Office Use Only	
Project Code	
Project Type	

FINAL REPORT 2022

Applicants must read the *SAGIT Project Funding Guidelines* prior to completing this form. These guidelines can be downloaded from www.sagit.com.au

Final reports must be submitted by email to admin@sagit.com.au as a Microsoft Word document in the format shown **within two months** after the completion of the Project Term.

PROJECT CODE	TEI121
PROJECT TITLE (10 words maximum)	
Faba Bean nutrient omission trial	

PROJECT DURATION *These dates **must** be the same as those stated in the Funding Agreement.*	
Project start date	**1/04/2021**
Project end date	**30/04/2022**

PROJECT SUPERVISOR CONTACT DETAILS *(responsible for the overall project)*		
Title:	**First Name:**	**Surname:**
Mr	Adam	Hancock
Organisation:	**Thomas Elder Institute**	

ADMINISTRATION CONTACT DETAILS *(responsible for all administrative matters relating to project)*		
Title:	**First Name:**	**Surname:**
Mr	Adam	Hancock
Organisation:	**Elders Rural Services**	

PROJECT REPORT: *Please provide a clear description for each of the following:*

Executive Summary (200 words maximum)

A few paragraphs covering what was discovered, written in a manner that is easily understood and relevant to SA growers. A number of key dot points should be included which can be used in SAGIT communication programs.

Eleven nutrients were assessed for response in Faba Beans across two common soil types in the South East. Two identical trial sites were established at Sherwood and Frances, thirteen treatments were replicated and randomised to capture a complete range of fertiliser requirements including a treatment missing each one of the eleven nutritional elements. Plots were harvested and grain tested for complete nutritional analysis.
Assessments included one tissue test timing, dry matter cuts at peak biomass, drone NDVI+NDRE of each plot, yield and grain analysis. Tissue test results were compared to the standard faba bean tissue test evaluation table. The main findings and highlights are:

- It is common for tissue tests of Faba Beans in the South East to suggest calcium, magnesium, boron, zinc, copper, manganese and molybdenum are low.
- Tissue tests collected from these trial sites indicated that faba beans should have responded to calcium, potassium and boron but there was no response, tissue test response curves need to be updated.
- Yield responses were significant to molybdenum application at Sherwood but follow up work is needed.
- There was a significant economic response to inoculation at Sherwood despite no yield response.
- No treatments had any effect on grain protein.
- A revised grain yield nutrient removal chart was developed
- Phosphorus had the largest response on grain yield.

Project objectives

A concise statement of the aims of the project in outcome terms should be provided.

The key objective of this project was to explore and quantify any nutrient/fertiliser responses in Faba Beans by conducting a complete omissions trial.

The thirteen treatments included eleven different fertilisers being applied at different rates and multiple timings which guaranteed to exceed crop demand before deficiency occurred. A key objective was being able to guarantee that no fertiliser was applied too late, not enough times or not at a high enough rate. Majority of the treatments would not be economical, although the purpose of the omissions trial is to indicate if any nutrient is limiting and whether further research is required to assess critical levels and economical application rates of each nutrient.
A key project objective was to collect a tissue sample from each plot to assess the accuracy of the current tissue test critical ranges which is a tool commonly used by growers to determine the chances of observing a fertiliser response. We were able to compare tissue test results from an untreated and a treated sample for each nutrient after the fertiliser application to assess if we observed an increase which would indicate the success of the treatment.
Other objectives included measuring the impact of inoculating faba beans on yield, biomass, post-harvest deep nitrogen testing and the stubble carbon nitrogen ratios at Sherwood to determine the net nitrogen benefit from the breakdown of the faba bean stubble.

We will also be able to release a revised grain yield nutrient removal chart.

Overall Performance

A concise statement indicating the extent to which the project objectives were achieved, a list of personnel who participated in the Research Project including co-operators, and any difficulties encountered and the reasons for these difficulties.

One important requirement for the success of the trial sites was to achieve maximum yield potential which allows the chance of observing responses from extra fertiliser rates or uncommonly applied fertilisers. This requires good site selection and average to above average weather conditions. Site selection had to be located in an area of a paddock that was most representative of the district Difficulties were encountered at Sherwood with the grower seeding through the initial trial site at night, meaning the site had to be moved into the last paddock being sown where a layer of non-wetting sand caused un-even germination. This was overcome by scoring each plot for the effect on establishment, SAGI were able to overlay this data and smooth out the results. This has created a change in practice of how we flag trial sites and communicate with all farm staff, not just the manager.

Seasonal conditions were below average for both sites. Generally, across both sites there was below average rainfall in May with no large rainfall events occurring until 8th of June, followed by a decile 7-8 rainfall for July which caused transient water logging on the seedling faba bean crop at Frances. The total annual rainfall for Frances was 116mm below average and 106mm below average for Sherwood. Both sites received severe frost events on the 15th of September and the 11th of October, the faba bean crops appeared to handle the frosts quite well but this likely limited some yield potential. Despite these conditions the site yields were surprisingly still around the grower's average. There were no differences observed from frost damage across treatments.

The SARDI Struan agronomy team were sub-contracted to manage all aspects of the trial site and some of the assessments including plant counts, tissue testing, biomass cuts and collecting grain samples. Overall SARDI are great co-operators however one issue to overcome was SARDI were prevented from being able to work during the COVID lockdowns. One of the main treatment timings was due during the lockdown, even though SARDI could have performed this task whilst being in compliance with the lockdown laws they could not, this treatment I completed myself.

The first of the foliar sprays was completed on the 23rd July, second spray 10th September and third on the 30th September.
Tissue tests were collected thirty days after the first foliar fertiliser spray and immediately before applying the second spray. Attention was made to test leaf material that was not present at the time of the first spray. A summary of tissue test critical ranges from Reuter Robinson has been tabled and compared to the test results collected. Multiple examples were discovered of current critical ranges suggesting likely responses from nutrients where nil responses were observed.

SAGI were contracted to perform statistical trial design and data analysis. This is the first time we have contracted a statistician to be involved with one of our projects, where we usually have Amanda Pearce and rely on SARDI's Genstat license. Overall, this has been a worthwhile experience, we have learnt a lot about trial site design and management. SAGI have learnt a lot about farm gate level research trials, however SAGI's workload and limited administration staff resulted in the statistical report being completed at the end of May, four months overdue. Having a biometrician involved became critical when an unfortunate event occurred which created variability across the trial site.

KEY PERFORMANCE INDICATORS (KPI)

*Please indicate whether KPIs were achieved. The KPIs **must** be the same as those stated in the Application for Funding and a brief explanation provided as to how they were achieved or why they were not achieved.*

KPI	Achieved	If not achieved, please state reason.
Establish trial sites during early time of sowing window	Yes ☐ No ☒	Very late opening season rainfall
Have all tests and assessments collected by beginning of October	Yes ☒ No ☐	
Conduct Field days at both trial sites	Yes ☒ No ☐	Two crop walks at Sherwood and three at Frances.
Data analysed and final reports completed for SAGIT and OFT website.	Yes ☒ No ☐	As the project has continued with GRDC OFT upload has not occurred yet.

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

Provide sufficient data and short clear statements of outcomes.

Both trials consisted of 52 plots arranged in 13 rows by 4 columns. Each column formed a full replicate block of 13 treatments. Treatments were randomised to plots in a row-column design using the statistical package DiGGer (version 1.0.5) in the R (R Core Team, 2020). A separate randomisation was generated for each site.

Image 1: The Sherwood trial site towards the end of flowering, September 2021

At Sherwood there was uneven plot establishment so extra covariates were measured earlier in the season including NDVI (3 time points), plants per square meter (2 time points), vigor (2 time points) and patchiness (once).

All fertiliser applications were applied successfully and on time. Table one shows the final total rates of each nutrient that were applied.

	Rates/ha	Timing	Placement
N	Inoc	Seeding	Seed treatment
P	24 kg/ha	Seeding	Below seed
K	98 kg/ha	Pre seeding + 20% at seeding	Top dressed / Below seed
S	12 kg/ha	Seeding	Below seed
Ca	13.5 kg/ha	Seeding plus three foliar	Liquid injection
Mg	5 kg/ha	Seeding plus three foliar	Liquid injection
Zn	600g/ha	8 leaf, 5 % flower, post flower	Three foliar sprays
Mn	600g/ha	8 leaf, 5 % flower, post flower	Three foliar sprays
Cu	150g/ha	8 leaf, 5 % flower, post flower	Three foliar sprays
Mo	100g/ha	8 leaf, 5 % flower, post flower	Three foliar sprays
B	390g/ha	8 leaf, 5 % flower, post flower	Three foliar sprays

Table 1: The total rates of each nutrient that were applied, timing and placement.

Treatment Number	Treatment Name	SOP 75kg/ha + 134.5kg/ha MOP	MOP 196kg/ha	Innoculation	MOP at seeding (Sherwood Only)	PBoss @ 133kg/ha at seeding	MAP @ 109kg/ha at seeding	Cal-N Inject 58L/ha	Mg Ace Inject 59L/ha	Urea PSPE	Ca Ace Foliar 7L/ha x 3	Mg Ace Foliar 10L/ha x 3 x 3	Moly Foliar x 3	Boron13 x 3	Fe (All)	C
Trt 1	Nil N (Nil Innoc)		215g / plot		32g / plot	168g /plot			74ml / plot		√	√	0.05	1	√	
Trt 2	Nil P	95g SOP 138g MOP		√	32g / plot			73ml / plot	74ml / plot	30g / plot	√ @ 14L	√	0.05	1	√	
Trt 3	Nil K			√		168g /plot			74ml / plot	54g / plot	√	√	0.05	1	√	
Trt 4	Nil S		215g / plot	√	32g / plot		137g / plot	73ml / plot	74ml / plot		√ @ 14L	√	0.05	1	√	
Trt 5	Nil Ca	95g SOP 138g MOP		√	32g / plot		137g / plot		74ml / plot	24g / plot		√	0.05	1	√	
Trt 6	Nil Mg		215g / plot	√	32g / plot	168g /plot				54g / plot	√		0.05	1	√	
Trt 7	Nil Zn		215g / plot	√	32g / plot	168g /plot			74ml / plot	54g / plot	√	√	0.05	1	√	
Trt 8	Nil Mn		215g / plot	√	32g / plot	168g /plot			74ml / plot	54g / plot	√	√	0.05	1	√	
Trt 9	Nil Cu		215g / plot	√	32g / plot	168g /plot			74ml / plot	54g / plot	√	√	0.05	1	√	
Trt 10	Nil B		215g / plot	√	32g / plot	168g /plot			74ml / plot	54g / plot	√	√	0.05		√	
Trt 11	Nil Mo		215g / plot	√	32g / plot	168g /plot			74ml / plot	54g / plot	√	√		1	√	
Trt 12	Complete		215g / plot	√	32g / plot	168g /plot			74ml / plot	54g / plot	√	√	0.05	1	√	
Trt 13	Untreated															
		4 weeks before seeding		At seeding - PhossBoss, MAP & MOP banded below seed						PSPE	Foliar sprays in crop					

Table 2: The application rates and timings of actual fertiliser products across the different treatments.

Table 2 shows the fertiliser types used to successfully provide each treatment with highest rate achievable without creating an imbalance with any additional nutrients that could not be corrected across all treatments.

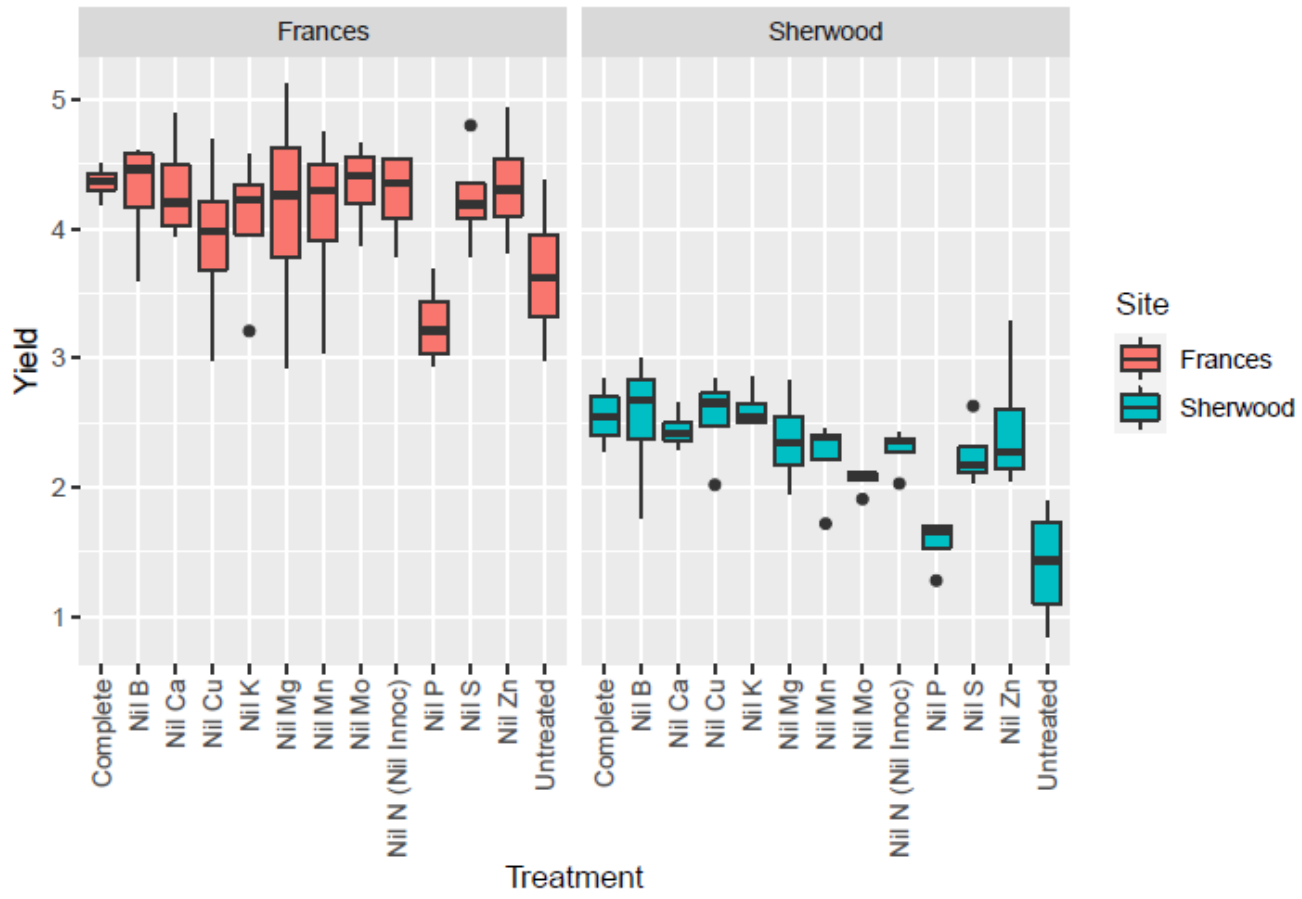

Figure 1: Plot of yield grouped by treatment and site.

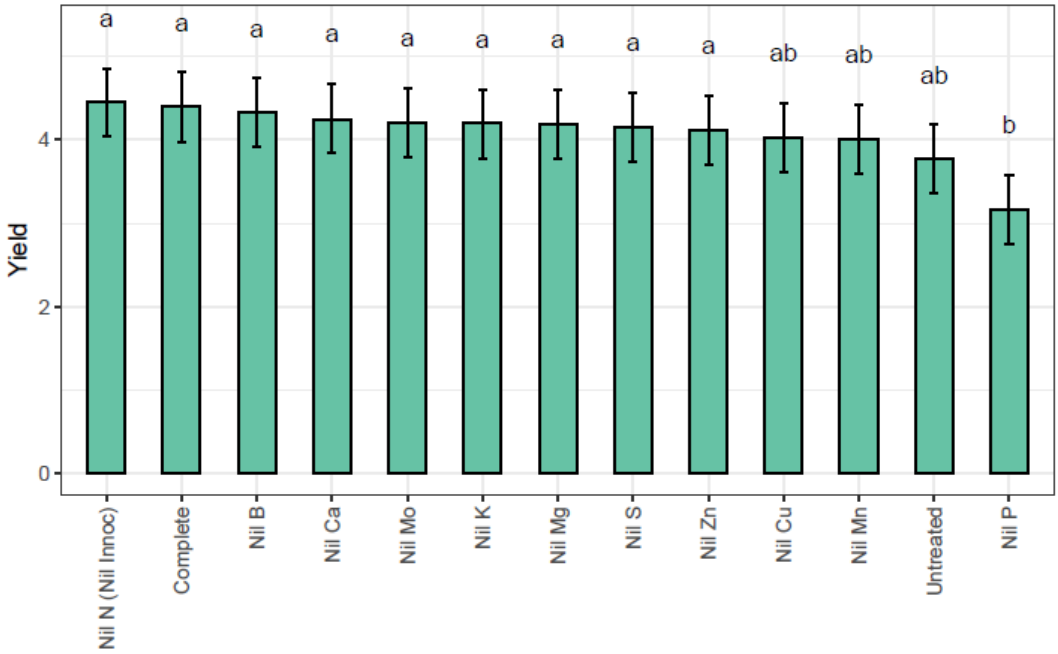

Figure 2: Frances yield values

Frances dry matter results

Treatment	predicted.value	std.error	groups	ci	low	up
Complete	10.14	0.87	a	1.48	8.66	11.62
Nil Mo	9.58	0.87	a	1.48	8.09	11.06
Nil S	9.58	0.87	a	1.48	8.09	11.06
Nil Mg	9.30	0.87	a	1.49	7.81	10.78
Nil Ca	9.05	0.87	a	1.49	7.57	10.54
Nil Cu	9.03	0.87	a	1.48	7.55	10.51
Nil B	8.89	0.87	a	1.48	7.40	10.37
Nil Zn	8.56	0.87	a	1.48	7.08	10.05
Nil N (Nil Innoc)	8.51	0.87	a	1.48	7.03	9.99
Nil K	8.43	0.87	a	1.48	6.94	9.91
Nil Mn	8.18	0.87	a	1.48	6.70	9.66
Nil P	7.48	0.87	a	1.48	6.00	8.96
Untreated	7.42	0.87	a	1.48	5.94	8.91

Figure 3: Frances drymatter results taken at peak biomass.

The Frances trial was a dryland site located on heavy loam over brown clay soil. Only two significant yield differences occurred at Frances being the untreated and the Nil phosphorus treatments, all other treatments were largely insignificant. Soil tests suggested the site will be responsive to phosphorus. Statistically for any treatment to be significant the yield difference needed to be greater than 820kg/ha.

Interestingly the relationship between yield and biomass when comparing all plots was very weak, when we only included the treatments that had a significant difference on biomass (the complete, untreated and nil phosphorus) the relationship showed some significance in Figure 4 however was still noisy, likely explained by the frost effect on aborted pods and the variability of distance to sub soil layers across the site impacting the plot's accessibility to soil moisture.

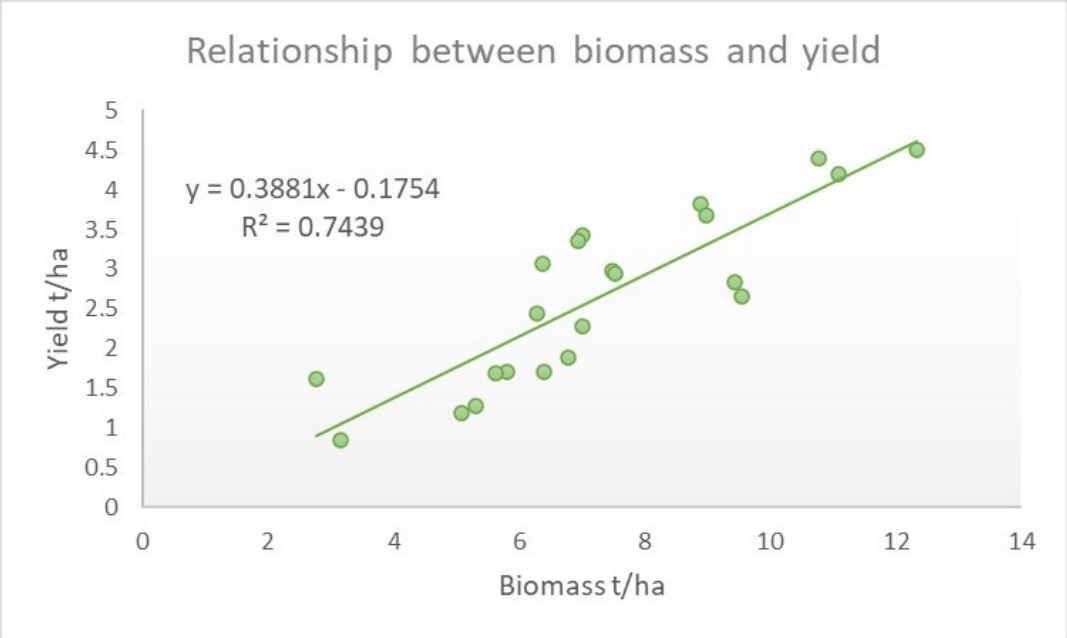

Figure 4: Relationship between yield and biomass across treatments with significant biomass differences.

There were four discrepancies at Frances between tissue test critical ranges and actual yields. Tissue test ranges suggested a slight chance of response to calcium, zinc and manganese whilst suggesting a very a high chance of response from boron, of which there were no observed yield gains from these four treatments. Some variation between tissue test critical ranges and actual response is generally acceptable however the Boron test results were half that of the published

adequate range. A review is suggested of the boron response curve. No other correlations of interest have been found between phosphorus tissue tests, grain phosphorus content or yield.

Nutrient	Results Untreated	Results treated	Percentage difference treated vs untreated
N (%)	5.17	5.05	-2.32
P (%)	0.35	0.34	-2.86
K (%)	2.65	2.72	2.64
S (%)	0.26	0.26	0.00
Ca (%)	0.59	0.64	8.47
Mg (%)	0.27	0.27	0.00
Cu (mg/kg)	10	11.25	12.50
Zn (mg/kg)	26.25	25.25	-3.81
Mn (mg/kg)	40.25	36	-10.56
B (mg/kg)	16.75	16.5	-1.49
Mo (mg/kg)	0.41	1.03	151.22

Table 3: Tissue rest results comparing treated vs untreated at Frances.

It's interesting to find substantial differences between Sherwood and Frances when comparing tissue test results from the treated and untreated nutrients. This was evaluated to assess the success of the fertiliser uptake. Tables 3 and 5 show only molybdenum and copper have both resulted in an increase, whilst Sherwood shows a much higher increase in trace elements. There are little differences between tissue test timing, fertiliser applications, growth stage and weather conditions between the two sites to explain this difference.

Sherwood

Treatment	predicted.value	std.error	groups	ci	low	up
Complete	2.62	0.16	a	0.27	2.34	2.89
Nil B	2.56	0.16	a	0.27	2.29	2.83
Nil K	2.53	0.16	a	0.27	2.25	2.80
Nil Cu	2.45	0.16	ab	0.28	2.17	2.73
Nil Zn	2.45	0.16	a	0.27	2.18	2.72
Nil Mg	2.43	0.16	ab	0.27	2.16	2.70
Nil Ca	2.34	0.17	ab	0.28	2.06	2.62
Nil N (Nil Innoc)	2.31	0.16	ab	0.27	2.04	2.58
Nil S	2.28	0.16	ab	0.27	2.01	2.55
Nil Mn	2.27	0.16	ab	0.27	2.00	2.54
Nil Mo	2.08	0.16	abc	0.27	1.81	2.35
Nil P	1.63	0.16	bc	0.27	1.36	1.91
Untreated	1.39	0.16	c	0.27	1.12	1.66

Figure 5 Sherwood yield results.

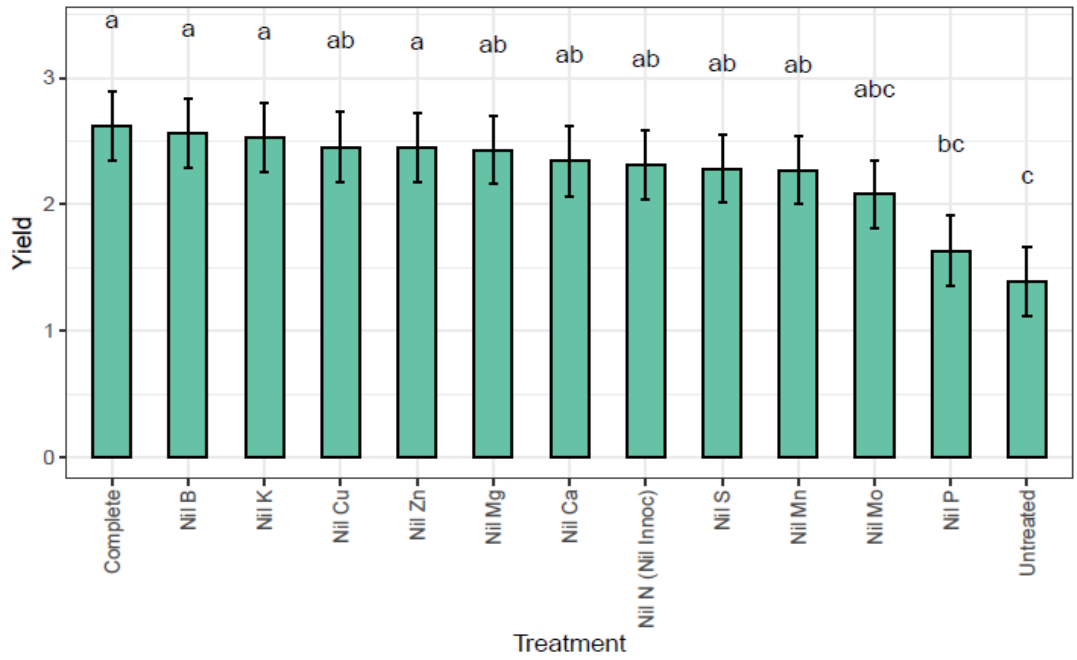

Figure 6: Sherwood yield values

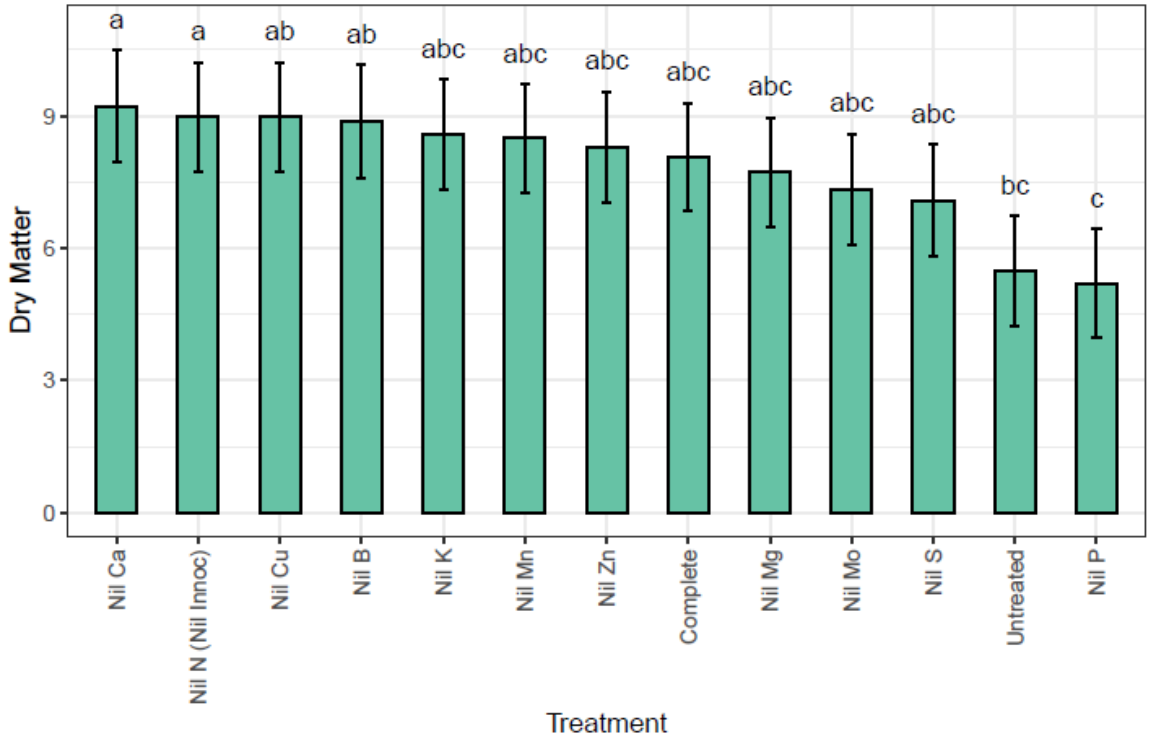

Figure 7: Sherwood biomass results t/ha

The Sherwood trial was a dryland site located on undeveloped sand over clay soil.
The smallest observed difference in yield between two treatments that is likely to give a significant ($p<0.05$) difference is approximately 560 kg/ha. The Sherwood trial suffered from variable establishment across the site due to the variability in non-wetting sand throughout the topsoil and the dry start, resulting in uneven emergence and variability in final plant counts between the plots. At three stages, plant counts, plot health scores and NDVI's were collected to be used as a covariate to smooth out the data, SAGI have a selection process to determine which of the assessments at which timings are suitable to be applied as a covariate. As the Untreated and Nil Phosphorus were already significantly different, the only other treatments that were reassessed under covariate scrutiny was Nil Manganese and Nil Molybdenum. SAGI also use the Turkey Test, so we assessed the results using CV LSD. Nil manganese under any form of analyses was still not significant, however nil molybdenum become significantly less yielding than the complete. The soil test from the trial site suggested a chance of likely response from phosphorus and molybdenum applications based on the pH result. It also suggests a requirement for copper and potassium

however it is common to see no response from potash even after a topsoil test suggest potassium is required due to the amount of potassium available in the 20-30cm layer.

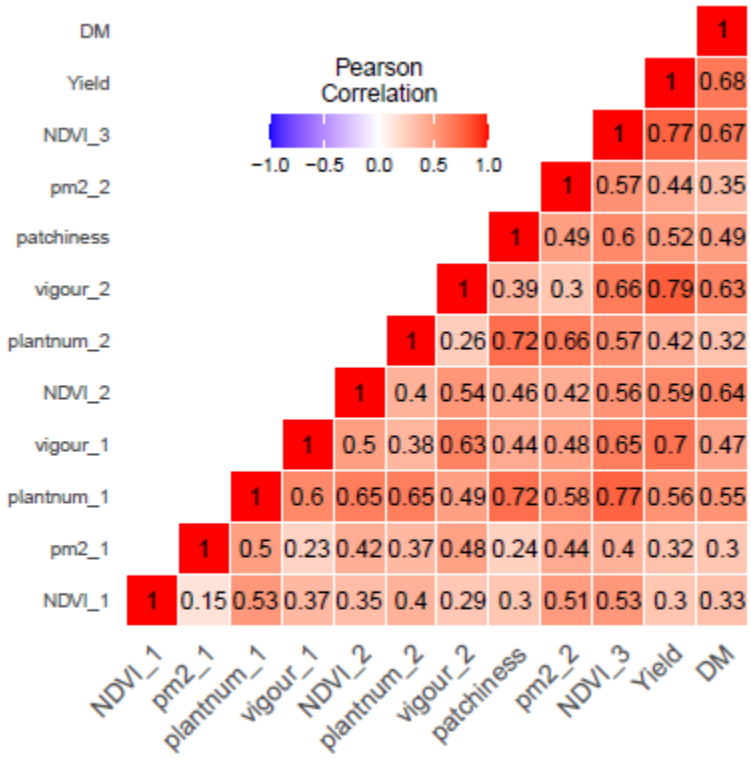

Figure 8: SAGI correlations between Dry matter, yield, plant numbers, plot vigor scores and NDVI.

Some relationships with moderate strength existed between assessments, the strongest being between yield and plot vigour scores taken in August. It was interesting to find little relationship between dry matter and other assessments. There was a weak correlation between NDVI, plant counts and yield, the remaining 30% of unexplained correlation could be due to flower abortion before pod set due to climatic conditions.

At Sherwood, post-harvest stubble C:N ratios were collected on the un-inoculated and inoculated plots, along with stubble biomass, to measure any net increase of nitrogen mineralisation from stubble caused by inoculating seed. A net increase of 31kg/ha of nitrogen will result during the breakdown of the faba bean stubble with inoculation, this is the result of a loss of -13kg/ha nitrogen where uninoculated and a +18kg/ha nitrogen gain in the inoculated.

The GRDC publication Managing Soil Organic Matter: a practical guide, outlines the measurements and calculations to determine the net effect of nitrogen mineralisation or immobilisation from the C:N ratio of any organic matter.

	Stubble /ha	C:N	The amount of carbon present in the stubble added to the soil.	The amount of nitrogen present in the organic matter added to the soil	Allow for 30 per cent of the carbon being used by microbes to grow, with the remaining 70 per cent respired as carbon dioxide.	Microbes have a C:N ratio of 12:1 therefore require 1 kg of nitrogen for every 12 kg of carbon.
Uninoculated	6520.00	49:1	2934	59.88	880.2	73.35
Inoculated	5790.00	31:1	2605.5	84.05	781.65	65.14

Table 4: Calculations and measurements to determin net nitrogen benefit from stubble.

Nutrient	Results Untreated	Results on treated	% difference treated vs untreated
N (%)	4.85	5.1	5.15
P (%)	0.33	0.31	-6.06
K (%)	2.07	2.15	3.86
S (%)	0.22	0.21	-4.55
Ca (%)	0.35	0.37	5.71
Mg (%)	0.24	0.25	4.17
Cu (mg/kg)	6.15	10.9	77.24
Zn (mg/kg)	35	50	42.86
Mn (mg/kg)	48.75	63.25	29.74
B (mg/kg)	19	26	36.84
Mo (mg/kg)	0.29	7.9	2624.14

Table 5: Tissue test results treated vs untreated Sherwood

	N	P	K	S	Ca	Mg	Zn	Mn	Cu
	kg/t Faba Beans						g/t Faba Beans		
Treated	45	2.7	10.5	1.75	1	1.2	24	10	12
Range	42 - 48	2.6 - 2.8	10 - 11	1.6 - 1.8	0.9 - 1.1	1.2 - 1.2	22 - 26	10 - 11	11 - 13
Untreated	44	2.6	10.75	1.75	1.05	1.25	23	11	13
Sherwood							40	17	5.5

Table 6: Revised grain nutrient removal results.

Table 6 shows the combined grain nutrient removal across the two sites, with the trace elements listed separately for Sherwood as the three nutrients were the only significant differences between the sites. A key assessment was to measure any luxury removal of nutrition due to high fertiliser application rates, as there was no difference in nutrient removal between treated and untreated this validates that growers are able to apply maintenance applications of these fertilisers without the concern of luxury removal.

NDVI and NDRE drone imagery was collected by Michael Zwar to coincide with the peak biomass cuts. The Sherwood site was assessed as this site had significant differences with biomass. NDRE resulted in a slightly stronger relationship with biomass, however the accuracy between the sensors and biomass was variable but much less than the relationship between yield and biomass. The relationship is stronger with lower biomass lower yielding crops, as biomass increased NDRE and yield didn't always increase accordingly. There was no correlation found between the NDVI or NDRE and any tissue test result.

AGTECH SERVICES
YOUR PRECISION AG SPECIALISTS

Sherwood Trial NDRE

Image Capture Date:
September 15 2021

ROW	1	2	3	4
Buffer	0.076	0.137	0.117	0.14
1	0.124	0.148	0.17	0.207
2	0.19	0.204	0.233	0.261
3	0.198	0.212	0.223	0.218
4	0.183	0.165	0.137	0.196
5	0.206	0.161	0.185	0.203
6	0.203	0.193	0.189	0.204
7	0.184	0.192	0.218	0.223
8	0.116	0.144	0.211	0.221
9	0.193	0.183	0.19	0.189
10	0.194	0.143	0.248	0.28
11	0.196	0.177	0.25	0.242
12	0.201	0.182	0.237	0.247
13	0.213	0.185	0.26	0.176
Buffer	0.159	0.144	0.177	0.17

Statistics	
Treatment	Mean NDVI
Untreated	0.151
Complete	0.202
Nil P	0.149
Nil Ca	0.217
Nil B	0.213
Nil Mo	0.197
Nil Mg	0.204
Nil S	0.187
Nil K	0.224
Nil Cu	0.222
Nil Zn	0.198
Nil N	0.199
Nil Mn	0.213

Figure 9: Sherwood NDRE plot imagery.

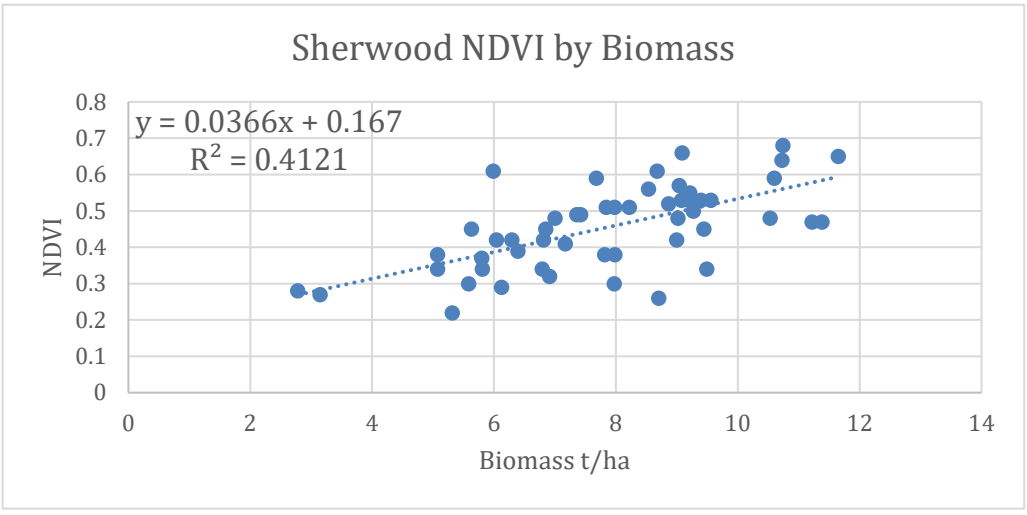

Figure 10: Sherwood NDVI by biomass

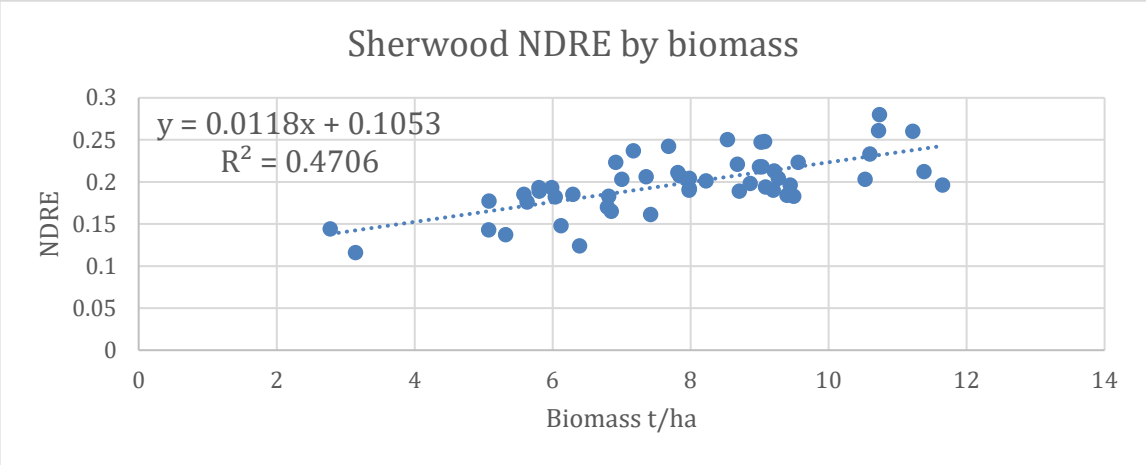

Figure 11: Sherwood NDRE by biomass

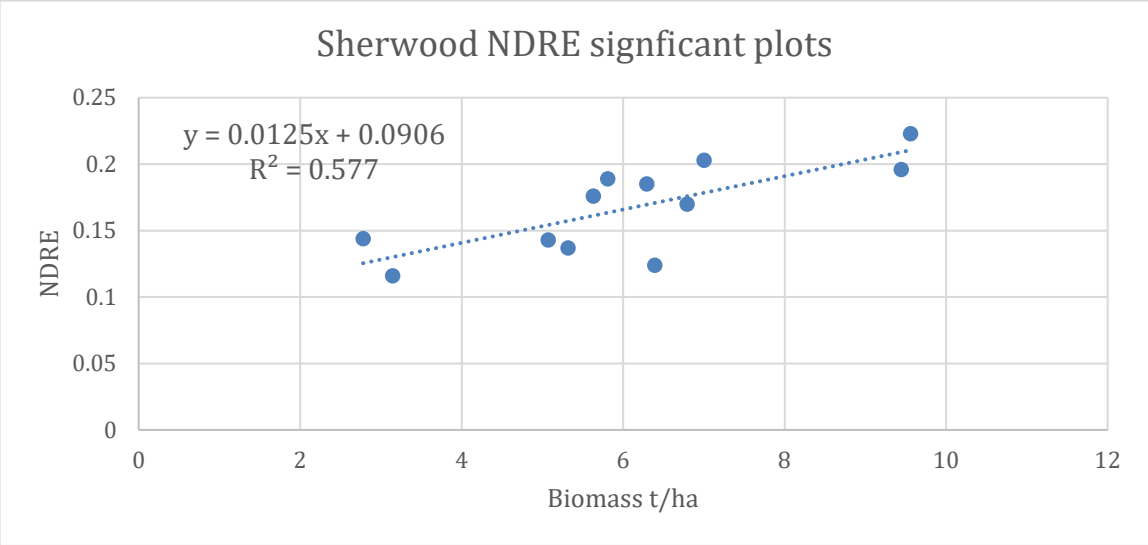

Figure 12: Sherwood NDRE of plots that resulted in significant differences with biomass

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

Please provide concise statement of any conclusions reached &/or discoveries made.

The project highlights the need to question the claims regarding yield response from the less commonly applied fertilisers in particular magnesium, boron, calcium and potassium. Further research in potassium has commenced in the South East under a new GRDC project.

Four nutrient response curves in the tissue test evaluation table have been revised. Zinc, manganese, boron and calcium all tested as responsive where no response was seen. Appendix A shows the results and a draft publication of the revised critical ranges.

Growers aiming to apply maintenance rates of nutrition based on average yield or adopting a replacement program based on the previous seasons yield is in general a sound strategy, this can be done without concern of luxury removal of nutrition.

Growers should check their decision to not inoculate faba beans where this decision has been made solely because of the lack of yield response. The increase of nitrogen made available by the inoculated treatments was significant. Growers can check this by testing their faba bean stubble post-harvest for C:N easily at any lab.

Phosphorus is likely the most important fertiliser to get right for pulse crops. There was a positive relationship observed between yield and biomass, where phosphorus application had the largest positive impact on biomass. Growers should apply a phosphorus rich strip to check their program if nothing else.

NDRE had a slightly better relationship with biomass than NDVI. NDRE maps of a faba bean paddock collected around peak biomass could be used as a guide to highlight the low biomass areas for scouting and ground truthing.

INTELLECTUAL PROPERTY

Please provide concise statement of any intellectual property generated and potential for commercialisation.

Nil

APPLICATION / COMMUNICATION OF RESULTS

A concise statement describing activities undertaken to communicate the results of the project to the grains industry. This should include:

- *Main findings of the project in a dot point form suitable for use in communications to farmers;*
- *A statement of potential industry impact*
- *Publications and extension articles delivered as part of the project; and,*
- *Suggested path to market for the results including barriers to adoption.*

Note that SAGIT may directly extend information from Final reports to growers. If applicable, attach a list of published material.

Oct 22nd the Keith and Sherwood Mackillop Group Crop Walk visited the Sherwood site, Oct 15th Mackillop Group visited the Frances trial site. At the time of the crop walks limited results were able to be discussed as this relied on yield results and final reports from SAGI.

The results from this project have led to a revised and amplified research project funded by the GRDC to expand on the treatment list and locate this trial in an additional four locations around the South East to capture all soil types around the region. Tissue test collections will expand on the revised tissue test data base.

At this stage, pending more significant responses in this year's trial, the likely potential impact on industry will be increased grower confidence in the use of tissue testing to both reduce costs on fertilisers being used unnecessarily or apply where required. The author hopes these findings will also encourage growers who are not inoculating pulse crops to double check the potential residual nitrogen gains achieved by inoculating. This project has also highlighted the need to collect your own grain nutrition test if you are adopting a replacement program.

There will be a publication proposed, Appendix A, with a collated table for the current tissue test critical ranges alongside the tissue test results from this project, however we now suggest waiting until 2023 to include the 2022 trial site results.

POSSIBLE FUTURE WORK

Provide possible future directions for the research arising from the project including potential for further work and partnerships.

The strengths and weaknesses regarding the effectiveness of complete nutrition omission trials have been discussed. A trial site consisting of macro (NPKS) and micro trace element treatments results in a statistically less sensitive trial where you achieve large responses from macro treatments and small responses from trace elements. Potentially smaller, but real, yield increases from trace elements may register as non-significant when the larger treatment responses result in large LSD's. Generally, growers are happy with a 4:1- 5:1 dollar return on inputs, with a foliar trace element application which cost $5/ha, then a yield increase of 0.05t/ha of faba beans would be a 4:1 - 5:1 return; however, a complete omissions trial has not been sensitive enough to report this. Future work should consider splitting macro and micro treatments. Some advice from SAGI suggest that more replications should be applied to these trials and more untreated controls in the trial may improve sensitivity.

GRDC have funded a continuation of the trial for 2023, we have added another treatment and increased the rates of all fertilisers and added an additional timing. Two tissue tests will be collected and further work on the C:N ratios of the stubble.

Until now only Nutrient Advantage Labs has been involved, recently we held a meeting with GRDC and APAL to arrange access to the tissue test results.

Future work will look at the role of grain nutrition analyses, particularly the anecdotal claims regarding grain zinc and cobalt as an indicator of response. Grain analyses was not major assessment in this project, but a large pool of data was collected to be shared and analysed for future work.

Appendix A:
A draft likely publication of revised tissue test results

Guidelines for diagnosing nutrient deficiencies in Faba Bean crops*

Nutrient	Critical Range (Australian)[1] Early flowering YML		Critical Range (German)[2] Onset flowering YML	Sherwood Results 10-12 leaf	Frances Results 10-12 leaf
	Marginal	Adequate	Adequate		
N (%)	1.6-2.5	4.3-5.0	2.8-3.5	4.85	5.17
P (%)	0.19 - 0.24	0.30 - 0.55	0.25-0.45	0.33	0.35
K (%)	1.8-2.0	2.2 - 4.0	2.1-2.8	2.07	2.65
S (%) *(Whole shoot)*		0.25[3]		0.22	0.26
Ca (%)		0.6-1.2	0.5-2.0	0.35	0.59
Mg (%)		0.24-0.50	0.25-0.7	0.24	0.27
Na (%)		0.02-0.4		0.2	0.33
Cl (%)		<0.8		0.7	0.78
Cu (mg/kg)		5-25	7-15	6.15	10
Zn (mg/kg)	19	28-140 19-24	30-70	35	26.25
Mn (mg/kg)		50-300	40-100	48.75	40.25
Fe (mg/kg) *(Whole shoot)*		103[3]		84	109
B (mg/kg) *(Whole shoot)*	5-50[3]	30[3]	40-80	19	16.75
Mo (mg/kg)	0.19	0.4-5.5	0.4-1.0	0.29	0.41

*Data collected from Plant Analysis page 137-138

[1] Weir, R.G. and Cresswell, G.C. (1994) Plant Nutrition Disorders. 4. Pastures and Field Crops. Inkata, Melbourne

[2] Bergmann, W. (Ed) (1992) Nutritional Disorders of Plants: Development, Visual and Analytical Diagnosis. Gustav Fischer, Jena, Stuttgart, New York.

[3] Growth stage unknown, whole shoot.
Snowball, K. and Robson, A.D. (1991) Symptoms of Nutrient Deficiencies and Toxicities: Faba Beans and Field Peas. Soil Science and Plant Nutrition, School of Agriculture, Univ. of Western Australia, Perth.