Farm Net Zero Herbal leys for dairy field lab

Final report

September 2025

Authors: Laura Gude, Dr Daniel Enriquez-Hidalgo and Andrew Brewer

Summary of the report

The aim of the field lab was to show if milk production (yield and composition) changed according to whether the cows grazed herbal leys (multispecies) or ryegrass-clover swards.

Context

Although Multi Species Swads (herbal leys) can be beneficial to soil and animal health, farmers in Cornwall were worried that they would negatively impact milk quality and yield.

Trial design

46 spring-calving dairy cows were assigned to two separate groups. One group grazed perennial ryegrass and white clover swards (PRGWCS), the other group grazed multispecies swards (MSS) or herbal leys, both located in a comercial farm. Cows grazed these swards from 23rd April until 17th September 2024. Individual milk yields were recorded on weeks 1, 4, 6, 11, 13 and 21; and milk composition was estimated on most of those weeks. Forage data was collected regularly (herbage mass, pre- and post-grazing extended sward heights, nutritional and botanical compositions).

Findings

Cows grazing multi-species swards (MSS) or herbal leys had ~40% greater herbage availability and consistently higher pre- and post-grazing sward height than those grazing ryegrass white clover swards (PRGWCS), indicating lighter grazing for the PRGWCS cows. PRGWCS were grass-dominated, while MSS showed greater botanical diversity, with higher proportions of herbs and legumes, especially later in the season.

MSS herbage had lower dry matter (−20%), water-soluble carbohydrates (−30%), and neutral detergent fibre (−13%), but higher crude protein (+27%) and ash (+13%), reflecting particularly the greater presence of legumes and herbs. Despite these compositional differences, digestible organic matter was similar between swards.

Milk yield (10.2 kg/d) and milk composition did not differ between treatments overall, although small, week-specific advantages for PRGWCS were observed for milk solids and protein. The lack of milk response was likely due to similar digestibility and trade-offs between higher protein in MSS and higher sugars in PRGWCS.

Take home messages

Multi-species swards and ryegrass white clover swards have different nutritional values. However, cows grazing multispecies swards were able to maintain similar milk and solids yields to their counterparts grazing conventional perennial ryegrass and white clover swards for at least the 5 months that lasted the trial.

Recommendations & next steps

Cattle outcomes, such as milk yield or milk solids yields, grazing multi-species swards will depend on how the swards are managed and, therefore, the presense of the species that

have the potential to offer different characteristics to those observed in conventional ryegrass white clover sward.

Under the management conditions used in this study, herbages in the milti-species and ryegrass white clover swards had different herbage characteristics, but despite that, cows grazing either of swards had similar milk yields. While we didn't assess other charactersitics of these swards, these findings highlight that multi-species swards' potential soil and biodiversity benefits can be achived withouth compromising cattle productivity.

We only managed to study both groups until September and under a wet year, therefore would be very valuable to assess cattle responses grazing these swards later in the grazing season and also under drier conditions, when herbs's contribution to the multi-species swards and their effects shall be greater.

Useful resources

https://www.sciencedirect.com/science/article/pii/S0022030219310537

Main report

1 Field lab question:

Does milk yield and composition change according to whether the cows graze herbal leys (multispecies swards) or ryegrass-clover swards?

2 Background

Most UK dairy systems graze their cows on perennial ryegrass and white clover swards (PRGWCS) because they are productive, generating herbage of high nutritional quality, and they are easy to establish and manage, being highly responsive to external inputs.

However, in recent years many dairy farmers have considered including more diversity in their grazing platforms. This is partly due to an increased understanding of the potential benefits of multispecies swards (MSS), and partly because increasingly erratic weather patterns (particularly prolonged droughts) have raised concerns about the long-term sustainability and resilience of ryegrass swards. Establishing herbal leys / MSS on grazing platforms can provide many benefits, including:

- Improving soil structure and health through deeper and more varied rooting systems
- Providing resilience in dry periods due to presence of deeper rooting species
- Extending the grazing season due to varied and complementary growth curves
- Benefiting carbon sequestration through deep-rooting species that build soil organic matter, diverse plant and microbial communities that improve soil structure and nutrient cycling.
- Providing Nitrogen fixation from legume species, so less artificial fertiliser is required.
- Improving livestock growth rates when rotationally grazed through a combination of enhanced nutrition, improved health, and a reduction in internal parasites
- Improving animal health: higher mineral content and potentially anthelmintic properties means potentially less need for wormers
- Improving biodiversity through providing a diverse and nutritious food source and habitats for bird and insect species.

However, there is little information about how increased sward diversity impacts milk yield and quality. This effect on milk has not been properly trialled, recorded and shared in the UK before, due to the difficulty of creating a trial which can accurately compare the two swards on real farms.

This unquantified effect is a potential financial risk for dairy farmers who rely on steady milk production for their milk contracts. Since processors require a reliable, consistent volume of milk to meet market demand, ensuring a consistent output is essential to manage risks and secure a predictable income in a volatile market.

In this Farm Net Zero field lab Andrew Brewer, dairy farmer in Cornwall, wanted to provide data on this effect. He split his dairy herd and monitored the difference between milk produced by cows grazing PRGWCS and cows grazing MSS.

For clarity, in this report we shall use the term 'multispecies sward' (MSS) to include diverse swards and herbal leys.

3. Who's involved

The idea for this field lab arose from Andrew's previous work with Farm Carbon Toolkit, and grew from the Farm Net Zero project discussion groups. The field lab is part of the Farm Net Zero Project in Cornwall, funded by the National Lottery Community Fund.

The trial is an Innovative Farmers field lab, coordinated by Laura Gude. The research is being led by Dr Daniel Enriquez-Hidalgo of the University of Bristol Veterinary School, with assistance from Cornwall Wildlife Trust and Amanda Dutton. The analysis is being carried out by Cornwall College laboratory, and AFBI lab in Northern Ireland (chosen because they are able to calibrate the usage of NIRS to estimate multispecies sward nutritional composition).

4. Trial design

Andrew and his wife Claire are dairy farmers in Cornwall, and MSS now make up about 30% of their grazing area. In April 2024, 46 spring-calving cows of Andrew and Claire's farm were matched in pairs according to their calving date, lactation, previous milk and milk solids yields. From within each pair with similar characteristics, each cow was randomly allocated to one of two groups. One trial group was grazed on MSS, and the other, a control group, was grazed on PRGWCS. The trial lasted from April – September 2024.

Forage samples were collected at monthly intervals from the swards about to be grazed by each group. These samples were cut to mimic the residuals left by the cows, thereby giving as accurate a picture as possible of what the cows would be eating the next day. A subsample was separated into grass species, herb species and weeds to provide a rough profile of the species composition in the swards. Another subsample was then weighed and dried at the Cornwall College laboratory and then sent to AFBI laboratory, chosen because they are able to calibrate the usage of NIRS (Near Infrared Spectroscopy) a cheaper option than the traditional wet chemistry method, to estimate MSS' nutritional composition.

Morning milk yield was measured on weeks 1, 4, 6, 11, 13 and 21 of the trial. Morning milk samples were taken on weeks on weeks 1, 4, 6, 9, and 21. Milk samples were taken within three days of the forage sampling to reflect the forage samples collected. Milk samples were then sent to be analysed for protein, fat, lactose and somatic cell count. Milk solids were then calculated for the weeks when milk yield and contents were available.

6. Results and discussions

Forage

The main forage characteristics can be seen in Table 1. The results of the trial showed that the cows grazing the MSS had almost 40% more herbage on offer that the PRGWCS control group, though at the later part of the trial the herbage on offer was similar for both groups. An 11% higher (and persistent along the study) pre-grazing extended sward height was observed for the MSS swards. The cows grazed the herbage more lightly, having 11% higher post-grazing extended sward height than the cows grazing PRGWCS.

Herbage botanical composition, as expected, varied along the grazing season. The PRGWCS were dominated by grasses, with 8% DM of legumes and 4% of weeds. Legumes and weeds were more expressive at the latter part of the grazing season. Almost half of the DM from the MSS was of grasses, almost one third of herbs, 15% of legumes and 6% of weeds. Herbs presence was low (less than 15%) on weeks 13 and 21 but quite high, more than 50%, on weeks 17 and 28. Herbs' space was taken up mainly by grasses earlier on the year but on weeks 21 and 28 legumes were quite evident, competing well with the other species. This trend is expected as legumes, especially white clover, prefers the warmer and drier conditions observed during the summer.

Herbage quality on offer varied along the trial, likely as a response of the species variations within the swards on offer, particularly for the MSS.

The MSS had overall 20% lower DM but 27% higher crude protein than the PRGWCS, being that the differences were highest at the later part of the study, likely reflecting the higher presence of herbs and legumes at this time of the year. MSS had 30% less WSC than the PRGWCS, reflecting both, the higher presence of grasses rich in WSC in the PRGWCS and the particularly lower WSC of the legumes that were more evident after week 17.

The MSS had 13% lower neutral detergent fibre than the PRGWCS, but both swards had similar acid detergent fibre. The herbs' known high mineral content was likely the reason behind the 13% higher ash content observed for the MSS.

Overall, reflecting the contrasting responses in herbage mass, carbohydrates and protein, the two swards had a similar digestible organic matter, but the PRGWCS had a higher dry matter, neutral detergent fibre and water-soluble carbohydrates, but lower crude protein and ash contents. The multispecies swards had greater content of legumes and herbs, but lower grasses than the PRGWCS swards.

Milk

The cows from both groups had similar morning milk yields (10.2kg/d) in both groups.

In addition, the milk constituents were also similar: milk solids (0.82kg/d), protein (2.91%), fat (3,22%) and lactose (4.35%) contents. All milk variables changed across time, reflecting natural physiological milk lactation responses with no major differences between both groups. However, the milk solids were 25% higher for the cows on the PRGWCS on the first week of the trial and the protein content was 35% higher for the cows grazing PRGWCS on the 9th week of the study. The lack in milk production (yield and solids) differences was

unexpected since, for example, a previous metanalysis carried out by McCarthy et al (2020) [1] including studies from different parts of the world, but not from the UK, has shown that MSS can increase milk production when compared to less diverse swards. The lack of milk production differences we observed is in line with the similar OMD that the herbages showed.

On one hand, it is possible that the PRGWCS had a relative low restriction in protein, hampering the potential higher production that these cows could have due to the higher water-soluble carbohydrates that these swards had. On the other hand, the low water-soluble carbohydrates, despite the MSS' lower neutral detergent fibre but higher protein and greater herbage masses, may have resulted in slightly lower herbage quality than expected, thus not generating a positive effect in milk production.

Table 1. Effect of sward type on sward measurements, herbage chemical and botanical composition.

	Sward type			Sward		Sward type
	MSS	PRGWCS	SEM	type	Week	x Week
Herbage mass (kg DM/ha)	1775	1274	74.4	***	***	***
Pre grazing height (cm)	23.1	20.7	0.59	***	***	0.25
Post grazing height (cm)	10.5	9.5	0.04	***	***	***
Chemical composition (DM, g/kg)						
DOMD (%)	64.3	65.4	0.67	0.28	0.02	0.01
Dry matter	157	195	3.3	***	***	***
Crude protein	120	95	3.4	***	***	0.02
Neutral detergent fibre	442	511	10.6	***	***	0.84
Acid detergent fibre	296	307	5.5	0.15	***	0.07
Watter-soluble carbohydrates	139	199	6.6	***	***	0.01
Ash	120	106	2.3	***	***	0.30
Botanical composition (DM, g/kg)						
Legumes	146	79	16.7	0.01	***	0.35
Grasses	478	883	27.2	***	**	***
Herbs	315	0	21.1	***	***	***

[1] https://www.sciencedirect.com/science/article/pii/S0022030219310537

Weeds	61	39	17.8	0.38	0.67	0.06

SEM: Standard error of the mean; **: P<0.01; ***: P<0.001

Issues with the trial

The trial was onerous for the farmer as it required additional management time for Andrew and his team. It was also complicated in terms of managing the forage sampling and milk sampling to coincide.

Originally the trial was meant to last for a whole year, with pauses during calving periods. As Andrew usually outwinters his cows, we hoped that we could follow them throughout the year as they moved about the grazing platforms. However, the weather at the beginning of 2024 was extremely wet, and management requirements meant that Andrew was unable to split the herd until March. No milk samples could be taken until the cows had spent a month in their separate groups, since it takes up to four weeks for the rumen to adapt to the diet and the cow's body to respond.

Unfortunately, we were also unable to continue the trial beyond September due to circumstances beyond our control. This meant that we could not collect data during the autumn. Since species composition of MSS changes throughout the grazing period, with a dominance of grasses in spring, more clovers in the summer, and plantains and chicory producing well into the autumn, it was a shame not to be able to monitor the entire year.

Hannah Jones at Farm Carbon Toolkit soil sampling at a Cornish dairy farm

7. Conclusions

Despite the different herbage characteristics between perennial ryegrass with or without white clover and multi-species swards, cows grazing either of these swards had similar milk yields and milk composition in an on-farm setting.

The similar milk production is a positive result, since this entails that multi-species swards can provide other soil and environmental benefits, without compromising cows' milk production

The trial was restricted by the complications associated with splitting the herd in a real farm context, the extremely wet weather and the complications associated with forage sampling within 3 days of milk testing. All these issues meant that we did not achieve as large a data set as we would have liked. It would have been interesting to see whether the results changed further into the autumn. This was an ambitious trial, which is why it has not been carried out in the UK before.

8. Acknowledgements

The trials were run by Innovative farmers for the Farm Net Zero project. The Farm Net Zero Project was funded by the National Lottery Community Fund.

We would like to thank:

Andrew and Claire Brewer and their team, who have been generous in their time sharing their experiences and knowledge

Dr Daniel Enriquez Hidalgo of University of Bristol for his role as researcher for the project

Amanda Dutton for collecting milk samples

Cornwall Wildlife Trust for their role in forage sampling

Cornwall College for their forage analysis, and to the Duchy College team for their support throughout the trial

AFBI labs for forage analysis

Hannah Jones of Farm Carbon Toolkit for her advice, help and support