Farming Systems Trial 2011

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Take home messages

- **it is possible that a one off cultivation in no-till systems could increase crop yields in successive years**
- **Standard and Fuel Burners outyielded No Till, followed by Reduced Till, followed by Hungry Sheep**

Background

The BCG Farming Systems Trial was established in 1999 to compare the profitability and sustainability of four farming systems common to the southern Mallee. Since 2008, it has been managed on a 'maintenance' basis. The systems are managed to the same standard as previous years, and to the specifications of each system, but minimal data are collected. Since the establishment of the trial, this is the first time a period of two consecutive years with favourable growing conditions has occurred.

Aim

To compare the yields of crops grown under four different farming systems common to the southern Mallee region.

Method

Four farming systems ('Fuel Burner', 'Hungry Sheep', 'No Till' and 'Reduced Till') were established on the trial site in 1999, together with a 'Standard' Wheat-Pea-Canola-Fallow-rotation represented each year. The systems have since been managed by farmer champions, who have directed crop choice, timing and method of operations and the use of livestock in the systems.

- Fuel Burner: mainly cereals; regular use of tilled fallow commenced prior to harvest; low intensity livestock, mainly for prime lambs; full disturbance tillage at sowing.
- Hungry Sheep: intensive cropping (mainly cereals) and intensive grazing; winter lambing, with stocking rate decided in May and feeding to fill the feed gap; sheep grazing over summer to take advantage of stubbles and control weeds; early sown cereal/pasture forage for feed; generally full disturbance tillage at sowing.
- No Till: minimum soil disturbance seeding, with knife points and press wheels on 30.5cm spacing; no livestock; initial high use break crops; now many cereals and some chemical fallow (commenced in late winter).
- Reduced Till: flexible approach; can use tillage/full disturbance sowing but has mainly been chemical weed control and same seeding system as No Till; mix of cereals, canola and lower value break crops; some livestock on agistment over summer.

The plots at the trial site were split in 2006 to develop new systems within systems. No Till versions of Fuel Burner and Hungry Sheep were included, as were Straw-Added (5t/ha in Feb 2007) and Tillage (single pass in summer 2006 or 2007) treatments in No Till and Reduced Till systems. The new plots were managed with the same crop choice, sowing date, seed and fertiliser inputs, but using establishment and weed management techniques to suit each system.

Location:	Jil Jil (20km north-east of Birchip)
Replicates:	-
Sowing date:	15 March – 9 June 2011 (Some plots were re-sown due to poor germination and mouse damage)
Seeding equipment:	various see Table 1 N.B.

Results

The 2011 season delivered a wide range of yield results, from crop failures to 4t/ha wheat and barley crops. In general terms, the cereals did well and the break crops (canola, peas, and chick peas) did poorly. The 2011 crops following fallow did not achieve higher yields than those following a cereal or canola crop. The high summer rainfall ensured that all crops had significant stored soil moisture at the start of the season, lessening the comparative moisture effect of fallow crops. There was no evidence of a nitrogen effect. Table 1 shows the yield and quality results of the crops grown in the farming systems trial in 2011.

Treatment differences also need to be considered against the likely level of error; the yields achieved across the standard plots were very consistent for wheat (range: 0.28t/ha) and canola (range: 0.4t/ha) but inconsistent for peas (range: 0.93t/ha). It is reasonable to conclude that spatial variability did not have a significant impact in 2011, again due to the significant rainfall over the summer of 2010/'11.

The 2011 system average crop yields (Figure 1) show that the average wheat yields for the Standard and Fuel Burners were higher than for No Till, followed by Reduced Till, followed by Hungry Sheep. There was a similar trend for barley and canola (where the crop was sown for that treatment). There were too few pulse crops to compare meaningfully.

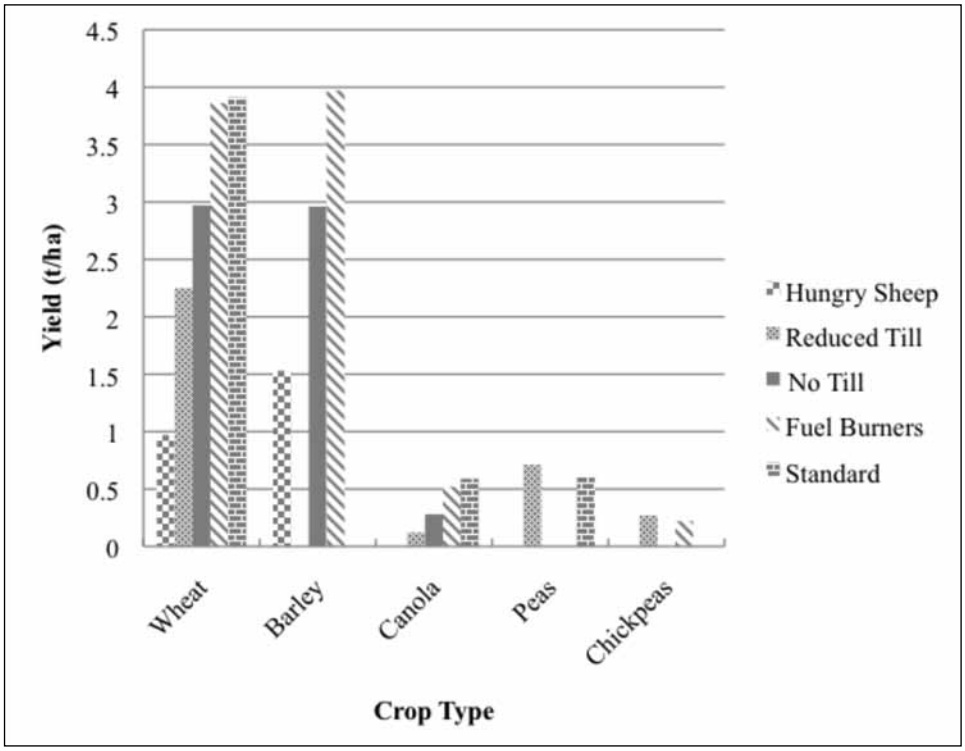

Figure 1. 2011 system average crop yields (N.B. where no yields are visible that crop was not sown for that system)

It is evident from Table 1 and Figure 1 that the cultivated treatments out-yielded the no-till treatments for all crop types, with the exception of canola which showed only a small change in yield.

Table 1. Yield (Y) and quality (P: protein%, S: Screenings%, O: Oil%) of crops grown in the Farming Systems Trial in 2011

Plot	Crop	No Till	Till	Straw
Fuel Burner				
8	Fallow			
10	Barley (Hindmarsh)	Y: 3.34t/ha~ P: 11.4%, S:2%	Y: 4.60t/ha*** P: 10.5%, S:2%	
18	Canola (Hurricane)	Y: 0.51t/ha* O: 39.7%	Y: 0.53t/ha* O: 42.3%	
21	Wheat (Correll)	Y: 3.46t/ha~ P: 11.0%, S: 12%	Y: 4.26t/ha*** P: 11.0%, S: 13%	
29	Chickpeas (Genesis 090)	Y: 0.03t/ha~	Y: 0.42t/ha***	
Hungry Sheep				
2	Barley (Hindmarsh)	Y: 1.86t/ha~ P: 11.3%, S: 4%	Y: 2.77t/ha*** P: 11.1%, S: 2%	
5	Barley (Hindmarsh)	Y: 0.50t/ha~ P: 14.4%, S:2%	Y: 1.01t/ha*** P:13.5%, S:4%	
13	Wheat (Correll)	Y: 0.53t/ha~ P: 11.2%, S: 23%	Y: 0.92t/ha*** P: 11.3%, S: 22%	
26	Wheat (Correll)	Y: 1.20t/ha~ P: 9.3%, S:23%	Y: 1.24t/ha*** P: 9.7%, S:21%	
32	Fallow			
No Till				
6	Barely (Hindmarsh)	Y: 3.62t/ha~ P: 11.5%, S:2%		Y: 3.69t/ha~ P: 11.8%, S:1%
11	Canola (Hurricane)	Y: 0.22t/ha* O: 39.5%	Y: 0.34t/ha** O: 36.9%	
16	Wheat (Correll)	Y: 3.11t/ha~ P: 11.2%, S: 5%		Y: 2.83t/ha~ P: 11.4%, S:6%
22	Canola (Hurricane)	Not harvested*	Not harvested**	
27	Barley (Hindmarsh)	Y: 2.23t/ha~ P: 10.0%, S: 2%		Y: 2.30t/ha~ P: 10.4%, S: 2%
Reduced Till				
3	Fallow			
14	Chickpeas (Genesis 090)	Y: 0.29t/ha~	Y: 0.26t/ha~	
19	Peas (Kaspa)	Y: 0.78t/ha~		Y: 0.64t/ha~
24	Canola (Hurricane)	Y: 0.17t/ha* O: 37.9%		Y: 0.08t/ha* O: 36.9%
30	Wheat (Correll)	Y: 2.03t/ha~ P: 10.9%, S: 20%	Y: 2.47 t/ha~~ P: 10.6%, S:13%	
Standard				
1	Wheat (Correll)	Y: 3.72t/ha*** P: 11.3% , S:3%		
4	Canola (Hurricane)	Y: 0.61t/ha* O: 37.0%		
7	Peas (Kaspa)	Y: 0.25t/ha~		
15	Wheat (Correll)	Y: 3.99t/ha*** P: 10.6%, S: 12%		
17	Peas (Kaspa)	Y: 1.18t/ha~		
20	Wheat (Correll)	Y: 4.01t/ha*** P: 10.7%, S: 19%		
25	Canola (Hurricane)	Y: 0.57t/ha* O: 36.1%		
28	Peas (Kaspa)	Y: 0.38t/ha~		
31	Canola (Hurricane)	Y: 0.57t/ha** 0: 35.0		
9, 12, 23	Fallow			

N.B. The higher screenings were probably more related to grain damage during threshing than to small grains.

* = *Sown using the Concord with Anderson Openers*

** = *Sown using the Concord with Anderson Openers and cultivated prior to sowing*

*** = *Sown using the Concord with 325mm Sweeps*

~ = *Sown with the Avon*

~~ = *Sown with the Avon with a pre work using the Concord with 325mm Sweeps*

Shaded cells indicate that the plots were resown using the same seeding system

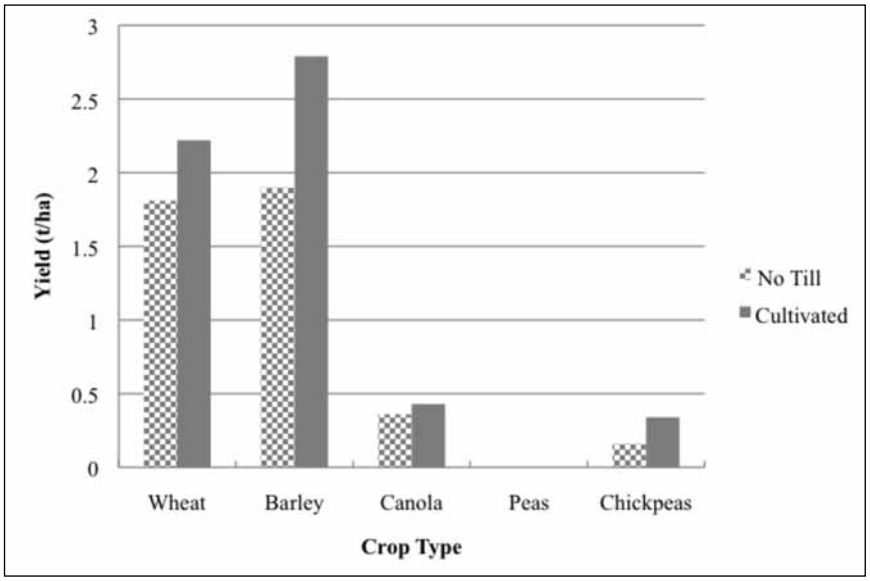

Figure 2. No Till vs Cultivated split plot average crop yields (N.B. where no yields are visible that crop was not sown for that split plot)

Table 1 and Figure 3 show that, in the No Till and Straw Added split plots, there was no clear trend for residual effects from the 2007 straw treatments.

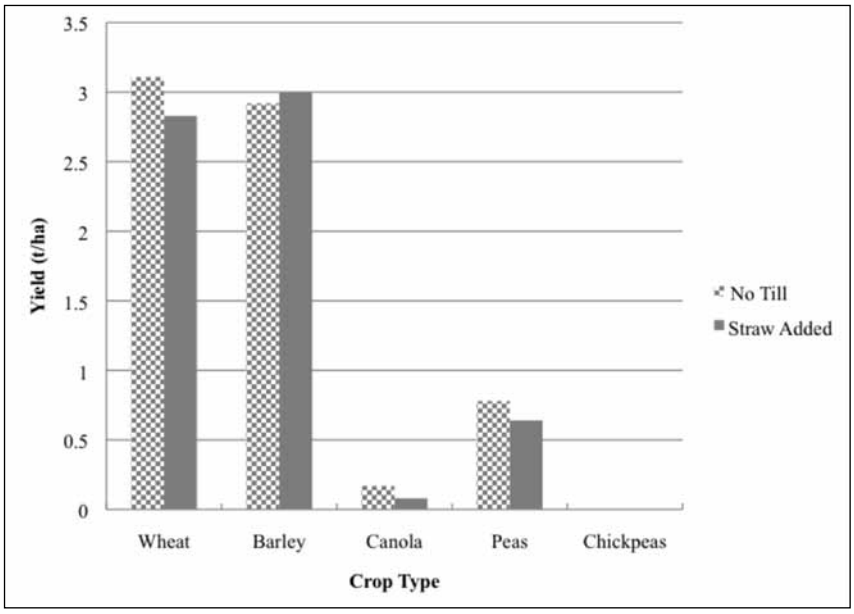

Figure 3. No Till vs Straw Added split plot average crop yields (N.B. where no yields are visible that crop was not sown for that split plot)

Interpretation

The systems site was riddled with problems during the 2011 season. This can account for some of the low yields that occurred in the trial. During sowing, rainfall events sufficient to ensure germination were rare. Germination was particularly problematic for the break crops (canola, chickpeas and peas).

Compounding the germination problems was the mouse infestation at the site. Despite regular baiting, a number of plots had to be re-sown. Even break crop plots that did not have to be re-sown germinated well outside the optimal window. The systems site is severely affected by subsoil limitations. Break crops do not perform well on this site unless they receive good spring rainfall; when they have to rely on accessing stored water they have not been as successful.

A further problem for the break crops was poor weed control on each system. There were consistent problems with skeleton weed, thistles and mustard in the break crops, particularly the legumes. It is not surprising that the break crop yields across all systems were poor in 2011.

The cereal production of the Standard and Fuel Burners systems easily out-yielded No Till, followed by Reduced Till followed by Hungry Sheep. A full assessment should include the value of livestock in the Hungry Sheep system, but that had not been collated at the time of writing. It is difficult to confirm why the Fuel Burner and Standard treatments out-yielded the other systems. However, one suggestion is that cereal germination of these treatments was better in these plots.

This is particularly relevant when compared with the Hungry Sheep system. There is a possibility that the heavy grazing over summer compacted the soil so that when the crop was direct drilled the soil formed large clods which had poor seed soil contact, in effect reducing plant densities, increasing weed competition and delaying germination. Seeding systems used support this theory: the predominant seeding system used for cereals in the Fuel Burner and Standard plots was full cut wide points as opposed to the majority of the No Till, Reduced Till and Hungry Sheep systems which were sown using knifepoints. It is apparent that the extra soil disturbance improved crop yields, probably as a result of better seed soil contact and germination.

In the 2011 season it is evident that the cultivated treatments out-yielded the No Till treatments for all crop types with the exception of canola which has only a small change in yield. Despite the fact that the cultivation occurred during the summer of 2006-07, there appears to be some beneficial carry over in 2011.

The exact reasons for this are unknown. However, there is anecdotal evidence from trial work conducted in Canada and NSW to suggest that a one-off cultivation in no-till systems can increase crop yields in successive years. One hypothesis is that "cultivation may actually be similar to rotation in changing the soil biology in positive ways, and if so, a targeted cultivation may actually be necessary to capture benefits from no-till soil. Think of cultivation as changing the soil biology of long-term no-till soil in ways that create changes to rhizosphere organisms to boost growth just like rotation sometimes does in ways we can never fully understand" (pers. comm., J. Kirkegaard, 2012).

One other hypothesis is that the cultivation disturbed the soil and in so doing reduced the pressure from soil borne diseases. Watt et al. 2006 state that though many structural and biological properties of soil improve under no-till systems, undisturbed soils can also favour root diseases such as *Rhizoctonia solani*, nematodes as well as inhibitory organisms such as Pseudomonas bacteria. This hypothesis will be tested in March 2012 when each plot will be analysed for the presence of diseases using DNA testing. Supporting this theory is that in most cases the cultivated plots were sown using a seeder with greater soil disturbance (full cut) compared with the no-till seeder (knife points).

Commercial practice: what this means for the farmer

In the 2011 season, the cultivated treatments out-yielded the no-till treatments, despite the fact that the cultivation occurred three years ago (during the summer of 2006-07). There is evidence in this trial to suggest that a one-off cultivation in no-till systems can increase crop yields in later years. There is no conclusive evidence to date. However, no-till farmers could consider incorporating tactical cultivation into their system to take advantage of some of the benefits of soils disturbance.

There were very few examples of successful break crops in the 2011 season at the systems site. The lack of decent sowing rain combined with mouse damage, delayed germination and strong competition from weeds all contributed. In many cases, it would probably have been best to convert the break crops into brown manure or hay crops to reduce the weed burden in subsequent seasons.

Acknowledgments

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References

Watt, M; Kirkegaard, JA, and Passioura, JB (2006) 'Rhizosphere biology and crop productivity,' *Australian Journal of Soil Research* 44, 299-317