

The Machinery Challenge - A cost comparison of machinery usage in four different farming systems.

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Introduction

The BCG-WFS Farming System Project (a comparison of 4 different farming systems) has created much discussion in the farming community over the last three years. Not surprisingly the centre of much of the debate has related to the profitability of each farming method. In 2002, work began to identify the key drivers of economic performance for each system. The first area of investigation was machinery!

While most farmers pay close attention and have a very good understanding of the dollar value that variable inputs (fertiliser, herbicide, seed etc) contribute to total farm costs, very few farmers give the same attention or have the same understanding of the costs associated with machinery. Given that benchmarks for the southern Mallee have indicated that the cost of machinery to a farm business is almost equal to those of variable costs, it is important that farmers work at understanding this area of their business at a more detailed level.

Costing machinery for each system within the farming systems project has been described as "mission impossible"! Conflict over the accuracy of using contract rates as well as the inability to use each champions own farm data due to differences in farm scale has made costing machinery an interesting process.

Background to the four systems

The four farming systems being investigated in the long term Farming Systems Trial are:

1. *Fuel Burners*: Paul Barclay- (conventional system including tillage, little or no stubble burning, low pulse intensity, fallowing for moisture).
2. *Hungry Sheep*: Ian & Warrick McClelland- (high intensity farming with livestock and cropping, no fallowing, tillage prior to cropping, pulses included in the rotation).
3. *Reduced Till*: Brad Martin- Brim Technology Group- (continuous cropping, some tillage, burning, stubble when required, pulses in the rotation, sheep when appropriate).
4. *Zero Till*: Alan Postlethwaite- (continuous cropping, including a wide range of pulses in the rotation, stubble retention, no tillage, wide row sowing, banding fertiliser, no sheep).

A novel approach to mission impossible!

A hypothetical farming situation was presented to each champion as follows:

- 1500ha within the southern Mallee to be farmed in accordance with the philosophy of their system
- Champions required to purchase machinery necessary to undertake major farm operations
- Asked to nominate a rotation that best reflected their current farming operation
- Management of these rotations was then based on a typical season.
- A machinery changeover policy (hours/years) for each piece of machinery was also nominated.

The plant: What machinery did they choose?

Fuel Burner: Paul Barclay pulled into the shed with a new 325 HP 4WD tractor (\$220,000), sufficient strength to pull his 12.2m (40ft) airseeder. Despite sowing the least amount of ground of all the champions, efficiency of operations made a triple box air-seeding outfit essential for the Fuel Burner operations (\$135,000 seeder & bar). The spray tractor of 150HP was purchased (\$115,000) in order to pull a brand new top of the range 28m, 4000L spray rig (\$80,000) - "brand is everything". For harvest, the purchase of a 2366 was made (\$228,000). Contractors are to be used to harvest any pulse crops.

Hungry Sheep: Ian and Warwick McClelland after shopping around came back with a 325 HP 4WD tractor (\$220,000) and a similar but slightly cheaper bar (12.2m) and seeding set-up as was purchased by the Fuel Burner (\$120,000). A new 150 HP 2WD spray tractor was bought (\$125,000) by the business along with a 24.35m 4000L trailing boom (\$55,000). Ian and Warwick also purchased a 2366 header for the end of season operations (\$228,000).

Reduced Till: A more conservative approach saw Brad Martin walk away from the machinery dealership with a 250HP 4WD (\$163,000) to pull his slightly smaller bar of 11m and double box seeder (\$123,000). The spray rig purchased was a 33m, 5000L boom (\$85,000), for which he bought a new 150HP 2WD tractor (\$115,000). For harvest, with the opinion "any colour would do" a 250HP header with 9.14m front, capable of handling his crop was purchased (\$228,000). Naturally we chose CASE IH!

Zero Till: Allen Postlethwaite decided that a 180HP 4WD (\$122,000) and a 100HP 2WD (\$77,000) tractor would be sufficient for undertaking his Zero Till operations. Allen also purchased a 9.14m chisel plough with 14inch spacings and a triple box air-seeder (\$125,000). A 27.4m, 4000L, spray rig was also purchased (\$80,000). To take the crop off a second hand 1680 header was purchased with approximately 3000hrs on the clock with the intention of turning it over at 4000hrs (\$110,000).

Cropping intensities varied across systems - Fuel Burners 60%, Hungry Sheep 73%, Reduced Till 86% and Zero Till, cropping 100%. Hectares sown to each crop type are indicated in Table 1.

Table 1. Annual hectares sown to each crop type by each of the champions.

Crop Type	Fuel Burner	Hungry Sheep	Zero Till	Reduced Till
Wheat	310	600	600	600
Barley	310	225	450	375
Peas	160			
Canola	120	120	225	150
Lentils		150	225	165
Fallow/Pasture	600	405		210
TOTAL	1500	1500	1500	1500

Results

Machinery Hours

Assumptions were made regarding travel speeds of the various machines with no allowances being made for differences in crop yield Appendix 1. Given the width of implement used, a work rate (ha/hr) for each piece of machinery was calculated. These work rates, were then able to be used to work out machine hours per operation within each system. From machine hour calculations machine replacement times were established.

In terms of operations throughout the year, each system varied in the amount of time spent on tractors, headers and spray outfits. Fallow preparation through cultivation rather than chemical fallow, was clearly indicated by the greater number of tractor hours being accumulated by the Fuel Burners 4WD tractor. In contrast, total reliance on chemical weed control in the Zero Till system was highlighted through tractor hours being substantially higher for the spray tractor as opposed to the bigger 4WD tractor. Hungry Sheep and Reduced Till tractor hours fell between these two extremes for both the 4WD and 2WD tractors (See Table 2).

Header hours accumulated across the farming systems were consistent with the cropping intensities nominated under each farming philosophy. Even less hours were accumulated by the Fuel Burner header, due to the use of contractors to harvest the pulse crops. Boom-spray, air seeder and bar hours worked were consistent with the 4WD and 2WD tractor hours. Machinery hours are presented in Table 2.

Table 2. Annual machine hours calculated for each farming system on hectares sown (Appendix 2), numbers of passes and machine capacity (size and speed).

	Fuel Burner (hrs)	Hungry Sheep (hrs)	Reduced Till (hrs)	Zero Till (hrs)
Tractor 4WD	637	311	256	182
Tractor 2WD	79	91	75	155
Header	106	157	185	215
Air Seeder & Bar	637	311	256	182
Boom-spray	79	91	75	155

Machinery Costs

i) Fixed Costs

The fixed cost for each piece of machinery includes the lost capital through depreciation and a 5% real interest cost on this lost value each year. Another cost that has been accounted for in the fixed cost figure, is an 'opportunity cost' of 5% for having that capital tied up in machinery as opposed to another investment. It is important to include this opportunity cost, even though each Champion would get some capital back at the end of the machines nominated life. Fixed cost calculations are presented in Appendix 3, 4, 5 and 6.

Per cropped hectare there was quite a large difference between the Fuel Burner and the other systems in terms of fixed costs. The Fuel Burner having a large capital expense spread over a smaller number of hectares sown.

Interestingly, when capital costs were spread over the 1500ha as opposed to cropped hectare the difference between the systems was reduced. Fuel Burners still however had the highest fixed costs at \$44/ha compared to \$37/ha, \$37/ha and \$35/ha for the Hungry Sheep, Reduced Till and Zero Till systems respectively (see Table 3).

ii) Variable Costs

Variable costs refer to the direct running costs of the machine and increase directly with machine use. Variable costs include repairs and maintenance, labour, fuel, lubrication, tyres, contract harvest and shedding. Costs assigned to each of these variables are listed in Appendix 1. Like fixed costs, variable costs were higher in the Fuel Burner operations, calculated at least \$16/ha higher than the other systems when compared on a total farm hectare basis. When compared on a per cropped hectare basis this difference increased to \$33/ha. Overall the Zero Till system has the lowest machinery cost on a hectare basis.

Table 3. Total fixed and variable costs calculated for each system

	Fuel Burner		Hungry Sheep		Reduced Till		Zero Till	
	\$/cropped ha /yr	\$/ha/yr	\$/cropped ha/yr	\$/ha/yr	\$/cropped ha/yr	\$/ha/yr	\$/cropped ha/yr	\$/ha/yr
Fixed Costs	73	44	50	37	43	37	35	35
Variable Costs	68	41	35	25	26	22	20	20
TOTAL	141	85	85	62	69	59	55	55

iii) Timeliness

A machinery cost often not thought of in dollar terms is 'timeliness'. A lack of timeliness of operations can incur a cost to the farmer indirectly in the form of either losses at harvest, or lower production than the farmer would have achieved with better timeliness of key operations. While a direct cost hasn't been allocated to each system in this instance, it has been considered by default by the champions through the machine capacity initially purchased.

Total costs

In terms of applying costs over cropped area the Fuel Burner system had the highest machinery costs followed by the Hungry Sheep, Reduced Till and Zero Till systems respectively. This trend was also found when costs were applied across the total farm hectares.

Discussion

Machinery Issues

Differences between machinery choice and use amongst the farming systems have uncovered a number of interest points of discussion. These differences have salvage value, timeliness and repairs and maintenance implications.

The bigger boom width used in the Reduced tillage system increased the work rate of the machine markedly. So despite acreage covered by the Reduced Till spray tractor being much more than that covered by the spray tractor of the Hungry Sheep system, the hours spent covering the same amount of country was much less (refer to Appendix 2). Theoretically, you would expect then at the same point in time in the future, the salvage value of the Reduced Till 2WD and spray unit would be more than an equivalent machine with a greater number of hours. During the same time repairs and maintenance would be less and there would also be a timeliness of operations advantage as well for the Reduced Till system. From another perspective however perhaps given the extra boom width there would be more wear and tear, resulting in a greater repairs and maintenance through the impact of rough ground and extra bouncing around over rough country.

Within the Fuel Burner operations, the reason for contract harvesting the pulse crops was to reduce wear and tear on the harvester and in the process maintain a significantly

higher salvage value at the time of trade in. While a greater salvage value was achieved, it did not reduce machinery costs greatly because of the tillage practices associated with this system. The machinery costs associated with this system were still the most expensive over both cropped hectares and over the entire farm. Whether or not timeliness advantages can justify this extra expense is debatable.

The use of contractors within the Fuel Burner operations also raises the issue of overcapitalisation. Despite using contractors and only harvesting 740ha/yr the Fuel Burner system still felt the larger header would be required. The question to then be posed is, can greater dollar returns be achieved from owning the larger machine compared to those achieved using a smaller machine. However in this case again timeliness is an important consideration.

There is also a timeliness cost when second hand machinery is being relied upon. This is particularly relevant to the Zero Till system, where harvest is reliant on a second hand machine. The potential down time through breakdowns is in theory a bigger risk for this machine than perhaps newer machines. Given that 100% of the farm needs to be harvested, what are the implications?

Comparing the machinery cost of each system has a number of implications for gross margins and the crop yield that must be achieved to recover costs. Before other variable costs are even taken into consideration such as fertiliser and sprays, the Fuel Burning system is already needing to achieve a return of \$141 per cropped hectare compared to a return of \$55 per cropped hectare for the Zero Till system. It is important to remember however that the Zero Till will have a greater variable cost bill, given the total reliance on chemical fallow and weed control.

Tax implications do arise through machinery ownership. While machinery should never be purchased with the sole intention of receiving a tax benefit, it is an important consideration when comparing each of these systems. While the Fuel Burner system has by far the greatest capital cost per hectare than the other systems, the system is also going to have a greater tax deduction through depreciation.

Take Home Message

While machinery ownership and management has its complexities, being aware of some of the aspects that directly impact upon its economic efficiency is a step in the right direction. Consideration of work rate efficiency and timeliness versus over-capitalisation and ultimate returns achieved by the system is very important.

The Farming Systems Project has identified that the cost profile of the different farming systems from most to least costly is, Fuel Burner, Hungry Sheep, Reduced Till and Zero Till.

Appendix 1.

Assumptions for Machinery Calculations

Travel Speeds

4WD 9km/hr-cultivation and sowing

2WD 18km/hr- spraying

Header 8km/hr- header

Working efficiency- Assumed 95%

Machinery Turnover

Maximum time to keep both 4WD and 2WD is 20 years given technology changes and its adoption.

Header contract rate

\$55/ha for pulses

Interest Rate

5% opportunity cost

Fuel Cost and Use

35c per litre of diesel given fuel rebate

4WD uses 45 litres per hectare (on average)

2WD uses 15 litres per hectare (on average)

Repairs and Maintenance

Tractors 5% of purchase price per 1000 hours

Headers 8% of purchase price per 1000 hours

Cultivator 3% of purchase price per 1000 hours

Boomspray 3% of purchase price per 1000 hours

Shedding

1-2 % of current machinery price (new)

Lubrication

Tractor 1% per 1000 hours

Header 1% per 1000 hours

Cultivator 0.5% per 1000 hours

Boomspray 0.5% per 1000 hours

Tyres

\$25,000 for set of tyres for 4WD tractor- replaced every 4000 hours

\$12,000 for 2WD tractor- replaced every 4000 hours

\$15,000 for replacement of header tyres

4WD-\$6.25/hr

2WD-\$3/hr

Header-\$3.75/hr

Appendix 2. Total hectares covered per annum by each machine.

	Fuel Burner	Hungry Sheep	Reduced Till	Zero Till
Tractor 4WD	6993	3418	2536	1575
Tractor 2WD	4085	4008	4434	7639
Header	777	1150	1355	1575
Air Seeder & Bar	6993	3418	2563	1575
Boom-spray	4085	4008	4434	7639

Appendix 3 Fuel Burner fixed and variable machinery costs

FIXED COSTS	Purchase Price	Expected Life (yrs)	Replacement Cost	Trade in Value	Depreciation	Annuity for Capital recovery plus interest	Interest on trade In	Total Annual Depreciation plus interest cost	
Tractor 1 325 HP	220000	8	220000	140000	80000	12376	7000	19376	
Tractor 2 150HP	115000	20	115000	40000	75000	6015	2000	8015	
Boomspray 94ft 4000L tank	80000	6	80000	50000	30000	5910	2500	8410	
2366 Header 30ft front	228000	15	228000	95000	133000	12808	4750	17557.9	
Cultivation Bar & Airseeder PTX 600 40ft 7.2 Inch spacings	135000	8	135000	85000	50000	7735	4250	11985	
\$/cr ha/yr	73							65344	
\$/ha/yr	44								
VARIABLE COSTS									
	Purchase Price	Shedding	R&M	Labour	Lubrication	Fuel	Contract Harvest	Tyres	Total
Tractor 1 325 HP	220000	3300	7006	7643	1401	10031		3981	33361
Tractor 2 150HP	115000	1725	455	950	91	416		238	3875
Boomspray 94ft 4000L tank	80000	1200	190	0	63	0		0	1453
2366 Header 30ft front	228000	3420	1938	1275	121	1860	8800	398	17813
Cultivation Bar & Airseeder PTX 600 40ft 7.2 Inch spacings	135000	2025	2579	0	430	0		0	5034
Sub-total		11670	12169	9868	2107	12306		4617	61537
\$/cr ha/yr	68.37								
\$/ha/yr	41.02								

Appendix 4- Hungry Sheep fixed and variable machinery costs

FIXED COSTS	Purchase Price	Expected Life (yrs)	Replacement Cost	Trade in Value	Depreciation	Annuity for Capital recovery plus interest	Interest on trade In	Total Annual Depreciation plus interest cost
Tractor 1 325 HP 4WD	220,000	20	220,000	110000	110000	8822	5500	14322
Tractor 2 140 HP 2WD (normally 2nd Hand)	125000	20	125000	27000	98000	7859.6	1350	9209.6
Boomspray 80ft 4000L	55000	6	55000	26000	29000	5713	1300	7013
40 ft Multivator & Triple Box Airseeder	120000	20	120000	60000	60000	4812	3000	7812
2366 Axial Flow 30ft front	228000	19	228000	75000	153000	12653.1	3750	16403.1
								54760
\$/cropped HA per year	50.0							
\$/ha /yr	36.5							
VARIABLE COSTS	Purchase Price	Shedding	R&M	Labour	Lubrication	Fuel	Tyres	Total
Tractor 1 325 HP	220,000	3300	3424	3735	685	4903	1945	17992
Tractor 2 150HP	125000	1875	571	1096	114	480	274	4410
Boomspray 94ft 4000L tank	55000	825	151	0	50	0	0	1026
2366 Header 30ft front	228000	3420	2868	1887	179	2752	590	11696
Cultivation Bar & Airseeder PTX 600 40ft 7.2 Inch spacings	120000	1800	1121	0	187	0	0	3107
Sub-total		11220	8134	6718	1215	8134	2809	38231
\$/cr ha/yr	35							
\$/ha/yr	25							

Appendix 5 Reduced Till fixed and variable machinery costs

FIXED COSTS	Purchase Price	Expected Life (yrs)	Replacement Cost	Trade in Value	Depreciation	Annuity for Capital recovery plus interest	Interest on trade In	Total Annual Depreciation plus interest cost
Tractor 1 250 HP	163000	19.5	163000	65000	98000	8104.6	3250	11355
Tractor 2 160HP	115000	20	115000	40000	75000	6015	2000	8015
Boomspray33m	85000	9	85000	55000	30000	4221	2750	6971
Bar & Airseeder	123000	8	123000	75000	48000	7425.6	3750	11176
Header 250 HP	228000	15	228000	75000	153000	14733.9	3750	18484
								56000
\$/cropped ha/yr	43							
\$/ha/yr	37							
VARIABLE COSTS								
	Purchase Price	Shedding	R&M	Labour	Lubrication	Fuel	Tyres	Total
Tractor 1 250 HP	163000	2445	2088	3074	418	4034	1601	13659
Tractor 2 160HP	115000	1725	429	896	86	392	224	3751
Boomspray33m	85000	1275	190	0	63	0	0	1529
Bar & Airseeder	123000	1845	3178	2223	199	1306	695	9445
Header 250 HP	228000	3420	1267	0	211	0	0	4898
		10710	7152	6192	977	5732	2519	33282
\$/cropped ha/yr	26							
\$/ha/yr	22							

Appendix 6- Zero Till fixed and variable machinery costs

FIXED COSTS	Purchase Price	Expected Life (yrs)	Replacement Cost	Trade in Value	Depreciation	Annuity for Capital recovery plus interest	Interest on Trade In	Total Annual Depreciation plus interest cost
Tractor 1 170 HP	122000	15	122000	60000	62000	5970.6	3000	8970.6
Tractor 2 100HP	77000	17	77000	41000	36000	3193.2	2050	5243.2
Boomspray	80000	3	80000	50000	30000	11016	2500	13516
Header	110000	5	110000	50000	60000	13860	2500	16360
2nd Hand (3000hrs 30ft								
Bar & Airseeder	125000	20	125000	60000	65000	5213	3000	8213
\$/cropped ha/yr	35							
\$/ha/yr	35							
VARIABLE COSTS								
	Purchase Price	Shedding	R&M	Labour	Lubrication	Fuel	Tyres	Total
Tractor 1 170 HP	122000	1830	1168	2298	234	3016	1197	9741
Tractor 2 100HP	77000	1155	596	1859	119	813	465	5007
Boomspray	80000	1200	371	0	0	0	0	1571
Header	110000	1650	1896	2585	118	3769	581	10599
2nd Hand (3000hrs 30ft								
Bar & Airseeder	125000	1875	684	0	0	0	0	2559
Sub-total		7710	4715	6741	471	7598	2242	29477
\$/cr ha/yr	20							
\$/ha/yr	20							