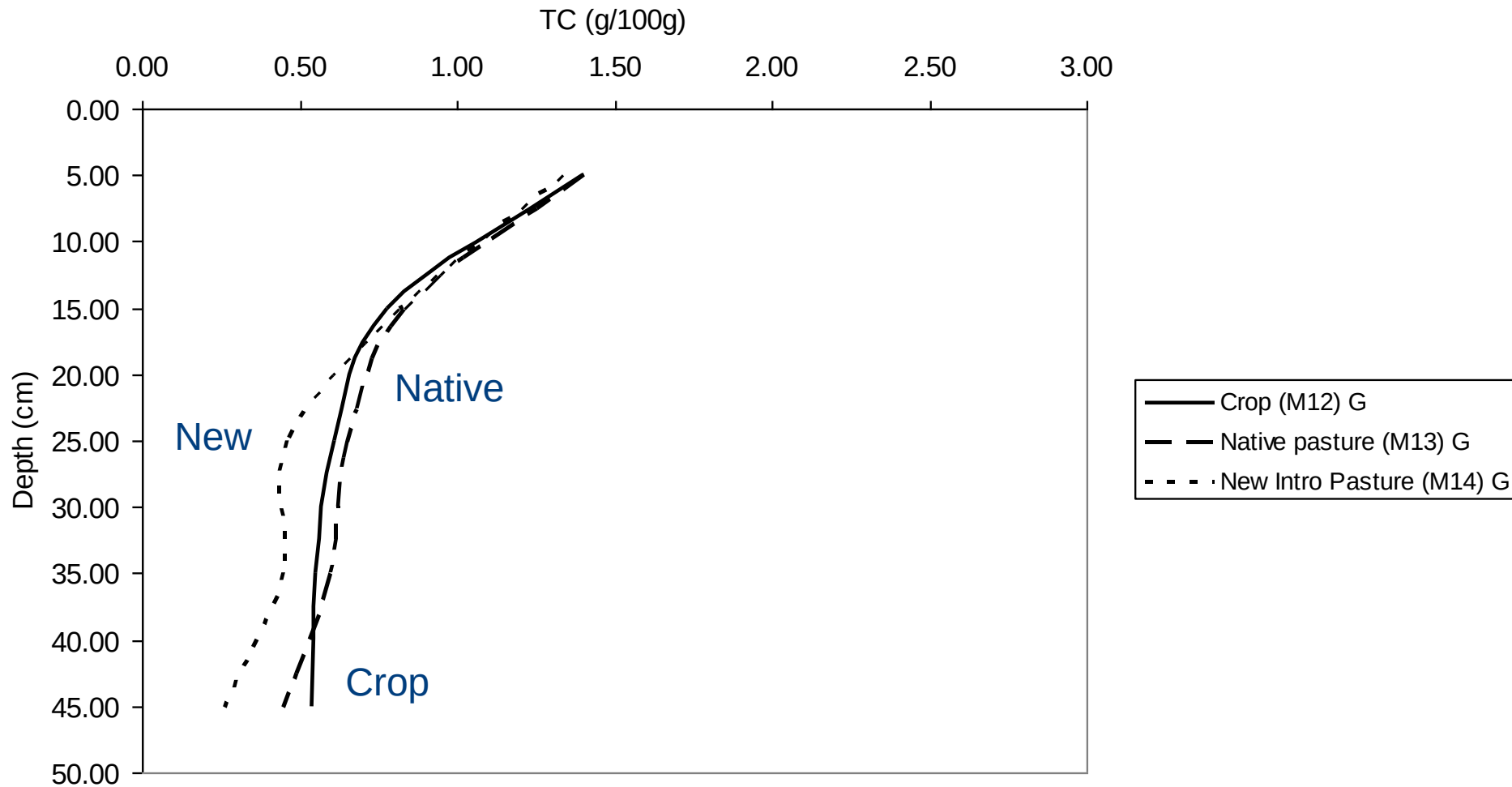


Differences in soil properties?

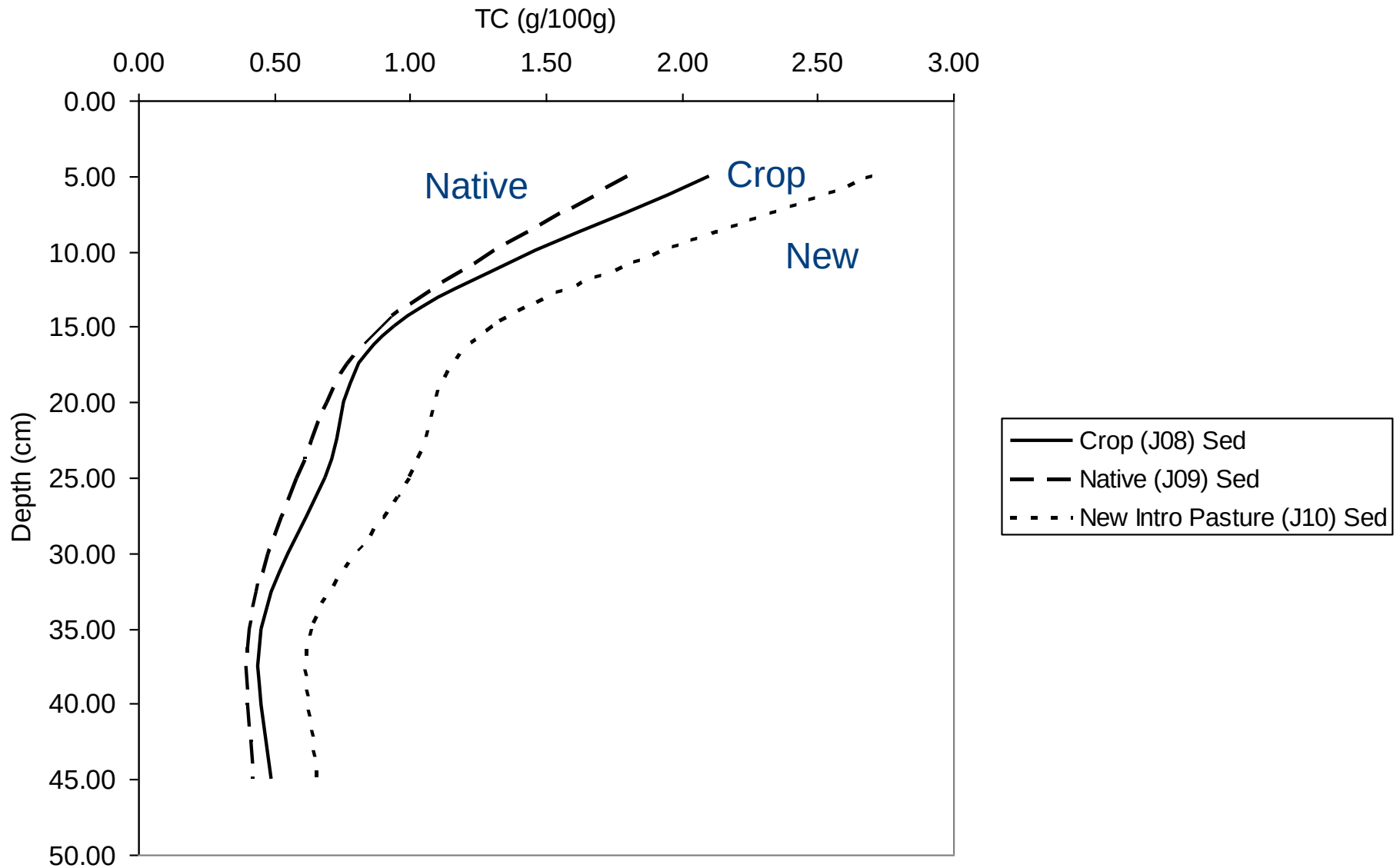


More accumulation and slower decomposition under old pasture?

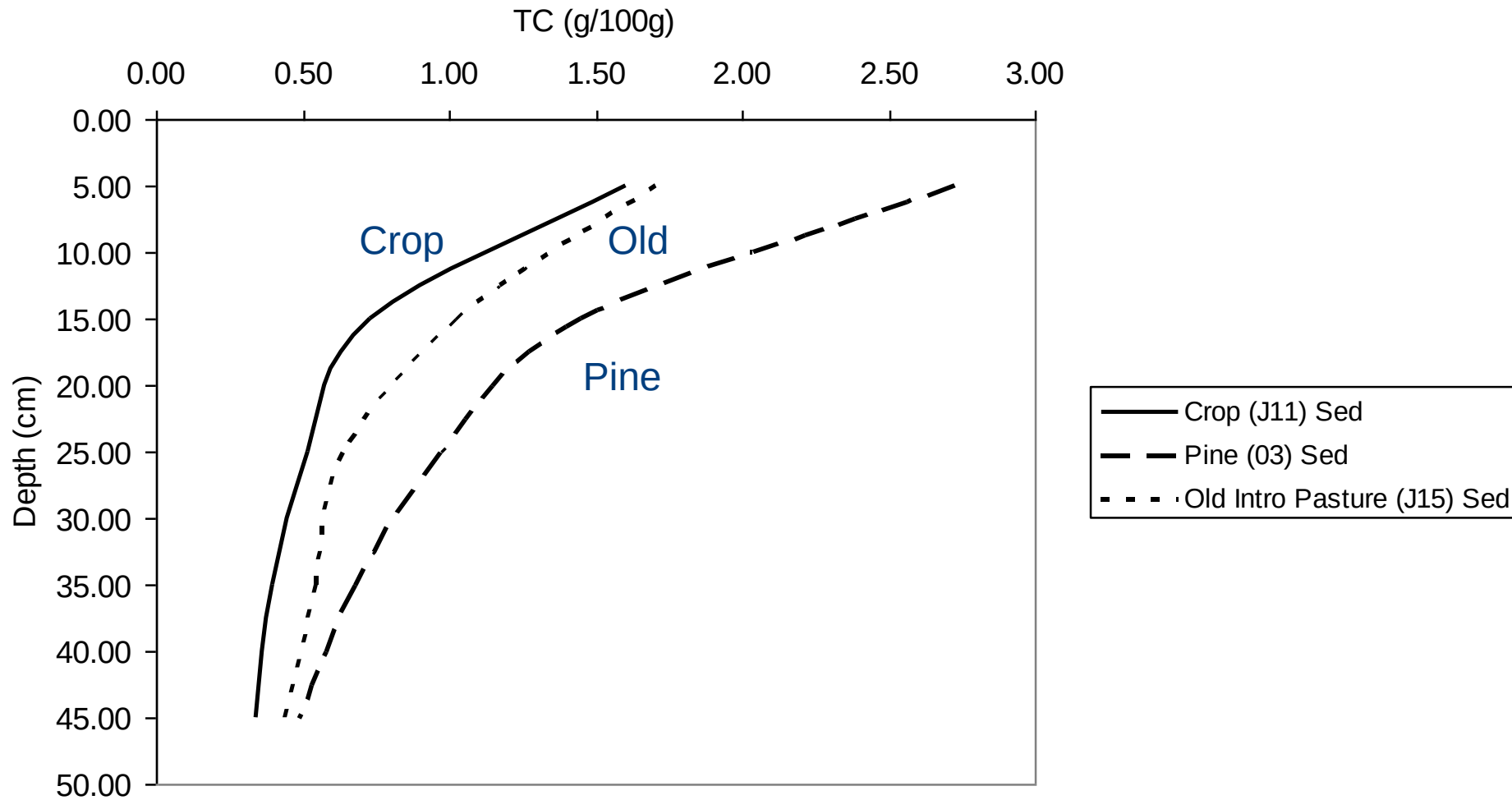
Soil carbon profiles (C concentration)



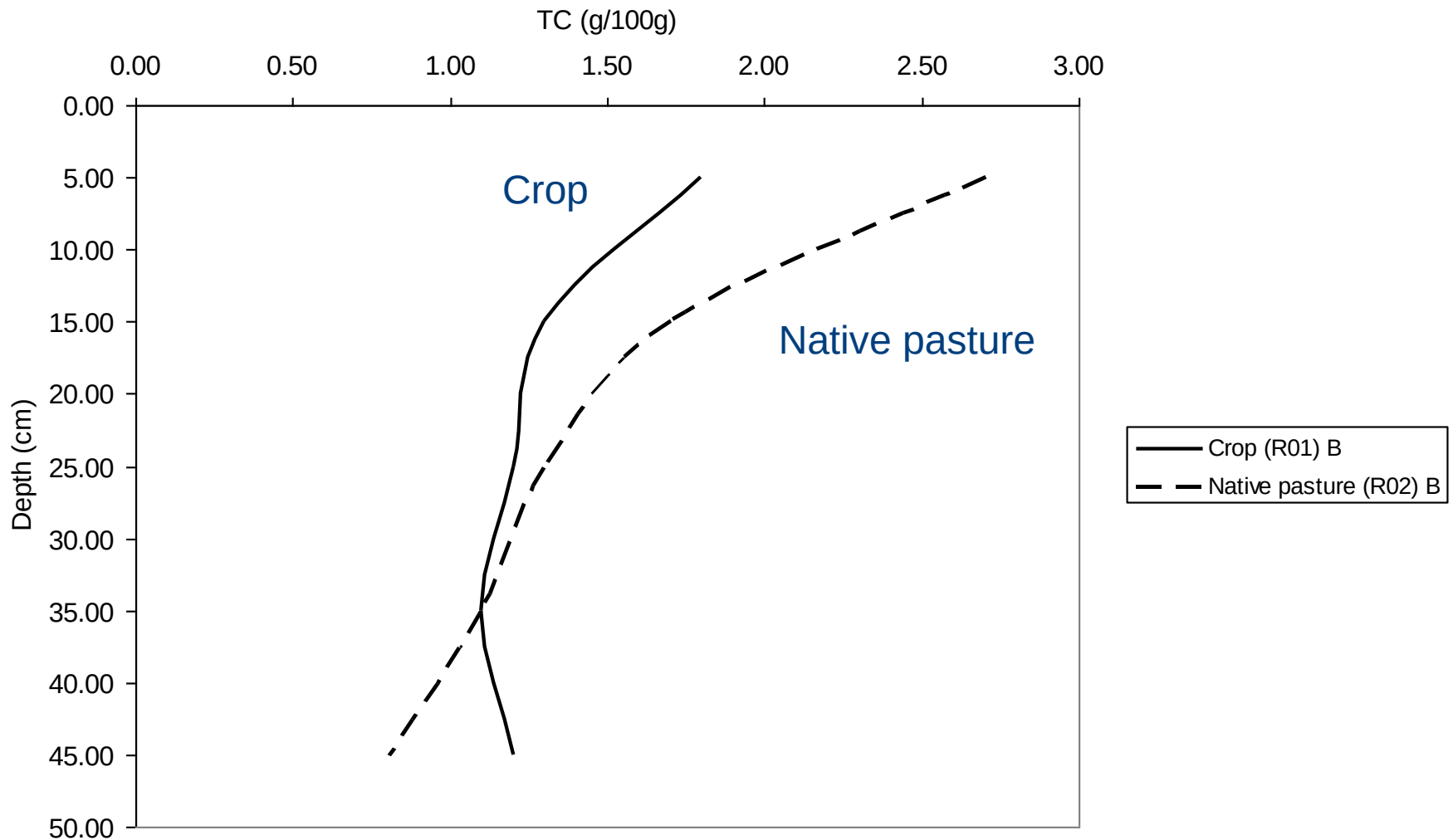
Soil carbon profiles (C concentration)



Soil carbon profiles (TC g/100g)

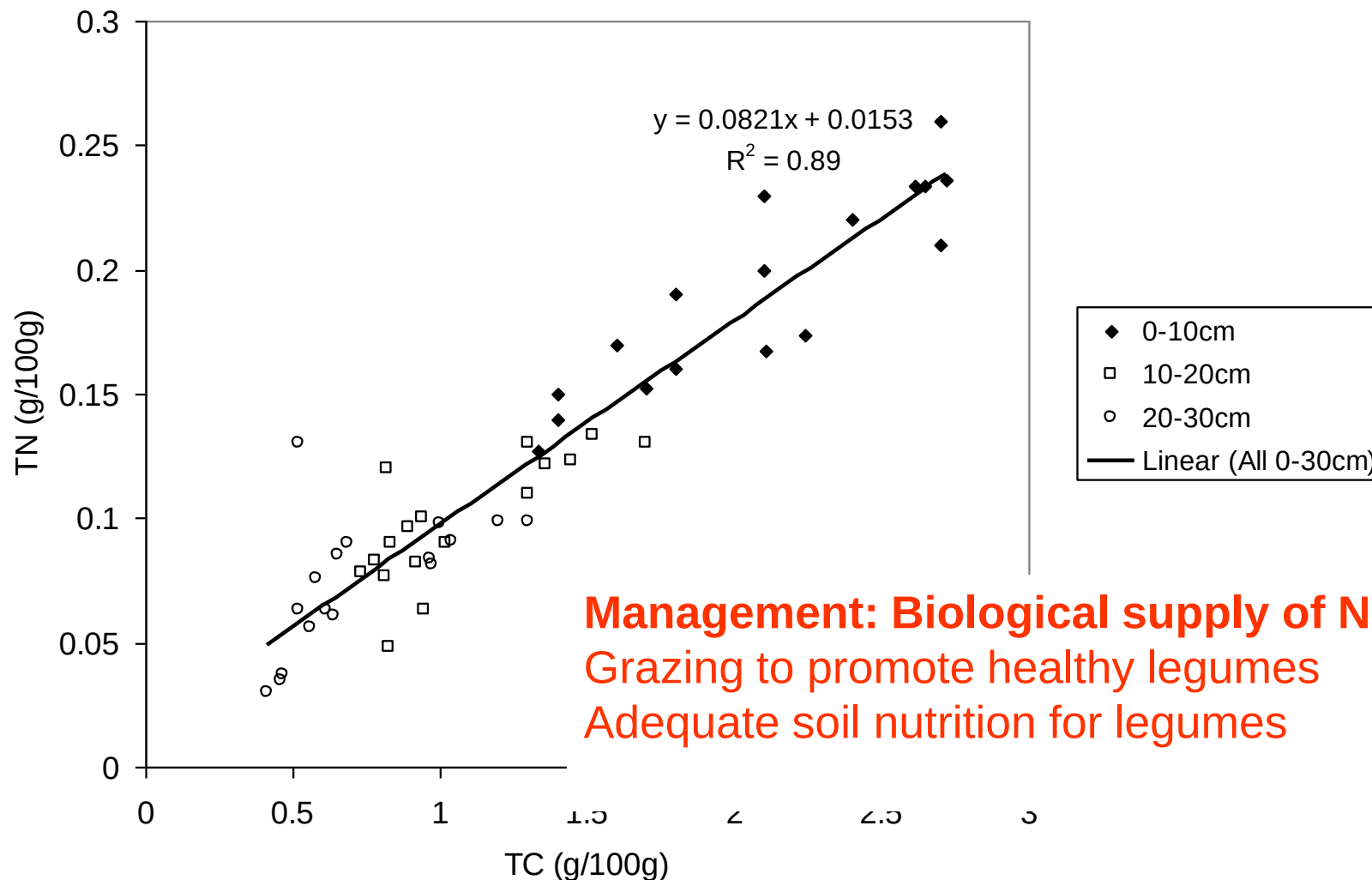


Soil carbon profiles (TC g/100g)



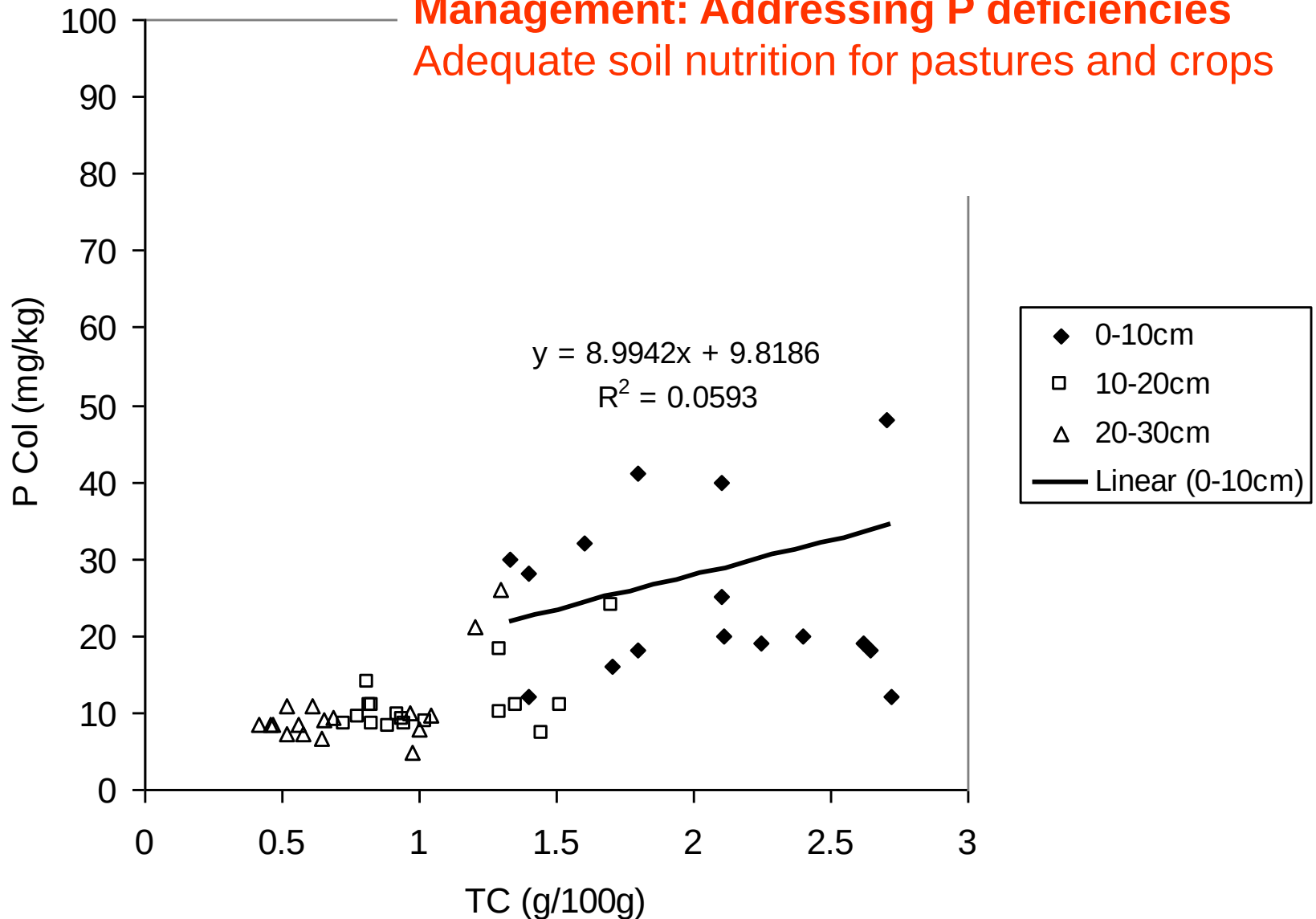
Do nutrients influence soil C?

Total carbon and total nitrogen



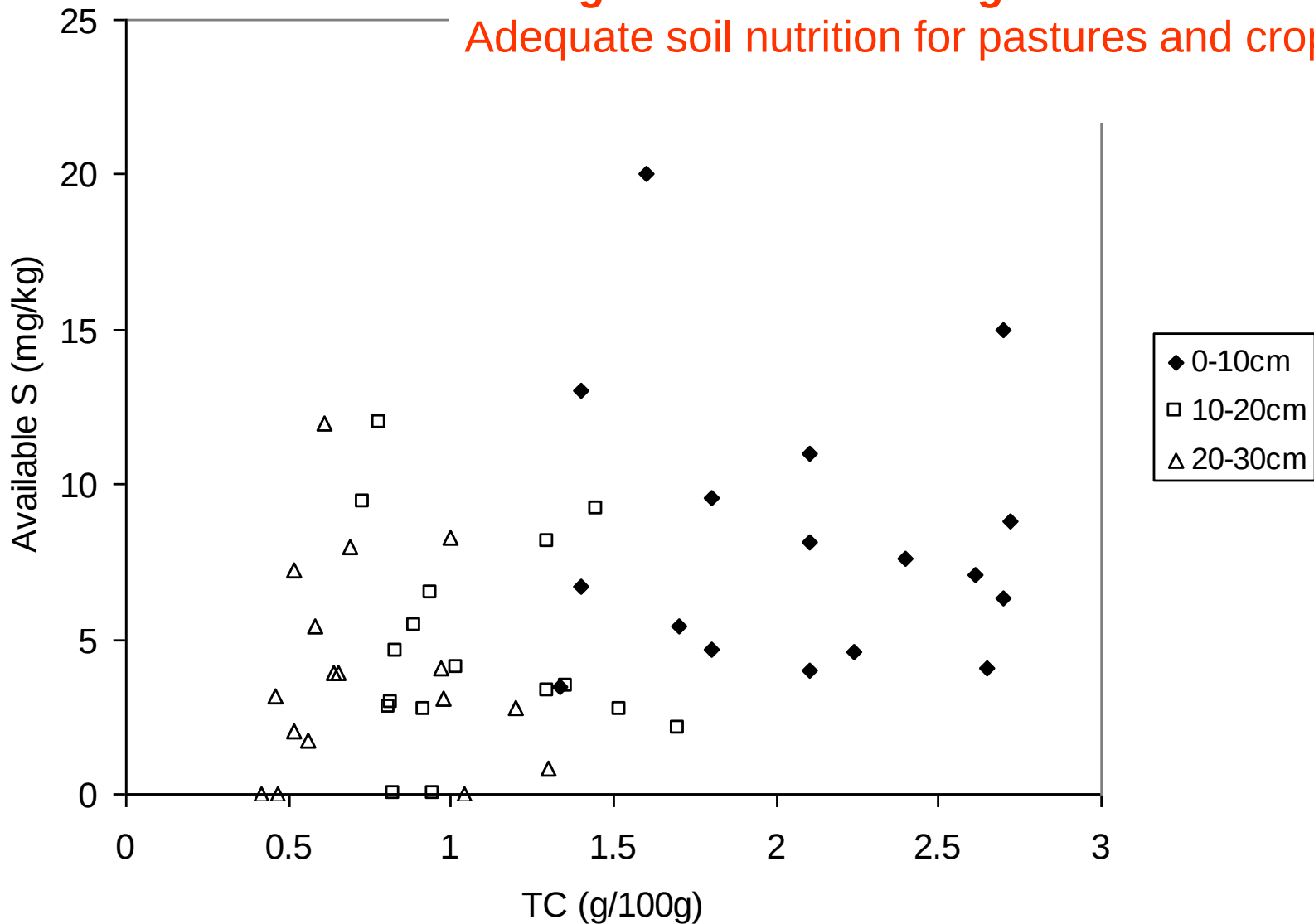
Total carbon and phosphorus (Col)

Management: Addressing P deficiencies
Adequate soil nutrition for pastures and crops



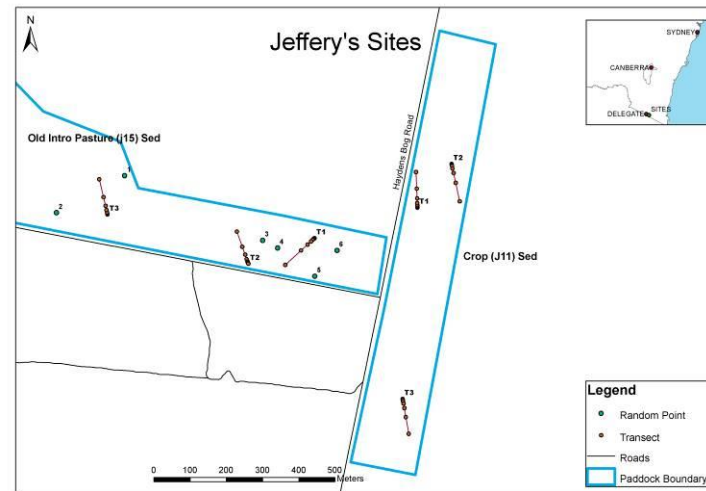
Total carbon and available sulfur (KCl_{40})

Management: Addressing S deficiencies
Adequate soil nutrition for pastures and crops

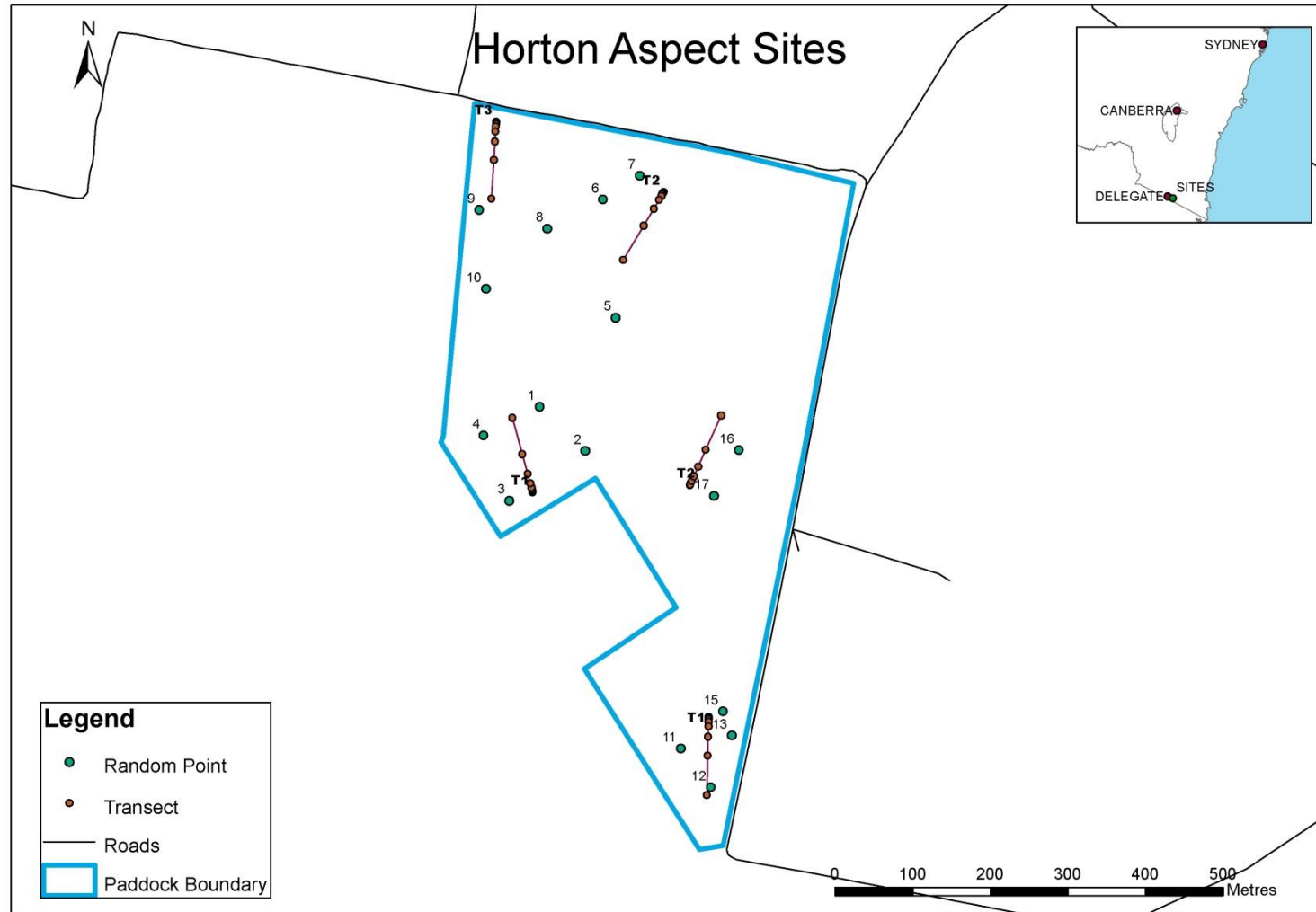


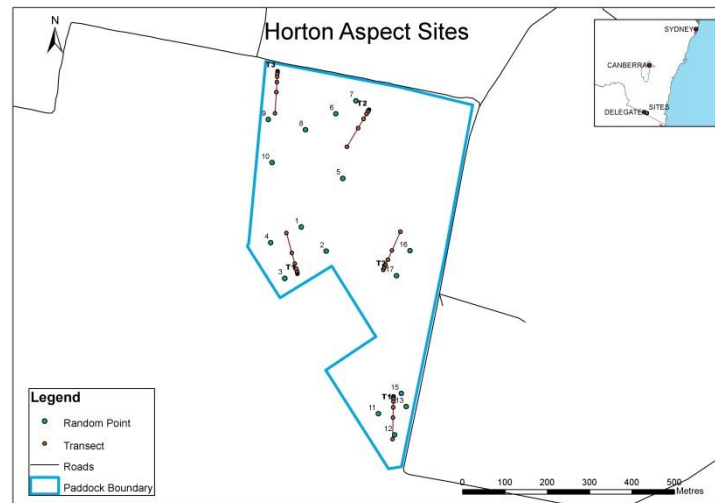
Activity 2: Soil C variation (variograms)

- Investigating soil C and P variation at the paddock scale
- 5 sites, cores to 30 cm
- Transects and random points
- WHY?
 - Explore whether or not the variability is significant
 - Determine the scale at which variability occurs (sampling protocols)
 - Investigate what may be causing variability in soil C



Aspect: SE vs NW

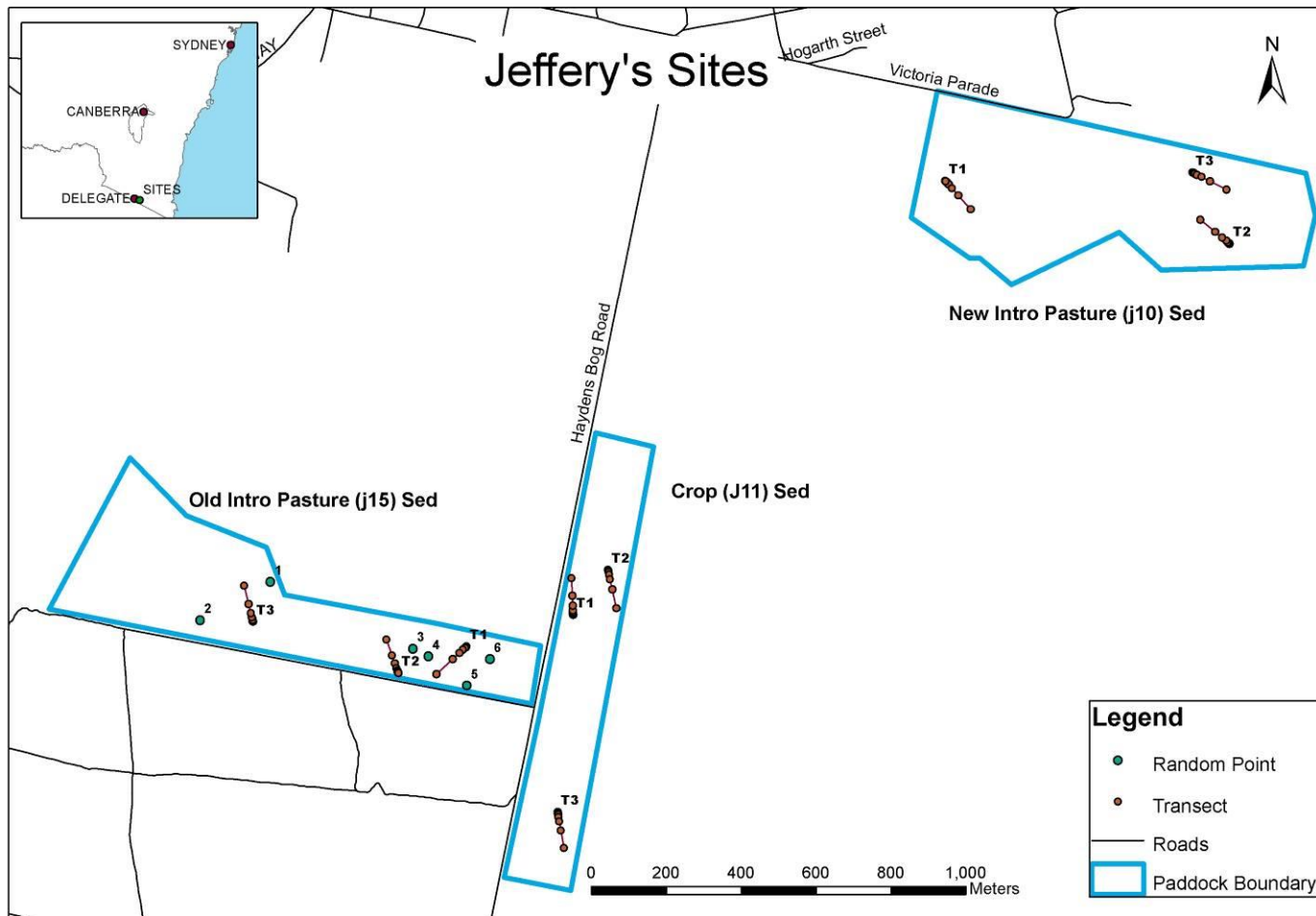




SE Aspect	Mean	se	sd	Min	Max	CL (95.0%)
<i>0 - 10cm</i>						
TC (n=34)	2.5	0.1	0.4	1.5	3.3	0.1

NW Aspect	Mean	se	sd	Min	Max	CL (95.0%)
<i>0 - 10cm</i>						
TC (n=35)	3.0	0.1	0.6	1.6	4.0	0.2

Old pasture, New pasture and Crop



New Intro Pasture
(J10-3)

Mean

se

sd

Min

Max

CL (95.0%)

0 - 10cm

TC (n=26)

2.0

0.1

0.6

1.3

3.8

0.2

Crop (J111-1)	Mean	se	sd	Min	Max	CL (95.0%)
0 - 10cm						
TC (n=24)	1.8	0.1	0.3	1.3	2.4	0.1

Old Intro Pasture (J15-2)	Mean	se	sd	Min	Max	CL (95.0%)
0 - 10cm						
TC (n=29)	3.0	0.2	1.0	2.0	6.7	0.4

Treatment	Sampling style	TC	TN	P (Col)	pH (CaCl2)	S (KCL40)
<i>0-10cm</i>						
NE Aspect	Sampling grid	2.1	0.2	20	4.6	4.0
	Variogram	3.0	0.3	33	4.6	10.3
SW Aspect	Sampling grid	2.2	0.2	19	4.6	4.6
	Variogram	2.5	0.2	23	4.6	9.3

So far...

- Strong positive correlation between C and N at all sites and depths and to some extent with P and S
- Considerable variability in C, N, P, and S at the paddock scale
- Majority of the variation in C in the surface 20cm
- Highest C stocks for perennial pastures
- Little difference in C with aspect and pasture age
- Liming decreased soil C
- Good seasons preceding sampling may be masking 'treatment' comparisons
- Need to remember that this is a point in time sampling, T2 results will help with comparisons

So what? *Why is this important?*

1. Importance of soil fertility

- C sequestration is strongly related to soil fertility
- We can influence available P and S to maximise biomass production and therefore OM supply to soil
- Nitrogen primarily from legumes
- Phosphorus and sulfur are commonly applied as mineral fertilisers to increase legume production, function and nodulation (thereby N fixation)
- But, this may come at a substantial cost... (i.e. you may not do it *only* for soil C)

2. Managing risk – how much could you *increase* soil C

- Soil C varies both spatially (variogram sites) but also temporally.
- Any rapid gains in carbon can generally be lost just as rapidly
- There is already a large background level of soil C in Monaro soils

Soil C is important for farmers because it influences water holding capacity, nutrient storage and supply, soil microbial activity and buffers soil temperature fluctuations.

Acknowledgements

Landholders whose properties were sampled
Monaro Farming Systems and the Australian Government
through Action on the Ground funding

Thank you

For more information:

Susan Orgill | Research Officer - Soil Carbon
NSW Department of Primary Industries

Wagga Wagga Agricultural Institute | Pine Gully Road | Wagga Wagga | NSW 2650
M: 0428 424 566 | E: susan.orgill@dpi.nsw.gov.au