Merriwagga CWFS Site -Crop Rotation and Tillage Systems

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Key Points

Continuous wheat under conventional cultivation has proven to be the most profitable cropping system so far, ahead of continuous rotation cropping (Rotation 1) by $136/ha for the period 1999-2003.

- Issues such as diseases and weeds are now starting to affect the profitability of the continuous wheat system.
- Minimum tillage needs ideal conditions at sowing to be successful on these soils.
- Seasonal variation has influenced cropping system comparisons, hence the need for the trial to continue into the future.

Background and Aims

A long term farming systems trial was established in 1999 aiming to investigate the *sustainability* and *profitability* of ***cropping*** *rotations* and *tillage methods* on Merriwagga soils. The paddock chosen has had a long history of traditional low input cropping. Soils are alkaline red earths (pH 7.2 $CaCl_2$), with a layer of limestone within 60cm of the topsoil. Average annual rainfall is about 370mm.

The trial is situated on Geoff and Ian Barber's property "Sylvanham" on the corner of Black Stump Rd and Greenhills Rd, approximately 10kms SW of Merriwagga. The Barbers have allowed the Merriwagga CWFS group to share-farm the trial site, allowing other trial work to be conducted around the core site. The trial is designed so that all operations are conducted using grower's equipment to make it realistic. The trial has been set up with 3 replications of all treatments, totalling 30ha in area.

System Treatments

1. **Continuous rotation cropping:** This system involves continuous cropping by rotating crops. When the trial began, this system was not common practice, and it is designed to see if this can be done economically in this environment. Since 1999, more growers are now using break crops. In general, a break crop is grown every second year after wheat. The choice of the break crop is mainly determined by the time of break and disease risks.
2. **Continuous "Wheat:** This treatment is not common in the area, however growers wanted to see what happens if wheat is continuously grown over a long period of time.
3. **Wheat/Ley/Fallow/Wheat:** This system has traditionally been practiced, however is declining as stock numbers reduce. Cropping occurs every third year in this system. After harvest the paddock is left as a ley, where naturalised grasses and legumes emerge. The paddock is grazed until it is brought into fallow the following year.
4. **Wheat/Fallow/Wheat.** This is also a traditional cropping system still practiced by some growers. The paddock is cropped every second year and fallowed in

between aiming to conserve soil moisture, mineralise nitrogen, and break disease cycles.

Tillage treatments

Each system treatment is divided into two tillage treatments.

1. **Minimum tillage:** This treatment involves sowing with narrow points into an unprepared seedbed. Weed control is by herbicides and in some cases burning. To the extent to which it is practical, the plots are not tilled in any way. Due to machinery limitations, nitrogen may be predrilled prior to sowing using narrow points, harrowing may occasionally be practiced to remove excess stubble or weed residues that may hinder sowing. 2. **Conventional tillage.** This system uses conventional tillage fallows and tillage to prepare the seedbed and remove/incorporate stubbles. Herbicides are still used in this system, however cultivation is the primary method of weed control. This treatment aims to emulate common tillage practices of the district when the trial began.

Below is the cropping timetable for each system. This summary contains the previous 5 year's crops, and the future 2 year's. Note change of cropping sequence as a result of failed crops in 2002 in both rotation systems.

Farming System Treatments	**Cropping Timetable**						
	1999	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Wheat/Fallow/Wheat	Fallow	Wheat	Fallow	Wheat	Fallow	Wheat	Fallow
Rotation 1	Peas	Wheat	Canola	Wheat	Wheat	Peas/Lupins	Wheat
Continuous Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat
Wheat/Ley/Fallow/Wheat	Ley	Fallow	Wheat	Ley	Fallow	Wheat	Ley
Rotation 2	Wheat	Peas	Wheat	Peas	Peas	Wheat	Lupins

Crop Data (1999-2003)

1999 Sown with Flexicoil airseeder using narrow points.

Crop	**Variety**	**Sowing Rate**	Fertiliser	**Sowing Date**	**GSR** (Apr-Oct)	**Yield**
Peas	Glenroy	100kg/ha	70kg/ha Sulphos	11th June	239mm	1.20 t/ha
Wheat	Janz	40kg/ha	85kg/ha Granulock l2Z	10th June	239mm	1.58 t/ha

2000 Sown with Flexicoil airseeder using narrow points (no till) and sweeps (conventional).

Crop	**Variety**	**Sowing Rate**	**Fertiliser**	**Sowing Date**	**GSR** (Apr-Oct)	**Yield**
Peas	Excell.	100kg/ha	150kg/ha Single Super	25th May	264mm	**1.35** t/ha
Wheat	Janz	45kg/ha	100kg/ha DAP 50kg/ha Urea predrilled	17th May	264mm	**2.69** t/ha

2001 Wheat sown with Flexicoil airseeder with narrow points, canola sown with Great Plains combine.

Crop	**Variety**	**Sowing Rate**	**Fertiliser**	**Sowing Date**	**GSR (Apr-Oct)**	Yield
Canola	Ag Outback	4kg/ha	100kg/ha Granulock 15 (30 units N topdressed)	27th June	153 mm	0.21 t/ha
Wheat	H45	45kg/ha	60kg/ha MAP (conv) 80kg/ha MAP (conv) (20 units N topdressed)	12th June	153mm	1.07 t/ha

2002 Crops sown with zero till combine seeder by Kondinin group.

Crop	**Variety**	**Sowing Rate**	**Fertiliser**	**Sowing Date**	**GSR (Apr-Oct)**	**Yield**
Peas	Excell	120kg/ha	70kg/ha Granulock l2Z	**24th** May	88mm	0 t/ha
Wheat	Chara	45kg/ha	70kg/ha Granulock 12Z 50kg/ha Urea	**24th** May	88mm	0 t/ha

2003 Wheat sown with Flexicoil airseeder using narrow points.

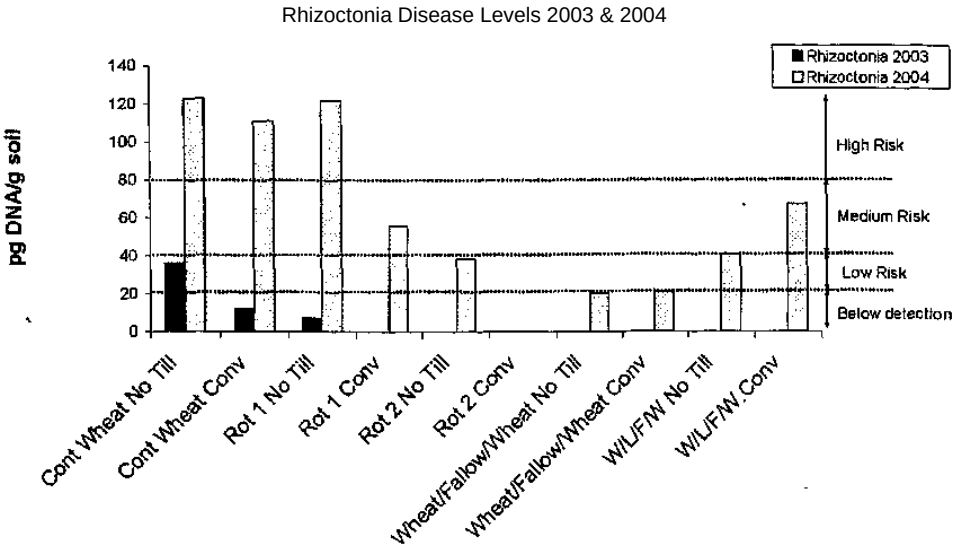
Crop	**Variety**	**Sowing Rate**	**Fertiliser**	**Sowing Date**	**GSR (Apr-Oct)**	**Yield**
Peas	Kaspa	140kg/ha	80kg/ha Granulock 12Z	26th May	196mm	1.20 t/ha
Wheat	Chara	50kg/ha	65kg/ha Granulock 12Z	30th Apr	196mm	2.73 **t/ha**

Result Summary, 1999-2003

Many measurements take place before and during the cropping season. These include soil nutrient and disease tests, establishment counts, weed counts, grain yield and protein, and most importantly gross margins. This allows a holistic comparison between tillage treatments and cropping systems.

Soil nutrient and disease tests:

Soil nutrient tests have been compared between each cropping system since the trial began. To date, very little soil nutrient differences have been observed in the top 10cm. Soil borne diseases however are starting to change, with the incidence of rhizoctonia and Pratylenchus neglectus becoming more predominant in some treatments. This is measured by the Predicta B root disease test.



Graph 1: Rhizoctonia levels measured in 2003 and 2004. *(Note: Only continuous wheat and rotation 1 were measured for root disease levels in 2003).*

The graph above shows that the continuous wheat system is allowing rhizoctonia levels to increase. Another point to note is the higher level of rhizoctonia under the minimum till system. This is because rhizoctonia levels are significantly reduced by cultivations. As expected, any cropping system following wheat has higher rhizoctonia levels in the following year. The same trend is occurring for Pratylenchus neglectus. By adding a break crop such as peas, the risk of yield loss from these diseases is significantly less. It will be interesting comparing yield differences at the end of the season given the results above.

Establishment and weed numbers: Both wheat and peas plants were counted at establishment to see if differences occurred between tillage systems. The number and presence of weeds were also counted.

Establishment counts for both tillage methods were not significantly different for both peas and wheat. When the wheat was sown, marginal moisture was present. The conventional plots came up much more even at first. We then received a small shower of rain, which germinated some of the minimum till seeds. This showed that minimum till was much less forgiving in marginal conditions than conventional tillage, primarily because of seed/soil contact.

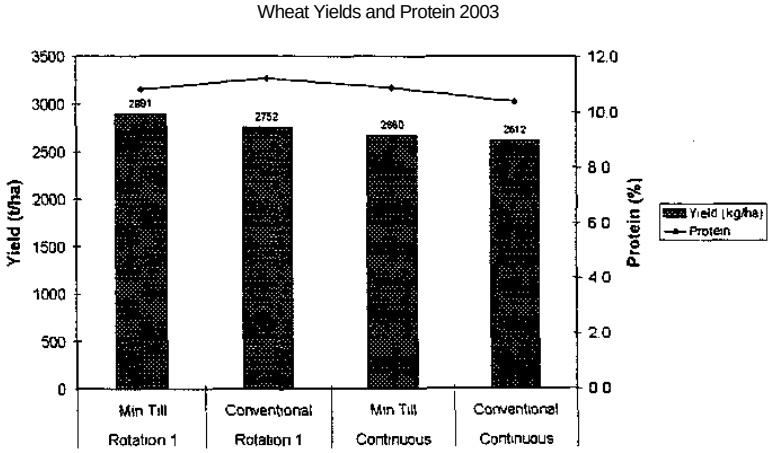
Weed numbers and spectrum also changed between tillage methods. In general, there were more weeds in the conventional plots than the minimum till plots. In particular, wild oats, mustard and fumitory were much more frequent in cultivated seedbeds. No pre-emergent herbicide was used this year.

2003 wheat yield results:

Rep	Plot Number	Rotation	Tillage Method	Protein	Screenings	Yield (t/ha)	Rank
3	**29**	Rotation 1	Conv	**10.6**	**0.8**	**2.87**	**5**
3	**28**	Rotation 1	Min Till	**10.2**	**0.6**	**2.90**	**2**
3	**23**	Continuous Wheat	Min Till	**10.6**	**0.8**	**2.72**	**8**
3	22	Continuous Wheat	Conv	10.1	**0.6**	2.55	**9**
2	**17**	Rotation 1	Min Till	**11.5**	**0.6**	**2.76**	**7**
2	**16**	Rotation 1	Conv	**11.9**	**0.8**	**2.50**	**10**
2	12	Continuous Wheat	Conv	**11.1**	**0.6**	**2.40**	**12**
2	**11**	Continuous Wheat	Min Till	**11.4**	**0.8**	**2.43**	11
1	**6**	Rotation 1	Min Till	**10.7**	**0.6**	3.01	**1**
1	**5**	Rotation 1	Conv	11.1	**0.7**	**2.89**	**3**
1	**4**	Continuous Wheat	Conv	**9.9**	**0.8**	**2.89**	**4**
1	**3**	Continuous Wheat	Min Till	**10.6**	**0.9**	**2.83**	**6**

Table 1: Yield and quality results for wheat in 2003.

Note: All Kaspa pea plots were harvested together, averaging 1.2t/ha. These yields were significantly affected by heavy frosts throughout the growing period.



Graph 2: Wheat yields and protein for 2003 season (N.B. Yield units are kg/ha not t/ha)

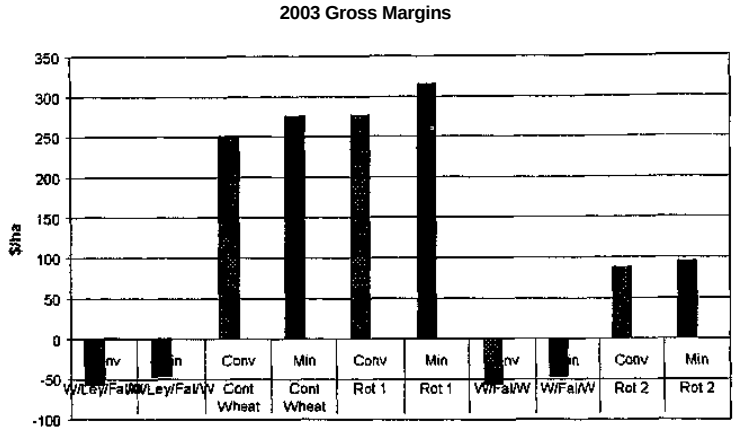
Rotation Statistics		Tillage Statistics	
Av SED	48.9	*Av SED*	Not significant
Av LSD	119.6	*Av LSD*	Not significant

As shown in. the above table and graph, the wheat yields obtained in Rotation 1 and Continuous wheat were statistically different. The yield difference between these two cropping systems was 186kg/ha. Protein levels were not significantly different. The N fixation from the break crops could be a lot greater but the 2002 field peas did not grow long enough to fix large amounts of nitrogen as a result of the drought.

Although minimum till plots yielded 94kg/ha higher than conventional plots, the difference between tillage methods was not statistically significant.

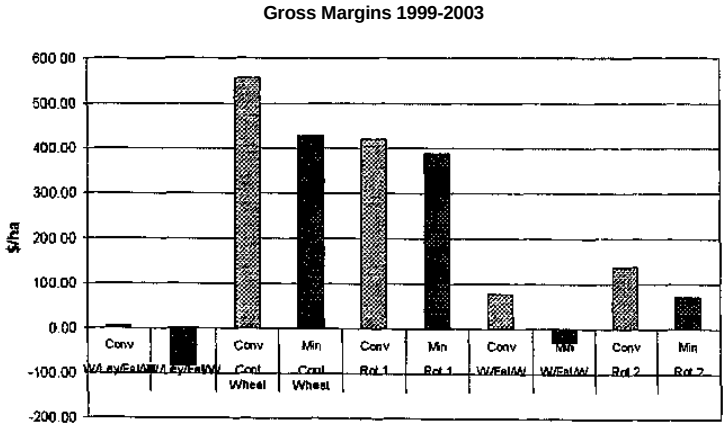
Gross Margin Analysis

Gross margins (GM) are considered one of the main aims for conducting this trial. When doing the GM analysis between systems, we have to remember that there are seasonal influences affecting results. For example if a system is in fallow in a good year, the system has missed out on the opportunity to capitalise from higher yields, making the short term GM analysis biased. This has been the case for Rotation 2 and also Wheat/Fallow/Wheat. The only way to overcome this bias is to continue the project for a longer period of time. Gross margins for the trial are highlighted below.



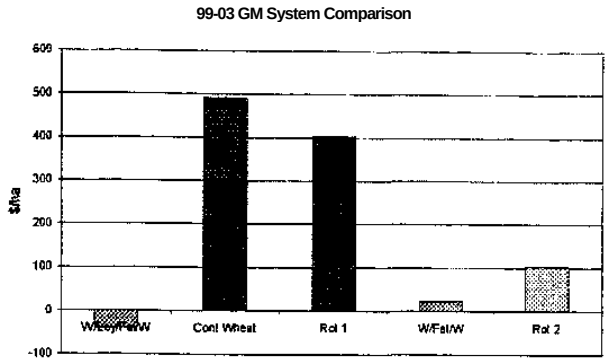
Graph 3: Gross margins for all plots in 2003.

Graph 3 shows the Gross Margin analysis for 2003. These gross margins would be slightly above district average in 2003.

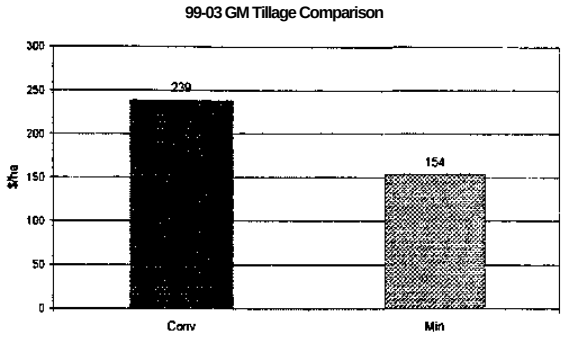


Graph 4: Gross margin analysis for all plots from 1999-2003.

Graph 4 shows the long term gross margin analysis for the period of the trial to date. At present continuous wheat has been the most profitable rotation. This is mainly because this system has capitalised from the good seasons (2000 and 2003). Rotation 1 is close behind continuous wheat. Rotation 2 had a marginal pea crop in 2000, causing the system to fall behind in the GM analysis. The following graph shows the system comparison from 1999-2003.



Graph 5: Gross margin comparison between cropping systems from 1999-2003



Graph 6: Gross margin comparison between conventional and minimum till cropping 1999-2003.

Graph 6 is showing the difference in profitability of the two tillage methods from 1999-2000. To date conventional style cropping has been the most profitable in the long term analysis, however this was not the case in 2003, where minimum till plots were on average $18/ha in front of conventionally cultivated plots.

Concluding Comments

The trial so far is showing some interesting results. Continuous wheat under conventional cultivation has proven to be the most profitable cropping system so far, ahead of continuous rotation cropping (Rotation 1) by $136/ha for the period 1999-2003. However it is important to remember that the gross margins of each farming system is greatly affected by seasonal conditions and to overcome this problem the trial needs to operate for a longer period of time. Many questions are still to be answered, and hopefully will be addressed in the future years of the trial. Issues such as root and leaf diseases in continuous wheat plots, profitability of rotation crops in the system, and the yield potential difference between minimum tillage and conventional tillage will be the main issues focused on into the future.

Seasonal variation has influenced cropping system comparisons, hence the need for the trial to continue into the future. The trial results are now starting to become meaningful and with further funding will produce useful results for regional growers now and in future years.