Conducting an investment analysis on header fronts

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AT A GLANCE…

- The most cost-effective means of increasing standing residue and improving harvest efficiency is increasing harvest height with existing machinery.
- Stripper fronts are an economic inclusion to harvest machinery where they replace draper fronts.
- Improved harvest efficiency drives adequate cost reductions to generate good returns on investment in stripper fronts.
- The addition of any benefits achieved from additional income during a wet harvest by reducing the extent of quality downgrading adds further weight to an investment case.
- The projected returns in this analysis are sensitive to business scale. Reductions in scale lead to reductions in returns on investment.
- The assumptions are based on limited stripper front experience thus ground-truthing with more data will be required to draw conclusions specific to circumstance.
- The inclusion of a systems' specific benefits and reductions in the cost of wet weather at harvest will further improve the investment case for change.

THIS article is written from an economic rather than an agronomic perspective. The intent is to deliver a case study at a pre-determined business scale to demonstrate the process for conducting investment analysis on header fronts. An economic analysis is presented of the costs and benefits of the inclusion of stripper fronts to disc seeding systems.

Crop residue management

One of the intentional benefits of moving from a tyne to a disc seeding system is the benefit of retained crop residue resulting in improved soil moisture retention and improved soil structural characteristics. Plant residues provide physical benefits by protecting the soil surface as well as several biological and soil structural benefits resulting in greater water holding capacity of the soil.

Stripper fronts leave more standing stubble.

John Francis has developed a process for assessing the investment into draper versus stripper header fronts.

The minimal disturbance of soil in disc seeding systems is proposed to add further benefit by resulting in less soil disturbance. This reduces the chance of soil moisture losses at sowing and results in a lower volume of soil being disturbed thereby reducing depletion of soil structure.

Plant residue management and retention is an important component of a system intent on conserving moisture for subsequent crop growth. The management of plant residues is an important component of the system adopted.

The height that cereal crops are harvested can impact on subsequent seeding practices. Conventional harvest height (30–40 cm) can result in a significant proportion of the standing crop moving through the header and being redistributed over the paddock. This redistribution can lead to problems at sowing in disc seeding systems due to the redistributed straw being bent (hair pinning) and pushed into the furrow. This prevents soil to seed contact and reduces even crop emergence.

To overcome this issue some managers have adopted alternative harvest management tactics.

One of these tactics is to increase harvest height while another is to move from the use of a conventional header front to the use of a stripper header front.

TABLE 1: Draper versus stripper front analysis assumptions

Assumptions	
Total crop area	3000
Implement width (m)	12
Fuel cost ($/L)	$1.40
Harvest labour cost ($/hr)	$42
Harvesting hours per day	12
Servicing hours per day	2
Distance travelled per hectare (km)	0.8

An explanation outlining how stripper fronts work relative to conventional harvest fronts and highlighting some of the advantages and disadvantages follows. (This information is extracted from a paper by Broster, Rayner, Ruttledge and Walsh, 2018.)

Stripper fronts use rows of fingers on a spinning rotor to pluck grain heads and pods from mature crop plants. Compared to cutting and collecting the grain-bearing plant sections like conventional header fronts, stripper fronts leave more stubble standing.

By reducing the quantity of material being processed by the harvester, stripper fronts increase the speed and efficiency of harvesting. Anecdotal evidence suggests that stripper fronts are particularly effective in harvesting lodged and fallen crops, as the fingers can lift and remove the heads without the need for collecting large amounts of crop material.

The use of stripper fronts does have some disadvantages.

Tall standing stubble carries increased fire risk and requires sowing equipment which can clear the stubble.

Harvester settings need to be changed due to the decreased volume being processed, which requires some expertise and experience.

A faster harvest rate can have logistical implications – for example: more grain trucks may be required to keep up with the harvester.

Stripper versus draper front

An analysis of the marginal costs and benefits of a harvest system with a stripper front relative to a harvest system with a draper front has been conducted. Trial data from the flexible stubble management project (Swan *et al.* 2018) has been used for some analysis assumptions. Only the harvester and front costs and benefits have been considered in this analysis.

The comparison of the stripper front harvesting at a height of approximately 60 cm (stripper high) has been made with a draper front harvesting at conventional height of approximately 40 cm (draper low) and with a draper front harvesting at approximately 60 cm (draper high) to maintain as much plant residue standing as is practical with a draper front.

An identified constraint with harvesting high using a draper front is that it is improbable that the whole crop will be harvested at a height of 60 cm. The reason for this is that a proportion of the crop usually presents harvest feeding difficulties. This has been dealt with in this analysis by assuming that 80 per cent of the total cereal area can be harvested high while the remaining 20 per cent must be harvested at conventional heights and speeds.

Draper front harvesting was analysed at 40 and 60 cm cutting heights over 20 and 80 per cent respectively, of the harvest area.

One of the key advantages of raising harvest height is the ability to increase the speed of harvest. This improves harvest efficiency by increasing the number of tonnes per hour harvested. This occurs because the reduced residue requires less threshing thus more crop can be harvested at the higher speed.

This advantage expresses itself in cost savings by:

- Reducing depreciation. Fewer hours harvesting for the same harvested area results in additional ownership tenure with little marginal loss of machinery value.
- Reducing repairs and maintenance with the reduction in the amount of crop residue moving through the header.
- Reducing fuel costs. Fuel costs are reduced per unit of production and per unit of area due to the decreased horsepower requirements for threshing and due to the increased crop tonnage harvested per hour.
- Reducing labour costs. Typically, labour is charged on a rate per unit of time. Any increase in efficiency resulting in fewer hours for the same job results in a labour cost saving.

Analysis assumptions are provided in Tables 1, 2 and 3. Limited experience with stripper fronts in broadacre dryland crops forms the basis of some of these assumptions. Further experience will result in better quantification and greater confidence around the relative operational differences between header-front use.

The use of a draper front at high harvest heights reduces header hours by 10 per cent and header costs by 8 per cent when compared to the use of a draper front at low (conventional) harvest heights.

Given there is no capital cost to this change and significant benefit this should be the first step in improving standing plant residue levels.

The use of a stripper front at high harvest heights reduces

TABLE 2: Comparative harvest equipment capital and depreciation costs

		Header	Pick up front	Windrower	Header front	Header front trailer	Total
Draper conventional (40 cm)	Start value	$500,000	$43,500	$180,000	$105,000	$18,000	$846,500
	Years	4	12	10	12	10	
	End value	$300,000	$30,000	$108,000	$30,000	$16,000	$484,000
	Depreciation	$50,000	$1,125	$7,200	$6,250	$200	$64,775
Draper high (40 cm/60 cm)	Start value	$500,000	$43,500	$180,000	$105,000	$18,000	$846,500
	Years	5	12	10	12	10	
	End value	$300,000	$30,000	$108,000	$30,000	$16,000	$484,000
	Depreciation	$40,000	$1,125	$7,200	$6,250	$200	$54,775
Stripper high (60 cm)	Start value	$500,000	$43,500	$180,000	$110,000	$18,000	$851,500
	Years	6	12	10	12	10	
	End value	$300,000	$30,000	$108,000	$30,000	$16,000	$484,000
	Depreciation	$33,333	$1,125	$7,200	$6,667	$200	$48,525

TABLE 3: Variation in header performance at different harvest heights and fronts

	Draper 40 cm			Draper 20%of time at 40 cm & 80% at 60 cm				Stripper 60 cm		
Rotation crop	**Canola**	**Cereal low**	**Total/av**	**Canola**	**Cereal low**	**Cereal high**	**Total/av**	**Canola**	**Cereal**	**Total/av**
Speed (km/hr)	6.5	8.7	—	6.5	8.7	10.8	—	6.5	14.1	—
Harvest efficiency (t/hr)	19.5	40	—	19.5	40	50	—	19.5	65	—
Yield (t/ha)	2.5	3.85	—	2.5	3.85	3.85	—	2.5	3.85	—
Harvest efficiency (ha/hr)	7.8	10.4	—	7.8	10.4	13.0	—	7.8	16.9	—
Fuel use (L/ha)	6.4	7.5	7.1	6.4	7.5	6.6	6.7	6.4	4	4.8
Fuel use (L/hr)	50	78	66.8	50	78	85.7	68.9	50	68	58.4
Fuel use (L/t)	2.56	1.95	—	2.56	1.95	1.71	—	2.56	1.04	—
Grain loss (kg/ha)	50	50	—	50	50	50	—	50	50	—
Grain value ($/t)	$500	$249	—	$500	$249	$250	—	$500	$250	—
Harvest loss ($/ha)	$25	$12	—	$25	$12	$13	—	$25	$13	—
Area (ha)	1000	2000	3000	1000	400	1600	3000	1000	2000	3000
Crop area (% total)	33%	67%	—	33%	13%	53%	—	33%	67%	—
Harvest days	11	16	27	11	3	10	24	11	10	21
Rotor hours	128	192	321	128	38	123	290	128	118	247
Downtime	20%	20%	—	25%	25%	31%	—	30%	30%	—
Engine hours	160	241	401	160	48	162	370	160	167	327
Downtime hours	32	48	80	32	10	39	80	32	48	80

header hours by 23 per cent and header costs by 21 per cent when compared to the use of a draper front at low (conventional) harvest heights.

The economic comparison should not be based on the change from the draper front at conventional height to stripper front rather the change from the draper front at increased height as this option should be progressed first.

The bottom line

Given that there are large efficiencies to be achieved by moving from a draper front at conventional height to 60 cm, and that there is little to no associated capital cost, this should be the first step in increasing standing residue retention.

Based on the assumptions in this analysis the marginal investment in a stripper front, assuming that it replaces a draper front, is $5000. The annual benefit has been calculated by assessing the difference in costs between using a stripper front and using a draper front high. The marginal value of the increased operating efficiency over a 3000 hectares canola wheat rotation is $5.54 per hectare equating to $16,600 assuming the labour component is not a sunk cost.

This generates a return on marginal investment of over 300 per cent and suggests that the operating efficiencies alone are adequate to present a very good business case for investment.

Where the draper front is retained and a stripper front acquired in addition, then the marginal investment increases from $5000 to $123,000 with the same stream of annual benefits. This reduces the return on investment to six per cent which is just above the cost of debt funding.

This suggests that there is no business case for retaining a high value draper front if a stripper front has been purchased. The exception is where the marginal harvest efficiency results in quantifiable benefits during a wet harvest or where the stripper front brings quantifiable and unique systems' benefits. Additional investment of a magnitude of $80,000 with no additional operating costs results in the rate of return falling to 15 per cent.

This suggests that there is scope for the purchase of a lower cost draper front – or additional out-loading capacity – provided 15 per cent is still an acceptable rate of return.

Wet weather benefits

Increasing height and improving harvest efficiency may also lead to reductions in the cost of weather damage when it occurs.

FIGURE 1: Large time and cost efficiencies are achieved by increasing harvest height regardless of front choice

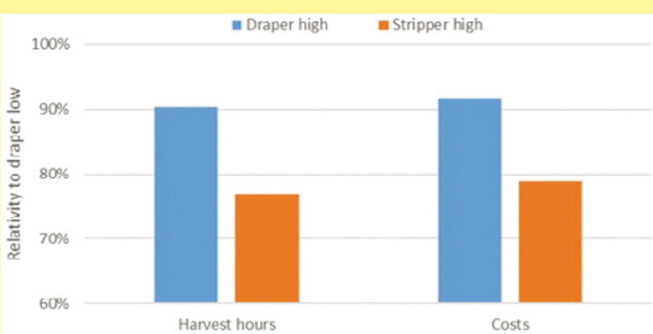
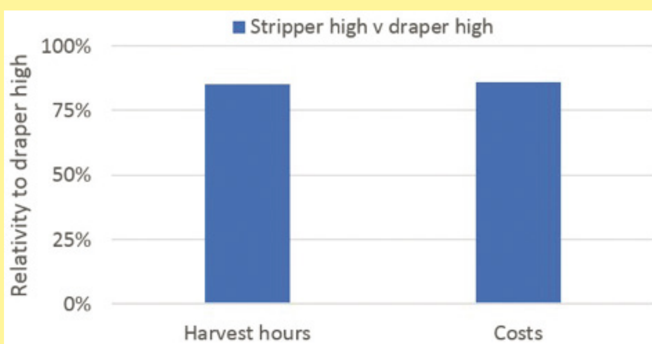


FIGURE 2: The marginal benefit of moving from a draper to a stripper front is 15 per cent in time saved and 12 per cent in cost savings



The value of these marginal benefits has not been included in this analysis.

For harvest efficiency to generate value by reducing the quantity of downgraded quality in wet harvests, management can't stop at the header front. The improved harvest efficiency only generates value in wet weather if the outloading machinery is matched to the increased header capacity.

In other words, there is no benefit in the header doing less hours if, from a weather damage perspective, it is consistently stopping and waiting to be unloaded.

In some cases, this will mean that additional investment must also be made in chaser bins, mother bins and trucks. The extent of the required investment will depend on:

- The capacity of the existing machinery;
- The marginal increase in capacity from the change in harvest height; and,
- The components of the outloading machinery that are owned by the operator.

Systems' benefits of harvest height

A systems-related benefit which is difficult to allocate specifically to the stripper front, is the contribution, over time, of additional standing residue to increased surface soil moisture. This, in theory, could generate more timely sowing opportunities with less emergence problems than systems retaining less standing residue.

Other costs

One study found that grain losses where stripper fronts were used were far higher than those where draper fronts were used for harvest. User experience suggests that improving understanding of how the losses were occurring and investing time in better machinery setup prior to starting can minimise losses regardless of front.

This is a management issue so the cost of grain losses has been assumed to be no different regardless of the header front used.

To sum up

The most cost-effective means of increasing standing residue and improving harvest efficiency is increasing harvest height with existing machinery.

Stripper fronts can generate solid economic returns on investment where they replace draper fronts and where scale is adequate. But they must be set up efficiently to achieve these benefits.

The outcomes of this analysis are specific to this case study, but the process can be followed to establish investment returns where assumptions from this case study vary.

This paper complements the analysis of the costs and benefits of disc versus tyne seeding equipment which is provided in the paper Swan et al. (2018) titled *'Flexible stubble management – how to reap returns to the bottom line'*.

Acknowledgements:
The conclusions delivered from the analyses are based on discussions and assumptions drawn from the following sources:

- **Trial data generated in the flexible stubble management project (Swan et al. 2018).**
- **Experiences of farm business managers with a range in farming systems, scale and farm machinery.**
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