CWFS Alternative pasture legumes in NSW Central West

Trial Report - 2022

Only a small proportion of farmers have tried some of the alternative hard-seeded legume pasture options and only a few have revisited the sub-clover/medic scene. Over the years, within the footprints of the Central West Farming System (CWFS) region, more focus and efforts have been devoted towards the annual cropping systems, primarily on dual-purpose cereals and canola.

Very little demonstration of new feedbase options has occurred throughout the CWFS region in recent years. While there is a significant capacity for self-regenerating hard-seeded legumes in the Central-West of NSW, these are yet to be widely adopted. This is also true within our CWFS footprint, where producers have not extensively used these hard-seeded legumes although there is much interest from our members around this topic, particularly in relation to drought tolerance. This interest has been the impetus for this project which will showcase and demonstrate the most profitable and successful pastures in the low rainfall zone of central west NSW. The information generated from the project's activities will allow producers to make educated decisions and encourage them to adopt new pastures and/or better manage existing pastures within their farming system. This will enable producers in areas with unproductive pastures and reduced soil nutrition to re-invigorate their pasture paddocks and reappraise their approach to pastures, ultimately increasing productivity and carrying capacity.

This producer demonstration site (PDS) project is a three-year project funded by Meat & Livestock Australia concluding at the end of 2023. The project was established at three sites in early 2021:

- the grower paddock scale site north of Condobolin focusing on two hard seeded legumes- Biserrula and French serradella
- a species comparison at Condobolin ARAS sown over an old lime trial
- a species comparison at Gunning Gap

The range in sites allows for different soil types and climates to be assessed. The first year of the demonstration was focused on establishing the pastures, assessing biomass and allowing them to set seed. In the second year the sites were oversown with a wheat crop and grain quality assessments following their harvest will help determine the nitrogen benefit these pastures can provide, and the third year the sites will be assessed for pasture regeneration, establishment and production value. Seven feed bases were used at the comparison sites at Condobolin ARAS and Gunning Gap (Table 2), which include lucerne and a dual-purpose wheat as the local benchmark.

Table 1: Site descriptions: locations, 2022 rainfall, soil analysis, farming system

	Gunning Gap	Condobolin	North Condobolin
Rainfall 2022 season	838.2 mm (Bureau Station: 065103)	876.6 mm (Bureau Station: 050052)	746 mm
Soil type	Red clay loam	Red clay loam	Red sandy loam
pH (CaCl2) 0-10cm	5.1	Lime: 5.1 Un-limed: 4.7	4.6
Colwell P (mg/kg) 0-10 cm	105	Lime: 21 Un-limed: 17	45

Sulfur (mg/kg) 0-10 cm	3	Lime: 9.1 Un-limed: 5.7	3

Table 2: Varieties included in the two species comparison sites

	2021 Treatments		2022 Treatments	
	Species	**Variety**	**Species**	**Variety**
Treatment 1	Biserrula	Kasbar	Wheat	Scepter
Treatment 2	French Serradella	Cadiz	Wheat	Scepter
Treatment 3	Bladder clover	Bartolo	Wheat	Scepter
Treatment 4	Annual medic	Cheetah	Wheat	Scepter
Treatment 5	Subterranean clover	Izmir	Wheat	Scepter
Treatment 6	Lucerne	Titan5	*Retained Lucerne plots from 2021*	
Treatment 7	Dual-purpose wheat	LongReach Kittyhawk	Wheat	Scepter

Results

Establishment

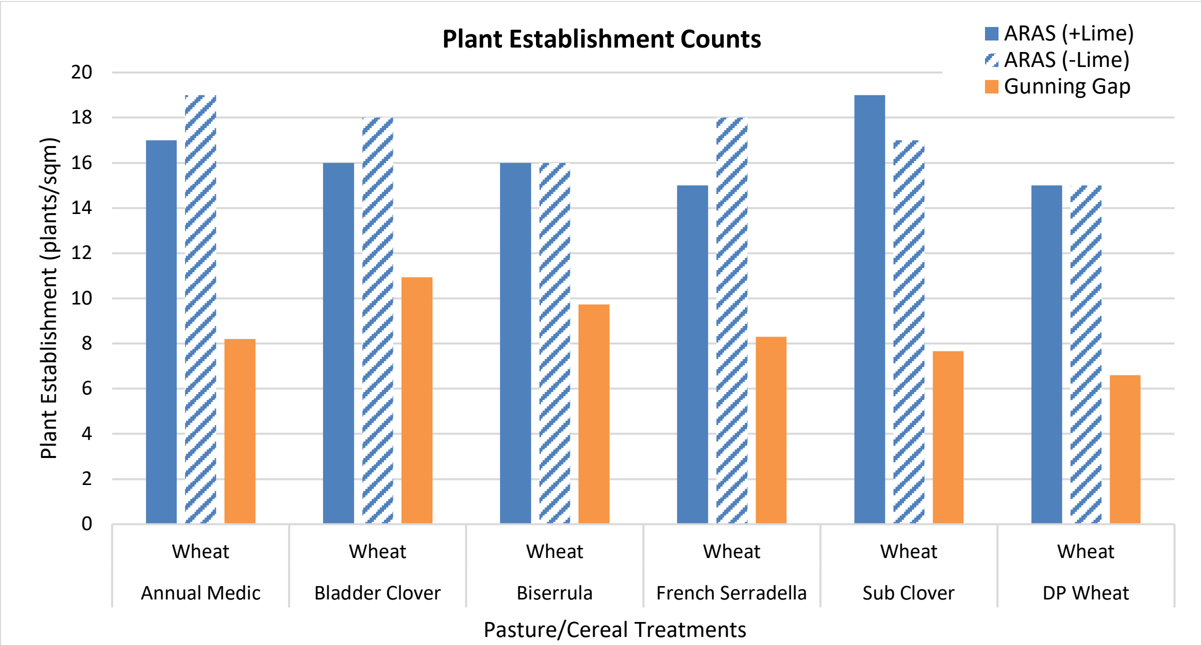

Figure 1: Plant establishment counts (plants/m2) at ARAS and Gunning Gap site. Amongst the crop species enlisted at the bottom of bars, the upper crops refer to 2022 crop (Scepter Wheat) and the lower crops refer to 2021 pasture/cereal treatments.

Plant establishment counts at ARAS site were done after 14 days of sowing and these varied non-significantly (*P-value*>0.05) across different species and lime treatments at Condobolin ARAS site (Figure 1). Values ranged from 19 wheat plants/m^2 in un-limed annual medic and limed sub-clover treatments to 15 wheat plants/m^2 in limed serradella and DP Wheat and un-limed DP Wheat treatments (Figure 1).

Plant counts at Gunning Gap site was done 17 days into sowing and as with Condobolin ARAS site, Gunning Gap site had non-significant (*P-value*>0.05) varied plant establishment. Values ranged from 11 wheat plants/m^2 for Bladder Clover treatment to 7 wheat plants/m^2 for DP Wheat treatment (Figure 1).

There were no visible signs of mice damage.

Plant establishment counts at the producer demonstration site north of Condobolin were completed on the 10 June 2022, 36 days after sowing. The site experienced a significantly wetter season across the whole growing period. The Lancer wheat establishment in the serradella treatment (Lancer Wheat- S) pasture phase area had a higher number of plants at 41 plants/m2 establish compared to the lancer wheat establishment in the biserrula pasture phase treatment (Lancer Wheat- BS) area that had 39 plants/m2. (Figure 2). This may be due to the noted higher level of plant organic matter left from the biscerulla than the serradella in the pasture phase, that had not yet completely and evenly broken down across the paddock, by sowing time and plant establishment counts noted by both the host producer and advisors.

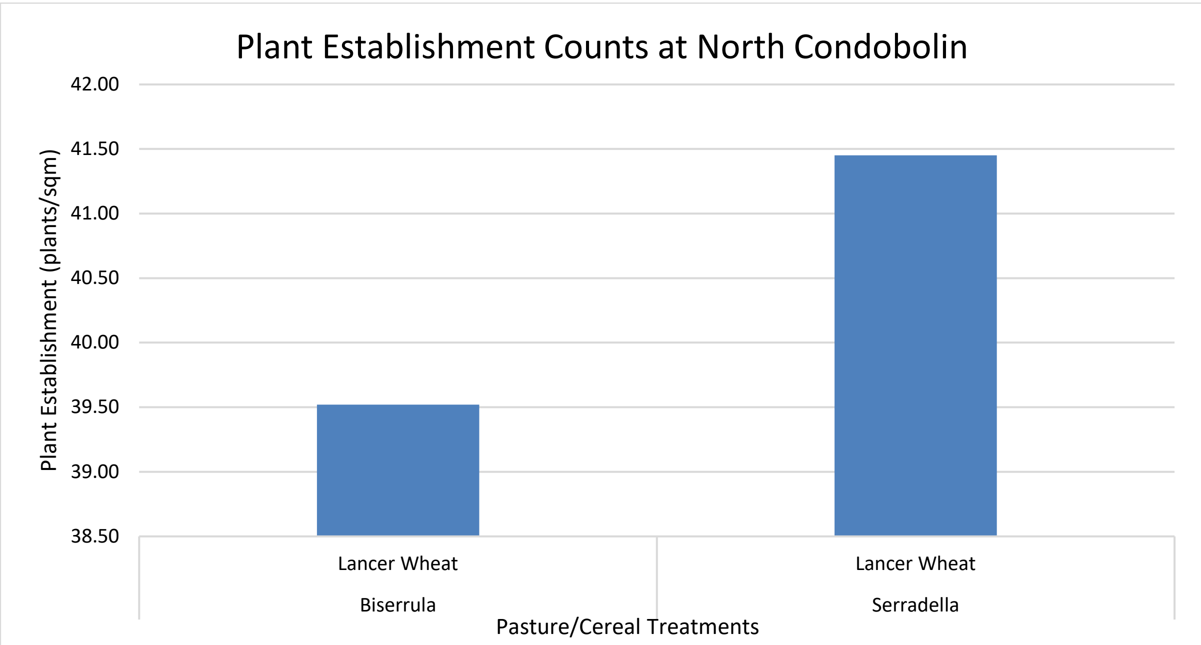

Figure 2: Plant establishment counts at North Condobolin site. Amongst the crop species enlisted at the bottom of bars, the upper crops refer to 2022 crop (Lancer Wheat) and the lower crops refer to 2021 pasture treatments.

Image 1: Image from North Condobolin site taken in second year (October 2022) of project demonstrating the difference in Lancer wheat growth due to pasture treatments (Photo Credits: Wendy Gill)

Dry Matter Percentage

The dry matter production data was derived from biomass cuts taken from all the three sites after 92 at ARAS site, 93 days at Gunning Gap site and 97 days at North Condobolin site. The following dry matter percentages (DM%) data has been derived based on their green herbage and dry herbage weights.

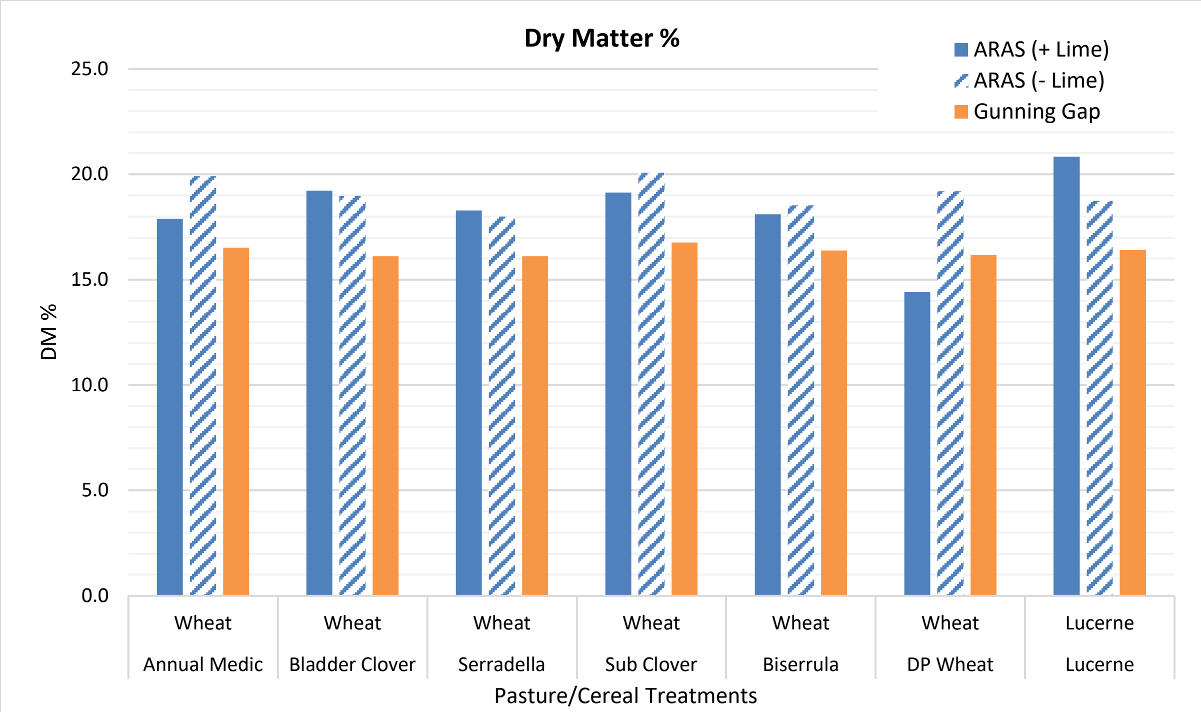

Figure 3: Dry Matter Percentage at ARAS and Gunning Gap site. Amongst the crop species enlisted at the bottom of bars, the upper crops refer to 2022 crop (Wheat/Lucerne) and the lower crops refer to 2021 pasture/cereal treatments.

Based on ANOVA testing, there were non-significant differences between limed and non-limed treatments and within each treatment at ARAS site (ranging between 14.4% and 20.8%). Likewise, there were no significant differences between different pasture treatments at Gunning Gap site (ranging between 16.1% and 16.8%).

Feed On Offer (FOO)

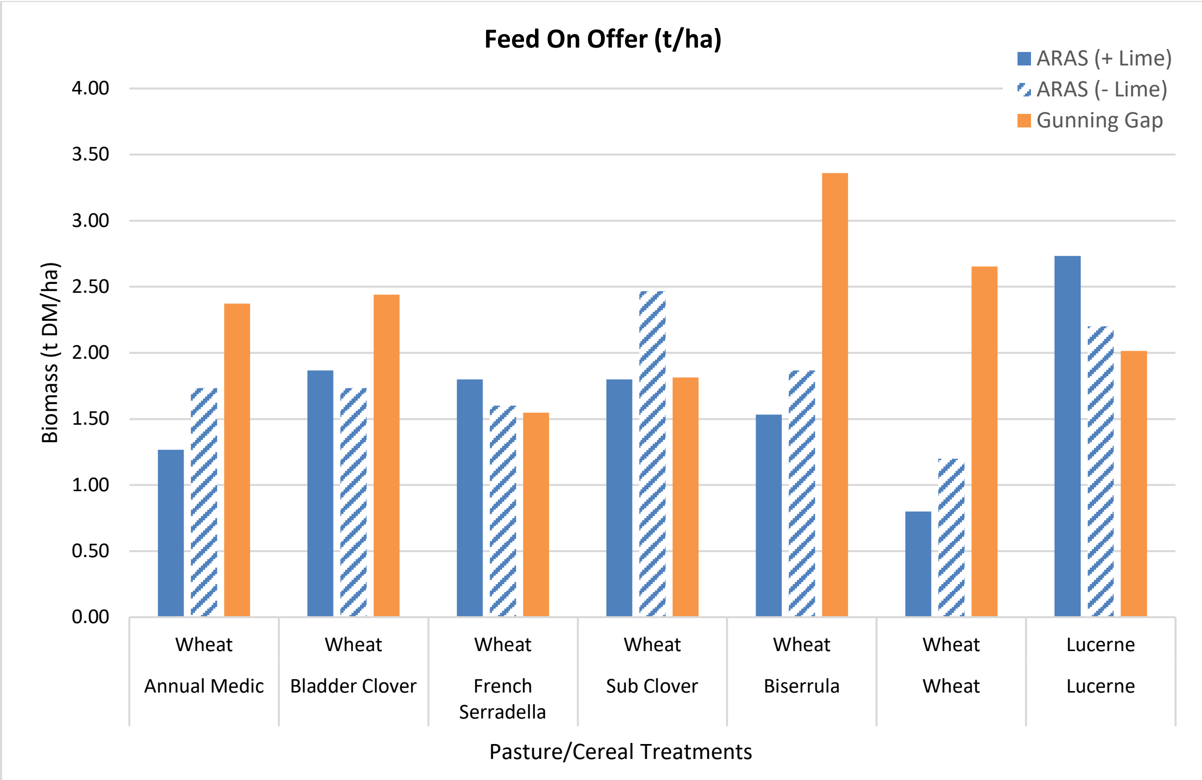

Figure 4: Food On Offer (FOO) at ARAS and Gunning Gap site. Amongst the crop species enlisted at the bottom of bars, the upper crops refer to 2022 crop (Wheat/Lucerne) and the lower crops refer to 2021 pasture/cereal treatments.

The Food On Offer (FOO) was assessed using the biomass cuts taken in later winter. There was a mixed trend in FOO between the limed and non-limed treatments at Condobolin ARAS.

The highest FOO at limed treatments was produced by Lucerne (2.73 t/ha), while wheat on sub clover treatments produced highest FOO in non-limed treatments (2.47 t/ha). The highest FOO at Gunning Gap was produced by Wheat on Biserrula treatment (3.36 t/ha). Wheat onto the pasture treatments produced more FOO (DM t/ha) than wheat sown onto wheat plots. Although overall FOO has been low in 2022 due to prolonged wet conditions throughout the year, but there were no significant differences in FOO between limed, non-limed and Gunning Gap treatments. However, a significant difference (*P-value*<0.05) has been observed in combined FOO for all the three sites between wheat on French Serradella treatment and retained Lucerne treatment.

Apart from wheat on French Serradella and Sub Clover treatments, wheat on the remaining treatments grew more FOO at Gunning Gap, compared to Condobolin. The higher FOO at Gunning Gap would be attributed to better soil conditions in less acidity and higher soil nutrition (Table 1).

Crude Protein

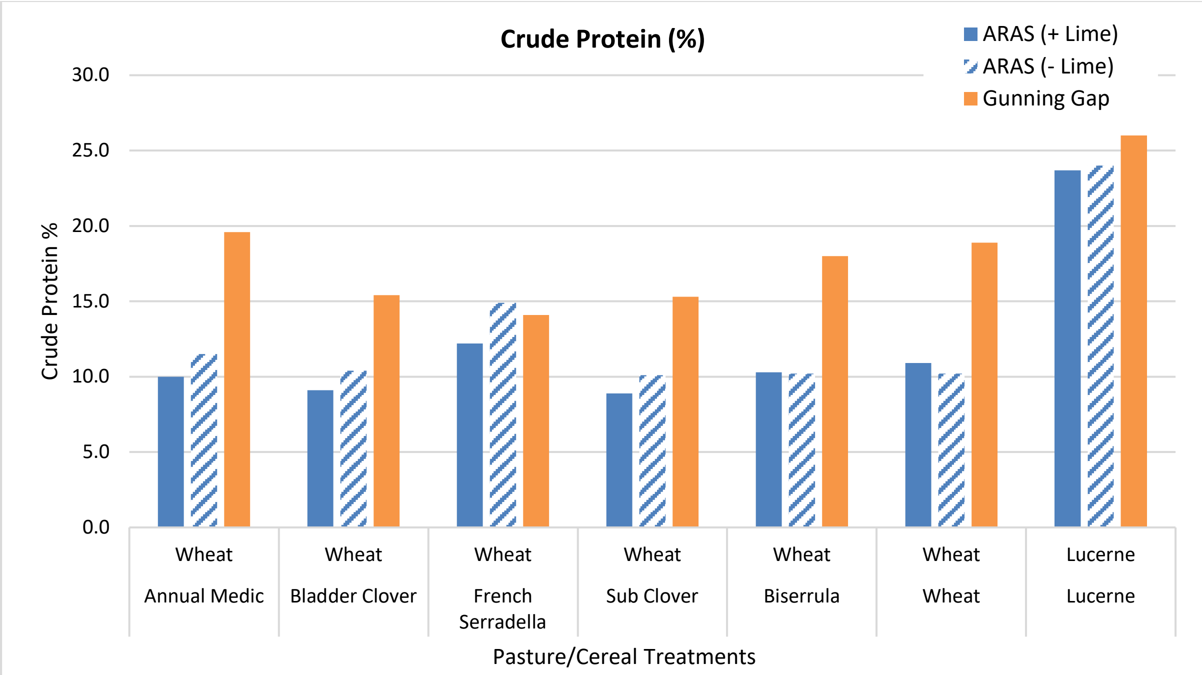

Figure 5: Crude Protein percentage at ARAS and Gunning Gap site. Amongst the crop species enlisted at the bottom of bars, the upper crops refer to 2022 crop (Wheat/Lucerne) and the lower crops refer to 2021 pasture/cereal treatments.

Crude Protein was analysed through NIR feed testing done at NSW DPI AgEnviro Labs (Wagga Wagga Agricultural Institute). Based on feed test results, there were significant differences in crude protein percentages between Condobolin ARAS and Gunning Gap (*P-value*<0.05). This would be related to more better soil conditions at Gunning Gap site. Within Condobolin ARAS treatments, there was a significant difference between Lucerne and the rest treatments (*P-value*<0.05). Clearly, Lucerne has the highest amount of crude protein amongst all the other treatments.

Metabolisable Energy

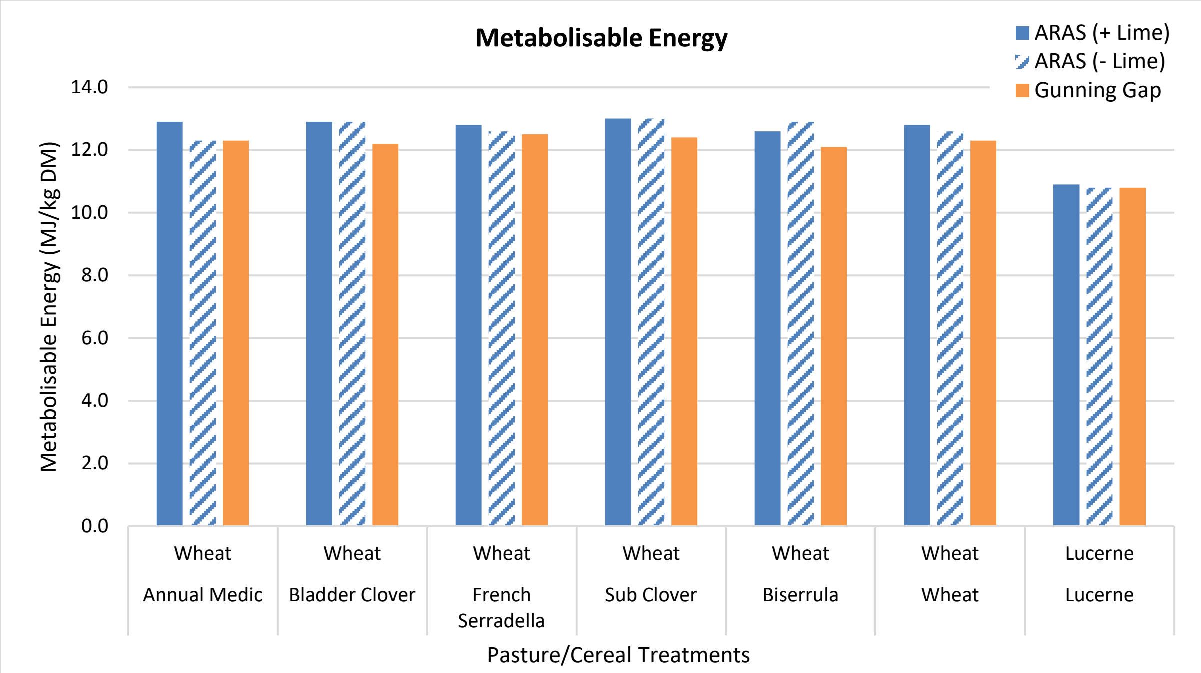

Figure 6: Metabolisable Energy at ARAS and Gunning Gap site. Amongst the crop species enlisted at the bottom of bars, the upper crops refer to 2022 crop (Wheat/Lucerne) and the lower crops refer to 2021 pasture/cereal treatments.

Metabolisable Energy (ME) is the amount of energy present in the feed that is available to an animal for maintenance and growth and in this project has been derived from the NIR feed test results. There was a significant difference in total ME for three sites between Lucerne and other pasture treatments (*P-value*<0.05). Lucerne had the lowest ME as compared to other treatments.

GrazFeed Modelling

GrazFeed modelling was worked to calculate daily gain in livestock weight by using the data from biomass assessments, feed test results and standard/ideal input values that would be more related to Central west NSW region. Following livestock were parameters were used for modelling purposes:

Main grasses of temperate region. 100% legume percentage. The land is levelled and month of modelling/assessment is October at 35°S. Mature ewes (24 months old), not pregnant or lactating of Large Merino breed type. Ewe's average fleece weight is 6.5 Kg, fleece yield is 70%, live weight is 60 Kg and ewe's mature weight is 65 Kg.

The effect of weather has not been taken into consideration and based on no supplement feed; the following results were derived.

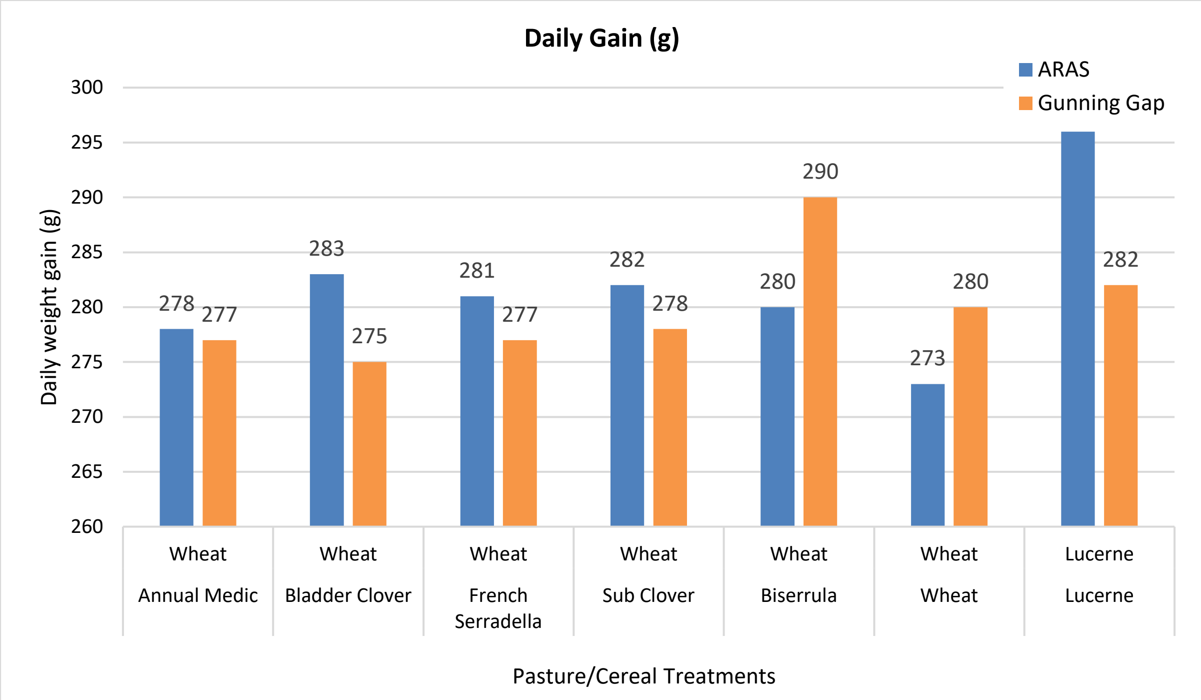

Figure 7: Daily gain (g) for mature ewes at ARAS and Gunning Gap site based on GrazFeed modelling. Amongst the crop species enlisted at the bottom of bars, the upper crops refer to 2022 crop (Wheat/Lucerne) and the lower crops refer to 2021 pasture/cereal treatments.

Lucerne on Lucerne treatment at Condobolin ARAS had the highest potential to rise the weight of ewes at rate of 296 gram/day; while at Gunning Gap, wheat onto Biserrula treatment had the highest potential (290 grams/day). Although, there were no significant differences in daily gains between Condobolin and Gunning Gap site; however, there was a significant difference in daily gain between Lucerne treatment and wheat on annual medic treatment and wheat treatment (*P-value*<0.05).

Discussion/summary

The results from North Condobolin site have not been included for comparison in statistical analysis for factors such as biomass and pasture quality features. This demonstration has only two treatments therefore was unable to be statistically compared & produce results with high levels of accuracy. Raw data results have been collected for all measures in the trial for the demonstration to discuss the two treatments on an applied farm scale with producers in extension. Also, the site was established with main objective of showcasing the trial results.

2022 has been an exceptionally wet season, with higher than annual yearly averaged reached by September across all three trial and demonstration sites around Condobolin. Across the region we have had prolonged flooding events greater than 1 in 100-year occurrences. Sowing managed to be completed on time in April & May, however with seed shortages and wet weather, Scepter wheat as sown at the trail sites at ARAS, Condobolin & Lancer was sown at the producer demonstration site, instead of dual-purpose grazing varieties.

Plant establishment counts were affected by wet weather at the point of germination, with Gunning Gap plant establishment, being most severely affected right across all 6 treatment types. At the producer demonstration site, the wheat in the serradella treatment strip, had higher plant establishment compared to the biserrula. This result could be linked to the biserrula treatment having a higher plant residual from the pasture phase, at the time of sowing and germination, compared to the serradella. Further work would need to investigate the impacts and positive contribution this pasture residual has to soil health, temperature, organic matter levels and nutrition in these pasture rotations.

At Condobolin for biomass production in wheat in this rotation this year, we saw all 6 pasture treatments produce higher feed on offer (FOO) compared to a straight wheat on wheat rotation, regardless of the treatment or exclusion from lime. At Gunning Gap, however with differing soil constraints and waterlogging affects we saw only the wheat + biserrula treatment being the highest producer of feed on offer, followed by the wheat-on-wheat rotation treatment. Gunning Gap produced more total volume of feed on offer across all (7) treatments compared to the FOO at Condobolin. This indicated that the wheat even under challenging soil and environmental constraints been able to positively gain benefits from the pasture phase in production of FOO. This gives great adaptability of pastures in rotations, for management of soil nutrition, for improving yield capacities and for improving grazing operations.

From the assessments of cereal plant nutritional quality, despite the wheat varieties scepter and Lancer being AH and APH classifications for grain, both varieties performed within industry standards for feed testing for livestock grain quality results. The (5) cereal wheat + pasture phase treatments & the wheat – wheat treatment in the trials had a higher Metabolizable Energy by a minimum of 1 MJ ME/kg compared to the Lucerne's metabolizable energy at both Gunning Gap and ARAS, Condobolin. This indicates that regardless of soil type and previous liming treatment history across the sites, it is possible to obtain higher, quality metabolizable feed bases production levels by utilising alternate legumes and wheat in rotations.

Lucerne produced the highest level of plant protein across all 7 treatments at Gunning Gap and ARAS, Condobolin. There was the greatest variability across all three sites, between the Gunning Gap site and ARAS Condobolin in protein levels in plant forage achieved in the scepter wheat across (6) of the (7) treatments. At the producer demonstration site biserrula had a higher protein level by 3.8% per kilogram of dry matter consumed if this crop was to be grazed. Whilst Gunning Gap results show that protein levels in pastures treatments can be equal to those of wheat-on-wheat rotations, it is important to note, that for animal production efficiency the amount of protein in livestock diet must balance the energy (MJ/kg ME) content of the diet if rumen fermentation is to have the greatest level of efficiency (Mackay, 2014). The impact of different soil nutrition and waterlogging at both these sites may have influenced findings. Different in-crop management decisions such as the application of urea, has been extensively researched. This can assist producers to also manipulate the outcome of protein levels for grain or fodder forage production outputs.

The utilisation of both biomass, FOO, metabolizable energy and protein data and information gives producers the ability to proactively manage crop rotations from legume pasture phases to produce feed bases that suit the market for livestock production outcomes, improve soil health and produce high quality grain products.

From the modelling, we see that average sheep daily weight gain across all (5) wheat - pasture treatments exceed the average daily weight gain of wheat-on-wheat rotations. At Gunning gap only the wheat – biserrula treatment exceeded the Wheat-Wheat rotation livestock average daily weight gain. The average daily weight gain results provide a strong case for the pasture rotation in cropping situations. It indicates nutritional quality aspects of all treatments combined energy, protein, dry matter, water used required by ruminant livestock for maintenance. Growth from this forage used in these rotations is being delivered by this forage and production is possible in sheep that are grazed on a pasture- cereal rotations including hard seeded legumes. This provides producers with an opportunity to strategically utilise pasture phases to provide forage benefits in livestock systems in the second year of a rotation as a cereal base. The cereal, if grazed as a dual purpose, offers utilization for sheep that can achieve efficiencies in finishing livestock and builds resilience into mixed enterprise systems.

Management is the key contributor to successful implementation and use of pastures phases including hard seeded legumes in cereal cropping rotations, to maximise the potential benefits they provide the Central West region.

Acknowledgement

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References:

Mackay, B (2014). Managing drought. Seventh Edition. NSW Department of Primary Industries. P39.