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Deep tillage: keep an eye on costs, as well as yields

By Amir Abadi, Research Economist, Geraldton and Andrew Bathgate, Research Economist, South Perth

Deep tillage overcomes compaction of sandy soils caused by movement of heavy machinery. Many experiments since 1981 have shown cereal yields improve as a result of deep tillage. However, the increased yield does not necessarily mean more profit when costs are taken into account.

To determine the profitability of deep tillage farmers must consider its impact on other farm operations. A whole-farm analysis is needed to accurately determine the increase in profit resulting from deep tillage.

This article describes an economic assessment of deep tillage on a sandplain farm in the northern wheatbelt. The increase in yield necessary to at least offset the variable and fixed costs of deep tillage is identified.

The relative profitabilities of various methods of implementing deep tillage are also calculated.

Results indicate that deep tillage is moderately profitable on sandplain soils, especially if yield increases of more than 400 kg/ha can be achieved. However, this increase is not likely to be achieved every year or in every paddock treated.

Preparing for deep ripping at Tenindewa in the northern wheatbelt sandplain. A 4WD tractor with an Agrowplow ripping implement and light covering harrows is being used.

Hard pans

Repeated passage of heavy machinery, especially on moist deep loamy sands, leads to soil compaction and the formation of hard pans. The hard pans are very dense sub-surface layers that inhibit root penetration, prevent plants’ access to moisture stored deeper in the soil and reduce nitrogen uptake by the crop.

Wheat yield improves after deep tillage

Deep tillage, which is also called deep ripping or sub-soiling, is a method of overcoming the problem of hard pans. Soil is broken up below the normal cultivation layer, often 30 to 40 cm deep, without inverting the soil.

Field trials and farmer experience in the northern wheatbelt have shown that the average increase in wheat yields due to deep tillage is 650 kg/ha on deep yellow loamy sands. This increase is about 40 per cent of the average yield obtained without deep tillage. However, there is a large variability in yield response. In some cases, yield has decreased, while yield increases up to 1.6 t/ha have been recorded.

To rip or not to rip?

The decision to rip should be considered as part of the overall farm operations because deep tillage affects other farm activities.
Deep tillage competes with the seeding operation for finance, time and labour. This competition reduces the profitability of deep tillage because it delays the sowing of crops, which may result in a reduction in yield. On the other hand, deep tillage complements direct drilling by improving soil conditions, leading to higher yields.

If these interactions are ignored, then the profitability of deep ripping may be overestimated.

**A suitable tool for economic analysis**

To better understand the place of deep tillage in the farm system, a whole-farm model was adapted from the northern wheatbelt version of MIDAS (Model of an Integrated Dryland Agricultural System) to emphasize cultivation techniques. The model was developed by the Department of Agriculture with funding from the Wheat Industry Research Committee of Western Australia.

The model represents the biological, physical and economic characteristics of a typical sandplain farm in the northern wheatbelt. Several production options are described, including choices about rotations and sheep flock structure. These options are limited by the area of land, available capital (machinery, etc) and family labour. The model describes a representative 2500 ha farm on the Eradu sandplain. Ninety per cent of the farm is assumed to be deep loamy sand, suitable for deep tillage.

The model includes a range of deep tillage options, including tilling in different stages of the selected rotations, the area of deep tillage and the timing of the operation. It also incorporates most of the important interactions between possible activities on the farm, with emphasis on deep tillage.

The model was used to identify the increased yield needed for the benefits of deep tillage to outweigh its costs (Table 1), and to determine which method of implementing deep tillage is likely to be the most profitable.

The model was used to investigate several aspects of deep tillage:

- The profitability of various sizes of deep tillage implements.
- The value of an additional tractor.
- The size of the area to be ripped.
- The residual effect of ripping on subsequent crop yields.
- The effect of different wheat prices on farm profits.

**Best rotations for deep tillage**

The results showed that deep tillage is most profitable in cereal-lupin rotations on deep yellow sandplain soils. A cereal-lupin rotation is the best land use strategy on the sandplain soils whether deep tillage is an option or not. However, a small area of permanent pasture may be needed to carry stock through winter.

Deep tilling of pasture in a crop-pasture rotation avoids competition for use of labour and machinery at seeding, but is still less profitable than in cereal-lupin rotations.

**Break-even yield response**

Due to the large variability of yield increases from deep ripping, the model was used to examine the profitability of several yield responses. Deep ripping with an 11-tine implement is profitable when the yield increase is 240 kg/ha or more, with a machinery complement capable of direct drilling 124 ha per day and assuming a medium term wheat price of $150 per tonne. At this yield increase, variable costs and the fixed costs associated with deep tillage are covered by its benefits.

With a yield increase of 400 kg/ha, inclusion of deep tillage increases profit by $10,000, provided that about 70 per cent of the area sown to wheat on the yellow loamy sands is deep ripped. This represents about 650 ha of wheat. However, if only 250 ha are deep tiled, profit is increased by only $5000 to $6000.

**Table 1. Costs of deep tillage used in this analysis**

<table>
<thead>
<tr>
<th>Variable costs</th>
<th>$/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel @ 40c/L, 24 L/ha consumption</td>
<td>10.00</td>
</tr>
<tr>
<td>Repairs and maintenance</td>
<td>8.00</td>
</tr>
<tr>
<td>Extra labour for summer ripping</td>
<td>4.00</td>
</tr>
<tr>
<td>Yield loss from delayed sowing</td>
<td>5.00</td>
</tr>
<tr>
<td>Interest on seasonal borrowings</td>
<td>3.00</td>
</tr>
<tr>
<td>Extra harvest costs (uneven trafficability)</td>
<td>3.20</td>
</tr>
<tr>
<td>Extra spraying costs</td>
<td>1.00</td>
</tr>
<tr>
<td>Extra seedling costs summer ripped paddocks</td>
<td>2.00</td>
</tr>
<tr>
<td>Extra hourly depreciation with heavy usage</td>
<td>1.30</td>
</tr>
<tr>
<td>Tyne replacement</td>
<td>0.50</td>
</tr>
<tr>
<td>Total</td>
<td>38.00</td>
</tr>
</tbody>
</table>

N.B. Fuel consumption is likely to be slightly less than shown above.
Farm profit at each yield response for two deep tillage programmes is shown in Figure 1. The horizontal line is the profit line of a farm without deep tillage.

**When to rip and how often**

The best times to rip are after summer thunder storms (more than 25 mm) and after seeding. Paddocks can be ripped safely for about five days after seeding without the risk of damaging the emerging crop.

The profitability of the wheat-lupin rotation, and hence the absence of a pasture stage in which deep tillage could precede crop sowing, means that deep tillage will usually compete for resources at seeding. For example if deep tillage increased yield by 360 kg/ha, the preferred periods for deep tillage are the five days immediately following seeding, three days in summer after heavy rains and for five days during the seeding operation.

The competition for resources at seeding time (for example, tractor time) is often overlooked in simple economic analyses of deep tillage. The cost of this competition is a shortening of the growing season which results from delayed sowing and a consequent reduction in cereal yield.

When farmers first adopt deep tillage it is important the operation does not conflict with seeding, to avoid the reduction in yield associated with late sowing. However, as the yield response to deep tillage increases, these yield losses become relatively less important. Therefore when deep tillage results in large increases in yield it is profitable to rip bigger areas, even at the cost of additional yield losses from delayed sowing.

The results indicate that the size of the increased wheat yield and duration of the yield response to deep tillage influence the most profitable frequency of the operation. For example if the increased yield from deep tillage is 240 kg/ha, it is only profitable to deep till half the area sown to wheat in the wheat-lupin rotation, or every second wheat crop.

If deep tillage increases wheat yield by 480 kg/ha or more, it is worth deep tilling almost all of the area planted to wheat in the rotation each year.

**Match the ripper to the existing tractor**

The correct size of deep tillage implement must match the power of the available tractor, to make the best use of tractor power and to minimize crop yield loss resulting from late sowing. The use of a larger tractor capable of operating a deep tillage implement with more than 11 tines means bigger areas can be ripped and yield losses from late sowing will be less.

Farm plans based on the larger machinery are more profitable when deep tillage consistently increases yield by more than 240 kg/ha.

However, the increased yield from ripping alone does not justify the purchase of a second, large four-wheel-drive tractor, because of higher fixed and operating costs of the additional tractor.

**How many hectares should be ripped**

If the expected increase in yield from deep tillage is more than 400 kg/ha, at least half of the area sown to cereals on the yellow sandplain soils should be ripped for the operation to be profitable.

The effect of the size of the tillage programme on farm profit is shown in Figure 1. In the first case, the area of wheat deep tilled is 250 ha, and 1000 ha of wheat are ripped in the second case. The model was used to examine several yield responses. In each case, an 11-tine implement with a 115 kW four-wheel-drive tractor was used.
In both cases, the break-even increase in yield is about 240 kg/ha. However, the effect of the increased yield on profit is much greater if a larger area is deep ripped. Yield increases below 240 kg/ha result in a smaller loss in profit with a smaller deep tillage programme because of lower fixed costs of machinery.

Given that the increase in yield from deep tillage varies from year to year, the suitability of each programme depends on the individual farmer’s cashflow and attitude to risk.

**Making the yield response last longer**

Minimizing vehicular traffic over the ripped paddocks to delay recompaction of the soil is desirable. Two situations were examined in relation to the duration of the effect of deep tillage and the size of the yield increase.

In the first case, it was assumed there was no residual effect on the second wheat crop after deep ripping.

In the second case, the residual effect was assumed to be 30 per cent of the original response in the second wheat crop after deep tillage.

Farm profit was increased by an additional $8000 with a residual effect of 30 per cent in the second wheat crop, resulting in a total increase in profit from deep ripping of $18,000 or 38 per cent.

**Wheat price**

The wheat price influences the profitability of the deep tillage operation. Fluctuations in price mean that deep ripping is not likely to be profitable in every year.

Two wheat prices were examined: net on farm prices of $150 and $130 per tonne. The break-even yield response is about 40 kg/ha lower at the higher wheat price. This is because at $150 per tonne the value of a given yield increase is greater, so a smaller increase is needed to offset the cost of obtaining the extra yield.

This means that any reduction in the price of wheat will reduce farmers’ incentive to adopt deep tillage.

**Conclusions**

Deep tillage in the northern wheatbelt is only profitable when the expected increase in wheat yield is at least 240 kg/ha in a cereal-lupin rotation on sandplain soils, if there is no residual effect on subsequent wheat crops.

The profitability of deep tillage is substantially reduced if small areas (250 ha or less) are ripped.

Best times for deep tillage are in summer (after cyclonic rains or thunder storms) or during the five days immediately after seeding. This timing will minimize competition between the ripping operation and seeding for use of time, labour and machinery.

The profitability of deep tillage depends on:

- The increase in yield.
- Appropriate crop rotations.
- Frequency and the area of deep tillage.
- Type and size of deep tillage machinery.
- Labour requirements.
- The timing of deep tillage during the seeding programme.

Other important considerations before deciding to adopt deep tillage are:

- The modest improvements in profit expected, unless a yield increase of 400 kg/ha or more is achieved.
- Cashflow.
- A farmer’s attitude to risk.
- The need to buy new equipment.

The possibility of low wheat prices and the difficulty of coordinating the seeding and deep tillage activities also need to be evaluated. However, a growing number of farmers in the northern wheatbelt region have successfully incorporated deep tillage into their seeding programme on the sandplain soils.

**Further reading**

