Soil acidity and management in the Yorke Peninsula district

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Acknowledgement of Country

The Department for Environment and Water acknowledges Aboriginal people as the First Peoples and Nations of the lands and waters we live and work upon and we pay our respects to their Elders past, present and emerging. We acknowledge and respect the deep spiritual connection and the relationship that Aboriginal and Torres Strait Islander people have to Country.

The Department works in partnership with the First Peoples of South Australia and supports their Nations to take a leading role in caring for their Country.

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Foreword

The Department for Environment and Water (DEW) is responsible for the management of the State's natural resources, ranging from policy leadership to on-ground delivery in consultation with government, industry and communities.

High-quality science and effective monitoring provides the foundation for the successful management of our environment and natural resources. This is achieved through undertaking appropriate research, investigations, assessments, monitoring and evaluation.

DEW's strong partnerships with educational and research institutions, industries, government agencies, Landscape Boards and the community ensures that there is continual capacity building across the sector, and that the best skills and expertise are used to inform decision making.

Ben Bruce
CHIEF EXECUTIVE
DEPARTMENT FOR ENVIRONMENT AND WATER

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Summary

Soil acidity is an emerging and significant problem in the Yorke Peninsula (YP) district due to adoption of more productive and intensive farming practices in recent decades. This is mostly occurring on the hard red-brown texture contrast soils, gradational soils and sand over clay soils, and is having a detrimental effect on crop and pasture yields.

The YP district covers an area of 821,200 ha, including 672,200 ha of cleared agricultural land. This is a highly productive agricultural area with a five-year average crop production value of more than $580 million per annum (PIRSA, 2024).

It is estimated that approximately 66,000 ha of agricultural land (10% of the total agricultural area) is currently affected by acid soils (2025). The total area of potentially acidic land is 109,900 ha (16.4% of the total agricultural area) which could acidify in the future if no remedial action is taken.

Soil pH mapping in acid-risk areas has shown that soil pH can be quite variable in paddocks and that the range of pH can be quite large (such as a paddock at Sandilands with a surface pH $CaCl_2$ range of 3.8–8.0).

The annual production loss within acidic areas in 2020 was estimated to be $6.3 million. This production loss is likely to increase to $10.4 million per annum by 2050, assuming that current farming practices continue and that these soils are not adequately treated. Lime application is the primary method for treating soil acidity. In addition, soil modification techniques such as spading, delving or clay spreading are management options for the treatment of acid soils in some areas of the YP district where the underlying clay is neutral or alkaline and is close to the surface.

The economic performance of these management options was assessed by calculating payback periods (time taken to recover treatment cost outlay from increased production returns) for a wheat-barley-lentils rotation. Findings indicated the cost recovery for liming was 0.3–0.5 years, spading without lime was 0.3 years, and delving and incorporation of lime was 0.6–1.0 years. Clay spreading and incorporation showed longer payback periods of 1.1–2.0 years, reflecting higher initial costs and slower return on investment.

Annual lime use on YP was negligible in 2015 and has increased to 11,600 tonnes in 2025. Prior to 2020, lime use was less than that needed to balance the estimated rate of soil acidification (lime requirement). This resulted in an accumulated lime ‘deficit’, meaning soil acidity has worsened. However, lime use increased markedly from 2021 to 2024, above the lime requirement. This would have helped reduce the accumulated lime deficit and raise the pH of soils that were already acidic.

Treatment of soil acidity on YP by liming and soil modification has been shown to provide economic gains to agricultural production as well as maintaining soil health. Soil pH should be regularly monitored and appropriate treatments undertaken wherever soil acidity is identified.

Table 0.1. Fast facts of soil acidity and the Yorke Peninsula district

Land area	Native vegetation	134,800 ha (16.4%)
	Cleared	672,100 ha (81.9%)
	[Cropped each year]	[571,000 ha (approx. 85% of cleared, 70% of total)]
	Other	14,200 ha (1.7%)
	Total	821,200 ha
Rainfall (district)[a]	Annual	Average 380 mm (range 247–652 mm)
	Growing season (Apr–Oct)	Average 286 mm (range 158–455 mm)
Crop production	Five-year average crop value	More than $580M per annum
Major soil groups (cleared land)[b]	Calcareous soils (Group A)	261,000 ha
	Shallow soils on calcrete or limestone (B)	218,000 ha
	Deep sands (H)	91,000 ha
	Hard red-brown texture contrast soils (D)	43,000 ha
	Sand over clay soils (G)	37,000 ha
	Gradational soils (C)	14,000 ha
	Wet or saline soils (N)	5,500 ha
	Cracking clay soils (E)	2,000 ha
Extent of acidic soils	Estimated actual acidic 2025	66,000 ha
	Estimated actual acidic 2050	82,500 ha
	Total potential acidic	109,900 ha
Annual cost of production loss		$6.3 million (2020) $10.4 million (2050, projected)
Lime use	Lime requirement (2025)	11,000 t lime per year (= annual acidification rate)
	Lime applied (2025)	13,500 t lime per year (avg. last 3 years, 2022-25)
	Accumulated lime deficit (1999–2024)	20,900 t lime
	Catch-up lime requirement (pre-1999)	2,200 t lime
Lime sources	Local	Kulpara Quarry (Kulpara) Barossa Lime (Depot at Clinton) White Hut Lime (Daly Head)
	Outside of district	Clare Quarry (Spalding) Penrice (Angaston) Barossa Lime (Seelander's Quarries) Barossa Quarries etc.

a. Period 1982–2005

b. Source: State Land and Soil Information Framework; DEW (2021a)

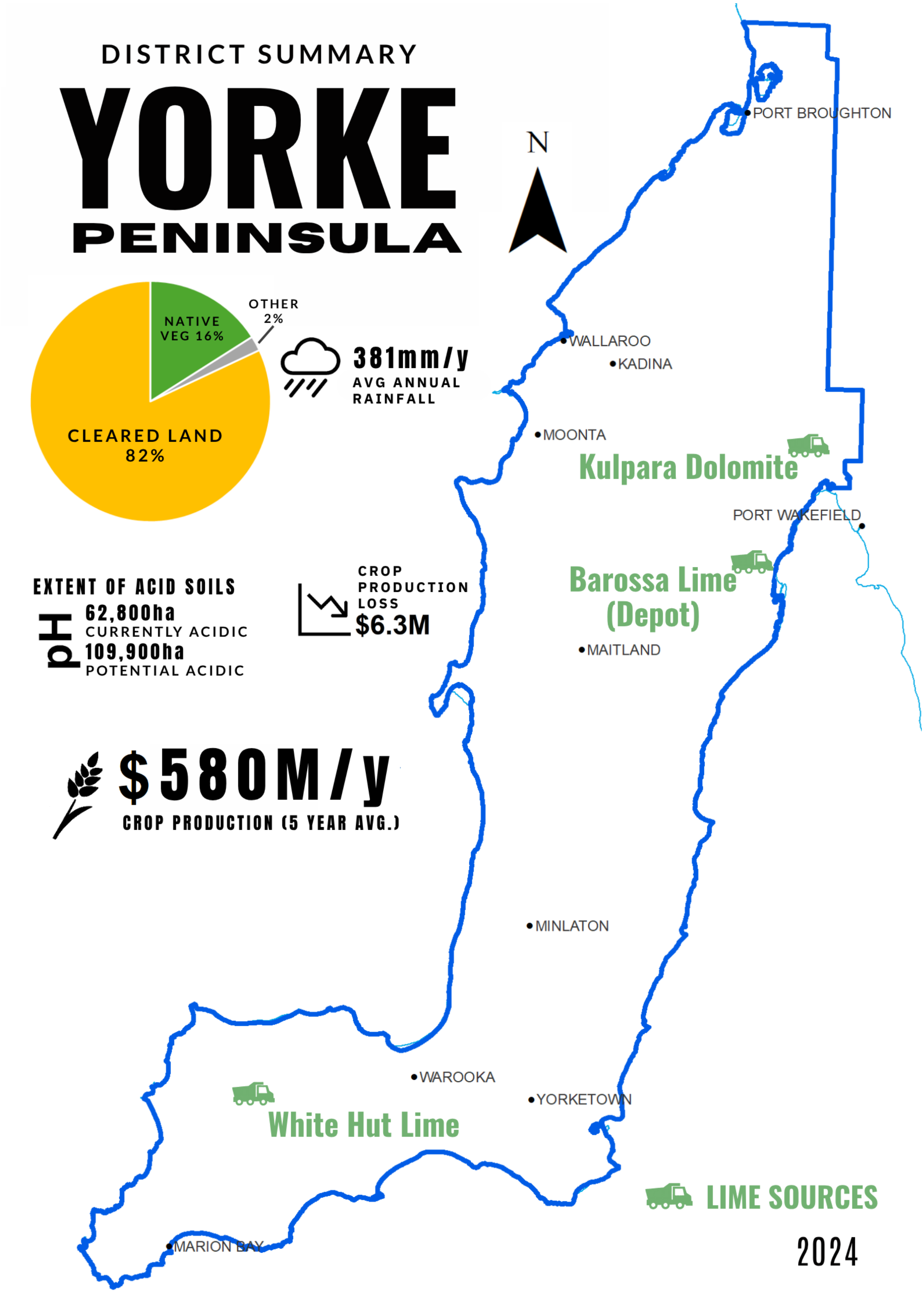

Figure 0.1. District summary, Yorke Peninsula

1 Introduction

The Yorke Peninsula (YP) District is a productive agricultural cropping and grazing area in South Australia (SA). Due to the intensification of farming practices and rising production levels over recent decades, soil acidity is becoming an emerging and significant problem in many parts of the district.

In 2025, an estimated 66,000 ha (10%) of agricultural land were affected by acid soils. This could expand to 109,900 ha in the future (16.4% of agricultural land) if no remedial action is taken.

Soils are classified as acidic where the pH measured in calcium chloride ($CaCl_2$) is less than 5.5 (DEW 2016). Soil pH can be measured using one of the following methods:

- pH in calcium chloride solution (1:5 soil solution ratio), the standard method for acidic soils
- pH in water (1:5 soil water ratio), which gives a pH value approximately 0.8 units higher than calcium chloride method.

For the purposes of this report, all mentions of soil pH in this report are referring to values measured using a calcium chloride solution, unless stated otherwise.

When soil pH falls below pH 5.5 the productivity of crops and pastures declines. Essential nutrients such as phosphorus, magnesium, calcium and molybdenum become less available to plants. Additionally, microbial activity begins to decline, while toxic levels of aluminium can develop, severely impacting root development and plant growth.

Acid soils can be treated by application of agricultural liming products, and in some situations, by soil modification. Agricultural soils will continue to acidify, even after liming, so regular soil testing is needed to monitor soil pH.

1.1 Report purpose

This report documents:

- the extent and severity of acid soils in the YP District
- the impact on crop and pasture yield
- management options and costs to ameliorate acid soils
- lime application compared to estimated soil acidification rates and pH levels, and estimated future lime requirement.

This report aims to improve the awareness and understanding of soil acidity issues in the YP district and outline potential management options for landholders.

2 General description of the Yorke Peninsula district

The YP district covers an area of 821,200 ha, of which 672,200 ha (81.9%) is cleared agricultural land.

2.1 Climate

The YP district has a Mediterranean climate with cool wet winters and warm to hot dry summers. The relatively close proximity of agricultural land to the coast helps moderate temperature extremes. The mean annual rainfall across the district ranges from around 330 to 500 mm, with the highest rainfall occurring along the central part of the Peninsula. Maitland has the highest annual rainfall, of about 500 mm. The mean rainfall for various centres are outlined in Table 2.1. Approximately 75% of the annual rainfall is recorded during the 'growing season' between April and October (Figure 2.1). The mean annual rainfall for agricultural land in the district has been spatially calculated as 380 mm, with a mean growing season (Apr–Oct) rainfall of 286 mm[1]. In wet winters, flooding and waterlogging can occur in poorly drained low-lying areas.

Table 2.1. Mean annual rainfall for centres in the Yorke Peninsula district

Centre	Mean annual rainfall in mm (year of first record)
Bute	394 (1885)
Kadina	389 (1876)
Maitland	503 (1879)
Price	324 (1944)
Stenhouse Bay	451 (1966)
Warooka	445 (1861)

Source: Bureau of Meteorology

[1] Based on monthly gridded rainfall 1982–2025 from the Bureau of Meteorology

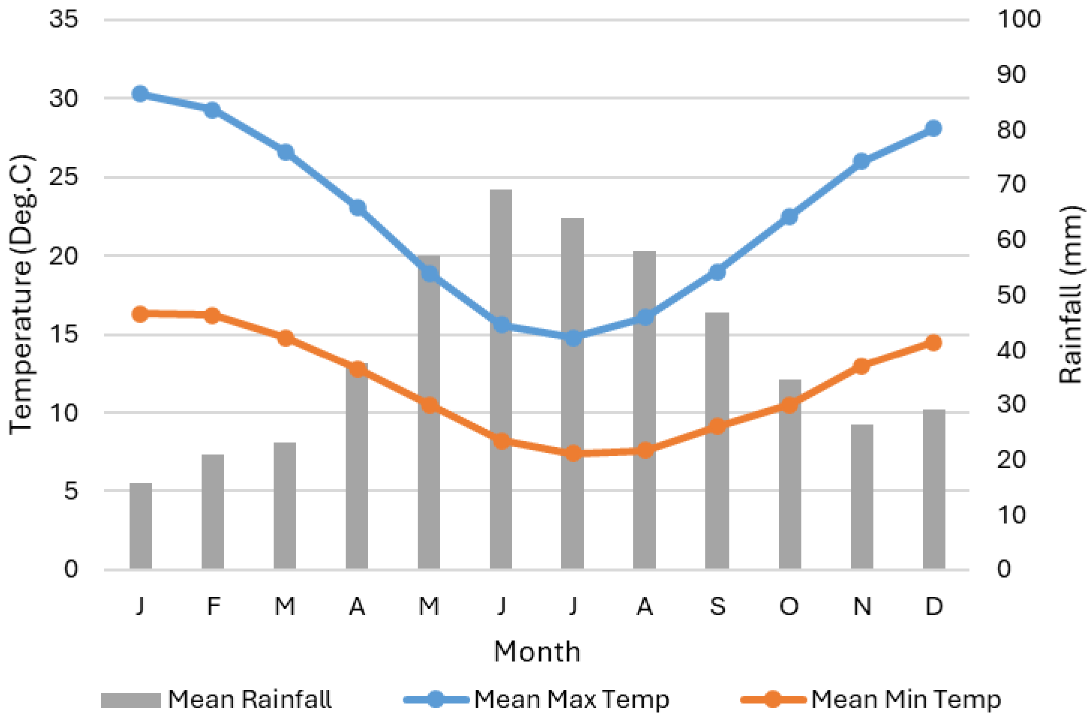

Figure 2.1. Mean monthly rainfall, maximum and minimum temperatures for Maitland

Source: Bureau of Meteorology (rainfall data 1879–2020; temperature data 1956–2020)

2.2 Topography

The YP district consist of a diversity of landscape features, such as rugged cliffs, sandy bays, agricultural plains, salt lakes, samphire flats, granite outcrops, and limestone karsts.

The South Hummock Range lies north of Port Wakefield. Around Bute there are gently undulating plains sloping towards the coast. The plains are overlain by dunes which run in a north-west to south-east direction and are typically 5–10 metres high. There are short watercourses from the Hummocks–Barunga Ranges that dissipate on the western slopes.

South of Kadina, the land is undulating to gently undulating with few prominent hills or well-defined drainage lines. The highest point is 240 metres above sea level just north-east of Arthurton. On the southern YP between Edithburgh and Warooka there are many saline lakes and swamps that are barely above sea level. These generally fill with water in winter and dry out over summer.

2.3 Soil types

Nine major soil groups occur within the YP district (Table 2.2 and Figure 2.2). Calcareous soils are the most widespread (39% of area), followed by shallow soils on calcrete or limestone (32%), and deep sands (14%).

Table 2.2. Soil groups on cleared land in the Yorke Peninsula district

Soil group	Area (ha)	Percentage of cleared area
Calcareous soils (Group A)	261,100	38.8
Shallow soils on calcrete or limestone (Group B)	217,700	32.4
Deep sands (Group H)	91,500	13.6
Hard red-brown texture contrast soils (Group D)	43,000	6.4
Sand over clay soils (Group G)	36,700	5.5
Gradational soils with highly calcareous lower subsoil (Group C)	14,300	2.1
Wet soils (Group N)	5,500	0.8
Cracking clay soils (Group E)	2,000	0.3
Shallow soils on rock (Group L)	172	<0.1
Not applicable	306	<0.1
Total	672,200	**100%**

Source: State Land and Soil Information Framework

Further information in: DEW (2021a,b)

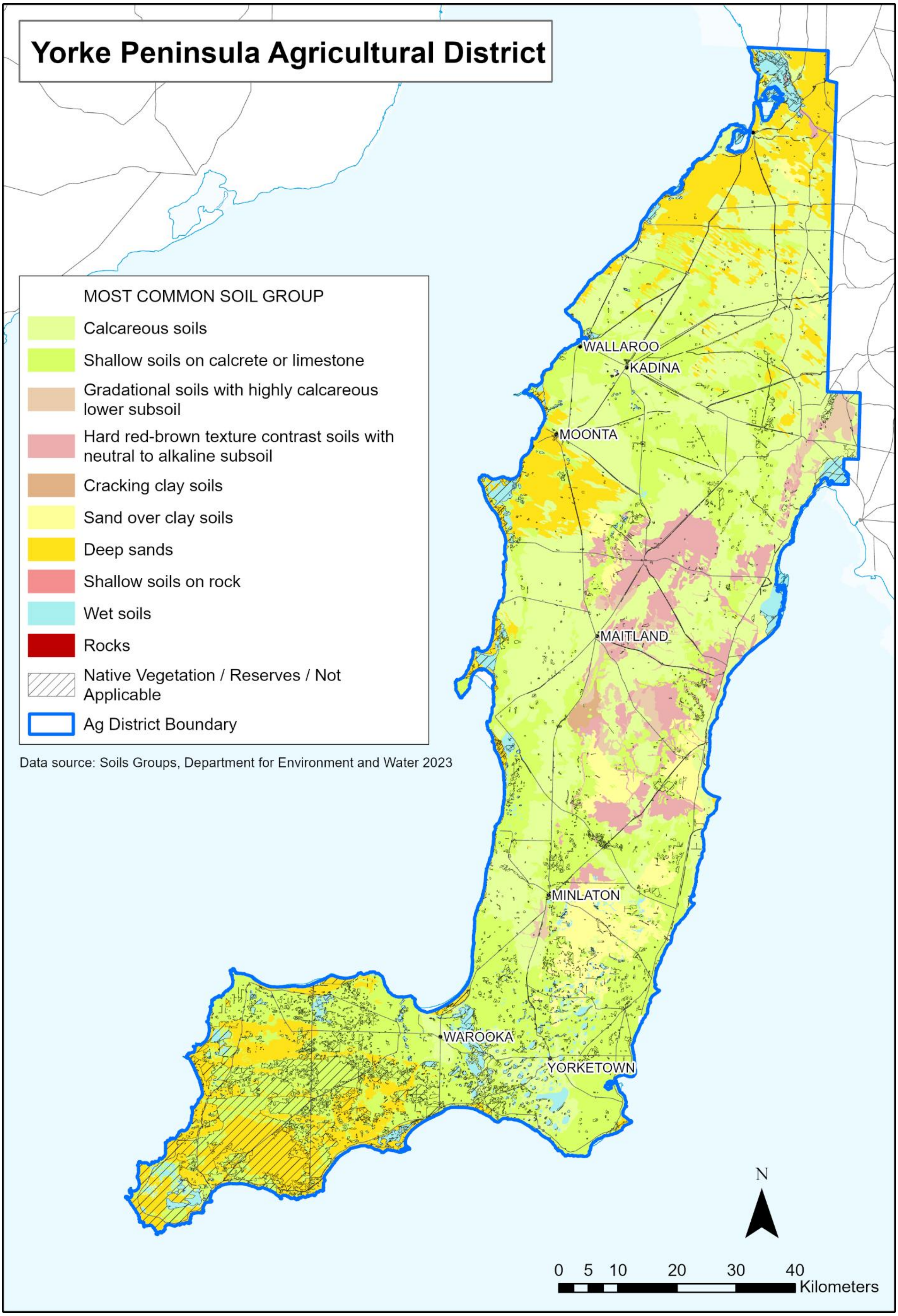

Figure 2.2. Most common major soil groups in the Yorke Peninsula district

2.4 Land use

Most land in the district (672,200 ha; 82% of the district) is used for dryland agriculture (Figure 2.3), of which approximately 85% (571,000 ha) is cropped each year. The main crops are lentils, barley, wheat, hay, durum, canola, beans, peas and smaller areas of chickpeas, oats, vetch, lupins and triticale.

Sheep and beef cattle are also significant enterprises.

There are 134,800 ha (16.4% of land) of native vegetation in the district (Figure 2.3), predominantly within conservation areas. This includes the large Dhilba Guuranda–Innes National Park (Dhilba Guuranda–Innes) on the 'foot' of the Peninsula, and a number of Conservation Parks which are important for supporting the region's biodiveristy: including Althorpe Islands, Bird Islands, Clinton, Leven Beach, Minlacowie, Point Davenport, Ramsay, Thidna, Troubridge Island, Warrenben and Wills Creek, which are important biodiversity resources for the district. There are also a number of smaller reserves, and Heritage Agreement properties, as well as remnant native vegetation along roadsides, swamps and saline areas.

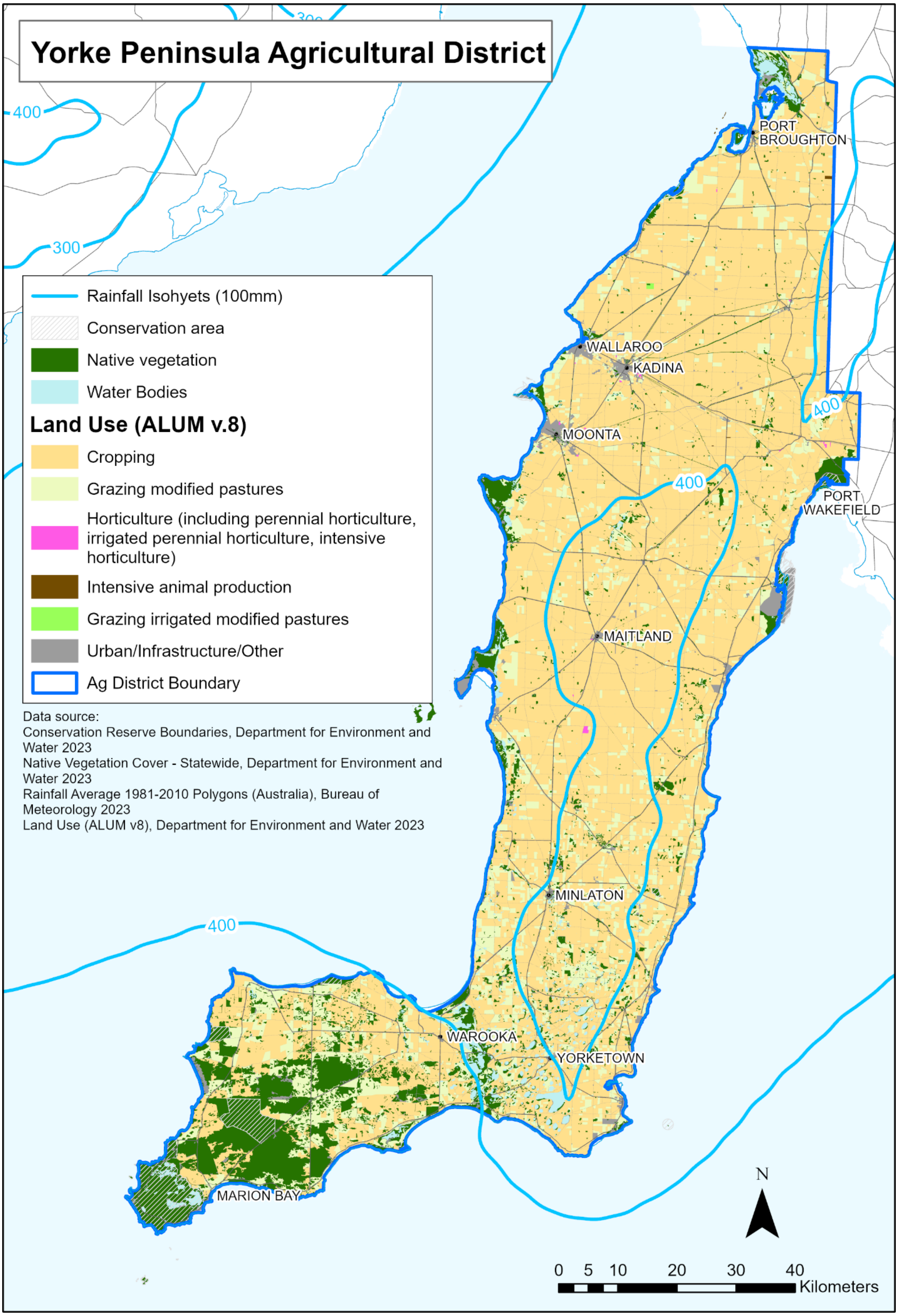

Figure 2.3. Land use types in the Yorke Peninsula district with rainfall isohyets

3 Soil acidity causes and impacts

3.1 Causes

Soil acidity is an increasingly widespread and significant issue across the YP district, especially on the hard red-brown texture contrast soils, gradational soils and sand over clay soils.

Although soil acidity is an inherent characteristic of some agricultural soils, the rate of soil acidification is accelerated under intensive and productive farming practices. Key drivers include increased use of ammonium-based nitrogen fertilisers (especially sulphate of ammonia), nitrate leaching, and the removal of alkaline nutrients in plant and animal products.

Table 3.1 illustrates the acidifying effects of some commonly used nitrogen fertilisers. For example, approximately 65 kg/ha of lime is required to neutralise the acidification associated with the application of to 100 kg/ha of Di-Ammonium Phosphate (DAP) while approximately 83 kg/ha of lime is required to neutralise acidification resulting from an application of 100 kg/ha of urea.

The amount of lime needed (lime equivalent) to counteract the acidification caused by agricultural product removal is shown in Table 3.2. For example, 36 kg/ha of lime is needed to maintain soil pH following the removal of 4 t/ha of cereal grain.

Table 3.1. Lime equivalents to neutralise acidification of common fertiliser products (at 50% leaching rate

Fertiliser	Nitrogen content (%)	Kg lime per kg N to neutralise acidification	Kg lime per 100 kg product to neutralise acidification
Urea	46	1.8	83
Ammonium nitrate	34	1.8	61
Sulphate of ammonia	21	5.4	113
Di-ammonium phosphate (DAP)	18	3.6	65
Calcium nitrate	15	-1. 4[a]	-21
Mono-ammonium phosphate) (MAP)	10	5.4	54
Superphosphate	0	0	0

a. Increases alkalinity

Source: Adapted from Cregan and Helyar (1986)

Table 3.2. Lime equivalents to neutralise acidification from removal of agricultural products from the paddock

Product type	Kg lime required to neutralise acidification per tonne of product removal
Wheat grain	9
Grain legume	20
Pasture (60% legume)	40
Lucerne hay	60
Cereal hay	30
Wool	14

Source: Adapted from Slattery et al. (1986)

Rates of soil acidification due to agricultural production vary according to land use, farming system and productivity (Table 3.3). Acidification rates are typically higher in more intensive and productive farming systems.

Table 3.3. Typical acidification rates (equivalent lime requirement to neutralise) of different cropping and grazing intensities

Land use	Category / intensity	Acidification rate (kg/ha/y) lime equivalent
Cropping	Continuous cropping	250
	Intensive cropping	200
	Cropping / Grazing	100
Grazing	Intensive grazing	150
	Moderate grazing	100
	Extensive grazing	40

Source: Adapted from Merry (Unpubl.)

3.2 Effects of soil acidity

When soil pH falls below 5.5 ($CaCl_2$), the availability of key nutrients, including calcium, phosphorus, magnesium, zinc and molybdenum, declines, leading to reduced plant growth and productivity. Increased soil acidity also suppresses microbial activity, resulting in lower rates of nutrient mineralisation. The survival of *Rhizobia*, essential for effective nodulation and nitrogen fixation in pulse crops, is diminished If soil pH declines below 4.8 ($CaCl_2$), aluminium becomes increasingly soluble and can reach toxic concentrations in the soil solution. Elevated aluminium levels restrict root growth and development, further limiting water and nutrient uptake and reducing crop performance.

Crop and pasture species vary widely in their sensitivity to soil acidity. Species such as lucerne, lentils, annual medics and faba beans are particularly sensitive to acidic conditions. As soil acidity increases, even more tolerant species may experience reduced growth and productivity (Table 3.4). Understanding species-specific tolerance to soil acidity helps inform crop and pasture selection and prioritise timely soil testing and liming.

Table 3.4. Tolerance of crops and pastures to soil acidity (low soil pH and soluble soil aluminium)

Very Sensitive	Sensitive	Tolerant	Highly tolerant
Lentils	Canola	Wheat[a]	Oats
Faba Beans	Phalaris	Sub-clover	Triticale
Chickpeas	Barley	Ryegrass	Lupins
Lucerne	Wheat[a]		Couch grass
Annual medics	Peas		
Durum wheat			

a. Some wheat varieties are sensitive while others are tolerant. Wheat varieties that have some tolerance include Wyalkatchem, Mace and Scepter.

Source: Condon & Conyers (2021)

Symptoms of soil acidity include reduced, uneven crop and pasture growth (Figure 3.1), yellowing of crops, poor nodulation of legumes and restricted root development. If soil acidification is not addressed, a further reduction in productivity is likely, thereby limiting plant options to acid tolerant crops and pastures. Acid-tolerant weed species, including ryegrass, couch grass and sorrel, may also dominate in areas affected by soil acidity.

Figure 3.1. Symptoms of low soil pH (soil acidity) in a Faba bean crop, including stunted growth and plant yellowing

Soil acidification occurs more rapidly in sandy-textured soils due to their low pH buffering capacity. In contrast, calcareous soils, defined by the presence of calcium carbonate ($CaCO_3$) throughout the soil profile, typically exhibit little or no long-term change in pH, as the $CaCO_3$) effectively neutralises acidity.

If soil acidification is left untreated, the sub-surface and sub-soil layers may also be affected. Acidification may also occur directly in subsurface soil layers as crops exude H^+ ions, acidifying the rooting zone. This sub-surface and sub-soil acidification can be much more difficult and expensive to treat.

Where plant growth is reduced in acidic soils, plant water use is often reduced. This can contribute to rising water tables and increased soil salinity. Additionally, the occurrence of bare or partially bare soils as a result of reduced plant growth under acidic conditions increases the risk of wind erosion.

Soil pH stratification is an increasingly recognised issue in no-till cropping systems and permanent pastures, particularly where acid-sensitive crops and pasture species are grown. Stratification occurs when soil pH in the surface layer is relatively higher than in the underlying soil, primarily due to the retention of plant residues at the surface, surface application of lime, and the limited downward movement of lime through the soil profile. As a result, the sub-surface layer, typically at 5–15 cm depth, and the subsoil layers below may continue to acidify over time. This leads to the development of a pronounced vertical pH gradient, with progressively lower pH values below the top few centimetres of soil (Table 3.5).

To adequately characterise soil pH stratification, soil sampling and monitoring of acid soils should, where practicable, be undertaken at 5 cm depth increments rather than conventional 10 cm intervals. This approach provides improved resolution of acidity in the sub-surface soil layers (e.g. 5–10 cm and 10–15 cm), which are often more strongly affected by acidification than the surface layer.

Table 3.5. Example of soil pH stratification at a SARDI lime trial site at Sandilands on the Yorke Peninsula

Lime Source & application rate[a]	Soil pH ($CaCl_2$)[b,c]		
	Depth (cm)		
	0-5	5-10	10-15
Control	4.41	4.07	4.26
Penrice 2 t/ha	5.24	4.23	4.43
Penrice 4 t/ha	5.55	4.45	4.60
Penrice 6 t/ha	5.97	4.90	4.63
Kulpara 4 t/ha	5.05	4.31	4.38
Agricola 4 t/ha	5.99	4.48	4.45
Warooka 4t/ha	5.77	4.40	4.78
Penrice 4 t/ha incorporated*	5.82	4.55	4.64
Penrice 6 t/ha incorporated*	6.38	5.21	4.86

a. Applied in 2019. All treatments were surface applied except for the last two (*).

b. Soil pH tests done in autumn 2023

c. Least Significant Difference LSD (0.05) = 0.42

Source: GRDC project (UOA 2206-009RTX). Unpublished data.

3.3 Yield penalty and production loss

When soil pH ($CaCl_2$) declines below 5.5, the growth and productivity of many crops and pasture species are adversely affected. Yield reductions associated with increasing soil acidity for a range of crops and pastures are presented in Table 3.6 and Figure 3.2. Crop and pasture responses to soil acidity can vary depending on soil type, management history, and varietal tolerance, and therefore actual yield impacts may differ from those presented.

Table 3.6. Estimated percentage yield loss for crop commodities due to low soil pH ($CaCl_2$)

	Percentage grain yield loss relative to control		
Crop	**pH 5.0-5.5**	**pH 4.5-5.0**	**pH <4.5**
Wheat	0	5	10
Durum	5	15	30
Barley	5	15	30
Peas	5	15	30
Lupins	0	0	5
Beans	15	30	50
Chickpeas	15	30	50
Lentils	15	30	50
Vetch	15	30	50
Canola	3	10	20
Hay	5	15	30
Oats/triticale	0	0	5
Medic	15	30	50
Clover	0	20	40

Source: Adapted from Stott, Crawford and Norng (2019)

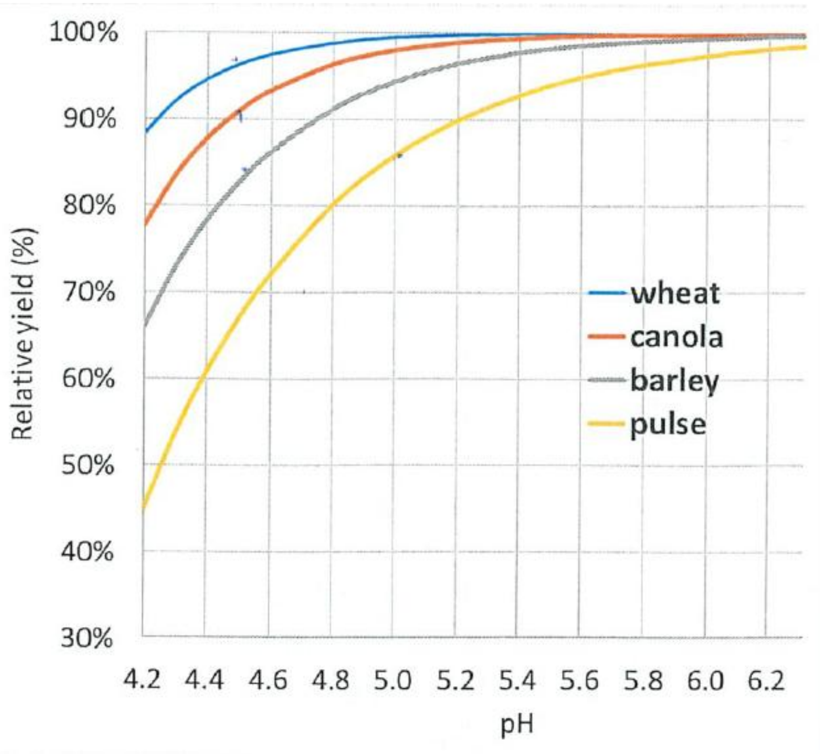

Figure 3.2. Estimated decrease in crop yield due to decrease in soil pH (from Stott et al. 2019)

In the YP district, the estimated annual production loss attributable to soil acidity in 2020 was approximately $6.3 million, based on the area of land assessed as acidic at that time (Harding 2023, unpublished; Appendix A). If no additional soil acidity management practices are implemented, the estimated annual production loss is projected to increase to approximately $10.4 million over the next 10-50 years (Appendix B).

Without effective and ongoing management, productive farming systems will continue to increase both the extent and severity of soil acidification. Practices such as regular liming or other soil amendment and modification strategies are required to mitigate further degradation of soil productivity.

4 Treatment of soil acidity

Soil acidity can be managed through a range of approaches, including the application of alkaline amendments (such as agricultural lime and dolomite), soil modification techniques that redistribute or incorporate alkaline material, and changes to farming systems to reduce acidification rates through crop selection, fertiliser management and residue management. Organic amendments and soil conditioners may also improve soil physical condition and buffering capacity but generally have limited capacity to directly neutralise soil acidity.

Among these options, the application of agricultural lime and targeted soil modification practices are the most effective and widely adopted methods for directly ameliorating acid soils in a South Australian broadacre farming context and are the focus of this report. Lime application is the primary means of increasing soil pH in surface layers. Soil modification techniques, such as ripping, delving, spading and clay spreading, can be used where appropriate, to address sub-surface acidity by incorporating lime deeper into the profile or introducing neutral or alkaline sub-soil material. These approaches are only suitable where underlying sub-soil materials are neutral to alkaline.

4.1 Lime

The application of agricultural lime is the most widely used method for neutralising acid soils. Lime requirements are determined by the initial soil pH, target (desired) soil pH, soil texture, and lime quality, expressed as neutralising value (NV). Typical application rates range from approximately 2 to 3 t/ha at 100% NV, although higher rates may be required in some situations. Lime is generally applied at intervals of around 8 to 10 years to neutralise ongoing soil acidification.

Agricultural lime is predominantly composed of $CaCO_3$ and may also contain magnesium carbonate ($MgCO_3$) at varying concentrations, such as in dolomitic lime (e.g. Kulpara dolomite).

The cost of lime application depends on application rate, lime quality, freight distance and spreading costs, and typically ranges from approximately $120 to $240 per ha. As lime moves slowly through the soil profile, incorporation or mixing within the topsoil (e.g. through tillage) may improve the rate and effectiveness of pH correction. It may take several years to achieve the target soil pH if lime is applied to the surface only.

Once soil pH has been increased to the target level (e.g. pH 5.5 $CaCl_2$), the economic return from liming is generally rapid. For a wheat–barley–lentil rotation, the estimated payback period, time taken to recover treatment cost outlay from increased production returns, is approximately 0.3 to 0.5 years, based on average yields and commodity prices. This will vary with crop type, rotation, yield and market conditions. Ongoing maintenance applications of approximately 2 to 3 t/ha every 8 to 10 years are required to counteract annual acidification.

In addition to productivity benefits, liming plays an important role in maintaining soil health, providing environmental benefits (better nutrient efficiency, reduced N fertiliser requirement, increased microbial activity) and reducing the risk of subsurface and subsoil acidification.

4.2 Soil modification

A range of machinery may be used to modify soils to raise their pH, both with and without the incorporation of lime. Ripping, delving or clay spreading are options on the YP for the treatment of acid soils. These options involve mixing neutral or alkaline sub-soil clay throughout the topsoil (see examples in Figure 4.1). It is crucial that the pH (and presence of $CaCO_3$) of the sub-soil clay is checked to ensure adequate alkalinity before using these methods. In soils that do not contain alkaline sub-soils, the addition of lime is recommended if ripping, delving or clay spreading. Figures 4.2 and 4.3 show the potential for clay spreading and delving on soils with acidity potential in the YP district. The criteria for clay spreading is the presence of a sandy surface soil texture. For clay delving, the requirements are a sandy surface soil texture, subsoil clay shallower than 60 cm, a clay layer thicker than 30 cm, and no rock within 60 cm.

Table 4.1 summarises some of the soil modification treatments, the estimated costs and the estimated payback periods of increasing the soil pH from 4.5 to 5.5. The payback period was based on a wheat–barley–lentil rotation, and focused primarily on remediating soil acidity, but additional benefits may be achieved with the use of soil modification. Depending upon the modification method used, these may include overcoming water repellent sands, reducing compaction, reducing erosion, improving soil structure and fertility, and improving water holding capacity. It is important to identify all soil constraints before undertaking soil modification to ensure that it is a suitable approach.

For all the soil modification methods outlined in Table 4.1 below, thorough incorporation of neutral-alkaline clay into the topsoil is required to be effective for treating soil acidity. Other machinery options can include deep ripping with inclusion plates, Bednar plough, off-set discs, one-way plough, mouldboard plough, with and without the addition of lime.

Table 4.1. Soil modification treatments for acid soils, approximate costs and payback periods

Tillage method	Summary	Est. cost ($/ha)[a]	Est payback (y)[b]	Longevity (y)[c]
Deep Ripping	• Deep ripping results in minimal incorporation depending on the ripper tynes, however it can bring up neutral or alkaline clay which can alter surface soil acidity, provided that the clay is within 0.6 metres of the surface. • Ripping will only be effective on acid soils if neutral or alkaline clay is brought to the surface. In trials at Sandilands and Bute, ripping has not been effective for amending acid soils. • Bryce and Pluska (2021) estimated that the effects of deep ripping (e.g. reduced soil compaction) may last for two to ten years depending on the soil type and traffic management.	60–100	0.1–0.2	2–10
Spading	• Spading mixes soil to a maximum working depth of 0.35–0.4 metres. There needs to be adequate neutral or alkaline clay close to the surface to be effective. Can incorporate a range of surface spread amendments (e.g. lime, gypsum, organic matter, sub-soil clay and nutrients). • Trial at Bute showed that spading significantly increased lentil yields, but spading with lime had a greater effect on soil pH and lentil yields (Foxx 2023). • Bryce and Pluska (2021) estimated that the effects of spading for managing acidity may last three to ten or more years.	130	0.3	3–10
Delving and incorporation	• Delving (Figure 5.1) is the use of wide tynes that bring up neutral to alkaline pH clay from the lower part of the soil profile (to maximum 0.6 m depth) to the surface layer (Woodard and Harding 2010). The delved clay then needs to be incorporated into the surface soil.	300–450	0.6–1.0	10+
Clay spreading and incorporation	• If the clay is too deep in the profile for delving, clay spreading can be an option. • Clay spreading is the removal of sub-soil clay from excavated soil pits, transportation to the site and spreading on the soil surface (Figure 5.2). The total distance from the clay pit must be considered in the total cost per ha. If the distance is too far, the cost of	500–800	1.1–2.0	Up to 20+

Tillage method	Summary	Est. cost ($/ha)[a]	Est payback (y)[b]	Longevity (y)[c]
	transporting the clay to the site will prove un-economic. • The clay spreading rates can vary from 100 to 300 t/ha. The neutral to alkaline clay on the surface will need to be fully incorporated. The cost depends on the machinery used, amount of clay applied per hectare, distance travelled from • the pits, the amount of material stockpiled, and the amount of incorporation (Woodard and Harding 2010). • Monitoring in the South East has shown that clay spreading has mostly lasted for 40 years, with continued improved production on treated paddocks. However, in some paddocks, re-acidification has occurred after 10–20 years (Dennerley and Fraser 2016), particularly where clays that were spread contained little or no lime.			

a. Approximate cost of tillage method ($/ha) without added lime

b. Approximate payback period (years)

c. Estimated time the treatment may last (years)

Figure 4.1. Clay delving (left) and clay spreading (right) at Bute.

4.2.1 Amelioration of acidic and sub-surface or sub-soil layers

Sub-surface and subsoil acidity can develop where surface soils are already acidic and where inherent soil properties or intensive production accelerate acidification. Maintaining surface soil pH above 5.5 ($CaCl_2$) is important, as once acidity develops at depth it is difficult and costly to remediate, with tillage-based interventions only feasible for some soils.

Various trials across SA have demonstrated that high rates of lime can be effectively incorporated into soils using tillage-based methods such as ripping, rotary hoes, or mouldboard ploughs. These techniques have proven effective at thoroughly mixing lime throughout the surface soil layer (0–10 cm), ensuring more uniform pH correction and faster amelioration of acidity in the root zone. In some soils, these methods can also facilitate partial movement of lime into the sub-surface layers, improving pH in deeper horizons and helping to reduce the risk of subsoil acidity. The choice of method depends on soil texture, machinery availability, and the depth of acidity, with careful consideration needed to avoid soil structural damage or erosion risk. Findings of recent lime trials in the YP district are given in Section 5.3.

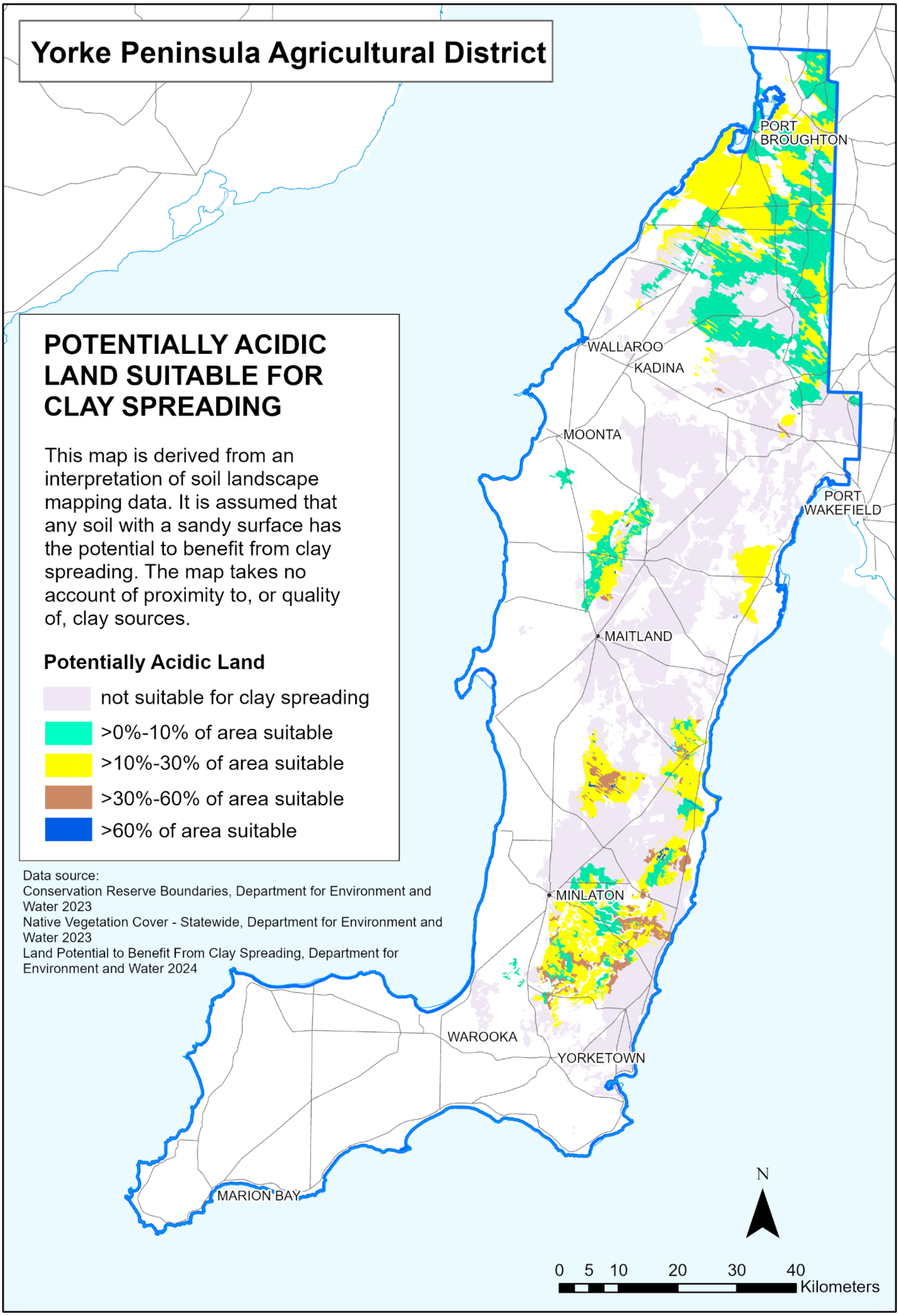

Figure 4.2. Potentially acidic land suitable for clay spreading in the Yorke Peninsula district

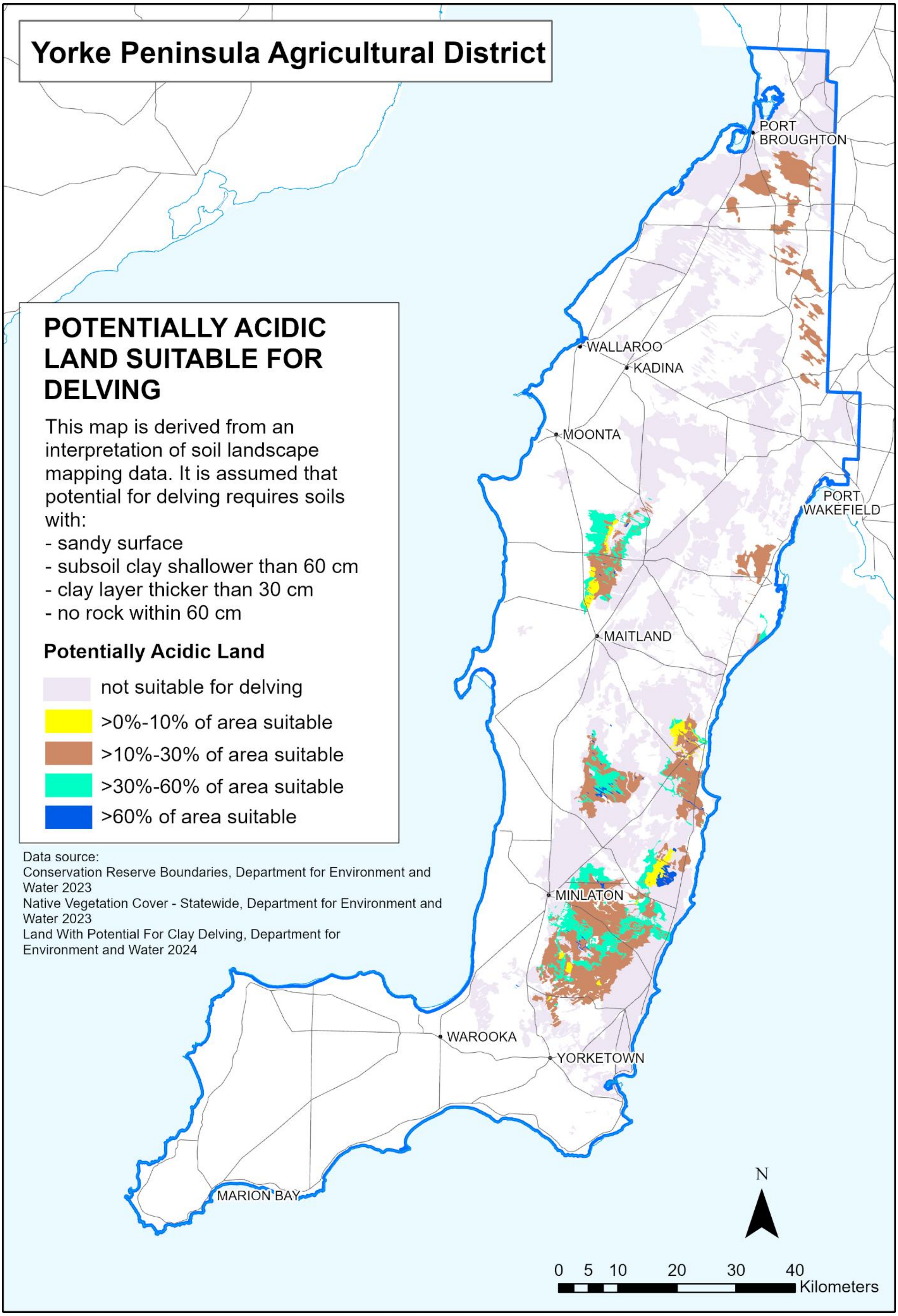

Figure 4.3. Potentially acidic land suitable for clay delving in the Yorke Peninsula district

5 Soil acidity in the Yorke Peninsula district

5.1 Area affected

The distribution of acid soils in the YP district was determined from DEW's soil attribute database using the Australian Soil Resource Information System (ASRIS) data set.

Figure 5.1 shows the distribution of currently acidic ($pH_{CaCl2} \leq 5.5$) surface soils (0–10 cm), as well as those at risk of acidification in the short term and soils that are not likely to become acidic in the short term but could become acidic over the long term without intervention (i.e. liming or other soil modifications practices).

It is estimated that in 2025 approximately 66,000 ha (10%) of agricultural land on the YP were affected by acid soils (Appendix C). The total area of potential acid soils (Appendix C), which could become acidic in the future without adequate management is 109,900 ha (16% of agricultural land). The possible timeframe for development of future acidity is thought to be in the order of 10-50 years but will vary according to soil, climate and management factors.

Highly productive, intensive cropping systems with high nitrogen inputs result in the highest acidification rates. As a result, these areas have the highest risk of soil acidification, even when current soil pH levels are close to neutral. Soil acidification occurs more quickly on soils with low pH buffering capacity (i.e. sandy textured soils). Emerging soil acidity can appear in a patchy distribution within paddocks, depending on the soil type and management practices.

Soils with a surface pH of at least 7.5 ($CaCl_2$) or those highly calcareous in nature are considered to have no future acidification potential. These soils occur mostly along the western side of the YP, on the 'foot' of the Peninsula and in smaller areas on the eastern side near Price.

The area affected by sub-surface or sub-soil acidity is unknown, but is likely to occur in areas where the surface soil is currently acidic, or in areas where the surface soil is at risk of acidity.

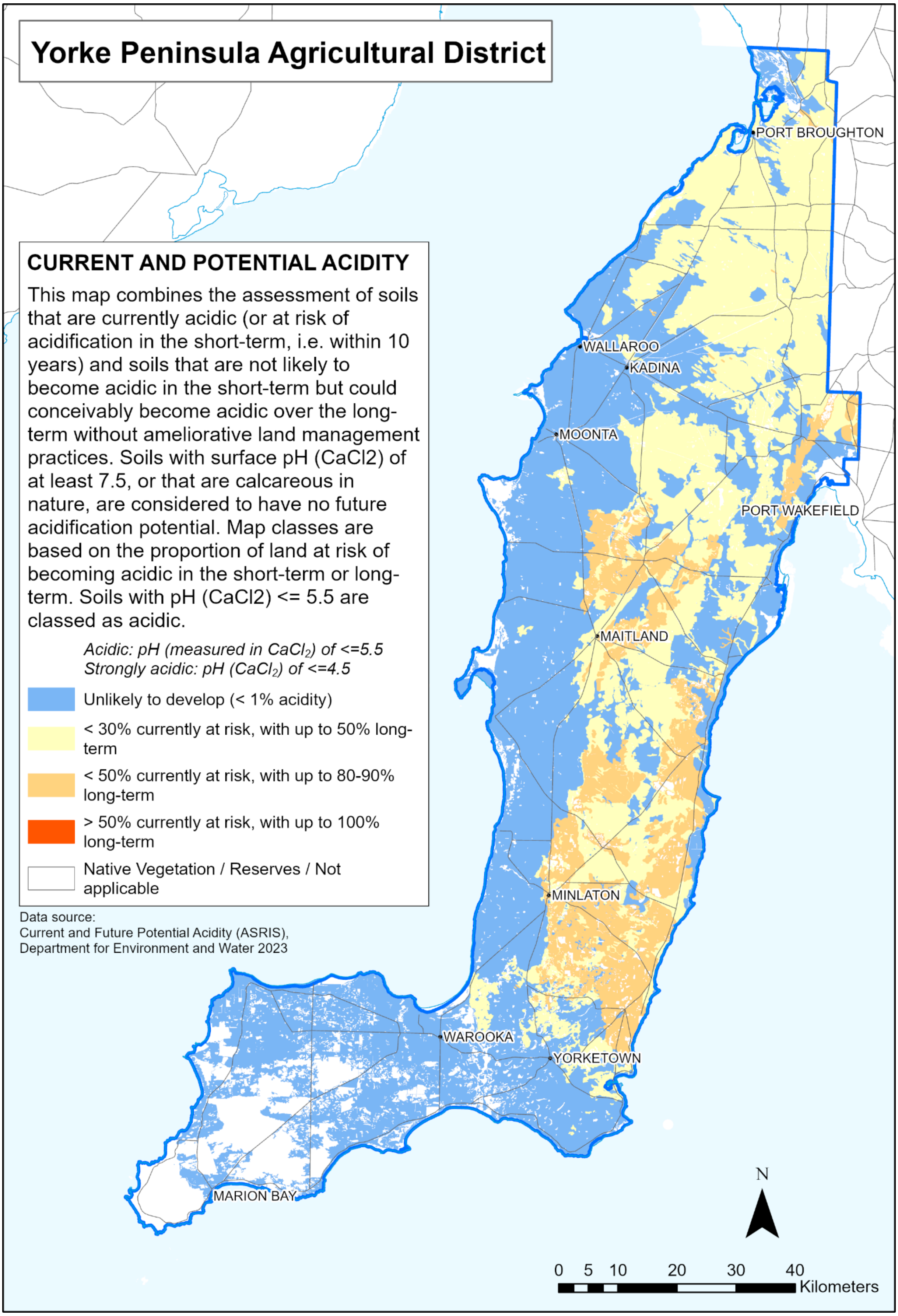

Figure 5.1. Current (baseline at 2015) and future potential acidity in the Yorke Peninsula district

5.2 Soil pH monitoring

5.2.1 Monitoring sites

Soil pH surveillance and monitoring sites have been established in areas of the South Australian agricultural zone which are already acidic or susceptible to developing acidity, to gain a better understanding of the extent and severity of acid soils and to monitor changes over time.

Surveillance sites are designed for rapid one-off surface measurements of soil pH, whereas monitoring sites are used for tracking long-term soil pH changes at set depths down the profile and over time (Forward and Hughes 2019). Traditionally, measurements are taken at 10 cm increments but are increasingly sampled at 5 cm increments to account for pH stratification.

Formal soil pH surveillance and monitoring sites have yet to be established in the YP district, as soil acidity is a relatively new and expanding issue in this region. However, liming trials have been established to assess production responses and effects on soil pH (Section 5.3).

5.2.2 Soil pH mapping

Soil pH mapping has been available to landholders since 2015, either through grid mapping or with a Veris® soil pH mapping machine. In SA, there are now six businesses offering Veris® pH mapping, and three businesses offering grid mapping. Most of these businesses have carried out some mapping on the YP.

Of the total area mapped by PIRSA–SARDI on the YP using the Veris® machine (1,211 ha), more than 21% of the area had a soil pH less than 5.5 ($CaCl_2$). Of the total area below pH 5.5 ($CaCl_2$), 56% had a soil pH of 5.0–5.4; 31% had a pH of 4.5–4.9 and 13% had a pH less than 4.5 ($CaCl_2$).

Figure 5.2 shows a paddock (36.6 ha) at Sandilands mapped by a Veris® machine with soil samples taken at approximately 5–8 cm depth. This paddock has a coarse sandy loam (25 cm deep) with some ironstone and quartz gravel over a reddish medium clay. The map demonstrates the variability of soil pH ($CaCl_2$) across the paddock scale, ranging from 3.8 to 8.0. About half of the paddock (51%; 18.7 ha) had a soil pH ($CaCl_2$) less than 5.5. Precise soil pH mapping is useful as it can identify areas for targeted lime application.

Normalised Difference Vegetation Index (NDVI) is a metric for measuring plant health and biomass, using the reflection of red and infra-red light in satellite imagery. NDVI data can be used to produce crop yield maps and provide a guide for identifying acidic soils. Areas mapped as having low plant biomass (NDVI maps) or low yield could be an indicator for the presence of acidic soils, only if all other plant growth constraints have been eliminated as causes (e.g. disease, nutritional problems, weeds, soil types, rockiness etc.). Acid-sensitive crops such as lentils are particularly good indicators of acidity through NDVI mapping. Figure 5.2 highlights this by demonstrating the relationship between a soil pH map and lentil NDVI map. Using this paddock data, the annual value of production loss for lentils could be in the order of $8,446 (based on $700/t) or an average loss of $230/ha.

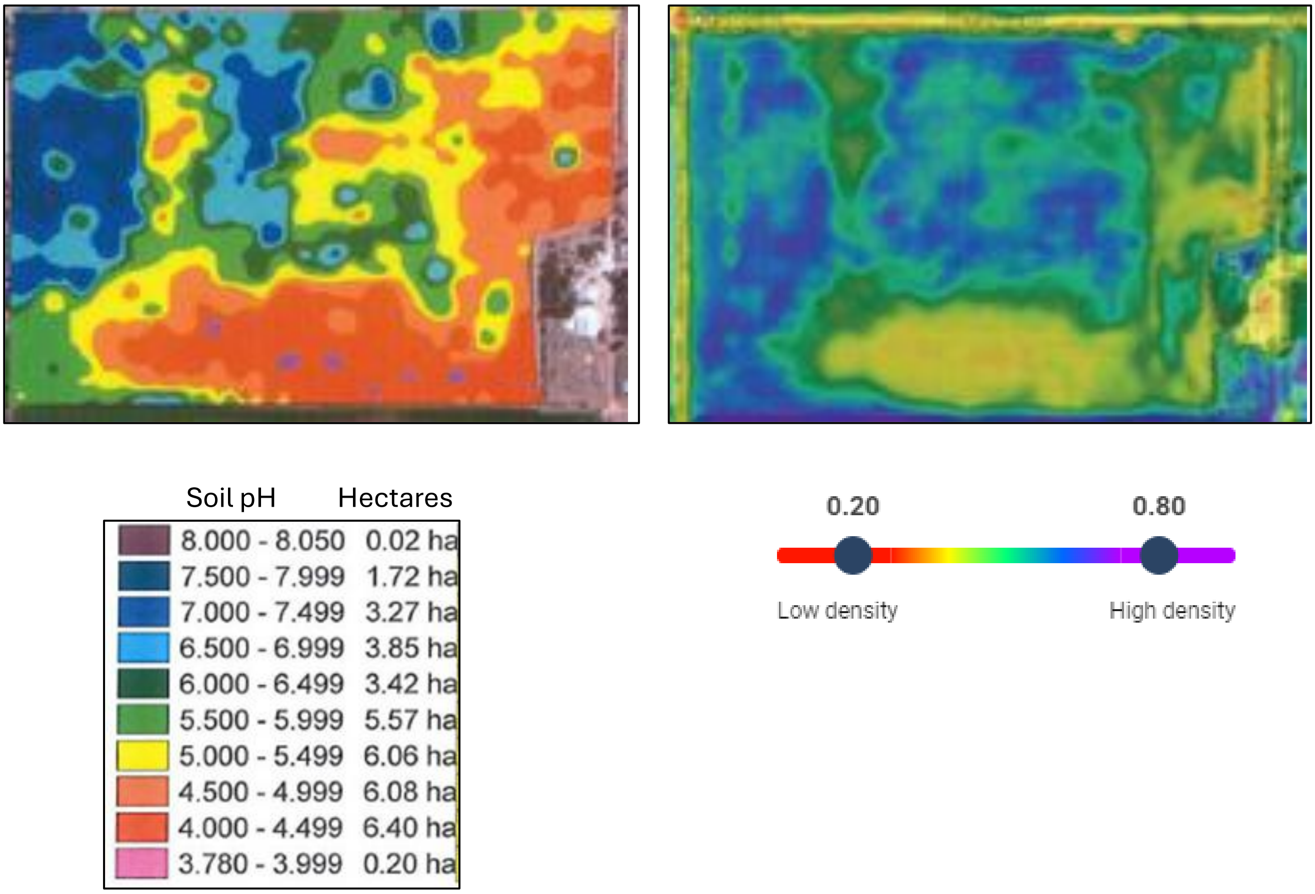

Figure 5.2. Soil pH Veris® map, Sandilands with pH area table (left); NDVI (Decipher) map of lentils on same paddock, measured in August (right)

5.3 Lime trials

As part of Grains Research and Development Corporation (GRDC) funded projects, lime trials were established in the YP district in 2019: One at Sandilands (GRDC project UOA 2206-009RTX), and two at Bute (GRDC project UOA 2206-009RTX and USA103-002RTX). These were implemented to assess the effects of different lime products, rates of lime application, and the application method used (broadcasting versus incorporation) on soil pH and resulting crop and pasture production. A further trial partly funded by GRDC was established by Trengove Consulting, PIRSA, Southern Cross University and University of SA, at Bute in 2019.

Sandilands (2019–2024):

- Treatments included a range of lime products including Penrice, Kulpara, Agricola and Warooka at different rates, with or without tillage.
- Consistent responses were achieved with lime in most years; up to 30% in lentils and 10-20% in wheat.
- The highest yield responses occurred with lime at 6 t/ha, followed by lime at 4 t/ha.
- Most products applied at 4 t/ha produced little change in soil pH at depths below 5 cm, indicating minimal downward movement of lime through the profile.
- Lime at 6 t/ha with tillage produced the largest increase in soil pH below 5 cm.

Bute (1) (two trials)

- The first trial investigated the effectiveness of four different lime sources.
- Lime sources included Kulpara, Angaston, Penlime, Clare Quarry and a local source, applied at 2 or 4 t/ha.
- Over five years, there were no differences in grain yield and quality between the lime product or rates treatments. The lack of lime responses were attributed to the site being only marginally acidic.
- The second trial investigated the effect of seven incorporation techniques with lime at 4.6 t/ha.
- There was no significant overall yield response to applied lime with any of the incorporation methods over five years. In common with the first trial, the general lack of response to lime application was attributed to the site being only slightly acidic.
- Some yield responses occurred in individual seasons: There was a yield response in lentils (but not cereals) in two seasons with ripping, off-set inclusion plate and spading treatments.

Bute (2)

- The aim of the trial was to understand how the uniformity of soil lime mixing by spading affected crop response and soil pH.
- Treatments included lime rates of 2.2 and 6.6 t/ha with a low, medium or high uniformity of spading.
- In the fourth year of the trial, increased lentil yields were achieved from spading and lime treatments. Addition of lime and mixing with low, medium or high uniformity were the highest yielding treatments.

5.4 Soil acidification and lime use

5.4.1 Lime requirement

DEW has estimated the annual lime requirement for the YP district from a spreadsheet model that uses several data sources, including the types and intensity of agricultural land uses, and the extent of acidic soils (DEW 2023). This incorporates estimated changes in the area of acid soils and lime requirement over time.

DEW and PIRSA are developing a spatial model for more accurate estimation of annual acidification rates for different soil types, land use and rainfall.

The estimated annual lime requirement for the YP district has increased from less than 200 tonnes in 2010 to 11,000 tonnes in 2025 (Figure 5.3).

The lime requirement on YP is projected to potentially increase to 13,700 tonnes by around 2050. This estimate is based on assumptions of increasing agricultural production, particularly more intensive and productive cropping systems, and higher nitrogen use over time.

This estimate is for the surface soil layer (0–10 cm) only and does not include the lime required to balance sub-surface soil acidification (this has not yet been estimated).

5.4.2 Lime use

Lime use data has been collected from lime sellers indicating the amount of lime used annually on agricultural land in SA since 1999 (within financial years). Lime use within the YP district is estimated from this data using local knowledge held by PIRSA–SARDI soils and farming systems specialists.

About 11,600 tonnes of lime was used on acidic agricultural land in the YP district in 2025 (Figure 5.3). This is a decrease from 16,800 tonnes estimated in 2024, possibly due to the dry season in 2024 and limited availability of lime from some sources. Lime applied (as a three-year average to 2025) was 13,500 tonnes per year (Appendix C). It is assumed that there was no lime used prior to 2015. From 2015 to 2020, lime use increased slightly to 2,900 tonnes, then increased markedly in 2021 and 2022. This is likely to be due to increased landholder awareness of emerging acidity on YP from extension activities, such as workshops and presentations, lime trial work and paddock soil pH mapping.

Lime use will need to continue to increase or at least be maintained in coming years due to the increasing estimated trend in lime requirement (Figure 5.3).

In the YP district, lime is sourced from several quarries, including Kulpara, Clare Quarry (Spalding), Penrice (Angaston), Barossa Lime (Seelander quarries), Barossa quarries, and the recently established White Hut Lime at Daly Head. Barossa lime can be accessed from the Clinton depot (Figure 0.1).

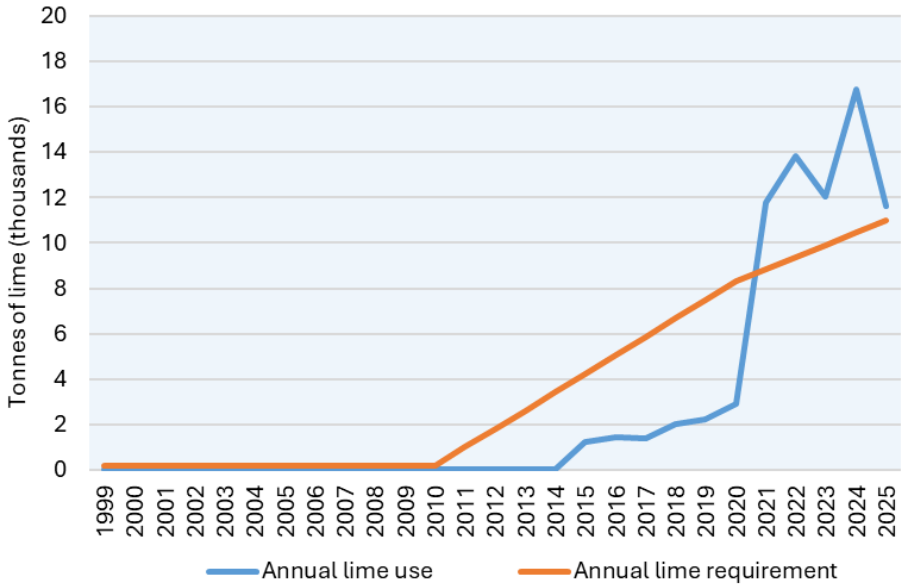

Figure 5.3. Estimated annual lime use and lime requirement in the Yorke Peninsula district, 1999–2025

5.4.3 Lime balance

To better understand the risk of soil acidification and future lime requirements in the YP, estimates of lime use were compared to the amount of lime that would be required to neutralise the estimated annual acidification rate of soils (i.e., lime requirement). Subtraction of the actual lime use from the lime requirement gives the lime balance in the district (i.e., potential lime deficit). The cumulative lime balance since 1998 (start of available lime use data) is shown in Figure 5.3.

Until 2020, the amount of lime used on YP was below the estimated lime requirement (Figure 5.3). This has resulted in an accumulated lime deficit (shortfall) which reached 37,000 tonnes in 2020 (Figure 5.4). This indicates that soil acidity was generally increasing over this period. Due to the large increase in lime use since 2020, (as discussed in Section 5.4.2) the accumulated lime deficit has decreased to 20,900 tonnes in 2025. If lime rates continue to be higher than the lime requirement in coming years, this accumulated lime deficit could reduce to zero. However, a further lime deficit would likely have accumulated prior to 1998.

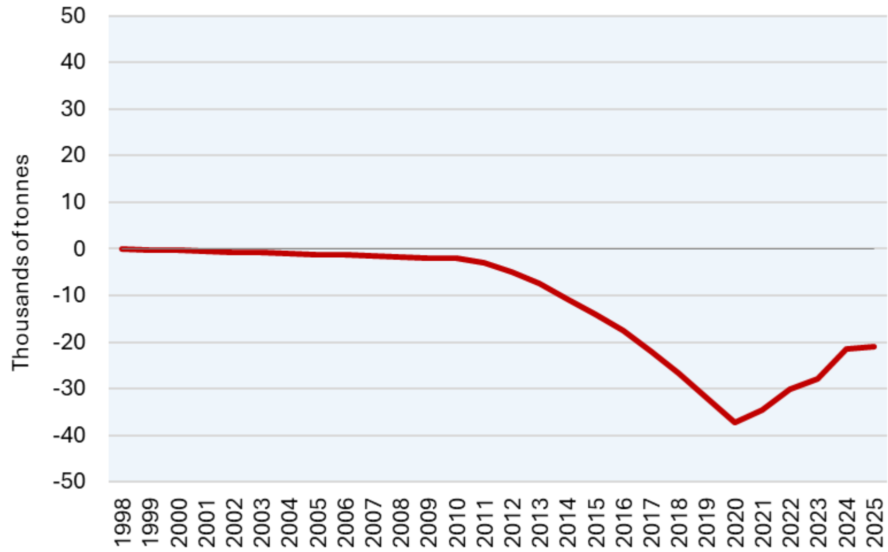

Figure 5.4. Estimated cumulative lime balance the Yorke Peninsula district, 1999–2025

5.4.4 Catch-up lime requirement

In addition to the annual lime application needed to balance annual acidification rates, lime is also required to raise the pH level of existing acidic soils to fully productive levels. This is termed the 'catch-up' lime requirement. It is the sum of historic or inherent acidity (pre-agricultural use) and induced acidity due to agriculture.

The catch-up lime requirement for the YP district up to year 2000 was estimated to be 2,230 tonnes, to raise the surface (0–10 cm depth) pH to 5.5 and the sub-surface (10–20 cm depth) pH to 5.0. This was estimated from soil pH test data and soil type information (DEW, 2023).

6 Conclusions

Soil acidity is becoming increasingly widespread and significant in the YP district, especially on the hard red-brown texture contrast soils, gradational soils and sand over clay soils, where it is having a detrimental effect on crop and pasture yields. It is important that land managers and agricultural advisers are made aware of the significant threat and cost of soil acidity to the district's productivity.

An estimated 10% (66,000 ha) of agricultural land was acidic in 2025, and a total of 16.4% (109,900 ha) is potentially acidic. Soil pH mapping (e.g., Veris® and grid sampling) in acid-risk areas has shown that soil pH can be quite variable within paddocks, over a range of several pH units. This is a valuable method to identify acidic soil areas and guide lime application and other treatments. Soil pH should be regularly tested (approximately every five years) to monitor acidity levels and avoid pH falling below critical levels for plant production. Ongoing monitoring of soil pH after treatment of soil acidity will be required as productive agricultural soils will continue to acidify. Liming is the most common and effective approach to treat acidity, while soil modification techniques (provided that the underlying clay is close to the surface and has a neutral or alkaline pH) such as spading, delving or clay spreading, are also options for the treatment of acid soils.

Soil acidity trials have shown that treatment of acid soils in the YP district can be financially beneficial. Long-term liming and acidity trials should be maintained to evaluate the extended effects of treatments on soil pH and productivity, with findings actively shared to guide effective acidity remediation strategies.

Lime has been increasingly used to treat acid soils on YP since 2016. Lime use was less than the estimated lime requirement up to 2020, and a lime balance deficit accumulated, increasing soil acidity. Since then, the lime deficit has lessened as lime use rates have exceeded the lime requirement. Lime use rates need to continue to increase to overcome this deficit and reduce acidification.

Lime supply and demand should be monitored in the district to track lime availability against current and potential future demand, and to assess lime inputs compared to the annual lime requirement.

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8 Appendices

A. Yield penalty due to current acidity (2020) in the YP district

Yield Penalty Model - Currently acidic									**Yorke Peninsula**	
Total Agricultural Area		**674,128**		**Est Ha actual acidity 2020**		**49,919**	**7.40**	**%**		
Area of land currently acidic at 2020									49,919	ha
Crop	85	% Pasture	15	%						
Crop	Assume	42,431	hectares acidic							
Assume	100	% is below a pH 5.5 and not treated with lime (lime sales data)						42,431	ha	
Assume	56	% at pH 5.0 - 5.5 ($CaCl_2$)		23,761	hectares		From soil pH mapping data			
	31	% at pH 4.5 - 4.9 ($CaCl_2$)		13,154	hectares					
	13	% at pH <4.5 ($CaCl_2$)		5,516	hectares					
				Area (hectares)						
Assume	Crop	% area		pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5				
	Wheat	30		7128	3946	1655				
	Durum	2		475	263	110				
	Barley	31		7366	4078	1710				
	Peas	2		475	263	110				
	Lupins	0.5		119	66	28				
	Beans	2		475	263	110				
	Chickpeas	1		238	132	55				
	Lentils	24		5703	3157	1324				
	Vetch	0.5		119	66	28				
	Canola	1		238	132	55				
	Hay	2		475	263	110				
	Oats/triticale	4		950	526	221				
		100		23,761	13,154	5,516				
				% yield loss				t/ha yield loss		
Assume	Production losses	Ave Yield		pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5		pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5
	Wheat	3.49		0	0.05	0.1		0.0	688.6	577.5
	Durum	3.22		0.05	0.15	0.3		76.5	127.1	106.6
	Barley	3.5		0.05	0.15	0.3		1289.1	2140.8	1795.5
	Peas	1.82		0.05	0.15	0.3		43.2	71.8	60.2
	Lupins	1.4		0	0	0.05		0.0	0.0	1.9
	Beans	2		0.15	0.3	0.5		142.6	157.8	110.3
	Chickpeas	1.26		0.15	0.3	0.5		44.9	49.7	34.8
	Lentils	2		0.15	0.3	0.5		1710.8	1894.1	1323.9
	Vetch	0.58		0.15	0.3	0.5		10.3	11.4	8.0
	Canola	1.8		0.03	0.1	0.2		12.8	23.7	19.9
	Hay	4.6		0.05	0.15	0.3		109.3	181.5	152.2
	Oats/triticale	2.8		0	0	0.05		0.0	0.0	30.9
				Value ($)						
Assume	Value of production losses	Prices ($/t)		pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5		Total		
	Wheat	350		0	241,008	202,136		$443,144		
	Durum	450		34,430	57,179	47,957		$139,566		
	Barley	300		386,718	642,227	538,642		$1,567,587		
	Peas	450		19,461	32,319	27,106		$78,885		
	Lupins	400		0	0	772		$772		
	Beans	500		71,284	78,922	55,160		$205,367		
	Chickpeas	700		31,436	34,805	24,326		$90,567		
	Lentils	700		1,197,577	1,325,889	926,696		$3,450,162		
	Vetch	600		6,202	6,866	4,799		$17,867		
	Canola	630		8,084	14,916	12,510		$35,510		
	Hay	200		21,861	36,304	30,449		$88,613		
	Oats/triticale	250		0	0	7,722		$7,722		
	Total value of crop losses			**$6,125,762**						

Pasture	Assume	7,488	hectares acidic					
Assume	100 %	is below a pH 5.5 and not treated with lime (lime sales data)					7,488	ha
Assume	56 %	at pH 5.0 - 5.5 ($CaCl_2$)		4,193	hectares			
	31 %	at pH 4.5 - 4.9 ($CaCl_2$)		2,321	hectares			
	13 %	at pH <4.5 ($CaCl_2$)		973	hectares			
				Area (ha)				
Assume	Pasture	% area		pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5		
	Acid sensitive	50		2,097	1,161	487		
	Acid tolerant	50		2,097	1,161	487		
				4,193.2	2,321.2	973.4		
				t/ha				
Assume	Production losses (t/ha)			pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5		
	Acid sensitive			0.15	0.3	0.5		
	Acid tolerant			0	0.2	0.4		
				$				
Assume	Value of production losses	Prices ($/t)		pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5	Total	
	Acid sensitive	150		47,173	52,228	36,503	$135,904	
	Acid tolerant	150		0	34,819	29,203	$64,021	
	Total value of pasture production losses			**$199,926**				
	Total value of production losses			**$6,325,687**		per annum		

B. Yield penalty due to estimated future acidity in the YP district

Yield Penalty Model - Future acidic									**Yorke Peninsula**	
Total Agricultural Area		**674,128**		**Est Ha actual acidity 2050**		**82,457**	**12.23**	%		
Area of future land acidic									82,457	
Crop	85 %	Pasture	15 %							
Crop	Assume	70,088	hectares acidic							
Assume	100 %	is below a pH 5.5 and not treated with lime (lime sales data)						70,088		
Assume	56 %	at pH 5.0 - 5.5 ($CaCl_2$)		39,250	hectares		From soil pH mapping data			
	31 %	at pH 4.5 - 4.9 ($CaCl_2$)		21,727	hectares					
	13 %	at pH <4.5 ($CaCl_2$)		9,111	hectares					
				Area (ha)						
Assume	Crop	% area		pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5				
	Wheat	30		11775	6518	2733				
	Durum	2		785	435	182				
	Barley	31		12167	6736	2825				
	Peas	2		785	435	182				
	Lupins	0.5		196	109	46				
	Beans	2		785	435	182				
	Chickpeas	1		392	217	91				
	Lentils	24		9420	5215	2187				
	Vetch	0.5		196	109	46				
	Canola	1		392	217	91				
	Hay	2		785	435	182				
	Oats/triticale	4		1570	869	364				
		100		39,250	21,727	9,111				
				% yield loss				t/ha yield loss		
Assume	Production losses	Ave Yield		pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5		pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5
	Wheat	3.49		0	0.05	0.1		0.0	1137.4	954.0
	Durum	3.22		0.05	0.15	0.3		126.4	209.9	176.0
	Barley	3.5		0.05	0.15	0.3		2129.3	3536.1	2965.8
	Peas	1.82		0.05	0.15	0.3		71.4	118.6	99.5
	Lupins	1.4		0	0	0.05		0.0	0.0	3.2
	Beans	2		0.15	0.3	0.5		235.5	260.7	182.2
	Chickpeas	1.26		0.15	0.3	0.5		74.2	82.1	57.4
	Lentils	2		0.15	0.3	0.5		2826.0	3128.7	2186.8
	Vetch	0.58		0.15	0.3	0.5		17.1	18.9	13.2
	Canola	1.8		0.03	0.1	0.2		21.2	39.1	32.8
	Hay	4.6		0.05	0.15	0.3		180.5	299.8	251.5
	Oats/triticale	2.8		0	0	0.05		0.0	0.0	51.0
				$'s						
Assume	Value of production lo:	Prices ($/t)		pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5		Total		
	Wheat	350		0	398,101	333,891		$731,992		
	Durum	450		56,873	94,449	79,215		$230,537		
	Barley	300		638,786	1,060,841	889,738		$2,589,365		
	Peas	450		32,145	53,384	44,774		$130,304		
	Lupins	400		0	0	1,276		$1,276		
	Beans	500		117,749	130,365	91,115		$339,228		
	Chickpeas	700		51,927	57,491	40,182		$149,600		
	Lentils	700		1,978,176	2,190,124	1,530,732		$5,699,032		
	Vetch	600		10,244	11,342	7,927		$29,513		
	Canola	630		13,353	24,639	20,665		$58,656		
	Hay	200		36,110	59,968	50,295		$146,373		
	Oats/triticale	250		0	0	12,756		$12,756		
	Total value of crop losses			**$10,118,631**						

Pasture	Assume	12,369	hectares acidic					
Assume tha		100	% is below a pH 5.5 and not treated with lime (lime sales data)				12,369	ha
Assume		56	% at pH 5.0 - 5.5 ($CaCl_2$)	6,926	hectares			
		31	% at pH 4.5 - 4.9 ($CaCl_2$)	3,834	hectares			
		13	% at pH <4.5 ($CaCl_2$)	1,608	hectares			
				Area (ha)				
Assume	Pasture	% area		pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5		
	Acid sensitive	50		3,463	1,917	804		
	Acid tolerant	50		3,463	1,917	804		
				6,926.4	3,834.3	1,607.9		
				t/ha				
Assume	Production losses (t/ha)			pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5		
	Acid sensitive			0.15	0.3	0.5		
	Acid tolerant			0	0.2	0.4		
				$				
Assume	Value of production lo:	Prices ($/t)		pH 5.0 - 5.5	pH 4.5 - 5.0	pH <4.5	Total	
	Acid sensitive	150		77,922	86,271	60,297	$224,489	
	Acid tolerant	150		0	57,514	48,237	$105,751	
	Total value of pasture production losses			**$330,240**				
	Total value of production losses			**$10,448,871**	per annum			

C. Summary statistics of soil acidity in agricultural districts and SA

Region	Eyre Peninsula			Northern & Yorke				Central		Murraylands			South East		State
District	WEP	EEP	LEP	UN	MN	LN	YP	CHF	KI	NM	SM	LM	USE	LSE	Ag zone
Land use															
Native vegetation (ha)	1,094,018	349,901	294,092	722,952	322,830	83,318	134,839	191,589	257,526	342,635	458,526	415,981	575,199	230,561	5,473,968
Agric. land (ha)	1,335,791	690,272	426,818	900,192	746,586	244,470	672,167	252,036	175,742	536,048	846,462	301,641	938,948	893,374	8,960,546
Other (ha)	22,872	5,299	16,893	6,093	7,532	18,807	14,200	42,358	5,372	14,205	53,128	29,659	26,740	27,170	290,327
Total (ha)	2,452,681	1,045,472	737,803	1,629,237	1,076,948	346,595	821,207	485,984	438,640	892,887	1,358,115	747,281	1,540,887	1,151,105	14,724,841
Production loss															
Value of ag production 5 year average ($M/y)[a]	313	297	377	313	431	149	580	26	18	131	191	86	196	100	3,207
Loss of production ($M/y)[b]	0.1	1.2	13.7	6.2	9.4	6.7	6.3	6.9	6.9	0.7	0.1	4.0	14.7	10.6	87.3
Extent acid soils (applies to agricultural land only)															
Estimated acidic soils at 2025 (ha)[c]	5,278	88,881	166,071	150,442	217,815	109,881	66,017	203,435	150,939	3,765	86,914	18,724	398,027	358,243	2,024,432
Estimated future acidic soils (ha)[d]	84,837	208,041	202,941	263,804	276,159	123,256	82,457	208,538	153,820	8,385	193,644	37,829	495,617	411,745	2,751,073
Potential acidic (ha)[e]	113,116	277,388	270,588	351,738	368,213	164,342	109,943	221,444	161,916	20,964	484,110	94,573	708,024	588,207	3,934,565
Acidification rate 2025 (t lime/y)[f]	604	10,966	32,707	17,463	32,213	20,373	10,997	18,314	13,698	231	7,084	1,516	20,827	27,584	214,578
Lime applied 3y average (2025) (t/y)	0	13,042	47,625	17,981	35,962	22,476	13,486	18,546	20,022	225	3,367	898	40,871	27,248	261,747
Accumulated lime balance (2025) (t)[g]	-4	-49	-50	-75	-125	-139	-20.88	78	38	-1	-71	34	100	50	-234
Catch-up lime (2000) (t)[h]	0	28,553	178,754	176,354	272,208	142,708	2,232	373,900	365,091	5	71,737	38,566	478,138	523,754	2,652,001
Catch-up lime pre-2000 (t/ha acidic)	0.00	1.77	1.77	2.24	2.24	2.24	2.24	2.04	2.56	3.46	3.46	3.46	2.11	2.11	2.18

[a]Crop (grain) production only, 5-year mean to 2023–24

[b]As per Appendix A

[c]Estimated current area of actual acidic soils

[d]Estimated area of actual acidic soils in the next 10-50 years

[e]Total area of potentially acidic soils (could acidify in the future, if untreated)

[f]Estimated annual acidification rate on currently acidic soils (0-10cm)

[g]Cumulative annual lime use minus lime requirement (acidification rate) since 1999

[h]Estimated lime needed to raise pH of existing acid soils (at year 2000) to pH_{CaCl} 5.5 (0–10 cm) and pH_{CaCl} 5.0 (10–20 cm)

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