FarmLink
Research Report 2014

01

Maintaining Profitable Farming Systems with Retained Stubble

2014 Trial Site

Project Partners

FarmLink Research

CSIRO

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GRDC
Grains
Research &
Development
Corporation

Maintaining Profitable Farming Systems with Retained Stubble

The issues of Crop Sequences for Seeding Equipment; Rotary Harrows for Improved Herbicide Efficacy; Harvest and Post Harvest Stubble Management; and Stubble Management, Nutrition and Moisture Conservation in Mixed Farming Systems were all identified when developing the five year trial plan for the – Maintaining Profitable Farming Systems with Retained Stubble Project – funded by GRDC.

CSIRO, FarmLink Research, Farmers and Advisors have partnered to conduct the project across the FarmLink region aimed at investigating the potential of management systems to increase profitability when farming in full stubble retention systems.

The four key identified issues will be explored in-depth during the course of the project -

1) Crop Sequences for Seeding Equipment. Disc seeders have been widely adopted in our region to facilitate trouble free establishment of crops into large stubble loads. The disc seeder system has no registered pre-emergent herbicides available for weed control. Farmers and advisors are leading the development of systems that will successfully control a range of weeds. Crop sequences will be an additional tool to combat problem weeds in both the disc and tyne seeding equipment. This will be a small plot trial established into an existing population of annual ryegrass at the Temora Agricultural Innovation Centre.

2) Rotary harrows for improved herbicide efficacy. Local growers have been trialing the use of steel rotary harrows to increase herbicide efficacy, establishment percentages and reduce the impact of stubble born diseases. A farmer sown strip trial will be carried out to determine the differences between a range of treatments.

3) Harvest and post harvest stubble management. Some growers are harvesting at low heights to allow easy establishment of the following year's crop. This can reduce harvest efficiency and increase the time taken to complete harvest operations. A replicated farmer sown trial looking at the impact of short and high stubble height compared to post harvest treatments of burning and K-line trash cutting was established. Harvest delays increase potential for weather damage of grain crops which can decrease profitability.

4) Stubble management, nutrition and moisture conservation in mixed farming systems. This is an extension of the Water Use Efficiency Project and will be conducted at this trial site. Each plot will contain strips of knife point, spear point and disc openers to compare the impacts on each of grazing, stubble retention and burning.

The focus of the project for this 2014 Research Report falls on the third key issue - Harvest and Post Harvest Stubble Management - detailing results from the experiment located north of Wagga.

Harvest and post-harvest stubble management

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Introduction

It is often stated that management of stubble begins at harvest, and many stubble retention practitioners advocate harvesting cereal crops low to the ground and spreading trash across the width of the header to allow direct seeding into residues the following year. However, harvesting low has several drawbacks, including decreased harvest efficiency and increased grain losses, wear and tear on machinery and chances of weather damage. This is particularly the case in the S NSW environment which tends to produce high biomass crops, and with equi-seasonal rainfall is prone to harvest rain.

The aim of this experiment was to evaluate different harvest and post-harvest stubble management techniques and measure their effect on harvest efficiency, grain losses and growth and yield of the subsequent crop.

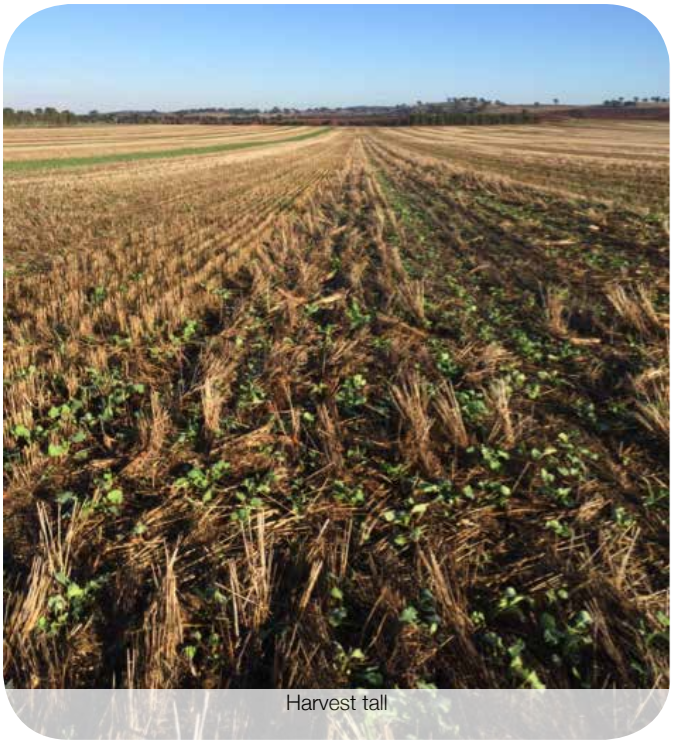
Methods

The experiment was located on the property of Ben and Lou Beck at Downside, north of Wagga. The Beck's farm on a 9 m controlled traffic system, and their sowing/harvesting swathes were used as 'plots' (9 m x ~800 m). Four different stubble management treatments were applied in a randomized complete block design with 3 replicates. Treatments were;

1. Harvest tall ('tall')
2. Harvest tall & burn in autumn ('burn')
3. Harvest tall & chop in summer ('chop')
4. Harvest short & spread ('short')

These treatments were applied to frosted wheat cv. Suntop crop in 2013 that yielded ~2 t/ha of grain and had 7.6 t/ha of stubble. All treatments were harvested with a John Deere JD 9770 STS with PowerCast tailboard and speed was adjusted to give an acceptable level of losses according to the combine

Figure 1. Comparison of stubble length in 'tall' and 'short' harvest height treatments


Harvest tall


Harvest tall & burn


Harvest tall & chop


Harvest short & spread

Figure 2. Canola growth in different stubble treatments 30 May 2014

grain loss monitor. Grain yield, fuel consumption and harvest speed and efficiency were taken from the combine yield monitor. The 'tall' treatment was harvest at 60 cm above the ground (just below heads) and the 'short' treatment was harvested at 15 cm (Figure 1). The 'chop' treatment was applied using a K-line Traschcutter™ (bars lay stubble on the ground where it is cut with self-sharpening discs) in December 2013. The 'burn' treatment was applied on 19 March 2014. On 19 April 2014 the trial was inter-row sown to TT canola cv. Bonito using an Excel single-disk seeder.

Crop emergence and NDVI were measured during the growing season, and soil and air temperature during winter. Hand harvest grain yield was measured by taking 15 x 1 m^2 hand harvests per plot across the elevation gradient in the field when 40% of seeds had changed color, and hand threshing once harvest-ripe. Machine harvest yield was measured by windrowing crop according to treatment readiness and then harvesting with JD 9770 STS and weighing yield from each plot in a chaser-bin fitted with load cells. Blackleg was scored after windrowing by digging up 50 stems

Figure 3. A comparison between ‘tall’ on left and ‘burn’ on right 13 August 2014

Figure 4. One of the ‘burn’ plots showing its more advanced stage of development relative to the stubble retain treatments (28 October 2014)

per plot, cutting at ground level with secateurs and scoring % stem canker infection. Frost damage was scored by counting the number of missing pods on 45 stems per plot and number of missing seeds in 225 pods per plot.

Results & discussion

Harvesting short reduced harvest efficiency by 3.8 Ha/h, yield by 0.14 t/ha and increased fuel consumption by 4.2 l/ha (Table 1). Based on combine running costs of $600/h and grain price of $250/t, harvesting short cost an additional $77/ha compared to harvesting tall.

Table 1. Harvest efficiency, fuel consumption and grain yield for wheat cv. Suntop in 2014 at different harvest heights. Values are means of three replicates taken from JD 9770 STS yield monitor and all differences are significant (P<0.05).

Harvest height	Efficiency (ha/h)	Speed (km/h)	Fuel (L/h)	Fuel (L/ha)	Efficiency (t/h)	Yield (t/ha)
Short (~15 cm)	5.7	6.2	54.3	9.6	14.0	2.05
Tall (~60 cm)	9.5	10.6	51.2	5.4	28.8	2.19
% decrease harvesting short	**41%**	**42%**	**-6%**	**-78%**	**51%**	**6%**

Soil and trash at seeding in 2014 were wet, and the Excel disc-seeder hair-pinned stubble and chaff lying on the ground in the 'short' and 'chop treatments. This was particularly bad in the 'short' treatment where chaff had been concentrated in bands due to inconsistent spreading by the combine across the swathe. In treatments with hair-pinning ('short' & 'chop'), canola establishment was reduced (Figure 2, Table 2). Establishment was better in the 'tall' and 'burn' treatments where there was no crop residue in the inter-row to interfere with the operation of the disc seeder. Early growth as measured by NDVI was slower in the three stubble retained treatments in comparison to the 'burn' treatment.

Table 2. Canola establishment and NDVI measured 30 May 2014

2013 stubble management	2014 canola establishment (plants/m²)	2014 crop NDVI 30 May 2014 (corrected for background stubble)
Tall	24	0.067
Burn	30	0.291
Chop	15	0.053
Short	16	0.027
P-value	**<0.001**	**<0.001**
LSD (P=0.05)	**3**	**0.052**

Development was also slower in the stubble retained treatments, and by 13 August the 'burn' treatment was in full flower whilst stubble retain treatments were just starting to flower (Figure 3). Minimum temperatures in August and September were extremely hostile (Table 3), and more frost damage was recorded in treatments which had higher plant densities ('tall' and 'burn' – Table 4, Figure 5). The exact reason for this is not clear, but we think the most likely explanation is that plants in the treatments with low density ('short' and 'chop') had more branches and soil water remaining, and could thus compensate better with more later flowering and growth. The more advanced development in the 'burn' treatment may have also contributed.

Table 3. Canopy temperature in the 'burn' and 'tall' treatments during August 2014

Time	Burn	Tall
8-Aug	-1.1	-1.0
9-Aug	-1.9	-1.8
10-Aug	1.3	1.3
11-Aug	-2.4	-2.0
12-Aug	-1.8	-2.0
13-Aug	-3.0	-2.8
14-Aug	-3.2	-3.8
15-Aug	-1.9	-2.0
16-Aug	-0.2	-0.3
17-Aug	7.7	7.7
18-Aug	5.9	5.7
19-Aug	2.0	2.1
20-Aug	-0.8	-0.8
21-Aug	0.4	-0.3
22-Aug	1.7	2.0

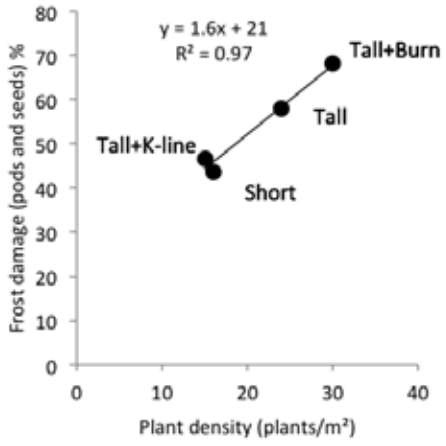


Figure 5. The relationship between plant density and frost damage in canola across different treatments in the experiment in 2014.

More frost damage in the treatments with high plant density meant that their higher dry matter could not be converted to yield, and there was no significant effect of treatment on either hand or machine harvest grain yield (Table 4). Even when yields were corrected for frost damage, there was no significant different between treatments. Blackleg infection was higher in the 'chop' treatment compared to the others, but there is no clear explanation as to why this may have been the case.

Table 4. Header and hand harvest grain yield, frost damage, frost adjusted grain yield and blackleg infection in the different stubble treatments in 2014.

2013 stubble management	Header grain yield (t/ha)	Hand grain yield (t/ha)	Frost damage (missing pods and seeds %)	Frost adjusted header grain yield (t/ha)	Blackleg (mean % stem infection)
Tall	1.3	1.4	58	2.0	19
Burn	1.2	1.4	68	2.0	25
Chop	1.3	1.6	43	1.8	36
Short	1.2	1.6	47	1.8	20
P-value	**0.486**	**0.508**	**<0.001**	**0.157**	**0.001**
LSD (P=0.05)	**NS**	**NS**	**8**	**NS**	**7**

Conclusions

Given that grain yields were equivalent in 2014, the relative advantages of the different 2013 stubble management techniques used here relate to their cost and ease of implementation. Using a combine harvester to manage stubble at harvest was expensive ($77/ha), increased wear and tear on the combine, and by slowing harvest exposed crops to greater risk of weather damage. Establishment was also poor in this treatment due to hair-pinning, but this may not have been the case if a tined seeder had been used to conduct the experiment. Harvesting tall and inter-row sowing was the cheapest form of stubble management and also gave good establishment. However, specialized equipment (disc seeder & 2 cm RTK) are required to achieve this in tall & heavy stubbles. Burning is cheap and effective at removing stubble, and allowed excellent establishment and greater early vigor for competition with weeds etc. However, because of its dependence on climatic conditions, it may be difficult to implement over large areas, particularly in hilly and timbered paddocks. Post-harvest stubble management of tall stubble with a K-line Trashcutter™ was much cheaper (~$12/ha) than cutting short with the combine, and gave a similar result in terms of establishment and plant yield.

Acknowledgements

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