Maintaining profitability in retained stubble systems on upper Eyre Peninsula

A joint EPARF and GRDC funded project.

Guideline 8: When to reduce stubble loads

Retaining stubbles in upper Eyre Peninsula farming systems reduces soil erosion risk due to higher levels of soil surface cover and lower levels of soil disturbance. Reduced tillage with more direct drilling seeding systems has increased soil moisture conservation and improved timeliness of sowing. Many upper Eyre Peninsula farming systems have both cropping and livestock enterprises, therefore stubble retention is important to lower soil erosion risk and to provide a feed source for livestock.

Retaining cereal stubble can have benefits to the farming system, but there can also be disadvantages. Cereal stubble management at harvest can impact on timeliness and cost of harvest, soil erosion over summer, soil moisture conservation, nutrient status, weed control, frost risk, and pest and disease levels. Management of high medic stubble loads prior to cereal cropping is important for timeliness, preventing seeding blockages and clumping of medic vine residue. This guideline aims to outline the benefits of retaining stubbles, but also addresses the issues that arise in stubble retention systems and when you might need to consider reducing the stubble load. Different methods of stubble reduction are discussed in Guideline 11: Stubble management and weed control.

What are the benefits of retaining stubbles?

- ✓ **Lower erosion risk over summer**
- ✓ **Maintaining or improving soil structure and soil health**
- ✓ **Maintaining or improving nutrient retention**
- ✓ **Source of feed for livestock**
- ✓ **Increased water infiltration and soil moisture retention**

When would you consider reducing the stubble load?

If the stubble load;

- ✓ **Affected timeliness of seeding, caused uneven seeding depth or potentially reduced establishment due to blockages**
- ✓ **Increased the risk of frost in frost prone areas**
- ✓ **Increased risk of pests such as mice and snails**
- ✓ **Reduced herbicide efficacy**
- ✓ **Increased stubble borne disease inoculum**
- ✓ **Tied up nutrients at crop establishment**

Wheat stubble loads or volume can be 1.3-2.8 times the grain yield, and can start causing issues in farming systems from 3-4 t/ha dry matter[1]. Cereal stubble management treatments imposed at harvest at Minnipa have shown stubble management and the seeding position (inter-row or on-row) in the following season have not impacted on crop production (yield or grain quality) or grass weed numbers over three seasons with relatively high stubble loads for this environment (Table1).

Table 1 Establishment and grain yield of wheat as affected by stubble management and seeding alignment, and initial stubble loads. *Values for stubble treatments are averaged over seeding alignment treatments and for seeding alignment are averaged over stubble treatments.*

2013-15 Stubble treatments	**2014 stubble load (t/ha)**	**2014 wheat yield (t/ha)**	**2015 stubble load (t/ha)**	**2015 wheat yield (t/ha)**	**2016 stubble load (t/ha)**	**2016 barley yield (t/ha)**	**2017 Stubble load (t/ha)**
Stubble standing high	3.4	2.40	5.8	1.19	4.3	2.14	4.3
Stubble standing low	3.8	2.45	6.9	1.28	5.1	2.24	4.6
Stubble cultivated	3.4	2.58	4.3	1.26	4.0	1.99	3.0
Stubble removed	-	2.62	-	1.20	0.6	1.91	1.4
LSD (P=0.05)	*ns*	*0.08*	*ns*	*ns*	*0.6*	*0.14*	*0.4*
Inter row		2.55		1.24	3.3	2.11	3.5
On row		2.47		1.22	3.6	2.02	3.3
LSD (P=0.05)		*0.06*		*ns*	*ns*	*ns*	*ns*
*No extra N				1.22	3.3	2.06	3.4
*60 kg/ha N				1.25	3.6	2.08	3.4
LSD (P=0.05)				*ns*	*ns*	*ns*	*ns*

How do I measure stubble loads?

To get an accurate measurement of stubble loads in the paddock the following sampling process may be followed;

> 1/10 m^2 (CROPTOP) square and collect dry stubble at 5 sample points.
> Weigh stubble (grams [g])
> Average the weight and multiply by 10 to get g/1m^2
> Simplified Average Weight (g/m^2)/100 = t/ha
>
> (i.e. conversion for g/m^2 to t/ha = weight / (1000 (kg) x 1000 (t)) x 10,000 (m to ha))

Alternatively visual photo references of different stubble loads as a percentage of groundcover, where 50% groundcover is recommended to prevent soil erosion, are provided in Figure 1, or more comprehensively in Stubble Management: A Guide for Mallee Farmers manual[3].

Stubble load management for seeding systems

Stubble management for the next seeding starts at harvest and stubble length is the key factor. There is no single solution to stubble management as it will depend on crop type and residue breakdown, farming systems and livestock grazing, machinery and seeding systems. Tined seeders have less ability to handle longer straw than disc seeding systems[1].

Tined seeders

Residue handling strategies for tined seeders to minimise residue clumping and maximise uniform crop establishment are[4];

- Cut stubble short
- Chop and spread residue evenly unless using weed seed capture.
- Maximise tine spacing on the seeder to prevent clumping and blockages.
- Operate in dry stubble at a lower speed.
- Inter-row sow or sow diagonal to stubble rows and along the direction of stubble lean.
- Partial removal of straw through baling can assist with reducing stubble quantities to manageable levels.
- Heavy grazing can remove significant residue but at the cost of increasing erosion risks and increasing evaporation of soil water. Light grazing of heavy residue should be avoided as trampled stubble with little reduction in quantity increases the likelihood of heavy clumping and blockages.

		
20% cover = 450 kg/ha	30% cover = 720 kg/ha	40% cover = 1000 kg/ha
		
50% cover = 1400 kg/ha	60% cover = 1800 kg/ha	70% cover = 2400 kg/ha
		No photo but no soil visible
80% cover = 3300 kg/ha	90% cover = 4000 kg/ha	100% cover = 6000 kg/ha +

Figure 1 Standing stubble % cover and stubble kg/ha estimates[3]

Maximising tined seeder capacity[4]

The following guidelines can assist with improving the tine drill capacity. These guidelines are indicative, and should be validated in local environments and considered in unison for effectively maximising the overall tine drill capacity[3]:

- The seeding tine vertical clearance should be at least 1.5 times the height of standing residue.
- The optimum tine shank is straight with only gradual changes in shape, has a round cross-section and is vertical or slightly leaning backwards.
- The shape of existing tine designs can be improved by adding simple round tubes known as residue guards. Their round, smooth surface improves residue flow and minimises the hairpinning and residue catching that is often promoted by the narrow edge on shanks and protruding brackets.
- Tine layout should be spread over 3 or 4 ranks to maximise the inter-tine spacing (Figure 2). The smallest inter-tine spacing within a layout represents its bottleneck and should be at least 1.3-1.5 times the residue length (for up to 4-4.5 t/ha wheat stubble). Heavier stubble may require 1.8-2 times the residue length to be non-restrictive.
- The stubble height should be no more than 65% of the vertical height between the ground surface and tine shank or mounting head
- Residue cutting coulters preceding the seeding tines can improve residue flow provided they successfully cut through residue[4].

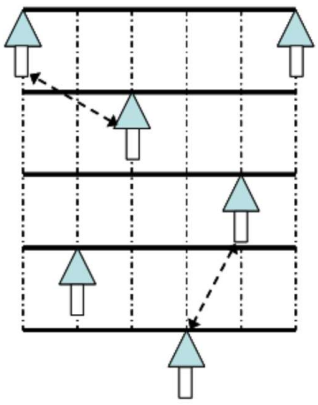

Figure 2 Tine layouts over 5 ranks increase the inter-tine spacing and greatly improve the drill capacity[4]

Disc seeders[5]

The adoption of disc seeders has been driven by their ability to handle heavy crop residues without clumping or blockages, and without specific requirements for stubble harvest or post-harvest management. A major potential limitation however is residue hairpinning. Hairpinning is where uncut residue is pushed into the furrow by the disc opener resulting in seed to residue contact and poor furrow closure. This can reduce germination and seedling establishment. Further seedling death can result when simultaneously applying pre-emergence herbicides at sowing. The ability to control hairpinning is therefore central to the success of disc seeders. This is achieved along two principles: i) minimise the need for residue cutting and ii) maximise the capacity to cut residue[5].

The need for residue cutting is minimised by avoidance techniques such as[5]:

- Maximising the height of harvested stubble and uniformly spreading straw and chaff to minimise residue load on the ground.
- Inter-row seeding using precision guidance to avoid the bulk of standing stubble. This is best achieved at wider row spacing (30 cm) as disc seeders often do not track as well as tine seeders, especially in hard soils. Travelling along the direction of harvest is preferred to control potential residue blockage with low clearance disc units. Controlled traffic farming with bare wheel tracks achieves the full potential of inter-row sowing without drawbacks of rolled stubble in wheel tracks.
- Using residue managers (row cleaners). Row cleaners aim to remove excess residue in the path of the disc opener and can complement inter-row sowing when dealing with matted loose residue, such as on header trails. Row cleaners are best suited to wider row spacing and non-sticky conditions, and operate best driving along stubble rows. They require contour following ability and good floatation in soft soils, and should be lifted out of operation when not required. The moving of residue to the inter-row is achieved at an optimum speed, while some farmers also use residue managers to generate additional soil throw in aid of herbicide incorporation[5].

The capacity to cut residue is maximised by[5]:

- Operating in dry stubble and firm soil conditions.
- A sharp cutting edge with thin disc wedge angle to deliver an effective parting cut component of the residue cutting process. Disc blades can be sharpened to improve performance in challenging paddocks.
- An operating depth optimised for the disc size.
- Unconstrained disc drive to maximise the sliding cut component of the residue cutting process. Disc drive is improved by reducing all sources of drag affecting the disc rotation.
- High down pressure capacity on disc units to match requirements for cutting matted residue.
- Driving along the leaning direction of stubble to cut stems at an angle[5].

Any post-harvest working operation is to be avoided for disc seeders as residue handling is significantly impaired in soft soil conditions. Longer term zero-till farmers indicated hairpinning problems decrease over time as soil physical and biological health improve under an integrated controlled traffic and full residue retention system[5].

While seeding rates can be increased to compensate for low seedling emergence, poor uniformity of crop establishment can remain an issue[5].

Stubble management for frost risk

High stubble loads can increase the severity and duration of frost events by reducing the amount of heat radiated from the soil at night, leading to lower canopy temperatures in the crop[6]. Stubble insulates the soil surface, which lowers the amount of heat absorbed into the soil compared with paddocks without stubble[6].

Trials conducted in WA low to medium rainfall zones into frost damage and stubble management[7] concluded that:

- Temperature variations, frost damage and yield were influenced more by position in the landscape than the implementation of stubble management practices.
- In moderate frost environments, higher stubble rates increased the severity and duration of frost events resulting in more frost damage and decreased yield[8].
- Stubble height had no effect on temperature, frost damage or yield when total stubble biomass was the same.
- Reducing stubble had no negative impact on gross margins in frost free seasons or severe frost seasons, but could improve gross margins in moderate frost seasons.
- Stubble management can be used as a tool as part of a frost management plan[7].

Reducing the amount of stubble to below 1.5 t/ha in low production environments (2-3 t/ha wheat yields) generally decreases the severity and duration of frost events. Other practices which may also reduce the risk of frost on high frost risk areas of the landscape are; rolling sandy soils after seeding, practices which assist in storing heat in the soil heat bank (same as those that alleviate non-wetting soils) such as clay delving, mouldboard ploughing or spading which have multiple effects including increasing heat storage, nutrient availability and infiltration rates. Other agronomic practices are halving the sowing rate which creates a thinner crop canopy with more tillers resulting in a spread of flowering time, or cross sowing which results in a more even crop and a more even plant density, so heat is released from the soil heat bank more slowly to warm the crop canopy at head height in early morning when frosts are more severe. Cross sowing, however, increases sowing costs[9].

Sowing a crop which is not as susceptible or has a lower risk, may also reduce frost severity. Pasture rotations are a lower risk enterprise and oats are the most frost tolerant crop during the reproductive stage. Barley is more tolerant than wheat at flowering, but it is not known if barley and wheat have different frost tolerance during grain fill. Canola is an expensive crop to risk on frost-prone paddocks, due to higher input costs[9].

Stubble management and herbicides

Herbicides differ in their binding to stubble residues and movement through the soil profile with soil water, which affects the uptake of the herbicide by weeds and the crop[10]. Stubble, existing weed cover and crop cover (for post sowing applications) in a zero or minimal till system will intercept some of the herbicide before it reaches the soil. The amount of herbicide intercepted will be proportional to the

percentage of ground cover. Interception can have two negative effects: herbicide can be tied up on the stubble or in the canopy and will not be available for weed control; and it can lead to uneven coverage on the soil surface lowering herbicide effectiveness and increasing weed escapes[10]. Soil texture and soil chemical properties can also affect herbicide movement and availability in the soil profile. Seeding systems and speed at sowing may also influence soil throw and hence herbicide movement in soil water.

Herbicides most affected by high stubble loads are trifluralin, triallate, pyroxasulfone, prosulfocarb and metolachor products. If grass weeds are an issue in paddocks with high stubble loads (greater than 50% stubble cover), removal of some stubble may improve herbicide activity and grass weed control. Other management options to increase herbicide activity in paddocks with high stubble loads include increasing chemical and water rates, using nozzle types to increase spray coverage, and reducing the height of the boom spray or stubble height so herbicides reach the soil surface easier and cover the soil more evenly.

See Guideline 4: Herbicide efficacy in cereal stubbles for more detailed information.

Stubble management and disease

Stubble borne diseases such as Take-all, Crown Rot, Yellow Leaf Spot, Eyespot and White Grain in wheat, and Barley scald, Barley net and spot form of blotch, will all have increased inoculum levels in an infected paddock with the retention of stubble. If the disease level was an issue in the previous season, a break from susceptible crops or stubble removal will reduce the number of spores present in that paddock in the subsequent year.

Every disease is different and may require a different management strategy, so know the factors which influence the disease inoculum and disease risk. Testing using PreDictaB may be useful if unsure of the disease and inoculum levels. Growing non-host break crops will help to keep disease inoculum levels low and grass weed control is also important for reducing cereal disease inoculum levels. Stubble management, removal by grazing, burning or cultivation, and seeding position may help with disease management. Fungicides may give economic control for some diseases, but not others[11].

See Guideline 5: Stubble management and cereal disease impacts for individual disease impacts and stubble management strategies.

Stubble management and pests

Changes in farming systems with increased stubble retention, continuous cropping, reduced tillage and reduced livestock numbers have provided a more favorable environment for certain pests within modern farming systems. Maintaining stubbles within crop rotations may increase potential pests, especially snails and mice, as the stubble provides shelter and a feed source.

See Guideline 3: Mice and stubble management on upper EP and Guideline 4: Snails and stubble management on upper EP for detailed management information.

Table 2 Yields (t/ha) and corresponding stubble loads (t/ha) in brackets[3]

Wheat	4.0 (7.4)	3.6 (6.7)	3.2 (5.9)	2.8 (5.2)	2.4 (4.4)	2.0 (3.7)	1.6 (2.9)	1.2 (2.2)	0.8 (1.5)
Barley	3.8 (6.8)	3.4 (6.0)	3.0 (5.3)	2.6 (4.6)	2.2 (3.9)	1.3 (3.2)	1.4 (2.4)	1.0 (1.8)	0.6 (1.0)
Oats	2.0 (6.0)	1.8 (5.4)	1.6 (4.8)	1.4 (4.2)	1.2 (3.6)	1.0 (3.0)	0.8 (2.4)	0.6 (1.8)	0.4 (1.2)
Canola	2.2 (8.8)	2.0 (8.0)	1.8 (7.2)	1.6 (6.4)	1.4 (5.6)	1.2 (4.8)	1.0 (4.0)	0.8 (3.1)	0.6 (2.3)

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