Raised Bed Farming - the end of waterlogged soil and salinity? Grower Experience

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Overview:

- Phillip Adams has been working on raised bed farming for the past seven years and is convinced the system has significant benefits.
- Raised beds increase the quantity of organic matter in the soil which is of great importance in improving soil structure and promoting germination and growth.
- All land is suited to raised beds, however paddocks where excess water is a problem (eg. sodic soils prone to waterlogging) will benefit the most. The aim of raised bed farming is to produce loose soil beds where water can drain off to prevent waterlogging in the root zones, to provide adequate drainage, and to store excess water for use when conditions turn dry.
- Raised beds drain and aerate the soil, allowing the retention of porosity and avoidance of waterlogging and subsidence when wet as excess surface and ground water is drained from the bed.
- Properly constructed and farmed raised beds are virtually permanent.
- Seeding difficulties can include poor seed placement, difficulties with seed/soil contact (especially canola), the need to modify equipment (including wheel tracking) and increased weed infestation.

Introduction

I first became interested in raised bed farming about seven years ago to aid in the drainage of some very flat sodic ground prone to waterlogging almost every year.

A trial was carried out with raised beds and no beds over a 35ha paddock. Canola was planted in the trial under very wet conditions. There was surprisingly good germination and the crop on the raised beds was outstanding. So for the last seven years since the trial I have been working on the best way to lay out large scale raised beds integrating existing farming equipment.

What are raised beds?

Raised beds are loose, deep seed beds which are both porous and soft, which drain excess water and remain drained and aerated. Undisturbed roots from previous crops and organic matter achieve the looseness and porosity on the raised bed.

Raised beds are 30cm deep and have furrows spaced every 6ft (1.83 m). The furrows act as drains and traffic lanes for all farm machinery.

It is important to note that while the furrows take up a proportion of approximately 25% of the paddock, the yield of a paddock using raised beds will still be approximately 20-30% higher than the yield of a conventioonal paddock. The yield should also increase over time as the organic matter in the bed improves and the weeds generated by newly furrowed beds are brought under control.

What are the benefits of raised beds as opposed to normal beds?

- Raised beds are less dense than normal beds, and as such, plant roots can explore a greater volume of soil.
- They also increase aeration of the root zone for the plants.
- They are soft when moist, with little load bearing capacity.
- They drain and aerate the soil, allowing the retention of porosity and avoidance of waterlogging and subsidence when wet as excess surface and ground water is drained from the bed.
- They increase the water holding capacity of root zones as they are able to absorb 3.5 times more water than normal seed beds.
- They have a substantially greater store of plant available water.
- They control traffic by using furrows as traffic lanes and drains.
- They assure machinery access in wet weather.
- They let the rain leach sodium from the root zone which prevents salinity.
- They let gypsum work as it is intended by flocculating clay particles thus increasing the micropore size.

How do raised beds work and what properties do raised beds require to work properly?

Raised beds increase the quantity of organic matter in the soil which is of great importance to improving soil structure and promoting germination and growth. Traditional gypsum treatments are only a relatively short-term solution in the improvement of soil structure. It is important to use gypsum to accelerate the build up of organic matter in the soil to increase the organic carbon, 12-15 ton/ha of drymatter is required to increase the organic carbon by 1%.

The increase of the organic matter in the soil profile increases the resilience of the soil to compaction, develops passages for water filtration, increases macropore size to allow carbon dioxide to exported to the atmosphere and be replaced by oxygen. So, when we develop raised beds we must also try to direct drill into previous years stubble to accelerate the build up of organic matter. Increased rates of nitrogen fertiliser in the first few years would be used to break down the previous year's stubble. It is noticeable that stubble breaks down very quickly in a soil which is high in nutrients and well oxygenated.

When direct drilling into the beds you are sowing into the same rows as the previous years thus creating a micro-climate in which the seed has an excellent chance of germination.

A well constructed raised bed also has drains with enough slope to remove excess water after rainfall events and prevent ponding.

What land and crops are suited to raised beds?

All land is suited to raised beds, however, paddocks where excess water is a problem will benefit the most as previously waterlogged soil will become useable. It is important to be aware, however that yield increases have also occurred in drier years because roots can better utilise the scare moisture.

All crops can benefit from this approach. I trialled raised beds with canola and wheat. However farmers in Western Australia have trialled a number of crops with extremely good results. These crops included wheat, canola, lupins, peas, oats and barley.

Raised beds are being trialled across the country. About 25000ha of land in Victoria is now under raised beds and over 10000ha in Western Australia. The area is increasing at a very rapid rate.

Construction of raised beds; method and timing.

When considering installing raised beds it is necessary to conduct soil tests and examinations and know the nature of the soil profile to a depth of 20cm. In particular knowledge is required of the following:

- The presence of gravel, roots and stumps, rocks or hardpans and clay. This will affect the depth to which to soil can be ripped and cultivated and will impact on the type of machinery used and the timing of construction.
- The density and dispersibility (or sodicity) of the soil. Sodic soils need to be stabilised in the short term by an application of enough gypsum to stabilise the soil in the beds.
- The soil moisture content. Beds are best constructed when moisture is at an optimum level. Soil moisture is usually nearer optimum in the spring and construction of beds in the spring usually fits in with other farming and spraying cycles in time for the next crops.

Properly constructed and farmed raised beds are virtually permanent. Due care in their construction will ensure immediate, effective performance and minimise the need for subsequent maintenance.

The primary goal in constructing raised beds is to optimise their porosity so that they have the required properties immediately. Subsequent attempts at renovation with stubble present will be difficult.

Secondary goals should be to minimise the risk of wind erosion during and after their construction and to control the weed growth stimulated by the disturbance caused during the construction.

The steps involved in bed construction are:

- Check the moisture content of the top 20cm of soil which is at or slightly less than the optimum which is the plastic limit of the moisture content at which soils with clay in them can be rolled into a thread of about 3-5mm diameter.
- Spread gypsum if required
- Rip and or chisel plough to top 20cm of the soil
- Form beds with a Furrower-bed - former (lister rig)

What machinery is required?

The key machinery required in the construction of raised beds is as follows.

- A ripper to rip the soil, in undisturbed soils to a depth of 20cm.
- A chisel plough to cultivate soil to a similar depth.
- Furrower-bed-former.

Trials have shown that the ideal equipment would be a 3-point linkage (tool bars). Tool bars can be used for all operations of ground preparation by the addition of different equipment for each operation.

Harvest equipment.

Modifications need to be carried out on the harvest equipment so the wheels track in the furrows.
Suggested modifications are as follows;
3.66m centres for bed 1.8 (6ft)
18" Drive Tyre (.45m)

Based on 9650 John Deere:

Header:	11.4 ton
Platform (front):	2.1 ton
Grain weight:	6.5 ton
Gross Weight:	20 ton

Front axle needs to carry 12 tons, (60%).

Rims 13x33 type RWH Earthmover rim.
Tyres 18R33 Michelin XOT E4T R Dump Truck Tyres.
At 50 psi rated at 10ton per wheel 2x 20 tons.
Safety factor 1.67

Raised beds, waterlogging and excess **water.**

Waterlogging occurs when the air filled spaces of the soil are reduced so that drainage to the land is halted. The maximum absorption capacity if the soil is reached. Any additional rain is run off. Water Use Efficiency (WUE) decreases dramatically in a wet year due to waterlogging.

The desire of raised bed farming is to produce loose soil beds where water can drain off to prevent waterlogging in the root zones, to provide adequate drainage and to store excess water for use when conditions turn dry. Properly installed raised bed furrows must have a slope which ensures the excess water entering them drains off the paddock. The beds must drain within two days. A plant is waterlogged if field capacity is reached for more than six hours.

The safe control and disposal of the water is essential. Therefore catch drains must be regularly spaced at right angles to the direction of the beds to conduct excess water safely to a drainage line or dam. The best form of cross/catch drain is a 'W' drain. The central spoil provides access which is always above the water line, and this access can be used for seed and fertiliser supplies during seeding and field grain storage during harvesting. Catch drains are recommended every 600m or so along the length of raised beds.

Waterlogging also raises the issue of compaction. A sheep weighing 25kg would exert a pressure of about 60Kpa or more per hoof, enough to deform moist soil, when wetter than field capacity. Raised beds with loose soil and adequate drainage are less susceptible to compaction and maintain their form when used for pasture. (Not recommended because of the compaction caused by the livestock, feed should be cut and feed separately).

What are the seeding difficulties on raised beds?

There have been two major problems experienced in trials in WA. The first is enhanced weed infestation particularly in freshly formed raised beds. My experience was similar to this but because of the lower than average rainfall the weeds were mainly confined to the furrows.

The second problem experienced in WA was that one year unusually soft soil in moist raised beds led to deep seed placement and poor establishment. My experience of this was not of seed placement but of seed soil contact, especially with the canola seed.

Raised beds require crops to be established by the no-tillage practice. This requirement combined with the nature of the raised beds creates very different seeding challenges compared to those normally experienced. These differences are:

- Raised beds are approximately 30cm high, from the base of the furrow.
- The soil in them remains soft. (The roots of previous crops retained by no-tillage crop establishment practice, and their drained, aerated and totally untrafficked state ensures the beds remain loose.)
- The total and precise traffic control imposed by the furrow creates a row-cropping situation. Crops with the same row spacing are sown in precisely the same row as the previous crop.

The particular seeding challenges presented by raised beds are therefore the control of the depth of seeding, the range of height seeders need to operate over and the clearance of stubble.

What capabilities do seeders need to **operate successfully on raised beds?**
No-tillage seeders suited to raised bed fanning need to possess the following capabilities:

- gauge/trailing wheels which match the furrow spacing;
- independent seeding mechanisms which can operate over a considerable variation in the height of the soil surface on the top and shoulders of beds;
- accurate seeding depth;
- separate fertiliser application and soil disturbance in the seeded row, to minimise the infection risk of soil-borne plant pathogens such as rhizoctonia;
- good soil coverage of the seed and good seed-soil contact without compaction;
- furrow shaping of sown row for water harvesting;
- good stubble cutting and clearance;
- ease of moving openers to alter row spacing.

In addition, the seeder needs the common capabilities of accurate seed and fertiliser rates and distribution.

Future work.

The things that I will be evaluating in the coming years;

- Gypsum, lime, and lime and gypsum mixtures, for two reasons:
  a) A correction of the ca /mg ratio.
  b) Cost effectiveness of gypsum and lime.
- Inter row spray techniques.
  Spray furrows with Roundup (saving 20% on spray costs).
- Changing wheel tracks on header.

References:

Raised Bed Farming Newsletter: Agriculture WA