6.6 Designing a farming system to reduce the reliance on stubble burning – Winchelsea, Inverleigh, Lake Bolac & Penshurst

Location: Winchelsea, Inverleigh, Lake Bolac & Penshurst.

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Rainfall (mm) April – November : Winchelsea – 173 mm, Inverleigh – 233mm, Lake Bolac - 137mm and Penshurst – 379mm. Frost was a regular event across all locations in October, as well as general low Spring rainfall.

Summary of Findings:

The Winchelsea site, sown in late April to Amarok red wheat, had yield variations across the site, with highest yielding plots reaching 3t/ha. These plots although nearest the shelter belts, were the stubble incorporated treatments. In comparison, where incorporation did take place with either the addition of chook manure or biological applications, there was a reduced yield of up to 0.6t/ha. Burning at this site yielded 2.33t/ha, being the lowest output for this site.

The Inverleigh site, sown at the end of May to Gairdner barley, also had variations across the site. Burning at this site was the highest yielding treatment giving a yield of 2.9t/ha. The lowest yielding treatment was the wide rows at 2.3t/ha, with establishment of plants in the furrows being poor, possibly contributing to a reduction in yield.

The Lake Bolac site sown in early June to Ruby wheat, gave similar results to those obtained in 2005. Mulching was the highest yielding treatment at 3.7t/ha. The burnt treatment yielded a little more than 3t/ha, with discing and aeration a little less than 2.8t/ha.

The Penshurst site sown to canola was seeded up to three times as a result of damage from ground larks and slugs, particularly where the paddock was NOT stocked. Where stock were run over Summer on the barley stubbles, establishment was far greater due to the reduction of pest habitat. Burning was the highest yielding plot in the grazed treatments yielding 2.67t/ha, whilst discing in the ungrazed plots was the best treatment with a yield of 1.78t/ha. Many of the ungrazed treatments suffered poorly from lack of establishment due to pest damage at emergence, resulting in no yield from these plots.

Overall, besides the high variability at Penshurst, little variation occurred across all other sites for plant establishment, disease, insects and Plant Available Water, mainly attributable to the dry season and low stubble loads from the 2005 season.

Background to the trial: This project builds upon the 2004/2005 programme of "Improving the productivity and sustainability of the high rainfall Victorian cropping systems through appropriate management of crop stubbles on farms". Four sites were established for this project, of which three have continued and one new site established.

The main aims of this project are to develop agronomic packages and seeding technology solutions which can allow for increased stubble retention practices, thereby reducing the dependence on burning. There are currently no well developed techniques to deal with stubble volumes generated by high yielding crops in the high rainfall temperate zone of southern Australia, apart from burning, which creates negative impacts on soil and air quality.

Trial Inputs: The season of 2006 did also have a great bearing on restricting input use.

Table 1. Trial Inputs for each NLP Stubble Retention Demonstration

	Winchelsea	**Inverleigh**	**Lake Bolac**	**Penshurst**
Crop Type & Rate	Amarok Wheat @ 75kg/ha	Gairdner Barley @ 90kg/ha	Ruby Wheat @ 90kg/ha	Summit Canola @ 3.75kg/ha x 3
Seeding Date	9/5/06	31/5/06	6/6/06	3/6/06
Fertiliser Rate	MAP @ 85kg/ha	MAP @ 100kg/ha	MAP @ 100kg/ha	MAP @ 100kg/ha
Chemical Regime	Roundup @ 1L/Ha + Hammer @ 40mls Knockdown, Hussar @ 200g/ha GS15	Sprayseed @ 2L + Triflur @ 1.2L IBS, Dual Gold @ 250mls + Diuron @ 500mls PSPE, Tilt @ GS30	Roundup 1.2 @ + Triflur @ 1.5L/Ha.	Roundup @ 1L/ha Knockdown, Simazine @ 2L/ha + 1.7L/Ha Triflur X IBS, Atrazine @ 1.5L/ha, 4 leaf.
In-Crop N	37kgN/Ha, 14/9/06	46kgN/ha, 27/8/06	Nil	41kgN/Ha, split: 24/8 & 21/9/06
Harvest Date	14/12/06	27/11/06	12/12/06	12/12/06

Trial Design: For the three existing demonstration sites, plot sizes varied on paddock design and available space, based on the size of treatment list. At Mt.Pollock, each of the 10 treatments were 32m x 400m, whilst at Lake Bolac the 6 treatments were 20m x 200mm and at Penshurst, the 16 plots were 12m x 40m.

At the Inverleigh trial site there were 7 treatments replicated 4 times spread across 4ha. The trial was a randomised block design with each plot 16m x 100m in dimension.

Trial Results: Basil soil characterizations were initiated in early April 2005 (Table 2) to act as a reference upon completion of the project. It is expected that this information,

including the soil bulk densities and macro-porosity will change throughout the profile over the three year program.

Table 2. Basal Soil Characterization All Sites, April 2005 & 2006. Some data still outstanding#

Stubble sites	Profile Depth (cm)	pH (water & CaCl2)	Organic Matter %	Soil BD (gcm^{-3})		Macro-porosity (%)	
Mt. Pollock	0-10	5.8 & 5.0	2.2	1.38		27.2	
	10-20	6.1 & 5.0	1.25	1.64		18.1	
	20-30	7.3 & 6.2	-	1.65		12.8	
	30-40	-	-	1.73		7.9	
	40-50	-	-	1.74		7.2	
Inverleigh	0-10	6.0 & 5.3	1.5	#		#	
	10-20	5.3 & 4.5	0.79	#		#	
	20-30	5.9 & 4.8	-	#		#	
	30-40	6.4 & 5.1	-	#		#	
	40-50	-	-	#		#	
Lake Bolac	0-10	5.8 & 5.0	2.1	1.47		23.7	
	10-20	5.6 & 4.7	0.66	1.53		26.7	
	20-30	6.7 & 5.0	-	1.58		21.3	
	30-40	-	-	1.51		19.1	
	40-50	-	-	1.39		16.8	
Hamilton				Grazed	Un-grazed	Grazed	Un-grazed
	0-10	5 & 4.2	3.7	1.4	1.3	13.1	9.7
	10-20	5.4 & 4.5	1.9	1.6	1.5	15.1	13.9
	20-30	6.3 & 5.1	-	1.6	*	7.5	*
	30-40	-	-	1.7	*	9.2	*
	40-50	-	-	1.6	*	7.1	*

Note: * Too much gravel in samples for a reliable estimation

The data not included in this table will be presented at the completion of this project, namely Cation Exchange Capacity and Exchangeable Sodium Percentages. It is proposed that three years of this project is a marginal time frame to expect changes to any soil physical outcomes, however, some improvement to soil chemistry and biology may result.

2006 Paddock Inspections - Pitfall traps were installed during early crop establishment and were collected again 7 days later. There appeared to be no significant levels of pest or predator numbers in either the assessed standing stubble or burnt treatments at the emergence stage for any site. Insects that were present included both beneficial and harmful earwigs at very low levels, spiders and carabid beetles (that were of importance). This may be a results of past use of insecticides in the paddock; as this will

influence pest:predator ratios (Horne, Pers.Comm; 2007). Interestingly, with the Spring collections, numbers were at a far greater level, however again, no trends could be easily established by Paul Horne and Jessica Page when in the field.

Other data to be analyzed looked at critical components of establishment, including plants per square metre, presence of foliage pests, disease, weed burdens and plant available water to 20cm. This data was collected approximately 6 weeks post seeding.

Determining plant counts was undertaken using the TOPCROP 50cm ruler methodology of plant numbers per metre row divided by the row spacing width. Overall, establishment was fair across all sites, with low establishment soil moisture causing less than desirable plants per square meter for cereals and canola.

Table 3. Plant Establishment data for each of the stubble retention sites.

Treatment List	Winchelsea, Wheat	Inverleigh, Barley	Lake Bolac, Wheat	Penshurst, Canola, +Sheep / - Sheep	
Scratch Till x 2	118.4	-	-	-	-
Scratch Till x 1	99.4	115.5	-	-	-
Chook Manure + Scratch Till	125.6	-	-	-	-
Mulcher	117.6	118.5	134	5.7	0.3
Conventional (Direct Drill)	125	122.3	-	14.8	7.5
Disc x 1	121	-	119	15.4	9.1
MO + Scratch Till	112.4	124.8 (No Incorporation)	131.3	-	-
Wide Rows	118.2	126.3	128.3	-	-
Bale & Reomove	113.6	-	-	7.4	1.2
Burn	111	124	121	14.6	7.2
Aerator	-	-	121.8		
Harvest Low	-		-	7.0	0.3
Harvest to Height of Row Spacing	-	121.3	-	-	-
Prickly Chain	-	-	-	4.4	1.2
Chook Pellets	-	-	-	6.7	15.6
LSD 5%	14.4	9.35	15.3	4.69	4.69
Significant Diff	Yes	Yes	No	Yes	Yes

Within each of the treatments, the correlation of plant establishment and yield should really be recognized, especially at Penshurst, where poor establishment resulted in very little yield, whilst elsewhere, sites that had fair to good establishment reflecting an acceptable outcome.

Across other assessments, there was no significant difference for presence of weeds, disease or insect burdens for each of the sites during these timed paddock observations.

Measurements of establishment Plant Available Water (PAW) from 0-20cm suggested that there was significantly more plant water available within the standing stubble

treatments when compared to the surface removal or incorporation plots (analysed 8th August for the Inverleigh site). These measurements were taken using a TDR soil moisture probe, with the burnt treatment showing the least soil surface moisture retained at establishment. These quantities although statistically significant may need time for review in the coming years to test their contribution to yield as burning in the 2006 drought topped this trial. Other sites showed similar outcomes, where incorporation had less PAW at seeding. Volumetric soil water analysis undertaken to 60cm at flowering showed highly variable PAW results from 0mm (of PAW) to only 10mm down the 60cm profile across all sites. This suggests that most crops survived at or below wilting point during this grain filling phase, possibly proving that root systems traveled further than the 60cm core depth. This data will now be assimilated into future results.

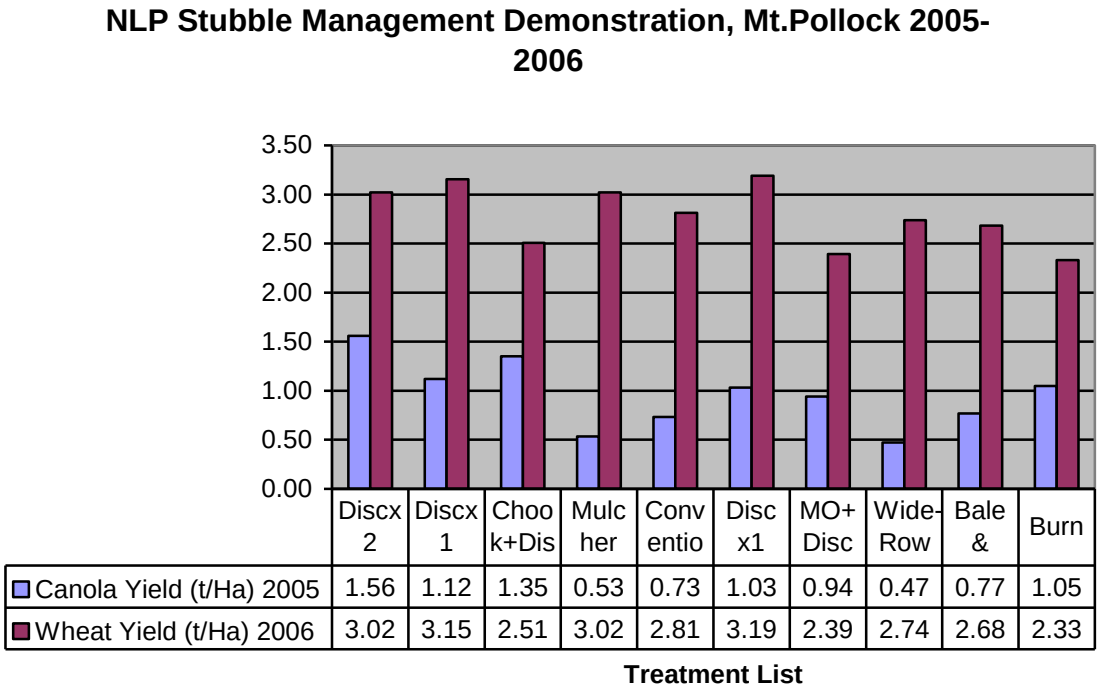
Penetrometer readings were undertaken in Spring to identify the degree of downward pressure required to penetrate the soil profile, as what a plant root may face in seeking moisture. As all sites were very dry in mid October, reporting these results would suggest little or no difference between treatments for soil friability in the top 20cm.

Soil biological sampling was undertaken using the Soil Foodweb Institute. These assessments were conducted to overview the active and total bacterial biomass in comparison to the active and total fungal biomass levels. As the timing was dry at collection, these results are still being interpreted, however, it has been noted that when comparisons were made between the standing stubble and burnt treatments, that the stubble retained treatment appeared to have greater biomass levels, although conversely, active levels in both treatments were way too variable to discuss with any great confidence across these four sites.

Yield outcomes for each site follows, showing that stubble retention can be achieved when seeding cereals and canola, if attention to detail is a priority.

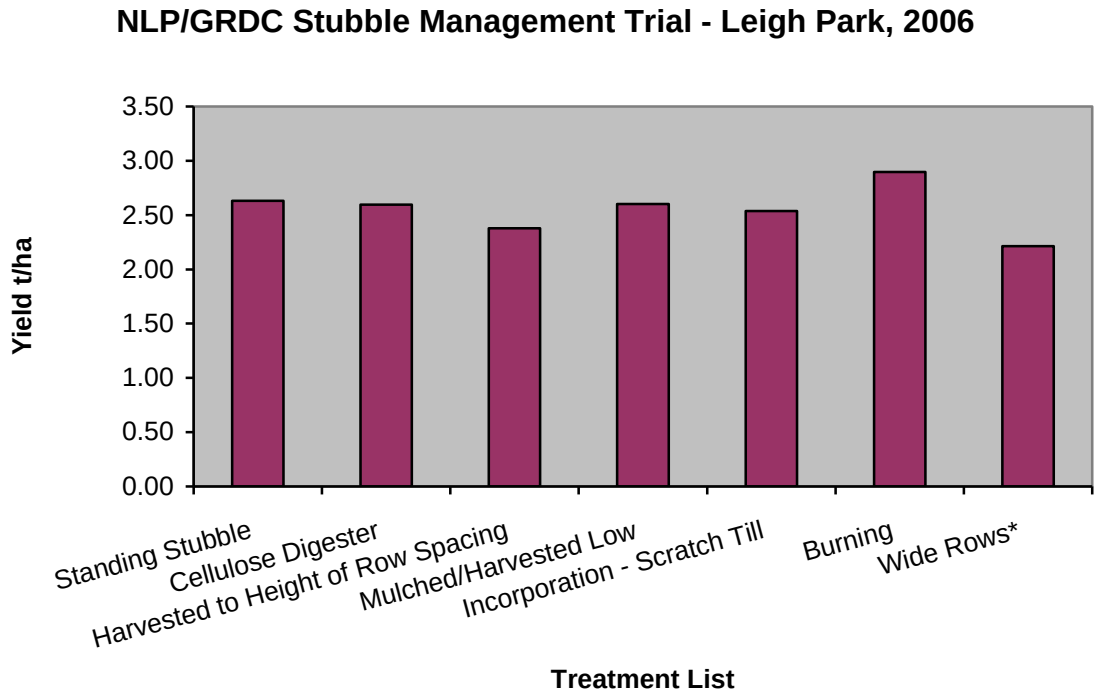
For the Inverleigh site (Mt.Pollock – Figure 1), burning showed no benefit for yield when growing cereals in 2006, reflecting a far different outcome to the canola crop (comparative yield) in 2005. This and other sites prove that seeding canola into cereal stubble needs care and attention to ensure adequate establishment. Press-wheels and separation of residue from the seed-line are two components that appear important for early plant vigour in our southern environments. Management of pest habitat is another critical issue to monitor.

Figure 1.Yield Outcomes for Canola 2005 and Wheat 2006 NLP Winchelsea Site.



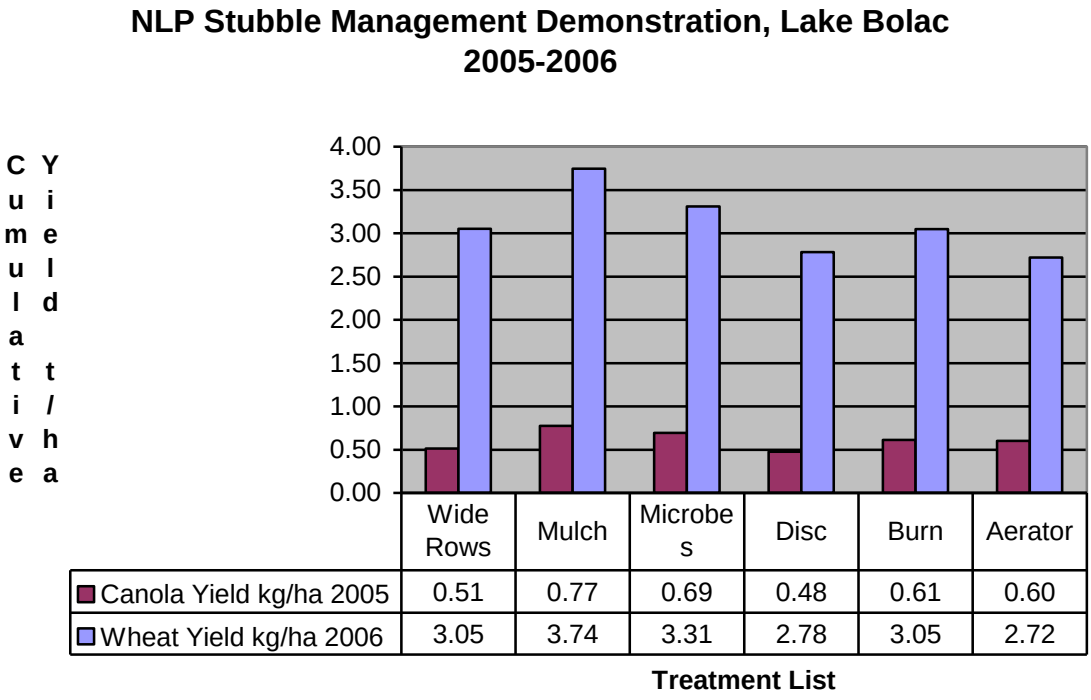
For the Inverleigh site (Figure 2), there was little variance across the site, with burning at this location giving the greatest outcome at 2.9t/ha (statistically significant). It is hard to suggest why this may have happened when PAW was lowest for this treatment at establishment; however access to minor events of rainfall during the growing season and lack of nutrient tie-up that may have occurred when breaking down retained stubble in other treatments could offer some reasoning. To cost this outcome, it could be suggested that in a drought with grain prices so high, the benefit was more than $100/ha from the burnt treatment.

Figure 2.Yield Outcomes for Barley 2006 NLP/GRDC Inverleigh Site.



When reviewing the treatment outcomes for the Lake Bolac site (Figure 3), interestingly, the mulch treatment yielded highest again in 2006 when compared to 2005. Whether this is a site affect with the surrounding protection of the cypress pines possibly having some influence, it does show that treatments other than burning were successful in achieving economic outcomes. The mulched treatment had a gross dollar output of $1122/ha, whilst the burnt treatment returned $915/ha gross. Without any doubt, it did show that removal of the stubble from the surface, whether by burning or incorporation, did lower plant available water.

Figure 3.Yield Outcomes for Wheat 2006 NLP Lake Bolac Site.

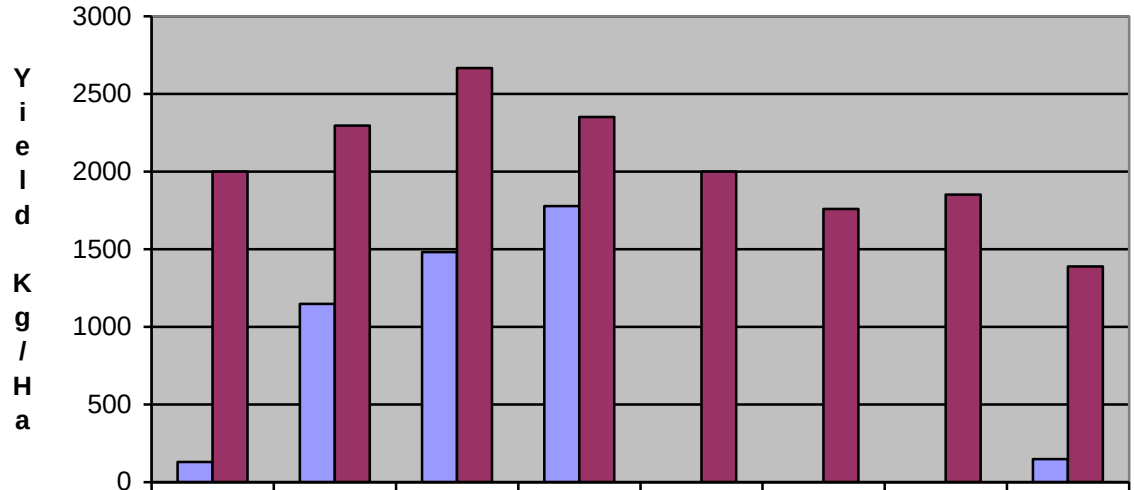


In comparison to the previous three cereal crops, the Penshurst canola site had significant establishment concerns with ground larks and minor slug attack. Without a doubt, the grazing of sheep removed much of the surface residue from the site and flattened much of the soil surface of habitat and protection for such pests.

In comparison, where residue had remained on the surface without stock, there was a dramatic outcome, with virtually all crop eaten by these pests. This suggests the importance of livestock grazing cereal stubbles prior to growing canola with total removal from burning yielding 2.667t/ha, discing 2.352t/ha and direct drill 2t/ha. These treatments when not grazed, were also the highest to yield, but considerably less than their counterparts. The treatment with the addition of dynamic lifter pellets did also yield well comparatively, suggesting that the standing stubble treatment performed better than the mulching, harvesting low and prickle chaining.

Figure 4.Yield Outcomes for Canola 2006 NLP Penshurst (Hamilton) Site.

Hamilton NLP Stubble Management Site 2006 - Canola
(2005 Barley Stubbles Ungrazed vs Grazed)



	Direct Drill	Chook Pellets	Burn	Disc	Stubble Mulch	Slash, Bale & Remove	Harvest Low	Prickle Chain
Ungrazed	130	1148	1481	1778	0	0	0	148
Grazed	2000	2296	2667	2352	2000	1759	1852	1389

Trial Observations: Due to the two dry seasons in 2005 & 2006, the data generated from these trials/demonstrations should be treated with caution. These results are a guide only. I would expect that many interactions will vary greatly in a wetter year. Use of the new SFS stubble seeder built in early 2006 has shown the importance of knifepoints and toolbar clearance when seeding into HRZ stubble retained situationa.

It will now be interesting to see management in 2008 of 7-8t/ha stubble after production in the 2007 season; this is what the trials should be all about. Interactions for shading, alleleopathy, insects, slugs and other concerns will then really be tested. Hopefully this current climatic phenomenon is about to change, retuning us to wet, cold and traditional southern farming system.

Further information about this project including access to the 2006 fact sheet, go to http://www.sfs.org.au/NLPStubble.htm for an update on what has happened, including additional data, photos and outcomes of other related trials. Additionally, seeding days and establishment walks will be conducted during the year to view outcomes and responses to each of the implemented treatments. It is on these days where farmers can see first hand the

Photographs:

Photo 1: Winchelsea site – 12” row spacings.

Photo 2: Inverleigh site – Direct Drill.

Photo 3: Lake Bolac site – Mulching Trt. grazed.

Photo 4: Penshurst site – Ungrazed vs