Long-term stubble retention and reduced tillage

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Key findings

- Crop water use and soil analysis values were very similar between the sites comparing long term reduced tillage and stubble retention.
- Reduced tillage and stubble retention has significantly contributed to increasing organic carbon levels at these sites.
- The grain yields of wheat were greatest at the sites with higher water use efficiency for each location.

Why do the trial?

A clear variation has developed between growers and their approach to sustainable farming. Some examples include growers reducing the input of organic matter by removing straw after harvest, producing less dry matter with delayed applications of nitrogen, and included export hay into rotations. In contrast to this other growers have maximised the input of organic matter through a long term adoption of reduced tillage and stubble retention. The long term effects of these differences, especially in relation to soil moisture and soil quality have not been measured.

How was it done?

Plot size 7 m × 10 m

Table 1. Sowing date and fertiliser rate of the A and B trial sites, for each location.

	Sites A & B	Sowing date	Fertiliser
2010	Condowie	29th April	35 kg/ha DAP Zn
	Saddleworth	7th May	80 kg/ha DAP Zn
	Spalding	6th May	40 kg/ha DAP Zn
2011	Condowie	21st May	40 kg/ha DAP Zn
	Saddleworth	16th June	90 kg/ha DAP Zn
	Spalding	19th May	150 kg/ha 32:10
	(Site B sown with commercial equipment)		
2012	Condowie	21st May	65 kg DAP Zn
	Saddleworth	18th May	100 kg/ha DAP Zn
	Spalding	17th May	80 kg/ha DAP Zn

Three permanent regional sites (Condowie, Saddleworth and Spalding) were established in 2010 within selected grower paddocks. The locations were selected such that they covered a range of soil types and rainfall amounts within the Mid-North of South Australia.

At each location, rotation trials were established in two paddocks which were separated by a difference in water use efficiency over the past 10 years. At each location one grower had been using long term reduced tillage and stubble retention practices (for more than 20 years, site A) while the other grower had only a shorter history for these practices (less than 5 years, site B). At two of the locations, the trial sites were separated by a road, while at the Spalding location the distance between the sites was 100 m.

A randomised complete block design with three replicates was used to conduct a rotation trial at each site and location, totalling 6 individual sites. A rotation was utilised to keep the site free of weeds and to provide a similar cropping history, for a standard comparison.

A standard knife-point press wheel system was used to sow the plots on 22 cm (9") row spacing.

All plots were assessed for grain yield and quality.

The matching sites at each location were sown with the same seeder, at the same time, using the same seed and same fertiliser. Nitrogen management and weed control were conducted as needed during the growing season and was also treated the same for the matching sites.

Results

Extensive soil analysis (drained upper limit, bulk density, nutrients, soil strength and water infiltration) at each of the sites showed only marginal differences between the site A and B paddocks. The site A paddocks had higher levels of organic carbon, this difference was greatest at Spalding and Condowie and could be a result of more than 20 years of reduced tillage and stubble retention. However, in some cases the site B paddocks had faster water infiltration and more penetrable soil (Tables 2 to 4). Root disease levels were not different between the sites.

At each site the measured soil strength was very similar. In fact, at the Saddleworth and Spalding sites the soil was easier to penetrate in the site B paddock. Saddleworth had the softest soil of the sites. Results for the rate of water infiltration were similar with the Spalding and Saddleworth site B paddocks having the fastest rate of infiltration. The Condowie site had the overall fastest rate of water infiltration.

Table 2. Penetrometer readings from each site. The values are the number of hits needed to reach the listed target depths.

Location	Depth (cm)	Site A	Site B
Saddleworth	0-5	3.8	2.4
	5-10	13.9	10.7
	10-15	24.2	24.0
Spalding	0-5	5.8	4.9
	5-10	16.1	11.2
	10-15	31.5	31.1
Condowie	0-5	3.0	4.2
	5-10	13.5	13.2
	10-15	40.7	34.3

Table 3. Water infiltration readings from each site. The value is the time taken (seconds) to reach each target depth, in seconds.

Location	Depth (cm)	Site A	Site B
Saddleworth	10	161.0	129.6
	13	84.5	37.5
	15	116.8	103.4
	18	58.5	30.5
Spalding	10	96.7	63.7
	13	66.0	38.7
	15	76.3	42.7
	18	34.3	18.3
Condowie	10	4.5	5.0
	13	5.0	4.9
	15	11.8	11.1
	18	29.0	na
	20	na	34.4

Table 4. Soil test analysis results for each site A and B, at each location, at the 0-10cm depth.

Analysis test	Saddleworth		Spalding		Condowie	
	Site A	Site B	Site A	Site B	Site A	Site B
Phosphorus (Colwell ppm)	31	28	41	63	44	31
Organic carbon (%)	1.81	1.76	2.37	1.74	1.84	1.13
EC (dS/m)	0.24	0.19	0.28	0.19	0.25	0.14
pH ($CaCl_2$)	7.1	7.3	5.8	4.7	7.9	8.0
pH (H_2O)	7.6	7.8	6.2	5.4	8.5	8.7

The rate of crop growth and leaf area expansion was similar between the site A and B paddocks throughout the project, although final dry matter production was lower for some of the site B paddocks. Measurements of crop water use show similar results between the site A and B paddocks and showed that in these productive farming systems 50 to 60% of the early season water loss is still through soil evaporation.

Table 5. The grain yield (t/ha) of wheat and barley at each trial site between 2010 and 2012.

Site	Crop	2010		2011		2012	
		Site A	Site B	Site A	Site B	Site A	Site B
Condowie	Wheat	2.9	2.9	1.91	1.41	2.60	2.20
	Barley	3.1	4.4	1.77	0.37	na	na
Spalding	Wheat	6.9	7.5	4.84	4.08	3.20	2.40
	Barley	7.4	8.4	5.02	3.45	na	na
Saddleworth	Wheat	4.5	4.1	5.38	5.36	4.10	4.00
	Barley	5.6	4.9	4.71	4.76	na	na

Table 6. The grain protein (%) of wheat and barley at each site between 2010 and 2012.

Site	Crop	2010		2011		2012	
		Site A	Site B	Site A	Site B	Site A	Site B
Condowie	Wheat	10.9	na	12.6	11.5	10.8	10.0
	Barley	11.1	na	12.0	12.2	na	na
Spalding	Wheat	10.4	10.8	12.9	14.8	13.7	13.6
	Barley	10.6	10.5	12.0	11.7	na	na
Saddleworth	Wheat	8.0	9.0	11.0	10.0	6.4	9.5
	Barley	9.1	9.4	12.3	12.3	na	na

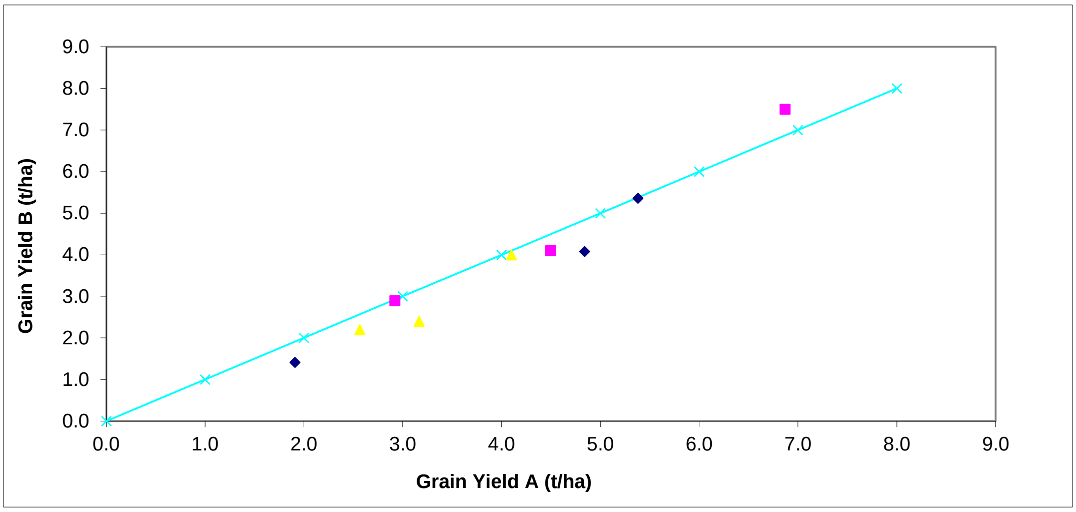

Figure 1. The grain yield of wheat at site A compared to site B for each site and season between 2010 and 2012.

The grain yield (Table 5) and total nitrogen offtake (Table 6) was similar between the sites, with the site A paddocks producing slightly higher yields (Figure 1).

By removing the commonly discussed variables of time of seeding, seeding rate, fertiliser rate, seeding equipment and crop rotation these paddock comparisons have shown that long term reduced tillage and stubble retention has contributed small improvements to crop water use, grain yield and quality. More significantly they have clearly shown that timeliness of operation, attention to detail and good rotation play a far greater role in obtaining optimum water use efficiency.