# Resilient Eyre Peninsula 2020-2023, focus paddock summary


Jacob Giles and Andrew Ware, EPAG Research



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# Resilient EP Project – Focus Paddocks

The Resilient EP project utilized a network of 42 soil moisture probes representative of the major environments and soil types found on Eyre Peninsula. Information collated from the soil moisture probes helped provide growers and advisors real time insights to the levels of stored soil moisture, which coupled with rainfall, form the biggest limiting factor of production in the region. This helped inform more reliable production and yield targets, allowed farmers to match inputs and adjust management strategies to suit.

To build confidence in the decisions that could be improved through an increased understanding of soil water eight focus paddocks were chosen to more intensively sample, monitor and test new approaches. These paddocks were sampled both close to the soil moisture probe and across the paddock to help provide understanding of how soil moisture and crop production at the probe site related to the rest of the paddock.

The focus paddocks were also utilized to provide background information for local discussion groups held around each of the focus paddocks. The discussion groups helped increase grower awareness of a range of alternative management strategies, ground truth hypotheses and aided increasing adoption.

Below is a summary of key learnings from each of the focus paddocks:

**Definitions**

PAWC – Plant available water content of a soil (or bucket size)

PAW – Plant available water – how much water that a soil is holding at a given time that is available to plants to utilise

N – Nitrogen

NUE – Nitrogen use efficiency

OC – soil organic carbon (%)

# Mount Dutton – Bruce Morgan

## Overview

This site is typical of much of the arable land south of Edillilie on Lower Eyre Peninsula. The soil type consists of a sandy loam topsoil transitioning to a heavy clay from 40-50cm. Ironstone is present throughout, with up to 40% of the soil volume consisting of gravel some areas of the paddock. The high proportion of gravel results in a poor ability of the soil to hold both water and nutrients. This coupled with frequent large rainfall events during winter makes nitrogen (N) difficult nutrient to manage. Grain yields are typically well behind the Cockaleechie and Yeelanna sites at around 4t/ha. Low plant available water capacity (PAWC), particularly in lower parts of the root growth zone, can result in rapid use of available water during spring, when temperatures and plant demand for water increase. In years like 2020 and 2022, with timely spring rainfall and below average early spring temperatures grain yields were high (6.2 and 5.5t/ha paddock average), but in years with high winter rainfall and or dry (2021) finishes yields are considerably lower (3.5t/ha). Acidity in the upper horizon gives itself to growing mainly Lupins as a nitrogen fixing break crop. Pastures are also a common break, and a mixed farming system lends itself well to such a soil type and environment.

## Issues

Soil: Acidity, Ironstone and poor soil structure leading to poor water and nutrient retention ability.

Biotic stresses: Ryegrass, foliar disease (Septoria, Blackleg, SFNB).

Soil Profile, 7 October 2020.



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**Rainfall, rotation and yield – Mt Dutton**

| Year | Crop Type | Rainfall (mm) Nov-Mar | Rainfall (mm) Apr-Oct | Yield (t/ha) |
|---|---|---|---|---|
| Long Term | | 84 | 436 | |
| 2022 | Barley | 233 | 425 | 5.5 |
| 2021 | Wheat | 93 | 477 | 3.2 |
| 2020 | Wheat | 55 | 426 | 6.2 |
| 2019 | Canola | 69 | 396 | NA |
| 2018 | Lupins | 136 | 419 | 1.93 |
| 2017 | Wheat | 118 | 356 | NA |
| 2016 | | 130 | 515 | NA |

*Table 1: Crop, average rainfall and yields 2016-2022 at Mt Dutton. Rainfall source: BOM (Coulta).*

## Paddock benefits and limitations.

This site has high rainfall and generally cooler finishes due to its southern location and proximity to the coast. This can lead to particularly high yields on occasion, but yields have shown to be highly variable. With lower yields in some years, driven by the periods of waterlogging during winter, poor water holding capacity of the soil and erratic spring rainfall. High winter rainfall paired with poor soil structure drives concerns of poor nitrogen use efficiency due to leeching, de-nitrification and yield targets not being realized with poor spring rain.

**Yield and deep N at sampling points.**

| | 2020 | | | 2021 | | | 2022 | | |
|---|---|---|---|---|---|---|---|---|---|
| Way-point | N (kg/ha) | *total N (starting + added) | Yield (t/ha) | N (kg/ha) | total N (starting + added) | Yield (t/ha) | N (kg/ha) | total N (starting + added) | Yield (t/ha) |
| 1 | 75 | 268 | 6.1 | 55 | 197 | 3.5 | 51 | 170 | 5.6 |
| 6 | 50 | 242 | 6.9 | 36 | 178 | 3.2 | 92 | 212 | 4.4 |
| 13 | 66 | 258 | 7.1 | 69 | 211 | 3.3 | 98 | 239 | 6.5 |
| 16 | - | - | 6.8 | 49 | 191 | 3 | 51 | 177 | 5.9 |
| 17 | - | - | 6.7 | 50 | 192 | 2.8 | 86 | 210 | 5.9 |
| 18 | - | - | 7 | - | - | 5.4 | 84 | 222 | 6.6 |
| Prob | 115 | 307 | 6.2 | 37 | 179 | 3.3 | 64 | 223 | 5.4 |

*Table 2. Nitrogen and resulting yields at sampling points in the Mt Dutton focus paddock 2020-2022. *Total N = pre-seeding soil mineral N (0-60cm) plus N added in season.*

**What have we learnt?**

The quantity and timing of rainfall coupled with the soil type has led to highly variable grain yields on this site. Matching N supply to match demand is extremely difficult to optimise in most seasons in this environment. Discussion groups in paddock and the Regional Innovators Group meetings have highlighted the importance of a strong balance between a N-fixing break crop and a lesser reliance on the use of synthetic N fertiliser. However, this may not always be the most profitable option.

In 2020 we learnt that N applications applied in small quantities, relatively frequently, through to crop booting gave the best opportunity to obtain the maximum yield in this environment. Trials that took place in this paddock showed us just how valuable high N rates can be in the right season (Paddock N strip trial 2020), but also the in effectiveness of N when used at high rates in a more 'normal' season (N rate trial 2021, Paddock N strip trial 2021). This points toward the need to create a more stable supply of N. This could occur by changing the source of N used or the soil it is applied to.

## Conclusions, questions and solutions.

- A strong dependence on synthetic N has proven to be risky in this environment as target yields are volatile creating hugely variable season by season demand coupled with hard to predict N losses from to leaching and de-nitrification.
- The use of legume crops or pastures to supply N in a form that is available to match crop demand and isn't as prone to N losses is a potential solution. However, the low profitability of


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grain legumes best suited to this environment and infrastructure, labour requirements, volatile wool and meat prices of livestock systems mean the benefit of producing organic N needs to be accurately calculated over the cropping cycle in this environment to fully demonstrate their value to growers.

- Some growers in this environment are planting crops considerably earlier (in early to mid-April) than current recommendations. Growers in the Wangary area are finding success from early sowing through crops having high biomass and large root systems in June/July when rainfall is typically high, in doing so the crops are better able to increase N uptake and reduce losses. This system also has crops filling grain when temperatures are cooler and less exposed to variable spring rainfall. This system has crops flowering earlier than current modelled optimal windows. Validating this system, its risks and opportunities through updated and targeted multi-season modelling may help increase grower confidence and practice change.


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# Cockaleechie – Dan Adams

## Overview

This paddock represents some of the most productive soil found on Lower Eyre Peninsula, matching medium-high rainfall with a soil that has high PAWC. The soil consists of clay loam that becomes higher in clay content with depth with minimal gravel content. Carbonate levels increase in deeper sections of the soil profile. The water holding capacity of this soil is very high and offers great finishing ability even in dry springs. It typically produces high yields, where wheat yields of around 8t/ha across large areas can be achieved. Rotations are dominated by cereal and canola crops. Organic carbon levels are around 2%. High levels of inputs are applied, particularly N. Pulse crops are grown where soil type allows e.g., lentils are being grown on free draining soils; however, this still has its issues with yields and margins comparatively low to that of cereals and canola. This property is purely cropping.

**Soil issues**: Heavy surface soils, acidity (being actively managed with liming program), some areas of sub-soil sodicity.

**Biotic stresses:** ryegrass, foliar disease (Septoria, UCI blackleg, Eyespot, powdery mildew)

## Rainfall/ Rotation/ Yield

| | | Rainfall (mm) Nov-Mar | Rainfall (mm) Apr-Oct | Yield (t/ha) |
|---|---|---|---|---|
| Long Term | Crop Type | 81 | 340 | |
| 2016 | Barley | 145 | 401 | 7.2 |
| 2017 | Lentils | 132 | 252 | 1.1 |
| 2018 | Wheat | 60 | 313 | 6.3 |
| 2019 | Wheat | 43 | 319 | 5.5 |
| 2020 | Canola | 60 | 366 | 2.9 |
| 2021 | Wheat | 79 | 327 | 6.2 |
| 2022 | Wheat | 187 | 395 | 7.4 |

*Table 3: Crop, average rainfall and yields 2016-2022 at Cockaleechie. Rainfall source: BOM (Cummins).*

## Paddock benefits and limitations

Good soil structure and a lack of sub-soil constraints are two of the major benefits that ensure consistently high yields year to year. Quite unlike that of Mt Dutton, timing of in season rainfall isn't as critical. If PAWC is full or near full by early to mid-August, a wheat crop will yield around 6t/ha with well below average spring rainfall. This is what we learnt from 2021 and historical data shows similar

patterns in 2019. There may of course be exceptions to this with extreme weather events, such as heat shock events or frost.

Good soil structure also allows for a high nitrogen use efficiency (NUE) in comparison to other soils on the Lower Eyre Peninsula.

In season mineralisation of nitrogen is thought to be an important source of N supply for this paddock. Trial work in 2021 saw high yields with no significant differences across varying N treatments despite a spread of N rates, with N deficits being explained by high mineralization rates. Being able to predict mineralization rates more accurately in this environment may help refine N management strategies. However, due the reliable returns being achieved from N in this environment the grower is bullish in their approach to N application with mineralization only relied on to provide upside on high target yields or in high extremely high production years like 2022.

While the soil structure is good, small areas of the paddock become either too heavy, sandy or rock becomes present. Soil pH is variable across the paddock with sandier, rockier areas tending to maintain a lower pH. The grower has an active liming program to combat this and utilises VRT to address variable soil types.

The heavier topsoil found at this site can increase the risk of poor establishment particularly when seeding into dry/ partially dry soils. This ultimately results in less tillers per hectare and has the potential to decrease in yield. To combat this, variable seeding rates are used to match changes in soil texture.

Sporadic waterlogging can be an issue at Cockaleechie. However, this is restricted to relatively small areas and most commonly when water logging is experienced, most of the crop yields above average. In-season soil sampling in 2022 displayed the plant's ability to move roots past waterlogged subsurface layers and access dryer horizons further down the profile and showed minimal stress as a result.

**Yield and deep N at sampling points.**

| | 44Y90 CL Canola 2020 | Vixen wheat 2021 | | | | Vixen wheat 2022 | | | | Emu Canola 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Waypoint | Yield (t/ha) | N* (kg/ha) | Total* N (kg/ha) | Yield (t/ha) | Protein (%) | N (kg/ha) | Total N (kg/ha) | Yield (t/ha) | Protein (%) | N (kg/ha) |
| 1 (Probe) | 3.4 | 90 | 245 | 8.1 | 10.2 | 58 | 258 | 7.1 | 11.6 | 55 |
| 2 | 2.8 | 59 | 214 | 6.5 | 10.5 | 66 | 266 | 8.3 | 12.1 | 110 |
| 3 | 3.2 | 43 | 198 | 5.5 | 9.5 | 41 | 241 | 8.6 | 11.6 | 30 |
| 4 | 3.0 | 72 | 227 | 7.3 | 11 | 29 | 229 | 7.4 | 10.9 | 30 |
| 5 | 2.9 | 90 | 245 | 6.4 | 10.2 | 57 | 257 | 7.7 | 11.1 | 30 |

*Table 4: Nitrogen and resulting yields at sampling points in the Cockaleechie focus paddock 2020-2022. *Total N indicates initial measured (0-60cm) plus that added in season.*

## What have we learnt?

The use of soil moisture probes at this site have been highly valuable in helping determine yield potential and then match N supply to reach potential. This is driven by a high PAWC soil, and the reliable response to N application.

The use of variable rate technology is highly beneficial to the grower for liming, seeding rate and nitrogen according to pH, soil type and/or yield potential.

## Conclusions, solutions and questions.

- Very high yields are possible in this environment, driven by accurately targeting yield potential and matching N requirement. The use of tools such as measuring soil moisture either through a soil moisture probe or by using accurately calibrated models like Yield Prophet® and measuring soil N have greatly increased confidence in being able to push grain yields to levels past what was once thought only theoretically possible.
- The use of grain protein, coupled with yield maps in this environment has the potential to aid in understanding spatial variability of nitrogen levels across the landscape and offers the potential to further refine N application.
- Even with relatively high urea prices this site has demonstrated that cropping systems with low legume content can be highly profitable provided N can be applied at rates to match yield potential.
- (Relatively) high organic carbon appears to be a critical factor in this high production system in helping buffer sub-optimal applications in high production years.
- Variable rate technology is useful at this site.


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- This paddock has proven valuable in being able to push the yield frontier in the Lower EP region, helping provide new insights on the levels of production that are possible and how they can be achieved.

# Yeelanna – Jordan Wilksch

## Overview

This site has clay loam soil gradually increasing to a heavy clay at depth, however, does not have the yield potential of the Cockaleechie property due to sub-soil constraints, primarily sodicity. However, wheat will yield 5t/ha in an average year. Organic carbon of approximately 1.6% sees relatively good mineralisation of nitrogen. The paddock is suited to lentils in most parts. Stored soil moisture is valuable in most years as water is generally the main limitation of grain production in this area. This is due to slightly lower rainfall than Southern EP and ability to store high quantities of water in soils high with PAWC. Time of establishment can create stark yield contrasts. Heavy topsoil that requires significant rainfall to establish crops and can be an issue in some seasons.

**Soil issues**: Sub-soil sodicity, some boron at depth and some topsoil acidity.

**Biotic stresses**: ryegrass, foliar disease (Septoria, UCI blackleg)

## Rainfall/ Rotation/ Yield

| | Crop type | Nov-March Rainfall (mm) | Apr-Oct Rainfall (mm) | Grain Yield (t/ha) |
|---|---|---|---|---|
| **Year** | Long term | 83 | 330 | |
| **2016** | Wheat | 104 | 449 | |
| **2017** | Lentils | 108 | 256 | 1.1 |
| **2018** | Wheat | 97 | 346 | 7.5 |
| **2019** | Wheat | 42 | 346 | 6.5 |
| **2020** | Wheat | 48 | 349 | 4.2 |
| **2021** | Lentils | 90 | 338 | 2.5 |
| **2022** | Canola | 221 | 382 | 3.2 |

*Table 5: Crop, average rainfall and yields at Yeelanna from 2016 - 2022. Rainfall source: BOM (Yeelanna).*

## Paddock benefits and limitations

High PAWC (150mm) allows the grower to store large quantities of moisture. Like Cockaleechie, this can help reduce risk by allowing reliable targeting of yield, better use of out of season rainfall, and increased nitrogen use efficiency. It can also benefit the grower through a better estimation of the quantity of grain they will have to market and may even influence crop choice (i.e., lentils vs canola).

The major limitation in this paddock is sodicity. While some boron is found, extensive soil sampling and testing has shown that it is limited to minor parts of the paddock and high soil boron levels don't align with the larger low yielding areas of the paddock. Consistently lower yielding areas of the paddock are mainly seen when growing lentils. This is due to waterlogging as a result of low topography and higher clay content combined with high ESP values. The poorer producing zones in the paddock typically experience a 50-100% reduction in lentil yields, compared to lower wheat yields of approximately 10-50%. Gypsum spreading and incorporation has long been practiced on the farm (30 years), yet high levels of sodicity still exist.

At Yeelanna, time of establishment can create stark yield contrasts. Heavy topsoil requires significant rainfall to establish crops which can create large yield gaps between and within paddocks. This is especially an issue with canola. Precision seeding equipment is utilised to help counteract this issue.

## Yield and deep N at sampling points

| | Scepter wheat 2020 | | | XT Hurricane Lentils 2021 | | Emu Canola 2022 | | |
|---|---|---|---|---|---|---|---|---|
| **Waypoint** | **N to 60cm (kg/ha)** | ***Total N** | **Yield** (t/ha)** | **N to 60cm (kg/ha)** | **Yield (t/ha)** | **N to 60cm (kg/ha)** | **Total N (to 60cm)** | **Yield (t/ha)** |
| **Probe** | 62 | 198 | 4.2 | 101 | 2.8 | 84 | 204 | - |
| **4** | 102 | 238 | 6.0 | 13 | 2.1 | 82 | 202 | 2.9 |
| **8** | 88 | 224 | 6.6 | 48 | 3.3 | 110 | 230 | 3.4 |
| **11** | 122 | 258 | 5.9 | 38 | 0.7 | 76 | 196 | 3.4 |
| **14** | 83 | 219 | 6.7 | 63 | 3.6 | 88 | 208 | 2.8 |
| **17** | 67 | 203 | 3.1 | 39 | 3.2 | 117 | 237 | 3.2 |

*Table 6: Nitrogen and resulting yields at sampling points in the Yeelanna focus paddock 2020-2022. *Total N indicates initial measured (0-60cm) plus that added in season. **Yield attained from $m^2$ cuts taken immediately prior to harvest.*

## What have we learnt?

In 2020 the focus paddock was able to demonstrate the value of stored moisture in a year where spring rainfall was low. In 2019, the northern part of the paddock was terminated and cut for hay to help manage ryegrass. This had the effect of conserving soil moisture (around 60mm), leading to the wheat crop grown in 2020 yielding 2-3t/ha higher than where the 2019 crop was taken through to harvest. This demonstrates the value of understanding the quantity of PAW so that yield can be correctly targeted and fertilised.

Areas of high sodicity and low topsoil pH correlated strongly with lower yielding parts of the focus paddock. The linking of geo-referenced soil tests to yield maps has assisted in identifying the cause of the poorer production. The grower has been aware of this for some time and has applied gypsum and lime as a remedy, however these remain poorer producing parts of the paddock suggesting further intervention may be necessary.

**Conclusions, solutions, and questions.**

- Having a method to measure soil moisture and then understanding the effect that stored moisture has on grain production has greatly improved the accuracy of being able to predict grain yields and apply inputs accordingly on this paddock. In this instance an effective soil moisture probe that has been in place for over 6 years was able to achieve this.
- Despite 30 years of targeted gypsum application, sodicity is still having a negative impact on grain yield, particularly when lentil crops are grown. To improve the consistency of lentil production in this area further investigation is required on solutions to this issue.


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# Wharminda – Ed Hunt

**Overview**

Soils in the Wharminda area are typically sandy with varying degrees of non-wetting and various depths to clay. The clay can be hostile to plant growth with high carbonate and boron levels in some places. Typically, organic carbon and soil phosphorous levels are low. The area can experience frost events. Pastures are often sown vetch and provide good ground cover on sandy soils and a good source of organic N. While rainfall is significantly lower, this site presents some similar challenges to Mount Dutton. PAWC is relatively low, resulting in poor soil moisture stores when demand for moisture in high during spring. This tends to limit high inputs of N fertiliser required to chase high yields, as such inputs relatively small but 'topped up' as the grower depending on environmental signals during the growing season.

**Soil issues**: non-wetting sands and boron in sub-soil (frequently 60cm).

**Biotic stresses**: brome grass, foliar disease (Yellow leaf spot, SFNB)

Soil Profile, 7 October 2020.

**Rainfall, rotation and yield.**

| Year | Crop Type | Rainfall (mm) Nov-Mar | Rainfall (mm) Apr-Oct | Yield (t/ha) |
|---|---|---|---|---|
| Long Term | | 87 | 252 | |
| 2022 | Vetch | 205 | 115 | Hay |
| 2021 | Barley CL | 77 | 228 | 2.6 |
| 2020 | Wheat | 45 | 247 | 2.3 |
| 2019 | Pasture | 51 | 180 | |
| 2018 | Wheat | 109 | 192 | 1.3 |
| 2017 | Pasture | 89 | 205 | |
| 2016 | | 141 | 339 | |

*Table 7: Crop, average rainfall and yields at Wharminda from 2016 - 2022. Rainfall source: BOM (Wharminda).*

## Paddock benefits and limitations.

Farming in this area can be challenging. Rainfall is variable and low and is paired with a soil that doesn't hold much moisture and can be difficult to establish crops into. Growers in this environment have found succuss with mixed farming systems where low inputs can lead to high yields of 4t/ha in the right years.

Deep sands with varying degrees of non-wetting can be left bare and exposed to erosion making crop establishment more difficult. While this is a limitation, soil amelioration and management practices can be used to mediate, with practices such as soil ripping, delving and spading and clay spreading being used by growers to remedy constraints such as high soil strength (hard pans), non-wetting soil and reducing the erosion potential and increase water holding of the topsoil by increasing clay content. Some areas are simply too deep to clay and seen as too hard to ameliorate. These areas are planted out to Veldt grass or similar and can also be fenced off from sheep.

**Yield and deep N at sampling points.**

| | Vixen Wheat 2020 | | Spartacus Barley 2021 | | Vetch 2022 |
|---|---|---|---|---|---|
| **Waypoint** | **N to 60cm (kg/ha) 30th May** | **Yield (t/ha)** | **N to 60cm (kg/ha) (5th May)** | **N to 60cm (kg/ha) (20th July)** | **N to 60cm (kg/ha) (15th March)** |
| **P** | | | | | 50 |
| **6** | 55 | | 25 | 57 | 14 |
| **7** | 110 | 2.7 | 44 | 42 | 13 |
| **8** | 67 | 2.3 | 44 | 52 | 35 |
| **12** | 91 | 1.8 | 41 | 45 | 39 |
| **13** | 106 | 2.5 | 45 | 50 | 34 |
| **18.2** | | 2.4 | 49 | 34 | 34 |

*Table 8. Deep nitrogen testing and corresponding yield 2020-2022 at Wharminda. Rainfall source: BOM (Wharminda).*

## What have we learnt?

In the Wharminda most growers are acutely aware of the highly variable nature of the crop production (ranging from 1.5t/ha – 4t/ha between seasons). Experience in this area has generally left growers risk averse towards the application of high rates of inputs. As such, robust rotations form the foundation of the N strategy, an example of this is the vetch pasture sown in 2022 amongst wheat and barley (for early ground cover) in the focus paddock. Such a system is a low input system with the potential for high returns in the cropping phase. The use of livestock can add income diversity to the system when cropping is poor, but over grazing can quickly lead to erosion and needs consideration.

## Conclusions and solutions

- Pasture sown deep and early allows feed production as early as possible and maximises ground cover.
- Robust rotations allow for a minimal input system that has a high yield potential in good years.


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# Lock – Kerran Glover

## Overview

The soil in the Lock focus paddock consisted largely of sandy loams, with higher clay content in better parts of the paddock and calcrete layers at 30-60cm depth in the poorer areas of the paddock. The soil is highly calcareous in parts. The pH in the topsoil is around 7.5 (CaCl) but this rises to a pH of 8-9 as you move deeper in the profile. Despite much of the area being prone to frost, this paddock has good elevation and frost is not an issue. High levels of Boron were found as shallow as 40cm at some points across to the paddock.

**Soil issues**: Calcareous soils, boron, calcrete layers.

**Biotic stresses**: ryegrass, barley grass, foliar disease (yellow leaf spot, SFNB), heat.

**Rainfall, rotation and yield.**

| Year | Crop Type | Rainfall (mm) Nov-Mar | Rainfall (mm) Apr-Oct | Yield (t/ha) |
|---|---|---|---|---|
| Long Term | | 92 | 292 | |
| 2022 | Wheat | 165 | 292 | 5.7 |
| 2021 | Canola | 73 | 233 | 1.51 |
| 2020 | Vetch | 65 | 252 | |
| 2019 | Wheat | 42 | 198 | 1.9 |
| 2018 | Wheat | 100 | 241 | 3.6 |
| 2017 | | 107 | 191 | |
| 2016 | Wheat | 42 | 400 | 3.5 |

*Table 9. Crop, average rainfall and yields 2016-2022 at Lock. Rainfall source: BOM (Lock).*

## Paddock benefits and limitations.

The soil at Lock, particularly around the soil moisture probe has a good PAWC. The benefits of this are demonstrated most in years with dry spells. 2021 was an example of this, where only 6mm of rainfall was received in September but because of the soil stored moisture the canola crop managed to finish well and produce above average yields (1.5t/ha). However, there are areas of the paddock that have considerably lower PAWC and as such do not finish well in poor years. This is due to calcrete layers, shale and also boron and carbonate at depth. Understanding of the variation in yield potential across the paddock assists the grower in ensuring N decisions are optimal. Measuring PAW in season assists with such decisions. Having a productive vetch phase in the rotation has seen high soil N levels and required minimal amounts of synthetic N added to obtain high yields.

**Yield and deep N at sampling points.**

| | 2019 | 43Y92CL Canola 2021 | | | Scepter Wheat 2022 | | | 2023 |
|---|---|---|---|---|---|---|---|---|
| Way-point | Wheat (t/ha) | N to 60cm (kg/ha) | Total N (kg/ha) | Yield (t/ha) | N to 60cm (kg/ha) | Total N (kg/ha) | Wheat (t/ha) | N to 60cm (kg/ha) |
| Probe | 1.86 | 88 | 116 | 1.86 | 89 | 119 | 5 | 24 |
| 2 | 1.78 | 112 | 140 | 1.96 | 165 | 207 | 5.4 | 50 |
| 3 | 1.72 | 72 | 100 | 1.31 | 83 | 106 | 4.8 | 42 |
| 4* | 1.92 | 127 | 192 | 1.86 | 104 | 134 | 4.9 | 56 |
| 5* | 1.64 | 91 | 156 | 1.97 | 132 | 162 | 7 | 43 |
| 6* | 2.2 | 84 | 149 | 1.6 | 140 | 170 | 6 | 55 |
| 7 | 2.5 | NA | +28 | 1.7 | 122 | 164 | 5.9 | 30 |
| 8 | 1.9 | NA | +28 | 1.5 | 123 | 138 | 4.5 | 63 |
| 9* | 2.4 | NA | +37 | 1.4 | 180 | 210 | 6.3 | 92 |
| 11* | 1.9 | NA | +74 | 1.67 | 196 | 226 | 6.9 | 23 |

*Table 10. Deep nitrogen sampling and corresponding yields at Lock 2019-2023. Vetch grown in 2020.*These waypoints received additional N. 4, 5, 6 and 9 received an additional 37 units in 2021 growing season. Waypoint 11 received an additional 74 units of N.*

## What have we learnt?

Canola yields at this site in 2021 were exceptional for the area. The crops establishment was timely, nutrition was good and the selection of a high-yielding hybrid variety all contributed to this. The benchmark for canola prior to this was approximately 1t/ha. Through the use of Yield Prophet® in conjunction with discussion groups a high probability of canola yields greater than 1t/ha was determined. A PAWC of 100% paired with the most likely outcome of an average finish saw the forecast of a yield of 2.4t/ha or higher in 50% of years in late July. August and September were very dry which had a detrimental effect on yield. As can be seen above in table 10, yields still far exceeded the 'normal'. This has now shifted the benchmark for this grower and others in the area for what can be expected of canola. As a result of discussion around this it is also well understood that crop nutrition must match yield expectations. The Regional Innovators Group believes that growers in the area have taken a more bullish yet calculated approach to N applications because of the Resilient EP project.

Yield maps and EM38 show considerable variation across this paddock. However, patterns are not consistent from season to season, and it is difficult to come to any conclusion as to what may work best in any particular year until it is too late. For this reason, the grower does not use VRT for N. They do however implement a P replacement program based on the previous year's yields. This is quite common.

## Solutions/ conclusions

- The 'benchmark' will change and needs to be pushed to realise true potential.
- Inputs must change to match new higher potential.


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- Deep N testing and the use of soil moisture probes can ensure inputs are as accurate as possible.

# Cootra – Todd Matthews

### Overview

The Cootra focus paddock is part of a dune swale land system. It has high levels of variability within paddocks, however, there are consistent patterns within that can be mapped with ease. Deep sand over clay features on the top of dunes. Sand over sandy loam clay with often calcareous clay at depth on mid sections of dunes. The swale or low-lying areas often feature clay loam over clay with calcrete layers of being an issue. These areas finish particularly poorly in dry finishes.

Soil profile on 12 October 2020.

### Rainfall, rotation and yield.

| Year | Crop Type | Rainfall (mm) Nov-Mar | Rainfall (mm) Apr-Oct | Yield (t/ha) |
|---|---|---|---|---|
| Long Term | | 100 | 278 | |
| 2022 | Barley | 135 | 315 | 2.8 |
| 2021 | Wheat | 84 | 207 | 3 |
| 2020 | Wheat | 78 | 275 | 2.4 |
| 2019 | Pasture | 67 | 167 | - |
| 2018 | Barley | 110 | 148 | 2.3 |
| 2017 | Wheat | 139 | 145 | 1.88 |
| 2016 | Pasture | | 273 | - |

*Table 11. Crop, average rainfall and yields at Cootra 2016-2022. Rainfall data source, in paddock gauge*

### Paddock benefits and limitations.

At this site at Cootra there is a high level of variation in yield across the paddock. These patterns tend to be similar across years which make it make it possible to manage inputs accordingly. By implementing VR technology, the grower has found they can keep inputs optimal to allow high yielding areas to reach their potential and not spend too much on lower yielding zones.

The lack of sub-soil constraints means rooting depth in the Cootra focus paddock is quite deep, with roots found growing to 110cm across large areas of the paddock. This means that PAWC is higher than similar textured soils with high levels of toxic elements. The higher PAWC means that confidence in a end result is increased and input decisions can be matched accordingly.

Lack of subsoil constraints could also lend itself to growing alternative break crops. While the grower grows either peas or medic on this farm as a rotation with cereals, other crops such as canola and lentils could be grown quite successfully.

Both heat and frost risk can be very detrimental to crops in this area. The southwest corner of the focus paddock has experienced frost in the past. Heat is an issue in this area. While modern genetics and timely sowing are used to mitigate heat risk, hot days of 30 degrees and greater can occur while crops are filling and can have a negative impact on yield.

**Yield and deep N at sampling points.**

| | Scepter wheat 2020 | | | Scepter wheat 2021 | | | Spartacus Barley 2022 | | | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Way-point | N to 60cm (kg/ha) | Total N (kg/ha) | Wheat (t/ha) | N to 60cm (kg/ha) | Total N (kg/ha) | Wheat (t/ha) | N to 60cm (kg/ha) | Total N (kg/ha) | Yield (t/ha) | N to 60cm (kg/ha) |
| 1 | 80 | 99 | 2.9 | 35 | 93 | 3.8 | 11 | 76 | 3.6 | 42 |
| Probe | 59 | 78 | 3.5 | 41 | 116 | 3.7 | 15 | 80 | 2.8 | 16 |
| 5 | 108 | 127 | 2.7 | 56 | 131 | 4.5 | 54 | 119 | 2.4 | 26 |
| 7 | 62 | 81 | 1.4 | 25 | 100 | 1.1 | 14 | 65 | 1.1 | 16 |
| 14 | 63 | 82 | 2.1 | 69 | 127 | 2.9 | 31 | 66 | 2.8 | 24 |
| 20 | | | 1.9 | 132 | 150 | 2.2 | 46 | 88 | 3.1 | 60 |

*Table 12. Deep nitrogen sampling and corresponding yields at Cootra 2020-2023.*

**Solutions/ conclusions**.

- Variable rate technology is a practical way of optimising inputs and increasing sustainability if done correctly.
- Soil type lends itself to making sound decisions in season based on stored soil moisture due to relatively good PAWC.
- Soil type lends itself to exploring growing alternative break crops.


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# Pinkawillinie – Paul Schaefer

## Overview

The site at Pinkawillinie is representative of the area. Soil types in the paddock include sandy rises, low clay flats and clay loam rises/ mid slopes. Soil type is generally very good in the paddock although sub-soil constraints (boron and/ or calcium carbonate) limit effective rooting depth to 80cm, even in better parts of the paddock. Good soil structure for large parts of the paddock means PAWC is large (approx 100mm to 80cm depth). The pH generally ranges from 7.5 - 8.5. Medic pastures dominate the break crop phase as they are the most reliable feed source for livestock in such an environment and fix high levels of N for subsequent crops.

**Soil issues**: Boron, calcium carbonate.

**Biotic stresses**: Heat and frost, brome grass.

Soil Profile, 12 October 2020.

## Rainfall, rotation and yield.

| Year | Crop Type | Rainfall (mm) Nov-Mar | Rainfall (mm) Apr-Oct | Yield (t/ha) |
|---|---|---|---|---|
| Long Term | | 103 | 225 | |
| 2022 | Wheat | 291 | 193 | 3.2 |
| 2021 | Barley CL | 74 | 133 | 2.93 |
| 2020 | Wheat | 81 | 250 | 2.4 |
| 2019 | Pasture | 51 | 141 | - |
| 2018 | Barley | 93 | 145 | 2.8 |
| 2017 | Wheat | 190 | 134 | 3.29 |
| 2016 | Pasture | 135 | 273 | - |

*Table 13. Crop, average rainfall and yields at Pinkawillinie 2016-2022. Rainfall source BOM (Buckleboo)*

## Paddock benefits and limitations.

Pinkawillinie is one of the northernmost areas of cropping on Eyre Peninsula, not far from Goyder's Line. The spring weather frequently brings cloudless skies which elevates the risk of heat and frost damage to crops. This can make decision-making to chase high yields difficult. In some seasons yield potential may be high with good autumn and winter rainfall, but as the final result is far from assured, applying high

inputs to chase high yields can be risky. Many growers implement mixed cropping/ livestock farming systems to help offset risk.

The soil at Pinkawillinie has the potential to store reasonable levels of soil moisture. The use of stored soil moisture from summer months into the following growing season can prove invaluable in years when poor growing season rainfall transpires. 2021 was an example of this. The paddock experienced a decile 2 year with only 130mm GSR. This would generally result in almost no crop however with the 60mm of measured stored water included, the resulting paddock yield was 2.9t/ha of Spartacus barley. This high PAWC means that such knowledge can be a useful indicator of yield potential.

While soil type variation is present at this site, VR application of N is not applied generally. The grower believes that for the size of the variable areas the input of time and cost doesn't provide a worthwhile return. This is the view of many growers on the upper EP as inputs are generally low to begin with and areas of land farmed are large. The grower does utilise a variable replacement program for phosphorous.

The Pinkawillinie focus paddock is an example of how well the mixed farming system can work on the upper Eyre Peninsula environment. Sheep provide income in poor years to maintain cashflow. Failed crops can be cut for hay to be later fed out in dry spells and annual cropping input costs are moderated as input costs (fertiliser, chemical and fuel) are required over a smaller proportion of land, however the workforce required to run and maintain the infrastructure required to run livestock on the scale that many Upper EP farmers now operate can be extremely difficult to source.

**Yield and deep N at sampling points.**

| | 2020 (Scepter wheat) | | | 2021 (Spartacus barley) | | | 2022 (Grenade CL wheat) | | |
|---|---|---|---|---|---|---|---|---|---|
| Way-point | N to 60cm (kg/ha) | total N (kg/ha) | Yield (t/ha) | N to 60cm (kg/ha) | total N (kg/ha) | Yield (t/ha) | N to 60cm (kg/ha) | Total N (kg/ha) | Yield (t/ha) |
| Probe | - | - | - | - | - | 3 | 41 | 71 | 3.5 |
| 4 | 72 | 79 | 2.2 | 31 | 62 | 3.5 | 8 | 38 | 3.3 |
| 5 | 86 | 92 | 2.1 | 87 | 117 | 2.4 | 57 | 87 | 2.2 |
| 7 | 80 | 86 | 2.5 | 29 | 60 | 3.9 | 25 | 55 | 3.5 |
| 9 | 96 | 104 | 2.7 | 17 | 48 | 3.3 | 19 | 49 | - |
| 16 | 56 | 62 | 2.6 | 17 | 48 | 2.8 | 27 | 57 | 2.6 |
| 18 | 65 | 71 | 2.7 | 23 | 54 | 3.1 | 11 | 41 | 3.5 |

*Table 14. Deep nitrogen sampling and corresponding yields at Pinkawillinie 2020-2022.*

**What have we learnt?**

- Stored soil moisture at this site is highly valuable.
- PAWC is good relative to rooting depth (80cm). This is highly beneficial in poor years if managed properly by summer weed management.
- Application of nitrogen is often seen as risky, so heavy reliance is placed on legume-based pastures to provide N for subsequent crops.

# Minnipa – Bruce Heddle

## Overview

This site is highly productive for the area. Parts of the paddock yield almost double what others do in any given year. A median PAWC of approximately 100mm is present through large areas of the paddock with higher and lower yielding areas in the paddock driven by changes in soil type and PAWC. For this reason, the grower utilises VRT to match inputs to yield potential based on yield potential throughout the season. Yield patterns from one zone to the next are similar across different seasons. Lower PAWC is generally seen in lower lying areas of the paddock with higher clay content, calcium carbonate and boron constraints at depth.

**Soil constraints:** Boron, calcium carbonate

**Biotic stresses**: Ryegrass, barley grass.

Soil Profile, 9 October 2020.

## Rainfall, rotation and yield.

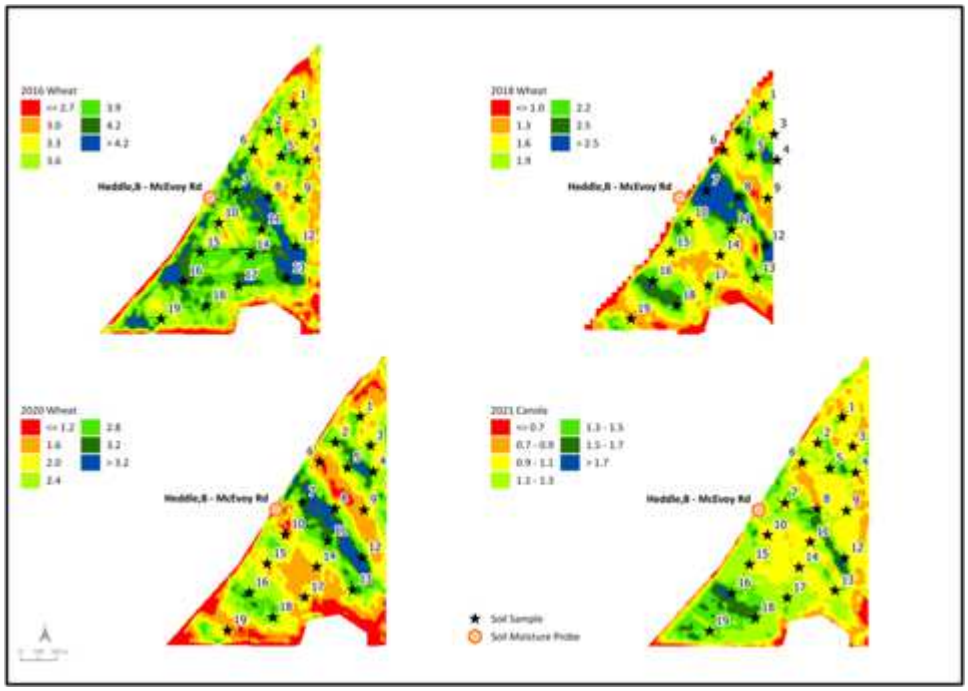
| Year | Crop Type | Rainfall (mm) Nov-Mar | Rainfall (mm) Apr-Oct | Yield (t/ha) |
|---|---|---|---|---|
| Long Term | | 85 | 204 | |
| 2022 | Wheat | 193 | 250 | 4.4 |
| 2021 | Canola | 68 | 210 | 1.0 |
| 2020 | Wheat | 90 | 218 | 2.2 |
| 2019 | Lentils | 39 | 216 | 0.7 |
| 2018 | Wheat | 62 | 186 | 2.25 |
| 2017 | Pasture | 82 | 141 | - |
| 2016 | Wheat | 66 | 260 | 3.4 |

*Table 15. Crop, average rainfall and yields at Minnipa 2016-2022. Rainfall source BOM (Minnipa)*

## Paddock benefits and limitations.

While this paddock has large variation in yield potential, the patterns in variation are very consistent. Figure 1 demonstrates that across different crops and years with variable rainfall yield patterns remain very similar. The grower is very aware of this and places a heavy weighting on the high yielding areas of the paddock when applying inputs (both N and P).

*Figure 1: Yield data displaying distinct zones in wheat and canola at Minnipa from 2016-2021.*




One major advantage to this soil type is its good PAWC. Many soils in the district have considerably lower PAWC and are far less dependable in tight seasons. While parts of this paddock struggle in poor finishes, overall, yields are high and the growers 'zero summer weed' policy has a lot to do with this. This is because maximum summer rainfall is preserved in the soil profile for the coming season. The grower is aware of the benefits of stored moisture and not only this but using it to their advantage by maintaining adequate nutrition year to year across all zones. VRT has benefited this grower to a large degree in paddocks such as this.

The low-lying areas of this paddock are a poorer soil type that generally have a shallower rooting depth and bring paddock averages well down. Sub soil constraints such as high boron and calcium carbonate levels significantly decrease the PAWC of a soil type. On the same note the paddock has some deeper soils with considerably higher PAWC. These zones yield much higher and consequently raise paddock averages. This clear-cut variation in PAWC and yield from one zone to the next can make yield and therefore input estimation quite simple. The use of soil moisture probes can also be useful in this context as if we know how one zone will yield relative to another then estimates at the probe can be related to the other zones and therefore the whole paddock.

This paddock at Minnipa, while being exposed to hot finishes, has a relatively low frost risk. This means that yield predictions in season are more certain, and the risk involved is less than would be otherwise. While heat can be an issue, timely sowing if the season allows is the best way to mitigate heat damage and can be done so if there is adequate moisture. Understanding soil moisture and the benefits of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deeper sowing could be one way that soil moisture is exploited to mitigate the end of season heat risk in particular years.

| | 2020 Scepter Wheat | | 2021 Trident Canola | | | 2022 Ballista Wheat | | | 2023 |
|---|---|---|---|---|---|---|---|---|---|
| Waypoint | N (kg/ha 0-60cm) | Wheat (t/ha) | N kg/ha 0-60cm) | Total N (kg/ha) | Yield (t/ha) | N (kg/ha 0-60cm) | Total N (kg/ha) | Yield (t/ha) | N kg/ha (0-60) |
| **Probe** | | | | 26 | 1 | 128 | 159 | 4.6 | |
| **1** | 193 | 2 | 92 | 118 | 0.9 | 93 | 93 | 3.7 | 41 |
| **3** | 75 | 2.1 | 162 | 188 | 1.0 | 177 | 177 | 4.2 | 118 |
| **7** | 149 | 2.9 | 36 | 138 | 0.9 | 91 | 122 | 4.6 | 50 |
| **8** | 101 | 2.6 | 20 | 122 | 1 | 37 | 137 | 5.1 | 31 |
| **12** | | 3 | 48 | 150 | 1.4 | 34 | 134 | 4.8 | 38 |
| **13** | 158 | 2.5 | 78 | 104 | 1.1 | 81 | 112 | 5.1 | 47 |
| **14** | 384 | 1.6 | 111 | 121 | 1.1 | 94 | 125 | 4.3 | 55 |

*Table 16. Deep nitrogen sampling and corresponding yields at Minnipa 2020-2022.*

## What have we learnt?

The site at Minnipa has variable PAWC across zones within the paddock. This can be beneficial with the use of VRT to optimise inputs. With the added knowledge of PAW by use of technology such as the soil moisture probe, yields can be optimised in season. The frost risk at this site is lower than other areas of Upper EP, reducing the risk of applying higher inputs. However, hot finishes are frequent, this can be mitigated by correct time of sowing matched with the correct variety of crop.

The grower and others in similar situations on the Upper Eyre Peninsula hold a position where they believe that higher yielding areas will have a lower water use efficiency in high rainfall years. The exact cause of this is not known. While insufficient N is an obvious cause, there are other limiting factors that could potentially lead to poor WUE in high rainfall years. These include calcareous soils that can decrease P use efficiency. Lack of P and low sowing rates can limit tillers and therefore head counts per area. These are all significant drivers of yield and may limit yield in good areas in high rainfall seasons. These may cumulatively be a cause of low WUE in high rainfall decile years.