Bed Farming – realising the profiles potential

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TAKE HOME MESSAGES

As we move into an era of unpredictable climatic conditions farmers are encouraged to improve their soil conditions to store more plant available water to facilitate greater water and nutrient use efficiency. Soil compaction and other hostile subsoil issues are limiting crop production throughout the country. The expansion of raised beds in broad acre now exceeds 40,000ha in south west Victoria alone, which has led to significant improvements in soil structure through the control of waterlogging. Controlled traffic and improved biological activity in the subsoil appear to be closely associated with the soil processes. The confinement of wheeled compaction through controlled traffic is delivering significant farm management and financial benefits.

Farmers cannot afford to not implement a Bed Farming System, either a raised bed or flat bed or combination of the two. There is now a great deal of evidence that says your farming system cannot evolve to its potential until you have adopted these simple yet advanced management systems.

Flat beds (CTF):

- Even with direct drilling, approx. 80% of a paddock will be covered by wheel tracks every season
- 80% of the damage to soil structure is created by just one wheel pass
- CTF limits wheeled compaction to 15-20% of a paddock
- One wheel pass at sowing reduced yield by 30%, while numerous passes reduced yield by 80%
- One wheel pass increased soil bulk density by and average of 10% in the 0-10cm zone, compared to a 20% increase with numerous passes
- Other benefits of CTF include improved trafficability, less input costs (fertiliser and chemical savings), reduced fuel bill, night operations, improved agronomy options, less driver fatigue and a simplified system
- CTF adoption exceeds 1,000,000ha across Australia – it is here and it is the future

Raised Beds:

- Raised beds in broad acre offer an excellent opportunity for controlled traffic cropping thus minimising the effects of compaction.
- Soil structure under raised beds has been measured to be different compared to flat paddocks and it appears that with time the differences become even greater
- The absence of compaction and the frequent wetting and drying of soils on beds would appear to be the main contributory factors to the improvement in soil structure
- Such soil structure differences have also been measured below the depth of initial tillage in the installation of beds
- The above changes have contributed to enhanced plant available water capacity on raised beds
- Such improvements should result in yield stability across years under changing weather conditions

INTRODUCTION

CTF is a smart, healthy cropping system, which delivers production and efficiency in an environmentally sustainable way to those who implement it. It literally means to control where you drive during cropping operations by driving along clearly defined, permanent wheel tracks, with the aim of minimising the area affected by wheeled compaction. By doing this we separate our paddocks

into sections, one which provides a healthy well structured medium for supporting crop growth, and one which provides the roadways for supporting vehicles and machinery. Raised bed farmers do all those things as part of their bed and furrow system. In fact we could refer to these systems as Bed Farming, some beds are flat others are raised!

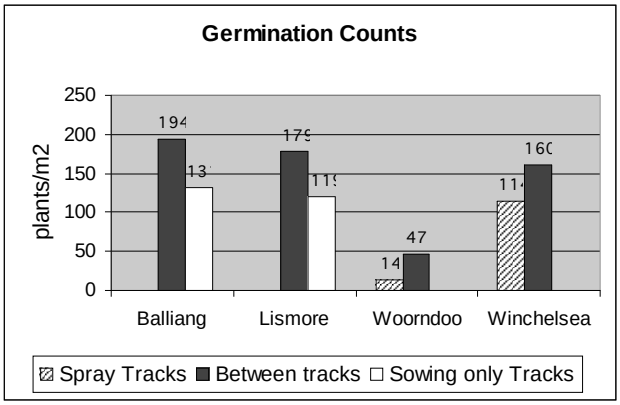
Work conducted by the southern grains team of the Victorian Department of Primary Industries has brought to light a number of benefits of bed farming systems. We have focussed on both flat beds and raised beds.

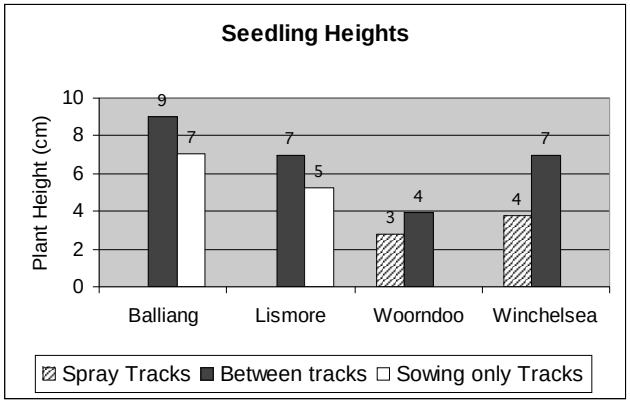
INVESTIGATING SOIL COMPACTION ON FLAT BEDS

Soil compaction costs agriculture up to $850 million every year in lost production. However, there are many farmers who are unaware of its presence. Managing compaction makes sense, and there is a lack of understanding, particularly in Victoria, about the effect it has on crop growth. In season 2004/05 DPI Precision Agriculture Agronomist Andrew Whitlock conducted a pilot study investigating the importance of CTF in Victoria through measuring the effect soil compaction on crop growth. The project consisted of four key case studies of CTF systems throughout south west Victoria.

The research component of this project aimed to quantify the effect of wheel compaction on crop growth. Measurements were conducted on four farms at different locations, lupins at Woorndoo and barley at Lismore, Winchelsea and Balliang.

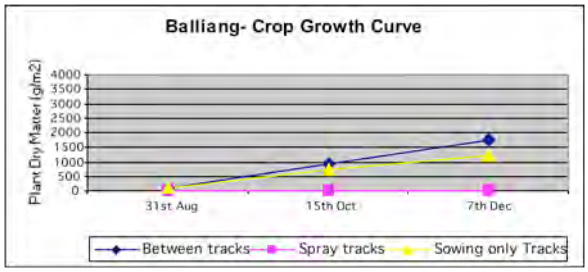
Crop Establishment:

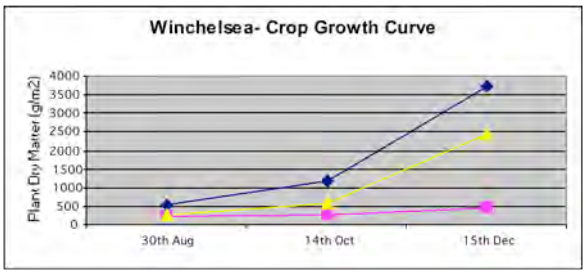


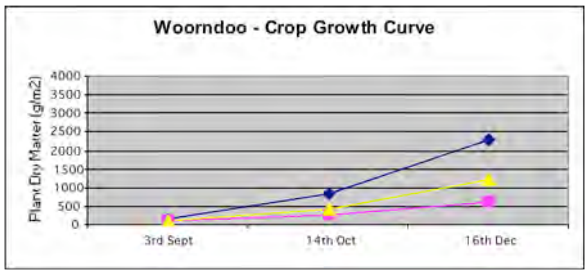


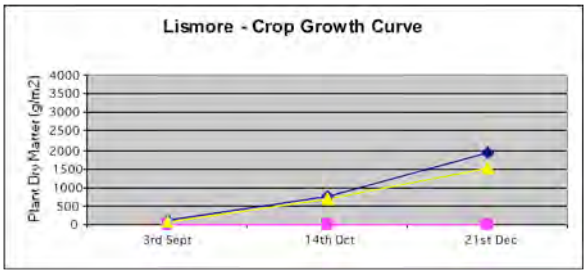
The average reduction in germination rates along wheel tracks was 30% for barley and closer to 70% for lupins. The seedling heights along the wheel tracks were also reduced at all four locations. The seeds not only struggled to penetrate the compacted surface, but eventual emergence was delayed and seedling vigour was reduced.

Crop Development:







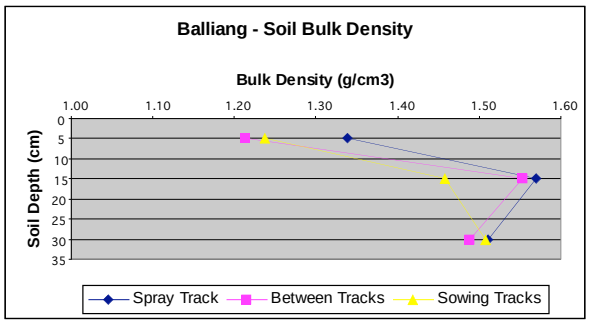


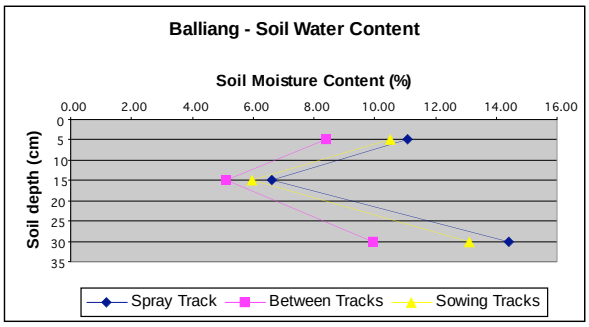
Crop growth measurements at three different times throughout the season (September, October and December). The crop growth rate along sowing only tracks was clearly lower than the corresponding growth of between tracks at all four sites and for each date of sampling. The differences varied between locations but were in the order of a 50-20% reduction of biomass along sowing only tracks. At Woorndoo and Winchelsea, the spray tracks were sown but this was not the case at the Balliang and Lismore locations, hence the incomplete data sets. The biomass measurements along the spray tracks were considerably lower than the corresponding measurements for both between tracks and sowing only tracks. This effect is apparently caused by the combination of compaction and physical traffic damage.

Tiller density was also reduced along sowing only and spray tracks, to a far greater degree than on the spray tracks. The data sets from all four locations confirm the theory that just one wheel pass can have a major effect on crop performance.

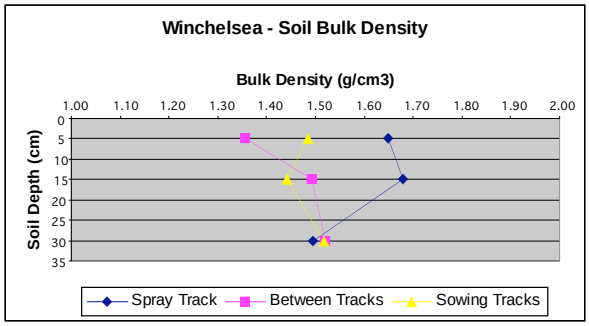
Soil Observations:

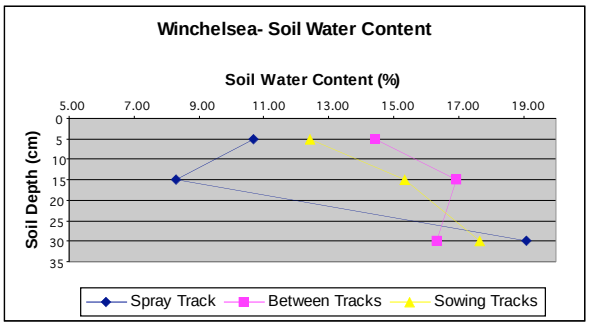
Balliang – The topsoil is a sandy clay loam with high levels of organic matter, overlying a light medium to medium clay subsoil. The subsoil wasn't found to be dispersive, however red and orange mottles were present throughout suggesting the prevalence of long-term, sub surface waterlogging.



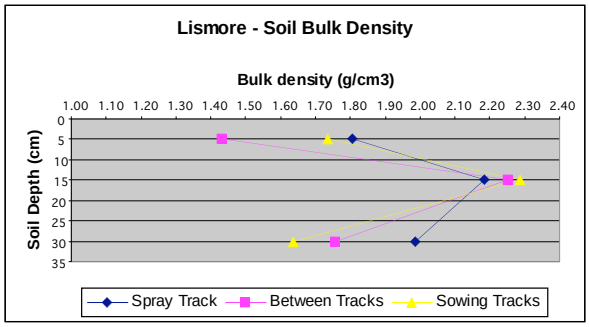


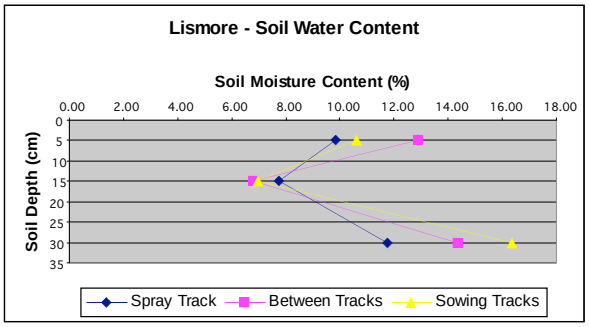
Winchelsea – duplex soil profile with A-horizon (0-25cm) consisting of a sandy clay loam and light sandy clay overlying a B-horizon with medium to heavy clays.



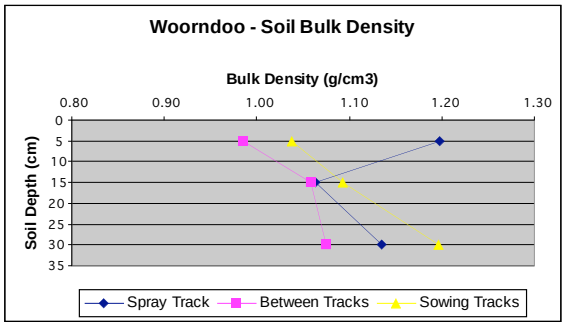


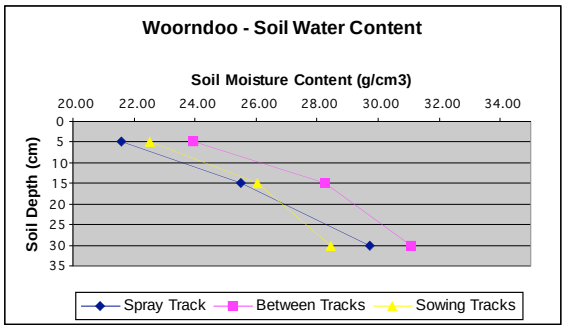
Lismore – Sandy clay loam with slight buckshot (0-5cm) over clay loam, sandy with increasing buckshot (5-30cm) over a sandy (30-50cm) and then medium clay (50cm+) subsoil. Significant buckshot levels (approx 50%) between 15-50cm.





Woorndoo – A unique soil type on lunette banks, a deep non-dispersive black cracking clay with light clay (0-30cm) over a medium clay (30-100+cm).



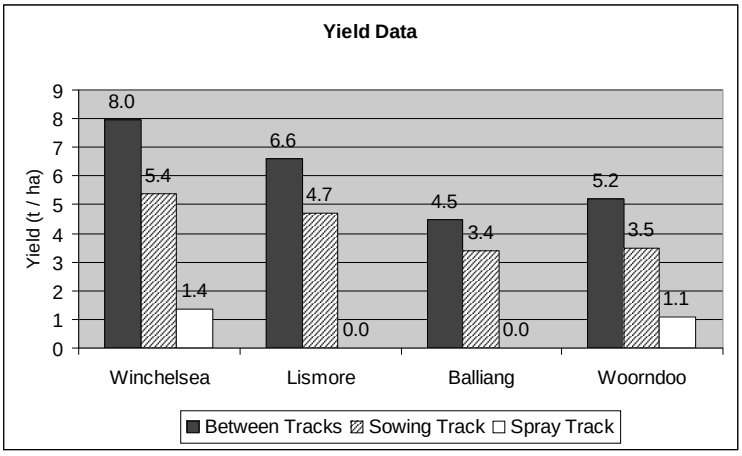


Average bulk density measurements (g/cm^3) from all four sites

Depth (cm)	Spray Tracks	Between Tracks	Sowing Only Track
5	1.5	1.25	1.38
15	1.62	1.56	1.57
30	1.53	1.46	1.47

The level of compaction caused by machinery was determined through the measurement of soil bulk density and soil moisture. These basic measurements highlighted the fact that random wheel traffic can compact the soil to a point where root penetration and soil water storage is severely limited. The measurements along the spray tracks (numerous passes throughout the year) showed bulk density readings exceeding the upper limit for root penetration of 1.6g/cm^3 at two of the four sites. The greatest impact was measured in the top 15cm. The one wheel pass at sowing also increased bulk density, thus limiting plant available water, at all four sites.

Final Yield:



This study of four different paddocks with different climate and soil types has found that one wheel pass at sowing will reduce crop yield by ~ 30% and numerous passes can reduce yield by ~ 80%. The yield reduction of spray tracks is a result of both compaction and physical traffic. The data highlights the damage that can be caused by just one wheel pass and the need to manage wheel compaction.

CONTROLLED TRAFFIC ON RAISED BEDS:

In southern Victoria, soil structure continues to be monitored for over eight years since the development of the raised beds. On the shrink-swell clays of the basalt plains, the absence of compaction (with controlled traffic) and minimum tillage are delivering a range of soil benefits to farmers that has resulted in the rapid uptake of raised beds in areas prone to winter waterlogging. The beds also offer an excellent opportunity for wetting and rapid drying of soil, which favours the rapid development of aggregates in certain soils. While we are not able yet to partition the effects of effective drainage, controlled traffic and minimum tillage, it is certainly a combination of these factors that are responsible for the enhanced crop yield on raised beds that is experienced in southern Victoria. These changes have, over the years contributed to yield stability in the region despite erratic weather patterns (Bruce Wightman and Renick Peries).

CONCLUSIONS

Cropping systems across different landscapes and soil types are suffering from soil compaction. Compaction is a continuous process ultimately resulting in a loss of soil macro-porosity, leading to low storage/supply of water and oxygen, and increased soil strength. This investigation of the effect of wheel compaction on crop growth supports the need to actively manage soil compaction. Wheel compaction reduced crop establishment leading to poor crop growth and reduced crop yields at all four sites. A single wheel pass at sowing increased the bulk density of the topsoil at all four sites, limiting root penetration and plant available water.

Controlled Traffic Farming, with or without raised beds, is generating a lot of interest and is being widely adopted across Australia. The benefits are delivered through a range of areas of crop management such as time efficiencies, making life easier, improved soil health, better crop growth and higher yields, increased accuracy of operations and reduction of inputs.

ACKNOWLEDGMENTS

Thanks for the cooperation of the four farming families involved with the soil compaction project. Particular thanks go to David Jamieson, Tom and Sam Dennis, James Bufton and David Langley. Thanks must also go to DPI-Victoria colleagues Renick Peries, Bruce Wightman and Chris Bluett for supporting the research.

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