Profitable pulses on ameliorated soils in 2024

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Key messages

- A thorough understanding of soil constraints and what is required to fix them must be known prior to amelioration.
- Amelioration of constrained soils on the lower Eyre Peninsula allows a wider range of break crops to be grown.
- The consistency of production of lentils through wetter years is still relatively unknown.
- Appropriate establishment rates are essential to optimise yields of beans.

Why do the trial?

It is well known that there is a need for a profitable pulse within the rotation on the lower Eyre Peninsula. Lupins have long been the answer due to their ability to grow successfully on acidic soils. However, the amelioration of soils has alleviated some issues such as low pH and waterlogging, with crops other than lupins now becoming an option. In recent years, the number of growers that have tried different legume break crops has increased with beans and lentils finding their way into new areas. This has been driven by extensive amelioration practices such as any one or a combination of liming, delving, ripping and spading. This trial was done to see if we can push more valuable pulse crops into an area where they had not previously been grown but may now be able to due to amelioration of constrained soils.

Crop requirements

pH

Beans and lentils both require a pH of >5.5 (CaCl) and preferably >6. A crop grown on a soil type where pH is <5.5 will initially establish, however when plants begin to produce significant biomass and flowers there will be dramatic yellowing of crops, with a significant decrease in yield potential, sometimes dying out completely.

Drainage

Lentils will not tolerate waterlogging. Waterlogging and low pH combined are a certain way to see a failed crop. Beans are more tolerant to waterlogging.

Salt and Boron

Lentils are particularly sensitive to both salt and boron. Fortunately, this is not an issue in the areas referred to in this article.

Table 1: Growing season rainfall (mm) distribution in 2024, BOM Cummins.

April	May	June	July	August	September	October	November
2	5	78	75	23	22	18	21

Amelioration

The paddock where the trial took place was a duplex gravel sand over clay. The sand had a pH of 4.3 and very little clay in the upper horizons. In January 2024, the paddock was spread with 5 t/ha of lime and 3 t/ha of gypsum, delved to approximately 700 mm, ripped to break up the interrow to 400 mm and spaded to approximately 350 mm. This allowed significant incorporation of clay, lime and gypsum towards the surface.

The methodical process undertaken by the grower saw that each known soil constraint could be addressed. Low pH, impenetrable clay layers resulting in poor drainage and low water holding capacity in sands were the main constraints. These were addressed by:

- Spreading lime
    - Increases pH.
- Spreading gypsum
    - Improves soil structure by adding calcium to sodic clay.
- Delving
    - Increasing water holding capacity of the profile as more clay is introduced to surface layers.
    - Allows the breaking up of impenetrable clay layer to increase drainage.
- Ripping
    - Breaks large clay clods and further disturbs 0-400 mm.
    - Loosens soil to allow the spader to pass.
- Spading
    - Mixes clay, lime and gypsum in the 0-350 mm zone. This process is essential as inputs do not move down the profile easily and returns from inputs may not be seen for many years.
- Rolling
    - Rolling with a large stone roller sped up the settling process allowing improved trafficability and seed bed preparation.

Table 2: Soil pH and Colwell K, June 2024.

Sampling site	1-3	1	2	3	1-3
Depth (cm)	0-10	10-30	10-30	10-30	30-60
pH ($CaCl_2$)	6.11	6.32	4.54	4.86	6.01
Colwell K (mg/kg)	74	36	75	33	

How was it done?

Beans and lentils were sown east of North Block, on the lower Eyre Peninsula. Treatments were sown on 7 June and 8 August, with two sowing rates and two varieties of both beans and lentils. Basic agronomy for these crops was undertaken with broadleaf and grass weeds controlled. While soil fertility looked reasonable, uncertainties around nodulation and potassium saw that a triple rate of granular inoculum (with seed), 92 kg/ha of nitrogen (as urea) and 20 kg/ha of potassium (as SOP) were applied.

Results

Figure 1: Time of sowing 1 lentils on 27 July following 150 mm of rainfall for June and July (left) and lentils and beans on 10 October just prior to senescence (right).

Table 3: Biomass, yield and harvest index, Cummins North Block 2024 (*number indicates plants/m^2)

	Biomass (t/ha)		Grain yield (t/ha)		Harvest index	
	TOS		TOS		TOS	
Treatment	**1**	**2**	**1**	**2**	**1**	**2**
Bendoc (15) *	3.16	1.07	1.81	NA	0.57	NA
Bendoc (28)	4.56	1.26	2.59	NA	0.57	NA
Samira (17)	3.1	1.31	1.77	NA	0.57	NA
Samira (29)	4.63	1.65	2.59	NA	0.56	NA
Highland (110)	3.11	1.42	1.64	0.66	0.53	0.46

Highland (150)	4.38	1.86	2.36	0.94	0.54	0.50
Thunder (110)	4.31	1.44	2.05	0.64	0.47	0.44
Thunder (150)	3.76	1.26	1.88	0.53	0.50	0.42
lsd						
TOS	*0.36*		*0.19*			
var/sow rate	*0.73*		*0.38*			
TOS X var/sow rate	*1.03*		*0.53*			

TOS = time of sowing

In Table 3 both lentils and beans yielded well enough to be brought into a grower's rotation when sown at TOS1. TOS2 did not see the same response. A significant increase in yield (approximately 0.8 t/ha) was observed when the sowing rate was increased in beans. The same did not consistently apply for lentils. Both pulse crops showed great biomass to yield conversion as shown by the harvest index similar or better than wheat in many instances (0.5).

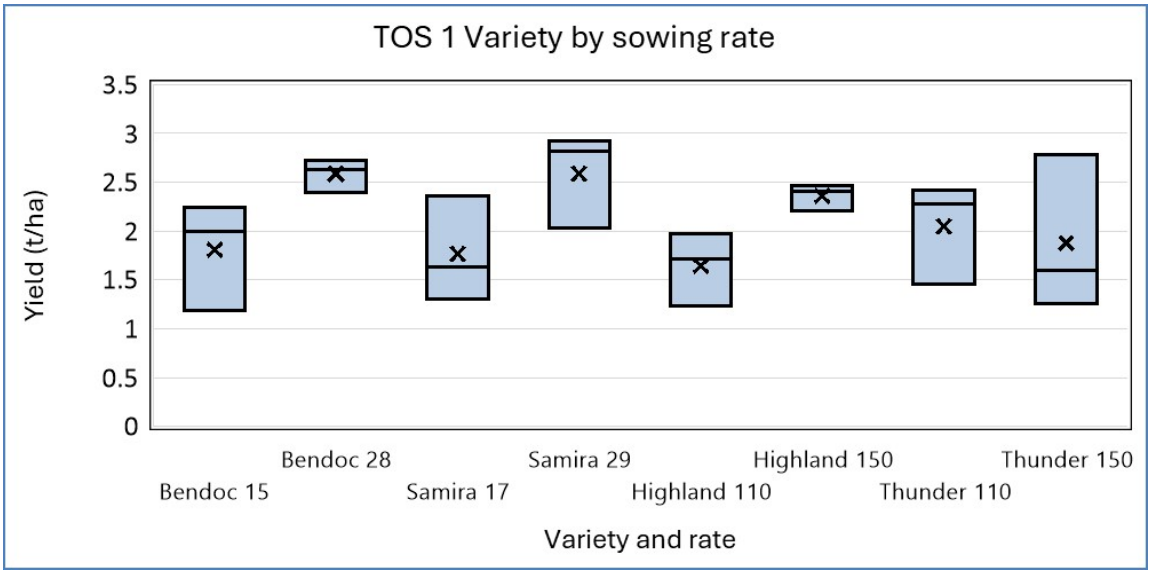

Figure 2: TOS 1 variety by sowing rate, North Block Cummins 2024. Numbers on varieties indicate plants per square meter. Each horizontal line within a box represents one of 3 replicates while x is the average of these.

One major point of difference is the inconsistency in lentil yields. Figure 2 displays that variation is significant with most treatments varying from 1-1.5 t/ha between the 3 replicates.

Discussion

The trial's success in 2024 hinged on the importance of the grower understanding of what was underfoot in the paddock leading up to amelioration and what was required to get the soil profile to where they wanted it to be. This cannot be stressed enough as the driver for successful change and how one might go about it.

While there is much doubt about growing a crop such as lentils in these parts of the lower Eyre Peninsula, the ability to grow them consolidates transformational thinking and actions to follow. Once a crop such as lentils can be successfully grown, or even beans for that matter as a steppingstone, one critical point is what opportunities this opens throughout the remainder of the rotation. Benefits to other crops could include lack of stress from waterlogging, better nitrogen and water use efficiency and increased herbicide efficacy as soil pH is optimized, just to name a few. Lentils are a good indicator crop due to their sensitivities and if they can be grown well then everything else will follow.

In the trial site variability means that the level of significance placed on variety and sowing density is less than it may be on a site where soil type is uniform. However, the benefit of this is it captures what may be expected in the paddock on a larger scale and gives a good range of yields that a grower can relate to.

Time of sowing two in lentils on 8 August was aimed at potentially overcoming the risk of waterlogging by sowing once this risk had lessened. Quick establishment, time to flowering and podding were all seen with a remarkable outcome given the dry finish. From sowing, flowering took place in early October (2 months post sowing) with pods set not long after. A lack of rainfall and the inevitable heat ended flowering not long after it started, which was reflected in yield (Table 3).

While the addition of urea and potassium may seem to have given the trial an unfair advantage, without the inclusion of a control to compare, the effect of these additions is unknown. The purpose of the trial was to prove that dramatic amelioration to change the soil's structure and pH would create new break crop options. In doing so other variables such as nutrition were accounted for to limit their influence on the trial.

Decision making and economics

The economic outcome of growing any crop long term can be looked at in many ways. It is difficult to do perfectly, however as is well known, some good parameters can be put around crop economics to assist in the decision-making process.

Table 4: Decile prices across decile yields for lentils to account for variability and risk over time. Variable costs from '2024 Farm Gross Margin and Enterprise Planning Guide for South Australia', decile pricing as per the RiskWi$e enterprise decision tool, decile yields based on local predictions.

	Decile pricing ($/t)	Variable costs ($/ha)	Decile yields (Rainfall decile, t/ha)					Average ($/ha)
			D1	D3	D5	D7	D9	
			1.5	2	2.5	2.5	2	
D1	439	581	78	297	517	517	297	341
D3	520	581	199	459	719	719	459	511
D5	635	581	372	689	1007	1007	689	753
D7	710	581	484	839	1194	1194	839	910
D9	930	581	814	1279	1744	1744	1279	1372
Long term average ($/ha)								777

Table 4 is a combination of the variability in pricing and yields to create a number or range of numbers to assist in decision making. Yield estimations were put together from what has been observed on the lower Eyre Peninsula. The purpose of Table 4, while every effort has been made for its accuracy, is more about the process than the numbers. Different growers will have different numbers that they are comfortable with using.

The above demonstrates how the change in crop pricing and variability in yields from year to year can be accounted for. While not every decision is as easy as profit per hectare, a structured, well-thought-out process will assist in outlining what is perhaps obviously a good decision, a bad one, or provide some clarity if you are sitting on the fence. There are other factors that must be accounted for such as risk in a combination of low decile years (price*yield), and if this occurs for multiple years in comparison to another more stable practice.

Where to from here?

This trial, while having some great learnings, also left some unanswered questions:

1. How will higher rainfall seasons affect yields?
2. How can we ensure that plants reliably nodulate sufficiently on these soil types?
3. How do ameliorated soils perform over time?

Conclusion

In the 2024 season, it was found that beans and lentils were a good break crop option at North Block. To add rigor and validity to rotational decision making, more years of data should be collated to allow

for seasonal variability. This will better our ability to look at the economic validity of our decisions regarding profitable pulses on ameliorated soils and how far the system can be pushed forward.

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Location
North Block, Cummins
Rainfall (BOM Cummins)
Av annual: 420mm
Av GSR: 340 mm
2024 Total: 286 mm
2024 GSR: 245 mm
Soil type
Ameliorated deep sand over clay duplex soil with ironstone gravel (approx. 40%)
Paddock history
2023: Wheat
2022: Canola
Plot size
1.85x10 m on 250 mm row spacing x 3 reps