# Summer fallow management in 2010 across Central West NSW

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**Abstract**
A series of replicated large scale trials were established in Rankins Springs, Gunningbland and Tottenham to evaluate the impact that various fallow management practices had on crop yield and grain quality, starting soil moisture reserves, and starting soil nitrogen.

Following the wet summer of 2010, these trials showed that grain yield in the subsequent crop could be increased by 50% through effective fallow management. Summer weed control had a major influence on yield, where full weed control strategies were the most profitable, averaging a return on investment of between 220-500%.

Stubble management, whilst influential, was less important for grain yield in these trials than weed control. As a result of the wet season, grain yield from summer fallow management was mostly attributed to retaining soil nitrogen reserves rather than improved soil moisture.

**Key Words**
Water use efficiency (WUE), stubble management, weed control, plant available water (PAW),

**Introduction**
Improved summer fallow management is thought to be a potential area for increasing winter crop performance, according to local benchmarking data from AGnVET services, crop modelling simulations (Hunt et al., 2011) and results from nine soil moisture monitoring sites across central NSW (McMaster et al., 2008).
Crop modelling suggests that additional PAW at sowing can increase WUE by 148% at Bogan Gate, 173% at Condobolin and 210% at Tottenham (Hunt et al., 2011). The significant contribution of summer rainfall to winter crop water use in central NSW is due to the combination of equi-seasonal rainfall distribution, moderate to high PAWC (McMaster et al,. 2008) and variable growing season rainfall. Further crop modelling suggests that only 1-3% of years will not return an investment on retaining summer moisture (Hunt et al., 2011).
However the ability for out of season rainfall to be stored and made available to a crop as PAW is dependant on both seasonal rainfall patterns (small number of large falls vs large number of small falls) and soil type (Hunt et al., 2011). Evaporation losses from fallows are closely linked to soil type as heavy clay soils tend to store a greater proportion of PAW towards the surface whilst sandier soils tend to store a greater proportion of moisture at depth (McMaster et al., 2008). Consequently heavy soil types require larger rainfall events for moisture to penetrate below the top 20-30cm which is most affected by evaporation.

The aim of this study was to identify and evaluate the key drivers for retaining out of season rainfall, and assess its contribution to grain yield. Treatments included a range of stubble management options (stubble standing/slashed/cultivated/deep ripped) combined with various summer weed control strategies (nil spray/miss first spray/complete spray/delayed spray)

**Methods**
Three trial sites were sown in 2010 across central NSW at Gunningbland, Tottenham and Rankins Springs. Each trial comprised three replicates of each stubble management and weed control timings.

Stubble management treatments included stubble standing, stubble slashed (with a mulcher), cultivation (1 pass with offset discs) and deep ripping (ripped to 50cm depth on 1m spacings and then offset disced twice), and were imposed after harvest in November and December, 2009. Weed control timings included nil spray (no fallow herbicides until a knockdown prior to sowing), miss first spray (first fallow spray excluded), delayed spray (first spray 14 days after complete spray) and complete spray (weeds sprayed at the ideal timing with a zero tolerance of weeds).

## Results

### *Gunningbland site*

### *Impact on moisture retention*

Stored moisture declined depending on how long summer weeds were able to actively persist, with an additional 49mm of PAW being retained when a complete weed control treatment was applied. The stubble treatments had no significant impact on moisture or nutrient retention.

Unusually high fallow efficiencies where achieved at Gunningbland, ranging from 29% to 46% (Table 1). This is significantly higher than the typical range of 20-30% which has been measured (McMaster et al, 2008) over recent years. It is postulated that the increased fallow efficiencies experienced in 2010 were due to higher than average rainfall during the later half of the fallow period (Feb/Mar/Apr). Consequently, soil evaporation losses would be reduced as rainfall occurred after the hottest period of the summer.

**Table 1: Impact of fallow management on nitrogen retention at Gunningbland site**

| Treatment | PAW (mm) | | Fallow efficiency (%) | Mineral Nitrogen (kg N/ha) | |
|---|---|---|---|---|---|
| Nil spray | 81 a | 100% | 29 | 54.8 a | 100% |
| Miss first spray | 114 b | 141% | 40 | 98.1 c | 179% |
| Delayed spray | 118 bc | 146% | 42 | 82.3 b | 150% |
| Complete spray | 130 c | 160% | 46 | 103.3 c | 189% |
| P - value | <0.001 | | | <0.001 | |

*Note for all trials:*

** PAW was measured to a depth of 1.2m, and mineral nitrogen was measured to 90cm.*

** Stubble management treatment results not displayed in Table 1 due to no significant response.*

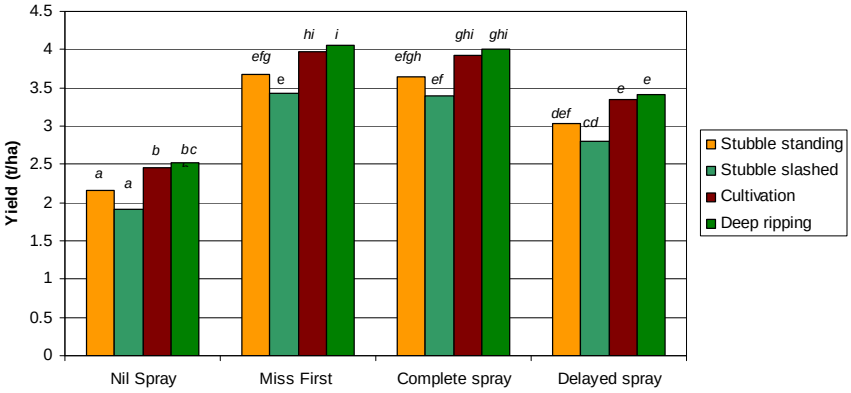
### *Impact on nitrogen retention*

Controlling all summer weeds increased nitrogen availability for plant uptake by 89% (48.5 kg/ha of Nitrogen as shown in Table 1). To replace this amount of nitrogen via urea would cost approx $68/ha (urea at $650/t on farm) if there were no losses. Whilst there was a slight trend for increased nitrogen mineralisation on the cultivation and deep ripping treatment, it was variable and not statistically significant.

### *Impact on grain yield and gross margin*

Controlling summer weeds gave the greatest response in both grain yield and profitability (data not reported in this paper), with yield increasing by 65% (over the nil weed control treatment) when a complete weed control treatment was applied. Grain yield also increased by 10% via cultivation and/or deep ripping. However, the most profitable treatment was stubble standing/complete spray with a return on investment of $5 for every $1 invested on fallow herbicide sprays.

**Figure 1: Impact of summer fallow management on grain yield at Gunningbland**




### *Tottenham site*

### *Impact on moisture retention*

The excessively wet summer period (467.9mm) resulted in most treatments having a full profile of moisture at sowing despite the various stubble and weed control treatments. However the full weed control treatment retained an additional 22mm of PAW over nil weed control. Stubble treatments such as stubble standing/slashed or cultivation had no significant impact on summer fallow moisture retention. The wet

summer also caused the slashed stubble to be washed from the site, effectively leaving this treatment as bare uncultivated ground.

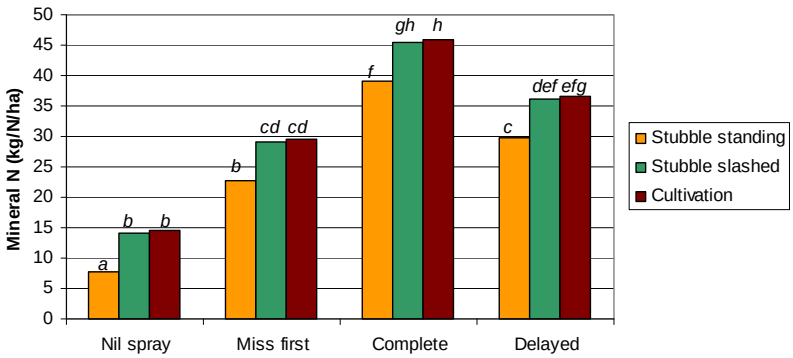
**Table 2: Impact of fallow management on moisture retention**

| Treatment | PAW (mm) | | Fallow efficiency (%) |
|---|---|---|---|
| Nil spray | 77.8 a | 100% | 17 |
| Miss first spray | 96.3 b | 124% | 21 |
| Delayed spray | 104.0 b | 134% | 22 |
| Complete spray | 100.1 b | 129% | 21 |
| P - value | 0.03 | | |

***Impact on nitrogen retention***

Controlling summer weeds had the greatest impact on preserving nitrogen availability for the following crop, with the complete control treatment having approximately 31 kg/ha more nitrogen than the nil spray control. An additional 5-7 kg/ha of nitrogen was made available via cultivation or by stubble slashed treatments. This small increase in nitrogen availability is postulated to be achieved via increased soil residue contact (cultivation treatment) or reduced nitrogen tie-up (stubble slashed treatment).

**Figure 2: Impact of summer fallow management on nitrogen at Tottenham**




***Impact on grain yield and gross margin***

Controlling summer weeds gave the greatest response to both grain yield (by up to 237%) and profitability (figures not reported in this paper). Similar to the Gunningbland site, every dollar invested in summer sprays returned an additional $4.60. Stubble treatments had no significant impact on yield.

**Table 3: Impact of fallow management on wheat yield**

| Treatment | Yield (t/ha) | |
|---|---|---|
| Nil spray | 1.01 a | 100% |
| Miss first spray | 1.69 b | 167% |
| Delayed spray | 2.11 c | 209% |
| Complete spray | 2.39 d | 237% |
| P - value | <0.001 | |

***Rankins Springs site***

***Impact on moisture and nitrogen retention***

Results not included as there were unexplainable variations and differences within and between treatments.

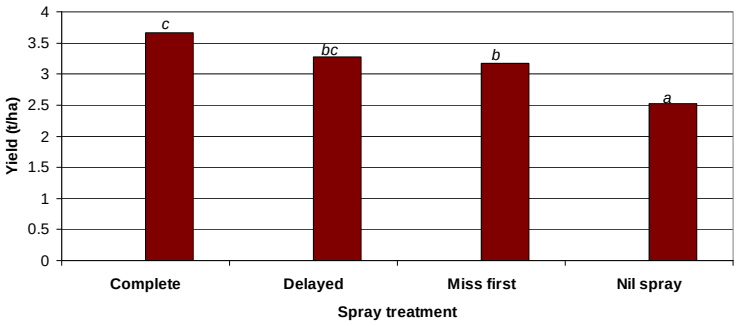
***Impact on grain yield and gross margin***

There was a significant influence of both stubble management (P=0.018) and weed control (P<0.0001) on yield and gross margin at Rankins Springs, but there was no significant interaction between stubble management and weed control treatments.

Weed control was again the major influence on yield at Rankins Springs (Figure 3). Similar to the other trials, highest yields (145% of nil) were obtained when all weeds were controlled. Each dollar spent on herbicides returned an average of $2.20 when the stubble was left standing.

The return on investment in this trial from herbicides was lower than the other two trial sites due to increased herbicide costs associated with 2 additional herbicide applications in a longer fallow period.

**Figure 3: Impact of weed control treatments on yield at Rankins Springs.**




Deep ripping (3384 kg/ha) and cultivation (3275 kg/ha) treatments were higher yielding than stubble slashed (3126 kg/ha) and stubble standing (2845 kg/ha) treatments. The more that stubble was physically destroyed in this trial, the higher the yields. This could be because of the observed high incidence of yellow leaf spot in the trial, in conjunction with less nitrogen tie up through nutrient immobilisation. It was also observed that the standing stubble treatments became noticeably waterlogged compared to other treatments with less stubble cover, which slowed plant development and growth. The combination of these issues resulted in lower yields where the stubble was left untouched and standing.

The highest gross margins were dominated by complete weed control, coupled with either cultivation or slashing the stubble (figures not reported in this paper).

## Discussion

In all trials it was clear that the less weeds that were allowed to grow during the summer the better. This allowed for higher nutrient and soil moisture retention in all trials. As 2010 was a wetter year than normal, nitrogen retention was considered more important than moisture, but this may not be the case in all seasons. One issue identified in the trials was the timing of weed control. In every trial, controlling weeds when they were young was easier and more cost effective. In both the 'delayed spray' and 'miss first spray' treatments, weeds were either harder to control or required higher rates of herbicides, or got to a stage where herbicides were no longer effective. This was particularly important where fleabane was present.

With fertiliser becoming a major input cost in cropping systems, efficiencies can be made via summer weed control. These results also highlight that cultivation and/or deep ripping can allow small increases of nitrogen mineralisation (benefits of 5-7 kg N/ha) due to increased soil nitrogen mineralisation, although this effect may be short term and at the expense of soil carbon. Further research will be conducted in 2011 and 2012 to assess the impacts of summer weeds on other specific nutrients (N, P, K and S).

The presence or absence of stubble had only a slight impact on grain yield at one of the three trial sites. 2010 was an extremely wet year and this may have masked possible benefits of stubble retention. Recent research suggests that stubble cover has little impact on crop evaporation losses during the hot summer months, but can improve infiltration rates during intensive summer thunderstorms, and improve sowing conditions during marginal autumns by retaining moisture near the surface.

## Conclusion

These trials clearly highlighted that grain yield may be increased by 50% by increasing stored soil water and nitrogen through effective fallow management. The greatest gains to both grain yield and profitability came via controlling summer weeds. Stubble management was less important in these trials.
The benefits of clean, weed free fallows are that they have a relatively low cost for high potential returns as the improved accumulation of both soil moisture (up to 60% increase) and soil nitrogen (up to 48 kg N/ha).

## References

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