Profitable stubble retention systems for the HRZ

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KEY MESSAGES

- Crops can be established and grown in 6.6 t/ha of retained stubble in the HRZ without compromising establishment
- Stubble retention in the HRZ requires careful systems based planning and attention to detail
- Seasonal conditions will strongly influence outcomes of stubble retention through factors such as pest pressure and conserving soil moisture
- Burning may not be an option in the near future because of unacceptable risks of litigation

BACKGROUND

The high rainfall zone (HRZ) commonly produces high yielding crops due to favourable environmental conditions. High yields correspondingly produce high stubble loads. Using the standard harvest index of 40% grain and 60% straw, a crop yielding 8 t/ha is likely to produce approximately 12 t/ha straw. In 2013, yields of greater than 10 t/ha grain were experienced in trials at both Inverleigh and Westmere.

High stubble loads can cause several problems for growers in the following year:

- Seeder blockages which impact on plant establishment
- Provides an ideal habitat for pests to survive
- Interception of herbicide sprays especially pre emergents.
- Increases frost risk (Paterson 2014)
- Carry over of diseases, Yellow Leaf Spot (YLS), Take-all, Crown-rot,
- Increased potential for nitrogen tie up.

Further to this, the common practice of reducing stubble loads through burning is becoming less popular with the wider public due to concerns with fire danger, health and safety, air quality and greenhouse gas emissions. This has prompted our investigation into other avenues for utilising stubble as an opportunity rather than burden.

The SFS section of the GRDC stubble (BWD00024) aims to test and develop farming systems where retained stubble is managed in the HRZ without a reduction in profitability for the grower. To do this reliably, commercial harvesting and seeding equipment was used. Growers and advisors are leading the development of machinery and management practices and provide invaluable knowledge and experience to the stubble project. The stubble project draws on this knowledge and research from other regions to develop a systems that will be as profitable as traditional burning, baling and incorporation techniques in the HRZ.

Retaining stubble has many positive impacts for crop production systems across all rainfall zones. Retained stubble provides excellent ground cover (>2.5 t/ha) thus reducing wind and water erosion, increases rainfall infiltration, reduces moisture evaporation (>4.5 t/ha), eliminates the need to burn, bale or incorporate and recycles nutrients back into the soil. Successful stubble retention requires a complex approach that considers every aspect of the system and their resulting impacts. Below are all areas to be investigated in the five year stubble project. The 2015 SFS portion focused on harvest management, seeding equipment, establishment of crops and weeds, dry matter (DM) production, pests, yield and profit in the HRZ of western Victoria and Tasmania.;

- **Harvesting to retain stubble** – height, chopper and spreader setup
- **Fallow management** – weed control, grazing, paddock traffic
- **Rotations** – weed control, disease management, nitrogen, suitability for establishment in stubble
- **Seeding equipment** – trash handling, row spacing, inter row sowing, soil disturbance, fertiliser toxicity
- **Establishment and dry matter production** – yield, plant density, canopy closure
- **Herbicide application** – interception, water rates, crop safety, resistance, nozzle selection and spaces
- **Weed establishment and control** – IWM, soil disturbance, herbicide contact, crop competition

- Pests – IPM, monitoring, control strategies, rotations
- Yield
- Costs and profit

METHOD

The SFS maintaining profitable farming systems in retained stubble project initiated six on farm trials or demonstrations in 2015 as detailed below.

1. Stubble management impacts on performance of JD 1890 disc and Morris Contour tyne seeders

Aim
Determine the performance of wheat established with disc and tyne seeders into 6.68 t/ha wheat stubble in 2015.

Stubble treatments
JD disc – 30 cm high trash spread evenly across the swathe
Morris contour – 15 cm high trash spread evenly across the swathe

Assessments
Harvest efficiency, pre sowing moisture, seeder trash handling, establishment, seed depth, crop growth rates (normalised difference vegetative index (NDVI)), weed establishment, pests counts, disease, tiller counts, head counts, DM at flowering, yield and harvest efficiency.

2. Stubble management impacts on canola crop performance with JD 1890 disc seeder

Aim
Determine the performance of Canola established with a JD 1890 disc into 6,76t/ha wheat stubble in 2015.

Stubble treatments
a. 30cm high trash spread evenly across the swathe
b. 15cm high trash spread evenly across swathe
c. 30cm high stubble windrowed and baled

Assessments
Harvest efficiency, pre sowing moisture, seeder trash handling, establishment, seed depth, early crop growth rates (normalised difference vegetative index NDVI), weed establishment, pests counts, disease, DM at flowering and yield.

3. Demonstration of seeders to inform growers of seeder suitability for stubble retention

Aim
Demonstrate and discuss with operators seeder performance in a range of cropping scenarios.

Stubble treatments
Canola, harvest windrows burnt

Assessments
Seeder attributes, seeder trash handling, establishment, seed depth, early crop growth rates (normalised difference vegetative index NDVI), weed establishment, disease, tiller counts, head counts, DM at flowering and yield.

4 and 5. Impacts of harvest weed seed (HWS) capture techniques on HRZ stubble retention, Streatham and Inverleigh

Aim
Determine efficacy of harvest weed seed destruction techniques on weed establishment in the following year

Stubble treatments
a. Harvest at maximum height and burn stubble
b. Harvest at 15cm high, windrow trash and burn windrow
c. Harvest at 15cm high and treat trash with weed seed destructor

Assessments
Harvest efficiency, weed numbers, weed seeds above and below 15cm pre-harvest, windrow burning suitability in grazed and ungrazed sites, soil weed seed bank levels, weed establishment pre-sowing, pest quantities and impacts on crop.

6. Demonstrate and discuss boom spray design and setup for suitability in stubble retained systems.

Aim
Inform and educate SFS growers on design, setup, and management of current boom spray units for use in stubble

RESULTS AND DISCUSSION

Harvest management to retain stubble for disc and tyne seeders

Harvesting is a major consideration for successful HRZ retained stubble systems. Several key points have been highlighted by 2015 project work and in previous studies.

- Harvest height should match your seeders capabilities to get through it; eg. JD Disc 30 cm, Morris Tyne 15 cm
- 10% loss of harvest speed for every 10 cm you lower the comb height
- Minimize trash that covers soil to reduces blockages and improve pre-em herbicide efficacy
- Chopper and spreader setup is critical to minimize blockages
- Trash should be spread evenly across the header width
- Reduce traffic and livestock on stubble to leave as much standing upright as possible

Table 1. Harvest efficiency data SFS disc versus tyne trial 2015

Treatment	Speed (ha/hr)		Fuel consumption (L/ha)	
JD Disc, 30 cm stubble	8.43	a	5.7	b
Morris Tyne, 15cm stubble	6.62	b	7.8	a
LSD (p=0.05)	0.21	1.0		
CV	1.73	9.2		

Seeding equipment

Figures 1 and 2. (right) JD disc on 30cm spaces. Industry standard unit includes row cleaner (1), disc (2), depth wheel (3), press wheel (4) and slot closer (5). Excel, NDF, Serafin Ultisow and Boss all run similar units (left) Morris Contour tyne and press unit. There are many variations on this design but basics are all similar

SFS have conducted extensive work on seeding equipment performance in relation to stubble retention (see report 9.3 on the 2015 SFS seeder demonstration). Key information thus far from this work is:

- Crops were established successfully
- Each seeder has varying capacity to handle retained stubble.
- Discs as a rule handle higher stubble loads compared to tyne and press wheel machines.
- Wider tyne spacing across and along the bar will improve stubble handling
- Real Time Kinematic (RTK) guidance is a critical component for successful inter-row sowing
- Changing angle of sowing direction slightly can minimize blockages
- Guidance auto steer on seeder bars will improve inter row sowing
- Tynes and discs have varying degrees of soil throw and crop safety for pre-em herbicides
- Isolation of fertiliser from seed will limit seed burn

Establishment

No major issues were identified when establishing wheat and canola in wheat stubble for the treatments used in 2015. (see tables 2 and 3) Seed placement was more consistent in disc machines in all work done (data not presented). Emergence data in HWS trial treatments showed no significant difference.

Table 2. Establishment in SFS disc versus tyne trial 2015. Wheat in 6.68 t/ha wheat stubble with no significant difference in establishment for any treatment in middle of seeder or on the wings. A 12 t roller split plot treatment showed no significant difference.

Treatment	Establishment (middle)	Establishment (wing)
JD Disc, 30cm tall stubble	128.7/m2	144.7/m2
Morris Tyne, 15cm stubble	132.3/m2	149.1/m2
Roll	134.0/m2	142.2/m2
No Roll	127.0/m2	151.6/m2

LSD (p=0.05)=not significant.

Table 3. Establishment in SFS disc in stubble management trial 2015. Canola in 6.76 t/ha wheat stubble. No significant difference in establishment for any treatment in middle of seeder or on the wings. Two additional trials comparing burn and stubble retention showed no significant difference for establishment, data not reported.

	Plants/m² wing	Plants/m² middle
JD disc – 30 cm high harvest	31.6	35.5
JD disc – 15 cm low harvest	29	36.1
JD disc – 30 cm high harvest, windrow, bale	32.5	32.63

LSD (p=0.05)=not significant. No significant difference for split plot roll treatments.

Dry matter production

Dry matter production is a good indicator of crop vigour and plant health. NDVI has a strong correlation to dry matter and was used to determine if there were differences between stubble treatments. The trial work determined that taller stubble reduced NDVI in the early stages of crop growth (data not presented). This has been found in similar studies in other regions. DM at flowering was not found to be significantly different. This indicates that the taller stubble reduces early growth but plants compensate later on to even out any differences.

Pests

Trials were monitored for pests at regular intervals. Split plot rolling with a 12 m roller weighing 12 t in the disc versus tyne and disc in stubble management trials to determine the impact of this treatment on slug numbers. Slugs were very low in numbers in 2015 and no statistical data was collected from any trials.

High numbers of millipedes were evidenced but no seedling damage was recorded in any trials.

Weeds

Weeds emergence and survival were monitored in all trials. The sporadic nature of weed emergence limited the statistical significance of the data collected. In paired test plots comparing disc and tyne seeders at 2 sites there was on average 0.65 ARG/m2 in the tyne sown areas compared to 0.19 ARG/m2 in the disc areas (data not presented).

Harvest weed seed trials in a 3.4t/ha Bolac wheat crop showed 65% of weed seed were collected by the harvester in 2014 at Streatham. In a similar trial at Inverleigh in a short Hindmarsh barley crop 95% of weeds seeds were collected when crops were harvested at 15cm high.

Table 4. Weed seed capture for harvest weed seed capture trials at Streatham and Inverleigh

	Streatham HWS	Inverleigh HWS
	Comb height >15 cm (seeds/m²)	**Comb height >15 cm (seeds/m²)**
ARG	354	95
Giant Brome	80	-
Wild Oats	6.4	-
	Comb height <15 cm (seeds/m²)	**Comb height <15 cm (seeds/m²)**
ARG	230	5
Giant Brome	51	-
Wild oats	0	-

Yield

Yields were collected by growers from the yield monitoring equipment. It was prepared for analysis by Precision Agriculture (see table 5). Yield for the disc seeder in stubble management trials was not available at time of writing but no differences in DM at flowering indicates yields will be similar. HWS trials were not taken through to harvest as they were sown to canola and strips could not be windrowed. Seeder demo yields are reported in a separate report in this results book (section 9.3).

While not significant at a 95% confidence level there was a considerable yield increase for the disc seeder in the disc versus tyne trial. There was a significant yield increase (0.25t/ha) for the rolled treatment in comparison to the unrolled treatment. Burning stubble at this site in 2015 reduced yield by 1.55t/ha according to the data collected at harvest.

Table 5. Yield (mean of treatments) and harvester efficiency data in the SFS disc versus tyne trial 2015. Burn area yields average of all treatments (disc in stubble management yield not available at time of writing).

Treatment	Yield (t/ha)		ha/hr		L/ha	
JD Disc, 30 cm stubble	3.71	ns	8.43	a	5.7	b
Morris Tyne, 15cm stubble	3.16	ns	6.62	b	7.8	a
LSD (*p*=0.05)	0.57		0.21		1.0	
CV	10.39		1.73		9.2	
Burn disc average yield	2.22					
Burn tyne average yield	2.08					

Means followed by the same letter are not significantly different at a 95% confidence level

Table 6. Yield in rolled versus unrolled treatment SFS disc versus tyne trial 2015.

	Yield t/ha	
Rolled treatment (disc and tyne)	3.56	a
No rolled treatment (disc and tyne)	3.31	b
LSD (*p*=0.05)	0.21	
CV	4.88	

Means followed by same letter do not significantly differ.

Profit

The trial comparing a JD disc and Morris tyne seeders in stubble retention systems demonstrated that burning was not as profitable in 2015. Apart from the seeders each treatment received exactly the same agronomy plan and yields did not differ significantly (p>0.05). There are also small cost savings for the disc system from faster sowing speeds, higher harvest efficiency and reduced fuel costs (see table 7).

Table 7. Cost calculations for sowing efficiency, harvest efficiency, fuel use and yield SFS disc versus tyne trial 2015.

	Sowing	Yield	Harvest time	Fuel use	Total
Variation disc versus tyne	4.8 ha/hr*	0.55 t/ha†	1.81 ha/hr§	2.11 L/ha**	
Value of differences ($/ha)	2.10	135.85	13.23	2.53	153.71

**Contract sowing @ $45/ha. 12 m disc takes 35 hr less time over 1000 ha at 12 km/hr versus 12 m tyne at 8 km/hr*

†Red wheat valued at $247/t. Value of difference between disc and tyne treatments mean yields

§1.98 extra minutes per ha valued at $6.66/min ($400/hr contract rate)

***2.11 L/ha less diesel valued at $1.20/L. Financial estimates of cost not yet available.*

CONCLUSION

The results of work done in 2015 must be reviewed carefully and should be considered as one year's data from one set of seasonal conditions. HRZ conditions of long wet winter months and water logging could drastically alter results and stubble retention has proved less profitable in these seasons in some other studies.

The lack of slug pressure at all sites in 2015 is of particular concern and management strategies suited to higher slug pressure will be required in, or after, above average rainfall years. However, it is encouraging that all trials established in retained stubble with no significant differences in 2015. It is also encouraging that no yield penalties were evidenced. Other HRZ zones of Australia

have experienced similar results (Condon 2013, Baxter 2014).

From the SFS project work, adopting stubble retention in the HRZ is a viable option in conditions such as those experienced in 2015. Many growers have developed systems based approaches that maintain profitability at similar levels to traditional methods. Growers are leading the development of individually tailored systems based on their equipment and resources. There have been significant technological gains made with RTK guidance, boom spray setup, harvest spreaders, seeder design and fertiliser management in recent years and this is ongoing.

Traditional methods of burning, baling, mulching or incorporating stubble are additional operations not required in stubble retention systems. Harvesting at 15 cm high significantly reduces harvest efficiency and has potential to cause damage to harvesters from rocks that are common throughout the Western Districts. Harvesting at 15 cm also increases trash placed onto the soil surface that can increase potential for seeder blockages and inhibit pre-em herbicide efficacy.

There are many things to consider in successfully implementing a stubble retention system but early indications are that with careful management it can be as profitable as removing stubble, be it through burning or baling. Retaining stubble has been shown in many cases to reliably establish crops earlier as a result of an increase in availability of seed bed moisture. Timely establishment is a key factor in achieving yield potentials.

Conversely there are many potential problems that can accompany stubble retention. Fertiliser toxicity, interception of herbicides, herbicide crop safety, reduced early growth, nitrogen management, increases in pest and disease levels are all areas of concern. Many have been and continue to be addressed by early adopters. Potential adopters will need to consider each one carefully and implement a system that minimizes these risks.

Adopting a stubble retention system will require attention to detail and some growers may find it easier to continue to manage a traditional stubble burning or removal program. Mixed farms with livestock and a pasture phase will increase complexity. If restrictions on burning are enabled in the future, growers will be forced to change from their traditional burning practices. The additional cost incurred in stubble removal will influence how growers approach this in the future. Data from across Australia has shown stubble retention is a viable option in the HRZ and this GRDC funded work will better equip growers to evaluate all of the options available to them for adoption.

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