Managing stubble and fertiliser to increase soil carbon

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Key Findings

- The addition of extra nutrients and stubble management (removed, incorporated or intact) did not affect grain yield or soil carbon stocks after three years of trial work.

Why do the trial?

Soil organic matter (SOM) consists of organic material derived from living organisms (plant, animal or microorganism) and is made up of three different fractions (POC- Particulate Organic Carbon, HOC – Humus, and ROC – Resistant). Only the ROC (mainly charcoal) and HOC (humus) fractions, which make up 20-80% of the total SOM, are regarded as permanent (slow to breakdown) in soil. Soil organic matter has a number of functions in soil (van Rees, 2013) including improved soil structure, release of available N and increasing plant available water storage. In recent discussions of Soil Organic Carbon (SOC) accounting programs farmers may benefit financially for sequestering atmospheric C (CO_2).

Analysis of nutrients in a series of Australian and international soils suggested that soil carbon stocks can potentially be increased if sufficient nutrients are applied (Kirkby et al. 2011). That is, the addition of N, P and S enabled the soil micro-organisms to break down the C rich residues from previous crops into SOM. The aim of this trial was to add normal, as required to optimise yield potential, and extra amounts of nutrients (N, P and S) to different stubble managements (intact, incorporated and removed) to see if SOM levels could be increased.

How was it done?

Plot size	2.7 m x 10.0 m	**Fertiliser**	Normal nutrition DAP + Zn 2% @ 100 kg/ha at seeding Extra nutrition DAP + Zn 2% @ 135 kg/ha, SOA @ 10 kg/ha and urea (46:0) @ 21 kg/ha at seeding UAN (42:0) @ 87 L/ha, 11th August all plots
Seeding date	5th June 2015		

Crop rotation

2012	2013	2014	2015
Gladius wheat	Fathom barley	Wallup wheat	44Y89 CL Canola

The trial was a randomised complete block design with three stubble managements (standing, worked and removed), two fertiliser rates (normal and extra) and four replicates. The trial was established at Hart in 2012 and the same treatments were overlayed in 2013, 2014 and 2015 with a crop rotation of barley, wheat, barley and canola, respectively. Fertiliser was applied according to the yield potential as generated by Yield Prophet® (normal nutrition). The high nutrient rate was the normal rate plus additional nutrients (N, P and S) required for the breakdown of 1.6 t/ha stubble from the previous barley crop (Kirkby et al. 2011).

Soil samples were collected for SOC analysis and bulk density (undisturbed ring method) to a depth of 0-10 and 10-30 cm at the start of the trial (autumn 2012) and after three seasons (autumn 2015).

Results and discussion

Grain yield

Across four seasons of trial work there was no difference in grain yield (Table 1) or quality (data not shown) for stubble management or the application of additional nutrients, analysed as an interaction or alone. From an agronomic view there was no yield or quality benefit in adding more N, P and S to aid stubble decomposition.

Table 1. Grain yield (t/ha) for all stubble and nutrition treatments trial from 2012-2015 at Hart.

		Grain yield t/ha			
Stubble	Nutrition	2012 barley	2013 wheat	2014 barley	2015 canola
Removed	High	2.05	5.89	4.02	0.71
	Normal	1.83	5.95	4.00	0.68
Intact	High	1.77	6.00	4.27	0.67
	Normal	1.69	5.82	3.91	0.65
Incorporate	High	1.76	5.88	4.14	0.69
	Normal	1.87	5.86	3.96	0.67
	LSD (P≤0.05)	ns	ns	ns	ns

Soil carbon

After three years of implementing different stubble and nutrient management strategies, soil C content (%) at Hart ranged between 1.5 and 1.8% for the topsoil (0-10cm) and 0.8 and 1.3% for the subsoil (10-30cm). There was no significant difference in SOC content between the 2012 and 2015 measurements (Figure 1).

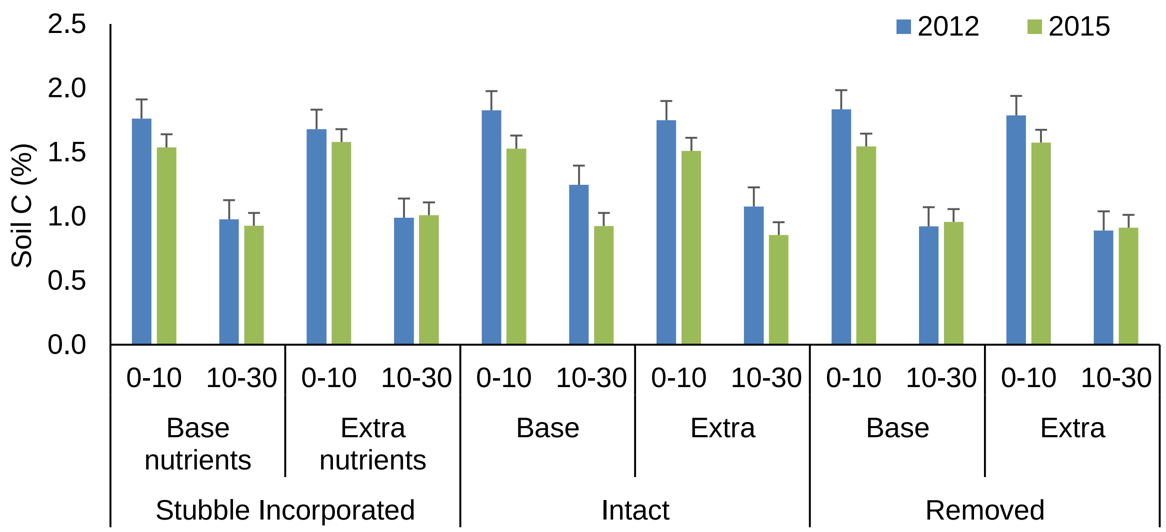

Figure 1. Soil organic carbon content (%) for the top and subsoil after three years of stubble and nutrient application treatments.

To measure the change in the amount of soil C over time, the soil mass per unit volume of soil has to be taken into account – in other words the amount of soil C is reported for a defined soil mass (ESM, Equivalent Soil Mass). The concept of ESM compensates for variations in the way samples were collected and also allows for variations in soil bulk density, resulting from different tillage practices.

Soil C stocks at Hart ranged from 35 to 40 t C/ha (Figure 2). However, there was no significant difference between 2012 and 2015 in soil C stocks between stubble management or nutrition treatments.

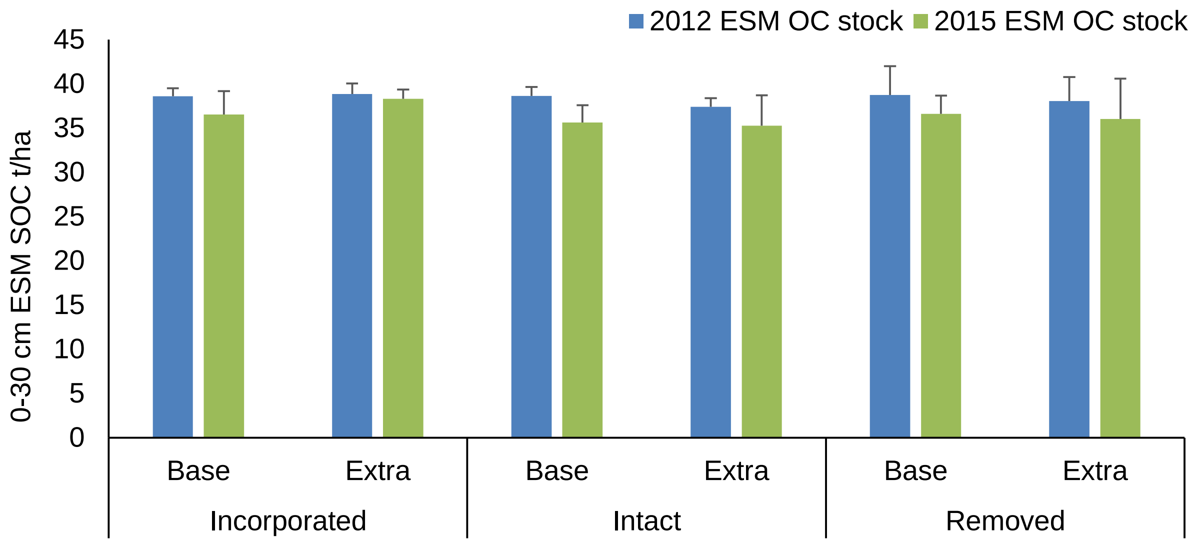

Figure 2. Soil Equivalent Soil Mass C stocks (t C/ha) in in 2012 (start of the trial) and 2015 after three years of stubble and nutrient application treatments at Hart.

The same result applied to the other seven trial sites located in SE Australia – there were no significant increases in SOC stocks at any of the sites. This work shows that increasing soil C stocks is a long-term process, and three years was not long enough to measure significant changes with the practices selected. This is consistent with a recent review indicating the largest gains in soil C stock were seen 5 to 10 years after adoption or change in practice (Sanderman et al. 2009). They also reported that improved management of cropland (eg. no-till or stubble retention) resulted, on average, in a relative gain in SOC of 0.2-0.3 t C/ha/year compared with conventional management across a range of Australian soils. The Hart trial will be re-measured again on the completion of the 2016 season after five years of trial work.

References

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