# DEEP RIPPING FACT SHEET

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

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# Correcting layers of high soil strength with deep tillage

**Deep tillage can ameliorate layers of high soil strength and allow roots to access subsoil water and nutrients. Major crop yield responses to deep ripping lasting three years or more have been recorded on sandy soils in the Southern Region.**

## KEY POINTS

- Deep ripping ameliorates layers of high soil strength that restrict root growth and uptake of subsoil water and nutrients.
- Yield responses are highest on deep sandy soils and less on heavier-textured soils.
- Deep ripping provides little benefit or can be detrimental on soils with sodic or toxic layers in the subsoil.
- Layers of high soil strength can occur with other constraints (for example, water repellence, acidity) and yield responses from deep ripping will be limited if these are not addressed.
- Investigation of the soil profile is essential to identify the type and depth of constraints.
- Wind erosion risk is a key consideration when deep ripping sandy soils, especially in water repellent sands if crop establishment is poor and/or when there is inadequate stubble cover. It is common for deep ripping to be deferred if there is inadequate stubble cover and the erosion risk is too high.
- Rolling soils after deep ripping flattens and consolidates the surface and breaks up clods, which improves trafficability and creates a suitable surface finish for crop establishment. It does increase the risk of soil erosion.
- Rapid crop establishment after deep ripping is critical to protect the soil from erosion and to stabilise the soil however.
- Deep-ripped soils are readily re-compacted by machinery traffic. Controlled-traffic farming systems minimise compaction and preserve the benefits of deep ripping for longer.

Photo: Evan Collis

Some growers use deep ripping to ameliorate soil constraints that otherwise restrict the uptake of moisture.

## Introduction

Deep ripping with tyne implements is primarily aimed at ameliorating subsoil layers of high soil strength through fracturing and loosening. These layers are formed by natural cementation and consolidation processes and by compaction from machinery traffic. Deep ripping variations include topsoil inclusion, deep placement of ameliorants and fertilisers behind tynes, and delving to lift subsoil clay to the surface to ameliorate water-repellent sands (Table 1). Spading and deep ploughing also provide some benefits via soil loosening, but are primarily aimed at mixing soil to ameliorate water repellence and incorporate amendments.

## High soil strength/ compaction

High soil strength restricts root growth, limiting access to water and nutrients, and can slow water infiltration through the soil profile, resulting in waterlogged areas and perched water tables.

In some sandy soils, layers of high soil strength develop through naturally occurring processes over time and this is exacerbated by machinery traffic. Tracking of machinery causes compaction, especially when soils are wet. Research has shown that after deep ripping, up to 80 per cent of re-compaction occurs in the first pass of machinery. In an uncontrolled system 40 per cent of a paddock can be covered by machinery tracks in one year if traffic is not restricted to defined tracks. As machinery is becoming larger and heavier, the higher axle loads are increasing the depth of the hardpan in the soil profile.

Livestock cause compaction, but this is typically in the topsoil and can be ameliorated with shallow cultivation, including with seeding equipment. Livestock do not cause compaction deep in the profile.

**Table 1: Summary of deep ripping approaches, soil constraints addressed, working depth, incorporation characteristics and approximate cost.**

| Strategic tillage method | Most suitable soil types | Principal constraints addressed | Implement working depth (cm) | Implement impact on incorporation of topsoil and soil amendments | Estimated cost ($/ha)[A] |
|---|---|---|---|---|---|
| Deep ripping | Deep sands, loamy sands, deep sandy duplex | Compaction, hardpans | 30–70 | Minimal incorporation. Backfill to 15cm. | $40–$90 |
| Deep ripping with topsoil inclusion | Deep sands, loamy sands, deep sandy duplex | Compaction, hardpans, subsoil acidity, subsoil infertility | 30–70 | Topsoil slots from surface typically to depths of 35–40cm, but ripping depths can extend to 70cm. Can partially incorporate surface-spread amendments (e.g. lime, nutrients, organic matter). | $55–$95 |
| Amendment placement in subsoil using ripper | Duplex soil, clay soil, loam | Compaction, hardpans, subsoil acidity, subsoil fertility | 30–60 | Direct deep placement of amendments (e.g. organic matter, lime, gypsum, nutrients) in bands at depths up to 70cm. | $300–$1400[C] |
| Subsoil clay delving and incorporation | Duplex soil[B] | Water repellence, compaction, fertility of A-horizon | 60–120 | Backfill likely due to wide delving tynes and high disturbance. Subsequent clay incorporation will mix soils and surface-applied amendments to 15–45cm. | $300–$450 |

A Cost estimates based on contractor rates and quoted costs from growers who have adopted practice.
B Optimum depth range of sand over clay for delving is 20–60cm.
C A large component of this cost is sourcing and applying amendments.

Source: Adapted from Davies et al., 2019

## Responses to deep ripping

Responses to deep ripping vary according to soil type (Table 2) and are more consistent, and continue for longer, on deep sandy soils compared with heavier-textured soils. In sandy soils in the medium and low-rainfall zones, cereal yield increases of 0.5 to 1 t/ha (30 to 80 per cent, depending on baseline yield) have been recorded in the first year after deep ripping. Responses also vary according to seasonal conditions, with smaller responses in dry years where there is no subsoil moisture to exploit or in wet springs where the crop is not reliant on subsoil moisture. Responses decline in successive years as soil strength increases through natural processes and/or compaction caused by machinery, but they typically continue for three or more years, depending on the soil and management.

In recent research, yield resonses to deep ripping have been similar in higher-value crops such as canola and pulses. Growing these higher-value crops after ripping can increase returns, provided establishment and erosion risk are managed. Sowing pulses and canola in the second or subsequent years after ripping, when erosion risk is reduced, can still increase returns from deep ripping on responsive soils.

On heavy-textured soils, duplex soils with hostile clay or sodic subsoils, soil with chemical constraints in the subsoil and cracking clays (vertosols), yield responses to tillage are often small or negative and may not last beyond one season.

**Figure 1: Yield responses from deep ripping are more consistent and persist for longer on deep sandy soils.**

Photo: GRDC

It is common for plant productivity to be limited by other soil constraints as well as high soil strength (Table 2). The occurrence and combination of constraints varies across soil types and regions. For example, sandy soils may also be constrained by water repellence, acidity and subsoil nutrient deficiencies, while heavier-textured and duplex soils may be constrained by sodic subsoils and other chemical constraints such as high acidity, aluminium, boron and salinity. More information on soil type and yield response to deep ripping can be found here.

The full yield response and return on investment in deep ripping will not be realised unless these other constraints to production are ameliorated. Ameliorating other constraints, such as water repellence to overcome poor crop establishment, may provide a greater return than deep ripping and be a higher priority. In some cases, it may not be economically viable or possible to ameliorate the constraints, making returns on deep ripping unlikely. The Ranking Options for Soil Amelioration (ROSA) tool, developed by WA's Department of Primary Industries and Regional Development (DPIRD), evaluates the economics of soil amelioration for the western region and can help

**Table 2: Summary of deep ripping responses of wheat crops across soil types and their associated constraints.**

| | RELIABLE RESPONSES ▶▶▶ | | VARIABLE RESPONSES ▶▶▶ | | | FEW RESPONSES | |
|---|---|---|---|---|---|---|---|
| **SOIL TYPE** | **DEEP SANDS** | **NEUTRAL–ALKALINE SANDS** | **DUPLEX–DEEP (A HORIZON >30cm DEEP)** | **DUPLEX–SHALLOW** | **SODIC CLAY** | **RED AND LOAMY EARTHS** | **BLACK VERTOSOL** |
| 0cm<br>**CULTIVATED ZONE**<br>10cm | Water repellence | Water repellence | Water repellence | Waterlogging | Waterlogging | | Self-mulching |
| **HIGH SOIL STRENGTH**[1] | Acid layer<br>(15 to 30cm) | High soil strength<br>(10 to 70cm) | High soil strength | High soil strength | High soil strength | High soil strength | |
| 25cm<br>**SUBSOIL PROBLEMS THAT MAY BE ASSOCIATED WITH HIGH SOIL STRENGTH**<br>70cm<br>100cm<br>200cm | High soil strength<br>(10 to 70cm)<br>High density<br>Porous<br>Low water,<br>N and K holding<br>N and K leaching | High soil strength<br>(10 to 70cm)<br>Low nutrient availability<br>Salinity<br>Boron | Waterlogging<br>Sodic clay<br>Anaerobic<br>High density<br>Poor structure<br>Salinity<br>Boron | Waterlogging<br>Sodic clay<br>Anaerobic<br>High density<br>Poor structure<br>Boron | Waterlogging<br>Sodic clay<br>Anaerobic<br>High density<br>Poor structure<br>Salinity<br>Boron<br>High alkalinity | Acid layer<br>High density<br>Well structured | Salinity<br>(Cl-) |
| **MEAN WHEAT YIELD RESPONSE RANGE IN YEAR OF RIPPING** | WA 13 to 125%[2] | VIC/SA 30 to 80% | WA 14 to 60%[2]<br>NSW 0 to 20% | 4% | NSW 0 to 33%<br>WA 47%<br>VIC –10 to 10% | Few | Few |
| **BEST BET MANAGEMENT** | Rip<br>Deep mix/invert<br>Soil wetters<br>Near/edge row sowing<br>Incorporate/deep place lime<br>CTF | Rip<br>Deep mix/invert<br>Soil wetters<br>Near/edge row sowing<br>CTF | Rip<br>Deep mix/invert<br>Soil wetters<br>Near/edge row sowing<br>Incorporate/deep place lime<br>CTF | Do not rip<br>CTF | If dispersive, apply gypsum or gypsum-lime blend<br>Rip if subsoil compacted and dry<br>CTF | Few responses<br>CTF | Few responses<br>Self repairing<br>CTF |

[1] Caused by machinery and/or naturally occurring
[2] Higher yield responses tend to be from deeper ripping

Source: Adapted from table compiled by by J Kirkegaard with input from Dr S Davies, DPIRD; Dr L Macdonald, CSIRO; Prof R Armstrong, DJPR; Dr David McKenzie, SOILmgt.

identify the strategy or combination of strategies that will provide the greatest return. Similar decision aids are being developed for the southern region.

Controlled-traffic farming (CTF) systems, which restrict machinery to the same tracks, preserve the benefits of deep ripping by restricting compaction to the tracks and reducing or eliminating re-compaction caused by machinery. In systems where traffic is not managed, sandy soils may need to be re-ripped every two to three seasons to overcome compaction. In CTF systems, yield gains from deep ripping last longer, resulting in a higher return on the investment in deep ripping.

## Identifying high-strength subsoils

Areas of poor crop growth and premature ripening are indicators that soil constraints are restricting root growth and the crop has restricted access to subsoil moisture and nutrients. The occasional vigorous plant that has exploited a crack in the hard subsoil layer or more vigorous growth over old cable or pipelines could be indicators that high soil strength is the main constraint. Waterlogging and perched water tables in heavy-textured soils often result from poor infiltration due to high soil strength in the subsoil. However, these symptoms are not specific; investigation of the subsoil is required to confirm which constraints are present and the depth at which they occur.

The following techniques can be used to investigate further.

### Push probe

Push probes are made of steel rod (typically 8 to 10mm diameter) with a pointed end and a T-piece handle, which are pushed into the soil by hand (Figure 2). Layers with high soil strength can be detected from the changing force needed to push the rod into the soil. Push probes provide an indication of the depth to, and the thickness of, the layer of high soil strength. Penetration force is strongly influenced by soil moisture and this should be taken into consideration when making assessments; dry soils require more force to push the rod into the soil. A zone of increased resistance may indicate a layer of dry soil or could indicate a layer of gravel or rocks. Ideally, assessments of soil strength should be done when the whole profile is wet.

### Cone penetrometer

Digital cone penetrometers work in a similar way to push probes, but provide a quantitative measure of soil strength. A sensor measures the resistance or soil strength as it is pushed into the soil. For cereals, root growth is restricted when penetration resistance in moist soil is above 1.5 megapascals (MPa) and severely restricted above 2.5MPa. As with push probes, penetration resistance is strongly influenced by soil moisture, gravel layers and rocks. Changes to penetration force in soil profiles with layers of wet and dry soil can be confused with changes in soil strength. Ideally, measurements should be taken when the whole soil profile is wet. A comparison with readings from other areas in the paddock and a known non-compacted area on similar soil types is useful.

### Soil pits

Soil pits dug with a spade or backhoe allow a visual assessment of root growth, moisture levels and physical constraints down the soil profile. A lack of roots below a certain depth and/or horizontal growth of roots may indicate high soil strength, but can also be an indicator of other constraints such as soil pH extremes, sodicity, and toxic levels of aluminium, boron and salinity. Unused soil moisture at depth (for example, 30 to 80cm) at the end of the season also indicates root growth and function are being impaired.

It is important to determine the depth to the bottom of the high soil strength layer as this informs the depth of ripping required (Figure 3a). When struck with a trowel or screwdriver, this layer feels more dense and stronger than the soil above and below it. On some sands, high soil strength starts at 20 to 25cm and continues to depth (Figure 3b) rather than being in a defined layer.

In clay soils compacted layers often have a distinct upper and lower boundary with large clods that may have a platy (horizontal) shape. In poorly structured cracking clays, clod faces are dull rather than shiny.

The soil may feel puggy when wet and wet clods will stretch and tear apart like raw pastry rather than breaking apart. When dry, the clods are not friable, but break where you apply force rather than parting along natural fracture faces. If the soil is dispersive, small clods placed in a jar or cup of distilled water or rainwater will disperse without the need to shake them, and the water will turn cloudy within an hour.

### Chemical analysis

Chemical analysis of the soil by a laboratory is required to confirm constraints such as soil pH extremes, sodicity, subsoil nutrient deficiencies, and toxic levels of aluminium, boron and salinity. This is strongly recommended before any soil amelioration is undertaken. This requires careful sampling of soils to depth. Soil sampling guidelines can be accessed here.

### Test strips

Deep ripping strips across varying soil types and at varying depths can provide a useful indication of likely yield responses and help to assess how deep the soil will need to be ripped. Deep ripping test strips on previously ripped soil, or leaving an unripped strip within a paddock that has been ripped, can also provide a measure of the decline in response from ripping and if and when re-ripping will be economically viable.

More information on identifying high soil strength and subsoil compaction can be found here and here.

## Where to deep rip

Understanding the soil physical and chemical characteristics is essential to maximise returns from deep ripping and other amelioration practices. It also avoids damage to soil structure or bringing a hostile subsoil to the surface.

Precision agriculture tools such as yield maps, EM surveys, satellite or drone biomass imagery and gamma radiation surveys identify variation in soil types that can be correlated to areas of poor production.

These can be used to target soil assessment and if high soil strength is confirmed as the main constraint, zones for deep ripping can be defined. In dune swale systems, growers prioritise responsive sandy soils for deep ripping, but where to stop ripping down the swale can be poorly defined. Growers use knowledge of paddocks and soil types, and often rely on the skill of the operator to stop when the ripper will not penetrate sufficiently and is too hard to pull or the soil is left too rough or cloddy.

**Figure 2: Push probes and cone penetrometers can be used to identify layers of high soil strength and to assess subsoil fracturing and loosening after ripping.**

Photo: Evan Collis

## Planning deep ripping

### Erosion

Erosion risk is a key consideration when planning to deep rip, particularly on lighter sands. Deep ripping and rolling reduce standing stubble and rolling flattens the soil surface, leaving the soil more prone to wind erosion. Non-wetting sands are also prone to run-off and water erosion. Deep ripping when stubble loads are high (for example, after a cereal) and

**Figure 3: (a) A distinct compacted layer in a sandy loam. Note fractures in hardpan through which roots preferentially grow. (b) Massive unstructured soil between three rip lines, compared with the aggregated soil on the deep ripping breakout.**

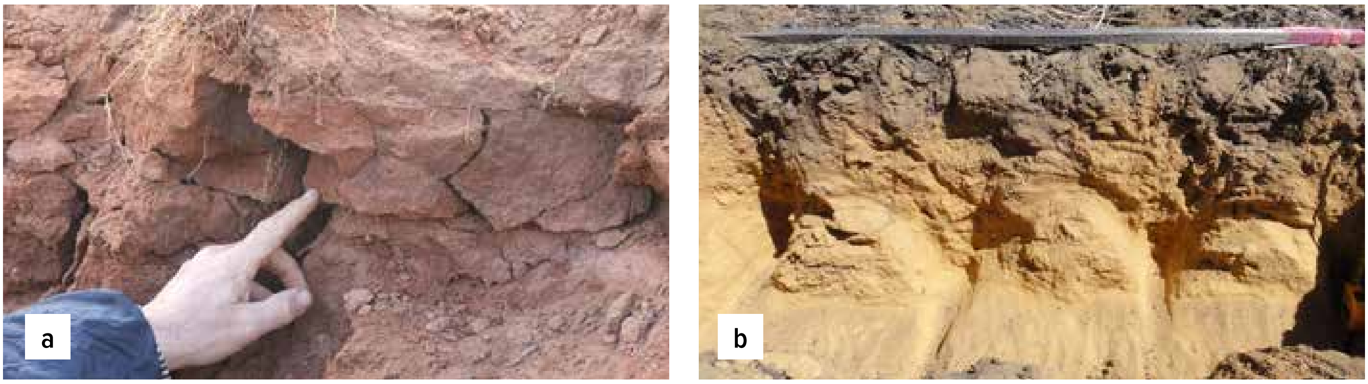
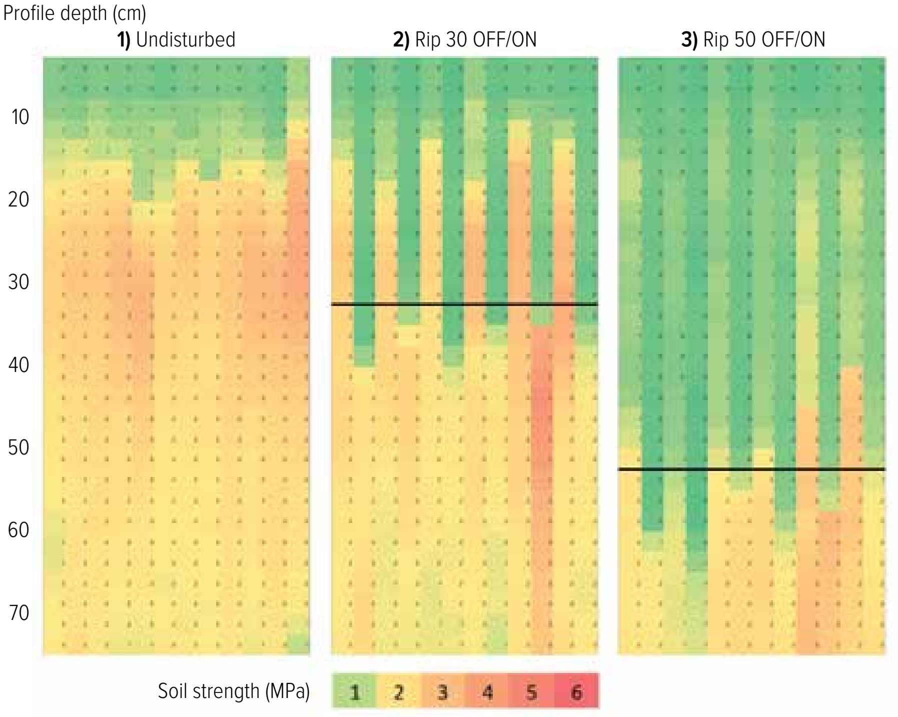


**Figure 4: The effect of ripping depth (30cm, 50cm) on the soil strength of a deep sandy profile indicating: 1) probable root restrictions (>1.5MPa) below 20cm in the undisturbed soil; 2) ripping to 30cm resulted in loosening of rip channels; 3) deeper ripping (50cm) achieved loosening between rip lines down to 40cm.**




Source: Lynne Macdonald, CSIRO, GRDC CSP00203

planting crops that cover the ground quickly reduce exposure to wind erosion. It is common for deep ripping to be deferred if there is inadequate stubble cover and the erosion risk is too high.

## Depth of ripping

Soils must be deep-ripped to below the layer of high soil strength to provide adequate fracturing and loosening of the subsoil (Figure 4). The required depth of deep ripping varies according to soil type and situation, and can be 50cm or more on sands in the SA and Victorian Mallee. Ripping deeper than needed increases costs by increasing draft force, tractor power requirements and fuel usage, as well as increasing wear and tear and reducing operating speeds for limited additional yield benefit.

## Soil moisture

Soil moisture is a critical aspect of successful deep ripping as it influences the draft force required and how effectively the soil is fractured and loosened. Deep ripping in dry soil requires greater draft force, increases fuel consumption and wear and tear and can slow operating speed, all of which increase costs.

Tynes may have difficulty penetrating to the required depth and the degree of soil fracturing and loosening may be suboptimal.

Deep ripping when the soil is too dry can also leave a rough surface, with large clods that are difficult to break down, creating problems with paddock preparation for sowing. Deep ripping when the soil is too wet causes smearing of clay soils and localised compaction around the tyne foot, which impedes water and air movement and root growth.

Tynes are at risk of working too deep in wet soils, thereby increasing power requirements, and may not create enough fracturing and loosening to overcome the layer of high soil strength.

Soil moisture should be below the plastic limit, which is loosely defined as the water content where soil behaves like plasticine. For clay and clay-loam soils, a simple test is to roll a ball of soil between your hands. If a long sausage (>10cm) forms without breaking easily, the soil is too moist for deep ripping.

Deep ripping in optimal moisture conditions presents logistical challenges as the window can be narrow and often coincides with other time-critical operations. In practice, growers are extending the window by deep ripping sandy soils in drier-than-optimal conditions and balancing the potentially higher operating costs and rough seedbed finish against expected returns. More information about deep ripping dry soils can be found here.

## Machinery

A range of commercial deep rippers and machines built on-farm with varying tyne designs and configurations are used for deep ripping. Many are designed for use in CTF systems with tyne spacings to accommodate tramlines. Tyne design, layout and spacing influence draft force requirements, the degree of fracturing and loosening of the subsoil, topsoil disturbance and mixing, and the condition of the soil surface after ripping. The optimum set-up will vary according to individual situations, however the key considerations are that the layer of high soil strength is effectively fractured and loosened and that the soil surface can be levelled for sowing.

More information on machine design and operation can be found here and here. A research report by the Kondinin Group on deep rippers can be found here.

## Inclusion plates

Inclusion plates can be fitted to the rear of ripper tynes (Figure 5). They work below the soil surface and are designed to allow topsoil from above the top edge of the plate to fall into the slot behind the tyne and be buried at depth. The topsoil contains organic matter and nutrients and may be ameliorated with lime or gypsum, which can promote deeper root growth if it is placed into the subsoil. Inclusion plates work best in dry, free-flowing soils and are less effective when the topsoil is moist or where there are high stubble loads.

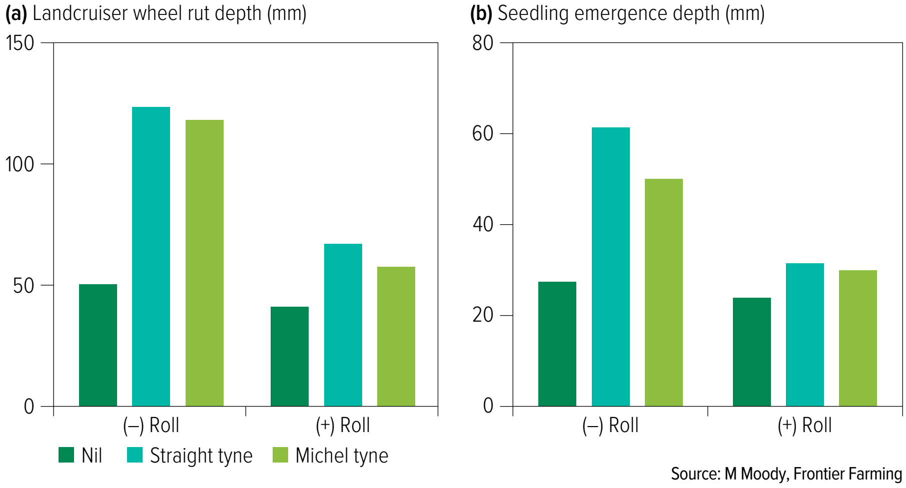
Deep ripping with inclusion plates requires more draft force and increased fuel use. Inclusion plates often leave deeper furrows that can be difficult to level off, can smear clay soils and can cause sideways compaction between ripping lines in sandy soils if the soil is not loosened by the tyne.

Yield responses to ripping with inclusion plates have been inconsistent and are mostly attributed to improved access to and uptake of nutrients from moist subsoil, following placement of topsoil at depth. Where the main constraint to root growth is high soil strength, deep ripping alone often

Figure 5: Topsoil inclusion plates fitted to deep ripping tynes on a Yeoman's Keyline Plough tynes.

Photo: Brett Masters, PIRSA

Figure 6: The effect of rolling with a flat steel roller on (a) soil consolidation and trafficability following deep ripping a sandy soil, assessed by measuring the depth of wheel ruts left by a Landcruiser, and (b) seed depth, following deep ripping.




Source: M Moody, Frontier Farming

provides a better return on investment than deep ripping with inclusion plates.

Research has identified improvements to the design of inclusion plates that increase the efficiency of operation and the quantity and depth of burial of topsoil. The yield responses from these improvements are yet to be quantified. More information on this work can be found here and here.

### Amendments

Research into the deep placement of amendments such as lime, gypsum and nutrient-rich organic matter in the subsoil is in progress. Responses to deep amendments depend on the characteristics and constraints in the subsoil. For example, deep placement of lime with inclusion plates has resulted in yield increases by reducing subsoil acidity within the slots, but deep ploughing and spading provide better incorporation of lime to the required depth.

Deep placement of nutrient-enriched organic matter (for example, chicken litter) has provided inconsistent results in the medium and low-rainfall zones, where similar responses are often measured when it is applied to the topsoil at lower cost. Yield increases initially appear to be mainly due to supply of nutrients, but the long-term effect is unknown at this stage.

In the high-rainfall zones, placing nutrient-rich organic matter into dispersive subsoils encourages root growth into this layer, resulting in improvements to subsoil structure. Yield responses are related to access to more plant-available water and nutrients and have been greatest when the crop is relying on subsoil moisture to fill grain during dry springs.

Research is continuing into the processes that lead to these yield improvements, alternative sources of organic matter and quantifying the benefits. Adding amendments to the subsoil on a commercial scale presents logistical challenges with supply and application of large quantities of material, and most equipment has been developed on-farm or for trial purposes. More information on this research can be found here.

### Weeds

Soil disturbance during deep-ripping buries weed seed, causing increased emergence from varying depths in the soil. This can lead to variable control with pre-emergent herbicides where weeds emerge from below the herbicide band. To manage this, consideration should be given to using robust pre and post emergent herbicide packages and to planting crop types and varieties which allow effective control strategies to be used in crop. Using 'imi' herbicides in 'imi' tolerant crops is one strategy that has been used successfully. Reducing weed seed banks in the seasons leading up to deep ripping can also assist.

### Monitor results

Check results after doing a test strip of deep ripping before committing to large areas. The degree of loosening and fracturing in the subsoil can be assessed by digging holes and making a visual assessment, and by comparing soil strength within and between the rip lines to that of unripped soil with a cone penetrometer or push probe. Also, assess the condition of the soil surface after deep ripping. An uneven soil surface caused by deep furrows and large clods can be difficult to level and may affect crop establishment.

## After deep ripping

Careful management of the soil after deep ripping is critical to avoiding erosion, maximising yields and achieving a return on investment. Deep ripping typically leaves soil uneven and very soft and can leave large clods on the surface, all of which present challenges for trafficability of seeding equipment and crop establishment. Issues with trafficability are exacerbated if deep ripping is combined with amelioration techniques such as spading and deep ploughing. Leaving the surface as flat as possible by filling in furrows, breaking up clods and consolidating the soil surface will improve accuracy of seed placement and crop establishment (Figure 6).

### Rolling

Rolling after deep ripping is common practice to consolidate and level the topsoil and break up clods, which improves trafficability, seed placement and crop establishment. Rolling can increase erosion risk by flattening the soil surface and reducing the amount of standing stubble. Strategies to mitigate the erosion risk include deferring rolling until just prior to sowing to maintain stubble cover for as long as possible and using rollers that leave the surface slightly ridged or indented. A range of rollers of varying designs are being used commercially (Figure 7). The ideal roller for individual situations will depend on soil type, the

Figure 7: Rollers range from (a) flat steel rollers to (b) rollers mounted on deep ripping machines. Note the reduction in standing stubble following ripping and rolling in Figure 7b.





Photo: Brad Bennett, AGRIvision Consultants

degree of topsoil consolidation and levelling required, the size and number of clods, erosion risk and the surface finish required for crop establishment. More information on roller types and suitability for various situations can be found here.

## Pre-emergent herbicides

Deep ripping combined with topsoil mixing, that is, spading and ploughing, can lower the organic matter content of topsoil, resulting in increased herbicide activity and increased risk of crop damage. Bringing clay to the soil surface can either increase or decrease herbicide activity, depending on the herbicide and the properties of the clay.

Where the soil is deep-ripped without topsoil mixing, the main issue is furrow collapse after seeding into soft soil, soil throw or the backfilling of furrows caused by erosion, which may concentrate soil-applied herbicide over the drill row and lead to crop damage. Applying herbicides to cloddy soil surfaces reduces the efficacy of some products and can concentrate the herbicide via preferential pathways of water infiltration.

Practices that reduce the risk of crop damage include rolling to consolidate the soil surface before herbicide application, retaining enough stubble cover to reduce erosion risk, forming stable furrows, accurate seed placement, reducing herbicides rates within the ranges stated on label recommendations, using herbicides that are safer on the crop and if possible avoiding pre-emergent herbicides in favour of post-emergent weed control.

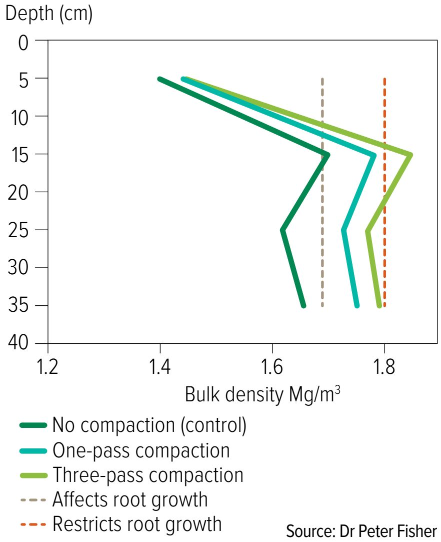
## Crop establishment

The main issue with seeding after deep ripping is poor crop establishment due to inaccurate seed placement. This is caused by poor flotation of seeding equipment, an uneven soil surface and movement of soil into drill row furrows via excessive soil throw, furrow collapse and backfilling of furrows during erosion events. Growers have found it useful to do a 'dry' test run with the seeder to assess seed placement and soil movement, which can also guide the use of pre-emergent herbicides.

Other techniques to improve crop establishment include:

- ground-following seeding equipment, where the seeding depth of each row is controlled by a press wheel;
- seeding systems that place seed into the furrow wall instead of the bottom of the furrow;
- seeding points that work shallow and deliver seed to the bottom of the furrow–worn or cut-off knife points have been used successfully;
- flexible, trailing seeding boots that maintain a shallow sowing depth on very soft soils;
- reducing pressure on tynes and press wheels;
- fitting wider press wheels to reduce bar sinkage and bulldozing of soil where bar weight is partially carried on the press wheels;
- fitting press wheels that produce shallow furrows with stable side walls;
- improving flotation by setting up lightweight, smaller seeding bars, half-filling air carts, lowering tyre pressures, increasing tyre width and locking castor wheels;

**Figure 8: Change in bulk density due to the trafficking treatments on a Loxton deep sand. Vertical lines represent theoretical thresholds above which differences in root growth can be observed.**




Source: Dr Peter Fisher

- deep ripping at an angle to the direction of working and seeding;
- seeding early and into moisture to promote rapid emergence and early growth to stabilise soil;
- selecting crop types and varieties that have long coleoptiles, emerge quickly, have vigorous early growth and cover the ground quickly – examples include sowing cereals in preference to pulses and canola, cereal rye on very sandy soils in preference to other cereals;
- increase sowing rates to compensate for reduced emergence;
- top-dressing some seed prior to sowing at an angle to the rip line

to compensate for poor seed placement by the seeder; and

- CTF systems – avoid ripping wheel tracks. Flotation can still be an issue for wheels that do not run on the permanent tracks, which creates uneven seeding depth across the width of the bar unless the depth of each row is controlled by a press wheel. Machinery that falls off the firm wheel tracks can become bogged, particularly when travelling at faster speeds for spraying. Options to manage this include leaving wider, unripped wheel tracks, using wider tyres, or running a shallow ripping tyne in line with the main wheel tracks to form a shallow channel that the sprayer can track in.

More information on establishing crops after deep ripping can be found here.

## Crop nutrition

Fertiliser programs will need to be adjusted to supply enough nutrients to match the higher production levels if the full benefits of deep ripping responsive soils are to be realised. Tactical, in-season application of some nutrients, for example, nitrogen, can help to improve yield potential in favourable seasons while avoiding over-fertilising in dry seasons. In some cases, the first crop post-ripping has access to leached nutrients that previous crops have not been able to access, and nutrition can be reduced for that season.

## Managing traffic

Traffic after deep ripping causes enough compaction to restrict root growth and access to soil water and nutrients (Figure 8). Restricting machinery traffic to defined tracks in CTF systems minimises re-compaction, maximises the longevity of yield benefits from deep ripping and delays the need for re-ripping.

## MORE INFORMATION

**Responses to deep ripping**
https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2020/02/deep-ripping-where-it-will-work-and-where-it-wont

**Identifying high soil strength**
https://www.agric.wa.gov.au/soil-compaction/identifying-soil-compaction

http://soilquality.org.au/factsheets/subsurface-compaction

**Deep ripping**
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