

RISKWIŞE 2023-2027 - THEME 1: NITROGEN Nitrogen Management Systems



*Testing N management decisions to inform
risk-reward, Griffith NSW.*

**ZONE 3 – Central West & Northern Riverina
Year 3 2025**

Griffith N Systems Trial 2025

KEY POINTS

- **Pre-sowing soil tests in 2025 showed that mineral N levels were highest where higher background N fertiliser rates had been applied in previous years, showing N management decisions do influence soil N carryover.**
- **In the pulse phase of the rotation the extra soil N did not translate into a yield or quality benefits for lentils in 2025. As such there was no economic return in 2025 in the lentil phase of the rotation. The results reinforce that pulse crops are unlikely to benefit from high soil N, especially when nodulation and fixation are effective.**
- **After 3 seasons, whilst many strategies are still running down the nitrogen balance, the Manure and High Risk Seasonally Responsive (assuming a decile 7-8 finish) treatments had the highest positive N balances. These 2 treatments also had the highest average nitrogen applied after 3 years.**
- **Overall, the third-year results demonstrate that N management benefits are strongly crop and phase dependent.**

BACKGROUND

This project is part of 'RiskWi\$e' (the National Risk Management Initiative) which includes a network of small plot and paddock scale trials across a range of production environments and systems nationally, all of which are aiming to quantify the risks and rewards of different nitrogen (N) management strategies and decisions over multiple years.

As N was identified by growers as a priority area for risk-reward decision making, the project is comparing a variety of decision-making approaches to inform annual N fertiliser applications including the use of tools like Yield Prophet to target pessimistic or optimistic seasonal conditions, longer-term strategic approaches like N banking or replacement strategies. N treatments for the Griffith longer-term N systems trial were driven by growers and grower experience with their N management strategies. These trials will characterise the yearly variability in response to N but importantly also measure carryover of residual N from one year to the next, and the economics behind each strategy.

The trials will not only provide useful data on these approaches but also provide a platform to explore how models and other tools can inform N fertiliser decisions to balance the long-term risks and rewards.

This report covers the nitrogen theme and trial results from the 2025 cropping season and cumulative data from 2023-2025 for the Griffith site. For previous year's results and more detailed background of this project, treatments and set up please refer to <https://www.aggrowagronomy.com.au/wp-content/uploads/2024/03/RiskWse-N-Systems-Trial-2023.pdf>

The RiskWi\$e project is ongoing and there is a catalogue of resources already available to farmers. Follow these links for more information:

<https://research.csiro.au/riskwise/>

<https://www.uwacaed.org/behaviouralscience>

TRIAL DETAILS

The Griffith site is located on the Ag Grow Agronomy research farm “Ridgetop” Beelbangera, approximately 16km NE of Griffith. 2025 is the third year of the trial, with canola sown in 2023, wheat in 2024 and lentils in 2025.

The trial was set up to compare the yield, grain quality, and profitability of different nitrogen (N) management approaches over the long term, with the aim of providing information on whether fertiliser N not used by crops in the year of application carries over to subsequent seasons, what the consequences of excessive N fertiliser are for crop productivity, and the effect of different N fertiliser strategies on legume productivity, N fixation and economic outcomes.

The trial consists of 12 treatments, table 1, with the first 5 treatments compulsory as part of the wider project. Treatments are designed using soil tests for water and mineral N, historic climate data, financial data and tools such as Yield Prophet based on rainfall deciles. The treatment code corresponds to the data in the results section.

As part of the rotation the trial was sown to GIA Thunder lentils at 40kg/ha on the 29th April 2025 with 120 kg/ha superphosphate. The trial was rolled 27th May 2025, with appropriate pest, disease and weed control undertaken on the trial post-emergent. The trial received 2 timely fungicide sprays in 2025. The trial was harvested 30th October 2025.

Table 1: Griffith site treatment list and description.

Trt No.	Treatment Name	Trt code	Treatment description
1	Nil	NIL	Nil N Control - no N fertiliser applied, P applied with superphosphate)
2	Grower Practice	DIS	Rate determined by current grower decision making (use same rate the host farmer is applying. If host farmer is growing a different crop type, work through the exact scenario in the trial and document how they reached their decision)
3	Low Risk	YP_D3	Low Risk Seasonally Responsive - Sufficient N applied to meet water limited potential yield assuming a decile 2-3 season finish (equivalent to Yield Prophet 75%)
4	Med Risk	YP_D5	Moderate Risk Seasonally Responsive - Sufficient N applied to meet water limited potential yield assuming a decile 5 season finish (equivalent to Yield Prophet 50%)
5	High Risk	YP_D7	High Risk Seasonally Responsive - Sufficient N applied to meet water limited potential yield assuming a decile 7-8 season finish (equivalent to Yield Prophet 25%)
6	Climate Forecast	YP_BOM	Seasonal Forecast Responsive - Sufficient N applied to meet water limited potential yield assuming whichever of treatments 4-5 is most likely based on BOM 3-month forecast
7	8% Gross Income	FIN	Financially Responsive - apply as much N fertiliser as can be purchased with 8% of gross income from the previous season at current market value of urea (source – FM500 benchmarking)
8	Replacement	REP	Replacement – apply N fertiliser equal to grain N offtake from previous season
9	Replacement+30%	REP_HI	Replacement +30% - apply N fertiliser equal to grain N offtake from previous season plus 30%
10	Replacement-30%	REP_LO	Replacement -30% - apply N fertiliser equal to grain N offtake from previous season minus 30%
11	Manure	MAN	Manure – proportion of N supplied through addition of manure of known N content.
12	Enhanced Fertiliser	EEF	Enhanced fertilisers – N fertiliser is supplied with coatings to reduce losses (e.g. urease inhibitors, polymers, nitrification inhibitors).

Soil Testing:

Soil tests were undertaken on 26th February 2025 in the 5 compulsory treatments for nitrogen, at depths of 0-10cm, 10-40cm, 40-70cm and 70-100cm. Table 2 shows an estimate of the total mineral nitrogen available (0-100cm) for plant uptake for each treatment at sampling and the total N applied in 2024. The Nil treatment had significantly lower pre-soil mineral N available than all other treatments tested, except the low risk treatment (treatment 3).

In previous years nitrogen rates for each treatment were calculated from these soil test results. Given lentils were sown in 2025, no nitrogen was applied in 2025.

Table 2: 2025 pre-sowing soil total mineral N kg N/ha (0-100cm) for 5 compulsory treatments in the trial, February 2025.

Trt No.	TREATMENT	Trt Code	Sowing total mineral N (kg/ha)	sig diff	2024 Total N Applied (kg N/ha)
1	Nil Control	NIL	30	<i>b</i>	0
2	Grower Rate	DIS	53	<i>a</i>	101
3	Low Risk (Decile 2-3) Seasonally Responsive	YP_D3	41	<i>ab</i>	56
4	Medium Risk (Decile 5) Seasonally Responsive	YP_D5	53	<i>a</i>	106
5	High Risk (Decile 7-8) Seasonally Responsive	YP_D7	58	<i>a</i>	146
<i>mean</i>			47		
<i>MSD (p=0.05)</i>			17.8		

Means followed by same letter do not significantly differ

Seasonal Conditions 2025:

Conditions straight after harvest 2024 were wet, with 90mm falling in November and December, which topped up the soil profile. The first 4 months of 2025 were dry, with below average rainfall and above average temperatures.

This trial was sown into moisture on 29th April after 14mm on 25th April, and emerged evenly. Warm and dry conditions persisted into May, with some much-needed rain falling towards the end of the month, table 3. Follow up rain occurred mid-late June, before the crop accessed stored moisture.

With warmer, windy days and frosts impacting topsoil moisture, below average rainfall continued throughout June, July and August as drought conditions strengthened.

Much needed rain occurred in early September, setting up the crop. The Beelbangera trials received 166.5mm of growing season rainfall (GSR) from April–October (200.5mm GSR average) with 76mm of this rainfall received from mid-September and October.

Table 3: 2025 Rainfall and Growing Season Rainfall (GSR) for the trial site, compared to long term rainfall taken at Griffith Airport.

MONTH	Ridgetop Rainfall 2025	Griffith Airport 2025	Griffith Airport Long Term (1958 to 2025)
January	4	4.4	36.3
February	18	23.6	28
March	32	25	35.3
April	13.5	12.4	29.3
May	18	14.8	36.1
June	25	29	35.1
July	24.5	22.4	32.4
August	9.5	17	34.9
September	50.5	32.8	32.7
October	25.5	7.2	39.4
November	13.5	21.2	36.3
December *	9.5	10.2	32.7
TOTAL	243.5	220	408.5
GSR (April - Oct)	166.5	135.6	239.9
<i>* to 16th December</i>			

RESULTS

2025 Results:

Establishment, NDVI, yield and grain quality were assessed on the trial.

Establishment:

Establishment was assessed on 13th June when the lentils were around 7 nodes. An establishment score and plant counts were taken on the trial, with the trial establishing well, figure 1.

The average establishment score of the trial was 7.8, with an average plant count of 75 plants/m².

Figure 1: Establishment June 2025.



NDVI:

NDVI measurements were obtained using a handheld GreenSeeker crop sensor, with two readings taken, mid to late vegetative stage and at flowering, figure 2. Table 4 summarises the 2025 NDVI results.

Figure 2: NDVI 1 at mid-late vegetative stage in July (left) and NDVI 2 at flowering in August (right).



Table 4: NDVI's data taken 24th July and 12th August 2025.

TREATMENT	Trt Code	NDVI 1	NDVI 2
Nil	NIL	0.40	0.64
Grower Practice	DIS	0.36	0.61
Low Risk	YP_D3	0.37	0.64
Med Risk	YP_D5	0.37	0.61
High Risk	YP_D7	0.41	0.65
Climate Forecast	YP_BOM	0.42	0.72
8% Gross Income	FIN	0.42	0.67
Replacement	REP	0.41	0.66
Replacement+30%	REP_HI	0.41	0.66
Replacement-30%	REP_LO	0.36	0.64
Manure	MAN	0.46	0.70
Enhanced Fertiliser	EEF	0.42	0.68
Average		0.40	0.66
MSD (p=0.05)		ns	ns

The average NDVI of the first reading was 0.40 and the second was 0.66.

There were no significant differences between treatments at both NDVI timings. However, there were some trends with the manure treatment having the highest NDVI early.

Nodulation:

A non replicated nodulation score was carried out on the trial to gauge the effect of the background nitrogen levels on nodulation, using the Yates et al scoring system, table 5. Nodulation was scored from 0-8, with a score of 4 or more considered adequate nodulation. The only treatments to have inadequate nodulation were the nil treatment and the low risk treatment, both of which had the lowest mean annual N rates applied. Higher N rates did not appear to impact nodulation, figure 3.

Table 5: Indicative nodulation score taken at flowering, September 2025.

Trt No.	Treatment	Trt Code	Mean annual N rate (kg N/ha)	Nodulation Score	Nodulation
1	Nil	NIL	0	2.5	scarce to moderate
2	Grower Practice	DIS	75	4.0	adequate
3	Low Risk	YP_D3	62	3.0	moderate
4	Med Risk	YP_D5	119	5.5	ample-abundant
5	High Risk	YP_D7	171	5.0	ample
6	Climate Forecast	YP_BOM	90	4.5	adequate-ample
7	8% Gross Income	FIN	86	4.0	adequate
8	Replacement	REP	108	4.5	adequate-ample
9	Replacement+30%	REP_HI	122	4.0	adequate
10	Replacement-30%	REP_LO	97	5.5	ample-abundant
11	Manure	MAN	173	5.0	ample
12	Enhanced Fertiliser	EEF	77	4.5	adequate-ample

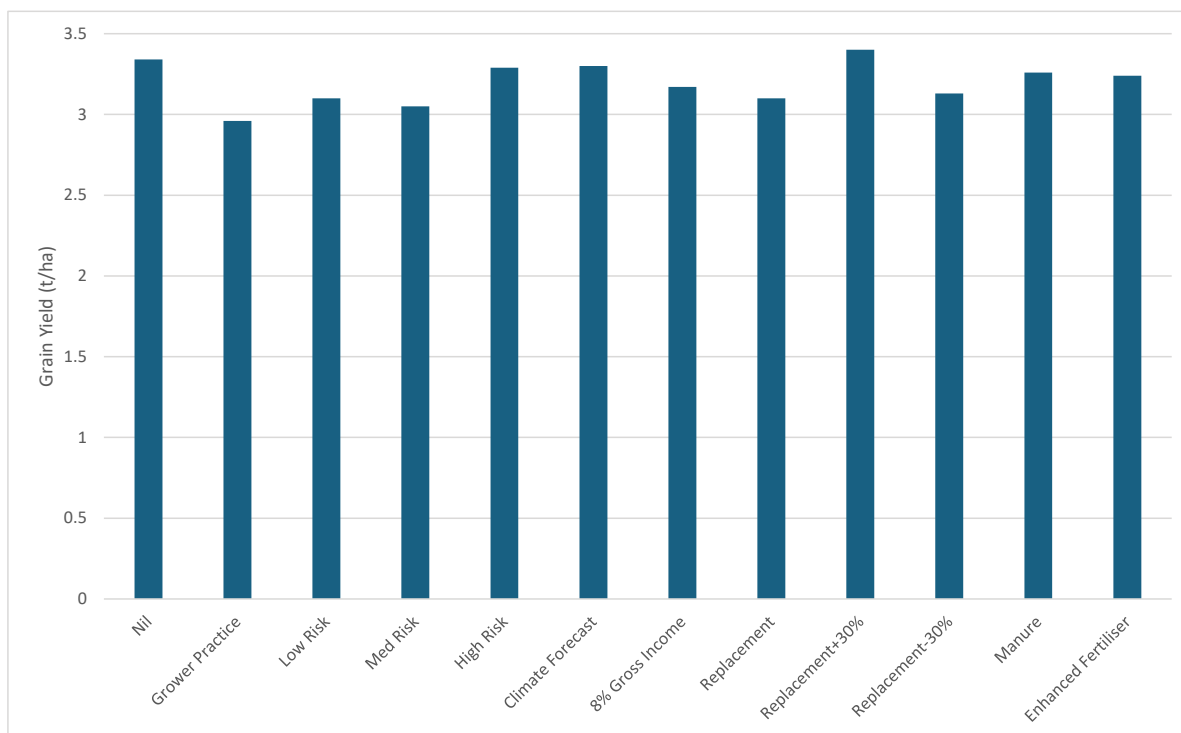
Figure 3: Lentil nodulation of the Nil (left), Grower practice (middle) and manure (right).



Grain Yield:

The average grain yield of the trial was 3.2 t/ha. There were no differences in grain yield between any of the treatments in 2025, figure 4. The yield of all treatments was between 2.96 and 3.40 t/ha. Lentil yield did not respond to the varying pre-sow soil mineral N levels in 2025.

Figure 4: 2025 Lentil Grain yield of the N Systems Trial.



Grain Quality:

A summary of grain quality data, including thousand seed weight, for 2025 is shown in table 6. Grain protein is yet to be tested.

The average thousand grain weight of the lentils was 34.78g. There were no differences in seed size of the lentils between treatments in 2025.

Table 6: 2025 Thousand seed weight for Griffith N Systems trial.

Treatment	Trt code	Thousand Grain Weight (g)
Nil	NIL	35.53
Grower Practice	DIS	33.93
Low Risk	YP_D3	34.95
Med Risk	YP_D5	34.41
High Risk	YP_D7	34.39
Climate Forecast	YP_BOM	34.83
8% Gross Income	FIN	35.08
Replacement	REP	35.35
Replacement+30%	REP_HI	34.58
Replacement-30%	REP_LO	34.96
Manure	MAN	34.74
Enhanced Fertiliser	EEF	34.64
mean		34.78
MSD (p=0.05)		ns



Partial N Balance 2025:

Partial N balance was calculated using total fertiliser N (kg/ha) minus the grain N export (kg/ha) plus the N fixation (kg/ha). There were no differences between treatments in terms of the partial balance for nitrogen in 2025, table 7.

Table 7: 2025 Partial N Balance (kg/ha) for Griffith N Systems trial.

Trt No.	TREATMENT	Trt Code	Partial N supply (kg/ha) mean	N export (kg/ha)	N fixation (kg/ha)	Partial N balance (kg/ha)
1	Nil	NIL	29.78	128.10	200.16	72.06
2	Grower Practice	DIS	53.45	113.78	177.78	64.00
3	Low Risk	YP_D3	41.01	119.13	186.15	67.01
4	Med Risk	YP_D5	52.52	117.27	183.23	65.96
5	High Risk	YP_D7	57.62	126.35	197.43	71.07
6	Climate Forecast	YP_BOM		126.72	198.00	71.28
7	8% Gross Income	FIN		121.82	190.35	68.53
8	Replacement	REP		119.15	186.17	67.02
9	Replacement+30%	REP_HI		130.53	203.95	73.42
10	Replacement-30%	REP_LO		120.09	187.65	67.55
11	Manure	MAN		125.22	195.66	70.44
12	Enhanced Fertiliser	EEF		124.44	194.44	70.00
mean				122.72	191.75	69.03
MSD (p=0.05)						ns

Note: N BALANCE CALCULATIONS

Partial N supply (kg/ha) - Calculated as sowing total mineral N (kg/ha) + fertiliser total N (kg/ha)

Partial N balance (kg/ha)- Calculated as fertiliser total N (kg/ha) - grain/hay N export (kg/ha) + N fixation kg/ha)

N export (kg/ha) - Grain N export calculated from grain N percentage of yield: (protein %)/N conversion factor * yield (kg/ha). Conversion factor 5.7 for wheat, 6.25 all other crops.

N fixation (kg/ha) - Calculated from grain or biomass yield as per [Peoples et al 2017, oi:10.1071/SR16330]. Grain legume N fixation (kg/ha) = grain yield (t/ha) * 60 (kg/t).

Economics 2025:

Given there were no differences in grain yield or quality between any of the treatments in 2025, and no differences in input costs between any of the treatments as no additional N was applied to the lentils, there were no differences in lentil partial gross margin for 2025 between any of the nitrogen treatments.



2023-2025 Results

Cumulative Partial N balance (2023-2025) (kg/ha):

The cumulative partial balance of nitrogen after 3 years is shown in table 8. It is calculated from the total N applied minus N removed in the grain after 3 years. After 3 years the manure treatment (treatment11) and the high risk treatment (treatment 5) had the highest positive nitrogen balance with 84 and 79 kg N/ha respectively. This is also represented in figure 5.

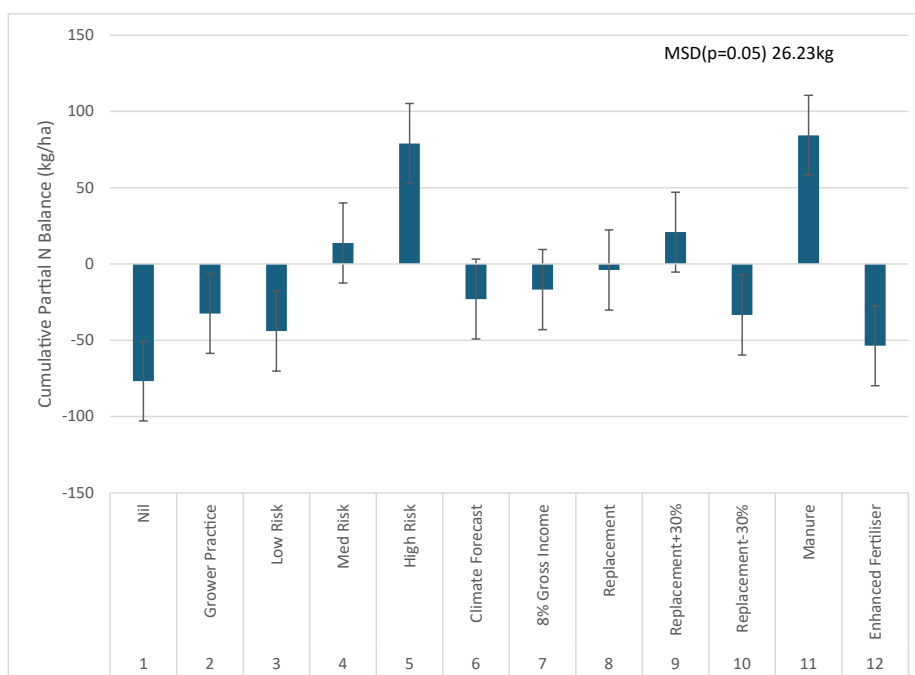
All other treatments, except replacement + 30% and medium risk treatments, had a negative N balance. These treatments have continued to run down the nitrogen. The Nil treatment (treatment 1) had the greatest negative balance, with a deficit of 77 kg N/ha. The replacement treatment (treatment 8) was close to zero after 3 years.

Table 8: Griffith N Systems trial 3-year cumulative partial N balance (2023-2025).

Trt No.	TREATMENT	Trt Code	Cumulative partial N balance (kg/ha)	Sig Diff
1	Nil	NIL	-76.69	<i>g</i>
2	Grower Practice	DIS	-32.40	<i>def</i>
3	Low Risk	YP_D3	-43.88	<i>ef</i>
4	Med Risk	YP_D5	13.83	<i>b</i>
5	High Risk	YP_D7	78.95	<i>a</i>
6	Climate Forecast	YP_BOM	-22.95	<i>cde</i>
7	8% Gross Income	FIN	-16.75	<i>cd</i>
8	Replacement	REP	-3.88	<i>bc</i>
9	Replacement+30%	REP_HI	20.91	<i>b</i>
10	Replacement-30%	REP_LO	-33.42	<i>def</i>
11	Manure	MAN	84.30	<i>a</i>
12	Enhanced Fertiliser	EEF	-53.52	<i>fg</i>
mean			-7.13	
MSD (p=0.05)			26.23	

Note: Means followed by same letter are not significantly different

Figure 5: Cumulative partial balance of nitrogen after 3 years (2023-2025).



Gross margin (\$/ha):

After 3 years the cumulative partial gross margin shows all treatments have returned a profit over the Nil control treatment, table 9. Profit remains driven by grain yield and the cost of nitrogen applied, with no nitrogen applied to the pulse phase of the rotation.

The manure treatment after 3 years has returned the highest profit, with \$740, followed by the replacement plus 30% treatment with \$704.

Table 9: Cumulative Partial Gross Margin Data (2023-2025) for each treatment of the Griffith N Systems trial - Profit (\$/ha) for each treatment, compared to control (treatment 1).

Trt No.	Treatment	2025 Lentil Grain Yield (t/ha)	2025 Revenue *lentils \$600 On farm	2025 Total N applied (kg N/ha)	2023-2025 Total Revenue \$	2023-2025 Total N applied (kg N/ha)	2023-2025 Total Treatment Costs (\$)	Revenue minus Treatment Costs (\$)	2023-2025 Profit (compared to control)
1	Nil N Control	3.34	2004	0	4812	0	0	4812	\$0
2	Grower Practice	2.96	1776	0	5457	149.2	323	5135	\$323
3	Low Risk Seasonally Responsive (Decile 2-3)	3.1	1860	0	5419	123	233	5186	\$374
4	Medium Risk Seasonally Responsive (Decile 5)	3.05	1830	0	5609	237	442	5166	\$354
5	High Risk Seasonally Responsive (Decile 7-8)	3.29	1974	0	5957	341	628	5329	\$517
6	Climate Forecast - Seasonal Forecast	3.3	1980	0	5719	180	355	5363	\$551
7	8% Gross Income - Financially Responsive	3.17	1902	0	5569	171	324	5245	\$433
8	Replacement	3.1	1860	0	5596	215	411	5184	\$372
9	Replacement+30%	3.4	2040	0	5995	194	479	5516	\$704
10	Replacement-30%	3.13	1878	0	5655	243	355	5301	\$489
11	Manure	3.26	1956	0	6103	345	550	5552	\$740
12	Enhanced Fertiliser	3.24	1944	0	5633	154.2	350	5283	\$471

Note: Costs are based on actual paddock costs; Treatment costs are those above the standard paddock costs and are the costs attributed to the actual N treatment only.

Costs include:

2023

* Canola does not include oil bonus

Canola on farm price \$625/t

Paddock cost \$575.95/ha

Nitrogen Fertiliser Input Costs based on 2023

Urea \$727/t plus \$10/ha application

Green Urea \$767/t plus \$10/ha application

Gran Am \$580/t plus \$10/ha application

Manure \$18/t plus \$18/ha application

2024

Wheat on farm price \$300/t

Paddock cost \$607.35/ha

2024 fertiliser costs

Urea \$975/t (April 2024)

Urea \$840/t (July 2024)

Both plus \$10 /ha application

2025

Lentil on farm price \$600/t

Paddock cost \$650.14/ha

2025 fertiliser costs

No added N treatments

DISCUSSION

This trial was established to quantify the agronomic risks and rewards of different nitrogen (N) management strategies across multiple seasons. By the third year, the system was in a pulse phase (lentils, 2025), providing an opportunity to assess whether legacy N strategies influenced crop performance, soil N dynamics, or in-season crop growth.

Despite clear differences in pre-sowing soil N status this did not translate into any agronomic benefits in the lentil phase. Pre-sowing soil tests in 2025 showed that total mineral N (kg N/ha) was highest in treatments that had received greater background N inputs in previous years, indicating that N strategies did affect residual soil N supply. However, this increased soil N availability did not result in measurable differences in crop growth or yield outcomes.

In 2025, there were no yield benefits from any of the N treatments. Grain yield, seed size and overall crop performance were the same across all treatments, regardless of how much background N had been applied in previous years. NDVI measurements during the season also showed no differences in crop vigour or canopy development. This indicates under the conditions experienced in the 2025 season, lentils were not limited by nitrogen and did not respond to either current or historical N inputs. As a pulse crop, lentils can meet much of their N requirements through nitrogen fixation, reducing their dependence on soil N. As such the higher starting soil N did not improve crop growth or grain yield, as expected.

From a risk–reward perspective, the higher background N increased soil mineral N levels going into the lentil crop. However, the extra N did not improve yield, seed size or crop vigour, meaning there was no economic return in the lentil phase of the rotation. Despite this, after 3 years, the cumulative partial gross margin remains driven by grain yield, with all treatments returning a profit over the Nil control treatment.

Overall, the third year of the trial being in a pulse phase, showed that N management benefits are strongly crop and phase dependent. In the pulse phase, the reward for higher soil mineral N was negligible, reinforcing the value of tailoring N strategies to crop type and seasonal conditions. Continued monitoring in following phases of the rotation will be important in determining if the elevated soil N observed in high-N treatments translates into benefits later in the rotation, or whether the risks associated with higher N inputs outweigh any delayed rewards.

How are growers using the results?

Growers are using the results from the RiskWise N systems trials to make more informed and lower-risk nitrogen (N) management decisions by aligning fertiliser strategies more with seasonal risk and profit potential. The outcome is higher achievable yields and profitability.

They are using soil testing to quantify starting mineral nitrogen levels, and incorporating historic climate data, such as rainfall deciles, to assess the likelihood of different seasonal outcomes and matching N inputs to seasonal risk. More growers are using tools such as Yield Prophet to simulate crop yield potential under different rainfall scenarios and N strategies, allowing them to test “what-if” scenarios before committing to applying any fertiliser.

It has led to a more adaptive N management strategies, with a shift from more fixed, upfront nitrogen decisions to risk-managed, data-driven strategies that better match N supply with crop demand, seasonal conditions, and economic return.



ACKNOWLEDGEMENTS

RiskWi\$e is conducted in partnership with grower groups, 6 action research group leads, research/extension partners, CSIRO and the Grains Research and Development Corporation (GRDC).

Ag Grow Agronomy and Research is leading RiskWi\$e work on nitrogen decision making in the Griffith area.



The RiskWi\$e project is ongoing and there is a catalogue of resources already available to farmers.

<https://research.csiro.au/riskwise/>

<https://www.uwacaed.org/behaviouralscience>

Visit the RiskWi\$e website

<https://research.csiro.au/riskwise/resources-and-tools/>

RiskWi\$e is made possible thanks to the involvement of all partners and was established through an investment of the Grains Research and Development Corporation (GRDC).

<https://grdc.com.au/research/partnerships-and-initiatives/strategic-partnerships/riskwise>

RiskWi\$e

– the National Risk Management Initiative

