Improving sheep nutrition through assessment of regional feedbase nutritional deficiencies (project ON-00710).

Introduction

The low rainfall Mallee of New South Wales, Victoria and South Australia covers an area of approximately seven million hectares and is an important livestock and wool-growing area of Australia. Farmers in this region have previously identified that improving their understanding of the nutritive value of pastures in the Mallee environment would allow them to better manage their livestock and feed resources.

Project Objectives

This project aimed to achieve the following:

- Identify the nutritional value and mineral content of a range of Mallee pastures and grazing crops including variation between seasons over two years.
- Develop a dataset of the nutritional value and mineral content of low rainfall pastures for use by producers and industry.
- Increase producer confidence and decision-making ability in relation to sheep management through the development of region-specific feedbase resources.
- Conduct grower events at the end of the project to extend results, with the aim to building database of farmers to target for participating in Lifetime Ewe Management.

Method

To identify the nutritional value and mineral content of Mallee pastures, a range of pasture and crop plant species were selected for sampling. These species were chosen to represent those that were most relevant to the Mallee region and of interest to producers. Six of the most relevant and common pasture or grazing crop species were selected for sampling each season across both years of the project. An additional five species were selected to be sampled twice per year, representing more strategic analysis of species used less commonly or that may be grazed in a failed crop season.

Samples were collected in 2020 and 2021 to provide a comparison of the nutritive value of the same feed types across years. Samples were collected in winter, spring and summer. It was originally intended that samples would be collected in autumn of each year as well; however due to the project start date in 2020, samples could not be collected in autumn of that year, and in 2021 no autumn samples were collected due to a very late break to the season.

Samples were collected by cutting plant material from each sample location using shears. The sample material was representative of the whole plant. Care was taken to avoid excessive soil in the samples that could affect mineral analyses. The harvested material was immediately dried in a laboratory oven then sent to the Feedtest laboratory (Werribee VIC) for nutritive value and mineral content analysis.

Year 1 – 2020

The six ‘core’ sample species were:

1. Barley
2. Lucerne
3. Peas
4. Veldt
5. Vetch
6. Regenerating natural pasture (medic base)

The five ‘strategic’ sample species were:

1. Canola
2. Lentils
3. Oats
4. Serradella
5. Studenica vetch

Some pasture samples were collected from commercial farming properties, however the majority were collected from existing research and development sites across the Mallee. Table 2Table 1 shows the location and type of site for each sample species collected in the project.

Table 1. Sampling location and site type for each pasture or crop.

Pasture/Crop	Location	Site type
Vetch	Werrimull, VIC	Pulse R&D
Barley	Speed, VIC	Cereal R&D
Oats	Speed, VIC	Commercial farm
Serradella	Piangil, VIC	Pasture R&D
Canola	Speed, VIC	Brassica R&D
Peas	Werrimull, VIC	Pulse R&D
Regenerating pasture	Piangil, VIC	Pasture R&D
Veldt	Patchewollock, VIC	Commercial farm
Lucerne	Speed, VIC	Hill seep R&D
Lentils	Werrimull, VIC	Pulse R&D
Studenica vetch	Koolonong, VIC	Vetch evaluation

Year 2 - 2021

The six ‘core’ sample species were:

1. Barley
2. Lucerne
3. Peas
4. Veldt
5. Vetch
6. Regenerating natural pasture (medic base)

The five ‘strategic’ sample species were:

1. Canola
2. Lupins

3. Oats
4. Serradella
5. Regenerating natural pasture (grass base)

Table 2 shows the location and type of site for each sample species collected in the project in 2021.

Table 2. Sampling location and site type for each pasture or crop.

Pasture/Crop	Location	Site type
Barley	Kulwin	R&D
Lucerne	Turiff	R&D
Peas	Tempy	R&D
Veldt	Yarto	Commercial
Vetch	Piangil	R&D
Regenerating natural pasture (medic base)	Piangil	Commercial
Canola	Kulwin	R&D
Lupins	Tempy	R&D
Oats	Kulwin	R&D
Serradella	Piangil	R&D
Regenerating natural pasture (grass base)	Tempy	Commercial

Results

Year 1 – 2020

The laboratory analyses of the pasture and crop samples submitted in 2020 showed the nutritive value across the season declined as the plants matured and senesced. This can be seen in 1 as the energy and protein content declined from fresh winter growth to dry summer feed.

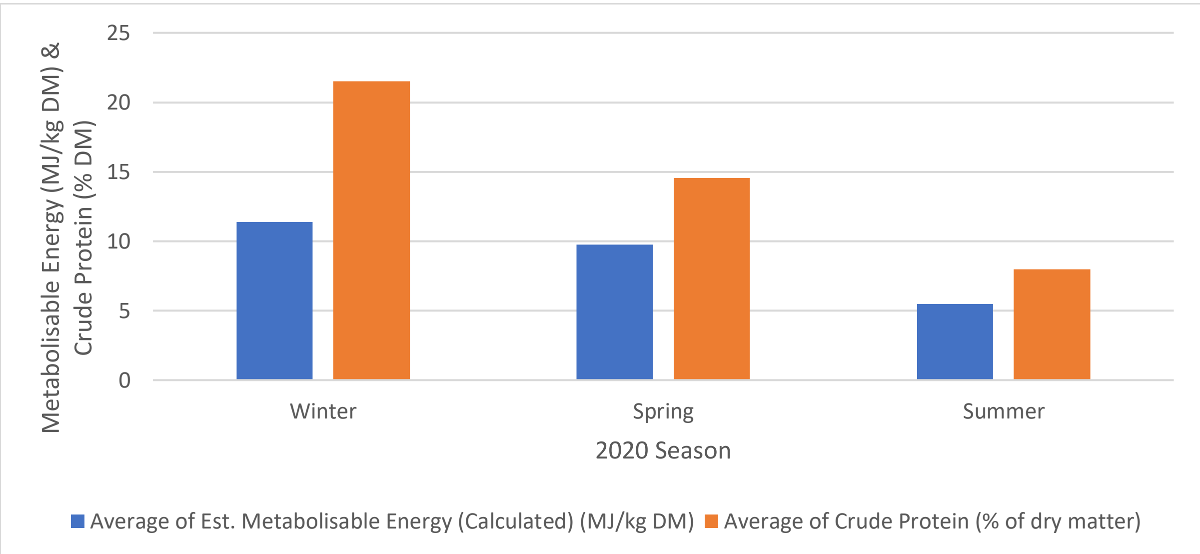

Figure 1. Average metabolisable energy and crude protein content of all samples combined for each season.

The metabolisable energy content of the samples generally showed the same trend of declining from winter to summer across each individual species; however, the level of decline varied between species (Figure 2). For example, vetch significantly declined from winter to summer, whilst lucerne was more stable in feed quality throughout the season.

The highest energy content species in winter included canola, vetch, barley and oats. The lowest energy content species included veldt grass and natural regenerating pasture.

Peas showed an increase in energy content from winter to spring and then declined significantly to summer as dry feed.

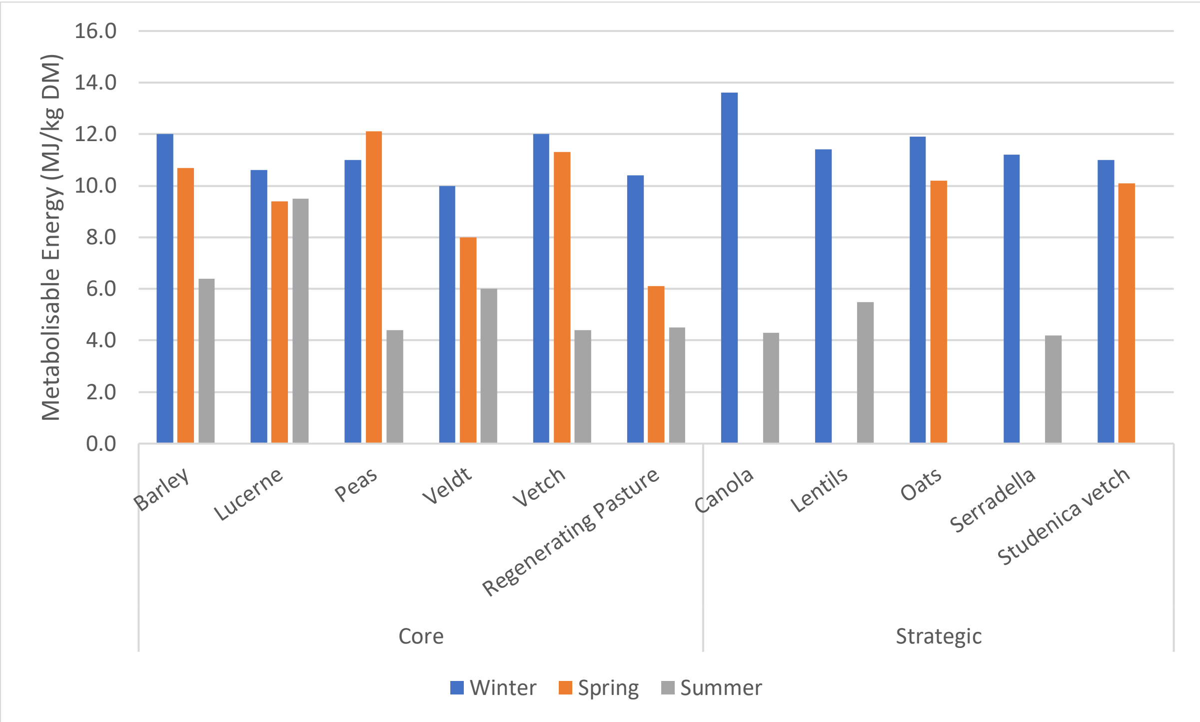

Figure 2. Metabolisable energy content of each species across seasons.

The crude protein content of different species again followed the trend of declining from winter to summer (Figure 3). In general, grass species (barley, oats, veldt) showed lower protein content across all samples than legume species (lucerne, peas, vetch).

Canola had the highest protein content of 30.3% in winter, while the barley summer sample had declined to less than 1% (not visible on graph below), the lowest protein content of all species. Winter protein content of Studenica vetch was approximately 5% lower than the core vetch sample.

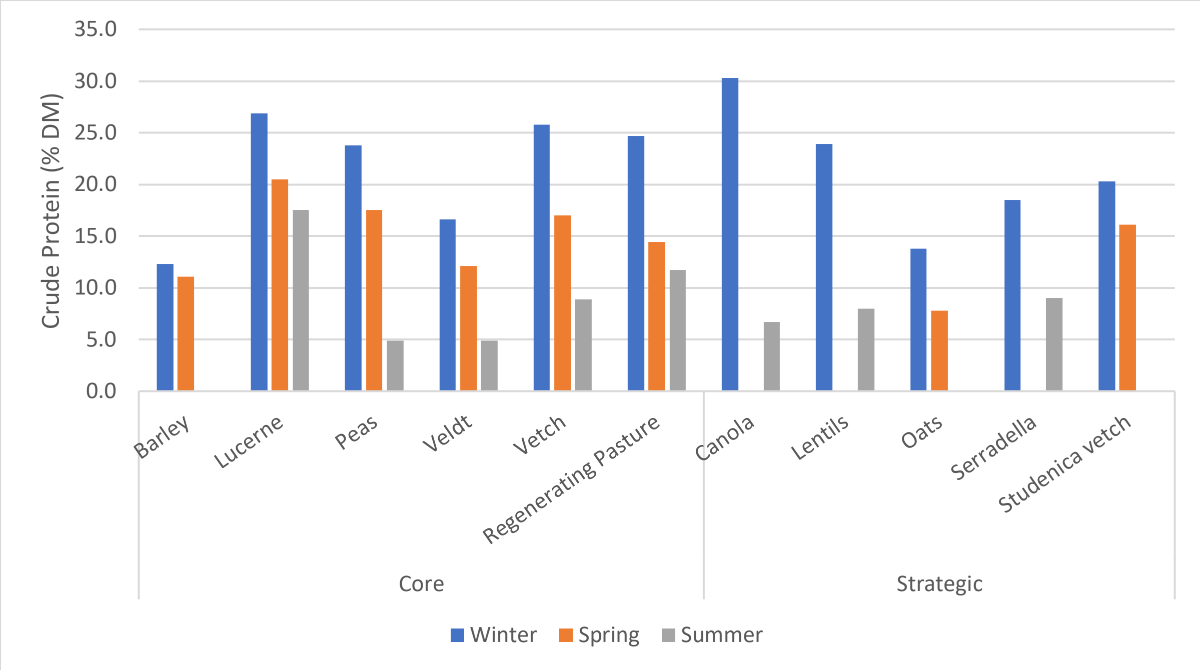

Figure 3. Crude protein content of each species across seasons.

All feed samples were also analysed for mineral content. The content of pastures for minerals such as calcium, magnesium, sulphur, cobalt, selenium and copper were assessed as the minerals typically of most interest to sheep producers.

Calcium content of all pastures was generally satisfactory in these samples reaching the minimum required amount for sheep of 2000mg/kg DM, with many samples exceeding the typical upper reference range of 8000mg/kg Ca. The only sample to not meet the minimum requirement was oats in the spring 2020 samples. In general, the cereals and grass pastures were lower in calcium content than legume species.

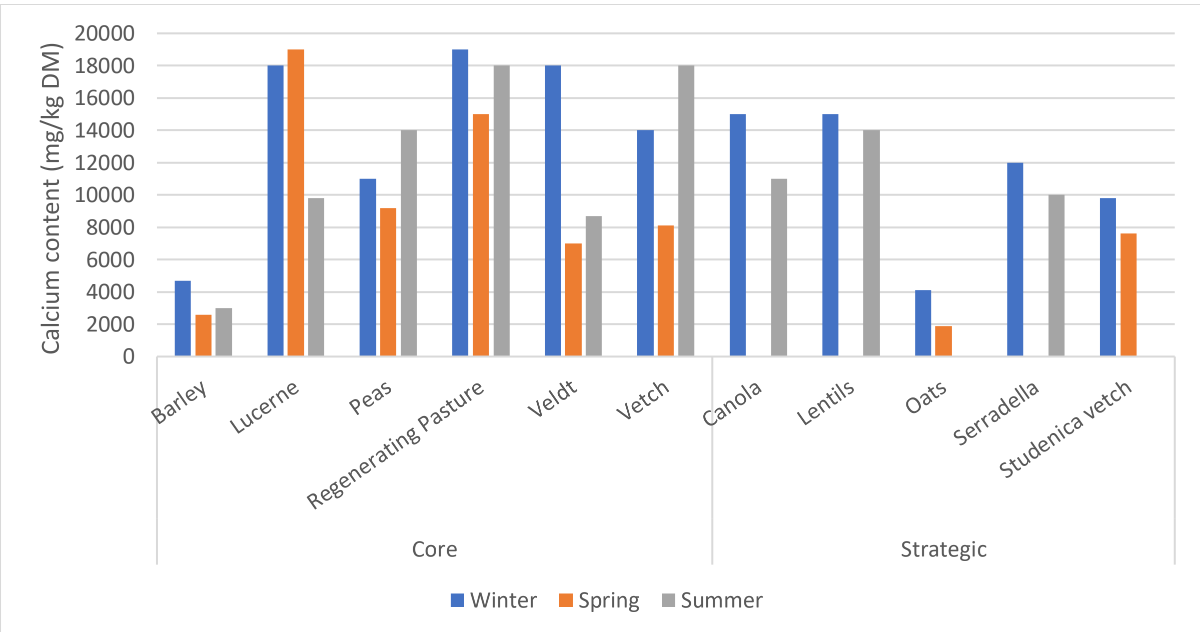

Figure 4. Calcium content of each species across seasons.

Sulphur content of pasture during winter was largely within the normal range for sheep (1400-2600mg/kgDM), with all samples above the minimum level; however, canola sulphur content exceeded the normal range to reach a maximum of 6100mg/kg DM. Spring and summer samples showed a significant number of deficiencies with over three quarters (76.5%) of samples deficient in sulphur.

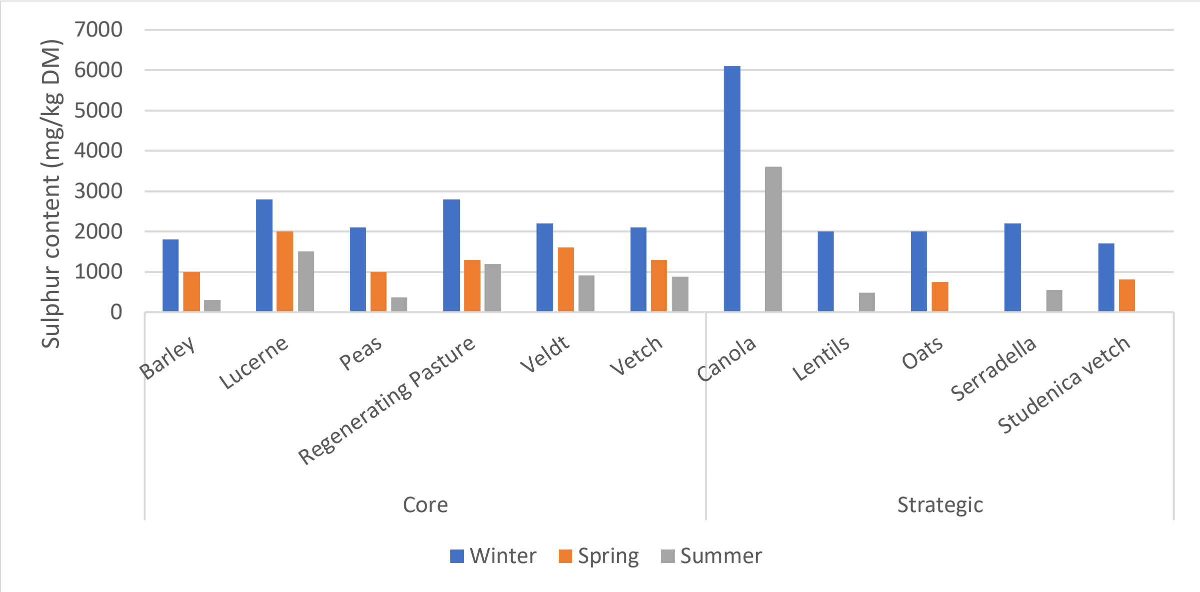

Figure 5. Sulphur content of each species across seasons.

Cobalt content of pastures was highly variable, but mostly adequate for sheep, with only 14.3% of samples below the minimum required level of 0.1mg/kg DM. Cobalt content of pasture typically increased as pastures matured from early winter growth to dry summer feed.

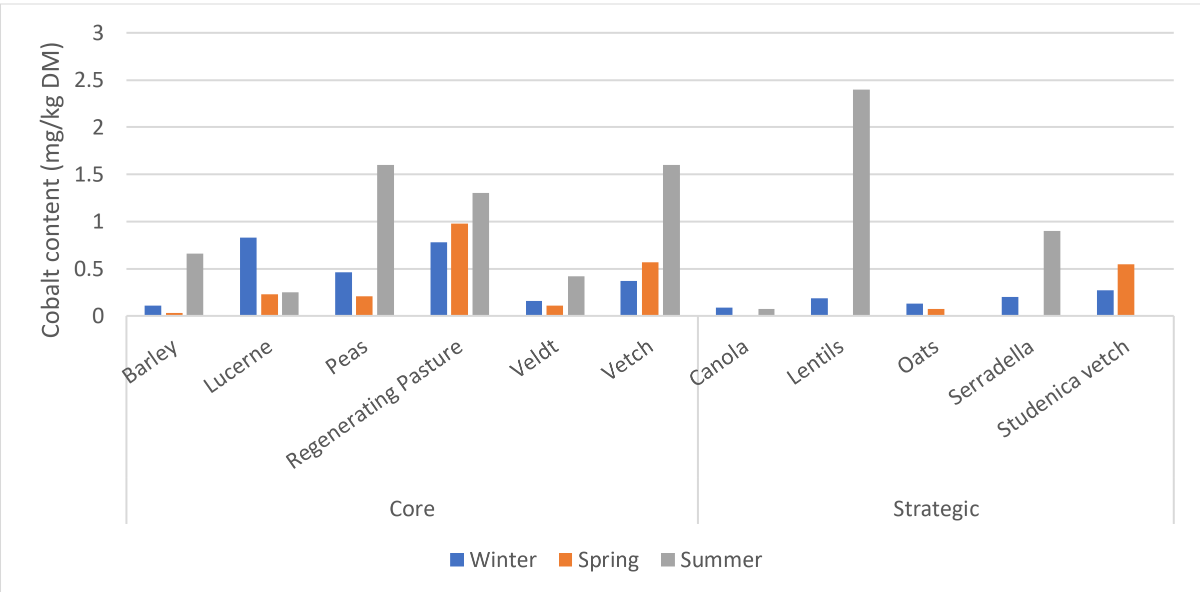

Figure 6. Cobalt content of each species across seasons.

Copper content of the species tested showed that most pastures were adequate for copper content as assessed by the minimum required level of 5mg/kg DM. Spring samples for barley, oats, lucerne and peas showed a deficiency.

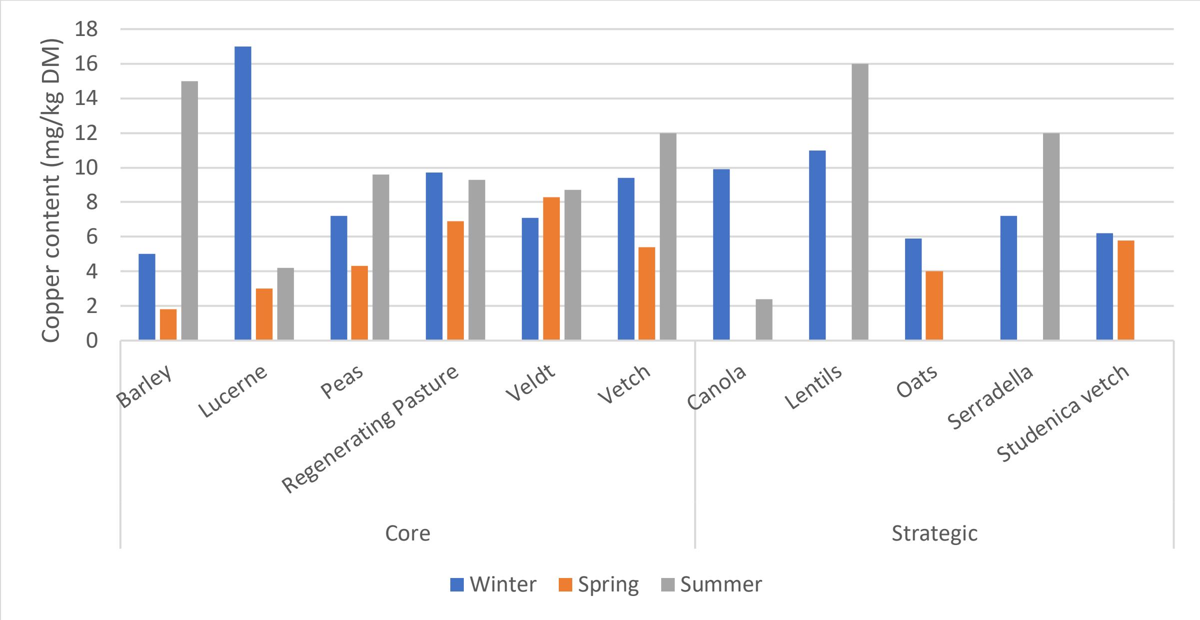

Figure 7. Copper content of each species across seasons.

Selenium content of the pasture was adequate in all samples except two (winter oats and winter canola) where the content was below the minimum required level of 0.1mg/kg DM. A strong seasonal trend was not apparent, with spring in particular being highly variable across species. However, in general, an increase in selenium content from winter to summer was observed.

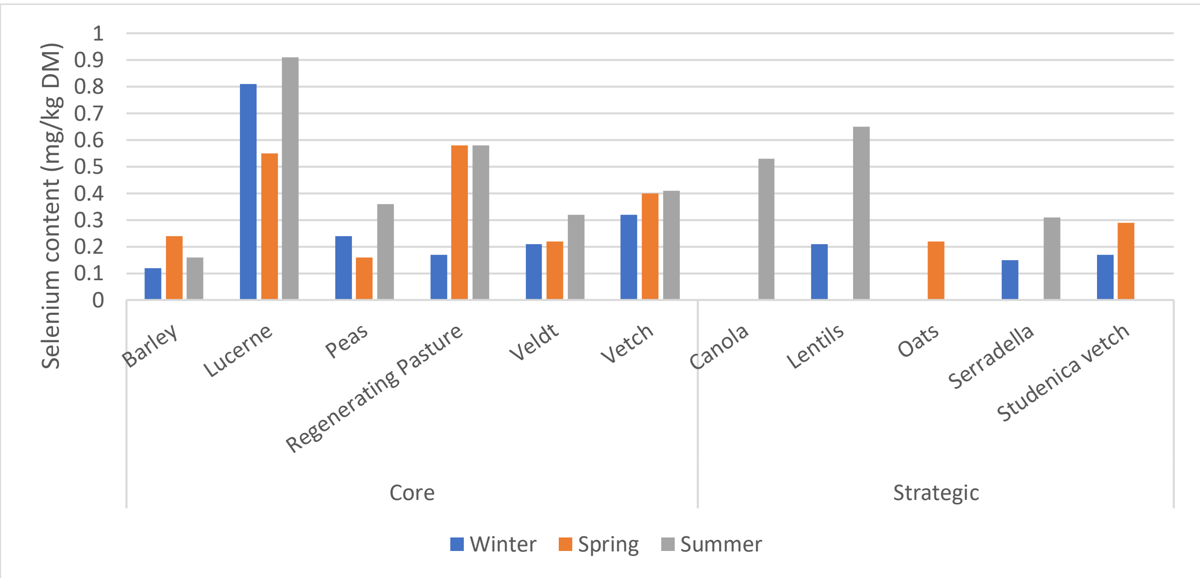

Figure 8. Selenium content of each species across seasons.

Year 2 - 2021

The laboratory analyses of the 2021 pasture and crop samples again showed that nutritive value declined as plants matured and senesced (Figure 9).

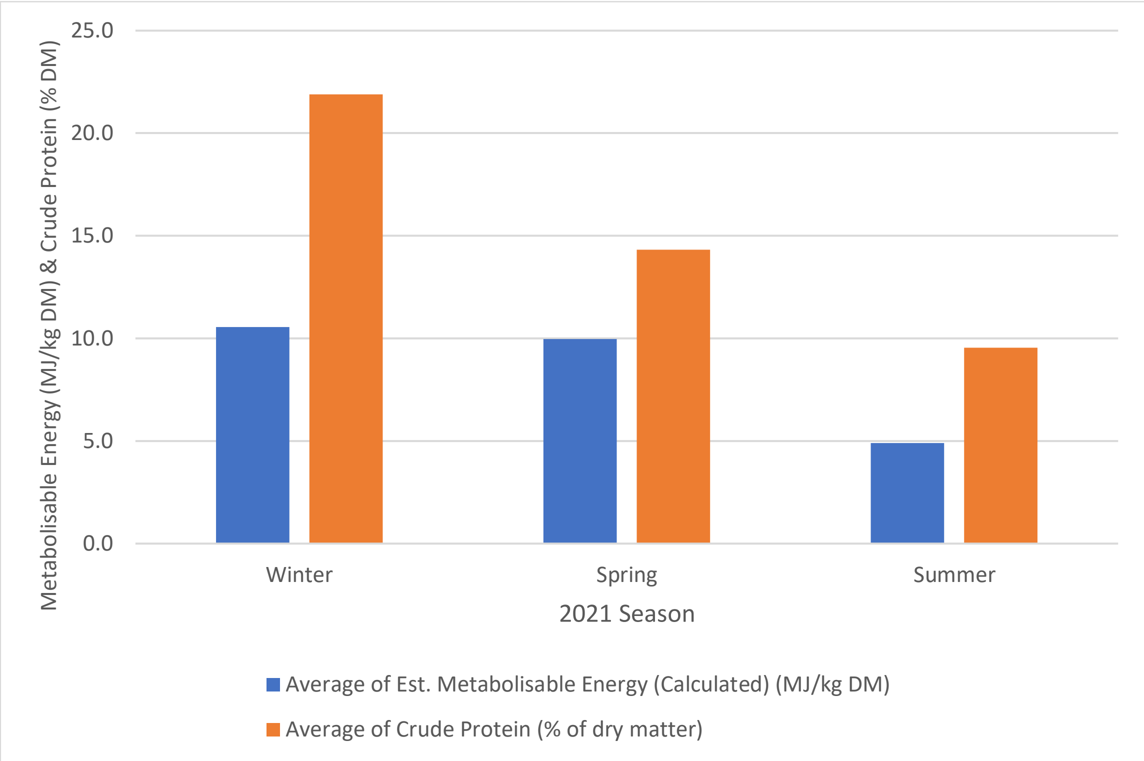

Figure 9. Average metabolisable energy and crude protein content of all samples combined for each season.

The metabolisable energy content of the samples generally showed the same trend of declining from winter to summer across each individual species, again with some variation between species (Figure 10). For example, vetch significantly declined from winter to summer, whilst lucerne was more stable in feed quality throughout the season.

The highest energy content species in winter included canola, barley and oats. The lowest energy content species included veldt grass and natural regenerating medic pastures.

Veldt showed an increase in energy content from winter to spring and then declined significantly to summer as dry feed. The winter growth of veldt had been slow and sampling also included some dry residual plant material, which is likely to have affected the winter feed test results.

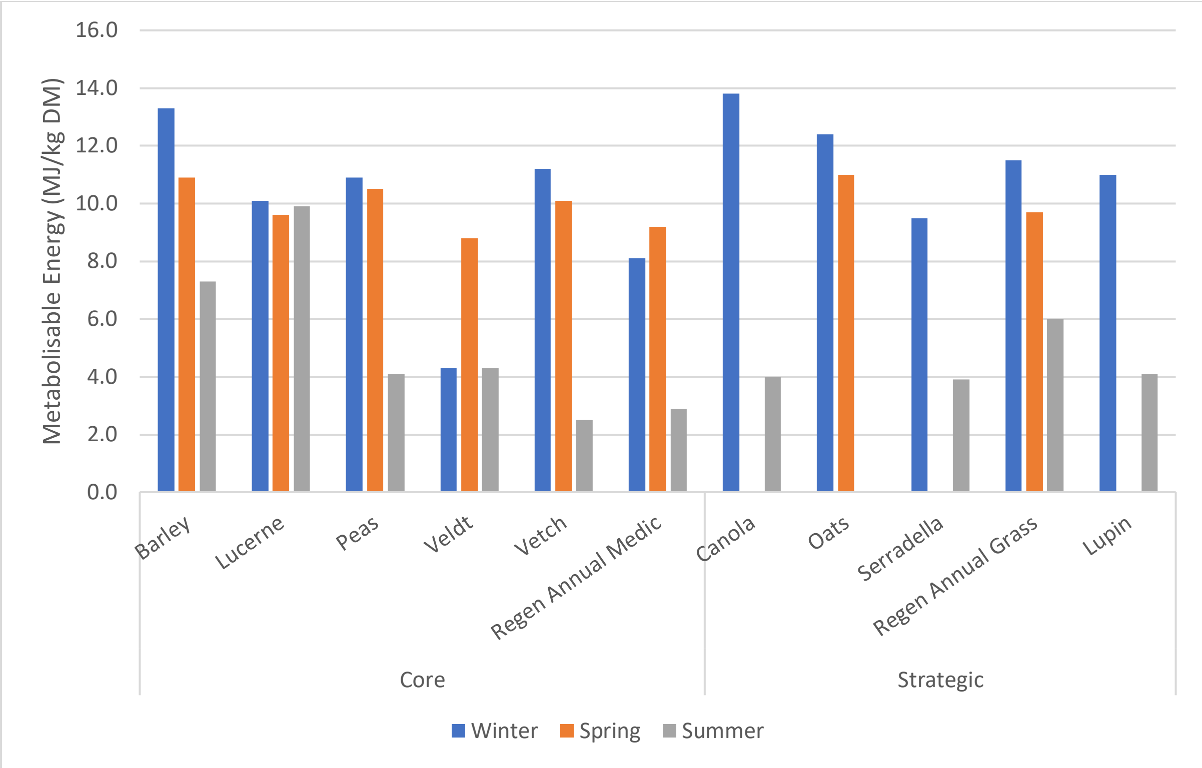

Figure 10. Metabolisable energy content of each species across seasons.

The crude protein content of different species again followed the trend of declining from winter to summer (Figure 11). In general, grass type species (barley, oats, veldt) showed lower protein content across all samples than legume species (lucerne, peas, vetch).

Lucerne had the highest protein content of 34.1% in winter, while the summer veldt sample declined to 5.1%, the lowest protein content tested of all species.

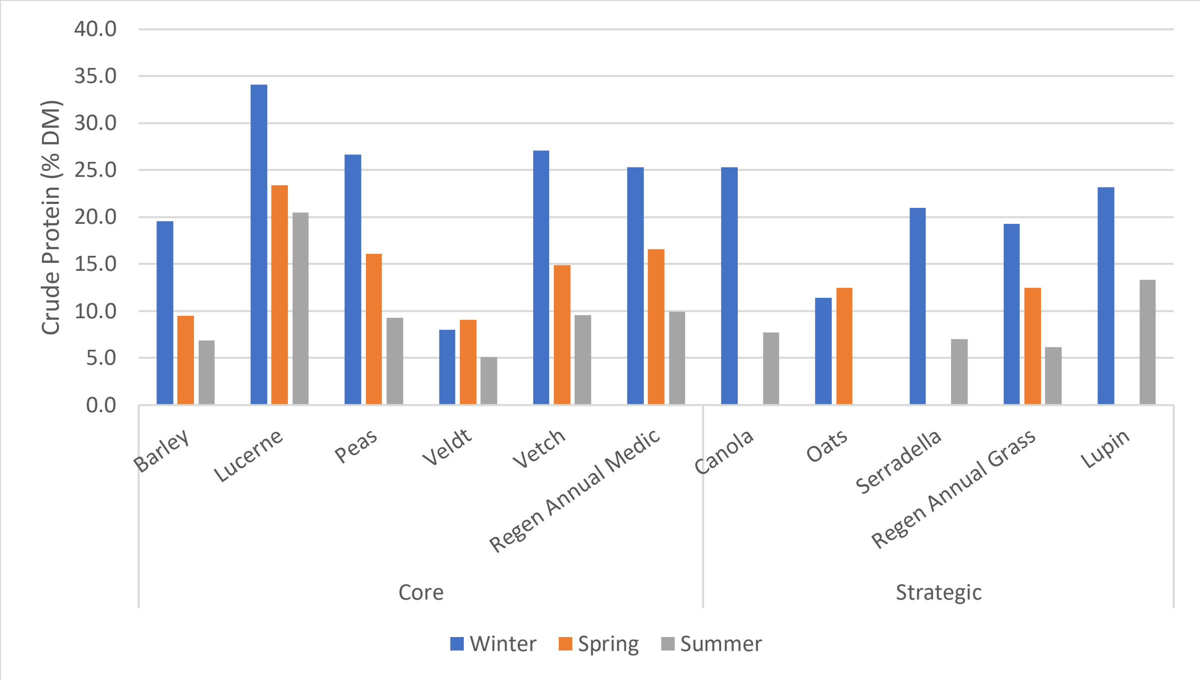

Figure 11. Crude protein content of each species across seasons.

Once again, all feed samples were analysed for mineral content. The content of pastures for minerals such as calcium, magnesium, sulphur, cobalt, selenium and copper were assessed as the minerals typically of most interest to sheep producers.

Calcium content of all pastures were generally satisfactory in these samples as they reached the minimum required amount for sheep of 2000mg/kg DM, with many samples exceeding the typical upper reference range of 8000mg/kg Ca. Oats in winter and barley in spring were the only samples not to meet the minimum required level. In general, the cereals and grass pastures were lower in calcium content than legume species, with an exception being veldt grass which tested similarly to species such as lucerne, peas and vetch.

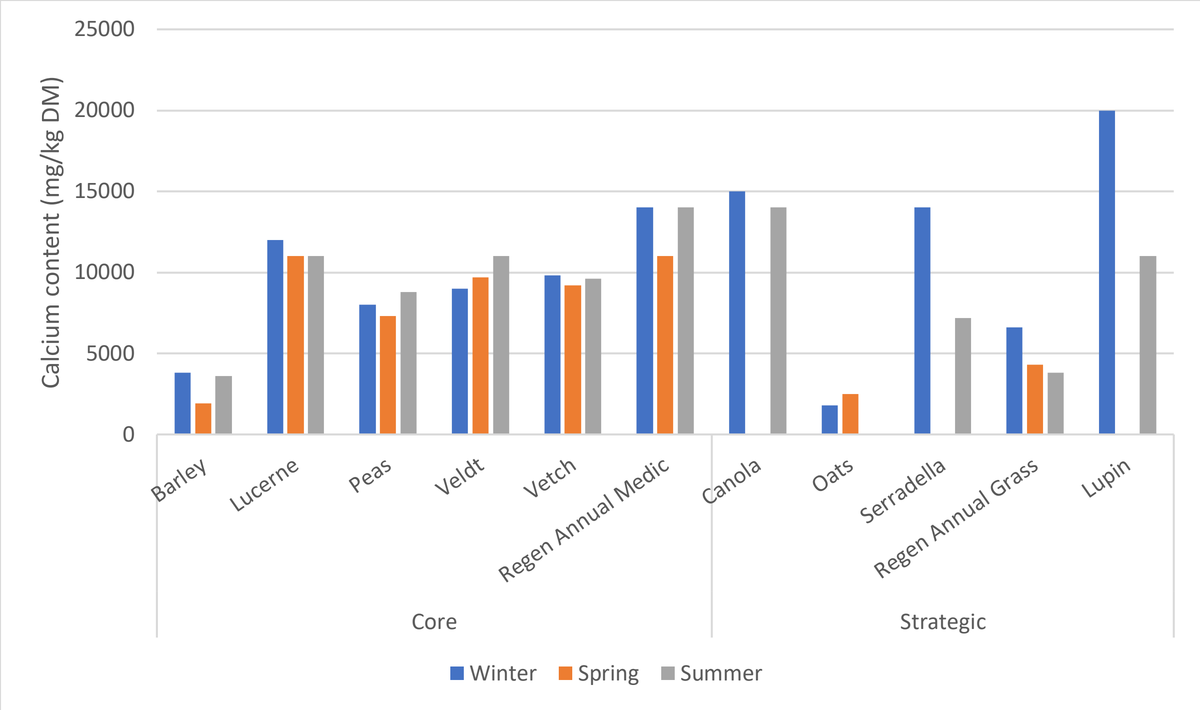

Figure 12. Calcium content of each species across seasons.

Sulphur content of pasture during winter was largely within the normal range for sheep (1400-2600mg/kgDM), with all samples except for oats above the minimum level. Canola in winter recorded the highest sulphur content of 4,300mg/kg DM. Spring and summer samples showed a significant number of deficiencies with 61% of samples deficient in sulphur.

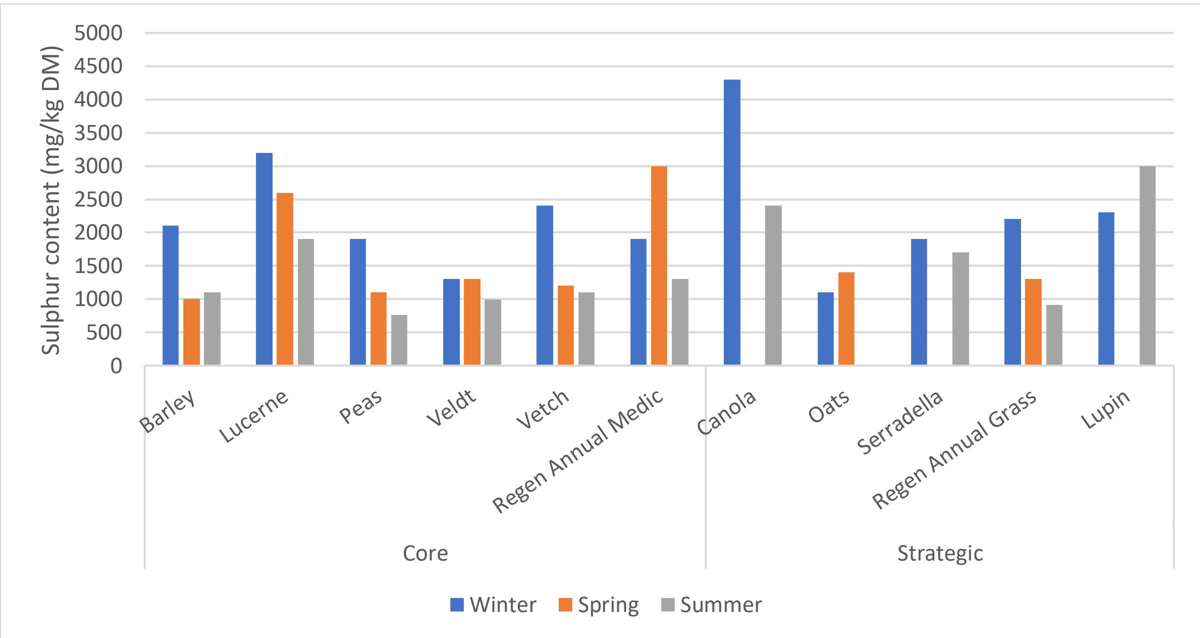

Figure 13. Sulphur content of each species across seasons.

Cobalt content of pastures was highly variable, but mostly adequate for sheep, with 75% of samples above the minimum required level of 0.1mg/kg DM. Cobalt content of pasture typically was lowest in spring compared to winter and summer.

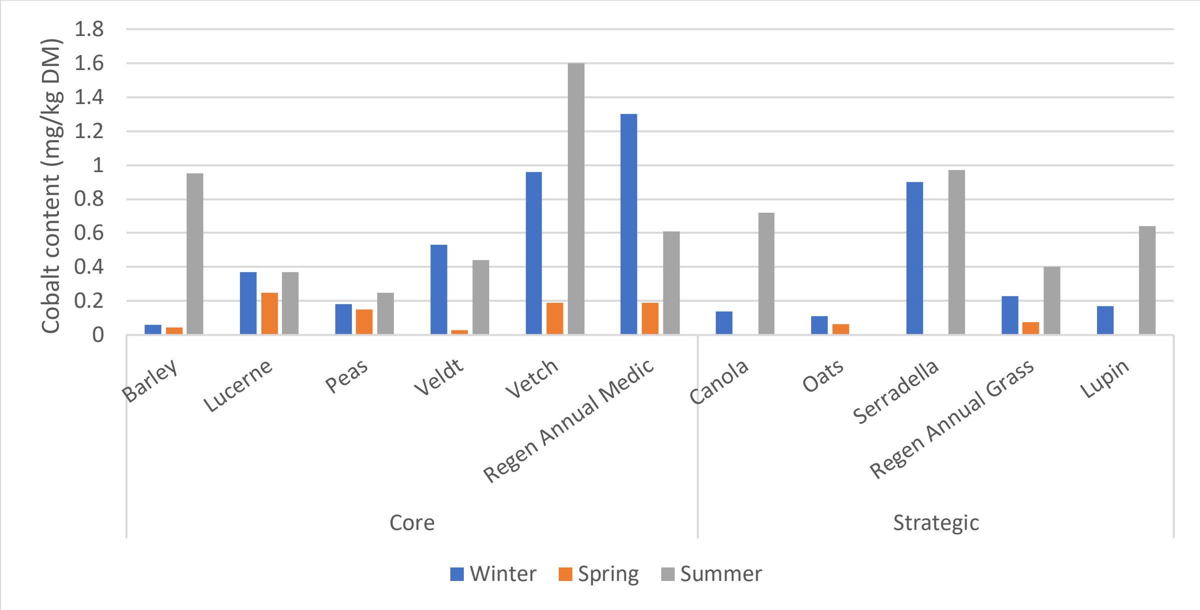

Figure 14. Cobalt content of each species across seasons.

Copper content of the species tested showed high variability between species and season. Approximately half of the samples tested were considered deficient as assessed by the minimum required level of 5mg/kg DM.

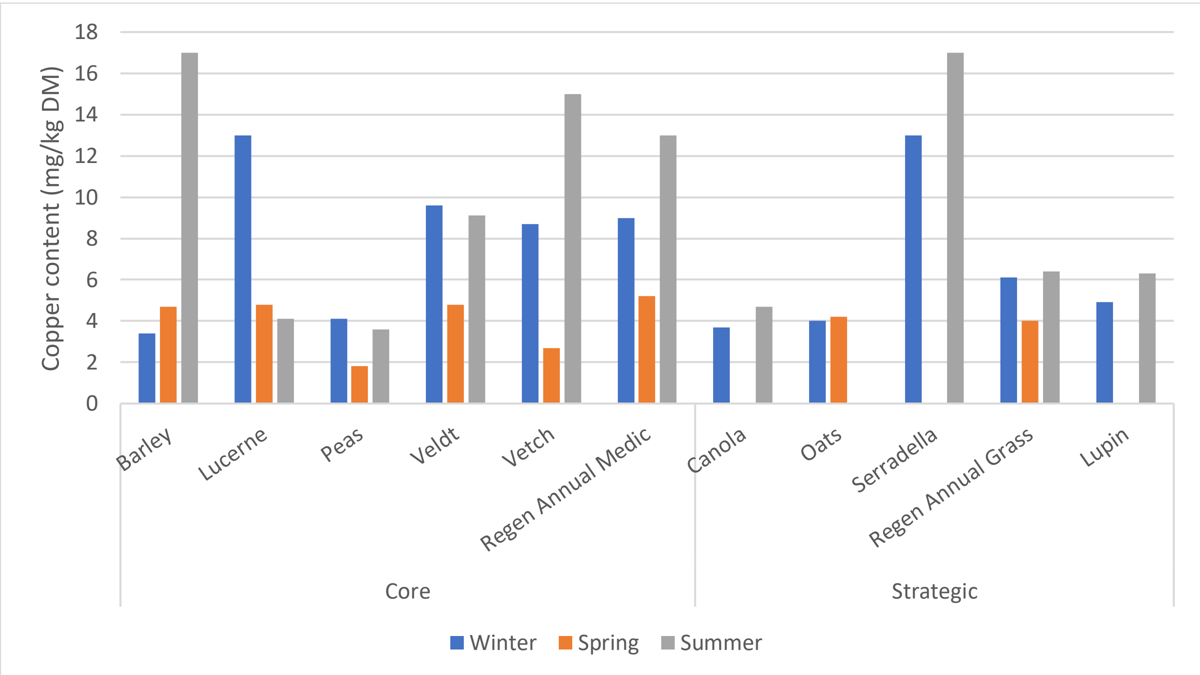

Figure 15. Copper content of each species across seasons.

Selenium content of the pasture was adequate in all samples except for peas in winter, and peas, oats and barley in spring, where the content was below the 0.1mg/kg DM required. For many species, it was common for selenium content to decline from winter to spring and then increase to maximum level in summer. Lucerne was an exception to this trend, displaying the highest selenium content in winter.

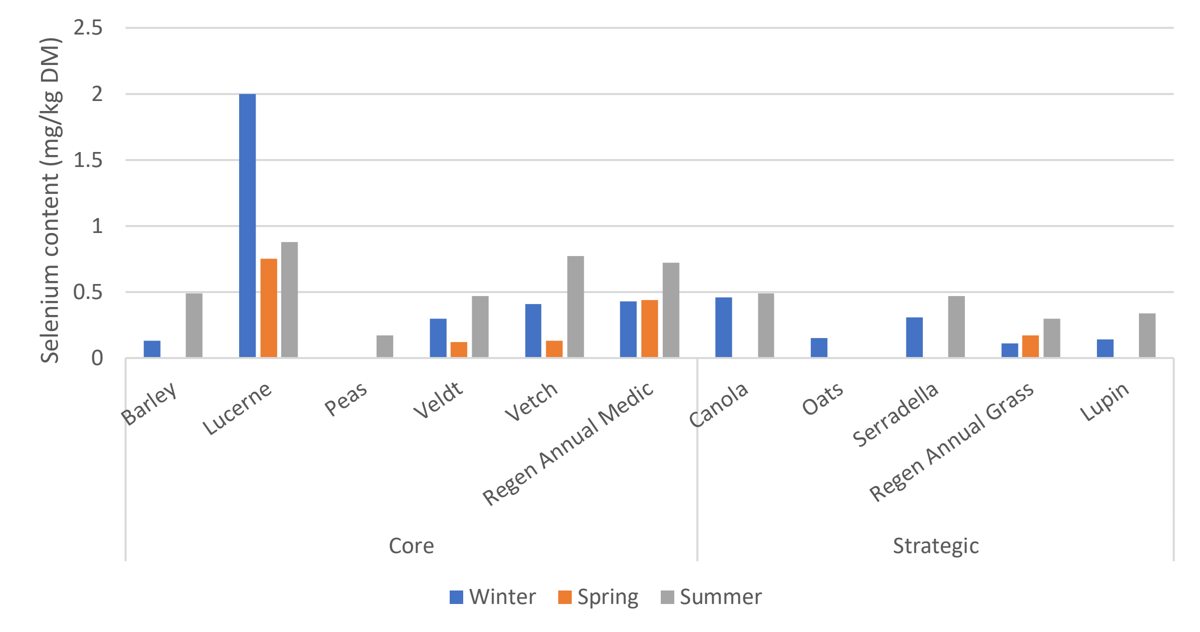

Figure 16. Selenium content of each species across seasons.

Discussion

The results from this project demonstrated the value of feed testing pastures and grazing crops with some findings falling outside expected values. For example, 2020 summer testing revealed particularly low protein in cereals (Figure 3), and 2021 winter testing showed very high energy content for barley (Figure 10). Whilst 'expected' ranges for mineral content of pastures or crops are not typically published due to the significant influence of soil type and fertiliser history, testing demonstrated the value of knowing mineral content to guide animal supplementation. Results from many samples showed sufficient levels of commonly supplemented minerals such as selenium (Figure 16), demonstrating that testing may allow cost savings where supplements are unnecessary. Testing may also reduce risks of toxicity where minerals such as selenium are over-supplied.

Other findings in this study followed expected trends – for example, the general decrease in quality from winter (early growth) to summer (dry feed). This was demonstrated in Figure 1 and Figure 9 and reflects the accepted change in quality shown in Figure 17, where a significant decline in nutritive value occurs as the plant progresses past flowering.

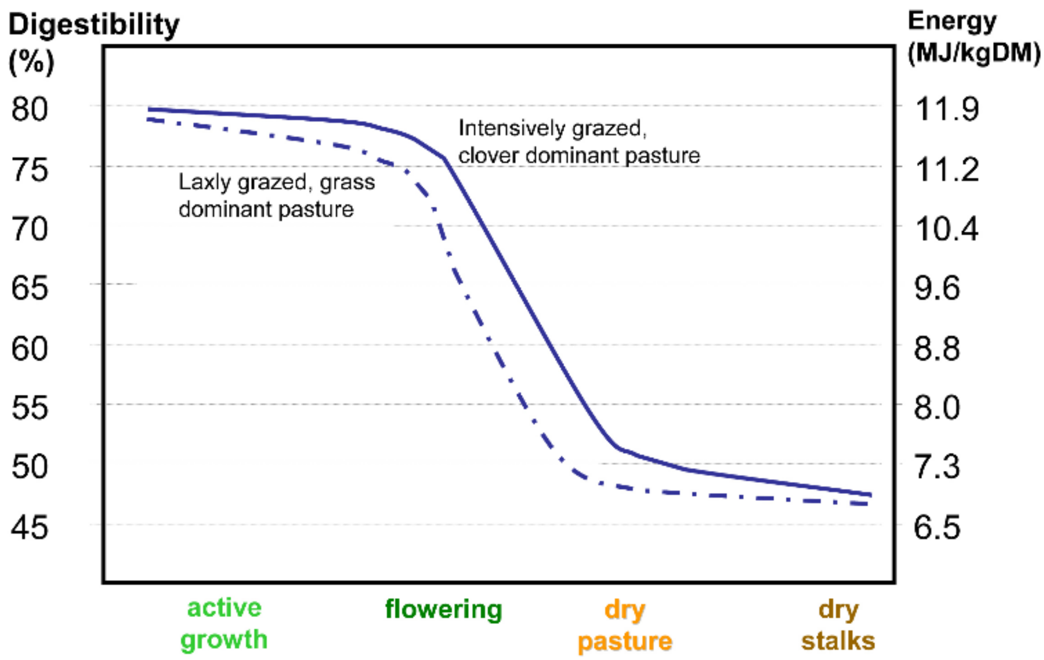

Figure 17. Change in feed quality of pastures for each stage of growth (source DAFWA).

Whilst most species declined significantly in quality from winter and spring to summer, lucerne stood out for maintaining quality from spring to summer (maintaining energy content and only dropping slightly in protein content; Figure 11). Whilst it would be expected that a plant species such as lucerne with some summer growth activity would maintain a higher quality in summer, these samples have demonstrated the extent to which it can provide a high quality summer feed resource compared to other species (Figure 18).

Figure 18. Comparison of lucerne and veldt grass pasture sampled in summer (December) 2020.

Veldt grass was one of the poorer quality summer feeds (Figure 2 and Figure 10), with the 2021 sampling showed a trend where its feed value peaked in spring at 8.8ME compared to 4.3ME in winter and summer. The images in Figure 19 show the appearance of veldt at each sampling time. The green plant material suggests in each season there has been some level of recent growth. However, from the winter sample in particular, it would be expected that the grass would be greater than 4.3ME. This may suggest some level of inclusion of older dry plant material in the sample, which would have reduced the overall feed quality of the sample.

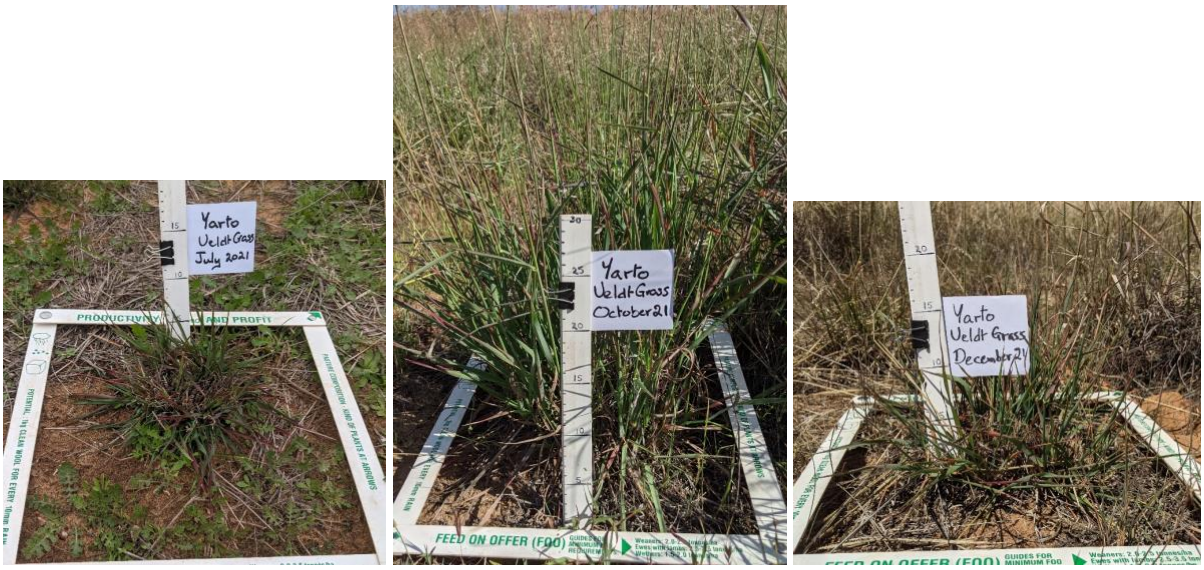

Figure 19. Comparative images of veldt grass in winter, spring and summer 2021.

Canola was a standout species for winter feed quality and highlights an opportunity for tactical grazing of this species when season permits. This may be in a good season where grazing can be expected to have little effect on grain yield, or in a low rainfall year where grazing allows some value to be salvaged from a failed crop. However, risks associated with nitrate accumulation need to be reviewed prior to grazing, particularly with failed crops.

Mineral analyses showed several interesting findings that could substantially impact farm management in the Mallee. Results showed that minerals such as calcium were largely adequate, particularly in non-cereal species. The oats and barley samples showed some deficiencies, particularly if considering interactions from minerals such as potassium and sodium and magnesium. Calcium supplementation for high demand animals such as pregnant or lactating ewes and young growing stock could still be required with these feeds.

Many animal health products such as drenches and vaccines have additional selenium or vitamin B_{12} added to provide a supplement to stock. Cobalt is synthesised into vitamin B_{12} in the rumen and if adequate levels of cobalt are available in feed, then adequate levels of vitamin B_{12} are produced for the animal. Results from these analyses showed that the majority of samples in the Mallee were adequate for both selenium and cobalt, representing a potential cost saving for producers using large quantities of these supplements. In addition, excess supplementation of selenium in particular can be toxic. This has been observed previously in the Mallee where stock have been unnecessarily supplemented with selenium in drench, vaccine and loose lick products. Testing for minerals like selenium can allow producers to save money and avoid these issues.

Conclusions

- Broadly, energy and protein of pasture and crops tested in this project followed expected trends, with highest energy and protein being observed during early growth and declining as plants mature towards flowering and senescence.
- This project has demonstrated the value of feed testing pastures and crops through showing the wide range in feed value of individual species and the opportunity for different management strategies to maximise farm productivity and profitability.
- Lucerne stood out as offering high energy and high protein content irrespective of season, while veldt grass was one of the poorer quality feeds, particularly in summer.
- Canola and barley were high quality winter feeds, highlighting the opportunity for tactical grazing of these species – either as a winter grazing in a good season or in spring on a failed crop. Risk of nitrate accumulation should be assessed prior to grazing canola as a failed crop.
- The nutritional requirements of sheep should be determined and considered against the feed value of the feed on offer. Feed tests can provide valuable information regarding which pastures are suitable for high demand classes of sheep such as growing lambs or pregnant ewes. Similarly, feed test results can also provide necessary information to determine correct supplementary feeding strategies if required.
- Standout mineral deficiencies included low calcium in cereals in winter and spring. Sulphur and copper showed large variation and many samples were deficient in spring and summer. Understanding these deficiencies and implementing a supplementation strategy is likely to be profitable in many areas.
- It was of interest that cobalt and selenium were adequate in most samples tested. Since many animal health products have these elements added as a supplement, there may be an opportunity for many Mallee producers to select alternative and cheaper animal health products, especially as excess selenium can be toxic.
- Results have highlighted the importance of using feed tests to better understand the nutritive value of pastures in the Mallee, so that feed and nutrients can be refined and animal performance optimised.
- Feed test results from this project are now available for use by producers and industry in the low rainfall areas of southern Australia. Key results tables from the two years of testing are included as Appendix A and can be used as a stand-alone resource in courses such as Lifetime Ewe Management. A more detailed description of results from the 2020 and 2021 feed test years, and individual feed test data, are available from the MSFP website.

Appendix A

This table provides a summary of the nutritive value of pastures and crops sampled within the AWI project *Improving sheep nutrition through assessment of regional feedbase deficiencies*. The Table shows laboratory results for digestibility, metabolisable energy and protein content for a range of typical Mallee feeds. Results can be used within industry programs such as Lifetime Ewe Management to more accurately guide estimates of pasture quality and pasture descriptors within those programs (ie Very High, High, Medium, Low).

Note: this table can be formatted to suit publication within relevant programs such as Lifetime Ewe Management following discussion with stakeholders. Depending on the final publication style, the table could be split to describe grazing crops and pastures separately.

Summary of Nutritive Value of Various Mallee Crops and Pastures

DMD = Dry Matter Digestibility (% DM)
ME = Metabolisable Energy (MJ ME/kg DM)
CP = Crude Protein (% DM)

	Stage of Growth		
	Active growth (Winter)	**Flowering/seedset (Spring)**	**Dry/senescent (Summer)**
Barley			
	DMD 82.8% (ME 12.7, CP 16.0%)	DMD 72.2% (ME 10.8, CP 10.3%)	DMD 49.3% (ME 6.9, CP 3.5%)
Lucerne			
	DMD 69.4% (ME 10.4, CP 30.5%)	DMD 64.5% (ME 9.5, CP 22.0%)	DMD 65.8% (ME 9.7, CP 19.0%)

Peas			
	DMD 73.1% (ME 11.0, CP 25.3%)	DMD 75.2% (ME 11.3, CP 16.8%)	DMD 33.9% (ME 4.3, CP 7.1%)
Veldt			
	DMD 67.7% (ME 10.0, CP 16.6%)	DMD 58.1% (ME 8.4, CP 10.6%)	DMD 39.5% (ME 5.2, CP 5.0%)
Vetch			
	DMD 76.8% (ME 11.6, CP 26.5%)	DMD 71.6% (ME 10.7, CP 16.0%)	DMD 29.2% (ME 3.5, CP 9.3%)
Regenerating Pasture (medic base)			
	DMD 63.0% (ME 9.3, CP 25.0%)	DMD 53.8% (ME 7.7, CP 15.5%)	DMD 31.1% (ME 3.7, CP 10.8%)

Canola		Not sampled	
	DMD 89.2% (ME 13.7, CP 27.8%)		DMD 33.7% (ME 4.2, CP 7.2%)
Lentils		Not sampled	
	DMD 75.8% (ME 11.4, CP 23.9%)		DMD 41.6% (ME 5.5, CP 8.0%)
Oats			Not sampled
	DMD 80.1% (ME 12.2, CP 12.6%)	71.0% (ME 10.6, CP 10.2%)	
Serradella		Not sampled	
	DMD 69.5% (ME 10.4, CP 19.8%)		DMD 33.1% (ME 4.1, CP 8.0%)

Lupins		Not sampled	
	DMD 73.1% (ME 11.0, CP 23.2%)		DMD 33.0% (ME 4.0, CP 13.3%)
Regenerating Pasture (grass base)			
	DMD 76.1% (ME 11.5, CP 19.3%)	DMD 65.8% (ME 9.7, CP 12.5%)	DMD 44.4% (ME 6.0, CP 6.2%)