European Grassland Federation 2025: Multi-species visit to Germinal Horizon Wiltshire

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1.0 Multi-species 2020

A multi-species trial was sown in April 2020 to assess the capacity of multi-species swards to bolster on farm grazing yields, identify the contributions of individual species to yield and quality, and to assess the variation in performance under different nitrogen regimes. Plots were cut every 21-28 days to simulate a grazing rotation.

Trial mixture formulations

These range in complexity from a perennial ryegrass monoculture to a diverse mixture with 16 species.

Perennial Ryegrass		Perennial Ryegrass + White Clover		Aber Multi-Species Grazing	
Species	**Kg/ha**	**Species**	**Kg/ha**	**Species**	**Kg/ha**
PRG	34.60	PRG	34.60	PRG	22.23
		W Clover	2.47	Timothy	2.47
				W Clover	2.47
				R Clover	3.71
				Chicory	1.24
				Plantain	1.85
TOTAL	**34.60**		**37.07**		**33.96**

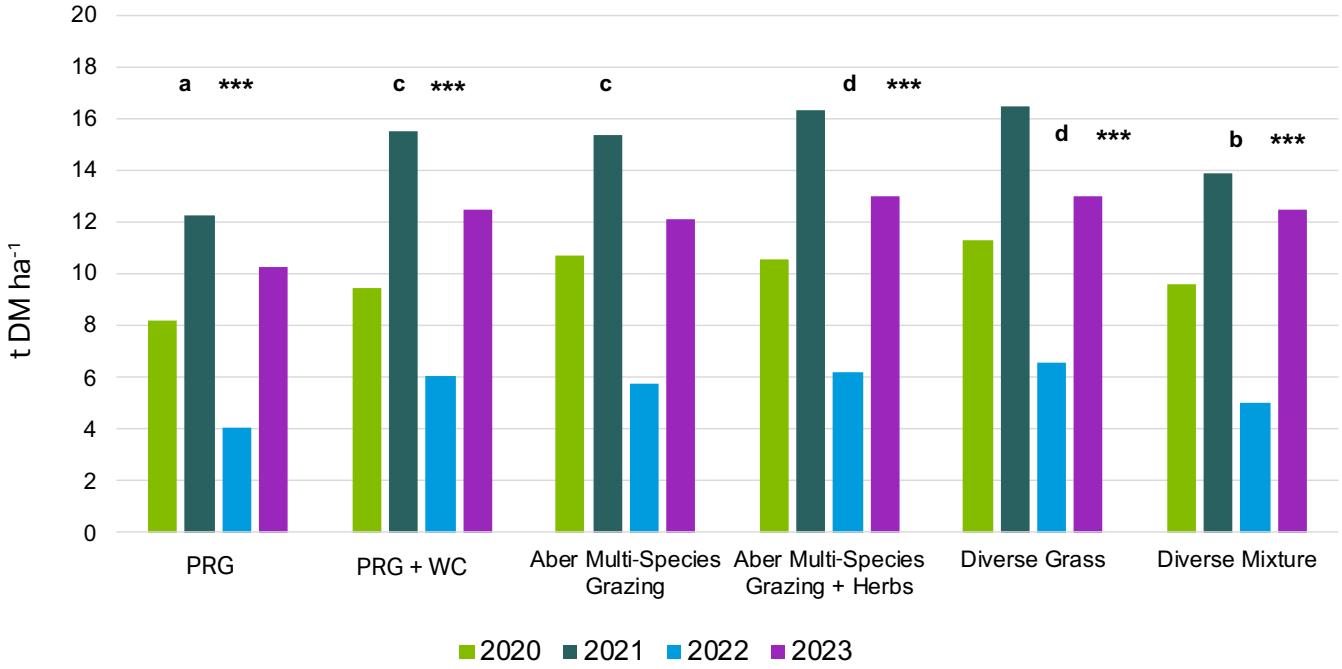
Aber Multi-Species Grazing + Herb Pack		Diverse Grass Mix		Diverse Mix	
Species	**Kg/ha**	**Species**	**Kg/ha**	**Species**	**Kg/ha**
PRG	22.23	PRG	7.42	PRG	3.21
Timothy	2.47	Timothy	2.47	Timothy	2.57
W Clover	2.47	Fescues	2.47	Fescues	2.89
R Clover	3.71	Cocksfoot	3.71	Cocksfoot	3.85
Alsike Clover	0.49	W Clover	2.47	R Clover	1.61
Black Medic	0.25	R Clover	3.71	Alsike Clover	1.29
Birdsfoot Trefoil	0.37	Chicory	1.24	Yellow Clover	2.57
Chicory	1.24	Plantain	1.85	Sainfoin	6.42
Plantain	1.85			Birdsfoot Trefoil	0.96
Other herbs	1.36			Chicory	1.93
				Plantain	0.32
				Sheeps Parsley	1.28
				Other herbs	1.06
TOTAL	**36.43**		**25.33**		**29.96**

The trial was tested under two nitrogen regimes.
Total annual levels were 150 and 250kg of nitrogen per hectare

Pre-first cut: taken 7th July 2020

The herbs established well and subsequently dominated the multi-species sward yields in the initial stages of the trial.

Over years yield summary



N.B * denotes a significant (*P*<0.05) mixture x nitrogen interaction.**

Key results

2020: The first season yields represented a part season of cutting following spring sowing – annual yields averaged 9.98t DM/ha.

2021: A good growing season which followed expected seasonal growth patterns - average annual yields totalled 14.96t DM/ha.

2022: Growth was significantly hampered by drought conditions with total annual yields averaging 5.62t DM/ha.

2023: Rain in the spring delayed first cut leading to high spring yields but then a return to expected seasonal growth thereafter - annual yields averaged 12.26t DM/ha.

There was a significant (*P*<0.001) yield elevation from the inclusion of legumes and herbs.

Additional fertiliser significantly (*P*<0.001) increased dry matter yields by 4.02t DM/ha over the lifetime of the trial.

There was a significant (*P*<0.001) nitrogen x mixture interaction displayed for all treatments, with the exception of Aber Multi-Species Grazing, which did not display a significant yield elevation from the additional 100kg N/ha.

Yield Summary: 2020-23

The perennial ryegrass monoculture was unilaterally the lowest yielding mixture, significantly (P<0.05) lower than all other mixtures, totalling 34.88t DM/ha over the lifetime of the trial.

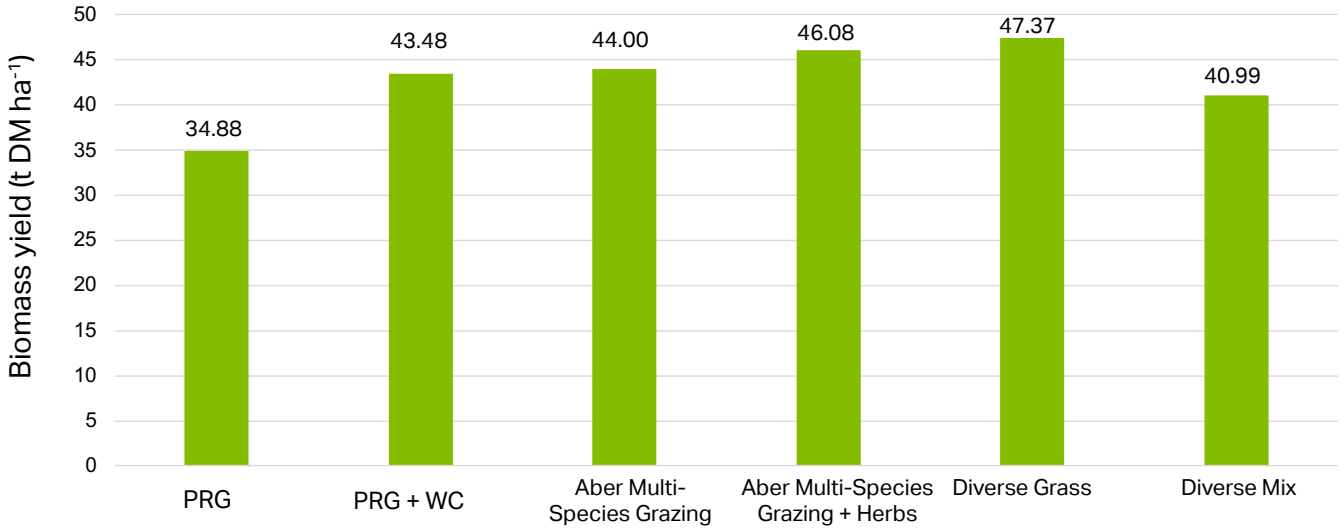
Adding white clover significantly (P<0.05) increased yields over the perennial ryegrass monoculture with lifetime total yields of 43.48t DM/ha.

The herb contributions from the more diverse multi-species swards meant they yielded significantly (P<0.05) higher than PRG + WC in the first harvest years.

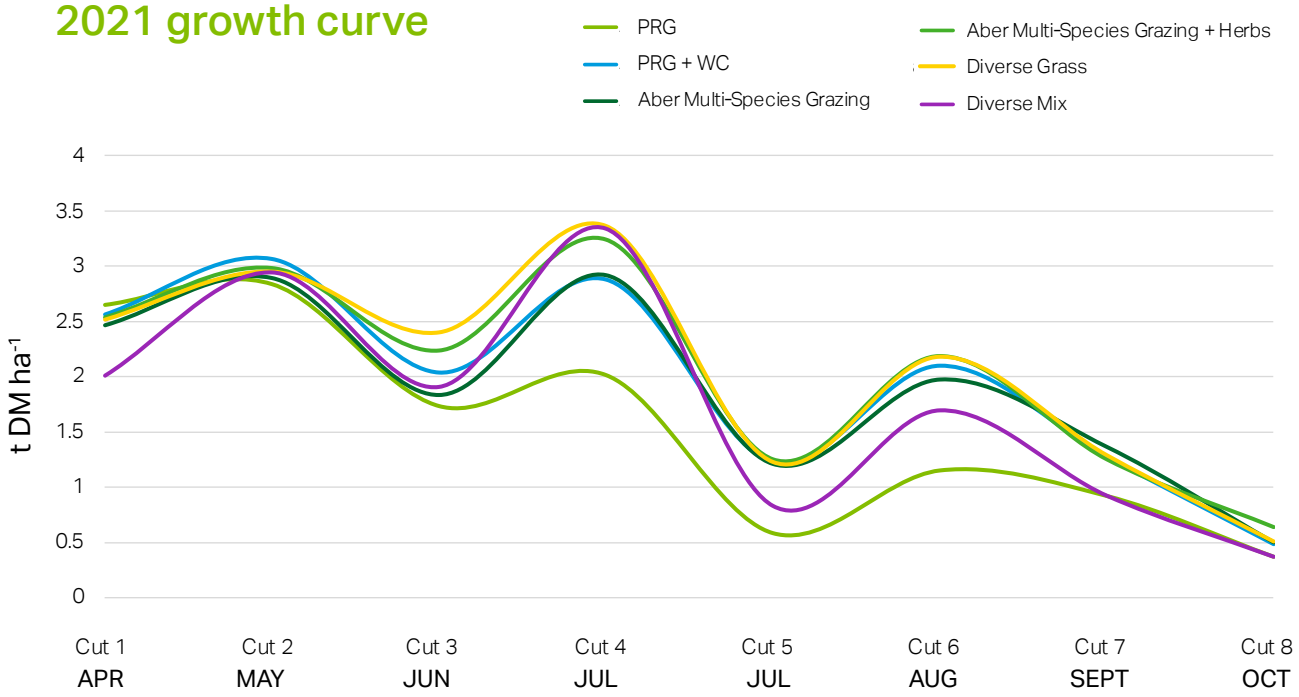
Herbal persistency depleted over time so in the latter seasons PRG + WC yielded comparably to the more diverse multi-species swards.

Generally, as the number of species increased so too did total dry matter yield. The exception to this was the Diverse Mixture which averaged 4.83t DM/ha less than the average of the other multi-species swards.

The Diverse Mixture contained 16 components of which some elements were very site specific. The Diverse Mixture also had the lowest perennial ryegrass seed rate, limiting first cut production levels. This allowed for increased persistency of some of the smaller herbs but ultimately compromised sward production.



2021 growth curve



Source of variation	d.f	m.s	v.r	F pr.
Mixture	5	1.902	102	<0.001
Fertiliser regime	1	0.8636	46.31	<0.001
Mixture x fertiliser regime	5	0.1902	10.20	<0.001
Residual	22	0.0187	0.87	

In the 2021 season significant (*P*<0.001) impact of both mixture and nitrogen application were observed. There were also significant (*P*<0.001) mixture x nitrogen interactions identified.

The perennial ryegrass and plantain components, present in most of the swards, meant that early season yields were broadly comparable. Where perennial ryegrass rates were lower reduced yields were compensated for by early season plantain growth.

The Diverse Mixture had reduced perennial ryegrass and reduced plantain therefore showed depleted yields early season in comparison to the other swards in trial.

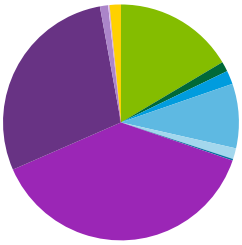
Between cuts 3-7 there were considerable mixture differentiations in yield. These differences were driven by how individual mixture components responded to climatic conditions.

Autumn cuts displayed lower yields with perennial ryegrass providing the backbone of yield at these timings.

Aber Multi-Species + Herbs sward changes over time

2020

Cut 1



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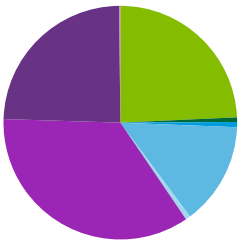
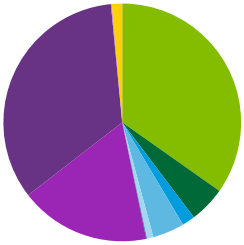
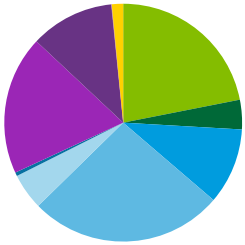


2021

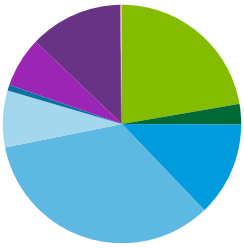
Cut 1



Cut 4

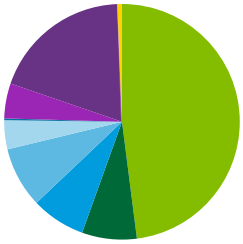


Cut 6



2022

Cut 1



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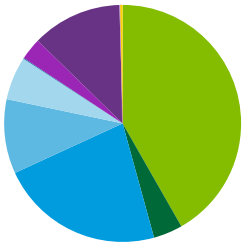
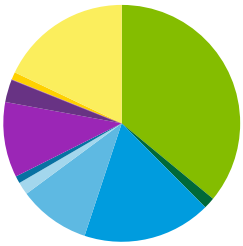
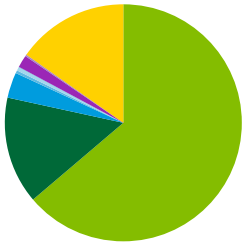


Cut 6



2023

Cut 1



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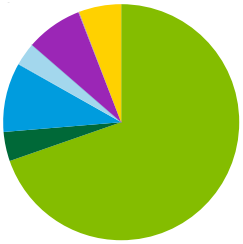


- PRG
- Timothy
- WC
- RC
- Alsike
- Black Medic
- Chicory
- Plantain
- Burnet
- Sheeps Parsley
- Yarrow
- Birdsfoot Trefoil
- Weeds
- Thatch

Summary

In Aber Multi Species + Herbs there were significant (*P*<0.05) botanical composition differences both between different cutting timings in the same harvest year and between different harvesting years.

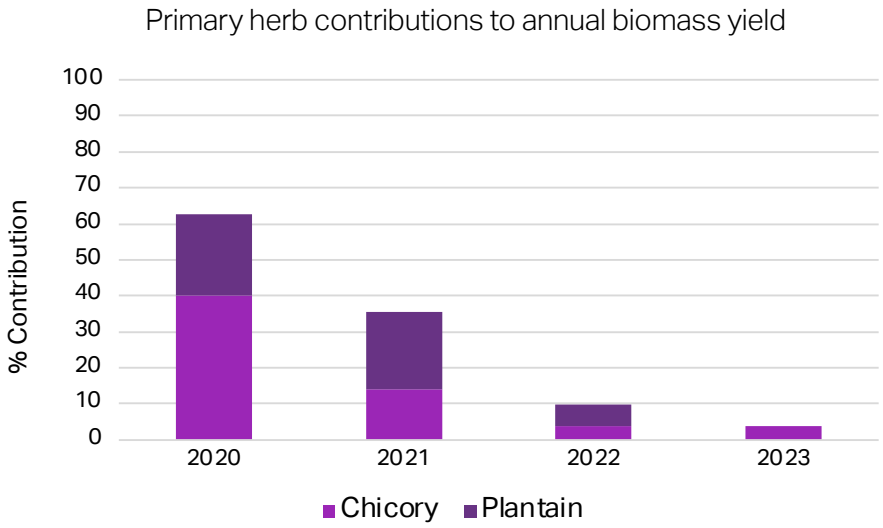
Overall, the primary herbs (chicory and plantain) dominated the initial season with a switch towards legume dominance by mid-season in 2021. During the severe drought in 2022 the legumes and grasses bolstered low total yields. In 2023 the culminating botanical separations of the trial period showed a grass takeover. Negligible contributions to yield from the 'secondary' herbs were observed at any assessment timing throughout the experiment.

Significant (*P*<0.05) interactions with nitrogen regime were also observed in some of the key species.

Multi-species sward component trends

Exploring multi-species sward compositions changes over the duration of the ley.

Chicory and Plantain



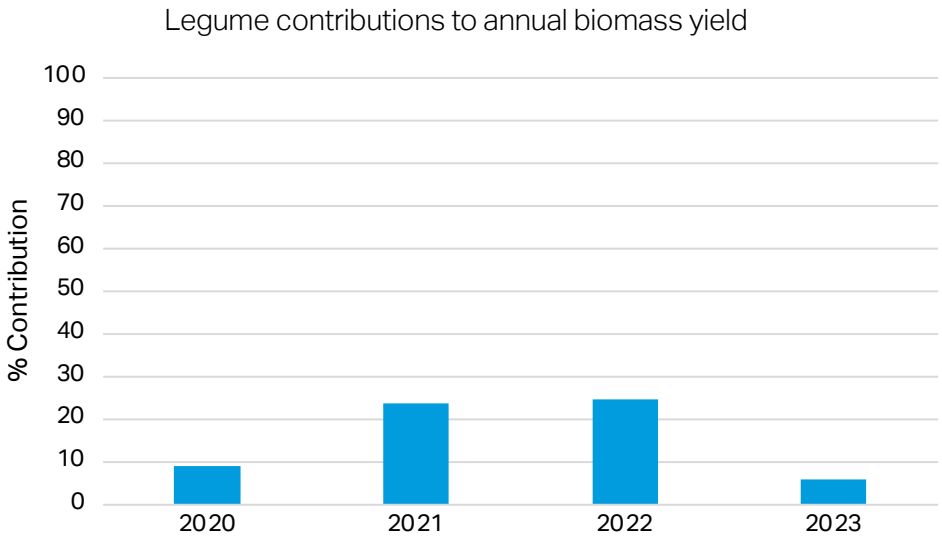
The dominant yield driver in the first two years were the primary herbs. Chicory and plantain collectively averaged 63 and 35 % of the total biomass in 2020 and 2021 respectively. The levels of chicory declined rapidly but then stabilised at between 3-8% across mixtures. Plantain displayed a more gradual decline but died out entirely by the final harvesting year.

Chicory contributions peaked mid-late season, often coinciding with periods of high soil moisture deficit. Plantain contributions were highest early spring but declined from mid-season onwards.

Chicory was highly responsive to nitrogen so an additional 20kg N/ha increased its contribution to first cut yield from 25.60% to 50.84% in 2020. No plant count differences were observed so it must be assumed that this was due to biomass production differences rather than adjustments in plant establishment levels.

Multi-species sward component trends

Legumes



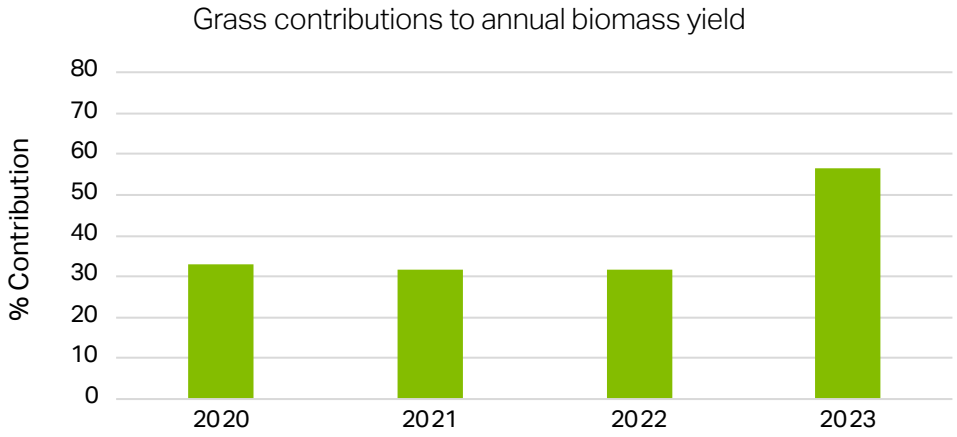
Legumes are known to be relatively slow to establish which was supported by relatively low first year contributions, averaging 9% of the total biomass. This elevated to maximum annual biomass contributions of 25% in 2022. The contraction to levels of 6% in 2023 was attributed to a prolonged drought in 2022 and subsequent plant loss.

In each season legumes were generally slow to accumulate biomass in the spring but increased in dominance from mid-season onwards. Over years the contributions from cut 1 averaged 12%, from cut 4 averaged 27% and from cut 6 averaged 43%.

Red clover was the dominant legume, followed by white clover, however red clover dramatically reduced from 2021-2023 with a 98.89% decline over two years. This was attributed to the frequent defoliation leading to weakening of plant reserves and depleted plant numbers. White clover expanded its contribution during the period of red clover decline and therefore partially buffered the overall legume contribution levels.

Multi-species sward component trends

Grasses

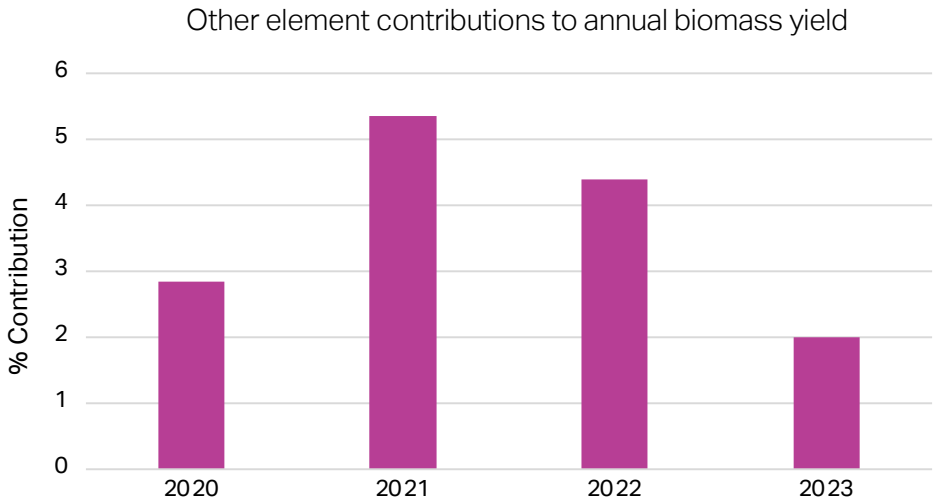


Perennial ryegrass dominance increased over the seasons from 31% to 56% by the final harvest year. Timothy followed the same trend over years but at overall lower levels with the peak reached in 2023 at just 9%.

Grass contributions followed the standard ryegrass growth curve with high contributions early season (35% at cut 1 in 2021), lower levels mid-season (22% at cut 4 in 2021) and slight elevation late season (22% at cut 6 in 2021).

Other elements

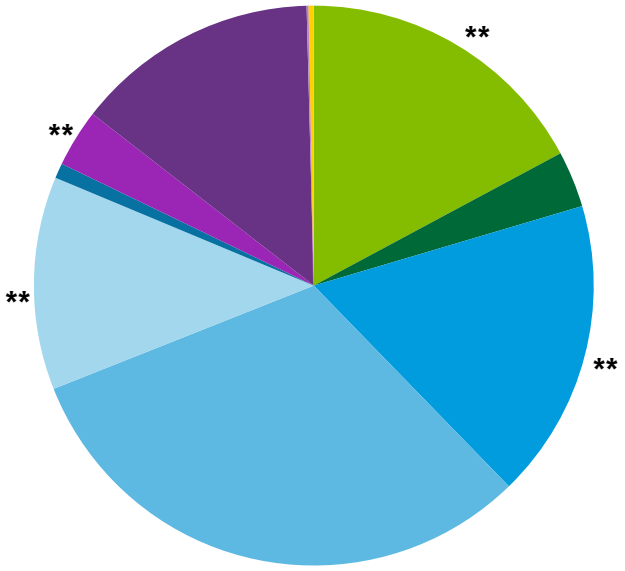
Aber Multi-Species Grazing + Herbs sward is displayed for contributions of secondary herbs and legumes in terms of biomass. The contributions of Alsike, Black Medic, Salad Burnet, Sheep's Parsley, Yarow and Birdsfoot Trefoil are presented below as an accumulated total.



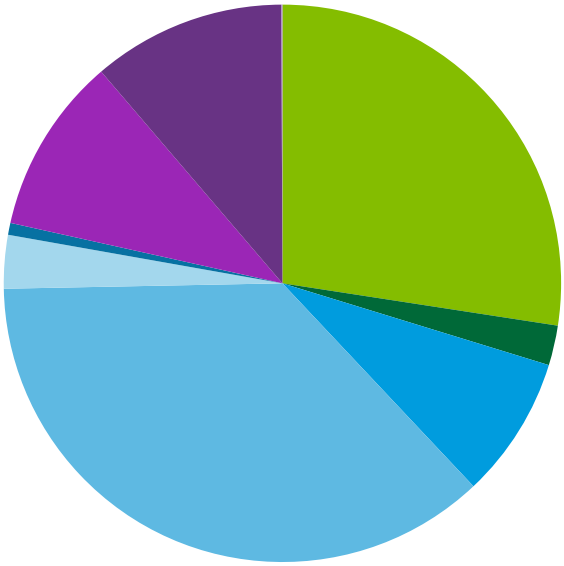
The total contribution of these six elements to biomass yield was very low. The majority of the biomass contribution was derived from Alsike clover, at 1.01% (2020), 4.51% (2021), 3.88% (2022) and 1.82% (2023). These elements did not constitute a significant proportion of total biomass produced from the sward at any timing.

Nitrogen regime impact on sward composition

Aber MSG + Herbs 2021
Cut 6 150kg N ha^{-1}



Aber MSG + Herbs 2021
Cut 6 250kg N ha^{-1}



NB ** denotes (*P*<0.01) component x N regime interaction.

PRG	Alsike	Burnet	Weeds
Timothy	Black Medic	Sheeps Parsley	Thatch
WC	Chicory	Yarrow	
RC	Plantain	Birdsfoot Trefoil	

Fertiliser significantly elevated biomass yields over the trial period. Fertiliser regime also impacted the composition of the sward as demonstrated in Aber Multi-Species Grazing + Herbs cut 6 in 2021. Species that have a higher nitrogen requirement or nitrogen use efficiency, such as perennial ryegrass and chicory, produced significantly higher levels of biomass under the 250kg N/ha regime.

In contrast legumes (Alsike and white clover) produced significantly higher biomass levels under the 150kg N/ha regime. This was attributed to improved biological nitrogen fixation at lower artificial nitrogen application rates.

2.0 Multi-species 2023

Trial mixture formulations

PRG	Kg/ha	PRG + WC	Kg/ha	Simple MS	Kg/ha	Aber MSG	Kg/ha
AberGain	34.6	AberGain	8.65	AberGain	6.80	AberGain	3.71
AberRoot	8.65	AberRoot	8.65	AberRoot	6.80	AberRoot	3.71
AberSevern	17.30	AberSevern	17.30	AberSevern	13.59	AberSevern	14.83
		AberPasture	2.47	AberPasture	4.32	Timothy	2.47
				Plantain	2.96	AberPasture	2.47
						AberClaret	3.71
						Plantain	1.85
						Chicory	1.24

Aber MSG + Herbs	Kg/ha	Diverse Grass	Kg/ha	Diverse Mix	Kg/ha	Future Mix	Kg/ha
AberGain	3.71	AberGain	1.86	AberGain	3.00	AberGain	1.86
AberRoot	3.71	AberRoot	1.86	AberRoot	3.00	AberRoot	1.86
AberSevern	14.83	AberSevern	3.71	AberSevern	3.00	AberSevern	3.71
Timothy	2.47	Timothy	2.47	Timothy	1.27	Timothy	2.47
AberPasture	2.47	Cocksfoot	3.71	Cocksfoot	4.00	Cocksfoot	3.71
AberClaret	3.71	Tall Fescue	1.24	Tall Fescue	1.27	Tall Fescue	1.24
Alsike	0.50	Meadow Fescue	1.24	Meadow Fescue	1.01	Meadow Fescue	1.24
Birdsfoot Trefoil	0.37	AberPasture	1.24	AberPasture	1.85	AberLasting	1.24
Black Medic	0.25	AberClaret	3.71	AberClaret	1.85	AberClaret	3.71
Plantain	1.85	Alsike	0.50	Alsike	0.16	Alsike	1.00
Chicory	1.24	Birdsfoot Trefoil	0.37	Birdsfoot Trefoil	0.16	Future BFT	0.37
Burnet	0.74	Black Medic	0.25	Sainfoin	6.24	Future grazing lucerne	5.00
Sheeps Parsley	0.37	Red Runner	1.24	Lucerne	0.88	Red Runner	3.00
Yarrow	0.25	Plantain	0.50	Plantain	0.50	Plantain	1.85
		Chicory	1.50	Chicory	1.50	Chicory	1.24
		Burnet	1.88	Burnet	1.88	Burnet	0.74
		Sheeps Parsley	0.38	Sheeps Parsley	0.38	Sheeps Parsley	0.37
		Yarrow	0.13	Yarrow	0.13	Yarrow	0.25

Trial nitrogen regime: 150kg N/ha (akin to animal returns)

Multi-species 2023: Context of future research

Chicory persistence

Previous study, at Germinal Horizon Wiltshire, indicated significant (P<0.05) differences in the persistency of chicory populations, after four harvest years. This was attributed to differences in the frequency of repeated defoliation.

An extended defoliation interval (42-56 days) increased the chicory population over a shorter defoliation interval (21-28 days).

Defoliation impact on total biomass yield and biomass quality

Biomass Yield

A Haldrup plot harvester was used to cut plots to a residual height of 5cm over a three-year period, on the 21-28 day and 42-56 day defoliation intervals. The data from the harvesting operations was utilised to calculate annual dry matter yields.

Defoliation timing significantly (P<0.05) impacted annual dry matter yields. The longer harvesting interval led to yearly yield mean elevations of 2.29t DM ha^{-1}.

Biomass Quality

Data was collated from mid-season defoliation, when the swards are generally under the highest levels of summer stress. No significant differences were demonstrated between the two mixtures under examination.

The longer defoliation timing, however, significantly (P<0.05) elevated the fibre content (MADF) by 2.4 percentage points. The higher levels of structural fibres co-occurred with a depression of the ME content of the swards. The metabolisable energy and crude protein decreased by 0.34 MJ/kg and 3.5 percentage points, respectively, under the longer defoliation interval.

Future Work

The preliminary results obtained from previous trials at Germinal Horizon Wiltshire sparked research questions which have informed the most recent multi-species trial, sown in 2023.

Research questions for future work :

- Are there differences in persistency of multi-species sward components under different defoliation intervals?
- How do residual cutting / grazing heights impact sward composition, yield and quality?
- Is the increased yield from longer defoliation intervals utilisable?
- Is there an impact on soil health from livestock treading in more lignified plant growth?
- How does the browsing nature of animals impact the quality of forage when adjusted for sward intake?

3.0 Legumes and forbs

Summary of species quality information

Component	Early season		Mid-season		Late season	
	ME	CP	ME	CP	ME	CP
Perennial Ryegrass	11.43	13.99	10.79	12.13	11.22	16.34
Timothy	10.61	15.44	10.28	15.54		
Cocksfoot	11.02	15.69	9.92	13.36	10.66	15.45
Tall/Meadow Fescue	11.79	12.64	11.44	16.41	11.12	16.18
White Clover	11.65	25.17	11.01	20.51	11.77	23.52
Red Clover	11.47	20.49	11.54	20.74	11.58	24.51
Alsike Clover	11.18	21.42	11.22	20.88	11.19	21.71
Black Medic	11.84	22.19	11.2	24.94	12.41	23.81
Sweet Clover	11.18	22	11.82	24.62	12.12	22.05
Sainfoin	10.29	15.83	11.36	20.21	11.67	21.18
Birdsfoot Trefoil	11.74	24.76	11.53	25.87	11.58	21.75
Chicory	11.92	15.02	9.65	13.23	11.27	18.08
Plantain	11.41	13.49	10.37	14.24	11.40	16.68
Sheep's Parsley	11.15	14.46	12.01	14.81	12.6	13.62
Knapweed	11.16	17.05	12.22	15.05	11.96	14.87
Yarrow			10.24	16.38	10.24	16.38
Burnet	12.02	14.22	12.02	14.22	12.66	17.12

ME = metabolisable energy CP = crude protein

The grasses displayed relatively stable ME and crude protein levels across the season.

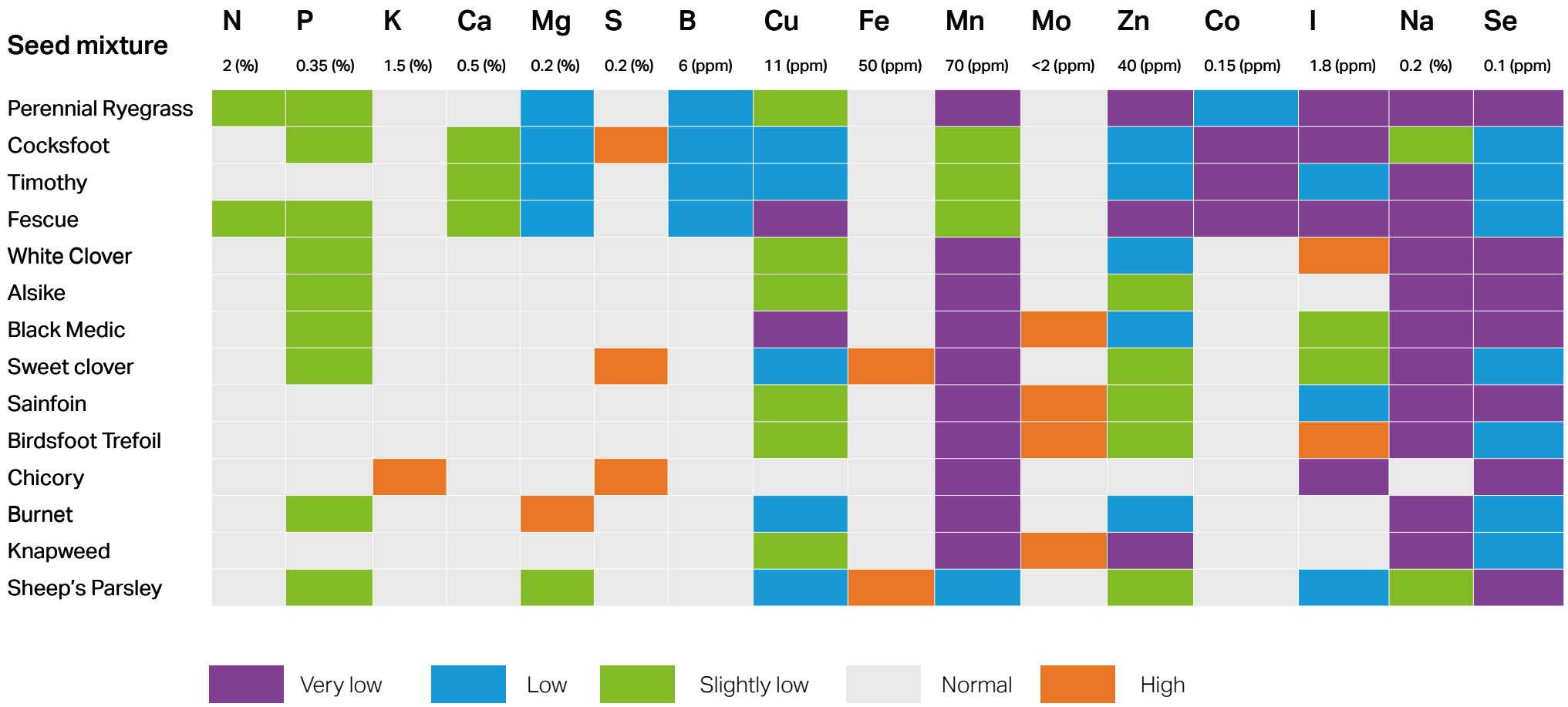
Legumes were the most ME and crude protein rich elements under test averaging 11.49MJ/kg for ME and 22.29% for crude protein across the testing period.

Sainfoin displayed some evidence of reduced crude protein levels early season, but this result was treated with caution due to the soil texture being suboptimal for sainfoin growth.

The herbs displayed the largest variation in quality parameters, both between species and between assessment timings. Herbs displayed ME levels comparable to the grasses overall but with large ME contractions displayed by chicory and plantain mid-season. This was attributed to the increased structural fibre and reproductive growth present in the chicory and plantain plants during the summer assessment timing. Crude protein levels were broadly comparable to the grasses but elevated late season in chicory, plantain and salad burnet.

Germinal Horizon

Species mineral content



Species mineral content

Forage mineral contents were driven by soil availability of minerals with low soil levels co-occurring with low tissue levels and vice versa.

In general, the grasses showed a decreased ability to assimilate minerals in aboveground material. The exception to this was manganese where cocksfoot, timothy and fescues displayed higher levels than the legumes and herbs under test.

Chicory displayed elevated levels of potassium and sulphur in aboveground material which was attributed to extraction from the soil via its deep tap root.

The legumes and herbs generally displayed a better ability to uptake zinc, cobalt and iodine and assimilate it into plant tissue.

Black medic, sainfoin, birdsfoot trefoil and knapweed displayed increased molybdenum levels in aboveground material.

Many of the secondary herbs contributed very low levels of biomass to overall sward yields so it was hypothesised that increased mineral contents would be unlikely to have any effect on livestock health due to limited intake quantities.