2023 Hyola Innovation Winter Canola Graze n Grain by Nitrogen Rate Results – Inverleigh Vic

Comparing Dry Matter Production, Grain Yields, and Gross Returns of Winter Clearfield® canola under a Matrix of 8 different Nitrogen rate strategies with grazed vs un-grazed.

[1]*Justin Kudnig, Pacific Seeds Melbourne*

Key messages

- TOS-related phenology responses and nitrogen management has a significant influence on early biomass development, DM production, grazing recovery times and potential grain yield of the winter graze n grain types.
- 400kg applied N/ha provided the best responses to both biomass dry matter feed production, grain yield production and associated gross returns, higher than the 200kg and 100kg N strategies.
- Treatments that were identified as probably the most aligned with previous research where 150-250kg of N applied which provide solid returns without taking on the extra production risk associated with the cost of fertilizer for 400 kg/ha and the varying growing conditions within or across seasons and environments.
- Nitrogen rate effects on plant growth and subsequent accumulation relationships of Nitrate levels in canola plants' Stem and leaf components has important ramifications for decisions on animal health considerations.

Key words: Winter type, Winter canola, dual-purpose, hybrid, CL, nitrogen rates, grazing, canola, Hyola, grain yield, gross returns, nitrogen management, nitrogen by grazing, dry matter production.

Background

As the cropping area of Graze n Grain Winter type canola increases significantly across Australia, (now estimated at 200,000ha) coupled with extraordinary dual-purpose gross returns from the combined grazing and grain components, growers and advisors are seeking more scientific-based information around some Nitrogen rate strategic comparisons across one and two grazing events.

Growers and advisors have been trying to find a balance across different paddocks and seasons between Nitrogen rate applications and timings, biomass dry matter production, and plant height and how these factors are affected by grazing events on final grain yield, and gross returns. Outside of using growth regulators, this research investigated how different nitrogen rate strategies interacted with grazed vs un-grazed canola across multiple growing environments.

Method

This research trial conducted near Inverleigh, Victoria forms part of a 4 trial MET group across Australia. This trial represents 1 of 4 trials in higher rainfall environments with a good range of differences for seasonal rainfall, cropping histories, soil types, and soil pH, whilst applying a combination of Best Management Practice (BMP) and District Standard Practice (DSP) treatments per each location, thus enabling a diverse set of data collection for accurate comparison.

1 Winter hybrid Clearfield® canola variety, Hyola Feast CL was sown with 8 Nitrogen rates applied graduating from 0 to 400 kg N per ha with one grazing event compared to 6 Nitrogen rates applied graduating from 0 to 400 kg N per ha with no grazing, grain only harvest. The target population for all treatments was 35 plants

per m2, based on 90% germination and an estimated 75% establishment survival factorial by adjusting all seed packet weights.

Measurements across all replicates and environments conducted were visual subjective vigour ratings at 4-6 leaf stage, visual maturity ratings at flowering and maturity, plant height (cm), grain yield (t/ha) using plot harvesters, and Gross return calculations using base assumptions included in tables provided.

Population, Yield and Oil% analysis for Single Sites were performed fitting Entry, Vigor, Leaf and Stem Dry matter, Flowering maturity (MATR), plant height (HGT) and yield (GYH) as fixed linear factors and spatial adjustments performed using the auto-regressive model hence giving a BLUE output for each site. Statistical Reference: Using ASReml (Gilmour *et al.,* 2023).

In addition, this site will be included in a Single Step Factor Analytic MET (Multiple Environment Trial) analysis with ASReml in a model with Nitrogen rates and grazing events as a linear fixed factor with Composite Entry as a random factor hence giving a BLUP for each site. Spatial adjustments were determined using the auto-regressive model. Significant G*E*M effects were identified by the MET analysis. Statistical Reference: Using ASReml (Gilmour *et al*., 2023).

Trial Name	**23STWL56_INV**		
Company Name	Pacific Seeds		
Individual contact	Justin Kudnig	**Contact number**	0408 408 616
Trial custodian	Audrey Gripper	**Contact number**	0436 479 484
Crop:	Canola CL	**Variety**	Hyola Feast CL
Site:	Inverleigh	**Previous crops:**	Wheat: Barley: Canola
Date sown: **Soil Type:**	10-Mar-23 Brown Sodosol	**Date harvested:** **Bulk Density: pH**	8-Jan-24 1.3: 5.70 (CaCl2)
Trial focus:	Hyola Innovation Winter CL Agronomy		

Treatment List

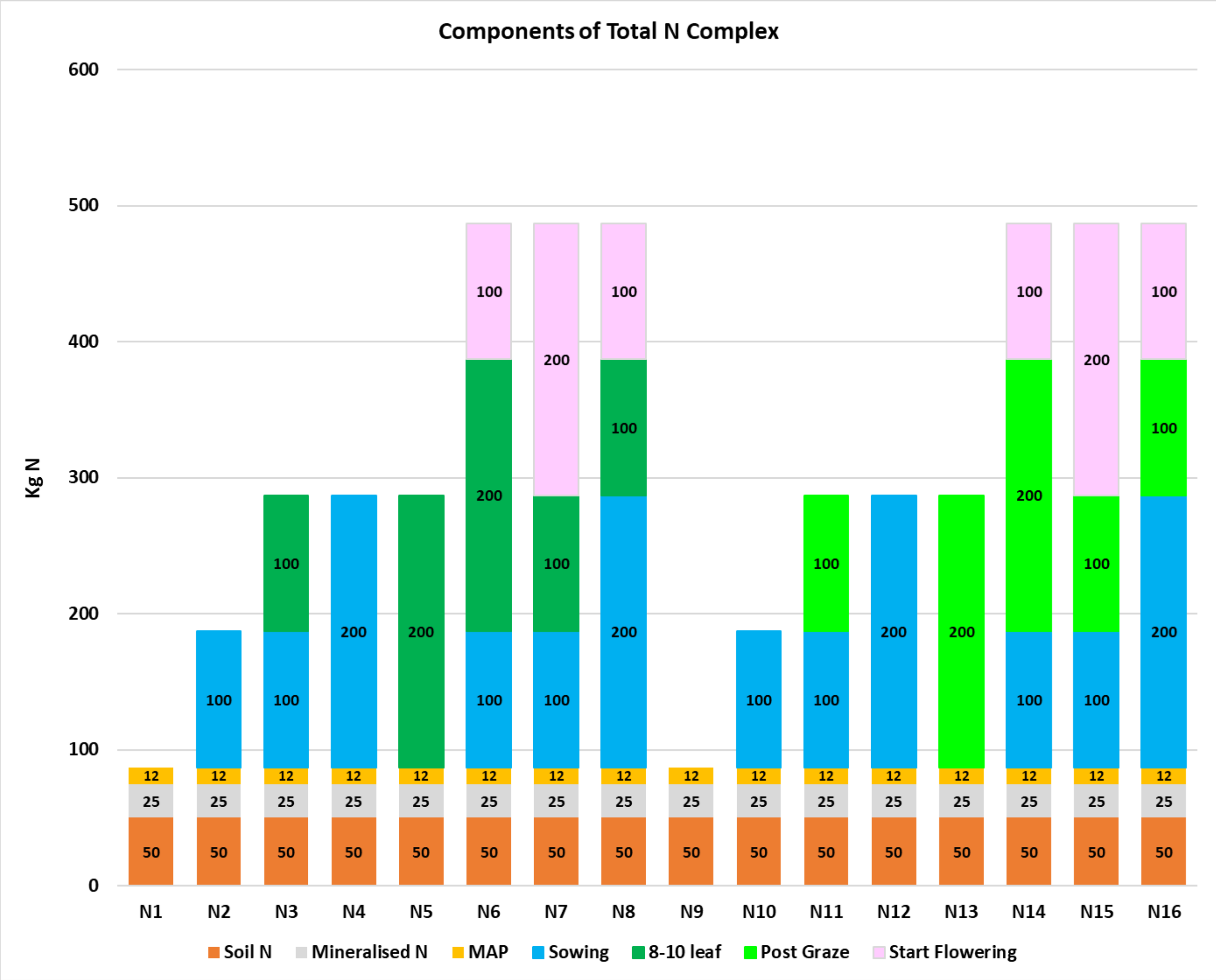
Grazing Treatment	Nitrogen Trt #	Applied sowing	Post Graze or 8-10 Leaf	Start Flowering	Total N Applied	Applied Urea $/ha
1 Grazing Event Simulated Treatment	1	0	0	0	0	$0
	2	100	0	0	100	$130
	3	100	100	0	200	$260
	4	200	0	0	200	$260
	5	0	200	0	200	$260
	6	100	200	100	400	$520
	7	100	100	200	400	$520
	8	200	100	100	400	$520
Nil Grazing Grain Only Treatment	9	0	0	0	0	$0
	10	100	0	0	100	$130
	11	100	100	0	200	$260
	12	200	0	0	200	$260
	13	0	200	0	200	$260
	14	100	200	100	400	$520
	15	100	100	200	400	$520
	16	200	100	100	400	$520

Table 1. Applied Nitrogen rates across different growth stages in total N kg/ha within the matrix of the number of grazing events.

Rainfall Data

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	2.6	0	1.6	1.4	0.8	1.8	0	0	4.2
2	0	0	0	0	0	0	0.2	0	0	0	0	0
3	0	10.8	0	0	18.8	3.6	0	0	0	6	0	0
4	0	17.2	0	0	4.4	0.2	0	0	0	5.4	0	0
5	0	0	0	0	0	0	2.8	0	1	0.8	0	0
6	0	0	6	0	2.4	0.6	0.2	0	0.2	1.2	0	0
7	0	0	0	5.4	2.2	0.2	0.2	0	0	0.2	0.4	0
8	0	0	2.6	24.2	1.2	21.2	4	0	0.4	0	0	0
9	0	0	0.6	0.6	0.4	2.6	2.8	0	7.8	0	0	8
10	0	0	0.2	0.2	0	0	2.8	2.4	1.2	0	0	10.6
11	0	0	0	1.8	0	0	0.2	0.2	0	0	0	1.4
12	0	0	0	12	0	0	0	0.4	0	3.6	0	0.6
13	0	0	0	0	0	0	0	1.6	0	2	0	2.4
14	0	0	0	0	0	10	0	0	0	3.2	0	2.4
15	0	0	0.6	0	0	0	0	0.8	0	0.6	0	0
16	0	0	0	21.4	0.4	0.4	1	0	0	3	0	0
17	0	0	0.4	0	0	0	0	0	0	0	0	0
18	7.8	0	0	0	0	11.2	0.2	4.6	0	0	0	0
19	0.2	0	0	0	0	12.8	1.2	2.2	0	0	0	6.4
20	0	0	0	0.2	4.4	2	0.2	0.8	4.6	0	0	0
21	0	0	0	0	1.8	0	1.6	0	5	0	0	0
22	0	0	0	0	0	1	0	1	0	7.2	0	0
23	0	0	1.4	0	0	3.6	0.4	3.8	0	1.4	0	0
24	0	0	0.2	0.2	0	0	0.2	0.2	0	0	0	0
25	24	0	0	0	0	1.6	0	0	0	0	14.8	17.2
26	0.8	9.2	0	0	5	6.8	0	0	0	0.8	16	12.8
27	0	1.4	0	3.6	0.8	0.6	0	0	0	0	0	3.4
28	0	0	6.4	0.8	4.8	0.6	6.8	0	0	0	0	0
29	1.8		0	0.4	0.8	0.6	0	0	0	0	4.4	0.2
30	0.2		0.2	0.2	0	0.2	0	1.8	0	0	18	0
31	0		1		0.2		4.6	0.2		10.2		0
Month Total	34.8	38.6	19.6	73.6	47.6	81.4	30.8	20.8	22	45.6	53.6	69.6
Year to date	34.8	73.4	93	166.6	214.2	295.6	326.4	347.2	369.2	414.8	468.4	538
Mar -Nov			19.6	93.2	140.8	222.2	253	273.8	295.8	341.4	395	
April - Nov				73.6	121.2	202.6	233.4	254.2	276.2	321.8	375.4	

Figure 1. 2023 Inverleigh Vic – Growing Season Rainfall Data (Winchelsea)



Graph .1. Total N availability showing Nitrogen rates across different growth stages encompassing Residual Soil N, Mineralised N, and Applied Nitrogen.

Trial Management

Simulated grazing event cuts for Leaf and or Stem Dry Matter

20-June-23: WOSR grazing cuts for leaf and stem

Grazing Treatments were dry matter cuts taken in 1m2 quadrants and then whole plots were all mechanically mown down to 10cm stem height to simulate a moderate to high grazing event.

Stem dry matter cuts were also taken from 1m2 for dry matter to assist in determining potential grain yield after any treatments final leaf dry matter cut operation.

Representative Leaf and Stem samples were also tested for Nitrate levels in mg/kg.

Figure 2a. 0Kg N – 15cm height frontal biomass

Figure 2b – 0 Kg N – above plot vegetation biomass.

Figure 3a. 100Kg N – 33cm height frontal biomass

Figure 3b – 100 Kg N – above plot vegetation biomass.

Figure 4a. 200Kg N – 41cm height frontal biomass

Figure 4b – 200 Kg N – above plot vegetation biomass.

Figure 5a. 200Kg N vs 0Kg N frontal biomass

Figure 5b – 100Kg N vs 200 Kg N – frontal biomass.

Figure 6. Audrey Gripper (SFS - Inverleigh) between grain-only treatment plots of 200Kg N and 400Kg

Figure 7. UAV overview image (Inverleigh Hyola Winter Innovation Trial) - April 2023

Figure 8. UAV overview image (Inverleigh Hyola Winter Innovation Trial)- September 2023

Results and Discussion

This trial was sown inside normal recommended sowing windows (February – March), on the 10th March 2023, however, there were some waterlogging conditions experienced early in the trial's growth during April to May 2023. These conditions led to limited Dry matter growth potential for total Dry matter yield and grain yield production.

Dry Matter yields from the total Leaf & Stem cut varied from 4.228 (t/ha) in the 0kg/ha N13 treatment to 8.336 (t/ha) in the N16 applied N treatment regime. The higher N rate treatments showed significantly higher Dry matter production than the lower N rate treatments.

Winter Entry by Treatment	Total DM (t/Ha) Leaf & Stem	LSD Sig
N9	4.432	*c*
N10	6.696	*b*
N11	6.999	*b*
N12	7.127	*b*
N13	4.228	*c*
N14	7.518	*ab*
N15	7.126	*b*
N16	8.336	*a*

Table 2. Total Dry Matter Production (t/ha) across N rate treatments N9 to N16 with CV = 10.334. LSD = 1.147, Mean Yield = 5.356

Treatment #	Leaf Nitrate mg/kg	Stem Nitrate mg/kg
N9	40.00	40.00
N10	40.00	166.71
N11	40.00	177.54
N12	40.00	713.72
N13	40.00	40.00
N14	40.00	267.71
N15	40.00	240.67
N16	40.00	793.53

Table 3. 1st Leaf and Stem Nitrate results (mg/kg) across N rate treatments N9 to N16

Leaf nitrate test levels across all N treatments from the DM leaf cut showed values around the lower detectable level of 40 mg/kg which are well within the acceptable levels of being safe to graze.

Stem Nitrates from the DM, across treatments N9 to N16, showed that the higher upfront at sowing N rate treatments N12 and N16 had levels between 700 to 800 mg/kg which is still safe for grazing because the published danger levels are above 1500 mg/kg which then has some limitations for grazing by cattle.

Block J, (2020) recommendations for nitrate levels between 1500 to 4000 pro-rata limitation of ration should apply including not feeding to pregnant animals, whereas levels > 4000 is dangerous and do not feed to animals.

General principles associated with nitrate accumulation are that the smaller the plant size, the more concentrated the nitrate levels are, especially in the Stem component of the plant.

This helps explain the results between Leaf and Stem tested nitrate values, including the increasing Nitrate trend relationship with the total N rates applied at sowing.

Treatment #	VIGR	MATR	HGT	GYH
N1	8.746	8.236	114.512	2.474
N2	8.498	7.984	115.988	2.700
N3	8.483	7.731	116.323	3.227
N4	8.228	7.973	117.563	3.259
N5	9.000	7.734	117.073	3.338
N6	9.234	7.730	113.921	4.093
N7	8.521	7.995	113.951	4.200
N8	8.516	7.747	113.944	4.206
N9	8.761	8.486	111.192	2.542
N10	8.508	8.477	110.833	2.587
N11	8.487	7.976	121.262	2.989
N12	8.707	8.216	109.556	3.066
N13	9.254	8.478	118.777	3.397
N14	8.985	8.476	118.111	3.807
N15	8.783	8.487	117.794	4.037
N16	8.528	8.489	115.291	3.559
Grand Mean Entry	**8.592**	**8.479**	**123.03**	**3.964**
CV_Percentage	**3.808**	**2.527**	**3.218**	**5.720**
LSD	**0.650**	**0.426**	**7.885**	**0.451**

Table 7. Analysed results for Plant vigor, flowering maturity, plant height, harvested grain yield across N rate treatments N1 to N16.

Analysed results for a range of measured traits are shown above in Table 7. Despite the large differences in N rate treatments, there was often no significant responses for early plant vigour, which may reflect the subjective nature of the assessments.

The flowering maturity scores did show some significant responses between lower N rate to higher rate treatments, with the overall trend of higher N rate treatments being slightly earlier to mature in the grain-only section and similar to mature in the grazed treatment section.

Plant height measurements in the grain-only treatment section generally responded to higher rates of N applied, however with the 3 treatments with a total of 400kg/ha N applied, the plant height decreased when compared to the 3 treatments with 200kg/ha N applied. In the grazed treatment section, there was a general trend for higher plant heights with the 200kg and 400kg/ha N treatments compared to the 0kg/ha and 100kg/ha N treatments.

Grain yield results within grain-only (N1-N8) or within grazed treatments (N9-N16) showed there were significant responses with the 200kg and 400kg/ha N treatments compared to the 0kg and 100kg/ha N treatments and also between the 200kg/ha N to the 400kg/ha N applied treatments.

When comparing grain yield results across grain-only (N1-N8) to grazed treatments (N9-N16) there were no significant responses between each of the comparable N treatments, meaning that the grazing event did not adversely affect the harvested yield values.

Whether grazed or grain-only, the 400kg/ha N applied treatments provided the highest harvested grain yields.

Nitrogen Rate by Grazing Event Trt	Mean Total DM Yield Kg/ha	Grazing yield (60% less 40% residual loss)	30kg Lambs/ha @ 1.2kg/DM/hd/day for 30 days	Total Value = Mean Lamb Yield $/ha @ 100g/day Meat @ $4/kg	Grain Yield Gross Return $/ha minus Nitrogen Costs	Total Gross Return Value $/ha
N1	0	0	0	$0.00	$1,657.58	$1,657.58
N2	0	0	0	$0.00	$1,679.00	$1,679.00
N3	0	0	0	$0.00	$1,902.09	$1,902.09
N4	0	0	0	$0.00	$1,923.53	$1,923.53
N5	0	0	0	$0.00	$1,976.46	$1,976.46
N6	0	0	0	$0.00	$2,222.31	$2,222.31
N7	0	0	0	$0.00	$2,294.00	$2,294.00
N8	0	0	0	$0.00	$2,298.02	$2,298.02
N9	4432	2659	74	$886.40	$1,703.14	$2,589.54
N10	6696	4018	112	$1,339.20	$1,603.29	$2,942.49
N11	6999	4199	117	$1,399.80	$1,742.63	$3,142.43
N12	7127	4276	119	$1,425.40	$1,794.22	$3,219.62
N13	4228	2537	70	$845.60	$2,015.99	$2,861.59
N14	7518	4511	125	$1,503.60	$2,030.69	$3,534.29
N15	7126	4276	119	$1,425.20	$2,184.79	$3,609.99
N16	8336	5002	139	$1,667.20	$1,864.53	$3,531.73

Table 8. – Total Gross Return Comparisons ($/ha) combining Mean Lamb Yield $/ha + Grain Yield gross returns across N rate treatments N1 to N16. (Assumptions: non-GM Grain Price = $670/MT, Urea @ $600/MT)

Mean Total Dry Matter yield refers to the N9 to N16 treatments, whereas for treatments N1 to N8 was the grain-only N applied treatments. Grazing Yield in kg/ha is expressed a 60% value less the 40% residual value.

Mean Lamb yield expressed as $/ha is based on the assumptions of the number of lambs for 30 days yielding 100g/day meat at $4.00 per kg. The Total Gross Return value provided as heatmap $/ha values are the combination of both the Mean Lamb Yield (Grazing Value) plus the Gross Grain Yield Returns (Nitrogen costs removed).

After one grazing event, gross $/ha returns were higher than grain-only treatments, including the treatment of 0 Kg/ha of N applied, ranging between $300 to $1900 per ha differences.

Overall, the 3 highest gross returns were demonstrated to come from the 1 grazing event treatments, N14, N15, and N16 at 400Kg/ha N applied, irrespective of N application timing.

Treatments N11 and N12 were identified as probably the most aligned with previous research where 150-250kg of N applied provides solid returns without taking on the extra production risk associated with the cost of fertilizer for 400kg/ha N applied and the varying growing conditions within or across seasons and environments.

Conclusion

Kirkegaard et al 2012, stated that factors affecting vegetative growth, flowering, seed-filling, and grain yield in canola included vapour pressure deficits, daylength, total solar radiation, maximum temperatures, minimum temperatures, and total monthly evaporation, rainfall and irrigation.

Overall, the results from this trial highlighted the need for growers to align with previous research which recommends earlier sowing into February and March for Winter canola types to complete yield recovery in crops defoliated in the vegetative stage and provide sufficient time and reasonable conditions allow sufficient biomass recovery to fulfil the water-limited yield potential.

Kirkegaard et al, also concluded that later defoliations than optimal timings prior to bud formation or after bud elongation, combined with accelerated development prevented the recovery of leaf area and biomass and reduced assimilation during pod-fill in defoliated plants.

It is important to note that TOS-related phenology responses and nitrogen management have a significant influence on early biomass development, DM production, grazing recovery times and potential grain yield of the winter graze n grain Winter types.

This research showed that 400kg applied N/ha provided the best responses to both biomass dry matter feed production, grain yield production and associated gross returns, higher than the 200kg and 100kg N strategies.

However, treatments that were identified as probably the most aligned with previous research where 150-250kg of N applied which provide solid returns without taking the extra production risk associated with the cost of fertilizer for 400 kg/ha and the varying growing conditions within or across seasons and environments.

Nitrogen rate effects on plant growth and subsequent accumulation relationships of Nitrate levels in canola plants, Stem and leaf components have important ramifications for decisions on animal health considerations.

Industry research by CSIRO, Departments of Ag, GRDC-funded groups, and by Pacific Seeds has demonstrated that TOS related phenology responses and nitrogen management have a significant influence on early biomass development, DM production, grazing recovery times, and potential grain yield of the winter graze n grain types.

Acknowledgments

Thanks to SFS personnel for trial management and operations. Thanks to Willow Liddle from Pacific Seeds for the trial designs and assistance with ASReml analysis. Special thanks to Dr John Kirkegaard, CSIRO Canberra for his ongoing technical guidance and review.

References

Block J, (2020) Nitrate Poisoning of. Livestock. V839 (Revised February 2020). NDSU EXTENSION. North Dakota State University. Fargo, North Dakota.

Bell LW, et al. (2015). Integrating canola and wheat into high-rainfall livestock systems in south-east Australia: 3. An extrapolation to whole-farm grazing potential and productivity. Crop and Pasture Science 66, 390-398

Dann PR, et al. (1977). The grain yield of winter grazed crops. Australian Journal Experimental Agriculture and Animal Husbandry 17, 452-461.

Dove H and Kirkegaard JA (2014). Using dual-purpose crops in sheep-grazing systems: a review. Journal of the Science of Food and Agriculture 94, 1276-1283

Harrison MT, et al. (2011). Dual-purpose cereals: can the relative influences of management and environment on crop recovery and grain yield be dissected. Crop and Pasture Science 62, 930-946.

Kirkegaard JA, et al. (2012). Refining crop and livestock management for dual-purpose spring canola (Brassica napus). Crop and Pasture Science 63, 429-443.

Kirkegaard JA, et al. (2020). Dual-purpose crops – direct and indirect contributions to profit. GRDC Updates Wagga Wagga February 2020.

Lilley JM, et al. (2015). An analysis of simulated grain yield and grazing potential of dual-purpose crops across Australia's high rainfall zone. 2. Canola. Crop and Pasture Science 66, 349-364

McGrath S, et al. (2021). Utilising dual-purpose crops effectively to increase profit and manage risk in meat production systems. Animal Production Science (in press).

Sprague SJ, et al. (2015). Forage and grain yield of diverse canola (Brassica napus) maturity types in the high-rainfall zone of Australia. Crop and Pasture Science 66, 260-274

Pacific Seeds
Growing possibilities

SFS
Southern Farming Systems