Society for ENGINEERING in AGRICULTURE
Ph: 02 6270 6562, Fax: 02 6273 4825
Ph: 02 9351 2947 Fax: 02 9351 3706
www.usyd.edu.au/su/agric/acpa/

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Will CTF earn growers carbon credits?

By Gary Alcorn

If agriculture is included in a national carbon trading scheme growers will have to become even more expert micro managers of their energy inputs and outputs to minimise charges.

At a Controlled Traffic Farming (CTF) conference in August in Dubbo, NSW, former University of Queensland Gatton agricultural engineer Dr Jeff Tullberg of CTF Solutions, explained the greenhouse gas contributions made by common farm inputs such as distillate, herbicides and nitrogen fertilisers.

He suggested a mix of farm inputs and tillage options which can minimise both grower costs and greenhouse gas emissions in a broad-scale cropping context common in grain, cotton and sugarcane production regions.

"Plants grow best in soft soil, wheels work best on roads – neatly encapsulates the major conflict at the centre of most mechanised agriculture, and the rationale for controlled traffic farming," Jeff said.

He emphasised three important outcomes happen when heavy equipment wheels are driven over soft soil.

- We use a lot more energy (i.e. tractor power) compacting soil under the wheels;
- More energy is then required to restore compacted soil to its previous condition; and,
- Important soil processes can't work as well until (2) has been fully achieved.

Paddock input costs will be reduced under CTF, he claims, by avoiding wasting energy first in compacting and then ameliorating (restoring) previous soil properties.

National method the best

"Natural amelioration is better and cheaper. It spreads slowly downwards under the influence of plant roots and soil biota, in addition to wetting/drying effects.

"In shrink/swell soils such as heavy grey and brown swelling clays it occurs very rapidly at the surface, but happens more slowly as it moves downwards through the profile," Jeff said.

The surface two cm might recover in two weeks, but it might take two years for this effect to get to 20 cm. Amelioration to 100 cm may take 10 years.

This is why some of the benefits of CTF are evident immediately, but improvements continue for a number of years, he said.

As far as agriculture's potential contributions to climate change via greenhouse gas emissions are concerned it's much easier to reduce inputs than boost treatment of gaseous outputs.

'"Without controlled traffic, we can't avoid driving over at least 50 per cent of land area per crop.

"The damage is immediate, so it's not surprising that farmers often continue to till in well-watered areas where erosion is not seen as an issue," he said.

Tillage only does a partial repair job, and then only down to tillage depth, but it has been the basis of cropping systems for thousands of years. Over large areas of Australia it has been replaced by minimum or zero tillage, random traffic systems, which are now being displaced by CTF – controlled traffic, zero tillage, he said.

His paper, *CTF and Climate Change* focused on those effects relevant to climate change: Fossil fuel energy incorporated in the fuel, herbicides and fertilisers, and on soil emissions and soil carbon.

CTF and the alternatives

The environmental effects of CTF are compared here to the alternatives. For the purposes of this article these are taken as:

- **Stubble mulch** – minimum tillage, random traffic systems aimed at maintaining at least 30 per cent residue cover, assumed here to involve three tillage, and one herbicide operation per crop.
- **Zero till** – random traffic, assumed here to involve four herbicide operations per crop, with some tillage required every third year on average (= 0.33 tillage operations per year).
- **CTF** – controlled traffic, zero tillage, opportunity cropping (= increased cropping frequency, reducing herbicide operations to three per crop).

While there are countless combinations of inputs, operations, soil and climate variations Jeff presented a simple Excel spreadsheet outlining a range of options and their values (see Table 1) intended to

TABLE 1: Crop production operations in different systems

System	Primary Till	Seedbed Till	Spraying	Planting	Harvesting
Stubble mulch	1	2	1	1	1
Zero tillage	0.33	0	4	1	1
CTF	0	0	3	1	1

TABLE 2: Fuel requirements of cropping operations in different systems, L/hectare

Operation	Chisel plough	Cultivator	Seeder	Sprayer	Header (4t crop)	System fuel use l/ha	CO_2 kg/ha
Stubble mulch	9.8	6.0	5.0	1.4	8.0	36.2	99.6
Zero till	9.8	0	5.0	1.4	8.0	21.9	60.1
CTF	0	0	3.0	0.7	6.0	11.0	30.5

be reasonably typical of broadacre cropping in eastern Australia. It can be readily manipulated to illustrate other systems.

Fuel requirements

Typical fuel requirements of farm machinery operations are quoted in various publications by state departments and the values quoted in the stubble mulch column of Table 1 are based on these.

Fuel use in individual zero till operations is assumed to be similar, except for spraying, while fuel use in CTF operations is much lower in operations such as seeding and spraying, where rolling resistance is a large component. Harvester fuel requirements are reduced by 30 per cent for the same reason (Table 2).

"For all practical purposes, each litre of fuel burnt produces 2.75 kg of carbon dioxide (CO_2), so it is quite straightforward to calculate the carbon dioxide production per hectare of cropping," Jeff said.

Herbicides

Reducing tillage certainly reduces on-farm fuel use. Unfortunately, the production of herbicides is an energy-intensive process, and often based on mineral oils.

Glyphosate is the most commonly used herbicide, and also the most energy intensive, which might account for some of the recent price increase.

Herbicide selection obviously determines the total diesel fuel equivalent of any given cropping system. For these estimates, he assumed for each other herbicide application, two glyphosate applications occur, so a reasonable assumption of average herbicide manufacture is 4.6 L diesel per hectare, or 12.7 kg CO_2 per hectare, per spray operation (Table 3).

This value could be reduced slightly to the extent that natural gas has replaced petroleum oil in this manufacturing process, he said.

Fertilisers

"People are often surprised to find that the production of nitrogen fertiliser is usually the largest single energy input to agriculture (other than the sun!).

"It's another significant source of carbon dioxide, a major cost, and another major inefficiency. Only around half of the nitrogen applied is taken away in crops, and the unused N is an important source of pollution and greenhouse gases," Jeff said.

Inefficient use of nitrogen is often associated with waterlogging, which might be part of the background for the common observation that more nitrogen is required in (random traffic) zero tillage systems.

TABLE 3: Diesel fuel equivalents of herbicides (manufacturing component)

Commercial product	Herbicide/s	Manufacturing energy MJ/kg	Application rate (label) kg/ha	Energy/spray MJ/ha	L/ha diesel equivalent
2,4–D Amine	2,4–D	98	0.500	49	1.2
Atrazine	Atrazine	190	0.500	95	2.4
SpraySeed	Diquat/Paraquat	430	0.250	108.1	2.7
Roundup CT	Glyphosate	511	0.450	229.95	5.8

*Petroleum feedstock, 1kg Diesel = 40MJ.

TABLE 4: Energy-related CO_2 emissions, from inputs (nitrogen fertiliser, herbicide and diesel fuel)

System	N application rate kg/ha	N production CO_2 kg/ha	Herbicide prod'n CO_2 kg/ha	Diesel fuel CO_2 kg/ha	Total CO_2 kg/ha
Stubble mulch	45*	205	12.7	99.6	362.3
Zero tillage	50*	245	50.8	60.1	405.9
CTF	40*	196	38.1	30.5	304.6

TABLE 5: Cropping system effects on emissions

System	Diesel fuel CO_2 kg/ha	Herbicide prod'n CO_2 kg/ha	N. production CO_2 kg/ha	Total CO_2 kg/ha	Soil emissions* CO_2E kg/ha
Stubble mulch	99.6	12.7	205	362.3	633
Zero Tillage	60.1	50.8	245	405.9	760
CTF	30.5	38.1	196	304.6	434

*N.B. These values are highly speculative

There are also a number of claims of 'greater yield with less fertiliser' in CTF. This has not been the subject of specific research, but most CTF trials have demonstrated greater yields (often 10–15 per cent), without any increase in fertiliser input.

He assumed zero tillage requires roughly 10 per cent more N, and CTF requires approximately 10 per cent less N, which is the basis of the values quoted in Table 4.

Nitrogen fertiliser production requires approximately 75 MJ of energy per kg of fertiliser, but the feedstock involved is almost always gas, which produces only 0.065 kg carbon dioxide per MJ energy.

For most practical purposes, we can therefore assume that about 4.9 kg carbon dioxide is produced per kilogram of N fertiliser produced.

Assumed application rates and emissions relate to nitrogen fertiliser production are included in Table 4, along with emissions related to herbicide production and diesel fuel. All these inputs are similar to the extent they are all energy-related.

They are all also a direct consequence of management inputs, and will change if these inputs are changed.

Jeff also assessed the impact of those highly active greenhouse gases, nitrous oxide and methane, as well as soil emissions in presenting this cropping system effects on emissions comparison (Table 5).

TO SUM UP

- Emissions from on-farm fuel use in CTF systems are approximately half those of random traffic zero tillage, and one third of those from stubble mulch systems.
- Emissions related to herbicide and fertiliser manufacture appear to be greater from random traffic zero tillage than from CTF or stubble mulch systems.
- Available evidence on soil emissions suggests that these should be very substantially smaller from CTF systems, but further research is needed.

"These conclusions could be expected to the extent that CTF allows cropping systems to mimic more closely the processes of natural vegetation systems that contributed to the greenhouse gas levels established prior to significant human interference," Jeff said.

Happy emission trading!

The full text of CTF and Climate Change is available at www.actfa.net ■