

Tillage and fertiliser effects on soil carbon

A 33 year study of carbon cycling, storage and emissions in a southern Queensland winter cereal system, confirmed that nitrogen use and emissions were the main contributors to greenhouse gas emissions.

Researchers Weijin Wang and Ram Dalal from Queensland Natural Resources & Water said: “With applied nitrogen critical for maintaining yield and profit, emphasis should be placed on optimising nitrogen use efficiency through fine tuning rates to meet crop need, and delivering nitrogen when it is needed by the crop — possibly using split applications and coated fertilisers with slower nutrient release profiles.”

Sourcing nitrogen from pulse crop and pasture sources, was seen as a good way to obtain the in-crop

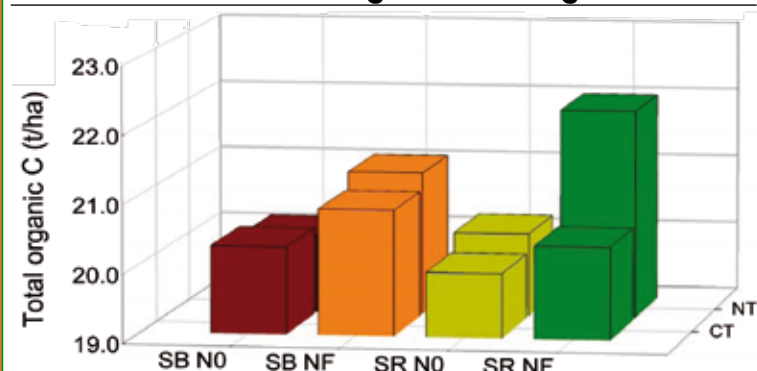
benefits of good N levels, while avoiding the high off-farm energy costs associated with the manufacture of N fertilisers.

The study was conducted at the Hermitage Research Station at Warwick on a vertosol soil and included stubble burnt (SB), stubble retained (SR), conventional tillage (CT), no tillage (NT), nitrogen fertiliser added (NF) and no nitrogen fertiliser added (NO).

“The study looked both at the impacts in the crop and soil (Figure 1), including carbon sequestration in soil and crop residue, as well as off-farm emissions involved in the manufacture and transport of farm machinery and variable inputs like fertiliser and herbicide. This enabled

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FIGURE 1: Organic carbon contents in the top 10 cm of soil under different long-term farming scenarios



(NT: no-till; CT: conventional till; SB: stubble burnt; SR: stubble retained; NO: no fertiliser N application; NF: N fertiliser applied)



Stubble broke down more slowly in no-till and no added nitrogen systems.

TABLE 1: Greenhouse gas emissions over 33 years in a cereal cropping system in SE Queensland as affected by tillage, N fertiliser and stubble management

Treatment	On-farm emissions (t CO ₂ equivalent/ha)							Off-farm emissions (t CO ₂ equivalent/ha)					Total (t CO ₂ equiv./ha)
	Diesel	Urea	CH ₄ (Stubble burning)	N ₂ O (Stubble burning)	N ₂ O (Stubble retained)	N ₂ O (Soil - from urea)	Sub total	Diesel (production & transport)	Machinery (manufacture & repair)	Urea (manufacture & transport)	Herbicide	Sub total	
CT NO SB	4.0		6.6	2.1	0.4		13.1	0.4	1.5			1.9	15.0
CT NO SR	4.0				3.9		7.9	0.4	1.5			1.9	9.8
CT NF SB	4.0	3.0	7.1	2.8	0.6	11.1	28.6	0.4	1.5	8.6		10.5	39.1
CT NF SR	4.0	3.0			5.7	11.1	23.8	0.4	1.5	8.6		10.5	34.3
NT NO SB	1.0		6.8	2.1	0.4		11.1	0.2	0.6		2.0	2.8	13.9
NT NO SR	1.0				3.9		5.7	0.2	0.6		2.0	2.8	8.5
NT NF SB	1.0	3.0	7.3	2.9	0.6	11.1	26.7	0.2	0.6	8.6	2.0	11.4	38.1
NT NF SR	1.0	3.0			6.0	11.1	21.9	0.2	0-6	8.6	2.0	11.4	33.3

CT: conventional tillage; NT: no-till; SB: stubble burnt; SR: stubble retained; NO: no N fertiliser; NF: N fertiliser applied

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the carbon balance sheet of different systems to be compared," said Ram Dalal.

"On average the no-till, stubble retained and + N fertiliser treatments increased soil organic carbon in the top 20 cm of soil by 0.35, 0.03 and 1.6 tonnes C per hectare in comparison to the conventionally tilled, stubble burnt and no N fertiliser treatments, respectively.

"This effect was most pronounced where all three (no-till, stubble retained and N fertiliser) were combined. On this heavy clay black earth, we found very little difference in organic C between stubble burnt and stubble retained treatments over 33 years. In the stubble burnt treatment, most of the stubble C is lost immediately during burning. While in the stubble retained treatment, most of the stubble C is lost from microbial decomposition over time.

The trial site had been farmed for several decades before the trial was started. It is likely that soil organic carbon had already been depleted to an equilibrium point, with little change in the conventionally tilled, stubble burnt, no N treatment since then. Based on this estimation, the no-till, stubble retained + N treatment significantly increased soil carbon by 2.3 tonnes per hectare over the 33 years of the trial.

This relatively modest gain in soil carbon was felt due to low plant productivity in a continuous cereal rotation, the long fallow period and rapid mineralisation of soil organic matter in the sub-tropical climate.

"The amount of carbon stored in crop residues showed a slightly different picture," says Ram. "There was less stubble retained (and thus less carbon) in the no-till + N treatment, than comparable treatments like no-till with no N, or either of the conventional tillage treatments. The rate of stubble decomposition was slowed by both the lack of tillage and the high C/N ratios where no N was added.

On-farm emissions

Total on-farm emissions varied greatly from 5.7 to 28.6 tonnes CO₂ equivalent per hectare (Table 1). N fertilisers (where used) were the single largest contributor to greenhouse gases in the farming system. This was due to the CO₂ generated in the breakdown of urea to ammonium, nitrous oxide emitted from N fertiliser applied and the high energy cost to make urea off farm.

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Cotton and sugar growers adapt

The cotton and sugar industries are looking up in Queensland after several tough years, according to Case IH Marketing Manager, Stuart Brown. He says that planning ahead and implementing strategies to maximise yields is the only way for farmers to survive.

Stuart says there is an emerging trend towards relocating cotton farms into northern Queensland. "We're starting to see a trend whereby cotton growers move north to capitalise on the abundant water supplies in traditional sugar growing areas such as the Burdekin."

Andrew Keeley is one such grower to move from the Darling Downs to the Burdekin last year, purchasing 320-hectares to get his operation up and running. "I've been

Andrew Keeley, pictured with his son Jack, moved from Darling Downs to the Burdekin last year to try his hand at growing cotton in a more predictable climate.

growing cotton in the Darling Downs for 10 years and, in the end, I got sick of the lack of water," Andrew says.

Andrew's first cotton crop was planted in December last year and although it's too early to tell how the season will progress, he has a good feeling it will be a success. The biggest challenge so far has been preparing the land. "We used our Case IH 8950 tractor to deep rip the land and prepare it for the cotton crop," Andrew says.

"But because the land had been used for growing sugar cane, we ended up having to hire contractors to go in after us with a rotary hoe. It was the only way we could break down all of the stubble," he said. "We've also got a Maxxum 125 which we're using for general farm tasks including slashing," he says.

Case IH's Stuart Brown says the industry is looking good for the coming year. The recent wet weather, along with strong forward prices, looks set to return the cotton crop to two million bales plus, and the industry is already working toward ensuring the infrastructure is in place to handle the increased volume. Stuart says, "It's looking like we might actually have an industry again.

Sugar growers are also introducing interesting strategies to cope with industry pressures, particularly volatile prices. "For example, a growing number of farmers have been planting cane on dual rows to increase yields. It does lead to higher water and fertiliser use, but this is offset by increased tonnage," Stuart says.

