Effective crop rotations

Peter Hooper, Hart Field-Site Group

This trial was funded by the GRDC as part of the water use efficiency initiative and conducted in collaboration with Chris Lawson and Victor Sadras, SARDI, and Glenn McDonald , The University of Adelaide.

Key findings

- Wheat following wheaten hay produced the highest grain yield, averaging 3.22 t/ha.
- The highest gross margin for the 4 years was from the standard rotation, which included field peas and canola.
- The greatest limitation to rotation productivity was from brome and barley grass, especially in the continuous cereal rotation.

Why do the trial?

This long term trial was part of the Hart water use efficiency project and aimed to look at the overall crop rotation, as compared to the wheat year alone. This is because in a rotation sequence wheat consistently follows a legume or pasture so the measured water use efficiency will often be very good. However, the water use for the total rotation may not be as high, i.e consecutive wheat or barley crops.

This trial aimed to assess three rotations used in the Mid-North, especially those incorporating export hay or continuous cereals.

How was it done?

Plot size 4 m × 10 m **Fertiliser** DAP (18:20) Zn 2% @ 80kg/ha

Rotations 1) Standard – Wheat, barley, barley, peas, TT canola

2) Cereal – Wheat, barley, wheat, wheat, barley

3) Hay – Wheat, wheaten hay, barley, wheaten hay, barley

This long term trial was conducted between 2008 and 2012, and was a randomised complete block design with three replicates. Three rotations were trialled and each of the five crops within each rotation was sown each year. The sowing time coincided with other trials at Hart, usually around mid to late May. The varieties used represented typical varieties for the area and nitrogen management and weed control were conducted as needed during the growing season.

A standard knife-point press wheel system was used to sow the plots on 22.5 cm (9”) row spacing.

All cereal grain plots were assessed for grain yield, protein and screenings. Soil water was measured prior to seeding each year.

Results

Only marginal differences in stored soil water (less than 15 mm) could be measured at the beginning of each season, even following field peas or export hay. The differences between the crop types were not significant.

After 2 to 3 years of the trial, the continuous cereal rotation had developed much higher levels of brome grass and barley grass. This weed pressure would have reduced the grain yield in these plots and is likely to have also increased levels of root disease.

The results for wheat alone produced a range in grain yields between 1.66 t/ha (wheat following TT canola in 2012) and 4.25 t/ha (wheat following TT canola in 2010) (Table 1 and see Table 3 for all results). The grain yield of wheat following wheaten hay was significantly higher, averaging 3.22 t/ha (Table 1). This was followed by wheat on canola and then wheat on wheat or barley. Although pre-season moisture measurements did not show any significant differences, it is likely that there was some residual moisture.

Grain protein ranged from 8.1% (wheat on wheat 2011) to 15.9% (wheat on canola 2012). Wheat following canola generally had higher grain protein as a result of the preceding pea crop and higher nitrogen rates applied to the canola. Wheat following barley consistently had the lowest protein levels, and highlighted the need for higher fertiliser rates in the absence of a legume crop within the rotation.

Table 1. The grain yield and protein of wheat following either wheat, barley, TT canola or wheaten hay in the long term rotation trial between 2009 and 2012 at Hart.

Crop	Year								Average
	2009		2010		2011		2012		
	Yield t/ha	Protein %	Yield t/ha	Protein %	Yield t/ha	Protein %	Yield t/ha	Protein %	
Wheat	2.69	10.8	3.60	8.2	3.08	11.8	1.88	11.2	2.81
Barley	2.47	10.0	3.46	8.3	3.29	10.8	1.66	11.1	2.72
TT Canola	2.43	11.1	4.25	10.2	3.71	12.7	1.64	15.9	3.01
Wheat Hay	3.07	10.7	3.51	8.7	3.19	11.6	3.10	11.7	3.22

Across the three rotations there was little difference between total crop water use. For each season between 2009 and 2012 none of the rotations consistently produced the highest gross margin (Table 2). Average gross margins for each year ranged from -$60/ha (continuous cereal in 2012) to $413/ha (continuous cereal in 2010). The standard rotation produced the highest cumulative gross margin of $4051, although there was surprisingly little difference between all the rotations.

Overall, this trial has shown that each of the rotations were water efficient and profitable. Weeds were the biggest limitation of the continuous cereal rotation, however the introduction of group B tolerant crops and new pre-emergent herbicides will help to reduce this problem. It also showed that the inclusion of a legume component within a rotation was not essential, however it was very useful for weed management and improving grain protein.

Table 2. Average and total gross margin $/ha for each rotation from 2009 to 2012 at Hart.

Rotation	Year								Total
	2009		2010		2011		2012		
	Average	Total	Average	Total	Average	Total	Average	Total	
Cereal	192	959	223	1116	413	2063	-60	-302	3837
Hay	200	1002	141	706	306	1531	77	384	3624
Standard	169	846	263	1315	403	2014	-25	-124	4051

The calculations use the Rural Solutions farm gross margin guide for prices and costs. Production costs used were $485/ha for wheat, $450/ha for barley, $470/ha for canola, $550/ha for hay and $450/ha for peas. All of these costs include contract harvesting and freight rates, otherwise the costs associated with hay making become significantly higher.

This is a very simple method for calculating gross margin and did not take into account the likelihood that more nitrogen fertiliser and pre-emergent grass herbicide would be required on the cereal rotation and less on the standard. Also the wheaten hay yields were slightly lower compared to the district oaten hay yields.

Table 3. Grain and hay yields for each rotation and year of the trial between 2008 and 2012 at the Hart.

Rotation	Year									
	2008		2009		2010		2011		2012	
	Crop	Yield t/ha	Crop	Yield t/ha	Crop	Yield t/ha	Crop	Yield t/ha	Crop	Yield t/ha
Cereal	Wheat	0.79	Barley	3.48	Wheat	2.86	Wheat	3.08	Barley	2.30
Cereal	Barley	1.92	Wheat	2.52	Wheat	3.59	Barley	3.57	Wheat	1.88
Cereal	Wheat	0.75	Wheat	2.69	Barley	4.68	Wheat	3.55	Barley	2.40
Cereal	Wheat	0.65	Barley	3.24	Wheat	4.06	Barley	3.53	Wheat	1.61
Cereal	Barley	1.97	Wheat	2.43	Barley	5.07	Wheat	3.04	Wheat	1.71
Wheat Hay	Barley	1.77	Wheat Hay	4.03	Wheat	3.51	Wheat Hay	5.32	Barley	1.70
Wheat Hay	Wheat Hay	3.90	Wheat	3.07	Wheat Hay	5.42	Barley	3.94	Barley	3.10
Wheat Hay	Wheat	0.92	Wheat Hay	4.03	Barley	4.92	Barley	4.14	Wheat Hay	6.20
Wheat Hay	Wheat Hay	3.90	Barley	3.19	Barley	4.21	Wheat Hay	5.32	Wheat	3.10
Wheat Hay	Barley	1.93	Barley	3.60	Wheat Hay	5.42	Wheat	3.19	Wheat Hay	6.20
Standard	Peas	0.47	TT Canola	0.92	Wheat	4.25	Barley	3.88	Barley	1.30
Standard	TT Canola	0.73	Wheat	2.43	Barley	5.03	Barley	3.97	Peas	1.50
Standard	Wheat	0.89	Barley	3.93	Barley	4.80	Peas	3.10	TT Canola	1.40
Standard	Barley	1.96	Barley	3.61	Peas	2.35	TT Canola	2.00	Wheat	1.64
Standard	Barley	2.10	Peas	1.90	TT Canola	2.03	Wheat	3.71	Barley	2.10