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Project Code	
Project Type	

SAGIT

FINAL REPORT 2023

Final reports must be submitted using the online application form at www.sagit.com.au with this Word document attached ***within two months*** after the completion of the Project Term.

PROJECT CODE	LEA 120
PROJECT TITLE	
Taking South Australian Canola Profitability to the next level	

PROJECT DURATION *These dates **must** be the same as those stated in the Funding Agreement.*						
Project start date	1/07/2020					
Project end date	30/06/2023					
SAGIT Funding	2020/21		2021/22		2022/23	

PRINCIPAL INVESTIGATOR *(responsible for the overall project and reporting)*			
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ADMINISTRATION CONTACT DETAILS *(responsible for all administrative matters relating to project)*			
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PROJECT REPORT:

Executive Summary (200 words maximum)

Recent advancements in canola yield have been achieved through practices like early sowing, aligning cultivar phenology and sowing timing with critical flowering periods, hybrid variety development, and effective blackleg control using fungicides. Building upon these practices, a question emerged: How can canola yields on Lower Eyre Peninsula be further enhanced?

To address this, a series of multi-year experiments were conducted between 2020 and 2022 on Lower Eyre Peninsula. These experiments focused on factors such as previous crop influence, stored soil moisture, and various nutritional strategies, all aimed at economical canola yield improvement.

The findings revealed:

- Canola yield was primarily driven by optimal nitrogen (N) levels in the soil before seeding, outperforming other nutritional and rotational treatments.
- The influence of previous crops (wheat vs. pulse) had little effect on canola yield in these experiments.
- Amplified rates of trace elements and sulphur displayed no discernible impact on canola yields, provided soil and plant tissue tests met current critical values.
- Notably, the wheat crop of 2022 grown on land previously used for pulses (canola in 2021) outperformed the wheat crop of 2020.

These insights underscore the significance of nitrogen management as a key lever for increasing canola yield.

Project objectives

1. To determine the maximum achievable water limited yield of canola (kg/mm) in the Lower Eyre Peninsula environment.
2. To determine the relative significance of key canola yield drivers once disease and phenology are optimised, including crop sequence and nutrition package in high production systems. This will provide information to better target and refine input costs and improve the profitability of canola.
3. To provide information to growers and advisors on Lower Eyre Peninsula on the yield driving mechanisms and profitability of high production canola systems

Overall Performance

Extent to which the project objectives were achieved:

1. To determine the maximum achievable water limited yield of canola (kg/mm) in the Lower Eyre Peninsula environment.

- In 2021 canola yields achieved 14 kg/mm, reaching the theoretic potential of canola.
- In 2022 canola yields were not able to achieve 14kg/mm, thought to be due limitations of photo thermal quotient (PTQ) during the critical period in that year. These data have been provided to Dr Kenton Porker for use in a paper to be delivered to the International Rapeseed Congress (Sept 2023) explaining the role of PTQ in canola yield development.

2. To determine the relative significance of key canola yield drivers once disease and phenology are optimised, including crop sequence and nutrition package in high production systems. This will provide information to better target and refine input costs and improve the profitability of canola.

- This project was able to determine that nitrogen was the key driver of yield, phosphorous may be important in some situations and that the role of previous crop, trace elements and sulphur were not as critical to push the canola yield frontier.

3. To provide information to growers and advisors on Lower Eyre Peninsula on the yield driving mechanisms and profitability of high production canola systems.

- This project delivered information to Lower EP growers, through presentations to Lower EP Spring Crop Walks, Lower EP Ag Expos, and articles in the EP Farming Systems Summaries (also located on the AIR EP website).

- The project also delivered to a wider audience through presentations to the independent consultant's group and participating in the SAGIT podcast program.

Personnel
Andrew Ware, research Agronomist, project lead
Mark Saunders, field assistant
Rhaquelle Meiklejohn, graduate research agronomist (intern)
Rebekah Fatchen, graduate research agronomist (intern)

Farmer Co-operators
Yeltukka – Michael Treloar and family
Coomunga – Peter Russell and family

Difficulties experienced and solutions.

- When no differences to treatments were achieved in the 2021 trials, refinement of the treatments in the 2022 trials helped provide clarity of key drivers of canola yield.

KEY PERFORMANCE INDICATORS (KPI)

KPI	Achieved	If not achieved, please state reason.
Set-up phase trials established at Wanilla and Yeelanna	Yes ☒ No ☐	
Crop walk visit to at least one site during Spring 2020	Yes ☒ No ☐	
Summary article introducing project and detailing 2020 activities produced and distributed as part of LEADA's harvest summary booklet	Yes ☒ No ☐	
2020 trials at Wanilla and Yeelanna over-sown with canola	Yes ☒ No ☐	
Set-up phase trials established at Wanilla and Yeelanna	Yes ☒ No ☐	
Crop walk visit to at least one site during Spring 2021	Yes ☒ No ☐	
Summary article detailing 2021 activities produced and distributed as part of LEADA's harvest summary booklet	Yes ☒ No ☐	
2021 trials (Wheat/ Pulse) at Wanilla and Yeelanna over-sown with canola	Yes ☒ No ☐	
Summary article detailing all project activities, cost benefit and risk analysis produced and distributed as part of AIR EP's harvest summary booklet.	Yes ☒ No ☐	
Satisfactory final report produced.	Yes ☒ No ☐	

TECHNICAL INFORMATION (Not to exceed **three** pages)

Understanding the drivers and limitations of canola yield potential is essential for discovering opportunities to push the yield frontier. The next significant stride in canola yield relies on consistently improving water use efficiency past 14kg/mm. However, achieving this goal needs to consider profitability and a comprehension of the risks associated with higher inputs.

Several management enhancements have recently improved canola yield. These include strategies like early sowing, appropriate cultivar selection aligned with critical flowering periods, and advancements in genetic and fungicide controls for blackleg disease. Over recent years, yield gains have also been achieved through the adoption of high nitrogen rates and hybrid varieties. These practices have escalated production costs and introduced increased risk, particularly during climatically volatile years.

To enhance our understanding of how canola yields can be improved beyond current best practice standards, we established multi-year trial sites at two locations on the Lower Eyre Peninsula. These sites were situated at Yeltukka, west of Cummins, a sandy loam over clay soil, and at Coomunga, northwest of Pt Lincoln, on an ironstone gravel sandy loam soil.

The trials comprised of a preparatory phase in the first year, during which blocks of wheat and pulses (either lupins or faba beans depending on the site) were sown, and nutrients were applied in preparation for canola planting in the subsequent year. The setup phases were conducted in both 2020 and 2021. Canola was then planted in 2021 and 2022. While in 2022 wheat was planted on the plots that underwent the setup phase in 2020.

This project sought to further improve canola yields through answering four key questions:

Q1. Do high yielding canola crops increase requirements for trace elements and sulphur?

As canola target yields aim to exceed 3 tonnes per hectare (t/ha), the demand for nutrients essential to plant growth also rises. Modern hybrid canola varieties experience rapid growth, particularly from the onset of flowering to peak biomass. This means that the biomass can surge from 4-5 t/ha to as much as 15-20 t/ha in around six weeks, creating a substantial and rapid need for nutrients. Some growers and advisors in the Lower Eyre Peninsula region have reported anecdotal responses to foliar applications of calcium, boron, and molybdenum when applied at early flowering.

The high demand of canola for sulphur (S) has been well understood by South Australian growers since the early years of the crop being produced. This is traditionally managed through the application of at least 0.5 t/ha of gypsum prior to a canola crop being planted or high analysis fertiliser at seeding, but questions are being asked if this is best practice to maximise canola yields in today's modern farming systems.

The High S treatment consisted of applications of 20 kg/ha of sulphur applied as gypsum, applied during the setup phase year. The high trace element treatment received 1.7 kg/ha Zn, 5 kg/ha Ca, 2.6 kg/ha Mn, 1 kg/ha Cu, 40 g/ha B, 2 g/ha Mo, and 1.35 kg/ha Fe through streaming nozzles in the setup year and also received 120 g/ha Zn, 150 g/ha Mn, 40 g/ha Cu, 50 g/ha Ca and 6 g/ha Mo applied as a foliar spray at early bloom in the canola crop.

Canola tissue tests collected from the 2022 trials showed that all trace elements from each site met the critical values detailed in Reuter and Robinson (1997).

Table 1. Canola yield results from district practice, high sulphur, and high trace element treatments.

Site	District Practice Yield (t/ha)	Yield High Sulphur (t/ha)	Yield High Trace Elements (t/ha)	lsd (p=0.05)
Yeltukka 21	3.45	3.48	3.58	*ns*
Coomunga 21	3.75	3.81	3.91	*ns*

Yeltukka 22	5.90	5.96	5.90	*ns*
Coomunga 22	5.50	5.25	5.42	*ns*

Higher rates of trace elements and sulphur didn't have any impact on canola yields above district practice in a situation where soil and plant tissue tests met current critical values and is representative of canola's tremendous ability to scavenge the soil to find and meet its nutritional requirements. This doesn't discount that nutrient deficiencies could occur in different soil types or situations but does indicate that prophylactic applications of trace elements are not generally necessary to achieve high yields.

Q2. Do high yielding canola crops have increased requirements for phosphorous?

Canola removes around 7 kg/tonne of phosphorous (P), with some seasonal and geographic variation. Canola yields frequently exceed 3 t/ha, exporting around 21 kg/ha of P. Rates of 105 kg/ha of DAP (or equivalent) are required to maintain P levels, assuming 100% efficiency, which rarely occurs. This requires new thinking in the quantity and delivery mechanism of phosphorous fertiliser to crops such as canola, which have a low tolerance to high levels of fertiliser near the seed.

To investigate if P is limiting potentially higher canola yields, high rates were applied in setup phase (year prior to canola).

Table 2. Soil test results, P application rates and canola yield results from district practice and high P treatments.

Trial	Treatment	pH (CaCl2)	Starting Colwell P	PBI	P applied Yr 1 (kg/ha)	P applied Yr 2 (kg/ha)	Canola Yield (t/ha)	lsd (p= 0.05) t/ha
Yel21	District P	6.4	29	27	18	22	3.45	*ns*
Yel21	High P	6.4	29	27	36	22	3.49	*ns*
Com21	District P	6.0	33	70	18	22	3.75	*ns*
Com21	High P	6.0	33	70	36	22	3.82	*ns*
Yel22	District P	7.1	37	31	18	22	4.91	*ns*
Yel22	High P	7.1	37	31	36	22	4.98	*ns*
Yel22	High P+	7.1	37	31	36	40	5.60	*ns*
Com22	District P	5.5	30	67	18	22	5.49	*0.33*
Com22	High P	5.5	30	67	36	22	5.46	*0.33*
Com22	High P+	5.5	30	67	36	40	5.82	*0.33*

In all four trials when canola was planted in this project, we did not observe a response to the incorporation of higher levels of phosphorus (P) during the preceding year. The intention was to increase the availability of residual P for the subsequent canola crop and reduce risk of seedling damage to high fertiliser rates. However, an improvement in canola yields was observed when additional P in the form of single superphosphate was broadcast before seeding canola in the 2022 Coomunga trial.

This outcome implies that, in high-yield scenarios on ironstone soils, phosphorus could represent a limiting factor. Consequently, the most effective approach might involve the application of higher P rates in the same year when the crop demands it.

Q3. How can we best manage nitrogen (N) to ensure that is not a limiting factor in high yielding canola?

Canola crops have a substantial nitrogen requirement (approximately 80 kg N per tonne of grain produced). The application of synthetic fertilisers has demonstrated effective in matching to crop demands. However, efficacy diminishes when high rates are required in high yielding situations. Research conducted within the high rainfall zone has shown that artificial nitrogen applications higher than 250 kg/ha N in the year of application, do not show any productivity gains, relying on organic N sources to increase productivity.

Given that some growers on the Lower Eyre Peninsula are now applying nitrogen rates exceeding 200 kg/ha to canola, it important to explore alternative, more efficient methods of nitrogen application and if further improvements in yield can be achieved.

Table 3. Soil mineral N tests (0-100cm) collected in Autumn before canola crop is planted.

Trial	District Practice Prev Crop: Wheat Total Min N (kg/ha)	District Practice Prev. Crop: Pulse Total Min N (kg/ha)	Everything High Prev. Crop Wheat Total Min N (kg/ha)	Everything High Prev. Crop Pulse Total Min N (kg/ha)
Yel21	46	80	142	128
Yel22	52	74	132	115
Com21	91	101	156	158
Com22	77	76	219	195

Mineral N soil test results show, as expected, that in district practice situations higher mineral N is available for canola following a pulse crop compared to cereal, but this advantage is lost in situations where high rates of N are applied to both preceding crop types. However, these results demonstrate that high residual levels of N can be carried over from one season to the next and show that strategies such as N banking may be effective on soil types previously thought to be at high risk of leaching nutrients.

Table 4. N application rates and canola yield results from district practice, high N and treatments where high rates of all nutrients were applied.

Trial	Treatment	N applied Yr 1	N applied Yr 2	Yield (t/ha)	lsd (p= 0.05)
Yel 21	District Practice	9 (+125*)	148	3.45	*ns*
Yel 21	Everything high	159 (+125*)	148	3.58	*ns*
Yel 21	High N	159 (+125*)	148	3.58	*ns*
Com21	District Practice	9 (+125*)	148	3.75	*ns*
Com21	Everything high	159 (+125*)	148	3.98	*ns*
Com21	High N	159 (+125*)	148	3.82	*ns*
Yel22	District Practice	9 (+125*)	100	4.92	*1.6*
Yel22	Everything high	159 (+125*)	100	7.19	*1.6*
Yel22	Everything high + chook	159 (+125*)	100 (+580**)	6.85	*1.6*
Yel22	High N	159 (+125*)	100	6.60	*1.6*
Com 22	High N	9 (+125*)	100	5.51	*0.36*
Com 22	Everything high	159 (+125*)	100	5.81	*0.36*
Com 22	Everything high + chook	159 (+125*)	100 (+580**)	5.89	*0.36*
Com 22	High N	159 (+125*)	100	5.77	*0.36*

*Denotes extra N applied to cereal plots in setup phase above what pulse plots received.
**Denotes estimated N in 20 t/ha chicken manure.

The 2021 trial results demonstrate that district practice nitrogen fertiliser rates of 148 kg/ha of N were sufficient to achieve canola yields in the 3-4 t/ha yield range, regardless of the N input from the previous crop, in a season where rainfall was average to slightly above average. This matches grower experience in the region, and possibly explains why the cereal/canola rotation has been so successful on Lower EP, and that fertilisation with artificial N in the year the crop is grown can be effective in achieving yields around 3 t/ha and achieve a water use efficiency of 14 kg/mm.

Rainfall in 2022 was well above average and provided the opportunity to strive for higher yields. In this instance very high canola yields were achieved at both sites and yield responses were achieved to high rates of N, high rates of all nutrition treatments and where 20 t/ha of chicken manure was applied. There was no significant difference in canola yields between treatments where high rates of N were applied in the previous season, where high rates of all nutrition treatments were applied and where 20 t/ha of chicken manure was applied, indicating that improvements in canola observed in the 2022 was being driven by access to high rates of N.

Q4. Can the previous crop have an influence on canola yield?
It is recognised that pulse crops generally don't utilise as much plant available water as cereals, providing opportunities to harvest soil moisture for the following crop as well as providing an additional source of N. The value of this was tested through seeding blocks of wheat and pulses (lupins at Coomunga and faba beans at Yeltukka) in the year prior to growing canola.

Table 5. Soil water differences, April 2022 (prior to planting canola) following wheat and pulses grown in 2021.

Trial	Total PAW Wheat (mm)	Total PAW Pulse (mm)
Yeltukka	80	120
Coomunga	38	60

Higher plant available water was measured following pulses compared to wheat at both Yeltukka and Coomunga prior to planting canola in 2021.

Well above average rainfall was observed between November 2021 and April 2022, which negated differences in available soil water following wheat compared to pulses in 2022.

The differences in soil mineral N prior to planting canola following wheat compared to pulses are shown in table 3.

Table 6. Effect previous crop on canola grain yield (t/ha) of Yeltukka and Coomunga 2021 and 2022.

Trial	Previous crop: Wheat (t/ha)	Previous crop: Pulse (t/ha)	lsd (p=0.05)
Yeltukka 2021	3.55	3.53	*ns*
Yeltukka 2022	5.49	6.02	*ns*
Coomunga 2021	3.82	3.88	*ns*
Coomuna 2022	6.28	6.23	*ns*

These data show that there was no effect of previous crop on canola yield, despite differences in mineral N and plant available water measured.

Modelling conducted by CSIRO has found that soils in the Lower EP environment reach drained upper limit during the June/July period in more than 50% of years. This means that there is typically no benefit to stored moisture in these years, as crop demand for moisture is low during winter months. To provide a simple method of calculating this probability for other environments, the CliMate® app that shows Cummins receives more than 100mm of rainfall over 30 days in May/ June/ July in 55% of years (which lines up with CSIRO modelling).

While nitrogen (N) was found to significantly influence canola yields, the modest N supply advantage of pulse crops over wheat in these trials is overshadowed by the total N needed to attain canola yields exceeding 3 t/ha in the two years of canola grown in experiments by this project.

Table 7. Grain yield (t/ha) of wheat 2022 at Coomunga and Yeltukka following different 2020 crops.

Trial	Previous crop: Wheat (t/ha)	Previous crop: Pulse (t/ha)	lsd (p=0.05) (t/ha)
Yeltukka	5.85	5.98	*0.07*
Coomunga	4.90	5.30	*0.13*

While no differences in canola yield were found to be driven by the previous crop grown, when wheat was planted in 2022 on the 2021 canola sites it was found that pulses planted in 2020 were still having an improved effect on wheat yield compared to wheat. This demonstrated the long-term effect of growing pulses in the farming system and replicates similar results found in recent GRDC funded farming systems experiments in NSW.

CONCLUSIONS REACHED &/OR DISCOVERIES MADE (Not to exceed <u>one</u> page)

Conclusions

- Having high nitrogen (N) levels in soil prior to seeding was the biggest driver of canola yield in 2022 compared to a range of other nutritional and rotational treatments.
- Canola yield was not influenced by the previous crop (wheat compared to pulse) where adequate N nutrition was present in the Lower EP environment in 2021 and 2022.
- Higher rates of trace elements and sulphur didn't have any impact on canola yields above district practice in a situation where soil and plant tissue tests met current critical values.
- The 2022 crop of wheat grown on a pulse in 2020 (canola in 2021), yielded higher than wheat (2020).

INTELLECTUAL PROPERTY

N/A

APPLICATION / COMMUNICATION OF RESULTS

Main findings:

- Having high nitrogen (N) levels in soil prior to seeding was the biggest driver of canola yield in 2022 compared to a range of other nutritional and rotational treatments.
- Canola yield was not influenced by the previous crop (wheat compared to pulse) where adequate N nutrition was present in the Lower EP environment in 2021 and 2022.
- Higher rates of trace elements and sulphur didn't have any impact on canola yields above district practice in a situation where soil and plant tissue tests met current critical values.
- The 2022 crop of wheat grown on a pulse in 2020 (canola in 2021), yielded higher than wheat (2020).

Potential industry impact statement

The ability to continue to push the yield frontier and understand the limitations of canola production helps provide insights into how growers can modify their management strategies and increase both productivity and profitability.

This project achieved this by demonstrating the ability to achieve very high canola yields in the Lower Eyre Peninsula environment.

It is expected that because of this project growers will adjust a range of canola management strategies. This will include the refinement of N management, with the exploration of banking N in the year prior. This project will help refine the use of some inputs such as application of trace elements in situations where they are not warranted.

While no clear benefit was demonstrated from growing a pulse compared to cereal previous to canola by this project, longer term benefits will continue to be explored as part of a longer term systems experiment.

Publications and extension articles delivered as part of the project.

Summary articles provided to EP Farming Systems booklet summarising activities in 2021 and 2022. Also located on AIR EP website.

Presentations made to Lower EP Crop Expo pre-seeding in 2022 (51 people) and 2023 (52 people).

Presentations made to SA/Vic Independent Consultants Sept 2021 and Jan 2023.

Participation in SAGIT podcast series May 2023.

Suggested path to market for the results including barriers to adoption.

The results of the project have been presented to a wide selection of Lower EP growers and advisors, with opportunities for interactive discussion of results.

Following presentation of results from this project, local consultants approached describing where they had unexplained observations of where their clients had achieved higher canola yields where urea had been applied late in the prior season. These observations will be used in a participatory action research approach to discuss with growers on Lower EP on the applicability of this approach as a management technique, with growers encouraged to apply late season N in the year prior to growing canola.

POSSIBLE FUTURE WORK

The following concepts that this project identified are worthy of further work:

N Banking on leaky soils.

The gravelly ironstone soils of Lower Eyre Peninsula have traditionally been difficult to develop efficient nitrogen management strategies on. These soils occur where winter rainfall is very high and leaching and denitrification of artificial nitrogen applications is widespread. The Coomunga site utilised in this project was on an ironstone soil and showed that by having nitrogen applied in the season prior to growing canola was an effective strategy in raising canola yields, with N retained in well above average rainfall. Understanding some of the mechanisms that enabled this to occur could transform the way that N is managed in this environment.

Value of stored summer moisture in the Lower EP environment

This project was able to demonstrate that additional soil water stored following pulse crops compared to cereals was of little value to subsequent canola crops due to high winter rainfall filling the soil profile at a stage in the growing season where there is low water requirement. Modelling suggests that this occurs in over 50% of seasons on Lower EP. This suggests that moisture stored over summer may be redundant for winter crop use in most years. Raising questions if stored soil moisture can be better utilised through the adoption of longer season crops (previously not effective due to the high vernalisation requirement of winter crop varieties in a relatively warm environment, which has crops flowering too late to reliably fill grain) or alternative land uses over summer.