Mouldboard plough decimates ryegrass and wild radish seed banks

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Purpose:	This paper aims to summarise the grain yield response and weed control achieved by a one-off soil inversion.

TRIAL SITE

Table 1: *List of trials indicating which are replicated trials and which are not*

Replicated small plot trials	Replicated large scale trials	Un-replicated farmer demos
Preston	Cosgrove	Horwood
Mitchell	Ayers	Harding
	Holmes	Smart (MI)
	Forward	Smart (CV)
	Tathra*	Kenny *
	Mullewa RS	Fordham *
		Kelly
		Brennan*

** denotes trials conducted in West Midlands area.*

BACKGROUND

Several Western Australian grain growers now own mouldboard ploughs. They are using this machinery to renovate sandy soils. Soil inversion achieved with a mouldboard plough aims to deplete weed seed banks, correct water repellence and incorporate lime to depth to correct sub-soil acidity. More detailed research by Dr Stephen Davies (DAFWA Geraldton) is currently under way to more accurately evaluate a range of deep tillage equipment.

TRIAL DESIGN

This paper is a summary of results from seventeen different trial sites. There are twenty-seven yield comparisons from eighteen sites over four growing seasons. Some sites are replicated trials while others are farm scale demonstrations with low levels of replication. In all cases, the sites were ploughed with a mouldboard plough to a depth of 25 to 35 cm deep with skimmers fitted to give the best inversion results. Most of these sites were ploughed when the soil was moist between May and August and sown immediately with a cereal crop / cover crop. All sites are sandy soils with the exception of Mullewa RS which is red loam.

RESULTS

The average grain yield response of 27 comparisons across 18 sites was 391 kg/ha. Some of these are one year comparisons only whereas others are yield comparisons for two to three seasons after a one-off soil inversion. Some yield comparisons are from randomised trials while others are from large scale paddock demonstrations with low levels of replication.

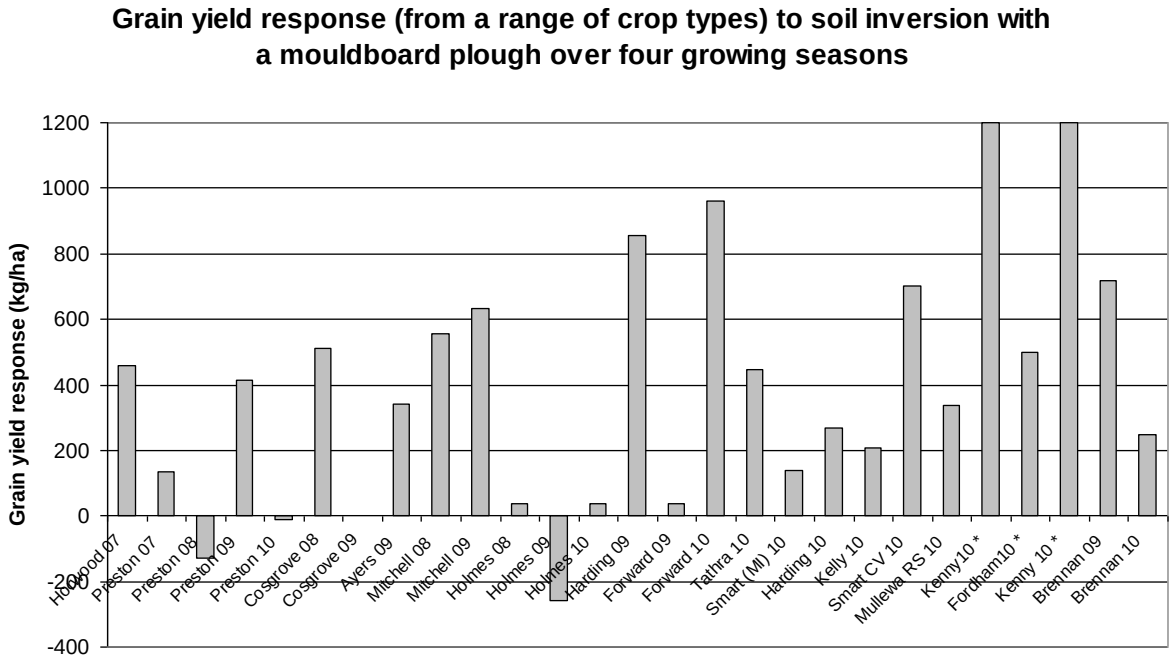

Figure 1: *Grain yield response from a range of crop types as a result of a one-off inversion with a mouldboard plough. Those marked with * are grain yield assessments made by hand harvesting.*

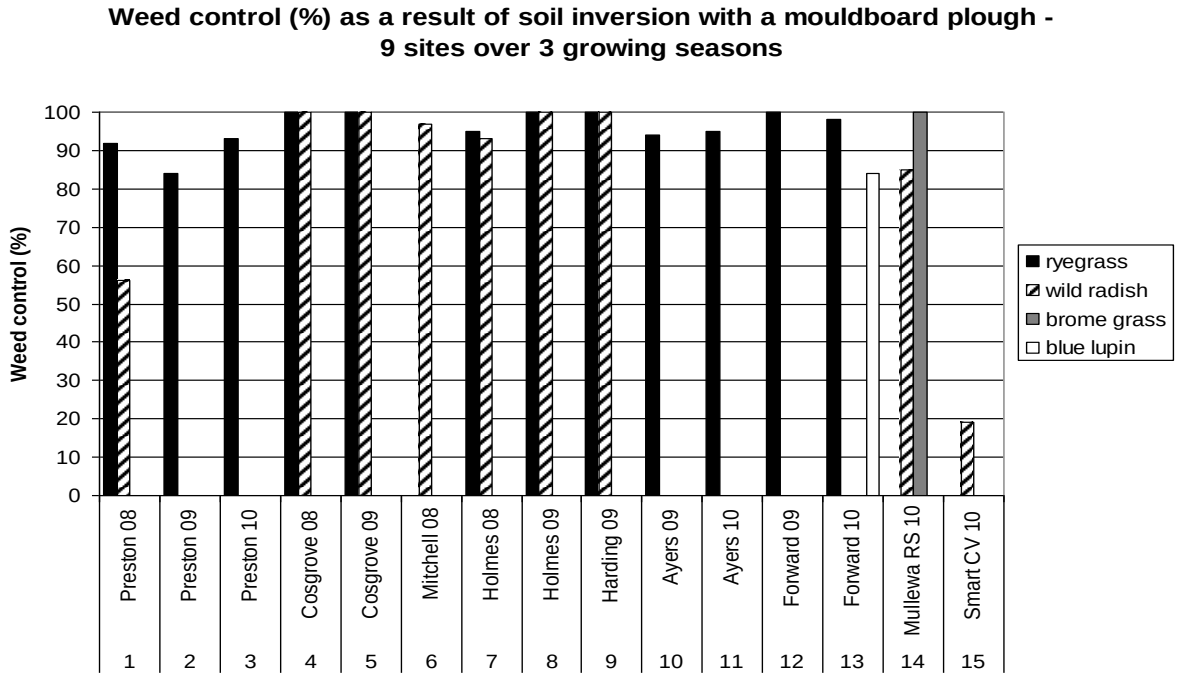

Figure 2: *Weed control (%) of four weed species as a result of a one-off soil inversion with a mouldboard plough. On average, 96% annual ryegrass (12 sites) and 83% wild radish (9 sites) control was achieved.*

FINANCIAL ANALYSIS

Several growers have estimated that the cost of mouldboard ploughing is $70 to $100 /ha. This takes into account all costs including purchase of plough, depreciation, labour, fuel etc..

DISCUSSION

The high level of grain yield response to soil inversion is very exciting. However, some sites have had little or no yield response while others have achieved an excellent yield response. The key to the future success of this technique is to improve our ability to pick responsive soil types to maximise the return on investment in this technology.

The very high level of weed control, which in some cases has been maintained for two to three years, is also very exciting. There is no doubt that a mouldboard plough has enormous potential to decimate a weed seed bank. However, it is imperative that the plough is set up correctly to achieve good weed seed burial. The Smart CV site is a good example of how it can go wrong. This site was ploughed in a rush during seeding in 2010 with a tractor that was not ideally suited to the plough (ie. not enough horsepower). Consequently, full soil inversion did not occur and many wild radish weed seeds were left in the topsoil. The grower knew this at the time but persisted with the trial to test the potential of the plough. This soil is extremely non-wetting and a very big yield response was achieved.

The Brennan site was established in 2009 at West Moora by Dave Gartner (AgLime) using the DAFWA three furrow plough to assess the potential for lime burial with a mouldboard plough. The site is deep yellow sand with moderate to high water repellence (water droplet penetration time 180 seconds). Treatment with the mouldboard plough corrected the water repellence (water droplet penetration time 0 seconds). The site was sown to wheat in 2009 and canola in 2010. Large yield responses were measured in both years. As yet there has been no response to lime.

In summary, all of the growers that have purchased mouldboard ploughs have been very happy with the performance of ploughed paddocks in 2010. Using a plough to invert the soil of a sandy, poor performing paddock every 10 to 15 years appears to be a fast, effective and economical way of renovating a paddock back to a point of high production. Of course this machinery will have its limitations and is not a universal panacea. However, our early studies are very encouraging. Research into this area is ongoing and will eventually answer some of the long term questions that continue to arise.

Some of the practicalities

Most of the growers so far have accessed machinery directly from Europe and then shipped it to Australia in sea containers. Some growers have purchased second hand ploughs for $30,000 to $50,000. These machines have been completely dissembled and cleaned to meet quarantine standards so there are many hours of assembly work involved. Some growers have accessed new machines for $90,000 to $130,000 for 9 to 14 furrow machines. The cheaper machines have sheer bolt break out while the more expensive machines have hydraulic break out. Sheer bolt machines have their limitations when it comes to rocks and stumps but have performed well nonetheless. All ploughs imported so far are reversible and so are suited to up and back ploughing.

A fourteen furrow machine can be set to cut 5.5 to 7 metres. They work to a depth of 30 to 35 cm at 8 to 10 kph. So the large machines can plough 4.5 to 7 hectares per hour at a cost of $70 to $100 / hectare (these are figures from growers). The power requirement is 30 to 35 hp per furrow depending on soil conditions and working depth. In good conditions a 450 hp 4WD wheel tractor can pull a 14 furrow plough but it will struggle in low soil moisture conditions. 4WD tractors often have the problem of the wide dual wheels running over the furrow which affects the depth and form of the first furrow. Track tractors are preferred for pulling large ploughs.

The large ploughs (12 to 14 furrow) have mainly been set up with a tool carrier that allows them to be connected to a large tractor without three point linkage. This allows the tractor to run on level ground. The smaller ploughs (8 to 11 furrow) are typically pulled by front wheel assist tractors in the 300 to 350 hp range with three point linkage. In this situation, one wheel of the tractor runs in the furrow.

There is clearly a large wind erosion risk immediately after ploughing. Paddocks should be sown to wheat for cover immediately after ploughing (preferably the same day). Wheat is more acid tolerant than barley and in many cases a profitable crop can be grown in the year of ploughing. Cereals are more tolerant to sand blasting than broadleaf crops and so are the obvious choice as a cover crop. Pay careful attention to seeding depth as it is easy to sow deep into soft soil. Rolling of the paddock is essential after ploughing unless your hobby is towing tractors out of bogs. Some growers are spreading seed / fertiliser and then rolling with coil packers to establish the wheat cover crop. Relatively light rolling (eg. coil packers) is all that is necessary to firm the top 5 to 10cm of soil after ploughing.

ACKNOWLEDGEMENTS

Many thanks to all of the growers involved in these trials and demonstrations. There are too many to mention individually, but we have covered a lot of ground in just a few years. Thanks also to Steve Cosh, Dave Nicholson, Trevor Bell and Larry Prosser for technical assistance.

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