Profitable crop sequences in the low rainfall region of upper Eyre Peninsula

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Location:
Minnipa Agricultural Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2014 Total: 407 mm
2014 GSR: 290 mm
Paddock History
Prior to 2011 > 10 years cereal
Soil Type
Red sandy clay loam
Plot Size
20 m x 2 m x 3 reps
Yield Limiting Factors
Nitrogen
Phosphorus
Grass weed competition

Key messages

- **A break of two years can produce a better financial outcome than continuous wheat over a four year period of production where there are substantial pressures on wheat performance (eg. grassy weeds).**
- **Wheat yields after a two year break were a significant step up from wheat crops following a one year break, which were in turn, much better than the continuous wheat. Large break crop benefits of 0.5-1.25 t/ha were achieved following a two year non-cereal break phase compared to continuous wheat .**
- **The break crop benefit of a one year break may only last one season if grass weeds are a significant factor. The major benefit of breaks in these long term cereal paddocks was to reduce grassy weed pressures for subsequent wheat crop phases.**
- **The benefit of a two year break had little to do with the phases chosen for those two breaks, providing that excellent grass weed control could be achieved in both.**
- **Many of the most profitable crop sequences over the four year period often started with a two year break phase.**

Why do the trial?

To determine the comparative performance of alternative crops and pastures as pest and disease breaks in an intensive cereal phase.

In low rainfall regions of south-eastern Australia broad-leaved crops make up only a very small proportion of the total area of sown crops. In light of increasing climate variability farmers have adopted continuous cereal cropping strategies as non-cereal crops are perceived as riskier than cereals due to greater yield and price fluctuations. At the same time, this domination of cereals is increasing the need for non-cereal options to provide profitable rotational crops, disease breaks and weed control opportunities to sustain cereal production. Currently, the most common 'break crop' is a poorly performing volunteer annual grass dominant pasture. They are often havens for cereal pests and diseases and are seen as having negative impacts on subsequent cereal grain yield and quality. For greater detail of trial management over the past three years refer to articles in EPFS Summaries 2011, p 111, 2012, p 94, and 2013, p 104.

How was it done?

In year four (2014) of the study all the treatments were sown to Corack wheat at 55 kg/ha with 65 kg/ha DAP on 11 May. A deep blade system (DBS) seeder was used as opposed to the knife points used the previous 3 years to address the accumulated stubble that had negatively impacted on establishment the year prior. Five treatments that had not had any legume break phase (2x continuous wheat, vetch/oats mix followed by wheat, oats then canola and canola then oats) in the previous two years also received 50 kg/ha of urea at sowing to compensate for any extra nitrogen deficiency.

From grass weed data in 2013 the decision was made to address heavily infested treatments with a pre-emergence mixture of Sakura @ 118 g/ha and Avadex @ 2 L/ha. The treatments were pea/oat, oat/pea, medic/wheat, pea/wheat, pea/canola, pea+canola/wheat. It was hoped that the continuous cereal treatments and the vetch+oat/wheat treatment would have reduced grass numbers having had Intervix applied in 2013. These three treatments and all remaining treatments received trifluralin @ 1.5 L/ha.

Four days post-sowing all plots were sprayed with chlorpyrifos @ 0.7 L/ha to address observed cut worms in the trial. Treated grain mouse bait was applied to the trial the same day.

On 22 July additional nitrogen was applied in the form of urea. Treatments were assessed using soil mineral nitrogen data and fertiliser application to determine available mineral nitrogen. Treatments with calculated levels of ≤ 100 kg/ha (canola/medic, medic/oats, pea/canola, canola/pea, oats/medic, fallow, medic/canola, medic/regenerated medic & canola) mineral nitrogen received 60 kg/ha urea, whilst treatments with 101-120 kg/ha (pea/oats, pea/wheat, pea & canola/wheat, oats/pea, Angel medic/wheat, Jaguar medic/wheat, sulla, vetch & oats/wheat, canola/oats) received 30 kg/ha. The two continuous cereals treatments and oats/canola had greater than 120 kg/ha mineral N and did not receive any additional fertiliser.

On the 6 August all treatments were visually assessed for the presence of broad-leaved weeds. As a result all treatments excluding oats/medic, fallow, and medic/oats were sprayed with 2, 4-D (2-ethylhexyl ester) @ 0.6 L/ha. On 15 August as a response to observed stripe rust in the district the trial was aerial sprayed with tebuconazole @ 0.29 L/ha.

Grass weeds were measured on 12 September when the wheat was flowering. Dry matter cuts were also taken at this time.

What happened?

Soils

Pre sowing soil water measured in the 0-90 cm profile on 14 April were similar across all treatments (which were all seeded to wheat in 2013 as well).

Following the application of nitrogen in the form of Urea either at sowing in the case for sequences that had not experienced a legume break or either in-crop for the remaining treatments, the total nitrogen available to the crop ranged between 112 and 145 kg/ha. Given that a wheat crop requires approximately 50 kg/ha nitrogen to produce one tonne of grain there was enough N for a 2-3 t/ha yield across all treatments.

Rhizoctonia solani AG8 varied only slightly across the treatments. Levels across all treatments were lower than what is generally required for crop damage and subsequent yield loss.

Table 1 Presence of Rhizoctonia solani AG8 in the soil pre-sowing, soil moisture from 0-.9m pre-sowing, total mineral N present in the soil, nitrogen available to the crop including soil N and fertiliser N, plant establishment counts, flowering biomass in 2014. Treatments in bold had extra N applied with the seed

2014	*Rhizoctonia* solani AG8	Soil moisture 0-90cm	Total mineral Nitrogen 0-90cm	Nitrogen available @ sowing	Plant est. counts	Flowering biomass
2011 outcome / 2012 outcome	7 Apr	14 Apr	14 Apr	11 May	29 May	12 Sep
	log (pgDNA/g)	mm	kg/ha	kg/ha	plants/m^2	t/ha
1 WHEAT grain / WHEAT grain	0.75[ab]	156	111	145	**81**[abc]	9.5
2 WHEAT grain / WHEAT grain	1.31[ab]	156	90	124	**50**[d]	10.7
3 ANG MEDIC seed / WHEAT grain	1.71[a]	163	100	126	87[abc]	11.7
4 VETCH+OATS hay / WHEAT grain	1.32[ab]	154	81	129	**64**[cd]	9.5
5 OATS hay / CANOLA grain	0.62[ab]	158	95	130	**67**[bcd]	9.6
6 OATS hay / FIELD PEA grain	0.98[ab]	155	98	123	92[abc]	11.4
7 OATS hay / EARLY SOWN MEDIC graze	1.42[ab]	150	82	121	97[a]	9.7
8 FALLOW / FALLOW	1.56[a]	148	82	121	92[abc]	10.1
9 ANG SOWN MEDIC seed / WHEAT grain	1.38[ab]	152	101	127	91[abc]	12.3
10 SOWN MEDIC hay / REG MEDIC+CANOLA graze	1.71[a]	150	85	124	91[abc]	12.7
11 EARLY SOWN MEDIC hay / CANOLA grain	1.23[ab]	150	85	124	90[abc]	12.5
12 EARLY SOWN MEDIC hay / OATS graze	1.84[a]	157	79	119	91[abc]	11.2
13 CANOLA grain / FIELD PEA grain	0.22[b]	162	81	120	92[abc]	13.4
14 CANOLA grain / EARLY SOWN MEDIC graze	1.31[ab]	171	73	112	84[abc]	11.1
15 CANOLA grain / OATS graze	0.79[ab]	156	82	130	**74**[abcd]	11.0
16 FIELD PEA grain / OATS graze	1.43[ab]	159	92	118	91[abc]	10.5
17 FIELD PEA grain / WHEAT grain	1.63[a]	179	92	118	96[ab]	11.1
18 FIELD PEA grain / CANOLA grain	0.77[ab]	158	81	120	91[abc]	11.4
19 FIELD PEA+CANOLA hay / WHEAT grain	0.78[ab]	160	95	120	96[ab]	11.0
20 SULLA graze / REG SULLA graze	1.73[a]	133	101	127	91[abc]	12.2

Production

Establishment counts trended lower in treatments that had not experienced a legume break throughout the sequence (Treatment no. 1, 2, 4, 5, and 15) because of additional nitrogen in the form of urea applied accidentally with the seed at sowing, which resulted in fertiliser toxicity. Although no statistical differences were observed in the flowering biomass it too has trended lower on those same treatments.

Despite the use of frequent and expensive grass selective herbicides in the continuous wheat controls (treats 1 & 2), grassy weeds were blowing out in this fourth season, both in the seed reserves in the soil and in the crop itself during the year (Table 2). The only treatments which had kept a lid on grassy weeds started with two years of a non-cereal (treats 8, 10, 14 and 20).

Grain yield of Corack varied from just over 3 t/ha to nearly 4 t/ha depending on the treatment imposed (Table 3). Quality was largely unaffected by treatment with proteins low (less than 10%) regardless of history and differing N management during the 2014 growing season. A very strong influence on yield of wheat in 2014 was the grassy weed pressure in that treatment. Figure 1 shows that for every 10 grassy weeds in the soil bank, yield of wheat dropped by 200 kg/ha.

Table 2 Weed seed bank annual grasses and in crop grass numbers counted at flowering on 12 September 2014

2014	Weed seed bank plants/m²										In-crop counts at flowering plants/m²				
	Barley G.	Annual Rye	Brome	W. Oats	Total annual grasses	Barley G.	Annual Rye	Brome	W. Oats	Total annual grasses	Barley G.	Annual Rye	Brome	W. Oats	Total annual grasses
Treat	13 May	13 May	13 May	13 May	13 May	4 Jul	4 Jul	4 Jul	4 Jul	4 Jul	12 Sep	12 Sep	12 Sep	12 Sep	12 Sep
1	73	7	1	0	**81^{a}**	11	3	5	0	**19**	4	19	38	0	**61**
2	33	18	1	2	**54^{ab}**	8	6	1	0	**14**	2	7	28	4	**41**
3	12	3	2	0	**18^{abcd}**	3	2	0	1	**7**	5	7	35	0	**47**
4	2	42	4	0	**48^{abc}**	6	13	0	0	**19**	1	36	3	6	**46**
5	31	13	2	0	**47^{ab}**	8	6	0	0	**14**	11	8	23	0	**42**
6	11	6	0	0	**17^{abcd}**	9	2	0	0	**11**	7	9	35	0	**51**
7	7	5	1	4	**16^{abcd}**	2	0	0	1	**4**	5	6	56	7	**74**
8	0	5	0	0	**5^{bcd}**	0	2	0	0	**2**	1	5	1	5	**13**
9	18	6	5	4	**32^{abcd}**	1	1	4	0	**6**	6	5	33	0	**45**
10	2	2	0	1	**5^{bcd}**	2	1	1	0	**4**	5	10	3	4	**22**
11	8	1	0	1	**10^{abcd}**	5	0	0	0	**5**	18	2	7	3	**29**
12	6	12	0	1	**18^{abcd}**	1	5	0	0	**6**	10	15	1	1	**28**
13	6	5	0	1	**13^{abcd}**	0	4	0	0	**4**	5	10	7	9	**31**
14	1	7	0	0	**8^{d}**	1	5	0	0	**7**	3	10	3	5	**22**
15	4	5	3	0	**11^{abcd}**	1	2	1	0	**5**	7	7	0	5	**18**
16	6	5	0	0	**10^{abcd}**	0	1	0	0	**1**	7	12	1	9	**28**
17	36	4	0	0	**40^{abcd}**	11	5	0	0	**16**	5	3	25	0	**33**
18	12	30	0	1	**43^{abc}**	3	7	0	1	**12**	14	7	1	1	**22**
19	28	18	0	0	**46^{abc}**	5	1	0	0	**6**	1	6	10	1	**18**
20	3	2	0	0	**5^{cd}**	1	1	0	0	**2**	5	8	2	2	**16**

Table 3 Yield and quality of wheat, 2014

2011 outcome / 2012 outcome	Average yield (t/ha)	Average test weight (g/hL)	Average screenings (%)	Average protein (%)	Average 1000 grain weight (g)
1 WHEAT grain / WHEAT grain	3.3	85.1	3.5	9.2	41
2 WHEAT grain / WHEAT grain	3.3	85.2	3.5	9.1	40
3 ANG MEDIC seed / WHEAT grain	3.7	85.7	2.9	9.1	41
4 VETCH+OATS hay / WHEAT grain	3.4	84.7	3.5	9.8	38
5 OATS hay / CANOLA grain	3.4	85.2	3.3	9.2	41
6 OATS hay / FIELD PEA grain	3.5	85.5	3.0	9.1	41
7 OATS hay / EARLY SOWN MEDIC graze	3.7	85.8	3.2	9.0	40
8 FALLOW / FALLOW	3.7	86.1	3.0	9.2	42
9 ANG SOWN MEDIC seed / WHEAT grain	3.4	85.6	3.0	9.1	41
10 SOWN MEDIC hay / REG MEDIC+CANOLA graze	3.6	85.5	2.6	9.3	40
11 EARLY SOWN MEDIC hay / CANOLA grain	3.6	85.6	2.7	9.4	41
12 EARLY SOWN MEDIC hay / OATS graze	3.6	85.4	2.9	9.5	40
13 CANOLA grain / FIELD PEA grain	3.8	85.3	2.9	9.4	41
14 CANOLA grain / EARLY SOWN MEDIC graze	3.5	85.5	3.0	9.0	41
15 CANOLA grain / OATS graze	3.5	85.1	3.5	9.4	40
16 FIELD PEA grain / OATS graze	3.8	85.4	2.9	9.2	41
17 FIELD PEA grain / WHEAT grain	3.5	85.7	3.3	8.9	42
18 FIELD PEA grain / CANOLA grain	3.7	85.5	2.6	9.1	41
19 FIELD PEA+CANOLA hay / WHEAT grain	3.6	85.5	2.8	9.2	41
20 SULLA graze / REG SULLA graze	3.6	85.2	2.6	9.4	40

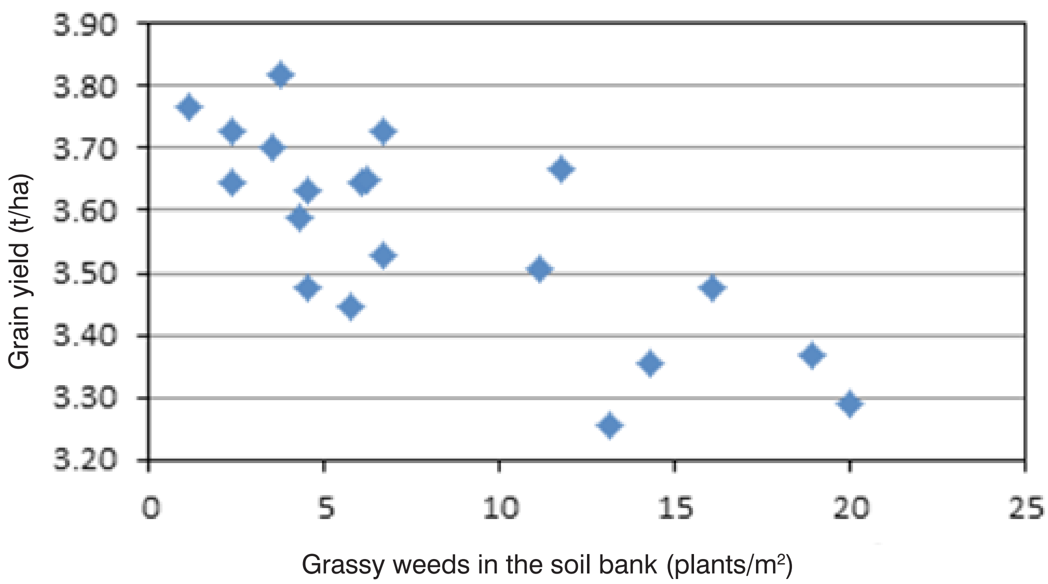

Figure 1 Impact of grassy weed pressure on grain yield of wheat in 2014

What does this mean?

The experience at this trial and several others in the crop sequencing project is that grassy weeds are a very important factor in determining productivity in our low rainfall farming systems and that to have a major and prolonged impact on grassy weed numbers, a commitment to a two year cereal break is necessary. If at least one of these break years are profitable, then this option can result in substantially better profits over the four year period compared to persisting with continuous wheat.

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Table 4 Cumulative gross margins of treatments in 2011, 2012 and 2013

2011					2012					2013					Cumulative		
Treat	GM ($/ha)	Stats	Crop choice	End use	Treat	GM ($/ha)	Stats	Crop choice	End use	Treat	GM ($/ha)	Stats	Crop choice	End use	Treat	3 yr cumulative GM ($/ha)	Stats
15E	411	a	Canola	G&G	20E	495	a	Sulla	Hay	8W	543	a	Wheat	Grain	15E	1009	a
13W	409	a	Canola	Grain	20W	487	a	Sulla	Graze	13E	487	ab	Wheat	Grain	19E	926	ab
15W	360	ab	Canola	Grain	19E	444	ab	Wheat	Grain	7E	475	abc	Wheat	Grain	15W	913	ab
13E	343	abc	Canola	G&G	3E	442	ab	Wheat	Grain	5E	472	abc	Wheat	Grain	7W	907	ab
7W	306	abcd	Oats	Hay	4W	429	ab	Wheat	Grain	6E	469	abc	Wheat	Grain	20E	839	abc
1W	296	abcde	Wheat	Grain	9E	422	ab	Wheat	Grain	11E	459	abcd	Wheat	Grain	4W	824	abcd
6W	291	abcde	Oats	Hay	17W	413	abc	Wheat	Grain	20E	455	abcd	Wheat	Grain	18W	798	abcd
5W	270	abcdef	Oats	Hay	2W	316	abcd	Wheat B	Grain	15W	442	abcd	Wheat	Grain	20W	762	abcd
2W	266	abcdef	Wheat	Grain	1W	295	abcde	Wheat A	Grain	12W	441	abcd	Wheat	Grain	5W	748	abcd
14W	239	abcdef	Canola	Grain	18W	268	abcdef	Canola	Grain	15E	440	abcd	Wheat	Grain	13W	747	abcd
14E	233	abcdef	Canola	G&G	10W	251	abcdefg	Reg medic/Canola	Graze	14E	438	abcd	Wheat	Grain	3E	743	abcd
4W	159	bcdefg	Vetch/Oat	Hay	16W	221	bcdefgh	Oats	Graze	14W	430	abcde	Wheat	Grain	16W	731	abcd
19E	142	cdefgh	Pea/Canola	Graze	7W	216	bcdefgh	Early sown medic	Graze	12E	428	abcde	Wheat	Grain	2W	727	abcd
18W	122	defgh	Pea	Grain	5W	194	bcdefgh	Canola	Graze	16W	426	abcde	Wheat	Grain	1W	722	abcde
5E	95	defghi	Oats	Graze	12E	189	bcdefgh	Oats	Hay	18W	407	bcde	Wheat	Grain	6W	700	abcde
16W	83	efghij	Pea	Grain	15E	158	cdefgh	Oats	Hay	10W	394	bcdef	Wheat	Grain	14E	699	abcde
6E	83	efghij	Oats	Graze	4E	143	defgh	Wheat	Hay	20W	385	bcdef	Wheat	Grain	14W	688	abcdef
7E	75	fghij	Oats	Graze	12W	123	defgh	Oats	Graze	7W	385	bcdef	Wheat	Grain	7E	663	abcdef
12W	-27	ghijk	Medic	Hay	7E	113	defgh	Early sown medic	Hay	11W	377	bcdef	Wheat	Grain	17W	623	abcdefg
3E	-36	ghijk	Jag medic	Hay	15W	112	defgh	Oats	Graze	6W	360	cdef	Wheat	Grain	13E	622	abcdefg
11W	-47	ghijkl	Medic	Hay	11W	99	defgh	Canola	Grain	13W	355	cdef	Wheat	Grain	5E	585	bcdefg
4E	-62	hijkl	Vetch/Oat	Graze	11E	88	defgh	Canola	Hay	19E	340	defg	Wheat	Grain	9E	571	bcdefg
12E	-70	hijkl	Medic	Graze	6W	49	defghi	Field pea	Grain	17W	340	defg	Wheat	Grain	12E	546	bcdefg
11E	-91	ijkl	Medic	Graze	14E	28	efghi	Early sown medic	Hay	3E	337	defg	Wheat	Grain	12W	538	bcdefg
20E	-111	ijkl	Sulla	Hay	14W	19	fghi	Early sown medic	Graze	9E	314	efgh	Wheat	Grain	10W	500	cdefg
20W	-111	ijkl	Sulla	Hay	5E	18	fghi	Canola	HAY	5W	284	fgh	Wheat	Grain	11E	456	cdefg
17W	-129	jkl	Pea	Grain	13W	-18	ghi	Field pea	Grain	4W	236	ghi	K. wheat	Grain	11W	429	defg
10W	-144	kl	Medic	Hay	8W	-35	hi	Fallow	Graze	4E	225	hi	K. wheat	Grain	6E	331	efg
9E	-165	kl	Ang medic	Hay	13E	-208	i	Field pea	Hay	2W	146	i	K. wheat	Grain	4E	306	fg
8W	-275	l	Fallow		6E	-221	i	Field pea	Hay	1W	132	i	K. wheat	Grain	8W	233	g

Summary of results from economic analysis

How was it done?

Gross margins have been calculated each year for each treatment. Input costs (chemicals and fertiliser) are calculated from invoices received through the MAC farm and include GST. Machinery and maintenance costs are from the Farm Gross Margin and Enterprise Planning Guide, 2011, 2012, 2013, and 2014. Grain prices were taken from the cash price at Port Lincoln Viterra on 1 December or closest date on the year the grain was harvested. Grain classification was determined from the Viterra receival standards for the year the grain was harvested.

The value given to hay crops uses the contracting rate as stated in the gross margin guide for oaten hay production for the corresponding year. Mowing was at a cost of $27/ha, super conditioning was $24/ha, raking was added twice at a cost of $7/ha, baling was $24/ha, and handling costs of $40/ha. Hay prices are estimated based on the quality and the market price as listed in the Stock Journal on 1 December or the nearest date of the year the hay was harvested. Taken into consideration was the fact that Eyre Peninsula has a limited hay market and selling in other regions would incur significant transport costs. To account for this the cost per tonne was downgraded in the calculation. The yield has had 12% added to account for desired moisture content of hay and had 12% removed to account for losses during raking and baling and maintaining cover on the soil.

To put a dollar value on crops or pastures that were mown to simulate grazing the potential stocking rate is calculated by the formula [((pasture grown – 1500 kg/ha)/200) x 50%] where 1500 kg/ha accounts for losses from trampling and residue left to maintain ground cover, and 200 refers to the kilograms of dry matter per dry sheep equivalent consumed over 200 days of winter grazing. Had potential stocking rates exceeded what was realistically possible for the region a cap would have been imposed. As it happened the highest was 10.5 DSE, a high but not unachievable stocking rate and so figures remained un-capped.

Cumulative gross margins are calculated by adding the profits of the three years together (2014 data still to be added).

What happened?

After thinning the treatments to reflect those that were considered a likely break crop option for the upper Eyre Peninsula region, 30 treatments of the original 40 were statistically analysed. The result was that 12 treatments were more profitable after three years than continuing to sow wheat. The overall most profitable rotation with $1009 cumulative over the first three years of the trial is canola grown for grain with an early simulated graze followed by oaten hay before returning to conventional wheat (Table 4) The second most profitable option was a one year break of a canola and field pea mixture with $926/ha. Other one year break treatments grossing higher than continuous cereals were a vetch and oat mixture cut for hay, and Jaguar annual medic also cut for hay, making $824/ha and $743/ha respectively.

In 2011 canola as a grain crop was the most profitable break crop option with $329 for a grain crop with an early graze and $336 for a straight grain crop compared to continuing to crop wheat for grain which made $291. A light graze early in the season made no difference to profitability compared to canola as a straight grain crop. Profits were similar to that of continuing to grow grain wheat and an oaten hay crop. These treatments were significantly better than legume hay and grazing options, and field peas for grain. Medic for seed, field peas for hay and fallow were less profitable than other measured break crop options with losses of greater than $258/ha. All medic options made a loss.

In 2012 the only break crop to make more money than returning to wheat following a 1 year break was the biennial legume sulla, with $487/ha and $495/ha for grazing and hay options respectively. The reason being that once established there are very little input costs the second year, yet you get large quantities of biomass that can be cut for hay or grazed. One year break treatments were more profitable the year after the break when sown back to wheat than having had no break at all.

Canola grain crops were less profitable than grain wheat in 2012 which reflects the lower yields as a result of a below average rainfall season.

Most notable in 2013 was that continuous cereals are the least profitable compared to all other treatments. However there is a varietal effect given that these treatments are sown to the lower yielding variety Kord CLPlus (NVT Results 2013). Input costs were higher than all other treatments with the exception of treatment 5 oats/canola which also received additional nitrogen which increased input costs by $30/ha. The application of Intervix has also contributed to lower gross margin. With 2013 being the first year back to wheat after the two year breaks it puts fallow on top through greater yields as a result of more moisture in the profile.

The hay crops incurred greater input costs due to contracting rates for hay production yet have still turned a profit.

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