BREAK CROP SUITABILITY ACROSS LANDSCAPES

Lentils on variable soils

THE PROJECT

This project "Break Crop Suitability Across Landscapes: Stage 2" was funded by the SA Drought Hub. A multi-regional approach was led by Upper North Farming Systems (UNFS) in partnership with Agricultural Innovation and Research, Eyre Peninsula (AIR EP). Case Studies spanning three farming groups and four node regions were delivered in 2024-2025.

BACKGROUND:

Managing break crops has long been a balancing act for growers in the Upper North and surrounding regions. Break crop options offer significant benefits (e.g. price potential, nitrogen fixation, cereal diseases, fertility & grass weed control), but their success is highly dependent on seasonal conditions (e.g. frost risk) and landscape variability (e.g. soil type, water holding capacity). Other risks include limited end-use markets, fragile stubble and reduced ground cover. In low rainfall and variable environments, this makes break crop selection and subsequent management complex.

AIMS:

To improve the understanding of break crop performance across Upper North landscapes and support more informed decision-making by identifying where and how break crops could be best positioned within farming systems.

KEY FINDINGS

- At Spalding, the highest grain yield was attained from sites that exhibited modest soil fertility (nitrogen, phosphorus, potassium) and yield was not correlated to subsoil salinity & soil boron, even though these constraints were present. Excess sodicity (and subsequently very low exchangeable calcium at depth) produced the lowest yielding site. The soil with the highest phosphorus & nitrogen status was the lowest grain yield – confirming other constraints appear present in this zone.
- At Melrose the lowest yield correlated to a low soil phosphorus and a marginal zinc status.
- Biomass (represented as hay yield) was correlated to grain yield at Melrose, but not at Spalding.
- Soil nitrogen balance can vary significantly with biomass & grain yield.
- Whilst some variation in soil pH, soil sulphur & trace elements levels existed across the sites, these were not correlated with grain yield.

WHAT WAS DONE?

Three focus points representing areas of different productivity, soil type and stubble load were identified within a single paddock at each of Melrose and Spalding (in the Upper North of South Australia).

At each focus point, the following were assessed:

- Soil parameters (0-10cm; 10-30cm; 30-60cm) pre-sowing and post-harvest.
- Crop establishment and growth:
  - NDVI measurements to indicate crop vigour.
  - Mid-flowering cuts to assess crop growth/hay yield potential.
  - Harvest index cuts to determine yield and grain quality.
  - Stubble assessments.
- Economics of production (provided by Pinion Advisory).

CASE STUDY *at Spalding*

GROWER:
Eric and Judith, Damien and Ruth, Ben and Fiona and their children farm together as "Sommerville Partners".

SOIL TYPE:
Brown grey clay loam, 5-30% gravel.

GROWING SEASON RAINFALL:
298mm.

Sommerville Partners

THE SOMMERVILLE PARTNERS ENTERPRISE:

Historically, canola has been the primary break crop due to its reliability and fit within the system. Recently there has been a shift toward exploring legumes to diversify break crop options and reduce nitrogen fertiliser inputs.

A range of legumes have been trialled, including faba beans, chickpeas and lentils. Faba beans have shown potential, particularly for N contribution, but present logistical challenges due to seed size and machinery requirements. Chickpeas (Kabuli types) have similar machinery issues and are susceptible to grain cracking, both being issues which limits their suitability for the enterprise.

Overall, lentils (cv. Thunder in 2025) are becoming an important part of the break crop mix, complementing canola and hay within a system designed to balance profitability, weed control, and soil improvement.

OBSERVATIONS AND DISCUSSION:

In this investigation of lentil adoption across the landscapes in the Upper North there are a range of variations in soil data exhibited. At Spalding the starting nitrogen, phosphorus, potassium, sulphur, organic carbon, subsoil pH, sodicity & exchangeable calcium all varied widely between the sites.

Site C was the highest grain yielding site, which also had the lowest pre-harvest biomass (and subsequent hay yield). This site exhibited moderate levels of nitrogen, sulphur & organic matter, high phosphorus and potassium. At depth it had moderate to high sodicity, moderate exchangeable calcium and was strongly alkaline. In contrast site A & B were the lowest yielding sites (with insignificant yield variation) exhibiting wide ranging nitrogen, phosphorus, organic matter, sodicity and exchangeable calcium (at depth).

Soil pH was not a significant driver of grain or hay yield at Spalding, although there was no significant variation in surface pH and no constraining acidity present.

Biomass prior to harvest (hay yield) appeared poorly correlated to soil test parameters and similarly was not well correlated to grain yield at Spalding. This metric demonstrates some zones would suit a hay salvage where terminal drought or frost put grain yield at risk.

Comparing starting (pre-sowing) soil nitrogen levels with post-harvest measurements, there are significant differences in how the zones nitrogen balance have changed. The highest yielding zone (site C) had a drop in measured soil nitrogen levels, as did the lowest yielding zone (site B). Site A had the lowest starting nitrogen level and was relatively low yielding but had a significantly higher nitrogen change by the end of the study. Understanding of nitrogen fixation processes, nutrient removal and other loss factors like leaching are likely important in explaining these differences across the zones.

Table 1. *Key soil test parameters and final hay and grain yield at Spalding.*

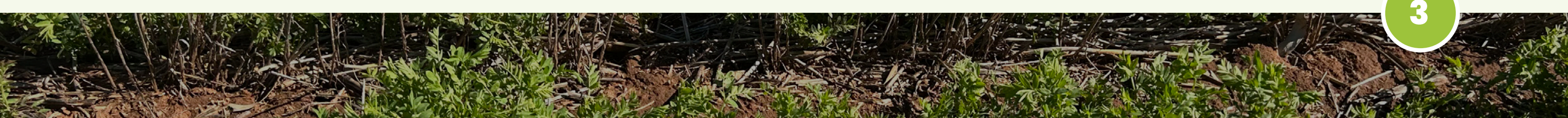
Pre-sowing	Focus point A	Focus point B	Focus point C
Nitrogen (kg/ha)	Low (~35)	High (~96)	Moderate (~66)
Phosphorus (Colwell, ppm)	Low (25)	Very high (88)	High (57)
Potassium	Moderate	High	High
Organic carbon	Low	Moderate	Moderate
Sulphur	High	High	Moderate
pH (30cm-60cm)	Slightly alkaline	Strongly alkaline	Strongly alkaline
Sodicity (30-60cm)	Not present	High	Moderate-High
Exchangeable Calcium (10-30cm)	High (84%)	Low (36%)	Moderate (49%)
Harvest and post-harvest	**Focus point A**	**Focus point B**	**Focus point C**
Nitrogen change (kg/ha)	+60	-14.4	-21.6
Hay yield (t/ha)	3.82	3.75	3.16
Grain yield (t/ha)	2.22	2.15	2.48

THE BOTTOM LINE:

Comparing the economics, there are opportunities for hay or grain, which is a useful management tool when frost or terminal dry conditions may risk a grain harvest. Residual nitrogen value varied widely across the sites, meaning future crops (eg canola, cereals) will likely respond very differently to applied nitrogen. This metric demonstrates value in zone soil testing for residual nitrogen after legumes in the Upper North region.

Table 2. *Economic comparison of lentil grain and hay systems for the focus points (courtesy Pinion Advisory)*

Gross margin comparisons (courtesy of Pinion Advisory)	Lentils at Spalding		
	Focus point A	Focus point B	Focus point C
Grain yield (t/ha)	2.22	2.15	2.48
Grain gross margin ($/ha)	$754	$714	$904
Value (± $/ha) of nitrogen remaining after grain harvest for 2026	$35	-$24	-$37
Hay yield (t/ha)	3.82	3.75	3.16
Hay gross margin ($/ha)	$843	$819	$617
Cost of nitrogen removal from hay compared to grain ($/ha)	-$132	-$130	-$109
Cost of potassium removal from hay compared to grain ($/ha)	-$171	-$168	-$142



CASE STUDY *at Melrose*

GROWER:
Andrew and Lydia Walter

RAINFALL (GS):
207mm

SOIL TYPE:
Brown-grey Clay loam, 15-30% gravel

Walter Family

THE WALTER ENTERPRISE:

Pulse choices are generally limited for this enterprise, as seasonal conditions and lower rainfall typically restrict the viability of alternatives such as faba beans. Field peas present marketing and delivery challenges, while vetch is less suitable due to the absence of livestock. As a result, lentils are considered as one of the more resilient and practical pulse options.

Lentils were sown into a paddock following a previous lentil crop to evaluate performance under a tighter rotation and to better understand the implications of back-to-back lentil production.

OBSERVATIONS AND DISCUSSION:

Continuing the interrogation of soil metrics at the Melrose location, significant variations were found with soil test levels of starting nitrogen, phosphorus (and phosphorus buffering index (PBI)), zinc and sodicity and boron levels at depth. The highest yielding site (Focus Point A) had significant sodicity at depth, elevated boron levels, but importantly had adequate available phosphorus and zinc levels. The lowest yielding site (site B) demonstrated high starting nitrogen, low available phosphorus (with the highest PBI) and marginal zinc levels. Comparatively to the highest yielding site, the lowest had no sodicity or boron constraints.

Soil pH was not a significant driver of grain or hay yield at Melrose, although there was no acidity found in surface (0-10cm) samples.

At Melrose, biomass prior to harvest (demonstrated as hay yield) correlated closely to grain yield. This is a common correlation in biomass constrained environments, indicating that enhancing lentil biomass could be a key driver to improving grain yield at Melrose.

Comparing starting (pre-sowing) soil nitrogen levels with post-harvest measurements there are minimal differences in how the zone's nitrogen balance has changed. In the comparison at Melrose, N balance across the study was inversely correlated to grain (and hay) yield. The highest yielding plot resulting in the smallest increase in soil N. This may indicate that the Melrose site had more even nodulation across the zones, even with significant biomass (hay yield) variation, and that grain removal was the significant factor affecting residual soil N levels.

__Table 1.__ Key soil test parameters and final hay and grain yield at Spalding.

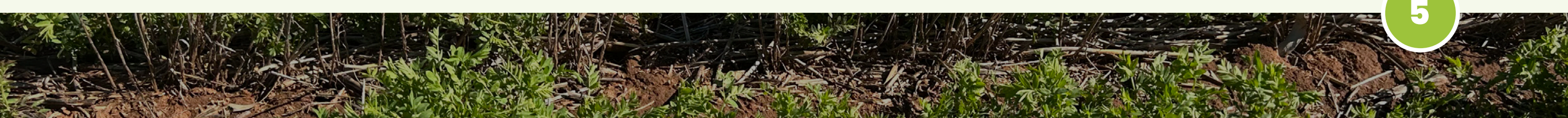
Pre-sowing	Focus point A	Focus point B	Focus point C
Nitrogen (kg/ha)	Low (~35)	Moderate (~88)	Low (~33)
Phosphorus (Colwell, ppm)	Adequate (39)	Low (19)	High (60)
PBI	High (98)	High (113)	Moderate (57)
Sodicity (30cm-60cm)	High ^	Nil	Moderate ^
Boron (30cm-60cm)	Elevated	Moderate	Elevated
Zinc (DTPA, ppm)	Adequate (0.81)	Marginal (0.77)	Adequate (0.88)
Harvest and post-harvest	**Focus point A**	**Focus point B**	**Focus point C**
N change (kg/ha)	+13	+40	+23
Hay yield (t/ha)	3.60	2.01	2.79
Grain yield (t/ha)	1.70	1.39	1.54

THE BOTTOM LINE AND DISCUSSION:

Comparing the economics for Melrose, the direct correlation with biomass (hay yield) versus grain yield indicates visual assessment of biomass could be useful in predicting grain yield, and allow simpler assessment of hay versus grain comparisons. Residual nitrogen after lentils at Melrose was less variable than at Spalding with the highest grain yield resulting in the lowest increase in carry forward nitrogen, and subsequently less residual N value.

__Table 2.__ Economic comparison of lentil grain and hay systems for the focus points (courtesy Pinion Advisory)

Gross margin comparisons (courtesy of Pinion Advisory)	Lentils at Melrose		
	Focus point A	Focus point B	Focus point C
Grain yield (t/ha)	1.7	1.39	1.54
Grain gross margin	$455	$277	$363
Value (± $/ha) of nitrogen remaining after grain harvest for 2026	+$22	+$68	+$39
Hay yield (t/ha)	3.6	2.01	2.79
Hay gross margin	$767	$223	$490
Cost of additional nitrogen removal from hay compared to grain	-$124	-$69	-$96
Cost of additional potassium removal from hay compared to grain	-$161	-$90	-$125



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