Timing the most important factor determining strategic till outcomes

No-till farming systems that include minimal soil disturbance and stubble retention offer a wide range of economic, environmental and soil quality advantages compared to conventional tillage systems. However, there is growing evidence that strict no-till is unsustainable due to implications from the lack of soil disturbance.

KEY POINTS

- The occasional strategic till can be a viable management option to minimise constraints from no-till systems without impacting on long-term soil health benefits.
- Consider the balance between soil erosion and degradation impacts from tilling against short-term profitability.
- Plan well. Timing is the major factor determining the success of strategic tillage.
- Watch the weather forecasts. Rainfall after the tillage operation determines the success of strategic till in no-till systems.
- There is a range of impacts from tilling and they change over time.

Can a till help deal with no-till constraints?

Adoption of continuous no-till has grown steadily in Australia and particularly in Queensland and northern New South Wales (NSW). There are concerns regarding the long-term sustainability of such systems due to both biological and physical constraints (Figure 1). Interest is increasing in the use of occasional strategic tillage (ST) to combat these constraints in no-till (NT) farming systems.

Growers have raised questions about the possibility of irreparable soil and environmental damage from occasional ST in otherwise exclusive NT systems. Fifteen trials have been conducted in the region to respond to these questions using tine and disc tillage implements.

Timing the most important factor determining strategic till outcomes

Figure 1: The biological and physical constraints associated with no-till systems.

**Constraints of no-till systems**

**Weeds**
Build-up of annual ryegrass, barnyard grass, liverseed grass, windmill grass and fleabane. Herbicide resistance can be a significant problem.

**Insects**
Build-up of soil insects such as *Helicoverpa*, armyworms and black field earwigs in the surface soil.

**Diseases**
Build-up of pathogens causing diseases such as crown rot of wheat, yellow spot of wheat, ascochyta blight of chickpea, stalk rot of sorghum.

**Subsoil nutrition depletion**
Subsoil nutrient removal and regular shallow application of immobile nutrients (phosphorus, potassium and zinc) result in relatively enriched surface soil and depleated subsoil (nutrient stratification). High evaporation dries surface soil impeding the ability of crop roots to access nutrients.

Figure 1: The biological and physical constraints associated with no-till systems.
Soil health

The adoption of ST by the grains industry will be driven by the interactions between three aspects:

1. system costs and profitability
2. soil health
3. environmental benefits.

Use of any tillage operation in NT systems must consider the balance between soil erosion and degradation impacts from tillage against short-term profitability (Figure 2).

Tillage impacts in no-till systems

The impacts of a tillage operation (either chisel tines, offset discs or chain harrows) in otherwise NT systems are summarised in Figure 3 and discussed below.

It is important to remember that impacts vary depending on soil type, soil moisture, existing weed seed bank and the timing and frequency of tillage.

ST operations are conducted at a time that minimises the risk of reduced soil water at seeding.

Nutrients can be reduced in subsoil

Strategic tillage causes a slight initial decline of soil organic carbon for a short period due to oxidation, which also releases carbon dioxide.

Also, one-time tillage tends to slightly decrease the amount of available phosphorus (P) in the surface 0–10 cm of soil and slightly increase the amount of available P at 10–20 cm soil depth. However, this effect is unlikely to counteract existing P-deficiency.

Grower recommendation: Occasional deep placement of P fertiliser (at approximately 15–20 cm) may be needed to meet the nutrient requirement of the crops.

Microbial biomass and activity is generally unaffected

Total microbial enzymatic activity and soil microbial biomass did not differ significantly at any site between tillage treatments and NT.

Grower recommendation: No action related to strategic tilling required.

Water and nutrient runoff increases when rainfall occurs soon after tilling

More water and soluble nutrients are lost when rainfall events occur soon after tillage due to the protective surface cover being removed. Trials showed an increase in runoff in Dermosol and Sodosol soils following ST but no impact in Vertosols.

Grower recommendation: Use of ST in soils that exhibit texture contrast properties (Sodosols) and weakly structured A-horizons (Dermosols) are likely to suffer negative impacts and should be treated with caution.

Productivity and profitability are improved, but only in the short term

Across all field sites, productivity increased by 100–150 kg/ha following ST operation in the first year. In the second year, there was no significant impact on productivity. Net returns per hectare from ST ranged from $2.50 to $32.80. The highest returns were obtained from chickpea crops.

Grower recommendation: Consider short-term gains from tilling in the context of enterprise operations, particularly planned crop rotations.
Which soil types are most suited to strategic tillage?

Five dominant soils types cover almost 97% of the cropping soils in the northern region (Figures 4, 5).

Soils that exhibit texture contrast properties (Sodosols, Chromosols) and weakly structured A-horizons (Dermosols) are likely to suffer negative soil health impacts. These soil types should be treated with caution when considering ST.

Generalisations about the impacts of using occasional ST on soil quality indicators in NT systems are difficult to make as soil responses have been inconsistent.

It is also important to consider subsoil constraints. Many soils in the northern region have single or multiple subsoil constraints, especially salinity and sodicity. Use of any tillage implements that invert the soil may have a serious negative impact as salts may be brought nearer the soil surface and could cause yield losses.

When to till?

Timing of a single, strategic till in an otherwise NT system is the most important factor determining its success.

Tillage too close to sowing reduces plant available water. This could result in unreliable establishment or a missed sowing opportunity in marginal rainfall seasons.

Rainfall between ST and sowing or immediately after sowing is essential to replenish soil water lost from the planting zone. A minimum of 75–100 mm rainfall is required so it is important that growers consider rainfall to their tillage schedule.

The probability of receiving 100 mm of rain prior to winter crops sowing in the northern region is 40–55% for a three-month pre-sowing period and 90–95% for a five-month pre-sowing period.

Tilling immediately after the harvest of the previous crop reduces surface cover, which can lead to increased soil erosion. The optimum timing of tillage will be influenced by soil water content and the purpose of the tillage (Table 1). Undertaking a tillage operation after legume crops, which typically produce less stubble cover, can minimise the impacts from loss of cover and reduce difficulties with stubble handling.

How to till?

Tillage implements that invert the soil (such as mouldboard ploughs) are rare in the northern region. Most growers use non-inversion tillage based on tine and disc implements. There were no significant differences between these tillage implements nor the frequencies of tillage passes in field experiments.

Table 1: Safe implementation of strategic tillage in otherwise no-till farming systems.

<table>
<thead>
<tr>
<th>Purpose of tillage</th>
<th>Optimum tillage time</th>
<th>Tillage implement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungal disease</td>
<td>Post-harvest, early in fallow</td>
<td>Disc or blade</td>
</tr>
<tr>
<td>Root-lesion nematode</td>
<td>Post-harvest, early in fallow</td>
<td>Disc for surface soil (0–0.1 m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequent tillage for subsoil (0.45 m)</td>
</tr>
<tr>
<td>Pest management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter crops</td>
<td>Post-harvest</td>
<td>Light tillage e.g. scarifier</td>
</tr>
<tr>
<td>Summer crops</td>
<td>Post-harvest, early in fallow</td>
<td>Chisel, disc to 0.1 m</td>
</tr>
<tr>
<td>Weed management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-crop</td>
<td>Prior to weed flowering</td>
<td>Shallow tine</td>
</tr>
<tr>
<td>Fallow</td>
<td>Prior to weed flowering</td>
<td>Shallow tine</td>
</tr>
<tr>
<td>Subsoil nutrient depletion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodic soil</td>
<td>Post-harvest, early in fallow</td>
<td>Para plough</td>
</tr>
<tr>
<td>Non-sodic soil</td>
<td>Post-harvest, early in fallow</td>
<td>Deep ripper tine</td>
</tr>
<tr>
<td>Stubble management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous crop harvest</td>
<td></td>
<td>Prickle chain, trash cutter</td>
</tr>
<tr>
<td>Fallow for partial removal</td>
<td></td>
<td>Offset disc</td>
</tr>
<tr>
<td>Soil physical constraints</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface soil</td>
<td>Early in fallow</td>
<td>Cross tine</td>
</tr>
<tr>
<td>Subsoil</td>
<td>Early in fallow</td>
<td>Deep ripping tine</td>
</tr>
</tbody>
</table>
The research

Fifteen on-farm experiments were established in Queensland and Northern NSW during 2012–15. All sites had a long history of continuous no-till.

The research trial sites established were:

- Five core sites with till and no-till treatments in otherwise no-till paddocks in winter 2012.
- Three core sites with treatments involving different timing, frequency and type of tillage implements (in winter 2013).
- Four sites using different types of tillage implements (strip tillage, narrow chisel, and disc) and an experiment to quantify the rate of moisture loss in freshly-tilled soil (in summer 2013).
- Three sites with and without tillage treatments to quantify runoff and loss of soluble nutrients immediately following tillage, under simulated rainfall (in summer 2015).

Soil samples were obtained prior to sowing crops in 2012, 2013 and 2014 and analysed for physical, chemical and biological properties. In-crop measurements included weed populations. Researchers also recorded grain yield and evaluated profitability.

Farms involved in the research: ‘Callitris’ Condamine (Rod and Margaret Hamilton); ‘Killaloe’ Moonee (Nev and Penny Boland); ‘Yallambie’ Wee Waa (Ken Stump); ‘Grandview’ Biloela (Darren Jensen); Waverley (Paul and Samantha Fulbohm); ‘Luellen’ Moree (Geoff Manchee); ‘Wyobi’ Jimbour West (Warakiri Farming Co.); ‘Wondal’ Yaraboon (Paul McNaulty and Paul Caster, Agronomist); ‘Kolora’ Emerald (Brian and Val Gregg).

Further reading


To obtain copies of these papers, please contact Yash Dang.

Useful resources


FAQs

Q. I’d like to till but should I just try it in one part of my farm?
A. A strategic till should fit with the objectives of your farm (Table 1). You may wish to trial in a paddock and see the results before applying it more widely.

Q. I consider what I do ‘minimum tillage’, does this information apply to me?
A. The information and guidance presented here are related to research conducted for long-term continuous no-till farming systems only. To explore what kind of tillage may be appropriate for your situation, talk to your agronomist, contact your state/territory government department or refer to Useful resources.

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