2015 Seasonal effects of strategic stubble treatments on nitrogen response in wheat in CWFS districts

John Small, Central West Farming Systems

GRDC project CWF00018 – Maintaining profitable farming systems with retained stubble in Central West, NSW

Background
CWFS are conducting trials at its regional sites that:
- investigate the impact of different stubble treatments imposed towards the end of the fallow have on nitrogen response (applied as urea) in wheat yield and quality
- evaluate any interaction between pre sowing stubble treatment and topdressing timing

During 2015 CWFS conducted these trials were conducted at 4 locations Mumbil Creek, Weethalle, Tottenham and Wirrinya.

During 2014 CWFS conducted a similar trial at 6 locations Nyngan, Alectown, Gunning Gap, Lake Cargelligo, Ungarie, and Tullamore. These trials have been previously reported.

Key Points
- The seasonal conditions experienced during these trials had a profound impact on the trial results.

- During 2015 stubble treatments imposed late in fallow had no impact on N response.

- Similar to 2014, during 2015 generally farmers were unable to predict final yield before sowing when the season experienced extreme weather conditions.

- During 2015 split N applications did not improve yields and had only a very minor impact on grain quality.

- During 2015 split N applications was not a way to reduce financial risk as opposed to all N fertiliser upfront since crop outlook at Z30 was positive.
Agronomic issues
The nitrogen demand for maximum yield and protein of dryland crops in Central West NSW is unpredictable until late crop development because of variable spring weather conditions, particularly rainfall. Potentially nitrogen fertiliser can be one of the largest variable costs in wheat production. These two issues have seen farmers adopt topdressing with urea as an important management strategy to balance the seasonal risks and rewards of nitrogen fertilizer. Various approaches to N budgeting have been developed that assist growers to justify how many dollars in the form of nitrogen to risk in an attempt to maximise returns in any one year.

A common rule of thumb used to determine crop nitrogen topdressing rates is 20kg/ha of actual N per tonne of expected grain yield. In agronomic N accounting logic this benchmark assumes unrealistic N recover rates from soil and fertilizer. The number also fails to account for any soil N at sowing or any N that may have mineralised incrop. Nevertheless, it continues to be a widely used “number” during the in-season decision making process to topdress crops where growers are not using computer based decision support tools to decide topdressing rates. Growers using the benchmark consider observations of crop performance, a ‘gut feel’ about how the season will finish, and a knowledge of their business position and market expectation to decide to spend (risk) money on N fertilizer.

Organic N in the soil profile provides the basis for N mineralisation in addition to the crop residues that are cycled near the soil surface. Recent research (Angus, CSIRO, 2013 Forbes GRDC Update) suggest that organic N declines by 2-3% in continuous cropping systems. Fertilizer applications or growing grain legumes reduces the rate of decline but does not maintain the level. To maintain yields with continuous cropping, it is suggested that the application of N fertiliser will need to double over the next forty years. Currently urea fertilizer manufacture requires a significant amount of natural gas with modern manufacturing facilities approaching thermodynamic maximum. The outlook is that whilst the availability of natural gas is unlikely to limit N fertiliser supplies, the cost of manufacturing will not fall due to improved production efficiency.

These two individual issues alone are pushing producers to use N fertilizer more efficiently. Testing the 20 kg/ha per tonne benchmark under a range of stubble conditions over a number of seasons will either confirm the number for Central West Farming Systems districts or help develop options for more efficient benchmarks.

Trial design
The trial is 12 ranges and 3 rows, and consisted of 4 replicates. Each replicate is 3 ranges and 3 rows. There are 3 stubble treatments; standing, burnt and cultivated. The wheat cultivar is Suntop. Sowing rate was 35 kg/ha, 40 kg/ha of MAP (4.4 kg N per ha) was also applied to all treatments to (try to) ensure phosphorus was not limiting.
At each site 3 treatments were developed based on the cooperating farmers yield expectation for the trial site. Each treatment represented a different application timing for urea topdressing based on 20 kg of N per tonne of expected yield/ha. This rate is a commonly used farmer/advisor benchmark across the region. The treatments were; 1: all urea applied at sowing, 2: a 50/50 split upfront and Z21, and 3: split 3 way upfront, Z21 and Z30.

2015 trial sites and results:

Wirrinya
The trial at the Wirrinya regional site suffered significant herbicide damage and will not be reported.

Mumbil Creek
Co-operator; Jeff and Tim Bennett
Paddock History; 2012 to 2014 wheat no till
Soil Type; Sandy loam
Stubble treatments imposed; March 2015
Sowing Date; 10 June. The trial was resown after a trial sown 7 May failed to establish due to seeder problems. Seeding rate 40 kg/ha, 63 kg/ha MAP fertiliser into moist seedbed
Harvest date; 16 November
Special notes; Cultivation treatment imposed with offset discs. Stubble conditions at sowing was 80% cover generally about 300mm high with an average load of 2 t/ha, ranging from 1.5 to 3 t/ha. The amount of standing stubble varied from 85 to 70% of total load. Available N to 120cm across the replicates varied from 57 to 84 kg/ha. 0-10 cm Cowell P values varied from 11 to 13 across the replicates with the 10-30cm varying from 3 to 4. PredictaB tests rated crown rot infection below detectable levels. The cooperating farmers were asked to provide a presowing yield estimate for the trial site if there was no financial risk to them in purchasing nitrogen fertiliser; their estimate was 3t/ha.

Site results
No significant interaction between presowing fallow stubble management and timing of nitrogen application was observed. Similarly as shown in the table below, during this trial no significant interaction was observed between timing of nitrogen application and grain yield or quality.

<table>
<thead>
<tr>
<th>Sowing (kgN/ha)</th>
<th>Z 21 (kgN/ha)</th>
<th>Z 30 (kgN/ha)</th>
<th>Yield (t/ha)</th>
<th>Protein (%)</th>
<th>Screenings (%)</th>
<th>Test weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>0</td>
<td>0</td>
<td>1.19</td>
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<td>37.3</td>
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<tr>
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<td>1.15</td>
<td>16.4</td>
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<td>74.2</td>
</tr>
<tr>
<td>Lsd (0.5%)</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

Weethalle
Cooperator; Luelf family “Malonga Park”
**Paddock History**: rotation is fallow with one cultivation, followed by wheat, followed by barley no till, then back to fallow. 2014 crop wheat

**Soil Type**: red sandy loam

**GSR**: 243mm

**Stubble treatments imposed**: March 2015

**Sowing Date**: 11 May. Seeding rate 40 kg/ha, 63 kg/ha MAP fertiliser into moist seedbed

**Harvest date**: 24 November

**Special notes**: Cultivation treatment imposed with offset discs. Stubble at sowing about 300mm high with an average load of 2 t/ha, ranging from 1.5 to 3 t/ha. The area between last year’s rows was generally bare. Available N to 120cm across the replicates varied from 113 to 145 kg/ha. 0-10 cm Cowell P values varied from 26 to 31 across the replicates with the 10-30cm varying from 6 to 7. PredictaB tests rated crown rot infection below detectable levels. The cooperating farmers were asked to provide a presowing yield estimate for the trial site if there was no financial risk to them in purchasing nitrogen fertiliser: their estimate was 3t/ha.

**Site results**

No significant interaction between presowing fallow stubble management and timing of nitrogen application was observed. Similarly, as shown in the table below, during this trial no significant interaction was observed between timing of nitrogen application and grain yield. The small differences in grain protein most likely would not change the commercial return to the grower.

<table>
<thead>
<tr>
<th>Sowing (kgN/ha)</th>
<th>Z 21 (kgN/ha)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>0</td>
<td>0</td>
<td>2.4</td>
<td>12.6</td>
<td>10.9</td>
<td>80.1</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>0</td>
<td>2.4</td>
<td>12.4</td>
<td>9.9</td>
<td>80.4</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>20</td>
<td>2.4</td>
<td>12</td>
<td>9.7</td>
<td>80.4</td>
</tr>
<tr>
<td>Lsd (0.5%)</td>
<td>n.s.</td>
<td>0.4</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td></td>
</tr>
</tbody>
</table>

**Tottenham**

**Co-operator**: Paul Adam

**Paddock History**: 2012 lupins, 2013 wheat, 2014 wheat

**Soil Type**: red sandy loam

**GSR**: 148 mm

**Stubble treatments imposed**: March 2015

**Sowing Date**: 27 May. Seeding rate 40 kg/ha, 63 kg/ha MAP fertiliser into moist seedbed

**Harvest date**: 26 November

**Special notes**: Cultivation treatment imposed with offset discs. Stubble at sowing about 300mm high with an average load of 3 t/ha, ranging from 1.5 to 4 t/ha. Stubble cover over the ground was generally 100% and the standing stubble represented about half the total load. Available N to 120cm across the replicates varied from 50 to 75 kg/ha. 0-10 cm Cowell P values varied from 15 to 16 across the replicates with the 10-30cm varying from 4 to 5. PredictaB tests rated crown rot infection below detectable levels. The cooperating farmers were asked to provide a presowing yield estimate for the trial site if
there was no financial risk to them in purchasing nitrogen fertiliser, their estimate was 3t/ha.

Site results
No significant interaction between presowing fallow stubble management and timing of nitrogen application was observed. Similarly, as shown in the table below, during this trial no significant interaction was observed between timing of nitrogen application and grain yield or quality.

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<th>Screenings (%)</th>
<th>Test weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>0</td>
<td>0</td>
<td>1.66</td>
<td>13.9</td>
<td>24.2</td>
<td>78.6</td>
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<td>1.64</td>
<td>14</td>
<td>23.2</td>
<td>78.3</td>
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<td>1.50</td>
<td>14.4</td>
<td>23.5</td>
<td>78.3</td>
</tr>
<tr>
<td>Lsd (0.5%)</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td></td>
</tr>
</tbody>
</table>

Discussion
The seasonal conditions experienced during these trials had a profound impact on the trial results. Heavily edited producer comments summarise the season as a "good start", "good winter rain" then a "disappointing dry Spring". "The disappointing spring" started with lower than expected rainfall in September, high daytime temperatures in the mid to high thirties followed by hot strong winds during the first week in October. A rainfall event during September would more than likely resulted in very different results both for the trials and the district crops generally. This combination of seasonal events resulted in significant grower optimism up to the start of spring and then an extremely hard and unexpected finish for all sites. It was one of those seasons in Central West NSW where growers had no options to limit financial risk targeting any yield because the late and sudden change in seasonal weather conditions meant all crop inputs would have already been applied.

With the hindsight of the season and harvest data, it is observed that there was no risk management option available with split applications; as by the time the season collapsed, the third time for applying topdressing had passed. The most profitable option this year was to put all fertiliser on upfront at sowing since this eliminated the cost and time of incrop spreading. As an aside, the appearance of the crops and soil moisture profile in late July and early August may have provide some growers with the incentive to apply even more fertiliser.

Acknowledgments
CWFS would like to acknowledge the support provided by the co-operating farmers; without their in-kind support the trials would not have been possible. The author also thanks Dr Neil Fettell for his support in compiling this report.
2015 Seasonal effects of strategic stubble treatments on wheat and barley in CWFS districts; Year 3 of a 5 year investigation

John Small, Central West Farming Systems

GRDC project CWF00018 – Maintaining profitable farming systems with retained stubble in Central West, NSW

Key Points

• During 2015 stubble treatments involving late burning or cultivation resulted in significantly different yields in wheat and barley in 2 of 3 trials conducted at Tottenham, Weethalle, and Mumbil Creek.

• The stubble treatments had no effect on cultivar rankings or grain quality at any site.

• The effects of stubble treatments observed during 2015 were similar to the effects observed during similar trials in 2013 and 2014. The trend emerging is best summarised:
  “Cultivation late in fallow to reduce stubble loads for sowing is the most likely option to reduce yield unless it resolves a physical soil constraint such as compaction or established hard to kill weeds. Burning late in fallow to reduce stubble loads for sowing is unlikely to significantly improve yields compared to sowing into district typical standing stubbles. Burning may be a good last minute option where despite good planning, stubble is still interfering with sowing.”

Background

CWFS are conducting trials at its regional sites that:

- investigate the impact of different stubble treatments (burning, cultivation or standing stubble) imposed towards the end of the fallow have on the yield of wheat and barley
- evaluate any cultivar responses within crop species to the impact of the different stubble treatments.

During 2013 and 2014 CWFS has conducted similar trials at 12 locations Tottenham, Euabalong, Weethalle, Rankins Springs, Wirrinya, Nyngan, Alectown, Gunning Gap, Lake Cargelligo, Ungarie and Tullamore (2 trials) which have been reported previously. Small statistically significant differences in yield due to stubble treatments were observed at 8 of the 12 trials. No cultivar responses to stubble treatments have been observed.
Ongoing trials during the CWFS “Rain n Grain n Stubble” project will hopefully allow responses to be predicted pre-sowing rather than just measured at harvest.

Agronomic issues
Stubble retention during fallows within cropping systems in CWFS districts is a common practice. The 2013 CWFS farmer survey (representing 47 producers managing 207,000 ha) highlighted that 70% of producers regularly maintained stubble cover over summer, whilst 20% regularly maintained fallows by cultivation alone. No simple relationship between farm size and stubble management practice could be determined. Anecdotally, the reliance on herbicide for weed control in stubble retained systems, and the increasing threat to system profitability posed by herbicide resistant and hard to kill summer weeds, have seen the adoption of more integrated weed management programs; including a reversion to stubble burning and cultivation. CWFS members are asking about short and longer term impacts of using chemical fallows, cultivation and burning in more seasonally specific dynamic combinations to resolve agronomic problems such as weeds, pests, disease or crop nutrition issues, with the aim of increasing profitability.

Trial design
The trial was 12 ranges and 10 rows, and consisted of 4 replicates. Each replicate was 3 ranges. The trial was a split plot with varieties nested in (stubble x crop) nested in replicates. There were 3 stubble treatments: standing, burnt and cultivated. There were 2 crop species, wheat and barley. For each crop species there were 5 varieties tested. They were selected on the basis “farmer interest” and type (early, late, disease response etc).
Figure 1: 2015 trial plan.

2015 trial sites:
Wirrinya
The trial at the Wirrinya regional site suffered significant herbicide damage and will not be reported.

Mumbil Creek
Co-operator; Jeff and Tim Bennett
Paddock History; 2012 to 2014 wheat no till
Soil Type; Sandy loam
Stubble treatments imposed; March 2015
Sowing Date; 7 May Seeding rate 40 kg/ha, 63 kg/ha MAP fertiliser into moist seedbed
Harvest date; 16 November
Special notes; Cultivation treatment imposed with offset discs. Stubble conditions at sowing was 80% cover generally about 300mm high with an average load of 2 t/ha, ranging from 1.5 to 3 t/ha. The amount of standing stubble varied from 85 to 70% of total load. Available N to 120cm across the replicates varied from 57 to 84 kg/ha. 0-10 cm Cowell P values varied from 11 to 13 across the replicates with the 10-30cm varying from 3 to 4. PredictaB tests rated crown rot infection below detectable levels.

Results
There was a yield response and no grain quality response to stubble treatment in wheat. The yield response showed burnt stubble was better than cultivation but not standing stubble, and standing stubble was no better than cultivation. No grain yield response to stubble treatment was observed in barley. No differences in crop performance were observed between treatments when considering plant emergence or biomass. The dry spring and heatwave conditions the trial experienced during early October more than likely limited any potential yield advantages from either stubble treatments or variety selection. It is suggested that the yields obtained despite these difficult spring conditions are a reflection of the timely fallow management undertaken by the cooperating farmer prior to sowing.

### Wheat trial

<table>
<thead>
<tr>
<th>Stubble</th>
<th>Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burnt</td>
<td>1.76</td>
</tr>
<tr>
<td>Cultivated</td>
<td>1.53</td>
</tr>
<tr>
<td>Standing</td>
<td>1.60</td>
</tr>
<tr>
<td>Lsd</td>
<td>0.20</td>
</tr>
</tbody>
</table>

### Barley trial

<table>
<thead>
<tr>
<th>Stubble</th>
<th>Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burnt</td>
<td>2.12</td>
</tr>
<tr>
<td>Cultivated</td>
<td>2.19</td>
</tr>
<tr>
<td>Standing</td>
<td>2.28</td>
</tr>
<tr>
<td>Lsd</td>
<td>ns</td>
</tr>
</tbody>
</table>

### Wheat Yield

<table>
<thead>
<tr>
<th>Variety</th>
<th>Yield (t/ha)</th>
<th>Protein (%)</th>
<th>Screenings (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condo</td>
<td>1.65</td>
<td>10.1</td>
<td>8.3</td>
</tr>
<tr>
<td>Gregory</td>
<td>1.58</td>
<td>9.9</td>
<td>8.4</td>
</tr>
<tr>
<td>Livingston</td>
<td>1.69</td>
<td>10.2</td>
<td>9.4</td>
</tr>
<tr>
<td>Spitfire</td>
<td>1.53</td>
<td>10.6</td>
<td>9.1</td>
</tr>
<tr>
<td>Suntop</td>
<td>1.69</td>
<td>10.2</td>
<td>11.8</td>
</tr>
<tr>
<td>Lsd</td>
<td>0.1</td>
<td>ns</td>
<td>2.3</td>
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### Barley Yield

<table>
<thead>
<tr>
<th>Variety</th>
<th>Yield (t/ha)</th>
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<tbody>
<tr>
<td>Buloke</td>
<td>2.17</td>
</tr>
<tr>
<td>Commander</td>
<td>2.03</td>
</tr>
<tr>
<td>Compass</td>
<td>2.21</td>
</tr>
<tr>
<td>Latrobe</td>
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</tr>
<tr>
<td>Oxford</td>
<td>2.11</td>
</tr>
<tr>
<td>Lsd</td>
<td>0.16</td>
</tr>
</tbody>
</table>

### Weethallee

**Co-operator; Leuff family “Malonga Park”**

**Paddock History:** rotation is fallow with one cultivation, followed by wheat, followed by barley no till, then back to fallow. 2014 crop wheat

**Soil Type:** red sandy loam

**GSR:** 243mm

**Stubble treatments imposed;** March 2015

**Sowing Date:** 11 May. Seeding rate 40 kg/ha, 63 kg/ha MAP fertiliser into moist seedbed

**Harvest date:** 24 November

**Special notes:** Cultivation treatment imposed with offset discs. Stubble at sowing about 300mm high with an average load of 2 t/ha, ranging from 1.5 to 3 t/ha. The area between last years’ rows was generally bare. Available N to 120cm across the replicates varied from 113 to 145 kg/ha. 0-10 cm Cowell P values varied from 26 to 31 across the replicates with the 10-30cm varying from 6 to 7. PredictaB tests rated crown rot infection below detectable levels.

**Results**
There was no yield or grain quality response to stubble treatment in wheat. No grain yield response to stubble treatment was observed in barley. No differences in crop performance were observed between treatments when considering plant emergence or biomass.

The dry spring and heatwave conditions the trial experienced during early October more than likely limited any potential for impact of stubble treatments. The very small difference observed in wheat yields and no difference in barley yields is most likely related to seasonal influence.

<table>
<thead>
<tr>
<th>Wheat trial</th>
<th>Yield (t/ha)</th>
<th>Barley trial</th>
<th>Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stubble</td>
<td></td>
<td>Stubble</td>
<td></td>
</tr>
<tr>
<td>Burnt</td>
<td>2.21</td>
<td>Burnt</td>
<td>2.76</td>
</tr>
<tr>
<td>Cultivated</td>
<td>2.30</td>
<td>Cultivated</td>
<td>2.60</td>
</tr>
<tr>
<td>Standing</td>
<td>2.35</td>
<td>Standing</td>
<td>2.59</td>
</tr>
<tr>
<td>Lsd</td>
<td>ns</td>
<td>Lsd</td>
<td>ns</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wheat</th>
<th>Yield (t/ha)</th>
<th>Protein (%)</th>
<th>Screenings (%)</th>
<th>Barley</th>
<th>Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condo</td>
<td>2.20</td>
<td>9.4</td>
<td>5.8</td>
<td>Buloke</td>
<td>2.69</td>
</tr>
<tr>
<td>Gregory</td>
<td>2.16</td>
<td>9.5</td>
<td>5.1</td>
<td>Commander</td>
<td>2.76</td>
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<tr>
<td>Livingston</td>
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<td>Compass</td>
<td>2.64</td>
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<td>Spitfire</td>
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<td>9.7</td>
<td>6.9</td>
<td>Latrobe</td>
<td>2.60</td>
</tr>
<tr>
<td>Suntop</td>
<td>2.49</td>
<td>9.4</td>
<td>5.6</td>
<td>Oxford</td>
<td>2.58</td>
</tr>
<tr>
<td>Lsd</td>
<td>0.21</td>
<td>ns</td>
<td>0.9</td>
<td>Lsd</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

Tottenham
Co-operator; Paul Adam
Paddock History; 2012 lupins, 2013 wheat, 2014 wheat
Soil Type; red sandy loam
GSR; 148 mm
Stubble treatments imposed; March 2015
Sowing Date; 27 May. Seeding rate 40 kg/ha, 63 kg/ha MAP fertiliser into moist seedbed
Harvest date; 26 November
Special notes; Cultivation treatment imposed with offset discs. Stubble at sowing about 300mm high with an average load of 3 t/ha, ranging from 1.5 to 4 t/ha. Stubble cover over the ground was generally 100% and the standing stubble represented about half the total load. Available N to 120cm across the replicates varied from 50 to 75 kg/ha. 0-10 cm Cowell P values varied from 15 to 16 across the replicates with the 10-30cm varying from 4 to 5. PredictaB tests rated crown rot infection below detectable levels.

Results
There was no yield or grain quality response to stubble treatment in wheat at the accepted 95% confidence level. At 92.5% a response between grain yield and stubble treatment became evident. A grain yield response to stubble treatment was observed in barley. No differences in crop performance were
observed between treatments when considering plant emergence or biomass and winter crop growth considered good. The dry spring and heatwave conditions the trial experienced during early October more than likely limited any potential impact of stubble treatments and most likely contributed to the high screenings observed. The final yields were also heavily influenced by the Spring conditions. Low protein levels reflect low soil nitrogen levels at sowing and the very limited N applied as starter fertiliser.

<table>
<thead>
<tr>
<th>Wheat trial Stubble</th>
<th>Yield (t/ha)</th>
<th>Barley trial Stubble</th>
<th>Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burnt</td>
<td>1.62</td>
<td>Burnt</td>
<td>2.11</td>
</tr>
<tr>
<td>Cultivated</td>
<td>1.51</td>
<td>Cultivated</td>
<td>1.79</td>
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<tr>
<td>Standing</td>
<td>1.68</td>
<td>Standing</td>
<td>1.98</td>
</tr>
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<td>9.7</td>
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<td>Livingston</td>
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<td>9.9</td>
<td>14.6</td>
<td>Compass</td>
<td>2.14</td>
<td></td>
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<tr>
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<td>10.2</td>
<td>12.6</td>
<td>Latrobe</td>
<td>1.99</td>
<td></td>
</tr>
<tr>
<td>Suntop</td>
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<td>10.1</td>
<td>14.6</td>
<td>Oxford</td>
<td>1.69</td>
<td></td>
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<tr>
<td>Lsd</td>
<td>ns</td>
<td>0.32</td>
<td>1.78</td>
<td>Lsd</td>
<td>0.23</td>
<td></td>
</tr>
</tbody>
</table>

2nd year effects of 2014 trials
This series of trials has been run over 2013, 2014 and now 2015. During 2014 the 2013 wheat replicates at trial sites were monitored for any second year effects by collecting biomass samples during the spring. At most sites there was a visual difference in the crop performance across the stubble treatments. Statistically at all sites and all stubble treatments there was no significant difference between the biomass production achieved during the Spring 2014.

During the 2015 spring, 2014 sites were visited and little visual difference between the wheat replicates could be observed. Based on the previous years’ results little benefit could be identified by collecting further samples and no further data was collected.

Discussion
There is no evidence from the 2015 trials that variety yield ranking changes with stubble or tillage treatment for either wheat or barley. Overall, 2015 produced similar results to 2013 and 2014 findings. All years have experienced in producer terms a “good start”, “good winter rain” then a “disappointing dry Spring” (heavily edited). The 2015 Spring was perhaps the most “disappointing” and limiting for crop performance since it was a combination of high temperatures and dry conditions. Based on observations made during 2013, 2014 and 2015, it maybe concluded that yield from any of the cultivars tested cannot be improved by pre sowing stubble management.
when a dry Spring is encountered. This may not be the case in a wet spring when foliar disease may impact crop performance.

Again as in 2013 and 2014, the seasonal conditions this year did not bring short term agronomic benefits or risks associated with stubble conservation, burning or cultivation into play. The autumn break was timely and all trial sites were sown with good seedbed moisture. Therefore, the potential benefit of retained stubble providing a more favourable seedbed for an extended sowing time was again not observed. Given the sowing speeds and efficiencies that modern sowing equipment can achieve, this perceived benefit of stubble retention may not be as important as when stubble retained systems were initially being developed.

During 2015, at Mumbil Creek wheat and Tottenham barley sites a significant relationship existed between yields and pre sowing stubble treatments. The burnt treatment yielded statistically higher than cultivation but not the standing stubble; although statistically the standing stubble was not better than the cultivation. This statement has been generally supported by 2013 and 2014 trials where yield responses have been observed except at sites where physical soil constraints to sowing, such as soil compaction and established weeds, were reduced due to the cultivation treatment.

Considering the implications to crop management in CWFS districts of this trial during the years 2013, 2014 and 2015, the following key points emerge:

- At sowing, the best option in terms of yield is to sow the cultivar with the highest yield potential for the sowing window
- Cultivation late in fallow to reduce stubble loads for sowing is the most likely option to reduce yield unless it resolves a physical soil constraint, such as compaction or established hard to kill weeds
- Burning late in fallow to reduce stubble loads for sowing is unlikely to significantly improve yields compared to sowing into district typical standing stubbles. Burning may be a good last minute option where despite good planning, stubble is still interfering with sowing.
- Burning may not be a cheap option. The cost of burning stubble needs to be considered both in terms of dollar labour cost and lost nutrients. Costs of compliance with burning regulations, WHS and insurance should not be underestimated.

Acknowledgments
CWFS would like to acknowledge the support provided by the co-operating farmers; without their in-kind support the trials would not have been possible. The author also thanks Neil Fettell for his support in compiling this report.
Is controlled traffic farming altering crop performance across seeder widths in CWFS districts?

John Small, Central West Farming Systems

GRDC project CWF00018 – Maintaining profitable farming systems with retained stubble in Central West, NSW

GRDC project ACT00004 – Application of CTF in the low rainfall zone.

Key Points

- Although not statistically validated a trend of either higher or lower NDVI’s in the centre of the tram tracks was observed on 7 of the 14 farms investigated.
- The trend to wider header fronts makes the practicalities of redistributing residue evenly back across the width of the header all the more difficult and may accelerate any rate of change in crop performance.
- In the short term CTF producers should target even redistribution of crop residue across header widths
- Further work is needed and the author would welcome collaboration from others in helping to design a future experiment and statistical analysis.

Background

Variation in crop yield across previous years header runs is commonly seen in drought years with the magnitude and consistency of the effect largely dependant on Spring conditions and often related to soil moisture conditions at sowing. Colin McMaster, NSW DPI, quantified this effect as part of his work with the CWFS Water Use Efficiency project in 2010. His work is best summarised by his photograph, picture 1 and graph below.

As a component of the CWFS projects, Maintaining profitable farming systems with retained stubble in Central West, NSW and Application of CTF in the low rainfall zone, initial investigations were undertaken to identify any possible impacts on crop growth in controlled traffic systems where the header residue maybe inconsistently spread back across the tram track width over a number of seasons. The hypothesis was that over time in controlled traffic farming systems the repeated uneven spreading of header residue back over the tram track width would result in changed soil conditions that would ultimately lead to different “management zones” along the tram track.
Agronomic Issues

Producers using controlled traffic farming (CTF) systems report improved soil structure which helps crops convert rainfall to grain. Growers also report improved timeliness of operations and better efficiencies from farm machinery in terms of improved fuel usage and reduced hours per hectare.

Apart from the initial capital cost of converting to CTF system generally growers have reported few problems. All farm practices eventually have both negative and positive impacts on system performance. For example herbicides worked really well until widespread herbicide resistance resulted in many cheaper chemical options not working.

Within the low rainfall cropping zone the CWFS districts probably have the longest history of farmer adopting CTF systems, so effort was made to investigate any potential longterm negative impacts of CTF farming. This resulted in a preliminary investigation into whether any differences in crop growth could be observed across the tram track width that may ultimately lead to different “management zones” along the tram track.
**Trial Design**

Fourteen producers across the CWFS region self-nominated to be involved in the project from an email sent to CWFS members in June 2015. Within this producer group the date of adoption of a controlled traffic system ranged from 2006 to 2014.

It was assumed that changes in NDVI across the seeder width represented changes in crop performance resulting from different nutrient or moisture conditions. If a difference in NDVI across the seeder width could be observed in an otherwise visually ‘even’ crop then it may suggest some difference in crop performance. These differences in NDVI maybe as a result of seeder setup and operation during the current crops establishment or some other longer term impact of CTF such as inconsistent spreading of header residue back across the tram track width over a number of seasons.

During the 2015 growing season 3 representative a joining seeder widths were selected. 5 NDVI data sets using a Trimble green seeker were recorded across each seeder width, each data set was roughly 10 m apart. This resulted in 15 data sets for each sampled paddock. The data sets were then individually corrected to ensure they represented the same direction and speed of travel across the sowing width. Finally all data sets were combined to provide a representative picture of changes in NDVI across the planter width.

**Results**

**Farm 1:** CTF practiced for 6 years, 2015 crop chick peas just flowering

![Graph representing Farm 1 results]

**Farm 2:** Lake Cargelligo

![Graph representing Farm 2 results]
Farm 2: CTF practiced for 4 years, 2015 field peas just flowering but had not completely covered ground.

Farm 3: CTF practiced for 3 years, 2015 crop chick peas just flowering

Farm 4: CTF practiced for 8 years, 2015 wheat GS 31
**Farm 5:** CTF practiced for 7 years, 2015 crop wheat GS31

**Farm 6:** CTF practiced for 3 years, 2015 crop barley GS30

**Farm 7:** CTF practiced for 2 years, 2015 crop wheat GS 33

**Farm 8:** CTF practiced for 8 years, 2015 wheat GS 30
Farm 9: CTF practiced for 9 years, 2015 crop wheat GS40

Farm 10: CTF practiced for 4 years, 2015 crop barley GS33

Farm 11: CTF practiced for 7 years, 2015 crop barley GS31
Farm 12: CTF practiced for 5 years, 2015 crop barley GS41

Farm 13: CTF practiced for 13 years, 2015 crop barley GS55

Farm 14: CTF practiced for 10 years, 2015 crop wheat, paddock windrow burnt 2014 and 2013.
Discussion:

If CTF systems resulted in changes in crop growth due to poor spreading of crop residue back over the full width of the header then the expectation was to observe a trend in a graph plotting crop NDVI against distance from edge of seeder width similar to C. McMaster’s (2010) yield vs distance from edge of header graph (figure 1).

Seven farms, 1, 4, 5, 6, 9, 13 and 14 show no trend at all. This suggests that the CTF farming system is not altering crop performance across the seeder width and that the farmers are achieving accurate seed and fertilizer distribution across the width at sowing. Possibly farm 5 results show some uneven seeder performance may be seen but this could not be confirmed.

Farms 7 and 8 may show a trend similar to McMaster. Notes from farm 7 suggest that some overlap of sowing widths may have happened which would explain the higher readings at the edge.

Five farms, 2, 3, 10, 11, and 12 exhibit poorer crop performance in the centre of the planter width. This result maybe due to the effect of wheel tracks or heavier crop residues relative to the rest of the paddock lowering crop performance. Again the exact cause could not be identified from the data collected.

Whilst the author acknowledges this work is not statistically validated a trend of either higher or lower NDVI’s in the centre of the tram tracks was observed on 7 of the 14 farms investigated. It is suggested by both the author and cooperating farmers that the idea that uneven redistribution of crop residue across header widths in CTF may result in future changes to crop performance across tram tracks. Further investigation is warranted as the trend to wider header fronts makes the practicalities of redistributing residue evenly back across the width of the header all the more difficult and may accelerate the rate of change in crop performance.

Acknowledgments:

The author acknowledges the support of cooperating farmers in allowing access to both their crops and paddock records. It is hoped that in the future with further work a more definitive result can be found.
Does stubble height influence subsequent crops?

John Small, Central West Farming Systems

GRDC project CWF00018 – Maintaining profitable farming systems with retained stubble in Central West, NSW

Key Points

- Stubble height did not affect fallow efficiency at Weethalle following the 2013 or 2014 harvests.
- Stubble height during the 2014 fallow did not impact on 2015 crop yields.
- Leaving higher stubbles may reduce harvest cost but may also cause issues during fallow sprays and sowing. Individual producers need to target a stubble height that best suits their equipment and techniques.

Background

At CWFS field days and grower events any discussion about stubble management usually results in the question “Does stubble height matter?” The answer to this question depends on the perceived benefit of stubble height at both harvest and within the next crop. Most producers agree that during harvest there is extra operational costs and lower header efficiencies in harvesting consistently lower to allow for harvest weed seed management options. Producers of peas, vetch and other prostrate crops will claim benefits of leaving higher cereal stubbles to support for these crops. At the 2013/14 CWFS windrow burning trial at Wyalong, it was observed that traditional knee high stubbles required an earlier and potentially extra fallow spray due to quicker weed emergence than beer can height stubble treatments used for windrow burning treatments.

During the 2013 and 2014 harvests, replicated stubble height trials using commercial equipment in commercial cereal crops were established by Mr Ian Luelf, Iona, Weethalle. CWFS used these sites to investigate any possible impact on subsequent management operations such as spraying or crop performance.

Agronomic Issues

Stubble height will have an impact on future paddock management.

Generally higher stubble results in cheaper harvest costs. Higher stubble may slow the surface evaporation rate which, in certain fallow seasons depending on rainfall distribution, may potentially improve fallow efficiencies. Higher stubble may slow surface evaporation which may extend the sowing window in marginal establishment years.
Higher stubble may hinder herbicide applications during the fallow and at crop establishment. Higher stubble may slow sowing once the root system decomposes. Higher stubble may result in extra weed germinations in fallow.

2013 Trial

At the 2013 harvest with the aim of documenting and quantifying any agronomic fallow impacts of different stubble heights, a replicated trial was established using a New Holland CR9070 with a honeybee front, whilst a wheat crop was being stripped. The trial consisted of 3 replicates and 4 target stubble height treatments, 15cm, 25cm, 30cm and 40cm. Plots were 12m (a header width wide) and 100m long.

Results:

<table>
<thead>
<tr>
<th>Targeted stubble height (cm)</th>
<th>Standing Stubble load (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>1300-1655</td>
</tr>
<tr>
<td>30</td>
<td>1015-1235</td>
</tr>
<tr>
<td>25</td>
<td>605-1000</td>
</tr>
<tr>
<td>15</td>
<td>605-735</td>
</tr>
</tbody>
</table>

Table 1. Average standing stubble loadings.

<table>
<thead>
<tr>
<th>Month</th>
<th>Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>December</td>
<td>0</td>
</tr>
<tr>
<td>January</td>
<td>16</td>
</tr>
<tr>
<td>February</td>
<td>17</td>
</tr>
<tr>
<td>March</td>
<td>60</td>
</tr>
</tbody>
</table>

Table 2. 2013 summer rainfall

Soil cores were collected from each plot during December and March and gravimetric soil water determined. As expected no differences were observed between plots in December. No differences were observed in March. There were no significant rainfall events during the summer that would potentially store any soil water, as a result there was no agronomical change in soil water between December and March. Although a zero tolerance to summer weeds was practiced, no fallow weed control was required until early April as result of the March rain.

Discussion:

During the dry 2013/2014 (refer Table 2) summer stubble height had no impact on fallow efficiency or management. Observations at a CWFS windrow trial at Wyalong concluded that earlier and, potentially, an extra summer spray was required where stubble heights were higher, but this was not seen at Weethalle.

2014 Trial

At the 2014 harvest, another replicated trial was established using a New Holland CR9070 with a honeybee front whilst a wheat crop was being stripped with the aim of again documenting and quantifying any agronomic fallow impacts of different stubble heights. The subsequent Scope barley crop was also monitored. The trial consisted of 4 replicates and
target stubble height treatments, 15cm, 25cm and 40cm. Plots were 12m (a header width wide) and 100m long.

**Results:**

<table>
<thead>
<tr>
<th>Month</th>
<th>Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>December</td>
<td>24</td>
</tr>
<tr>
<td>January</td>
<td>101</td>
</tr>
<tr>
<td>February</td>
<td>32</td>
</tr>
<tr>
<td>March</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 3: 2014 summer rainfall

No data on standing stubble loads is available due to the loss of stubble samples collected immediately following harvest. Soil cores were collected from each plot during December and March and gravimetric soil water determined. As expected, no differences were observed between plots in December. No differences were observed in March.

Fallow weed control was required during December, January and March but no difference in weed emergence rates were observed between plots.

A commercial crop of Scope barley was sown 18 May into good conditions. Crop emergence, growth and final yield data for each plot was collected over the season. No difference was observed between plot performance at emergence or yield. During early tillering it was observed that plots with 15cm and 25cm high standing stubbles were generally 1 to 2 tillers in front of the 40cm high plots. By stem elongation no difference could be observed. The crop suffered a very tight finish and all plots yielded approximately 2.6 t/ha, this was determined by hand cut quads prior to the commercial harvest.

**Discussion:**

Similar to the 2013 trial, no differences were observed in fallow efficiency or management required. This was despite a more favourable summer rainfall. Timing of summer weed control sprays was not affected as observed at Wyalong during 2013. Ryegrass was not a major weed at this site and this may have contributing factor to spray timing.

It cannot be determined whether the tight finish to the season limited any potential yield differences between treatments. Although as final tiller numbers were similar between treatments the impact was most likely similar for all plots.

**Acknowledgments:**

The author gratefully acknowledges the support of Mr Ian Luelf in establishing this trial whilst busy harvesting his crops. Without Ian’s support this work would not have been possible. CWFS field staff Glen Forbes, Mitchell Coote and Neil Williamson work in data collection is also acknowledged.