Better residue management for more sustainable cropping

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Abstract

The lack of a clear economic driver is hindering the development of better residue management methods. However, recent published data from a Western Australian long-term trial shows a 10% yield improvement from retaining residue compared to burning, with a no-till seeding system. A survey researching growers' views and practices and fieldwork investigating residue manager efficacy and spread straw evenness are reported.

Media summary

There is an economic and environmental benefit in retaining crop residues. Growers think that improved seeders would help them retain residues.

Key words

Residue manager wheels, harvester spreader performance.

Introduction

Residue management is an old topic that has mostly viewed crop residue as something that must be retained to protect soil from wind and water erosion and as a surplus material for grazing or baling to 'make a buck', but otherwise is a problem. The main problem has been: how to sow the next crop without choking the seeder or adversely affecting the establishment. There are also disease carry-over and weed issues arising from retaining residues.

But there is an upside: crop residues are an essential resource in the formation of the stable soil organic matter that greatly increases the moisture and nutrient holding capacity of soil and improving the structure of many soils. There is also evidence that some of disease problems relating to residue retention and no-till seeding such as rhizoctonia, reduce over time.

We need to find clever new ways to manage residue to maximise the benefits and overcome the problems.

Western Australia's broadacre cropping industry has benefited from the change to no-till seeding systems during the 1990s, a farm machinery revolution that is currently being rapidly adopted through the other southern states. The benefits are both economic (in seeding timeliness, a reduction in moisture loss at seeding and over time on some soils, improved soil structure that has reduced tractor power requirement and made soils more tractable to in-crop operations) and environmental (with a reduction in wind and water erosion because the soils are less disturbed).

When no-till seeding is placed in a 'conservation agriculture' framework, however, it is found to be one of several elements necessary for a complete system, the others being (Dixon, 2003):

- More complete soil cover at all times with crops or crop residues;
- Diverse crop rotations; and
- Minimal soil compaction.

Diverse crop rotations' are an ongoing quest and the rapid development of controlled traffic is working towards less cropland being affected by soil compaction. Both of these areas of development can be shown to have economic benefits, particularly controlled traffic, where gains can almost immediately be demonstrated from reduced overlapping and therefore resulting in lower quantities of inputs being required. New crops, once the agronomy has been worked out and markets have been established, can be relatively assessed in economic terms and fitted into rotations.

More complete soil cover' is easier to achieve in places such as South America where there is a higher and more even rainfall than here where rainfall is strongly winter-dominant and annual averages are in the range 250-400 mm). In southern Australia, with a prolonged summer dry spell, the option of sowing a second crop may only be an occasional opportunity when there is summer rain, so residue is all that we have to cover soils.

The most ardent conservation minded growers are working hard at retaining their residue and making changes to their farming system to be able to do this. At the same time, with a boom 2003 crop leaving more growers with a residue-handling problem for their seeding equipment, many opted to burn.

The Western Australian No-Tillage Farmers Association (WANTFA) pioneered and promoted no-till seeding and the other conservation agriculture methods in Western Australia (WA) cropping areas, and currently (with GRDC funding) has a project titled 'Developing Innovative and Sustainable High Residue No-till Farming Systems'. The principal expected outcome is to find ways for the 'successful establishment of crops with high residue levels at sowing within a more sustainable farming system'. In April 2003, a survey was made of members and also to 'AgMemo' (a Department of Agriculture of WA publication) subscribers of the Northern Region.

Results

Survey of residue management practices

There were 270 replies to the survey. Tables 1 and 2 summarise some of the answers from the survey returns of the WA growers (88.5% of responses, the other 11.5% are from members in eastern States). The average number of years of no-till seeding among respondents was 7.1 years.

Table 1. Percentage of survey respondents with the following practices and seeding equipment.

Practice or equipment	Yes (%)	Practice or equipment	Yes (%)
Have sheep	84	23 cm most common row	30
Feedlot sheep	27	Disc seeders	10
Phase farm	71	Seeders with disc coulters	17
Graze crop stubble	87	Seeders with press wheels	69
Cereal cut height, 22.5-30 cm	87	Seeders with harrows	19
Spreader on harvester	51	Seeders with stubble tubes	16

Chopper & spreader	27	Seeders with ‘residue manager' wheels	4
Chaff spreader	22	Those using paired rows	5
Residue is sometimes a problem at seeding	72	Those who expect to be into CT within 5 years	30
Those who practice Controlled Traffic (CT)	7		

Table 2. The proportion of suggestions made by respondents to resolve the problem of residue management.

Suggested practice	Yes (%)
Machinery at harvest, such as choppers and spreaders	25
Cultural practices, including burning, grazing, accelerated breakdown of residues, short straw varieties, sow back to pasture, or wide row in following crop	25
Seeding machinery and practice	42
Other machinery options: mowing, harrowing, baling, discing in	7
Residue no problem, current practice OK	1

Field work with ‘residue manager’ wheels

Last winter the effectiveness of residue manager devices used on growers’ seeders was investigated, with video of operation and crop establishment counts. The effect of clumping was assessed by comparing affected and non-affected sections of row. Establishing crops were found to differ markedly in their ability to cope with residue clumping. In the worst case, lupin and canola plant numbers were halved. On the other hand, excessive surface cover was found to affect cereals less, with plant numbers perhaps reduced overall by around 10% when residue levels were high.

One grower’s disc coulter set-up on his tined seeder was checked but residue levels were insufficient for a fair test. Four other residue management devices designed to prevent stubble ‘bunching’ around the tine sowing legs were tested or are being developed in WA.

Stubble tubes’ are guards that reduce the tendency for stubble to catch around tines. These are cheap to use but must be correctly designed and fitted to be effective. Their lower ends must be in the ‘boiling soil’ at the base of the tine and there must be no dramatic change in their profile that might encourage hesitation in the movement of residue past the tine. They must also be well secured to prevent tine ‘chatter’ ‘kicking’ them off.

The other three devices have a rotary action. One is a ‘treadwheel’, a device patented by the USDA that is essentially a spiked rubber wheel that runs alongside of the sowing leg. The wheel is positioned so the spikes flatten out on the soil surface and hold the stubble in place while the tine passes through it. A prominent Western Australian seeding machinery manufacturer is making prototypes for use in trials in 2004.

The other two are ‘row cleaners’. The Yetter residue manager wheel, also designed in the US, uses small spoked wheels to clear residue from the surface ahead of the tine or sowing unit. Normally the units are paired and ‘handed’ to counter side forces. This works well with paired rows, the larger gap between the pairs giving more space for the removed residue to be placed out of the way of the sowing units.

The third device was developed in WA but is now being produced in Queensland by Gessner. It uses a wheel with broad flat ‘teeth’ to scrape the residue off the surface ahead of the sowing unit, but unlike the Yetter, has a ‘depth band’ to prevent it digging into the soil surface.

In general, both worked well but neither was able to adequately clear the row when operating through anchored, flattened stubble (typically produced on sheep tracks).

The higher residue loads this year are indicating that a variety of tooth length options may be necessary to cater for various stubble levels without excessive surface cultivation or wrapping of residue around the wheels. A WANTFA member’s seeder is being set-up to compare the three residue manager wheel styles over the entire seeding program in 2004.

Stubble distribution

During the 2003-04 summer, wheat residue sites on farms throughout the WA wheatbelt were measured for residue distribution. In this trial, growers cut wheat stubble at three heights, the aim being to then be able to test their seeding equipment in autumn 2004. One finding was that the distribution is poorer the lower the stubble is cut (see Figure 1).

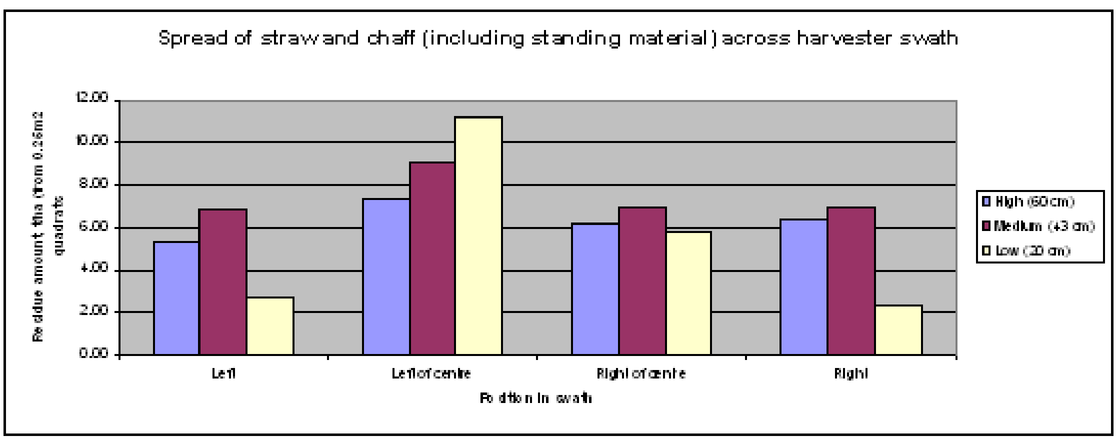

Figure 1. Spread of straw and chaff across harvester swath with different heights of cut

The uneven distribution of nutrients that occurs through poor spreading is something that will need to be addressed in controlled traffic systems. It is also visible in conventional harvest field patterns but could be corrected by starting the paddock every second year half a harvester front width in from the fence.

The need for an ‘economic driver’ for faster adoption of residue retention practices

DAWA published a very good residue management bulletin over ten years ago (Leonard 1993). There have been virtually no new practices developed since then, and some, such as the second cutter bar on the harvester, have almost disappeared.

Recently, a long term trial at Merredin has been reported (Riethmuller 2004) where the treatment of no-till seeding and retaining residue is showing a 10% yield benefit compared to where the residue had been burnt, on a red-brown sandy clay loam (in WA, a ‘heavy soil’). Soil organic matter has increased with stubble retention (1.21% total C) compared to burnt treatments (0.97% total C) (Hoyle 2004). Hoyle found that there were more microorganisms present and they were more active and there was also a greater quantity of N available for the crop from this activity in the residue retention treatment. There may well also have been a moisture conserving mulching benefit from stubble retention.

Translating those results to economic comparisons may help source research funding (Tullberg 2004) and adoption of better residue management systems. One simple analysis, based on the 10% gain of the 2.5 t/ha crop of this trial, an assumption that ten years would be required to get the full benefit, 1,000 ha of wheat would return an extra $17,500 on the fifth year average. This is, for example, similar to the cash outlay of equipping a 9 m wide seeder with 25 cm row spacing with residue managers costing $450 per row.

Conclusion

The fast rate of adoption of no-till seeding in WA had a clear economic driver and the bonus of environmental benefits. Similarly, the knowledge of an economic benefit would drive high residue farming systems. Decisions on adoption of and investing in better residue management methods and equipment would not then consist of grappling with a comparison between an ‘unvalued’ (in economic terms) ‘ideal’ with a current short-term problem.

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