ECONOMICS OF DEEP RIPPING
FACT SHEET

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

SOUTHERN
FEBRUARY 2024

Photo: Jack Desbiolles, UniSA

Cost–benefit analysis of deep ripping for your farm

The cost of deep ripping operations can be minimised by distributing ownership cost over a greater area and maximising power-use efficiency in the paddock.

KEY POINTS

- The magnitude and longevity of extra grain yield benefits drive deep ripping returns
- The capital cost and the proportion of responsive paddocks shape whole-farm gains from ripping
- Changes in operational (for example, fuel) or additional fertiliser costs have minimal impact on the economic viability of ripping in comparison to the effect of capital costs
- Where soil constraints can be improved, there are significant economic returns available from deep ripping
- Deep ripping is profitable when the present value of the benefits over an expected period exceed cost at a required discount rate

INTRODUCTION

High soil strength, resulting from factors such as compaction and hard setting, can significantly impede root penetration, therefore limiting access to moisture and nutrients at greater depths. Deep ripping involves the loosening of soil at depths beyond what traditional cultivation methods achieve. This approach holds the potential to enhance yields, particularly in compacted sandy soil conditions. It is important to note that deep ripping demands substantial investment, and its effectiveness can vary considerably based on factors such as site-specific conditions and seasonal variations (Schneider et al., 2017; Unkovich et al., 2020).

This fact sheet's main purpose is to offer growers and their advisers guidance on evaluating the economic viability of deep ripping, using farm-specific data. By following the method demonstrated in the example below, growers and advisers can effectively assess the financial gains linked to deep ripping. This approach allows them to customise their decision-making process to align with the specific and relevant conditions of their local context.

Example: deep ripping at 50cm depth at Bute, SA

The cost–benefit analysis presented in Table 1 evaluates the influence of soil ripping activities on a siliceous sand at Bute, SA over a seven-year planning horizon. The site has a high level of soil strength with penetrometer resistance exceeding 4000 kilopascals at 30 centimetres depth. In the analysis, soil ripping is performed in the initial year (Year zero), and in each subsequent year, a specific commodity is designated under the crop rotation pertinent to the respective farm. In this example, a remarkable 283 per cent return over seven years is attained.

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The following outlines the essential elements of a cost–benefit analysis:

COSTS

RIPPING COST

The assumed cost of deep ripping was set at $140/ha following the assumptions outlined in Table 2. The cost of deep ripping is influenced by several key factors, including the ripping depth (affecting power requirements), ripper width, tractor operating speed and field operational efficiency, which is represented by the time spent on the deep ripping processas a proportion of the total time spent in the field, including unproductive time. These assumptions regarding work rates have a significant impact on metrics such as total hectares ripped per hour (coverage) and the total hours needed to complete a ripping project for a given treated area (for example, 200ha). Depreciation is incorporated as an expense for both the tractor and ripper, calculated based on their purchase and salvage values divided by hours of use. Additionally, other costs, such as labour, fuel, repair and maintenance (R&M), can be adjusted to farm-specific circumstances. Extra seeding costs are also considered, accounting for extra tasks such as rolling for firming the ground before seeding.

REPLACEMENT FERTILISER COST

To account for the increased yields resulting from the ripping treatments without depleting soil fertility, extra fertiliser expenses are included in Table 1. These costs are incurred from Year 2 onwards. The calculation of these costs is based on the extra yield benefit and a benchmark of $50 per tonne of wheat yield spent on fertiliser for simplicity. This cost is then multiplied by the yield gain to determine the per-hectare expense.

PRESENT VALUE FACTOR (PVF)

Considering the variability in the timing of costs and benefits associated with investments, and the fundamental principle that the present value of a dollar is generally higher than its future value, primarily due to the potential to earn interest or investment returns, a discount rate becomes a crucial tool. This discount rate, typically defined as the rate of return required by growers or the opportunity cost of capital, is systematically applied to each projected cashflow to determine its present value.

For the purposes of this example, we have assumed a nominal discount rate of 9 per cent, which is equivalent to 6 per cent real opportunity cost of capital. This rate serves as the foundation for computing the present value factors for each year following the deep ripping procedure, using the formula: 1 / (1 + discount rate)^year. Subsequently, the costs and benefits for each year are multiplied by the corresponding discount factor to yield the discounted costs and benefits specific to that year (Table 1).

Table 1: Cost–benefit analysis example: Deep ripping at 50cm depth at Bute, SA.

	Annual replacement fertiliser cost (RFC) ($/t)								50
	Discount rate (DR)								9%
YEAR	0	1	2	3	4	5	6	7	Total
CROP ROTATION		Wheat	Barley	Lentil	Wheat	Barley	Lentil	Wheat	
COSTS									
Ripping to 50cm ($/ha)	140								
Amendments ($/ha)	0								
Replacement fertiliser cost ($/t)	0	0	48	31	40	56	42	29	
Total annual investment costs ($/ha)	140	0	48	31	40	56	42	29	386
Present value factors (PVF)	1	0.92	0.84	0.77	0.71	0.65	0.60	0.55	
Total discounted annual investment Costs ($/ha)	**140**	**0**	**41**	**24**	**29**	**36**	**25**	**16**	**310**
BENEFITS									
Yield of untreated (t/ha)		1.8	2.1	0.4	2.6	1.5	0.6	1.2	10.2
Yield of treated (t/ha)		2.8	2.8	1.2	3.7	2.4	1.2	2.0	15.9
Grain price ($/t) less freight		305	246	615	305	246	615	305	
Annual Increase in crop value ($/ha)		294	153	496	342	206	353	236	2081
Total discounted annual Benefits ($/ha)		**270**	**129**	**383**	**242**	**134**	**211**	**129**	**1498**
Net present value (NPV) ($/ha)									**1187**
Benefit–cost ratio (BCR)									**4.83**

Note: Replacement Fertiliser cost = (yield of treated – yield of untreated) × 50.
Present value factor = 1 / (1 + discount rate) ^year, for example $1/(1+0.09)^1 = 0.92$
Total diiscounted annual investment costs ($/ha) = Total annual investment cost × PVF.
Annual increase in crop value = (yield of treated – yield of untreated) × grain price.
Total discounted annual benefits = annual Increase in crop value × PVF.
NPV = total discounted benefit – total discounted investment cost.
BCR = total discounted benefit / total discounted investment cost.
On the assumptions therein, to achieve break-even in Year 1, a minimum initial grain yield benefit of 1t/ha is needed. This can be calculated as the total discounted investment cost / (year 1 grain price less freight × Year 1 PVF).
In this example, the 283% cost–benefit return over seven years is calculated as follows: (NPV benefit – total discounted investment cost) / total discounted investment cost × 100.

BENEFITS

The annual increase in crop value is calculated by multiplying the grain prices with the yield uplift resulting from deep ripping for each year. The yield values presented in Table 1 are derived from research trial results from an experiment conducted at Bute, SA from 2015 to 2021 (Ouzman et al., 2023). To calculate the discounted benefits, multiply the annual increase in crop value by the respective present value factors.

Rule for positive return project:
Net Present Value (NPV) > 0
Benefit–Cost Ratio (BCR) > 1

A fundamental principle for evaluating a sound investment project is to consider time lags and apply the necessary discount rate, which considers elements such as the investor's cost of capital, opportunity cost and risk tolerance. The primary criterion is that the cumulative benefits should exceed the total costs

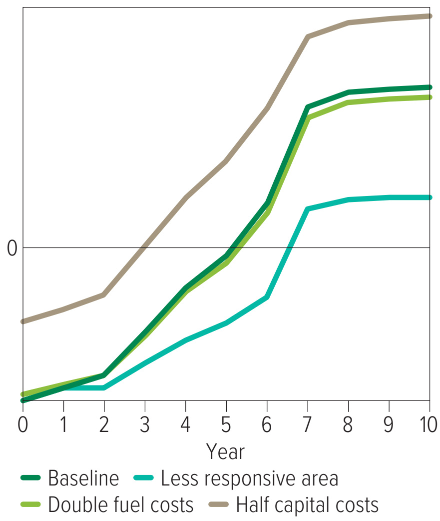
Table 2: Ripping cost calculation.			
A	Ripping depth (cm)	50	
B	Operating speed (km/h)	6	Assumption based on prior literature and expert opinion
C	Ripper width (m)	4	
D	Field operational efficiency	80%	Per cent of time spent doing the deep ripping operation in the paddock
E	Coverage (ha/h)	1.9	((C×B)/10)×D
F	Ripping area (ha)	200	Case-study assumption
G	Total hours	104	F/E
H	Tractor depreciation ($/h)	26	*(Value of tractor apportioned to ripping — Proceeds from sale apportioned to ripping)/Depreciable hours
I	Tractor depreciation ($/ha)	14	H/E
J	Tractor R&M ($/h)	10	
K	Tractor R&M ($/ha)	5	J/E
L	Ripper depreciation ($/h)	38	(Value of ripper – Value of ripper sale)/Depreciable hours
M	Ripper depreciation ($/ha)	20	L/E
N	Fuel consumption (L/h)	70	Assumption
O	Fuel cost ($/L)	1.8	Fuel cost less rebate
P	Fuel cost ($/h)	126	N×O
Q	Fuel cost ($/ha)	66	P/E
R	Labour ($/h)	40	
S	Labour ($/ha)	21	R/E
T	Seeding ($/ha)	15	To cover the cost of extra activities (for example, rolling after ripping)
U	Total cost ($/ha)	140	(I+K+M+Q+S+T)

Note: *Depreciable hours = starting hours – likely hours when sold.
If 20% of the total tractor operating time is dedicated to the ripping task, then the portion of the tractor's value allocated to ripping equals 20% of the tractor's value.

Deep ripping implements exist in many sizes and shapes, which impacts the costs of ownership.

Photo: Jack Desbiolles, UniSA

Figure 1: Potential shape of the NPV curves at a whole-farm scale.



Note: Ripping took place annually in the first 6 years.

by the end of the specified period and at a stipulated discount rate, typically denoted as NPV > 0. In this example, a positive NPV of $1187/ha over seven years, calculated by subtracting the total discounted costs from the total discounted benefits, indicates a profitable outcome for the investment in deep ripping. Generally, a higher NPV suggests a more lucrative and financially viable deep ripping project.

It is important to note that the Bute site example represents a best-case response, showcasing the upper range of gains. Our analysis of the 162 treatment site years, derived from on-farm sandy soil experiments in the southern cropping regions of Australia, indicates that the NPV of deep ripping varies between –$406/ha to $1187/ha. Additionally, there is a 95 per cent chance that a ripping depth of 50cm will yield an NPV above $150/ha within four years.

There are multiple factors that can influence the NPV that should be considered before embarking on a deep ripping operation. Consider examining the potential implications of a reduced yield benefit compared to expectations due to factors such as unresponsive soils, fluctuations in fuel and capital expenses, and alterations in the total treated area. Figure 1 illustrates the possible contours of NPV curves on a whole-farm scale, taking these variables into account.

The shape of the potential NPV curves in Figure 1 is based on a whole-farm example with a total farm size of 1470ha and a cropping intensity of 96 per cent. The average growing season rainfall is 207 millimetres. The deep ripping operation is executed at a depth of 40cm, with a capital cost of $223,000 for the tractor and $80,000 for the ripper. The fuel cost is set at $50 per hour, and the total area deep-ripped is 125ha. The crops grown on this farm include wheat, barley and lentils. The typical yield on the farm is 3t/ha for wheat, 2.7t/ha for barley and 1.5t/ha for lentils. Among the 125ha of treated baseline area, 60 per cent is classified as Class A land, which provides the full response to deep ripping, while 30 per cent is Class B land with response at a 70 per cent relative rate. Additionally, there is 10 per cent Class C land, with no response to deep ripping. In this sensitivity analysis, we contrasted a less responsive area with 30 per cent of Class A and B land and 40 per cent of unresponsive Class C land.

An alternative financial metric used to assess the economic feasibility of a deep ripping intervention is the Benefit–Cost Ratio (BCR). This ratio represents the present value of the total expected benefits of the ripping operation divided by the present value of its total expected costs. A BCR exceeding 1 implies that the ripping intervention is profitable, as the expected benefits surpass the expected costs. The BCR of 4.83 in this example tells us that for each $1 spent, $4.87 was generated. In general, a higher BCR corresponds to a more profitable ripping project.

WHOLE-FARM FACTORS TO CONSIDER

- Treat the right area of your paddock at the right depth and right time (soil moisture conditions). Time of sowing and soil amelioration may also coincide.
- Work to minimise upfront capital costs considering outright machinery ownership, syndicated purchase, second-hand purchase or using contractors.
- Select crop rotations that offer faster returns based on grain prices but also likely response to deep ripping.
- Consider adopting controlled-traffic farming to prevent re-compaction and make deep ripping benefits last longer.
- Consider time management across the whole farm when undertaking a soil amelioration program so that business-critical tasks are not delayed (for example, ensure sowing time across the rest of the farm is not delayed by the amelioration program).
- Although good returns from ripping sandy soils are likely, crop establishment risks post-amelioration are real. Therefore, attention to improved management and technical solutions is needed to mitigate these risks.

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USEFUL RESOURCES

GRDC Fact Sheet: ***Ripping Technology – Technology considerations for cost-effective subsoil loosening*** grdc.com.au/resources-and-publications/all-publications/factsheets/2022/ripping-technology-national-fact-sheet

GRDC Fact Sheet: ***Diagnosing Sandy Soil Constraints: High Soil Strength*** grdc.com.au/resources-and-publications/all-publications/factsheets/2022/diagnosing-sandy-soil-constraints-high-soil-strength-south-west

GRDC Fact Sheet: ***Deep ripping not appropriate for all soil*** grdc.com.au/resources-and-publications/all-publications/factsheets/2009/06/grdc-fs-deepripping

GRDC Fact Sheet: ***Inclusion ripping technology*** grdc.com.au/resources-and-publications/all-publications/factsheets/2022/inclusion-ripping-technology-national

GRDC Fact Sheet: ***Soil mixing by spading*** grdc.com.au/resources-and-publications/all-publications/factsheets/2022/soil-mixing-by-spading-national

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GRDC CODE

CSP1606-008RMX (CSP00203)

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ACKNOWLEDGEMENTS The authors would like to thank Therese McBeath (CSIRO), Melissa Fraser (Soil Function Consulting), Chris Saunders (UniSA), Jack Desbiolles (UniSA) and Mustafa Ucgul (Southern Cross University) for their valuable input and constructive comments, which have contributed to the improvement of the fact sheet.