5.1 FORAGE MIXES: PROVIDING THE QUICKEST WINTER FEED FOLLOWING TWO SOWING TIMINGS

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KEY MESSAGES

- Sowing early resulted in higher dry matter production and higher energy production.
- Barley and clover sown early produced the quickest and highest amount of feed.
- Due to a dry autumn and winter, growth was slow, and plant/mixes didn't mature until early spring.

Keywords: drought, fodder, winter feed, time of sowing

BACKGROUND

This three-year trial is investigating which species or species mixes produce the quickest feed after a late autumn break, or coming out of a dry period, to fatten livestock quickly. This can then be extended to which mixes provide the best quantity and quality of winter feed.

Species and mixes were selected based on those that could provide the best quality, quick maturity and other benefits such as suitability for cutting for hay or adding nitrogen to the soil.

Issues such as potential toxicities experienced under certain conditions or species flowering/finishing early will be investigated, along with determining if there was value in sowing before or after the break and the risks involved, such as a false break or pest attack.

In 2024, the trial site at Rokewood went on to experience an unusually dry autumn and winter and this report examines its effects on forage performance and whether it is better to sow early or later (and wait for moisture) (See Climate & Soil Data).

Table 1. Species mixes, variety names and sowing rates for each treatment in the trial.

Treatment	Species	Variety Name	Sowing Rate (kg/ha)
1. Annual ryegrass (ARG) + clover mix	Annual ryegrass	RGT Menvyl	20
	Persian clover	Moa	3
	Balansa clover	VNS	2
2. Ryecorn + clover mix	Ryecorn	Southern Green Ryecorn	60
	Persian clover	Moa	3
	Balansa clover	VNS	2
3. Ryecorn + Italian ryegrass (IRG)	Ryecorn	Southern Green Ryecorn	60
	Italian ryegrass	Accelerate 2	10
4. Forage oats + clover mix	Forage oats	Regency	30
	Persian clover	Moa	3
	Balansa clover	VNS	2
5. Forage barley + clover mix	Forage barley	Magnate	80
	Persian clover	Moa	3
	Balansa clover	VNS	2
6. Forage rape + annual ryegrass (ARG)	Forage rape	RGT Hybra	2
	Annual ryegrass	RGT Menvyl	8
7. Turnip + annual ryegrass (ARG)	Leafy turnip	Hunter	2
	Annual ryegrass	RGT Menvyl	8
8. Pallaton brassica	Raphanobrassica	Pallaton Raphno®	8

VNS – Variety Not Specified.

METHOD

Site Preparation

The site had previously been sown to phalaris and this was terminated on the 12th of April 2024 so that moisture continued to be removed from the site for as long as possible to simulate coming out of drought conditions. In future years, the area will be sown to a cover crop for this purpose. The site was then scarified, speed disced and rolled to try and create a uniform seedbed as the clay soil was very hard and cloddy.

Trial Management

The trial had two times of sowing; 26th April 2024 and 14th June 2024, both dry, as there was no real break in the season until July. Plots were sown with 130 kg/ha MAP at a depth of 5 mm using the SFS cone seeder with knives and press wheels. The trial was rolled post-sowing, sprayed with an insecticide (Pyrinex Super at 500 mL/ha) and regularly baited with Transcend (8 kg/ha) to prevent slug damage. Post mowing, plots had 200 kg/ha of urea applied to ensure nitrogen was not limiting growth.

Species & Varieties

Table 1 shows the species and varieties sown in 2024. These species and varieties may be changed each year in the future.

Measurements

Soil Moisture

Before each time of sowing, a 0-10 cm soil sample was taken and oven-dried at 80°c to determine the gravimetric moisture content.

Plant Establishment

Plant establishment was determined by counting the number of plants on either side of a 50 cm stick and converting it to plants/m^2. Counts were separated into primary species (main sown forage) and secondary species (companion species, such as clover).

Botanical Composition

Each plot was assessed for the species composition within each mix and was expressed as a percentage of the plot. The composition changed over time as some species in the mix matured before others.

Yield Assessment

Plots were mown when they reached 2000-2500 kg DM/ha. Brassicas were mown down to 10 cm and all other mixes were mown to 5 cm. This was to ensure that the brassicas were not over-grazed.

Table 2. Cutting dates for each season.

Season	Cutting Dates
Early spring	10-Sep & 2-Oct
Mid-late spring	22-Oct & 19-Nov
Early summer	23-Dec

Nutritive Value

Feed test samples were undertaken on species mixes taken at each time of cutting, except the December cut, to help determine animal performance predictions.

RESULTS & DISCUSSION

Plant Establishment

Plants were very slow to establish after a dry May and June, with the soil in June drier than at the end of April. Soil testing showed that the gravimetric water content of the soil decreased from 21% on the 26th of April to 17% on the 14th of June, highlighting the dry conditions experienced during autumn (Table 3).

Table 3. Mean gravimetric water content (%) of topsoil (0-10 cm) at each time of sowing.

Time of Sowing	Gravimetric Water Content
26th April	21%
14th June	17%

There was a statistical difference between sowing before the 'break' and after the 'break' (Table 4). Sowing early resulted in fewer plants (65 pl/m^2) compared to sowing later (107 pl/m^2). Despite decile 2 conditions, there was enough moisture in the soil for plants to germinate, albeit slower compared to optimal soil moisture conditions, and staggered germination of plants also occurred. Seed size has an influence on plant establishment, larger seeds such as cereals have a greater endosperm and higher starches compared with smaller seeds such as clover and brassica, providing them with greater seedling vigour after germination (GRDC, 2016).

Table 4. Mean plant establishment (plants/m^2) for each time of sowing, assessed on 29th July.

Time of Sowing	Primary Species (plants/m^2)		Secondary Species (plants/m^2)	
26th April	65	b	74	b
14th June	107	a	119	a
LSD P=0.05	8.86		19.76	
***p*-value**	<0.001		0.007	
CV (%)	21		26	

Means followed by the same letter do not significantly differ (p>0.05).

Botanical Composition

The botanical composition assessments showed some primary species, such as the annual ryegrass (ARG) in treatment 1, increased in composition from 48.6% of the plot in September to 97% of the plot in November (Table 5). For the leafy turnip, it declined from 35% to 8%, showing the brassica species had a limited growing season as it went reproductive in mid-spring.

Table 5. Mean primary species of each treatment mix as a percentage of the plot (%) assessed on 10th Sept and 19th Nov 2024.

Botanical Composition (%)				
Trt-ment No.	Primary Species	10-Sep	19-Nov	Change
1	Annual ryegrass	49 c	97 a	↑
2	Ryecorn	97 a	83 ab	↓
3	Ryecorn	84 b	47 c	↓
4	Oats	44 c	84 ab	↑
5	Barley	48 c	79 b	↑
6	Forage rape	37 d	34 c	↓
7	Turnip	35 d	8 d	↓
8	Pallaton Brassica	48 c	96 a	↑
	LSD P=0.05	5.6	14.7	
	p-value	<0.001	<0.001	
	CV (%)	10	22	

Means followed by the same letter do not significantly differ (p>0.05).

Table 6. Mean companion species of each treatment mix as a percentage of the plot (%) assessed on 10th Sept and 19th Nov 2024.

Botanical Composition (%)				
Trt-ment No.	Companion Species	10-Sep	19-Nov	Change
1	Clover	0.9 e	0.6 c	↓
2	Clover	3.2 bc	4.5 c	↑
3	Italian ryegrass	12 a	51 b	↑
4	Clover	2.1 cd	6.4 c	↑
5	Clover	1.2 de	6.5 c	↑
6	Annual ryegrass	4.1 b	66 b	↑
7	Annual ryegrass	4.5 b	92 a	↑
8	.	0 f	0 c	↑
	LSD P=0.05	0.8	16.3	
	p-value	<0.001	<0.001	
	CV (%)	28	55	

Means followed by the same letter do not significantly differ (p>0.05).

Table 6 shows that many companion (secondary) species in each mix increased in composition to extend the growing season, such as the Italian and annual ryegrasses. This information is used later in the report to show which species in the mix contributed to the majority of dry matter or metabolisable energy (ME) for each cut.

Yield

Figure 1 shows the dry matter (DM) production of each species mix for early spring, mid-late spring and December. It is important to note that mixes had not reached grazing maturity until the beginning of spring, highlighting the effect of a dry winter on species' production and growth. The barley and clover mix produced the highest DM, 1789 kg DM/ha, in early spring, making it one of the quickest mixes to produce early feed. Mixes that did not perform as well early were the Pallaton brassica (505 kg DM/ha) or forage rape + annual ryegrass mix (855 kg DM/ha). This is because brassicas require warmer temperatures to establish and reach grazing maturity.

Table 7 shows that once the temperatures warmed up (mid-late spring, December) the brassicas began producing the highest DM. In particular, the Pallaton brassica produced by far the most DM in December (1317 kg DM/ha) compared to all other species (the closest was annual ryegrass + clover with 530 kg DM/ha). Furthermore, when looking at the total DM production for the year, mixes became more comparable. The ryecorn + clover mix was the poorest performing in terms of dry matter production and forage rape and turnip mixes performed the best.

Figure 1 highlights the importance of selecting the right species to match the time when the most feed is required. For example, forage barley, ryecorn and annual ryegrass performed better in early spring versus other mixes in December.

The effect of the time of sowing (TOS) on DM production showed that the production in early spring was slightly higher for the first time of sowing, however, it was unable to be statistically analysed in the factorial design as the Pallaton brassica sown on the 14th of June was not cut as it had not reached grazing maturity (Table 8). In mid-late spring, sowing earlier proved to be the best for DM production, with a statistical difference between the two times of sowing – 1813 kg DM/ha for TOS1 and 1454 kg DM/ha for TOS2. The total DM for the year showed sowing early produced the most DM, with 3558 kg DM/ha, compared to sowing late, with 2886 kg DM/ha.

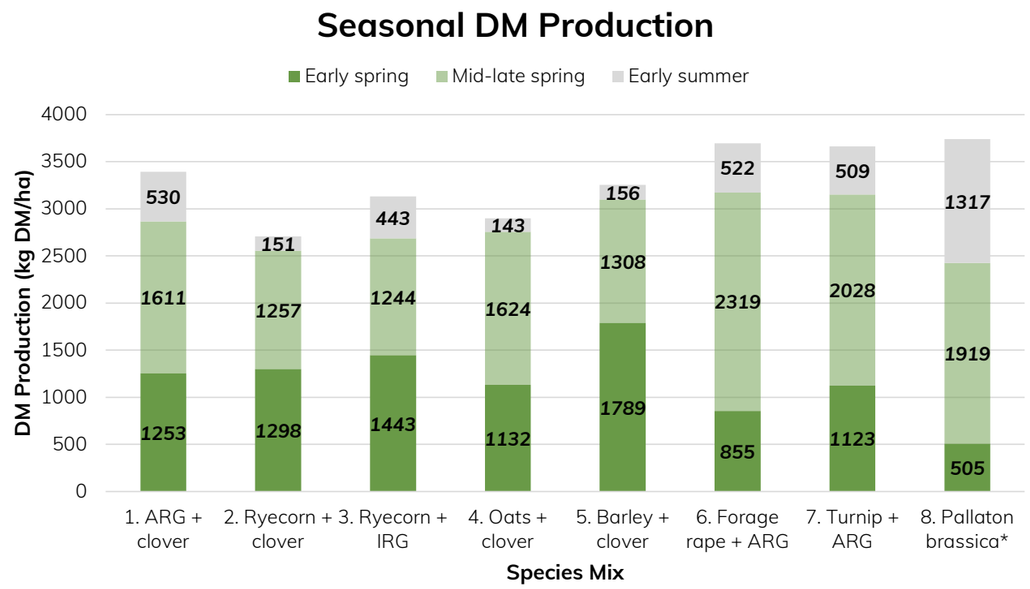

*Figure 1. Mean dry matter production of both times of sowing (kg DM/ha) for each species mix for early spring, mid-late spring and early summer. *The early spring Pallaton brassica cut does not include June sown plots as they were not mature for grazing.*

Table 7. Mean dry matter production (kg DM/ha) for each species mix in early spring, mid-late spring, early summer and total DM.

Dry Matter Production (kg DM/ha)				
Species Mix	Early Spring*	Mid-late Spring	Early Summer	Total
1. ARG + clover	1253	1611 bc	530 b	3307 ab
2. Ryecorn + clover	1298	1257 d	151 d	2673 c
3. Ryecorn + IRG	1443	1244 d	443 bc	3102 abc
4. Oats + clover	1132	1624 bc	143 d	2908 bc
5. Barley + clover	1789	1308 cd	156 cd	3155 abc
6. Forage rape + ARG	855	2319 a	522 b	3675 a
7. Turnip + ARG	1123	2028 a	509 b	3601 a
8. Pallaton brassica**	505	1919 ab	1317 a	3340 ab
LSD P=0.05	NA	299	287	494
p-value	NA	<0.001	0.001	0.009
CV (%)	NA	3	60	2

Means followed by the same letter do not significantly differ (p>0.05).
Early spring treatments unable to be analysed by ANOVA.
**Does not include TOS2 Pallaton brassica.*

Table 8. Mean dry matter production (kg DM/ha) for each time of sowing (26th April and 14th June) in early spring, mid-late spring, early summer and the total DM.

Dry Matter Production (kg DM/ha)				
Time of Sowing	Early Spring*	Mid-late Spring	Early Summer	Total
26th April	1229	1813 a	539 -	3558 a
14th June	1186**	1454 b	404 -	2886 b
LSD P=0.05	NA	165	143	256
p-value	NA	<0.001	0.06	<0.001
CV (%)	NA	3	60	2

Means followed by the same letter do not significantly differ (p>0.05).
Early spring treatments unable to be analysed by ANOVA
**Does not include TOS2 Pallaton brassica*

The longer growing period of the earlier sowing timing is likely a reason why the early sowing performed slightly better than the later timing.

Moisture was a limiting factor at both sowing times possibly due to differences in dry matter production of different species not being expressed. A study conducted by Hill (2011) found different results for best-performing species with the time of sowing. In early sowing (11th April) and late sowing (25th June) ryecorn was far superior in the late sowing and brassicas in the early sowing.

Figure 2 focuses on each mix's DM production for early spring, comparing the two times of sowing. Barley + clover sown early resulted in the highest DM production (1939 kg DM/ha) compared to all other mixes, statistically similar, however to the forage barley + clover at the second time of sowing. Mixes such as the annual ryegrass + clover or the Pallaton brassica performed better when sown earlier. Mixes such as the forage rape + annual ryegrass performed better when sown later.

Nutritive Value

The metabolisable energy for each mix was multiplied by the amount of dry matter produced to calculate the amount of energy per hectare produced by each mix (Figure 3). Once again, the forage barley + clover mix sown early was the highest, producing 23,619 MJ ME/ha. However, this was not statistically different from the annual ryegrass + clover mix sown early which produced 19,357 MJ ME/ha.

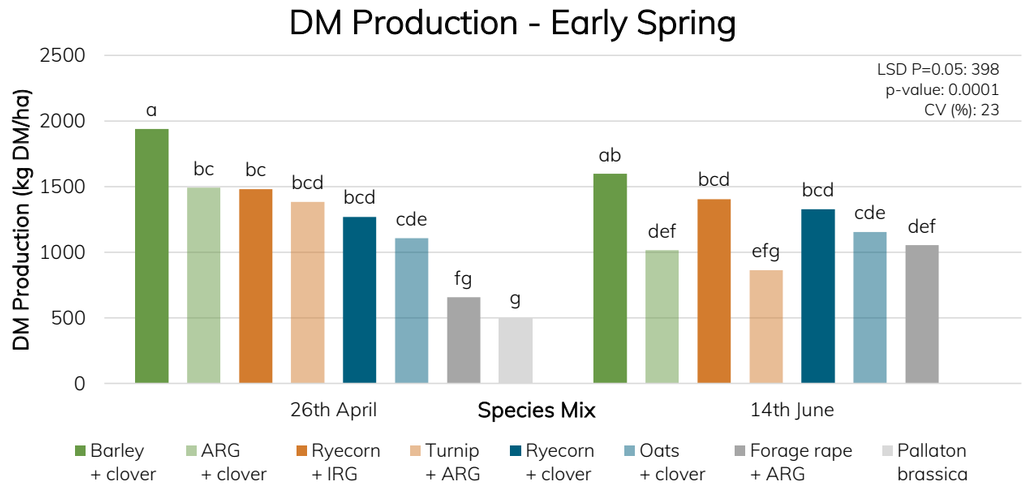

*Figure 2. Comparing the dry matter production (kg DM/ha) of each species mix with the time they were sown (26th April and 14th June). Means followed by the same letter do not significantly differ (p>0.05). *The early spring Pallaton brassica cut does not include June sown plots as they were not mature for grazing.*

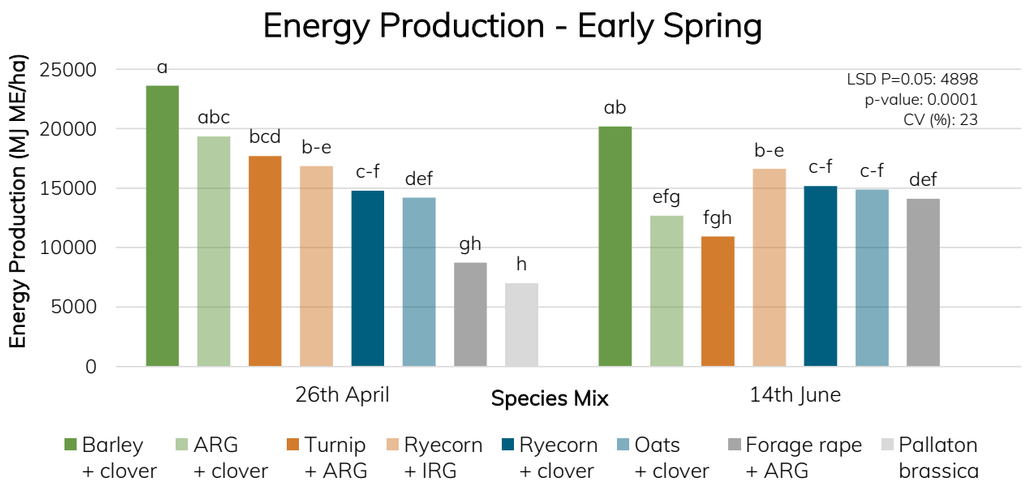

Figure 3. The energy produced (MJ ME/ha) for each species mix for each time of sowing (26th April and 14th June). Means followed by the same letter do not significantly differ (p>0.05). The early spring Pallaton brassica cut does not include June sown plots as they were not mature for grazing.

Table 9. Mean energy production (MJ ME/ha) for each time of sowing (26th April and 14th June) for early spring and mid to late spring.

Energy Production (MJ ME/ha)			
Time of Sowing	**Early Spring***	**Mid-late Spring**	**Total^**
26th April	15,286	20,709 a	37,323 a
14th June	14,740*	15,946 b	29,344 b
LSD P=0.05	NA	1841	2934
p-value	NA	<0.001	<0.001
CV (%)	NA	2	9

Means followed by the same letter do not significantly differ (p>0.05).

**Does not include Pallaton brassica TOS2. ^ Please note that no feed tests were done for the December cut, the 'Total' reflects cuts from 9th Sept to 19th Nov.*

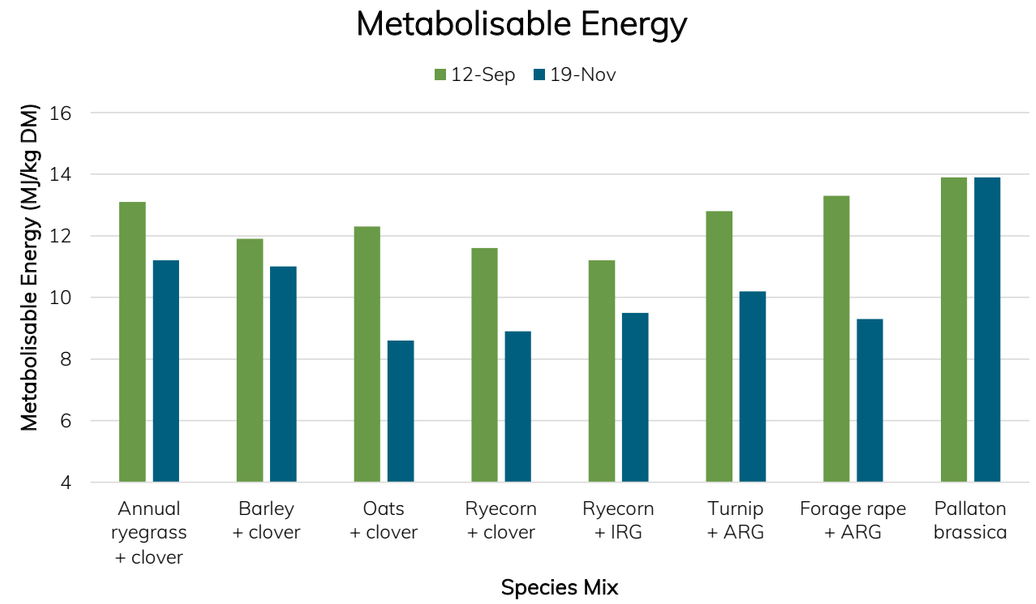

Figure 4. Metabolisable energy content (MJ/kg DM) of each species mix on the 12th of Sep and 19th of Nov 2024.

Similarly to the DM production, on average, sowing early resulted in more energy production, producing 37,323 MJ ME/ha compared to sowing late which produced 29,344 MJ ME/ha (Table 9).

Figure 4 shows the change in metabolisable energy content of each species mix from early spring to late spring where all mixes declined in quality over time except for Pallaton brassica which maintained quality.

Species Mixes

The ryecorn was selected for its ability to provide early feed, however, it also matures earlier. By adding Italian ryegrass to this mix it extended the growing season, and it increased to 51% of the sward by November. Forage oats and barley are reliable robust cereals sown for their quick maturity and winter production. Clovers were added to cereals to boost feed quality especially if taken to a hay/silage option. They were also added to provide potentially additional feed production through nitrogen fixation. The clovers however, as shown in Table 6, contributed very little to the sward against the more competitive species, meaning feed quality and nitrogen fixation became irrelevant.

Brassicas, in general, are fast germinators in favourable conditions, and this can allow them to be sown earlier than ryegrasses. They prefer soil temperatures around 12-14 degrees or higher and hence the later sowings and dry conditions did not suit them. They have been reported to have higher winter growth rates than ryegrasses and have the capacity for summer growth (Fulkerson, et al, 2011). They also provided high-quality feed, as shown in Figure 4.

Forage rape cannot be grazed for 8-10 weeks following germination or longer depending on the variety. They can become toxic to livestock at flowering and hence annual ryegrass was added to outcompete it, suppress flowering and dilute any toxicity. While annual ryegrass increased to 66% of the sward, the rape component remained high, which could have been potentially toxic. This mix is commonly used in the dairy industry where rainfall is higher and sowing timing is typically in early March. The Pallaton brassica is normally sown in spring and these results show its preference for spring growth, having the least winter production of the mixes. Its high feed quality however (Figure 4), and exceptional spring and early summer growth (Table 7) ensured it was a top performer for total dry matter production.

Trials by Hill (2008) had reported that leafy turnips were fast maturing and the quickest brassica to provide winter feed but can bolt to seed head after being grazed a few times. Figure 3 reflects these findings, as turnip + annual ryegrass was the third-highest performer for providing energy over winter.

Annual ryegrass showed its ability to provide quick winter feed but is slower than that of the cereals under late break conditions. Its performance could be improved by sowing earlier, and it could outperform cereals in wet or waterlogged conditions. It showed its advantage over cereals for extending spring growth.

Cost of Production

The pasture establishment cost was estimated to be $262/ha which included three sprays, fertiliser at sowing, machinery costs and one application of slug bait. The total seed cost and total establishment cost can be found in Table 10. The most inexpensive mixes were the turnip + annual ryegrass, oats + clover, and forage rape + annual ryegrass. The most expensive mix to establish was the Pallaton brassica at $860/ha.

Table 10. Total seed cost ($/ha) and total establishment cost ($/ha), which is the total seed cost + establishment cost ($262/ha).

Trt	Species Mix	Total Seed Cost ($/ha)	Total Establishment Cost ($/ha)
1	ARG + clover	$185	$445
2	Ryecorn + clover	$161	$421
3	Ryecorn + IRG	$209	$469
4	Oats + clover	$97	$357
5	Barley + clover	$203	$463
6	Forage rape + ARG	$100	$360
7	Turnip + ARG	$88	$348
8	Pallaton brassica	$600	$860

Based on the cost of establishment and the amount of DM produced, the barley + clover and turnip + annual ryegrass mixes had the lowest cost of production based on sowing in April – $0.24 to $0.25/kg DM (Figure 5). The most expensive mix was the Pallaton brassica, sown in April, due to its high cost of establishment and low DM produced in early spring.

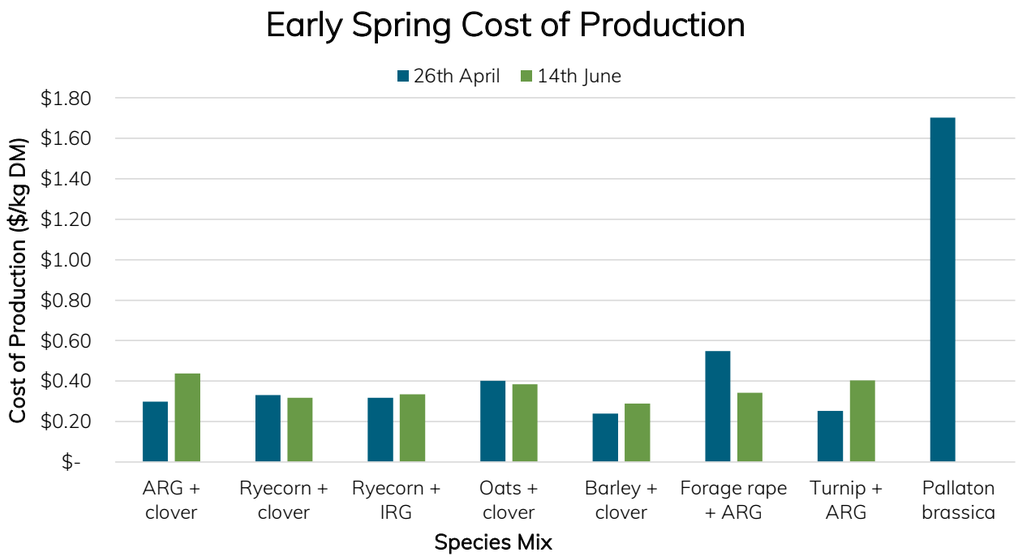

Figure 5. Early spring cost of production ($/kg DM) of each species mix for each time of sowing (26th April and 14th June). Note – ARG (annual ryegrass), IRG (Italian ryegrass).

In mid to late spring, the forage rape + annual ryegrass and turnip + annual ryegrass mixes had the lowest cost of production for both times of sowing ($0.15-0.16/kg DM when sown in April) (Figure 6). The Pallaton brassica again had the highest cost of production ($0.55/kg DM) when sown in June, but when sown in April the cost dropped to $0.36 which is comparable to other mixes such as barley + clover and ryecorn + clover.

The early summer cost of production increased considerably for mixes that contained cereals such as the oats + clover and barley + clover mixes, as their DM production was minimal in December (Figure 7).

Mixes containing brassicas (forage rape, turnip, Pallaton) had the lowest cost of production $0.53 to $0.89/kg DM. The annual ryegrass and Italian ryegrass in some mixes lowered costs due to their high DM produced in early summer.

The mixes with the lowest total cost of production were the forage rape + annual ryegrass and turnip + annual ryegrass, costing $0.09 to $0.11/kg DM (Figure 8). The Pallaton brassica had the highest total cost of production of $0.20/kg DM when sown in April and $0.33 when sown in June. For all mixes, the cost of production was lowest when they were sown in April compared to June.

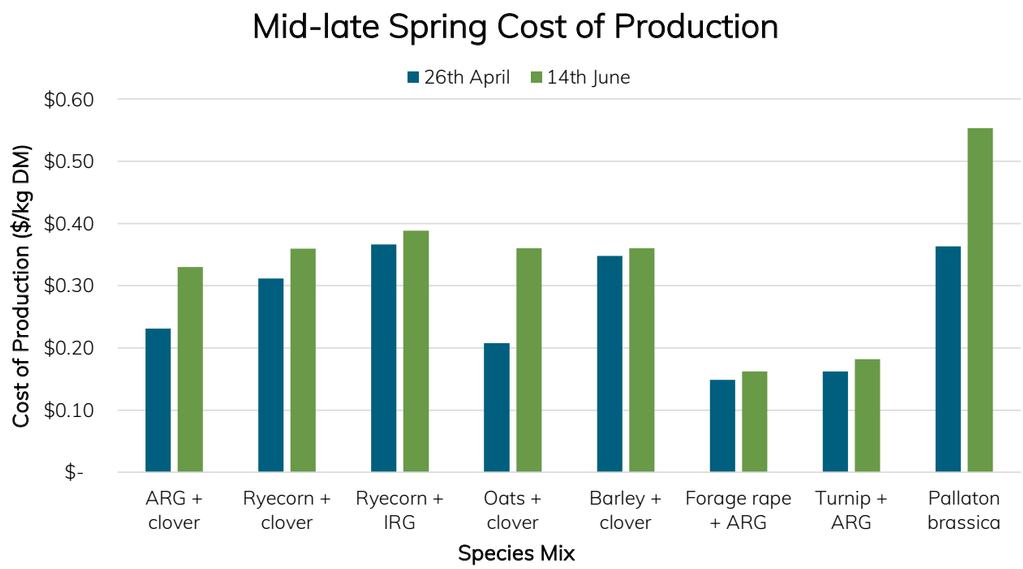

Figure 6. Mid to late spring cost of production ($/kg DM) of each species mix for each time of sowing (26th April and 14th June).

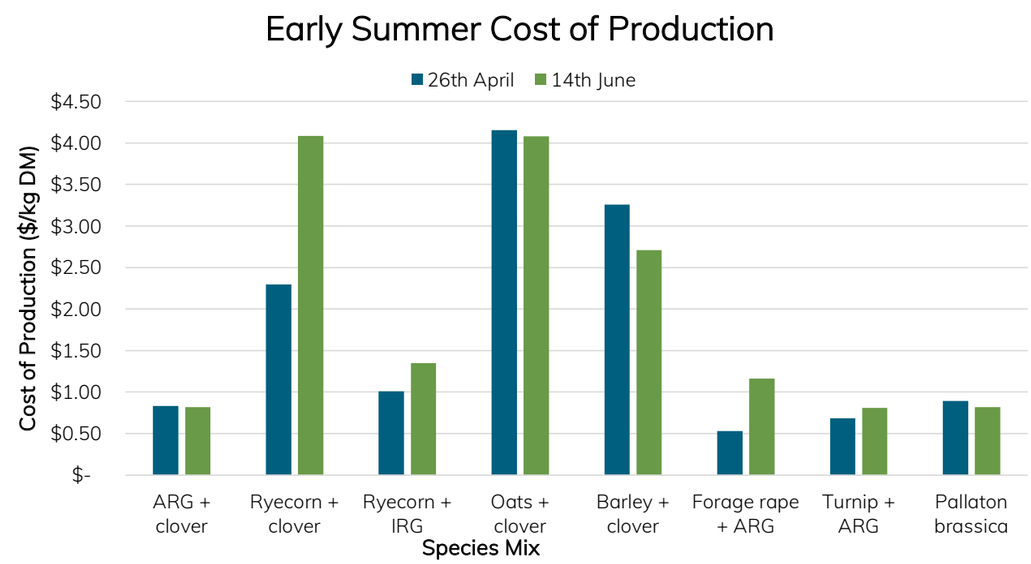

Figure 7. Early summer cost of production ($/kg DM) of each species mix for each time of sowing (26th April and 14th June).

Potential Weight Gains & Carrying Capacity

Potential weight gains and carrying capacity were calculated using the GrazFeed computer model. These were based on a 60 kg lactating ewe with a single lamb born in mid-July and weaned in mid-October. Inputs included DM production, ME, digestible dry matter % (DDM%) protein, and pasture height for each species mix, averaged across both sowing times.

In early spring, predicted weight gains for lambs ranged from 300 to 310 g/day, and for ewes ranged from 137 to 157 g/day (Figure 9). The highest weight gains were from the forage barley + clover mix.

Figure 10 shows the predicted carrying capacity of each species mix in early spring. The barley + clover mix had the highest capacity, predicted to carry 34 ewe and lamb units for two weeks. The Pallaton brassica had the lowest carrying capacity of 10 animals/ha as it produced the lowest amount of DM.

In mid to late spring, lamb daily weight gains ranged from 262 to 273 g/day, and ewes ranged from 141 to 162 g/day (Figure 11). The highest gains were seen from the forage barley + clover mix and the forage oats + clover mix.

In mid to late spring, the forage rape + annual ryegrass mix had the highest potential carrying capacity, with 43 ewes/ha to consume 2319 kg DM/ha over two weeks (Figure 12). The mixes with the lowest carrying capacities were the ryecorn + clover, ryecorn + Italian ryegrass and the barley + clover, carrying 23-24 ewes/ha.

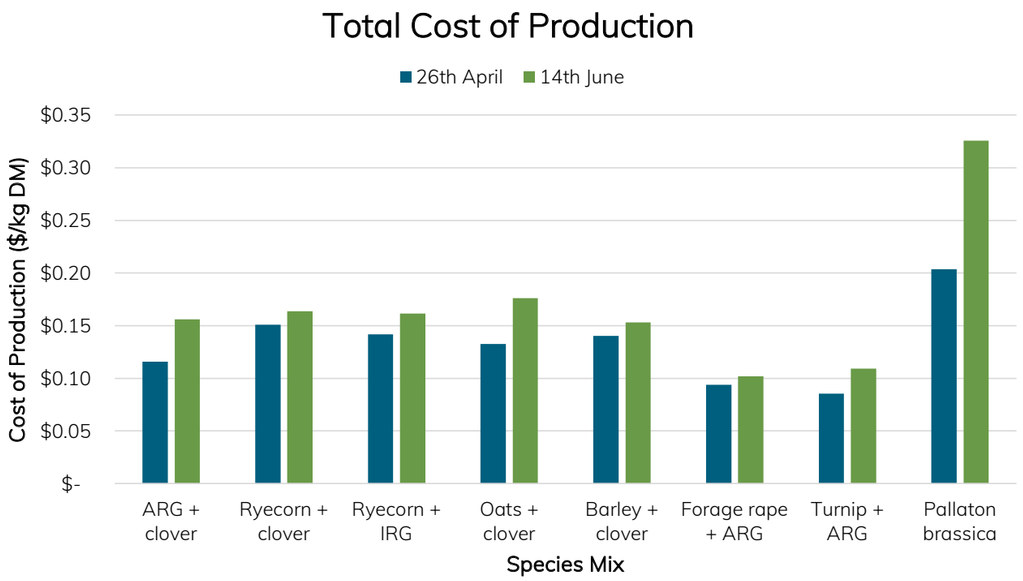

Figure 8. Total cost of production ($/kg DM) of each species mix for each time of sowing (26th April and 14th June).

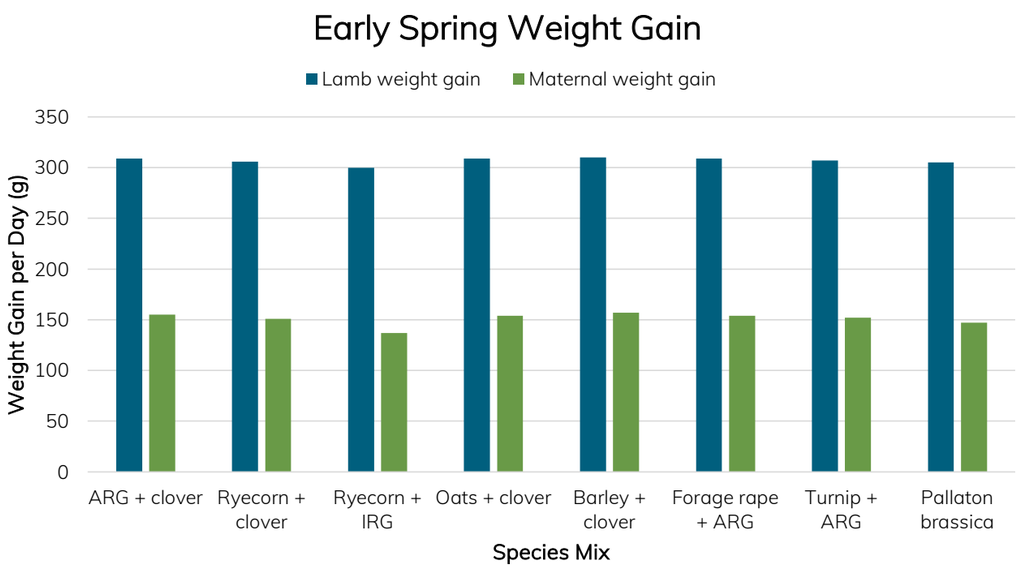

Figure 9. Predicted lamb and maternal weight gain (g) per day for each species mix based on early spring dry matter production.

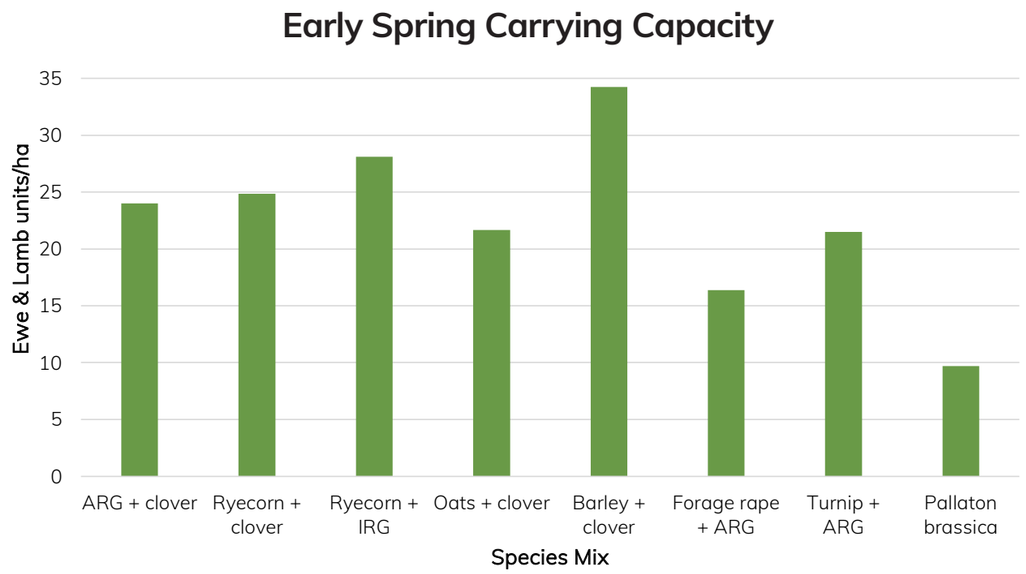

Figure 10. Potential carrying capacity of ewes and lambs based on early spring dry matter production.

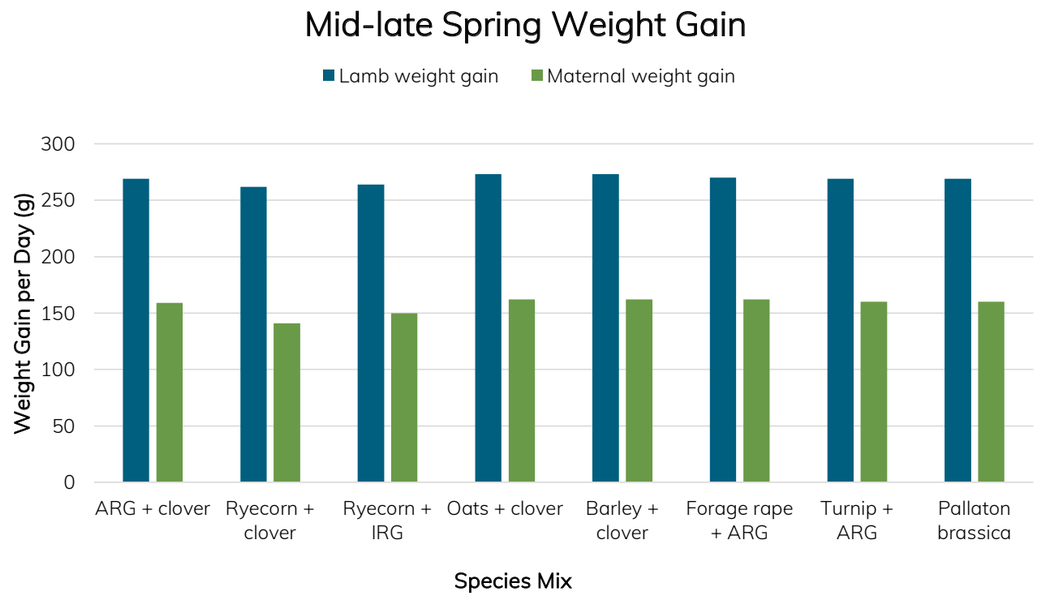

Figure 11. Predicted lamb and maternal weight gain (g) per day for each species mix based on mid to late spring dry matter production.

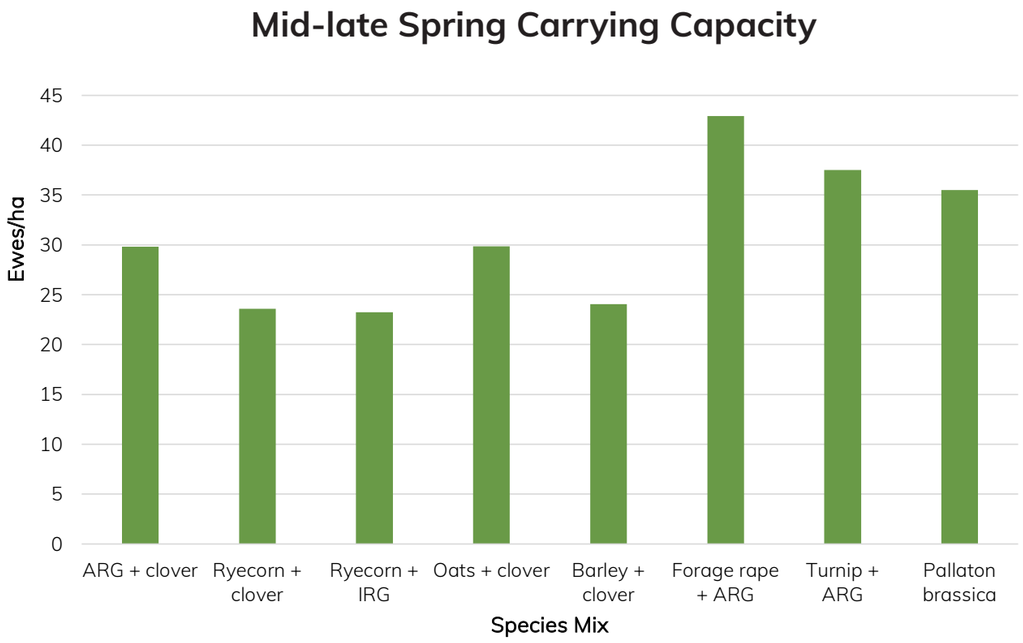

Figure 12. Potential carrying capacity of ewes based on mid to late spring dry matter production.

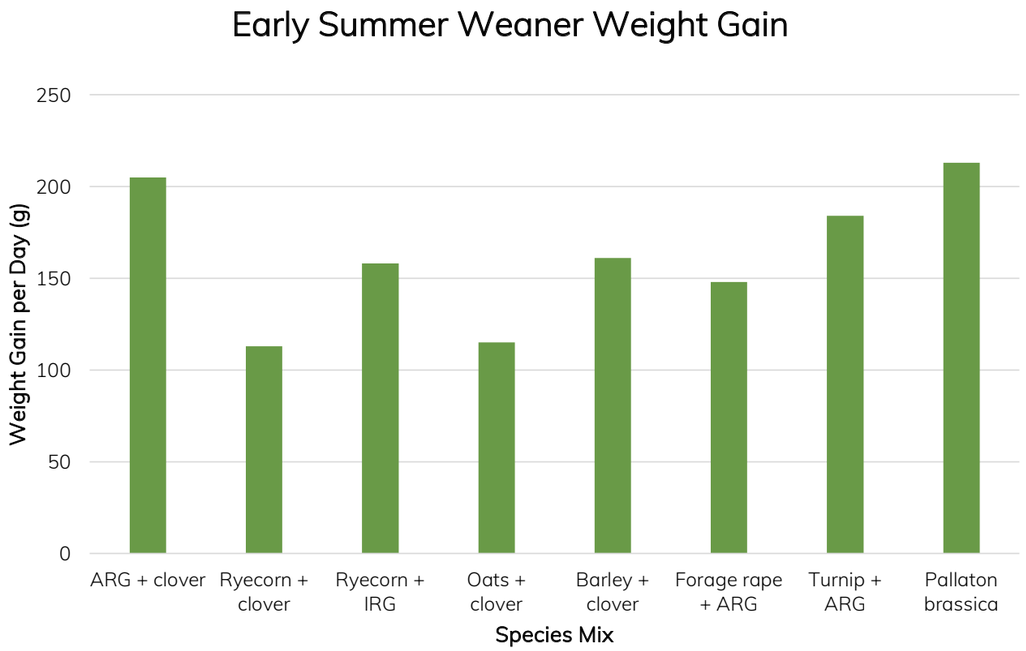

Figure 13. Predicted weaner weight gain (g) per day for each species mix based on early summer dry matter production.

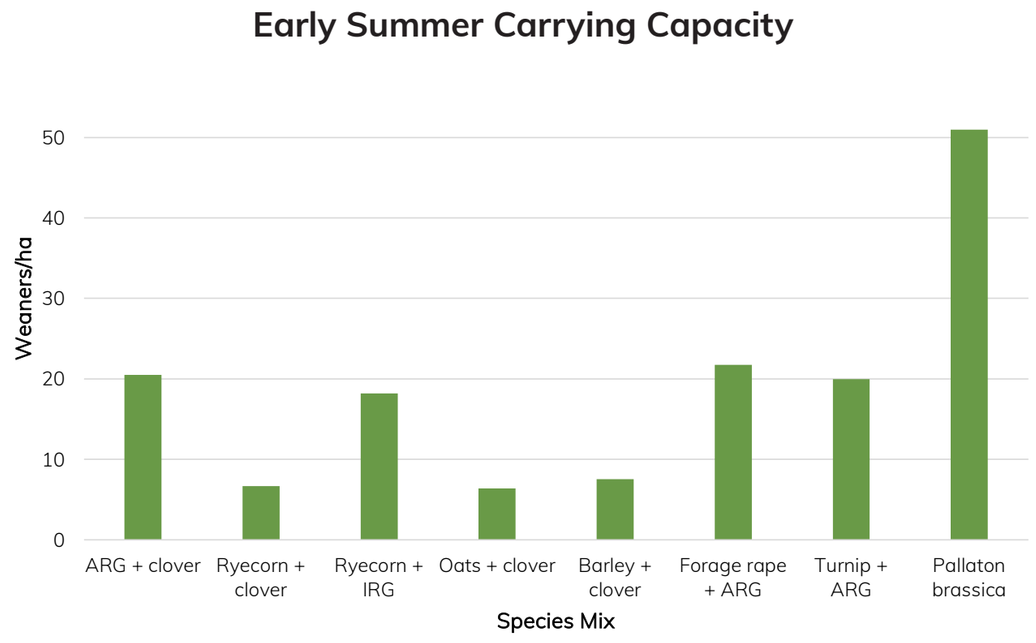

Figure 14. Potential carrying capacity of weaners based on early summer dry matter production.

In early summer, the lambs were now weaned and predicted daily weight gains ranged from 113 to 213 g/day (Figure 13). The highest predicted weight gains were from the Pallaton brassica. In early summer, the Pallaton brassica had the highest potential carrying capacity, as per the scenario of 51 weaners/ha to consume 1317 kg DM/ha in two weeks (Figure 14).

CONCLUSION

Although sowing late resulted in more plants being established, sowing earlier meant plants that did establish had higher growth earlier on, likely due to the warmer temperatures. This was reflected in the early spring DM and metabolisable energy produced.

The botanical composition of the mixes showed some companion species such as the clovers did not establish well or were outcompeted by the primary species. This contributed to the nutritive value results as those species were added to improve the feed quality of the mix over time. Mixes such as the turnips + annual ryegrass declined in quality as the brassica matured early, and the annual ryegrass continued to produce DM but did not have the same high quality.

Despite a late break and drought conditions in 2024, this trial showed that sowing early produced the greatest DM and the highest amount of quality feed. The forage barley + clover mix sown early was the best performing out of all mixes for early spring growth, although clover contributed little dry matter to the yield. Due to the dry autumn and winter, there was minimal winter growth from all mixes. This suggests that when there are unseasonably dry conditions, rather than using a 'wait and see' approach to sowing, sowing early with annual forages is a better approach to securing early spring feed.

This trial will be repeated in 2025 and 2026, with new mixes to determine the best species for the region and to explore a range of different seasonal conditions.

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