

# fallow management

in stubble retained systems in Central West NSW

Project code CWF00018

## KEY MESSAGES

- Zero tolerance of summer weeds in fallows is critical for future crop performance.
- Stubble loads over three tonne per hectare can adversely affect following crop yields.
- 'No till with No stubble is No good' on hard setting red/ brown soil types.
- Grazing stubble should not occur at the expense of timely weed control. A green pick costs soil water and soil nitrogen.
- Options to manage high stubble loads need to be considered annually.

## Overview

The major agronomic drivers for adopting stubble retained farming systems are to reduce costs and maximise the efficiency of operations. In turn retaining stubble can minimise the risk of soil erosion and assist growers to retain soil moisture.

In CWFS districts the main drivers of yield are fallow moisture and nitrogen (N), and to maximise benefits for the crop, residue cover should be maintained for as long as possible during summer and autumn.

Researchers French and Schultz (1984) noted that soil water stored before sowing was as effective in improving yield as in-crop rainfall.

Another critical aspect of fallow management is timely weed control.

## Fallow water conservation

The most significant effect of stubble on water balance is it actually allows the infiltration of summer rain and prevents run off. The second impact of stubble retention is it reduces evaporation.

Summer fallow rainfall contributes about 50 per cent of the average water-limited grain yield in CWFS districts, according to the crop simulation model,



Agricultural Production Systems sIMulator (APSIM) - Wheat. This finding was supported by joint CWFS and NSW Department of Primary Industry (DPI) trials during the GRDC Water Use Efficiency Project 2008 to 2013.

Rainfall events of 20 to 30mm or more can infiltrate below the evaporation zone at the soil surface and be stored for subsequent crop growth. Subsoil water that can be accessed by wheat during critical growth stages can be converted to yield very effectively. It should also be noted that N mineralises as well.

In a dry growing season, the subsequent crop benefits from more stored soil moisture. In a wet growing season, the subsequent crop benefits from more soil N.

To maximise the benefits for the crop, residue cover should be maintained as long as possible during the autumn period. Ideally it should be fully retained through winter for maximum soil moisture retention whatever stubble management process is used, as long as weed control is maintained.

In years with below average growing season rainfall (GSR), this process may increase yield. Stubble retention has a bigger impact on water conservation in years with rainfall distributed over several events rather than in a large single event. In very high summer rainfall years, residue effects are minimised due to full moisture profiles (Verburg *et al* 2012).

## CWFS Water Use Efficiency (WUE) trials

As part of the GRDC-funded CWFS Water Use Efficiency (WUE) project, NSW DPI managed fallow efficiency trials in 2010, 2011 and 2012.

The trial sites at Condobolin, Gunningbland, Tottenham and Rankins Springs investigated the impact of stubble management and herbicide timing on fallow efficiency.

A consistent finding of all trials was the importance of spraying fallows in a timely manner.

The trials looked in detail at the effect of three spray regimes and four stubble treatments on plant available water, soil nitrogen, phosphorus, potassium, sulphur and pH, as well as grain yield and quality parameters.

The trials showed that when weeds were controlled in summer fallow, there was a profitable increase in grain yield. This increase in yield may have resulted from increased amounts of plant available water or soil mineral nitrogen.

In contrast to weed control, stubble management had very little effect on grain yield in subsequent crops, being either slightly negative or slightly positive in different years.

## Long fallow trial – Merriwagga

The fallow trial managed by Griffith-based Ag Grow Agronomy and Research compared yield benefits and the economics of various management options over an 18 month fallow period.

The treatments included various spray timings (early vs late) versus a green manure vetch and a cover crop of oats. The trial consisted of five treatments.

The trial was set up on 7 March 2012 and the oats and the vetch were sown on 27 March 2012 (Table 1).

### Key findings:

- Controlling weeds in fallows 100 per cent of the time preserves maximum soil moisture.
- Spraying weeds late equated to lost income of \$85.56 a hectare due to reduced grain yield and quality (Figure 1).

Table 1: Trial treatments, replications and plot randomisation.

	Row	30m		
		Rep 1	Rep 2	Rep 3
12m	1	Full fallow spray	Fallow spray commenced September	Full fallow spray + oats
12m	2	Fallow spray commenced June	Full fallow spray + vetch	Full fallow spray
12m	3	Fallow spray commenced September	Full fallow spray + oats	Full fallow spray + vetch
12m	4	Full fallow spray + vetch	Full fallow spray	Fallow spray commenced June
12m	5	Full fallow spray + oats	Fallow spray commenced June	Fallow spray commenced September

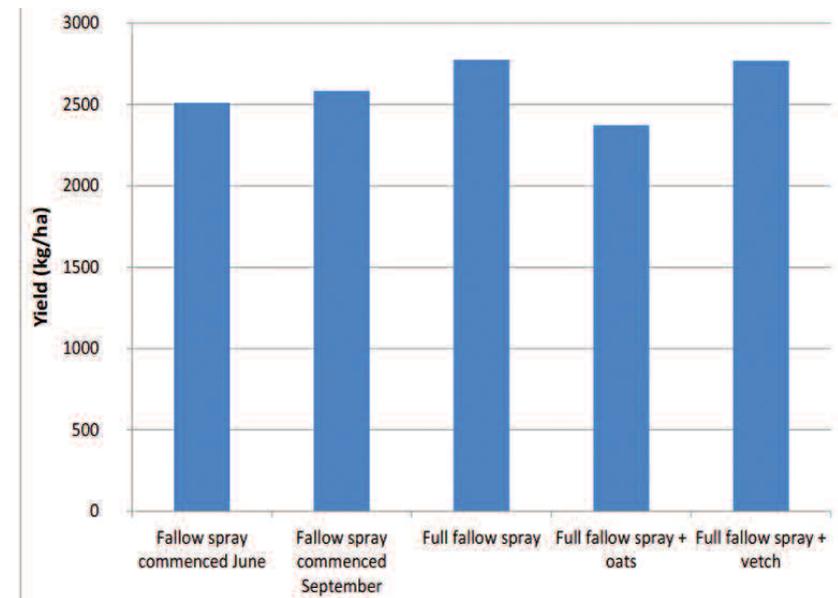


Figure 1: Average grain yield of wheat, Merriwagga 'long fallow' trial, 2013.

## Optimal stubble loads

The benefits of stubble retention are achieved at stubble loads between two to three tonnes per hectare. Cereal stubble above three tonnes per hectare post sowing is unlikely to provide any additional yield benefits and in favourable seasons can reduce yield.

The challenge is to manage high stubble loads without risking erosion and soil moisture loss.

As the growing season rainfall increases, the benefits of stubble diminish and even begin to negatively impact on crop yields.

In the CWFS district it appears that three tonnes per hectare is the maximum load to ensure the benefits of stubble retention. Any more and yields may be reduced, particularly in favourable seasons.

Options to manage stubble loads above three tonnes per hectare need to be made seasonally, and require regular monitoring. Good planning may allow other agronomic and farm efficiency gains to be achieved at the same time.

Options for reducing stubble loads between harvest and sowing include:

- Cultivate stubble into the soil during fallow
- Mechanically manage but retain stubble on the surface during the fallow e.g. mulcher, Kelly chain
- Burn
- Remove e.g. bale
- Graze during the fallow.

View the CWFS 'Good stubble, bad stubble' paper with embedded video here or follow link below.



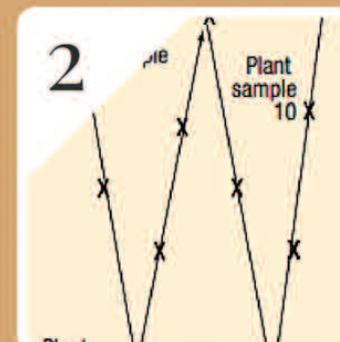
<http://cwfs.org.au/2015/09/02/good-stubble-or-bad-stubble-loads/>

## You can't manage what you don't measure

# STUBBLE WEIGHING GUIDE



Make up a 1m by 1m quadrat for your measurements.



Take some samples in a W shape across the paddock to account for variation.



Cut and collect the stubble within the quadrat area. Shears or a steak knife are both good bets.



Find some cooking scales to measure the weight. 100 grams of dry stubble = 1 tonne per hectare

## Managing sheep grazing on stubbles and their effect on subsequent crop performance

A trial to assess stubble grazing was run at Condobolin as part of the GRDC funded Water Use Efficiency (WUE) project.

While an increasing number of producers are moving towards conservation farming and stubble retention systems, some believe that livestock do not have a role in these systems.

This trial has shown that livestock can be included in the system, as long as the stubble load is not reduced below approximately 70 per cent cover or approximately 2t/ha of cereal stubble.

Stubble grazing should be managed to retain at least this level of cover whilst contributing value to the livestock enterprise.

Grazing of stubbles should be considered as a useful tool for the strategic reduction of stubble load, but not at the expense of summer weed control. Livestock, especially sheep, have the ability to remove grain spilled in the harvesting process; reducing volunteer cereal weeds in following crops.

### The trial results showed

- Sheep grazing on stubble and crops do not reduce crop yields, provided summer weeds are controlled and at least 70 per cent of stubble cover is maintained (two to three tonnes per hectare cereal stubble)
- Reduced water infiltration and yield from grazing are due to removal of cover rather than compaction i.e. it is grazing that does the damage.
- Sheep do compact the soil but only at the surface. This pressure is alleviated by the natural shrinking and swelling of soils and sowing with knife points.
- Grazing of stubbles and crops appears to make more N available to crops which can increase yield, though the mechanisms remain uncertain.
- Providing salt/urea licks to sheep grazing stubbles could be a valuable tool when decreasing stubble loads that are above 2-3 t/ha, but generally are low in nutrient and protein levels. Using weeds for 'a green pick' is not economical.

## Case study 1

**Grower:** Ian Manwaring

**Location:** Condobolin, NSW

**Enterprises:** Mainly cropping with wheat, barley and oats, sheep, cattle and goats.

**Soil and pH:** Red, hard setting with pH from 5 to 6.5.

**Property size:** 22,000ha.

### Overview:

The Manwaring's property is northwest of Condobolin. They run a mixed farming operation and, on occasion, take in stock on agistment as a sideline.

They classify themselves as conventional croppers, using whatever tools in the shed they need to fit any given season.

Ian generally crops a paddock for three years before putting it back into a pasture phase. The sequence is usually wheat followed by wheat, then barley under-sown with lucerne, medics and clovers. Oats is grown for grazing and for grain and hay.

The pasture phase usually lasts for three to five years depending on how well the pasture is performing.

Paddocks are sometimes grazed after harvest depending on the situation at the time. If rain has decreased the feed value, they are more likely to spray or cultivate. One useful aspect of grazing is allowing the stock a parasite-free paddock after drenching.

When grazing, the Manwarings have no set stocking period; again depending on the condition of the stubble and the season they may graze heavier stubble longer than normal if pasture is poor over the remainder of the property. This also allows some thinning of the stubble for subsequent sowing.

They generally plan to have stubble

management operations finished by the end of January.

The light cropping regime followed by a lengthy pasture phase has so far prevented the development of weed resistance.

Ian sees the retention of moisture as having the biggest value in retained stubble. With such marginal country, this is considered a valuable component of stubble retention.

However, they remain flexible and use the most economic tools available and, if stock returns are out-performing cropping, they tend to lean more towards maximising stock returns.

### Soil Health:

Ian has noticed that the mulch effect of chaff from the harvest is more beneficial to moisture retention than the standing stubble in the paddock. He feels that retaining heavy stubbles has led to nitrogen tie-up in some wetter years so he remains committed to being flexible in his cropping program.

Listen to a podcast of Ian's case study or follow link below-



<http://cwfs.org.au/podcast/fallow-management/>

## Case study 2:

**Grower:** Wayne Jarvis

**Location:** Tottenham, NSW

**Enterprises:** 1200ha cropping and a self-replacing Merino flock. Mainly cropping cereals but moving into break crops. Direct drill operation on one property while more traditional mixed farming on a second.

**Soil and pH:** Black belah to red loam with an average pH of 6.4.

**Property size:** 2400ha.

### Overview:

The Jarvis family has been farming with a no-till system for seven years, although the system varies and tillage is still used when necessary.

They have noticed an increase in yields and improved soil health on no-till country where sheep have been removed from the system.

However, on the mixed farming property the cost of chemical and spraying applications is reduced by the use of sheep, and the stock income provides another risk management option.

On the mixed farming area, sheep are used to graze stubble as part of the weed management strategy. Wayne finds that they use less chemical and find it easier to control fleabane, milk thistle and windmill grass. However stubble retention is sacrificed if need be for increased grazing opportunities.

On the no-till country, they rely on chemical control of weeds while maintaining a higher level of stubble retention. However, this season because of the heavy stubble load, they are looking at off-set ploughing some paddocks for improved weed control and less trash at sowing.

At times they also cool burn heavy stubble loads just prior to sowing.

### Soil Health:

It is noticeable to Wayne that the country they direct drill without grazing is much softer and more friable than the mixed farmed areas.

Follow link to Wayne's podcast:



<http://cwfs.org.au/podcast/fallow-management-nsw/>

## CWFS stubble project trial summary

As part of the GRDC-funded stubble initiative, CWFS conducted a series of stubble management trials at 12 differing locations (Tottenham, Euabalong, Weethalle, Rankins Springs, Wirrinya, Nyngan, Alectown, Gunning Gap, Lake Cargelligo, Ungarie, Mumbil Creek and Tullamore) from 2013 to 2017.

The different stubble treatments included standing, cultivating, mulching and burning. A variety of differing cultivars of canola, wheat and barley were grown at the sites.

Trial results can be viewed here: <http://cwfs.org.au/stubble-project-archive/>  
During 2013, 2014 and 2015 there were little difference in final yield due to the different stubble treatments except for late cultivation, which had a significant reduction in yield in two out of three sites in 2015; however grain quality was not affected.

It should also be noted that these three years all experienced a tight finish to the season with a dry spring.

2016 however was a decile 9 year across the CWFS district with a mild, wet winter and a wet spring. Stubble loads were above

average after harvest and at sowing in 2017 many growers who would normally retain stubble opted to burn for ease of operation.

Although not widely noticeable in the 2017 CWFS trials, commercially many growers observed less soil moisture at sowing and at anthesis (flowering) in paddocks that had had stubble burnt rather than those with retained stubble. As 2017 was another tight finish the impact on yield from removing the heavy stubble load may well have been greater than any possible reduction in yield from retaining a 3 tonne or more stubble load.

John Kirkegaard (CSIRO Canberra) also noticed this effect with his trials in Temora in 2017 and he discussed in his presentation at the 2018 GRDC Grains Research Update at Wagga Wagga.

However, the 2017 CWFS 'Seasonal effects of strategic stubble treatments on Canola in CW NSW' trial at Tottenham, NSW showed significantly better yield results from the burnt stubble treatment as opposed to standing, harrowed or cultivated stubbles, with the cultivated treatment proving the lowest yield (Table 2).

Table 2. Tottenham crop biomass (kgDM/ha) at flowering and harvest, yield (t/ha), harvest index, oil (%) and protein (%) under the different stubble treatments.

(Values followed by the same letter within each column are not significantly different ( $P < 0.05$ ))

Stubble treatment	Flowering Biomass (kg DM/ha)	Harvest Biomass (kg DM/ha)	Yield (t/ha)	Harvest Index	Oil (%)	Protein (%)
Burnt	1838	3316 <sup>ab</sup>	0.83 <sup>a</sup>	0.25 <sup>a</sup>	42.9 <sup>a</sup>	24.8 <sup>b</sup>
Cultivated	2416	2918 <sup>b</sup>	0.66 <sup>bc</sup>	0.23 <sup>b</sup>	42.3 <sup>ab</sup>	25.3 <sup>b</sup>
Harrowed	3429	3490 <sup>a</sup>	0.77 <sup>ab</sup>	0.22 <sup>b</sup>	41.2 <sup>bc</sup>	26.1 <sup>a</sup>
Standing	3086	2737 <sup>c</sup>	0.57 <sup>c</sup>	0.21 <sup>b</sup>	40.5 <sup>c</sup>	26.2 <sup>a</sup>
<i>Lsd</i>	<i>ns</i>	518.4	0.14	0.02	1.29	0.54

Stubble retention does benefit soil structure, prevents erosion and can increase soil organic matter; all of which are important to nutrient cycling and soil health. There is no single solution that will work in every paddock, every year for every crop. The major outcome from this project is to provide growers with options to allow them to make the best decisions on how to manage their stubbles.

Considering the implications of fallow management in CWFS districts from this trial during the years 2013 to 2017, 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. Stubble management techniques had no impact on differing cultivar's yields.
- 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 control of 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 typical district 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.

- Although stubble loads over 3 tonnes per hectare may negatively impact the following years crop by patchy or reduced emergence at sowing due to blockages or hairpinning, increased disease inoculum being present, higher frost risk due to microclimate or less efficient weed control - the removal of the stubble load by burning, if followed by a dry season, may in fact create larger crop losses (reduced stored moisture and higher evaporation rates).
- If heavy stubble loads are reduced by burning and the following one or two seasons are dry or have tight springs, it may take several years before a suitable percentage of stubble cover can be restored in those paddocks.

## References

- Re-evaluating the contribution of summer fallow rain to wheat yield in southern Australia (Hunt & Kirkegaard 2011)
- GRDC Water Use Efficiency project 2008-2013 (Haskins, McMaster, Menz 2012) French and Schultz (1984) Kirkegaard et al 2007, Verburg et al 2012.
- <http://www.agronomy2015.com.au/papers/agronomy2015final00393.pdf>

## Acknowledgements

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## Disclaimer

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This guideline has been developed by Central West Farming Systems Inc. (CWFS) as part of the Maintaining Profitable Farming Systems with Retained Stubble initiative, funded by the Grains Research and Development Corporation (GRDC). The initiative involves farming systems groups in Victoria, South Australia, southern and central New South Wales and Tasmania collaborating to validate current research at a local level and address issues for growers that impact the profitability of cropping systems with stubble; including pests, diseases, weeds, nutrition and the physical aspects of sowing and establishing crops in heavy residues.

During 2012 discussions with local producers resulted in CWFS identifying 13 subjects that impact on the management decisions for producers in Central West NSW.

Since then CWFS has undertaken a range of research, development and extension (RD&E) activities focusing on these subjects. These publications are an attempt to capture those activities and provide regionally specific guidelines for producers aiming to retain stubble in Central West NSW.

A primary part of this work has been to correlate existing resources and research from several organisations and CWFS thanks these respective organisations for their work. CWFS and the GRDC also thank the experts who technically reviewed these guidelines.