Demonstration of profitable legumes in the Western region - Carnamah

Alana Hartley, Research & Development Coordinator, Liebe Group

Key points

- Chickpea yield can be impacted by harvesting the crop too soon – before it is fully ripe.
- Field peas were a highly profitable legume option
- Where soil type permits, lentils have a good economic fit in the Carnamah region

Aim

To investigate the suitability and profitability of alternative legume crops in the Western Region.

Background

Previous research has suggested that most legume and pulse crops are best suited to fine textured soils of neutral to alkaline pH. While attempts to grow legumes and pulses in regions where the soil classification does not meet previously noted criteria has been varied in its success in the past, Western Australian growers have limited adoption of such crop types. This is in part due to suitability of soil type, competition against weeds and weed control options, yield, market access and overall profitability of legume crops.

Each site within this two year GRDC funded project, aims to demonstrate how, and if, certain grain legumes are suitable for the farming systems of each region in which the project will be implemented. The sites cover a vast range of soil types, rainfall zones and farming systems (cropping and mixed farming).

At the Carnamah Legume Demonstration site, three legumes were compared to canola, which is the current break crop option of choice in the area. Chickpeas, field peas and lentils aim to provide a profitable alternative to canola.

Trial Details

Trial location	Ian and Scott Bowman, Back Inering Rd, Carnamah	
Plot size & replication	19.02 m x 750m x 2 replications	
Soil type	Duplex	
Soil pH ($CaCl_2$)	0-10cm: 6.2 10-20cm: 6.2 20-30cm: 6.9	
Paddock rotation:	2015: Wheat 2016: Wheat 2017: Wheat	
Sowing date	24/05/18	
Sowing rate	Striker chickpeas: 80 kg/ha Gunya field peas: 80 kg/ha Hurricane lentils: 40 kg/ha Bonito canola: 3 kg/ha	
Fertiliser	Agflow Extra 65 kg/ha, ALOSCA 10 kg/ha (Group F, E & N)	
Herbicides, Insecticides & Fungicides		
(Pre-emergent)	Propyzamide 550 g/ha (whole site)	
	Field Peas & Chickpeas Terbyne 1 kg/ha Metribuzin 150 g/ha Spinnaker 50 g/ha (PSPE)	**Lentils** Diuron 500 g/ha Metribuzin 150 g/ha Spinnaker 50 g/ha (PSPE)
(Post emergent) **13/06/2018**	Chlorpyrifos 350 ml/ha (whole site)	
12/07/2018	Clethodim 500 ml/ha, Targa 150 ml/ha, 0.5% Uptake (whole site)	
22/08/2018	Aviator XPro 300 ml/ha (whole site)	
Growing Season Rainfall	240 mm	

Treatments

Plot	Rep	Treatment No.	Treatment
1	1	C	Canola
2	1	1	Lentils
3	1	2	Chickpeas
4	1	3	Field Peas
5	2	1	Lentils
6	2	2	Chickpeas
7	2	3	Field Peas
8	2	C	Canola

Trial Layout

Canola (Grower Crop) Plot 1	Lentils	**Lentils** Plot 2	**Chickpeas** Plot 3	**Field peas** Plot 4	**Lentils** Plot 5	Lentils	**Chickpeas** Plot 6	**Field peas** Plot 7	**Canola** Plot 8	Canola (Buffer)

Results

Soil analysis

Soil analysis was conducted at the beginning of the project, to measure base line nutrients. Further soil testing will be conducted after the legume phase, to determine the change in N status from the baseline results.

Table 1: Baseline soil nutrition status, Carnamah, February 2018.

Site	Depth	pH	PBI	Col P	Col K	KCl S	NO3N	NH4N	EC	OC
Carnamah	**0-10**	6.1	40.4	36	407	52.1	33	5	0.210	1.03
	10-20	7.5	77.5	11	314	22.9	10	< 1	0.445	0.40
	20-30	8.1	87.7	4	292	44.4	4	< 1	0.490	0.34
	30-40	8.4		3	322		3	< 1	0.716	
	40-50	8.2		3	278		1	< 1	0.624	

PreDicta B was conducted prior to the trial being sown, to determine the disease profile and risk at the beginning of the project. The results indicated that there was a low presence of disease at the site. PreDicta B will conducted again prior to next season and entering into the wheat phase, to determine if the legume crops have had an impact on the disease profile.

Table 2: PreDicta B Soil borne disease rating

Test	Result
Cereal Cyst Nematode (CCN)	Nil
Take All (Wheat & Oat race)	1.1
Rhizoctonia solani	0.7
F. pseudograminaerum (test 1)	Nil
F. pseudograminaerum (test 2)	1.7
Pyrenophora tritici-repentis (YLS)	2.9
Bipolaris	0.3
Pythium	1.0
Macrophomina phaseolina (collar rot/stem rot)	2.0

Disease detection rating

Low
Medium
High

Plant and weed establishment

Weeds were managed differently across each of the crop types demonstrated at the site. Specific herbicides were used to ensure adequate weed control without yield penalty due to crop herbicide safety. Where adoption of legumes in the past has been limited due to a lack of weed control options, herbicide and crop rotation management strategies now allow for legumes, such as those demonstrated, to be grown without an undue risk of a yield limiting weed burden.

Due to the sowing rates, ideal plant densities of each crop type and adequate pre-emergent herbicide control, there was no significant difference between plant and weed numbers.

Table 3: Crop plant and weed establishment counts, June 2018

Crop Type	Average plant establishment/m2	Average weed count/m2
Canola	61	6
Chickpeas	41	7
Field Peas	42	2
Lentils	101	7
P value	0.079	0.50
lsd	54.9	NS

The site was managed effectively with a herbicide regime suitable to each crop type. This meant that weeds did not influence crop establishment or yield.

Harvest results

Harvested yield varied across replicates, within and between crop types (Figure 1). There was a significant difference observed in yield of chickpeas and lentils between Rep one and two. This was due to poorer establishment observed in Rep two of the trial site. Although initial plant counts did not indicate any significant difference, site variability was a potential contributor to the variation in harvested yield.

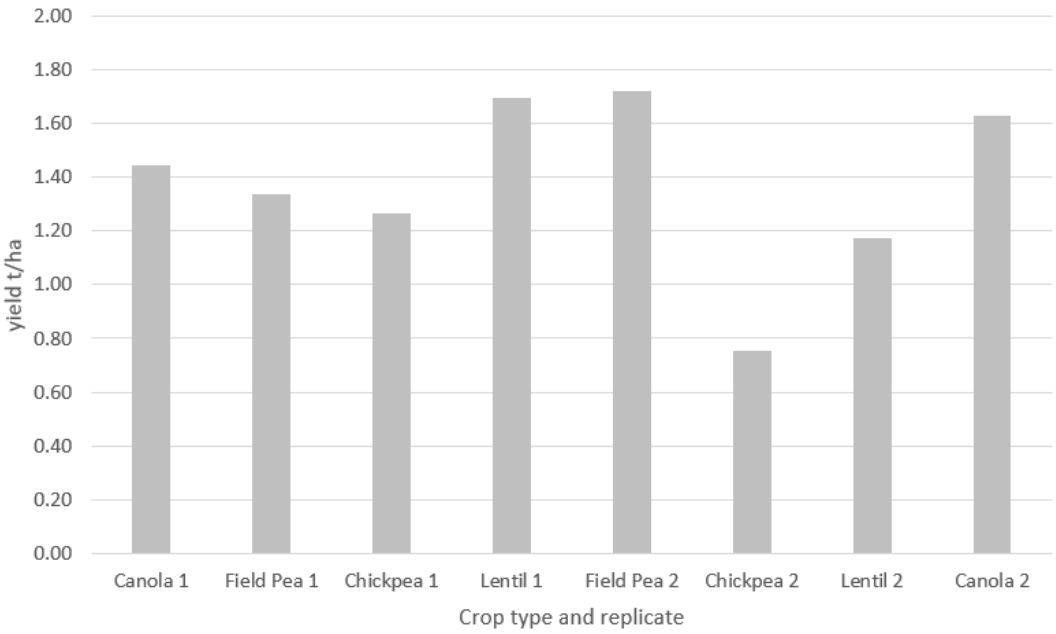

Figure 1: Crop yield (t/ha) by replicate

Site average yields by crop type showed little difference between canola, field peas and lentils. Chickpeas were the poorest performing crop type at that site, with Rep two lowering the average yield to 1.01 t/ha (Figure 2). This was due to the timing of harvest, where chickpeas are often the last crop to be harvested. As such the chickpeas were harvested too early and not all grain was being collected by the harvester. Grain loss was evident in the chaff which was exiting the rear of the harvester.

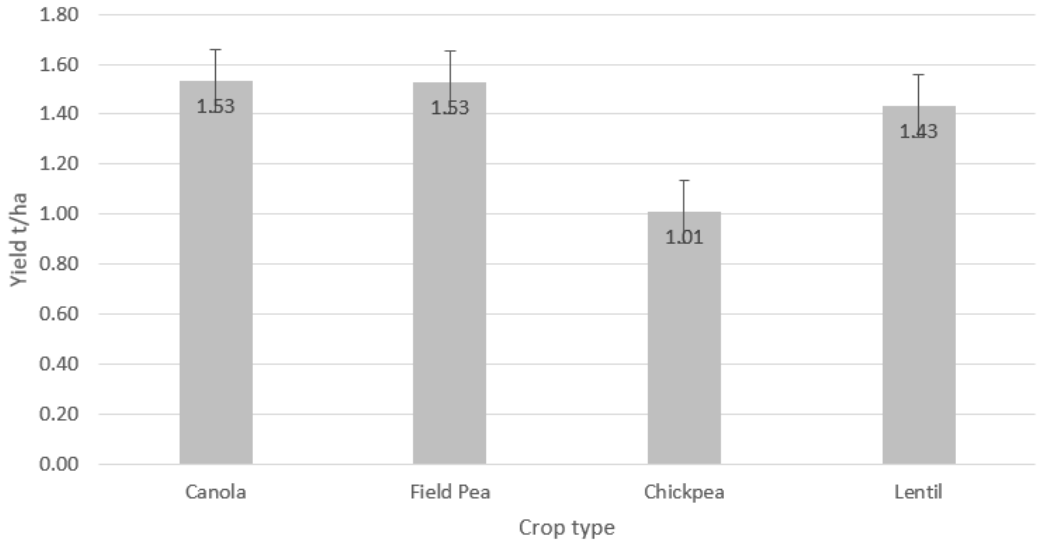

Figure 2: Average yield (t/ha) by crop type (combined yield data for both replicates)

Economic analysis

Assessment of enterprise profitability was conducted on a single seasons results, across each replicate, with the combined economic performance reported in Appendix A. Figure 3 summarises operating profit as earnings before interest and tax (EBIT). Good yields from both canola and field peas, coupled with strong prices at $592 and $600/t FIS respectively, saw these crops standout as the most profitable break crop option in the 2018/19 season. When compared to canola, field peas were a highly profitable legume option for this region, earning a combined operating profit of $359/ha.

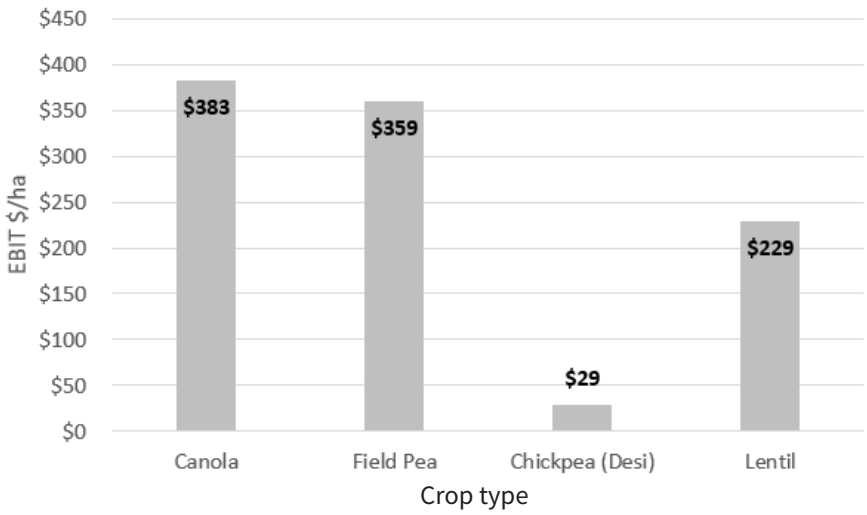

Figure 3: Combined Enterprise Operating Profit (EBIT) per hectare

Lentils were the next best performing legume crop in this demonstration with an operating profit of $229/ha. Operating profit for this crop was impacted by a discounted grain price of $500/t, which was considerably lower than the other enterprises in this analysis. With variable operating costs $37-89/ha lower than the other crops demonstrated, without the effect of price discounting on grain, lentils have good economic potential in this growing region.

Chickpeas were the least profitable crop type; suffering from low yields and high variable operating costs compared to the other enterprises in the analysis, only yielding an operating profit of $29/ha.

Comments

Adequate control of weeds and sufficient plant densities resulted in a clean, competitive crop at the Carnamah site. Canola remains a high earning crop that commonly forms part of a crop rotation in many farming enterprises. Robust agronomy packages and prices of the legume types demonstrated by this project, means crops such as field peas and lentils have potential suitability in the Carnamah region.

The need to harvest chickpeas early to match the logistics of harvest of the trial compromised the results for the chickpea treatments. Use of established management practices for the harvesting of chickpeas is required to reduce the incidence of yield loss at harvest time.

The ranking of each species on profitability should be viewed in light of the highly variable price of pulses from year to year.

Acknowledgements

The Liebe Group would like to thank the Bowman family for hosting this trial site and for the time and effort they have contributed to the management of the demonstration. The economic analysis for this project has been conducted by Ben Curtis and Stacey Bell of Farmanco. This project has been made possible through the GRDC investment: Demonstration of legumes for reliable profitability in the Western Region. Project Code: LIE1802-003SAX

Peer review: Alan Meldrum, Grain Growers

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Appendix A:

Enterprise Analysis Crop – Combined Replicates

Carnamah					
Crop Enterprise		**Canola**	**Field Pea**	**Chickpea Desi**	**Lentil**
Yield	t/ha	1.53	1.53	1.01	1.43
Average Grain Price (FIS)	$/t	$592	$600	$600	$500
Income	**$/ha**	**$908**	**$916**	**$605**	**$717**
Variable Operating Costs	**$/ha**	$	$	$	$
Seed, Treatment & EPR's	$46	$2	$61	$100	$21
Grain Freight (Up Country)	$32	$35	$35	$23	$33
Grain Handling Charges	$20	$24	$22	$15	$21
Crop Contract	$35	$35	$35	$35	$35
Other Crop Costs & Crop Ins	$22	$22	$22	$22	$22
Wages Gross	$28	$28	$28	$28	$28
R&M Mach./Plant/Vehicle	$42	$42	$42	$42	$42
Fuel & Oil	$27	$27	$27	$27	$27
Fertiliser, Lime & Gypsum	$86	$135	$70	$70	$70
Pesticide	$66	$42	$82	$82	$56
Variable Operating Costs	$	$392	$424	$444	$355
Variable Operating Costs	**$/ha**	**$392**	**$424**	**$444**	**$355**
Operating Gross Margin	$	$516	$492	$162	$362
Operating Gross Margin	**$/ha**	**$516**	**$492**	**$162**	**$362**
Fixed Operating Costs	$	$133	$133	$133	$133
Fixed Operating Costs	**$/ha**	**$133**	**$133**	**$133**	**$133**
Total Operating Costs	$	$525	$557	$577	$488
Total Operating Costs	**$/ha**	**$525**	**$557**	**$577**	**$488**
Operating Profit (BIT)	$	$383	$359	$29	$229
Operating Profit (BIT)	**$/ha**	**$383**	**$359**	**$29**	**$229**
Finance Costs	$	$36	$36	$36	$36
Earnings Before Tax (EBT)	**$**	**$347**	**$323**	**-$7**	**$193**
Earnings Before Tax (EBT)	**$/ha**	**$347**	**$323**	**-$7**	**$193**

Demonstration of profitable legumes in the Western Region - Dalwallinu

Alana Hartley, Research & Development Coordinator, Liebe Group

Key Messages

- Adequate pre and post emergent weed control is critical for maintaining yield potential and quality of grain legume crops.
- Canola remains the most profitable non-cereal crop type demonstrated at this site in 2018.
- Where vetch grain is not harvested and sold as feed, consideration of this legume crop type for its grazing value may be advantageous for a mixed farming system.

Aim

To investigate the suitability and profitability of alternative legume crops in the Western Region.

Background

Previous research has suggested that most legume and pulse crops are best suited to fine textured soils of neutral to alkaline pH. While attempts to grow legumes and pulses has had varied success in the past on un-preferred soil types, Western Australian growers therefore have limited adoption of such crop types. This is in part due to suitability of soil type, weed competition and weed control options, yield, market access and overall profitability of legume crops.

Each site within this two year GRDC funded project, aims to demonstrate how and if certain grain legumes are suitable for the farming systems of each region in which the project will be implemented. The sites will cover a vast range of soil types, rainfall zones and farming systems (cropping and mixed farming).

At the Dalwallinu Legume Demonstration site three legumes were compared to canola, which is the current break crop option of choice in the area. Chickpeas, field peas and vetch aim to provide a profitable alternative to canola.

Trial Details

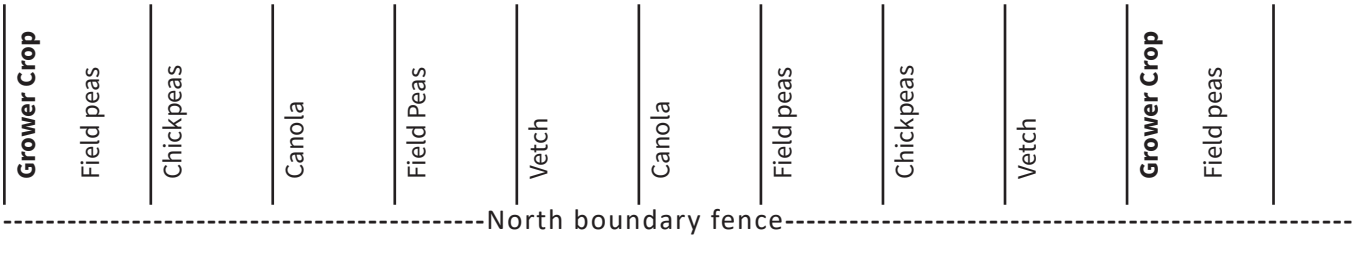
Trial location	Ian and Ainsley Hyde, Bell Rd, Dalwallinu
Plot size & replication	18.28 m x 300m x 2 replications
Soil type	Heavy red loam
Soil pH ($CaCl_2$)	0-10cm: 6.1 10-20cm: 6.8 20-30cm: 7.7
Paddock rotation:	2015: Wheat 2016: Wheat 2017: Barley
Sowing date	Canola, Vetch, Chickpeas 25/05/2018, Field Peas 11/06/2018
Sowing rate	Striker chickpeas: 90 kg/ha Twilight field peas: 100 kg/ha Volga vetch: 40 kg/ha Bonito canola: 3 kg/ha
Fertiliser	22/05/2018: NPK CZ 60kg/ha (canola, vetch, chickpeas) 11/06/2018: Double-Phos 60 kg/ha (field peas)

Herbicides, Insecticides & Fungicides	**Canola**	**Chickpeas**	**Field Peas**	**Vetch**
(Pre-emergent)	Trifluralin 2 L/ha Simazine 1.1 kg/ha Chlorpyrifos 200 ml/ha	Trifluralin 2 L/ha Simazine 1.1 kg/ha Chlorpyrifos 200 ml/ha	Metribuzin 150 g/ ha Diuron 600 g/ha Glyphosate 520 1.5 L/ha Chlorpyrifos 150 ml/ha	Trifluralin 2 L/ha Simazine 1.1 kg/ha Chlorpyrifos 200 ml/ha
(Post emergent)	13/06/2018: Atrazine 1.05 kg/ha Enhance 0.5%	18/07/2018: Clethodim 360 330 ml/ha Verdict 520 50 ml/ ha Chlorpyrifos 250 ml/ha Hasten 1%	18/07/2018: Clethodim 360 330 ml/ha Verdict 520 50 ml/ ha Chlorpyrifos 250 ml/ha Hasten 1%	18/07/2018: Clethodim 360 330 ml/ha Verdict 520 50 ml/ ha Chlorpyrifos 250 ml/ha Hasten 1%
Growing Season Rainfall	300 mm			

Treatments

Plot	Rep	Treatment No.	Treatment
1	1	1	Chickpeas
2	1	C	Canola
3	1	2	Field peas
4	1	3	Vetch
5	2	C	Canola
6	2	2	Field peas
7	2	1	Chickpeas
8	2	3	Vetch

Trial Layout



Results

Soil analysis

Soil analysis was conducted at the beginning of the project, to measure base line nutrients. Further soil testing will be conducted prior to seeding 2019, to determine the change in N status from the baseline results.

Table 1: Baseline soil nutrition status, Dalwallinu, February 2018.

Site	Depth	pH	PBI	Col P	Col K	KCl S	NO3N	NH4N	EC	OC
Dalwallinu	0-10	5.7	80.4	37	430	16.6	51	6	0.182	1.30
	10-20	7.4	157.3	9	258	4.8	9	1	0.047	0.90
	20-30	7.7	204.8	7	118	3.4	4	1	0.069	0.50
	30-40	7.7		5	94		4	2	0.133	
	40-50	8.3		3	96		2	1	0.179	

PreDicta B was conducted prior to the trial being sown, to determine the disease profile and risk at the beginning of the project. The results indicated that there was a low presence of disease at the site. PreDicta B will conducted again prior to next season and entering into the wheat phase, to determine if the legume crops have had an impact on the disease profile.

Table 2: PreDicta B Soil borne disease rating

Test	Result
Cereal Cyst Nematode (CCN)	Nil
Take All (Wheat & Oat race)	0.9
Rhizoctonia solani	1.1
F. pseudograminaerum (test 1)	3.4
F. pseudograminaerum (test 2)	Nil
Pyrenophora tritici-repentis (YLS)	1.3
Bipolaris	0.8
Pythium	1.4
Macrophomina phaseolina (collar rot/stem rot)	2.0

Disease detection rating

Low
Medium
High

Plant and weed counts

Weeds and plant counts were taken at establishment (four weeks after sowing) and again at late establishment, when the legume crops were at branching. There were no significant differences in plant numbers between crop types as shown in Table 3. A log transformation of weed counts suggest that there was some influence of weeds on crop establishment, however this was not highly significant. Counts were not taken for field peas, as they had only just been sown at the time the establishment counts were taken.

Table 3: Crop plant and weed establishment counts, June 2018

Crop type	Average plant/m^2	Log weeds/m^2
Canola	61	3.62
Chickpeas	60	2.33
Field Peas	Not sown at time of counts	
Vetch	50	2.51
P value	0.292	0.098
Lsd	NS	NS

Late plant and weed counts (Table 4), showed no significant difference between crop type, and weed counts by crop type. There was however a significant difference between weeds in the canola plots compared to other crop types demonstrated. Canola had the lowest average weed counts of all crop types, due to crop competition and shading of weeds and the addition of a post emergent herbicide.

Only a grass selective was applied to the legume crops, meaning broadleaf weeds and some grass weed survivors and late germinations remained uncontrolled, thus having some influence over the reduction in plant numbers from early establishment to late counts. Weed burden also has an influence on crop yield.

Table 4: In crop plant and weed counts, August 2018

Crop type	Average plant/m2	Average weeds/m2
Canola	37	5
Chickpeas	41	38
Field Peas	41	54
Vetch	38	25
P value	0.982	0.247
Lsd	NS	NS

Harvest yield

This demonstration was harvested using grower equipment, with yield being measured by weigh trailer. Crop yield by replicate (Figure 1) illustrates a downward trend in yield from replicate one to replicate two. This is due to a slight soil type change across the site at depth; where Rep two had a sandy texture and marginally lower pH to Rep one.

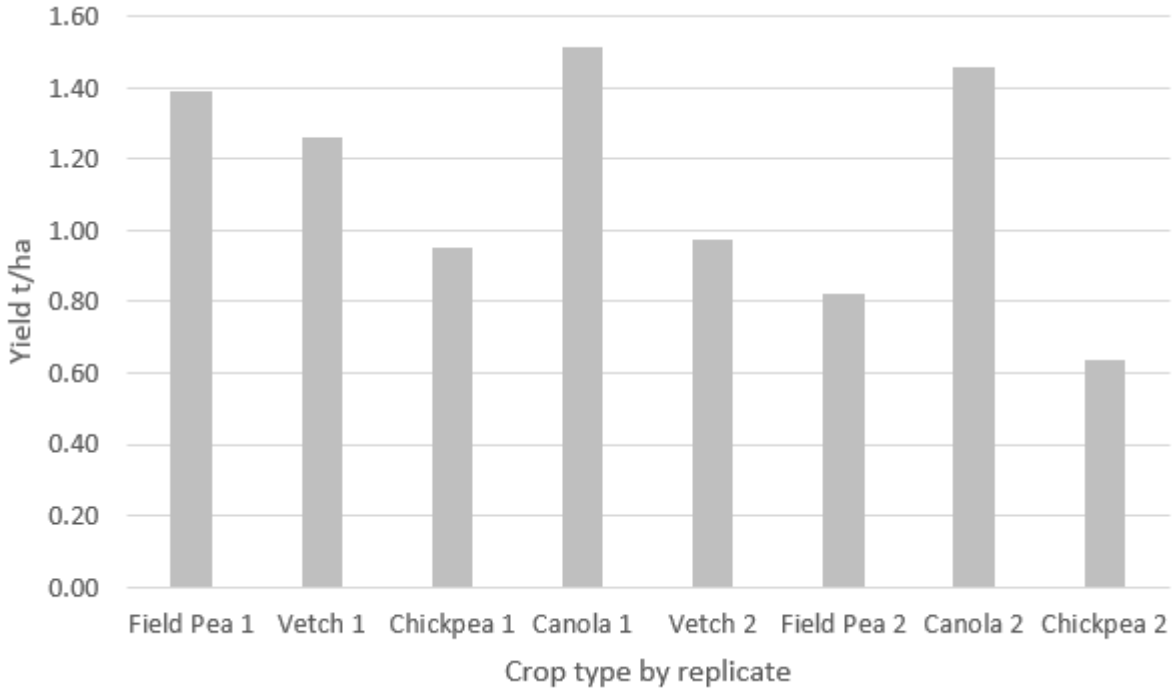


Figure 1: Crop yield (t/ha) by replicate

Canola was the only crop type in this demonstration that was not influenced by spatial variation in soil and weed burden. This is because canola is a more competitive crop, with cabbaging canola competed for sunlight and nutrients by shading germinating weeds. All other crop types were heavily influenced by the presence of broadleaf weeds such as double gee, turnip, capeweed, thistles and grasses. Hence reaffirming the need to adequately manage weeds both pre and post emergent. Chickpeas were the most influenced by weed burden.

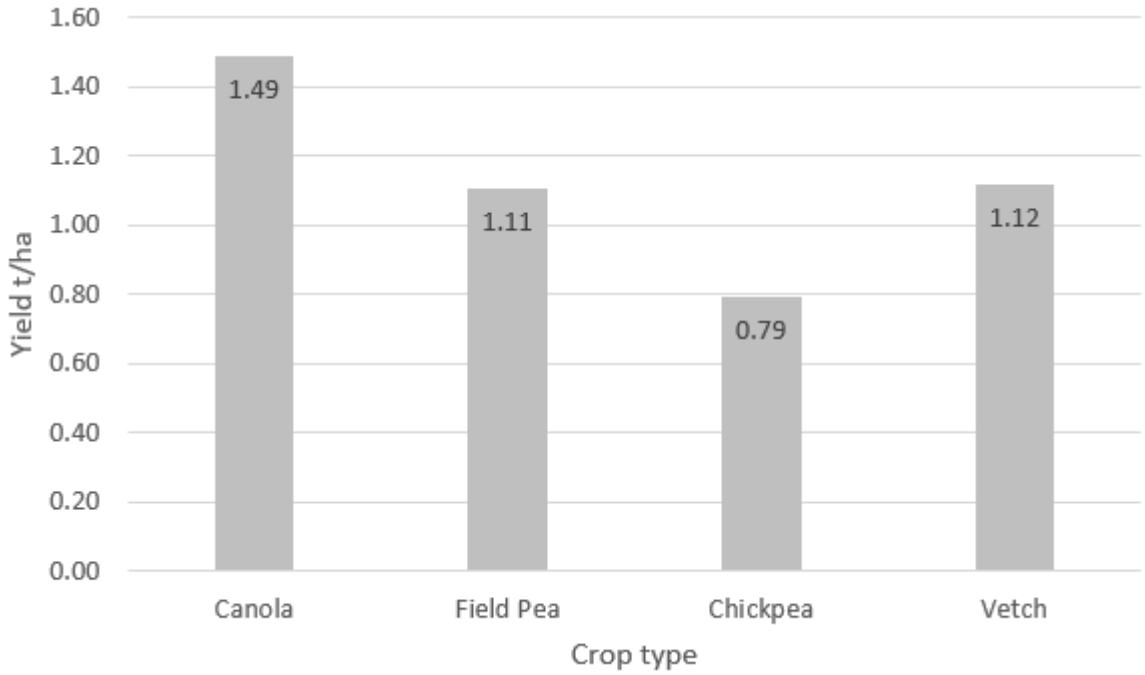


Figure 2: Combined average yield (t/ha) by crop type

Combined average yields (Figure 2), indicate that canola remains the most competitive break crop option at this site however, given sufficient post emergent weed control, field peas and vetch have a potential fit as a legume option for a farming system in this region.

Economic analysis

Assessment of enterprise profitability was conducted on a single season results, across each replicate, with the combined economic performance reported in Appendix A. Figure 3 summarises operating profit as earnings before interest and tax (EBIT). The value of nitrogen or updated disease status has not been factored into this analysis but will be adjusted for the wheat phase in 2019.

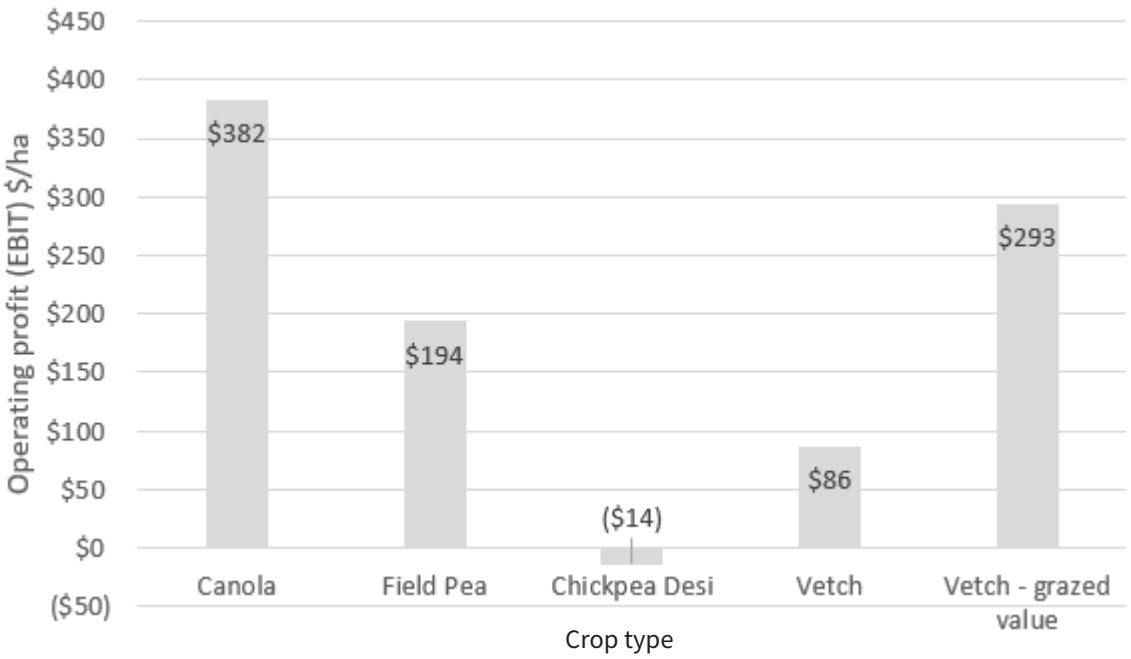


Figure 3: Combined enterprise operating profit (EBIT) $/ha, 2018

The highest earning crop demonstrated by this project was canola, with an operating profit of $382/ha. Field peas also yielded a positive operating profit at $194/ha but was not as profitable compared to canola due to the lower yield. Chickpeas were affected by poor yields and quality due to weed burden, resulting in a loss of $14/ha. The grain value of vetch achieved a modest $86/ha operating profit.

Vetch is a legume pasture species and will often be grazed, brown manured or cut for forage hay. The variety demonstrated at Dalwallinu, Volga, is a multi-purpose variety where livestock producers can maximise their returns from grazing both crop biomass and grain. A grazing value has been calculated in appendix A. The following assumptions have been made;

- 1 DSE consumes 1kg dry matter (DM) per day
- At the end of grazing there is budgeted to be 1000kg DM/ha remaining in order to retain enough cover to avoid paddock damage.
- In this example this means of the 3000kgs grown, 2000kg would be consumed. Of this 2000kg consumed lamb and wool production has been calculated and represents income.
- It is assumed that there would be single bearing ewes on this paddock as well which would turn off a lamb as well as a fleece.
- Sale price of sheep is $122 (average price for Medium Rainfall Farmanco clients as shown in the Farmanco Profit Series)
- Average wool cut is 5.39kg/hd, average price is $10.57/kg (average price and kg for Medium Rainfall Farmanco clients as shown in the Farmanco Profit Series)
- The dry matter figure is only a visual assessment and information taken from this analysis be considered with caution.

For livestock producers considering a legume species in the rotation, the Dalwallinu demonstration site indicated that grazed vetch provides significant economic advantage to both lamb and wool enterprises with a calculated operating profit of $293/ha.

Comments

To successfully grow a legume crop in a rotation, suitable agronomic and management practices must be considered. Adequate pre and post emergent of weeds in pulse crops is required to limit the impact on yield and quality; matching crop soil requirements with soil type and; consideration of harvesting equipment and settings to avoid yield losses add to the planning and success of a legume crop.

Canola remains a highly profitable non-cereal crop option within a rotation after the 2018 season at Dalwallinu. Where soil type permits, field peas have an economic fit within the farming system. Further work is required to determine the suitability of chickpeas in a rotation. While vetch performed well, the ability to control the weed burden must be considered prior to planting. The grazing value may also be considered, beyond the value of grain, for this crop type, where stock are a part of the farm program as the yield potential of vetch is much lower than for the other legumes.

Acknowledgements

Liebe Group would like to thank the Hyde family for hosting this trial site and for the time and effort they have contributed to the management of the demonstration. The economic analysis for this project has been conducted by Ben Curtis and Stacey Bell of Farmanco. This project has been made possible through the GRDC investment: Demonstration of legumes for reliable profitability in the Western Region.
Project Code: LIE1802-003SAX

Peer Review: Alan Meldrum, Grain Growers

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Appendix A

Dalwallinu						
Crop Enterprise		**Canola**	**Field Pea**	**Chickpea Desi**	**Vetch**	**Vetch - Grazing Value**
Yield	t/ha	1.49	1.11	0.79	1.12	3.00
Carrying Capacity for 150 days	DSE					13.33
Annualised carrying capcity	DSE					5.48
Average Grain Price (FIS)	$/t	$582	$600	$600	$500	
Income	**$/ha**	**$865**	**$664**	**$476**	**$558**	**$758**
Variable Operating Costs	**$/ha**	$	$	$	$	
Seed, Treatment & EPR's	$53	$2	$61	$91	$61	$61
Grain Freight (Up Country)	$26	$34	$25	$18	$29	
Grain Handling Charges	$16	$23	$16	$11	$16	
Crop Contract	$35	$35	$35	$35	$35	$35
Other Crop Costs & Crop Ins	$22	$22	$22	$22	$22	$22
Wages Gross	$28	$28	$28	$28	$28	$28
R&M Mach./Plant/Vehicle	$42	$42	$42	$42	$42	$42
Fuel & Oil	$27	$27	$27	$27	$27	$27
Fertiliser, Lime & Gypsum	$60	$104	$45	$45	$45	$45
Pesticide	$35	$32	$36	$38	$35	$35
Variable Operating Costs	$	$349	$337	$358	$339	$295
Variable Operating Costs	**$/ha**	**$349**	**$337**	**$358**	**$339**	**$295**
Operating Gross Margin	$	$515	$327	$119	$219	$463
Operating Gross Margin	**$/ha**	**$515**	**$327**	**$119**	**$219**	**$463**
Fixed Operating Costs	$	$133	$133	$133	$133	$170
Fixed Operating Costs	**$/ha**	**$133**	**$133**	**$133**	**$133**	**$170**
Total Operating Costs	$	$482	$470	$491	$472	$465
Total Operating Costs	**$/ha**	**$482**	**$470**	**$491**	**$472**	**$465**
Operating Profit (BIT)	$	$382	$194	-$372	-$253	$293
Operating Profit (BIT)	**$/ha**	**$382**	**$194**	**-$14**	**$86**	**$293**
Finance Costs	$	$36	$36	$36	$36	$56
Earnings Before Tax (EBT)	**$**	**$346**	**$158**	**-$50**	**-$289**	$237
Earnings Before Tax (EBT)	**$/ha**	**$346**	**$158**	**-$50**	**$50**	**$237**

Demonstration of profitable legumes in the Western Region - Kalannie

Alana Hartley, Research & Development Coordinator, Liebe Group

Key points

- Preparation of paddocks is key to the success of legume crops such as chickpeas and field peas. Control of weeds prior to sowing is crucial and, rolling to level the seed bed post seeding improves the ability to harvest such crop types.
- Field peas and chickpeas are more susceptible to frost damage compared to canola or lupins.
- Canola remains a highly profitable non-cereal crop in Kalannie in 2018.

Aim

Demonstrate the profitability of alternative grain legume crops across the Western Region

Background

Previous research has suggested that most legume and pulse crops are best suited to fine textured soils of neutral to alkaline pH. While attempts to grow legumes and pulses in regions where the soil classification does not meet previously noted criteria has been varied in its success in the past, Western Australian growers have limited adoption of such crop types. This is in part due to suitability of soil type, competition against weeds and weed control options, yield, market access and overall profitability of legume crops.

Each site within this two year GRDC funded project, aims to demonstrate how, and if, certain grain legumes are suitable for the farming systems of each region in which the project will be implemented. The sites cover a vast range of soil types, rainfall zones and farming systems (cropping and mixed farming).

At the Kalannie Legume Demonstration site three legumes are being compared to canola, which is the current break crop option of choice in the area. Chickpeas, field peas and lupins aim to provide a profitable alternative to canola.

Trial Details

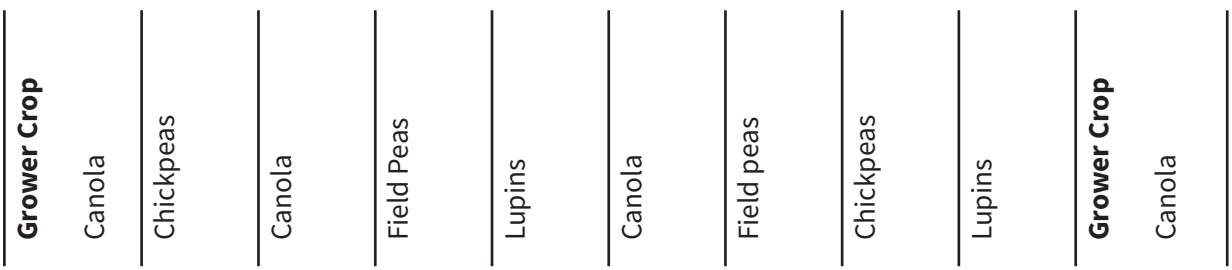
Trial location	McCreery Rd, McCreery property, Kalannie
Plot size & replication	12m x 200m x 2 replications
Soil type	Duplex – red loam over sand
Soil pH ($CaCl_2$)	0-10cm: 5.3 10-20cm: 6.1 20-30cm: 7.6
Paddock rotation:	2015: Canola 2016: Wheat 2017: Oats
Sowing date	03/05/2018
Sowing rate	Canola (snapper): 8 kg/ha Chickpea (Striker): 67 kg/ha Field pea (Twilight): 69 kg/ha Lupins (Jurien): 82 kg/ha
Fertiliser	03/05/2018: K-Till Extra 70 kg/ha 18/07/2018: Flexi N 70 L/ha
Herbicides, Insecticides & Fungicides **(Post emergent)** **Chickpeas** **Field peas & lupins** **Canola**	Simazine 1.1 kg/ha, Trifluralin 2 L/ha, Chlorpyrifos 0.2 L/ha (whole site) Broadstrike 12 g/ha, Factor 180 g/ha + 1% MSO, Veritas 0.5 L/ha Brodal 150 ml/ha, Metribuzin 100 g/ha Factor 180 g/ha + 1% MSO Atrazine 1.1 kg/ha, Clethodim 0.5 L/ha, Factor 80 g/ha + 1% MSO
Growing Season Rainfall	216 mm

Treatments

Plot	Rep	Treatment No.	Treatment
1	1	1	Lupins
2	1	C	Canola
3	1	2	Chickpeas
4	1	3	Field Peas
5	2	C	Canola
6	2	2	Chickpeas
7	2	1	Lupins
8	2	3	Field Peas

*Calibration issues were experienced during seeding, causing seeding rates to be applied incorrectly. Intended rates for crops were as follows: Canola – 3.5 kg/ha, Chickpeas 90 kg/ha, Field peas 100 kg/ha.

Trial Layout



Results

Soil analysis

Soil analysis was conducted at the beginning of the project, to measure base line nutrients. Further soil testing will be conducted prior to seeding 2019, to determine the change in N status from the baseline results. Over all benefits of additional N and a disease break, due to the legume phase, will be measured as the improved wheat yield and quality compared to the control (canola treatment).

Site	Depth	Col P	Col K	KCl S	O C	pH H2O	pH Ca Cl2	EC	PBI	NO3N	NH4N	Ca Cl2 Al
Kalannie	0-10	27	159	35.9	0.68	6.0	5.3	0.234	19.0	18	4	
	10-20	19	88	6.3	0.35	6.8	6.1	0.112	15.4	5	1	
	20-30	6	140	11.1	0.24	8.6	7.6	0.199	22.6	4	< 1	
	30-40	5	233			9.0	7.9	0.306		3	< 1	0.23
	40-50	4	264			9.2	8.2	0.589		4	< 1	0.34

PreDicta B was conducted prior to the trial being sown, to determine the disease profile and risk at the beginning of the project (Table 1). PreDicta B will be conducted again prior to next season and entering into the wheat phase, to determine if the legume crops have reduced the disease profile. No foliar fungicide was applied at this site early in the season due to the low disease pressure. A late application was applied to chickpeas only upon the presence of a low level of grey mould. Chickpeas were purchased pre-treated with Thiam fungicide.

PreDicta B results

Table 1: PreDicta B disease ratings - March 2018

Test	Result
CCN	0
Stem nematode	0
Take all	1.3
Gga	0
Rhizoctonia solani	0.7
Crown rot	0
Bipolaris	2.0
Pythium	1.0
Eyespot	0
P. neglectus (Nematodes)	0.1
Macrophomina phaseolina (collar/stem rot)	1.7
Phoma rabiei (chickpea aschochyta)	0

Disease detection rating

Low
Medium
High

Many other PreDicta B tests were conducted other than those listed, however, they all returned a result of zero or below detectable, and have not been listed in this article.

Plant and weed Counts

Canola establishment was significantly higher than the ideal range for an Open Pollinated (OP) TT variety at 170 plants/m^2 (ideal range: 30-40 plants/m^2 in a low rainfall zone). This was due to the seeding calibration error that was experienced at the time of sowing the demonstration.

Lupins were effected by poor germinating seed, resulting in significantly low plant counts compared to other crop types demonstrated. Ideal plant density for lupins is 45 plants/m^2. This improved slightly in by the late establishment counts (Table 3) in August.

Table 2: Establishment and weed counts – June 2018

Crop type	Average plants/m2	Average weeds/m2
Canola	170	19
Chickpeas	40	22
Field Peas	45	54
Lupins	18	27
P value	0.054	0.600
Lsd	104.3	NS

Field peas were also affected by the calibration error at seeding however establishment counts were within the ideal range of 40-50 plants/m^2. Seeding rates of 90-100 kg/ha of varieties such as Gunyah or Twilight, should achieve this target density. Plant density is important for field peas due to the structure of the crop canopy. These erect crop types use nearby plants as support, to avoid early lodging. Failure to meet target densities increases the risk of lodging creating difficulties at harvest and, reduces the crops competitiveness against weeds.

Chickpeas were slow to establish and were affected by the post emergent Broadstrike herbicide application, however, plants recovered and meet the target plant density range of 25-50 plants/m^2. The erect crop canopy, improved lodging resistance and decreased pod shattering is expected to assist with harvest-ability of this crop type.

There were no significant differences in weed counts during early establishment, although pre-emergent herbicides did not control weeds in the field peas as well as other crop types.

Post emergent applications of herbicides did control some weeds, with counts showing a significant reduction in weed populations at the time of late counts (Table 3). Weed control in the chickpeas was not as strong, due to the limited herbicide options for controlling broadleaf weeds, resulting in weed numbers significantly higher than the other crop types. Weed burden also caused a significant reduction in crop plant numbers, as shown in Table 3.

Table 3: Late plant and weed counts - August 2018

Crop type	Average plants/m2	Average weeds/m2
Canola	93	0
Chickpeas	15	16
Field Peas	41	3
Lupins	30	4
P value	0.046	0.008
Lsd	98.1	5.2

A late germination of weeds had significant consequences on final yield Figure 1, as limited herbicide options and crop stage did not permit a late post emergent application to control the late emerging weed population.

A mild frost event on the 9th of September had an impact on final yield, particularly for the field peas and chickpeas; where fully developed seed were frost damaged and shrivelled. A plot harvester was bought in to harvest 20 m 'plots' from each field pea replicate, to gain a more accurate yield from the site.

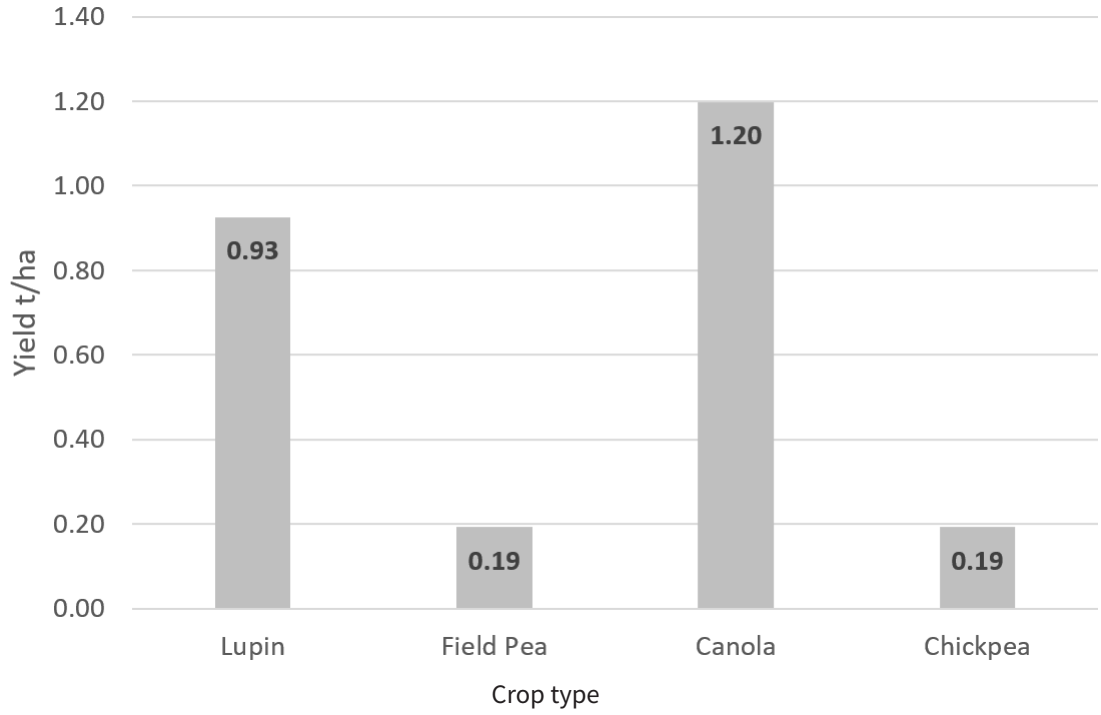


Figure 1: Average yield (t/ha) by crop type at the Kalannie Legume Demonstration Site

Due to the frost effected crop, yield has not been represented by plot and replicate in this report. Combined average yield by crop type in Figure 1, represents both replicates in the demonstration. Despite a seeding error and frost, both canola and lupins yielded well at 1.2 t/ha and 0.93 t/ha respectively. Field peas were significantly effected by frost whist the chickpeas were effected by frost and weed competition.

Economic analysis

Assessment of enterprise profitability was conducted on a single seasons results, across each replicate, with the combined economic performance reported in Appendix A. Figure 2 summarises operating profit as earnings before interest and tax (EBIT).

Variable input costs were similar across all legume crop types except canola, whose inputs were approximately $26/ha greater (appendix A). This did not have any significant effect on overall profitability, where canola was a standout, having an operating profit of $330/ha.

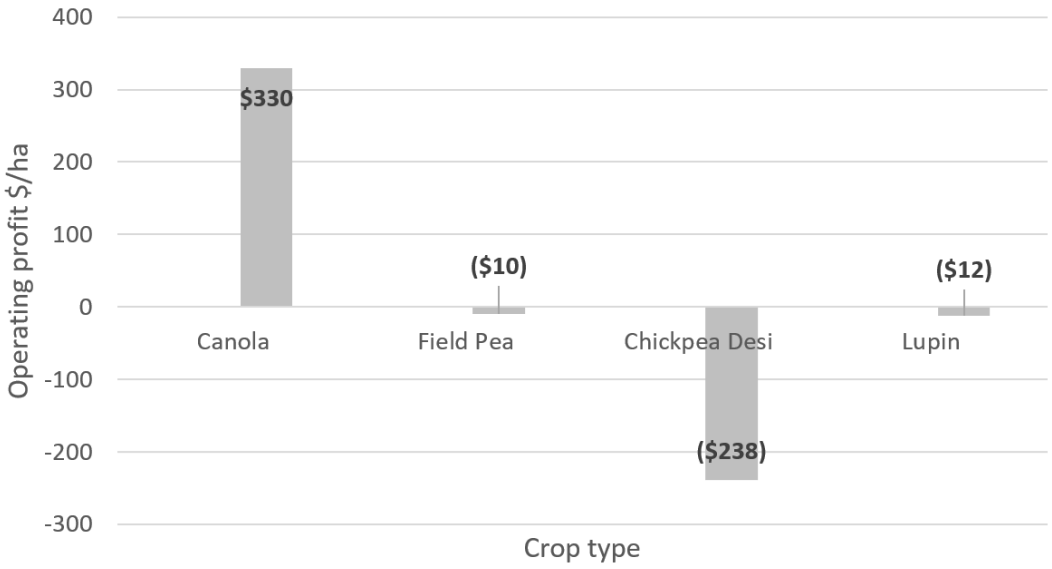


Figure 2: Operating profit (EBIT) per hectare, 2018

Weed burden, frost damage and poor quality seed resulted in negative operating profits for all legumes demonstrated.

Comments

Field peas and chickpeas suffered significant yield losses from frost. Adequate pre and post emergent control of weeds is also required to limit the impact of weed burden on yield and quality of legume crops. The weed burden at this site would have compromised the legume yields regardless of the affects of frost.

The alkaline pH of the site would also have restricted the yield potential of lupin. The comparative performance of the legume species to canola cannot be adequately assessed due to these factors.

Acknowledgements

The Liebe Group would like to thank the McCreery family for hosting this project over the next two seasons and their contribution of time, seed and fertiliser for the trial. Thank you also to the Nixon family for supplying the field pea seed for this demonstration.

Thank you to AFGRI equipment, Dalwallinu, for the supply of machinery to enable this demonstration to be sown.

Thank you to the Tactical Break Crop researchers at the Department of Primary Industries and Regional Development (DPIRD) for the agronomic support and advice for each of the crop types demonstrated at this site. Extended thanks to the team at the Wongan Hills Research Station who provided their services for harvesting the field peas at this site.

The economic analysis for this project has been conducted by Ben Curtis and Stacey Bell of Farmanco. This project has been made possible through the GRDC investment: Demonstration of legumes for reliable profitability in the Western Region. Project Code: LIE1802-003SAX

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Appendix A

Enterprise Analysis by crop – combined replicates

Kalannie

Crop Enterprise		Canola	Field Pea	Chickpea	Lupin
Yield	t/ha	1.20	0.57	0.19	0.93
Average Grain Price (FIS)	$/t	$592	$600	$600	$370
Income	**$/ha**	**$710**	**$343**	**$116**	**$343**
Variable Operating Costs	**$/ha**	$	$	$	$
Seed, Treatment & EPR's	$36	$5	$42	$68	$30
Grain Freight (Up Country)	$17	$28	$13	$4	$21
Grain Handling Charges	$10	$19	$8	$3	$10
Crop Contract	$21	$21	$21	$21	$21
Other Crop Costs & Crop Ins	$15	$15	$15	$15	$15
Wages Gross	$15	$15	$15	$15	$15
R&M Mach./Plant/Vehicle	$32	$32	$32	$32	$32
Fuel & Oil	$22	$22	$22	$22	$22
Fertiliser, Lime & Gypsum	$60	$101	$47	$47	$47
Pesticide	$59	$50	$64	$54	$68
Variable Operating Costs	$	$307	$280	$281	$281
Variable Operating Costs	**$/ha**	**$307**	**$280**	**$281**	**$281**
Operating Gross Margin	$	$403	$63	-$165	$61
Operating Gross Margin	**$/ha**	**$403**	**$63**	**-$165**	**$61**
Fixed Operating Costs	$	$73	$73	$73	$73
Fixed Operating Costs	**$/ha**	**$73**	**$73**	**$73**	**$73**
Total Operating Costs	$	$380	$353	$354	$354
Total Operating Costs	**$/ha**	**$380**	**$353**	**$354**	**$354**
Operating Profit (BIT)	$	$330	-$10	-$238	-$12
Operating Profit (BIT)	**$/ha**	**$330**	**-$10**	**-$238**	**-$12**
Finance Costs	$	$24	$24	$24	$24
Earnings Before Tax (EBT)	**$**	**$306**	**-$34**	**-$262**	**-$36**
Earnings Before Tax (EBT)	**$/ha**	**$306**	**-$34**	**-$262**	**-$36**

Demonstration of profitable legumes in the Western Region - Koorda

Alana Hartley, Research & Development Coordinator, Liebe Group

Key Messages

- Significant weed burdens can impact yield of legume crops considerably if not controlled well with rotation or pre and post emergent herbicide options.
- Without control of weeds, soil borne diseases can be carried from legume phase into the cereal phase.

Aim

To investigate the suitability and profitability of alternative legume crops in the Western Region.

Background

Previous research has suggested that most legume and pulse crops are best suited to fine textured soils of neutral to alkaline pH. While attempts to grow legumes and pulses in regions where the soil classification does not meet previously noted criteria has been varied in its success in the past, Western Australian growers have limited adoption of such crop types. This is in part due to suitability of soil type, competition against weeds and weed control options, yield, market access and overall profitability of such crops.

Each site within this two year GRDC funded project, aims to demonstrate how and if certain grain legumes are suitable for the farming systems of each region in which the project will be implemented. The sites will cover a vast range of soil types, rainfall zones and farming systems (cropping and mixed farming).

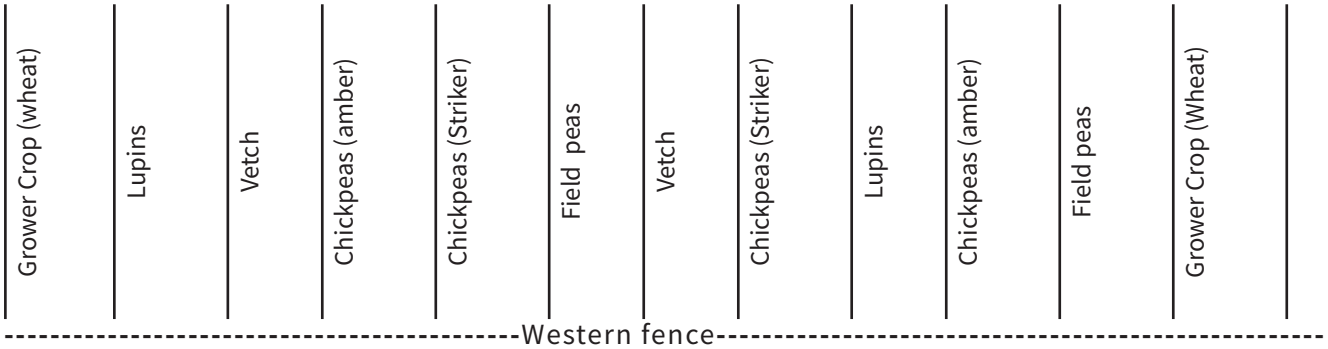
At the Koorda Legume Demonstration site three legumes are being compared to lupins, which is the current break crop option of choice in the area. Chickpeas, field peas and vetch aim to provide a profitable alternative to lupins.

Trial Details

Trial location	Nathan Brooks, Remnant Rd, Koorda
Plot size & replication	18.28 m x 300m x 2 replications
Soil type	Red-brown loamy sand
Soil pH ($CaCl_2$)	0-10cm: 5.5 10-20cm: 7.2 20-30cm: 7.7
Growing season rain	214 mm (taken from Koorda weather station)
Paddock rotation:	2015: Wheat 2016: Wheat 2017: Wheat
Sowing date	14/05/2018
Sowing rate	Chickpeas (Striker): 90 kg/ha Chickpeas (Amber): 90 kg/ha Field peas (Gunyah): 100 kg/ha Vetch (Volga): 40 kg/ha Lupins (Mandelup): 80 kg/ha
Fertiliser	14/05/2018: Agstar 50 kg/ha
Herbicides, Insecticides & Fungicides	
(Pre-emergent)	14/05/2018: Trifluralin 2 L/ha Simazine 1.1 kg/ha Chlorpyrifos 400 ml/ha
(Post emergent)	19/07/2018 Clethodim 360 250 ml/ha Hasten 1%
Growing Season Rainfall	236 mm

Trial Layout

Plot	Rep	Treatment No.	Treatment
1	1	1	Lupins
2	1	4	Vetch
3	1	5	Chickpeas (Amber)
4	1	2	Chickpeas (Striker)
5	1	3	Field Peas
6	2	4	Vetch
7	2	2	Chickpeas (Striker)
8	2	1	Lupins
9	2	5	Chickpeas (Amber)
10	2	3	Field Peas



Results

Soil analysis was conducted at the beginning of the project, to measure base line nutrients. Further soil testing will be conducted after the legume phase, to determine the change in N status from the baseline results.

Table 1: Baseline soil nutrition, March 2018

Site	Depth	pH	PBI	Col P	Col K	KCl S	NO3N	NH4N	EC	OC
Koorda	**0-10**	5.8	61.2	45	666	37.4	46	4	0.222	0.89
	10-20	7.6	97.1	17	635	20.2	20	1	0.190	0.86
	20-30	7.8	184.0	6	481	42.6	13	< 1	0.256	1.23
	30-40	7.7		4	329		11	< 1	0.390	
	40-50	8.6		3	335		13	< 1	0.534	

PreDicta B was conducted prior to the trial being sown, to determine the disease profile and risk at the beginning of the project. The results indicated that there was a low presence of disease at the site. PreDicta B will be conducted again prior to next season and entering into the wheat phase, to determine if the legume crops have had an impact on the disease profile.

Table 2: PreDicta B Soil borne disease rating

Test	Result
Cereal Cist Nematode (CCN)	Nil
Take All (Wheat & Oat race)	0.9
Rhizoctonia solani	1.4
F. pseudograminaerum (test 1)	3.2
F. pseudograminaerum (test 2)	Nil
Pyrenophora tritici-repentis (YLS)	0.6
Bipolaris	1.7
Pythium	1.4
Pratylenchus neglectus	1.1
Macrophomina phaseolina (collar rot/stem rot)	2.0

Disease detection rating

Low
Medium
High

Plant Establishment Counts

Early establishment counts taken in June, Table 3, showed no significant difference in plant numbers for each crop type. At the time of establishment, the site was free of weed burden.

Table 3: Plant establishment counts, June 2018

Crop type	Average plants/m²
Chickpeas (Striker)	26
Chickpeas (Amber)	32
Field Peas (Gunyah)	33
Lupins (Mandelup)	42
Vetch (Volga)	39
P value	0.389
Lsd	NS

Late application of post emergent grass selective herbicide and no broadleaf herbicide application influenced plant and weed counts, taken at late branching crop stage in August. Crop plant numbers remained relatively unchanged compared to establishment counts in Table 3. Weed burden was significant across the site. All treatments were affected by weeds, thus no significant difference was observed (Table 4) between crop types in their competitiveness or control.

Table 4: Crop plant and weed counts, August 2018

Crop type	Average plants/m²	Average weeds/m2
Chickpeas (Striker)	35	60
Chickpeas (Amber)	33	64
Field Peas (Gunyah)	39	47
Lupins (Mandelup)	39	86
Vetch (Volga)	41	63
P value	0.955	0.233
Lsd	NS	NS

Harvest results

Harvest results were heavily influenced by the presence of an uncontrolled annual ryegrass weed burden. Competition for moisture and nutrients and two mild frost events in August and September effected flowering and seed development. As such, yields were significantly below expectations in a season where rainfall was adequate. The best yielding crop, given the circumstances was field peas (figure 1) as the crop was competitive early and had lower weed burden (table 4) than the other less competitive crop types demonstrated.

The impact on weeds, although not significantly different between crops at this site (due to the uniformity of the burden), reinforces the need for careful selection of paddocks, herbicide weed control options and future rotation management.

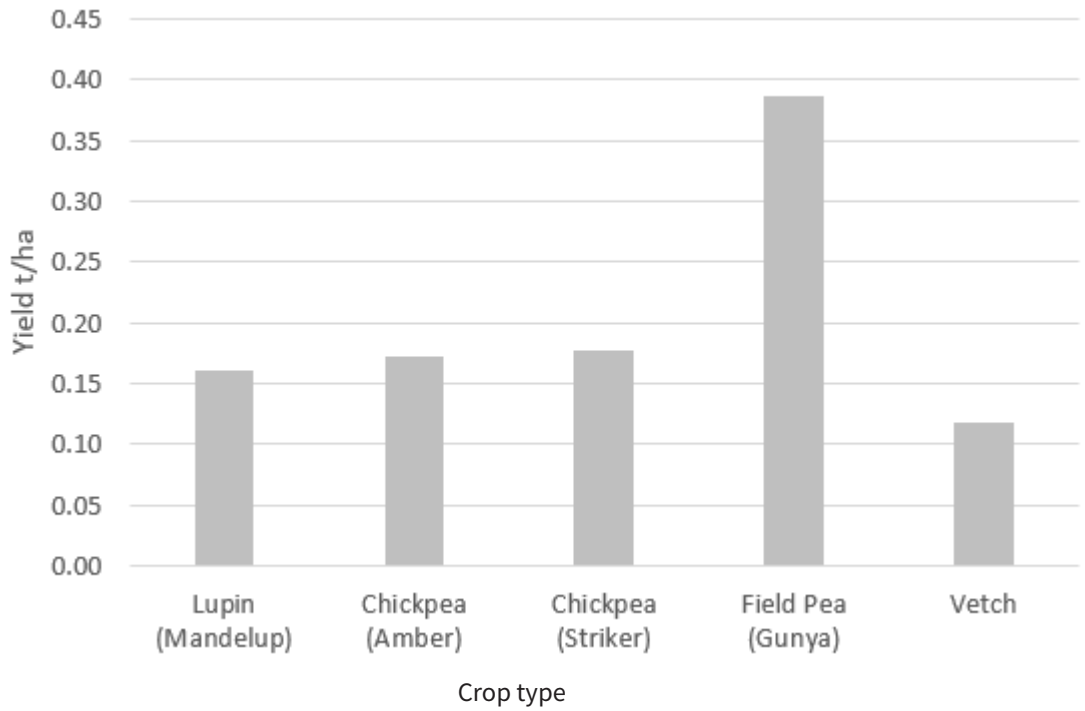


Figure 1: Average yield (t/ha) by crop type at the Koorda Legume Demonstration Site

Economic Analysis

Assessment of enterprise profitability was conducted on a single seasons results, across each replicate, with the combined economic performance reported in Appendix A. Figure 2 summarises operating profit as earnings before interest and tax (EBIT).

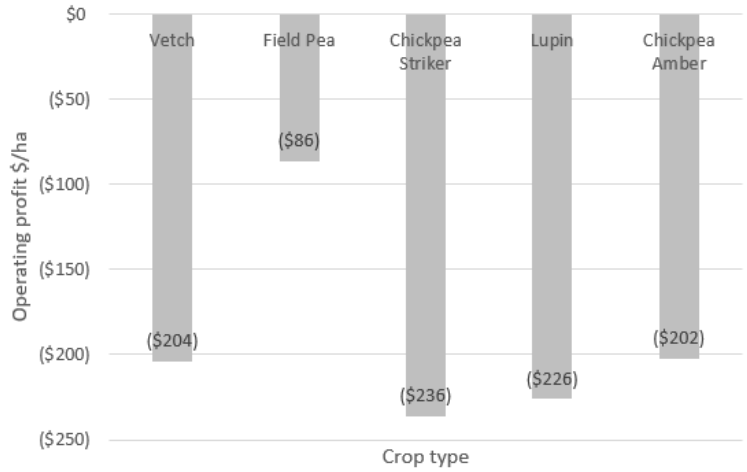


Figure 2: Combined Enterprise Operating Profit (EBIT)

The economic analysis uses standard grain quality standards to apply a value to each crop type grown at the site. No crop yielded an economic return.

Comments
Late germinating ryegrass and capeweed became a significant issue at this site in 2018, impacting highly on yield and quality of grain samples collected from each treatment. As such, adequate herbicide management plans to manage future weed burdens during the cereal phase of this project will be critical.

Early crop stand and biomass was good, suggesting potential for setting nitrogen in the soil. This will be measured with soil testing in 2019, coupled with measurement of wheat yield and quality.
Weeds are also a carrier of many soil borne diseases. PreDicta B will also be carried out across individual treatments to measure the presence of soil borne diseases after the legume phase.
The heavy weed burden, resulting in poor yields for all species, precludes useful recommendations for the best choice of legume species for this soil type using data from this demonstration.

Peer Review: Alan Meldrum, Grain Growers

Acknowledgements
Liebe Group would like to thank Nathan Brooks and his family for hosting this trial site and for the time and effort they have contributed to the management of the demonstration.

The group would also like to acknowledge the contribution of the Farmanco Agronomists and Consultants who have assisted our site hosts in the management of these sites and the facilitation of the Crop Sequencing workshops, which are being delivered across each of the port zones in 2018 and 2019. The economic analysis for this project has been conducted by Ben Curtis and Stacey Bell of Farmanco.

This project has been made possible through the GRDC investment: Demonstration of legumes for reliable profitability in the Western Region. Project Code: LIE1802-003SAX

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Appendix A

Economic analysis by crop – combined replicates

Koorda						
Crop Enterprise		**Vetch**	**Field Pea**	**Chickpea Striker**	**Lupin**	**Chickpea Amber**
Yield	t/ha	0.12	0.39	0.18	0.16	0.17
Average Grain Price (FIS)	$/t	$500	$600	$600	$370	$600
Income	**$/ha**	**$59**	**$232**	**$106**	**$60**	**$103**
Variable Operating Costs	**$/ha**	$	$	$	$	$
Seed, Treatment & EPR's	$51	$21	$60	$91	$31	$55
Grain Freight (Up Country)	$5	$3	$9	$4	$4	$4
Grain Handling Charges	$3	$1	$6	$3	$2	$2
Crop Contract	$21	$21	$21	$21	$21	$21
Other Crop Costs & Crop Ins	$15	$15	$15	$15	$15	$15
Wages Gross	$15	$15	$15	$15	$15	$15
R&M Mach./Plant/Vehicle	$32	$32	$32	$32	$32	$32
Fuel & Oil	$22	$22	$22	$22	$22	$22
Fertiliser, Lime & Gypsum	$32	$32	$32	$32	$32	$32
Pesticide	$34	$28	$35	$35	$39	$35
Variable Operating Costs	$	$190	$245	$269	$213	$233
Variable Operating Costs	**$/ha**	**$190**	**$245**	**$269**	**$213**	**$233**
Operating Gross Margin	$	-$131	-$13	-$163	-$153	-$129
Operating Gross Margin	**$/ha**	**-$131**	**-$13**	**-$163**	**-$153**	**-$129**
Fixed Operating Costs	$	$73	$73	$73	$73	$73
Fixed Operating Costs	**$/ha**	**$73**	**$73**	**$73**	**$73**	**$73**
Total Operating Costs	$	$263	$318	$342	$286	$306
Total Operating Costs	**$/ha**	**$263**	**$318**	**$342**	**$286**	**$306**
Operating Profit (BIT)	$	-$204	-$86	-$236	-$226	-$202
Operating Profit (BIT)	**$/ha**	**-$204**	**-$86**	**-$236**	**-$226**	**-$202**
Finance Costs	$	$24	$24	$24	$24	$24
Earnings Before Tax (EBT)	**$**	**-$228**	**-$110**	**-$260**	**-$250**	**-$226**
Earnings Before Tax (EBT)	**$/ha**	**-$228**	**-$110**	**-$260**	**-$250**	**-$226**