Fallow water impacts when harvesting with a draper front versus a stripper front in southern NSW

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Take home messages

- Stripper fronts offer growers the advantage of greater harvest efficiency in cereals whilst retaining the maximum standing stubble possible. This allows for improved retention of soil water over the summer and autumn fallow period.
- Draper fronts harvesting high in cereals also improves harvest efficiency and provides more standing stubble than short cut crops. This improves soil water retention in stubble retention systems.
- Differences in post-harvest stubble architecture between stripper or draper fronts are being measured to better understand impacts on capture and storage of soil moisture in southern NSW.
- Paddock-scale trials were conducted in southern NSW over the wet summers of 2021 and 2022 looking at stubble length and soil water differences for growers harvesting cereals with stripper or draper fronts in disc seeding systems. Data is being used in modelling with APSIM to enable extrapolation to other sites and against 30 years of climate data.
- Very wet seasons over the course of the project made research and data collection difficult when looking at soil water and fallow dynamics.

Background

Adoption of stripper fronts for harvesting cereal crops has increased over the last decade; perceived benefits include increased groundcover over the summer fallow, improved harvest capacity and improved crop establishment in disc seeding systems. By retaining high stubble loads, the aim is to improve soil moisture retention, creating a buffer against inconsistent fallow rainfall and providing more reliable conditions for crop establishment.

The differences in stubble architecture created by stripper versus draper header fronts is being investigated to better understand impacts on the capture of rainfall and storage of soil moisture, and ultimately fallow efficiency dynamics.

This project focused on the cereal component of the farming system in southern NSW. The aim was to address key crop establishment, development, and yield metrics, thereby facilitating decisions around the use of stripper fronts.

The strip and disc system

An objective of the research is to quantify if there is additional value in using a stripper front compared to a draper front in stubble retention farming systems when sowing with a disc seeder.

Some growers retaining cereal stubble have moved to stripper fronts for several reasons including more groundcover over the fallow period and during subsequent phases with low biomass crop types such as pulses and canola, increased harvest capacity and less hairpinning when disc seeding as thin tall straw and less/no chaff allows the disc to contact more soil surface than shorter cut draper straw.

This stripper/disc system is different to previous no-till stubble retention systems such as the draper/disc system where cereals can be cut high or low at harvest with the draper front or in the draper/tyne system where cereals are cut low at harvest and the seeder then inter-row sows through the standing stubble. Wider row spacings and accurate GPS guidance are critical for the success of these systems, especially in the tyne system, to allow the seeder to operate between the stubble rows.

A stripper front works differently to a draper front, whereby a rearward spinning rotor with rows of fingers pluck grain from the head. Approximately 85% of the grain is threshed in the front with tall standing stubble left behind. With a lower volume of plant material going through the harvester, stripper fronts can achieve significant increases in capacity and efficiency, especially in lodged crops whereby the fingers can remove heads without the need for processing large amounts of straw.

Harvest efficiency is improved through an increase in tonnes per hour and speed per hectare harvested as there is less residue to process and a reduction in threshing required. Growers have increased their harvest capacity with an improvement in timeliness, especially during a wet harvest where quality downgrades are likely and result in price discounts. A reduction in fuel cost and engine load is a major saving with growers stating they use half the volume of fuel per tonne harvested. Stripper front maintenance is generally low with a single gearbox and belt drive to spin the stripping rotor and grain-gathering auger. Stripping fingers will also wear and break when encountering sticks and rocks.

The Shelbourne stripper front can only be used to harvest cereals and some minor crops such as safflower and linseed and is not suitable for harvesting pulses or direct heading canola. As many growers need to harvest canola and pulse crops, the purchase of a stripper front can add additional costs to the whole farm budget. Keeping grain away from a high-capacity stripper front can be a challenge especially in high yielding seasons. Growers have addressed this by using additional chaser bin support whereby 2 chasers follow 1 harvester.

Grain loss is an issue that growers adopting stripper fronts need to manage. These losses generally occur at the header front or through the rotor. Kondinin Group analysis has indicated grain losses are increased when using a stripper compared to a draper front but much of this is related to growers seeking high capacity, for example 80–100 tonne/hour. Growers acknowledge this issue and measure grain loss using drop trays plus adjust settings and operating parameters to minimise losses. A more conservative harvest capacity of 40–50 tonne/hour has been found to minimise grain losses and allow harvest logistics to keep up.

Narrow row spacings, less than 200mm, are recommended to improve grain feeding into stripper fronts; the straw creates a constant wall of material pushing against the drum. This helps reduce grain loss from heads dropping under the front in wider row systems.

Other challenges include reduced pre-emergent herbicide options, mice risk, increased insect pressure in canola, and seeding through a thick mulch of straw. All of these issues are real but have been addressed by growers adopting diverse crop rotations, which is important in all stubble retention systems. These changes include sowing sensitive crops such as canola into pulse stubbles (not cereal straw) with the tall straw improving crop establishment with a disc seeder given less hairpinning.

Disc seeding – starting point

Disc seeding is the first step for success in stubble retention farming systems. Key outcomes include:

- Dry or calendar sowing without clods
- Retention of higher stubble loads at sowing and during low residue crop phases (pulse, canola)
- Potentially higher surface soil moisture at sowing and increased sowing window opportunity
- Allows adoption of narrow row spacings for crop competition while still retaining stubble

As with all systems there are compromises, such as a higher cost of maintenance, poor seed-soil contact due to hairpinning, poor penetration on hard soils and the seeding furrow left open. Growers have adapted their disc seeding configurations to overcome many of the issues outlined with a pro-active maintenance program and using aftermarket components that improve the precision and reliability of single disc seeding units. This includes adding hydraulic downforce, using sharp discs, replacing worn bearings and bushes, using a flexible firming wheel, seed tabs and crumbler wheels for consistent seeding depth and furrow closure.

Weed management programs are adjusted using double break pulse-canola rotations, croptopping, narrow row spacings, early sowing for crop competition and the adoption of harvest weed seed control (HWSC). Research by John Broster, Charles Sturt University and Michael Walsh, Sydney University, concluded that stripper fronts can collect an equal quantity of ryegrass seed as conventional fronts. This makes HWSC a viable form of non-chemical weed control. The biggest difference is the reduction in straw going through the header with a stripper, with Broster measuring 50% less plant material being processed.

Key differences between strip/disc and draper/tyne

- Tall cereal stubble
- Increased harvest capacity
- Reduced summer weed growth due to the thick mulch
- Sown with a disc seeder
- Narrow row spacings for crop competition
- Agronomy changes – early sowing, early nitrogen
- Greater risk of grain loss at the header front and through the rotor
- Disc seeder must be configured for accurate seed placement – sharp discs, hydraulic downforce, firming wheels, crumbler wheels, and furrow closure
- Reduced pre-emergent herbicide options
- Potentially greater frost risk with high residues – diverse rotations help mitigate the risk
- Canola is highly sensitive to insect pressure in stripper stubble, therefore sow after pulses

Key points using either strip and disc or draper and disc

- Harvest weed seed control is effective for reducing weed seedbanks
- Soil amelioration with lime and/or gypsum applications is required and strategic cultivation mixing lime to the depth of the acid band is critical in the first instance, followed by maintenance lime applications aimed at keeping soil pH ($CaCl_2$) higher than 5.5 and alkali moving downwards
- Diverse rotations are essential for stubble breakdown, nitrogen input, weed control, minimising disease
- Double break pulse-canola rotations are critical for nitrogen input, weed management and reduced insect pressure

Trial design

The work was undertaken as a collaborative venture between CSIRO, FarmLink Research, Charles Sturt University (CSU) and Grassroots Agronomy. The study was initially designed around four paddock-scale replicated trials located across southern NSW at Junee Reefs, Matong, Temora, Quandialla and Yuluma.

The sites represented a range of rainfall zones (low to medium) and soil types (red loam and vertosols) across southern NSW. In 2020, at all four sites, wheat crops were harvested with two contrasting header fronts (stripper and draper fronts) along strips of contrasting stubble heights. Each header front treatment strip, consisted of two header widths (2 x 12 metres = 24 metres), and three replications of each treatment strip (header front) was implemented at each site.

In each strip, two detailed measurement areas (each 30 metres long x 12 metres wide) were selected and monitored over the summer fallow (between harvest and sowing). In 2021 three of the sites (Yuluma, Quandialla and Matong were sown to barley and Junee Reefs was sown to lentils and not suitable for the trials. The three sites sown to barley were monitored during the winter of 2021 and summer fallow of 2021-2022.

Stripper and draper fronts were again used to harvest barley at Yuluma and Matong whilst the Quandialla site was flooded prior to and during the 2021 harvest, causing severe lodging and crop losses. In March 2022, two sites were re-established at Yuluma and Matong plus a new site established at Temora on a red chromosol in a wheat stubble.

The project measured and analysed the effects of stubble length and architecture on:

- Water capture, storage and conversion to grain yield
- Stubble breakdown rates
- Impacts on soil surface conditions, notably wind speed
- Canopy temperature
- Weed emergence, pest incursions and impacts on control measures required.

Grower-collaborators were engaged by the research team to conduct the paddock scale trials with their own farm machinery. All crops were sown with a disc seeder, consistent with the seeding system used by the participating growers. This reduced any establishment risk around stubble handling across a range of treatments.

Measurements commenced in 2021 and continued until harvest 2022. Additionally, CSU had ongoing trial sites from the previous three years. These were continued in 2021 and 2022 at Collingullie and Lockhart.

Trial outcomes

We were extremely fortunate to have some great collaborating growers that were able to establish seven large-scale experiments at very short notice following the project commencement in December 2020.

In the first year (2020-2021), the weather was favourable for measuring fallow moisture. The lack of rain in April, which followed good rain in February and March, provided an excellent scenario to examine differences in surface and stored soil moisture pre-sowing in 2021.

Two wet years followed that caused issues with data collection. By autumn-winter 2022, all sites were left unsown by the growers, with trafficability a major issue. CSU were able to maintain a site at Lockhart in 2022.

Overall, data was collected across the different sites in the fallow period of 2020-2021 and 2021-2022. CSIRO and FarmLink now have results from:

- chameleon sensors on the shallow soil water potential;

- soil temperature;
- the start and finish stubble weights (standing, flat totals) at mid-fallow and pre-sowing; and
- gravimetric soil water at harvest and pre-sowing.

At CSU, the focus was on windspeed and temperature data at different heights within the stubble. This data is expanding our understanding of stubble micro-climates. This team also took shallow Time Domain Reflectometry (TDR) soil water and temperature recordings and stubble weights mid-fallow and pre-sowing.

An important use for the field data is to aid the development of computer models that can extrapolate stubble architecture impacts on soil moisture to other sites across Australia and across different seasonal conditions. The aim is to understand, does using a stripper front add value, thereby supporting on-farm decision making.

Wet years

All sites received very high rainfall that has made both farmer and trial activities very difficult. Trafficability has been a major issue. The Yuluma and Matong sites were not sown in 2022 due to poor trafficability. Trial work was unable to be completed at these two sites, meaning end of fallow measurements were not able to be taken due to severe waterlogging, and differences between treatments would be unlikely.

In the second season of trials grain yield data was collected for the Matong and Yuluma sites. Unfortunately, there was no significant difference in yield between the stripper and draper treatments. This is likely due to the above average rainfall throughout the 2021 growing season that reduced any soil moisture differences between stripper and draper stubble.

The stripper and draper treatments did result in differences at the Temora site (not yet statistically analysed). As expected, there was more standing stubble dry matter found in the stripper treatments compared to the draper treatments. The opposite was true for “flat” stubble on the ground. The “flat” measurements showed more chopped up straw is spread on the ground following a draper harvest compared to a stripper front harvest.

The decomposition rate over summer was different at the Temora site. The draper treatment resulted in 7.1t/ha of stubble at the end of the fallow period, compared to 8.2t/ha for the stripper stubble treatment. This finding is consistent with industry observations that stripper fronts are useful for maintaining higher stubble loads over the fallow period. It is likely that the greater percentage of “flat” stubble from the draper front results in faster decomposition at ground level, where conditions are cooler over the hot summer months, and it is in contact with the soil.

Soil moisture results showed no significant difference across sites in year 2. The chameleon sensors at Temora show no major differences in soil moisture for most of the fallow period and this is consistent with the heavy rainfall received at this site. These sensors are designed to identify soil moisture changes at shallow depths near the surface. They would be useful in identifying early sowing opportunities in a dry year. Unfortunately, constant rainfall meant that both treatments were near or at field capacity for most of the fallow period.

Differences in soil moisture was shown in the 2020-2021 fallow period at the Collingullie site. At this site soil water content (SWC) data collected at 10cm depth was higher in the stripper treatment compared to the draper treatment. There were also differences in the rate of water loss post recharge events. The stripper treatment was slower to lose soil water and this supports the idea that higher stubble load systems will present more early sowing opportunities.

The Collingullie site also showed significant differences in wind speeds between treatments. At 10cm above ground in the stripper treatment the average wind run across the fallow period was 94% lower than in the draper treatment. The wind run differences between stripper and draper were reduced towards the end of the fallow period. This is likely due to stripper stubble degradation late in the fallow period. However, there were still significant reductions late in the fallow period and interestingly these differences were present post sowing.

Overall, the Year 2 data has been greatly impacted by above average rainfall across all sites. This has reduced the value of the trial data collected at most sites. Ideally this project would be undertaken in an average to below average rainfall fallow period. This would allow different stubble loads to have a bigger influence on soil moisture.

Data analysis and modelling by CSIRO is ongoing with a project report due by July 2023, which will be made available through the authors and GRDC information channels when complete.

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