Field lab: The Farming Network Diverse Swards Grassroot Club

Final report

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Take home messages

Grassland management techniques (grazing, liming, sowing diverse mixes, reducing N applications, improving drainage by spiking, spreading muck) across five participating farms were found to result in overall increases in sward diversity. Sward diversity, particularly numbers of grass species was higher on organic farms and livestock-only farms. Although no change in soil health was recorded using VESS tests[1], four out of five farmers observed a positive change in soil health on fields managed to increase sward diversity. Effective monitoring is valuable.

Context

The group included around 10 farms across Cumbria, five farms collected sufficient data to analyse. The group were keen to use the IF project to explore the potential for diversifying their grass swards. In particular, they wanted to build on their sward establishment experience to measure how their management of soils and grazing/cutting regimes, in low-input systems, under different weather conditions and seasons affect the species composition and performance of their diverse permanent pastures and long-term leys.

Trial design

In 2019/20, farmers identified the management techniques they were adopting to diversify swards and a field which they felt they could effectively monitor. Farmers sited either 2 or 3, 1*1m square quadrats in the target field using GPS locations (where possible), permanent markers, or by accurately mapping locations to ensure that they would be revisiting exactly the same location in subsequent years (2021 and 2022). Soil testing was also carried out in each field at the start and end of the trial.

Findings

No clear trends were associated with particular management practices, farmers were trialling a range of measures and on most farms, they were trialling several concurrently. However, all farmer's trialled rotational grazing approaches and most addressed chemical inputs. The most diverse swards were associated with sown multispecies mixes, no chemical inputs and rotational grazing. The quadrat sampling method provided valuable quantitative information on ***increases*** in species numbers on the target fields over the period of the study, which farmers failed to record with general observation. Soil testing, using VESS (Visual Evaluation of Soil structure) did not show any change in soil structure as a result of different sward management approaches between 2019/20 and 2022, but VESS tests on all farms indicated that soils were either in 'very good' or 'good' condition. All farmers reported that the process of looking more closely at their swards (using quadrats), whilst time consuming, was valuable.

Recommendations & next steps

[1] See for example, https://www.youtube.com/watch?v=bWCDBT2sEVs

Farmers should be encouraged to continue to observe and monitor their swards and their soils and keep records on their monitoring in relation to their management practices and any changes they make to them. For some farmers, reducing inputs and sowing diverse mixes or over-seeding pastures may further enhance sward diversity.

Useful resources

- How to use quadrats – N.B. ideally you will revisit the same locations so quadrats should be mapped in detail or a GPS to a specific corner of the quadrat should be located https://www.saps.org.uk/teaching-resources/resources/260/questions-about-quadrats/
- VESS testing video https://www.youtube.com/watch?v=bWCDBT2sEVs
- Norton, L. R., Maskell, L. C., Wagner, M., Wood, C. M., Pinder, A. P., & Brentegani, M. 2022. **Can pasture-fed livestock farming practices improve the ecological condition of grassland in Great Britain?** Ecological Solutions and Evidence, 3, e12191. 10.1002/2688-8319.12191

Farmer comment

Peter Kerr, farmer in the Diverse Swards Grassroots Club said "**Making the time to measure and record is always the hardest thing, but is crucial if we are going to improve any of the various things we are interested in. It makes you look at stuff you wouldn't ordinarily see".**

Main report

1 Field lab aims (up to 50 words)

The hypothesis that the field lab will test will be:

Productive species rich swards consisting of high numbers of herb, legume and grass species (>15) with high associated soil Carbon can be successfully established and maintained under a range of different management conditions in Cumbrian pastures.

2 Background (up to 250 words)

The benefits of multi-species or diverse swards are well researched, and include reduced need for artificial fertilisers, a wide range of rooting depths and morphologies that can improve soil structure permeability and resilience to climate extremes, increased soil biome diversity and improved access to soil nutrients and trace elements, thereby enhancing grazing for livestock.

The Grassroots Club run by The Farmer Network consists of 35 farmers. Prior to this IF project, these farmers were interested in the benefits of diverse swards and knowing more about how they may establish in the north-west of England, before investing in expensive seed mixtures. Ten farmers in the group tried to establish diverse swards on parts of their farms, each selecting the mixture that they considered best for establishing and maintaining species diversity under their grazing and management system. These ten farmers shared their findings on establishment and soil condition experiences through farm walks over the 18 months post establishment, both with each other, and with soil, drainage, seed and grazing experts.

Following on from these Grassroots Club meetings, some farmers who had tried to establish new diverse swards and others who were managing permanent pasture for higher sward diversity declared an interest in systematically recording and monitoring their progress over the next 3 years and sharing their findings. They particularly wanted to measure how their management of soils and grazing/cutting regimes, in low-input systems, under different weather conditions and seasons affected the species composition and performance of their diverse permanent pastures and long-term leys.

3 Methodology and data collection (up to 800 words)

In order to establish a baseline at the start of the project (at least) one pasture field on each of the farms was chosen to focus the measures on. The field chosen was ideally one for which soil sampling had already been carried out as part of the Grassroots Club's initial project described above. This meant that data that which have already collected (ac, below) could be used alongside new data as the project progressed, as a baseline against which to measure change.

Baseline Data:

Soil Sampling

A visual evaluation of soil structure was also carried out using the VESS test (see link to video in Useful Resources). In addition, standard soil sampling methodologies were used[2] to collect soils for chemical analysis. Soil analyses included the following measures - organic matter (ac), nutrient content (ac), texture (ac), pH (ac).

Site description

Farm type, altitude, slope, aspect, history of management, including sown species, numbers and types of grazers, cutting, inputs (including whether organic or run on organic principles). This data was extracted from initial sources and compiled into a spreadsheet for ease of access and for comparability across farms.

Vegetation sampling

Sward measures (from standard 1*1m quadrats) were recorded at 2 or3 locations on each target field (dependent on field size and variability). Within each quadrat the presence of each species, its' % cover within the quadrat and the presence and cover of bare ground and litter were recorded. Farmers also recorded the presence or absence of a mat of vegetation overlying the soil and vegetation height. Initial training in how to do VESS tests and monitoring quadrats took place in September 2019 and the baseline quadrat measures took place in June 2020 (when most plants were flowering to aid identification). Field Studies Centre ID booklets were provided to help with this, but unfortunately, due to Covid 19 restrictions, plant ID experience was limited.

Biomass

Farmers were encouraged to record biomass of vegetation (either once or twice a year on the target field) by cutting a standard section of vegetation, e.g., 20*20cm and weighting either fresh or dried material. Similarly, farmers were asked to record grass productivity where they were able (e.g., with a grass plate and ideally within areas where the grass could not be grazed, e.g., in cages).

Current management

The following management criteria were recorded for each pasture field which was being sampled.

1) Grazing - number of animals grazed and numbers of days grazing,
2) Inputs - manure, fertiliser, any additional sowing,
3) Cuts (if relevant) - Bales or trailers of silage/ hay produced on the target pasture fields.

Farmer questionnaire

[2] E.g., as included here, https://cawood.co.uk/wp-content/uploads/2022/04/Soil-How-to-take-a-Sample-Guide.pdf

A student researcher (Hunter 2023) collected qualitative data from farmers using a standard questionnaire containing 26 questions. The questionnaire sought to find out more about farmers' management choices, their aims for their grasslands and the value of the project to them, including what they were learning through taking part in it. The results from this questionnaire are described below. Standard ethical procedures, in line with the University of Lancaster's ethical policies, were adopted.

Analysis

The student researcher carried out analysis of quadrat data and the questionnaire described above as part of her Honours dissertation. This dissertation was provided to the group and this work has been used to help evaluate the Diverse swards project. Analysis investigated vegetation and soil change across time in the target fields and the effects of different management practices on the composition of the sward and soil in each pasture. This data was compared with extensive data held on pastures by the researcher. Questionnaire results are presented without further analysis.

Statistical Testing

Due to the differences between farms in the number of years in which data was collected and resulting unevenness of sample sizes for VESS tests, most statistical testing was ruled out.
One-Way analysis of variance (ANOVA) tests were used to analyse whether there was a statistical difference between the sward diversity as measured in the quadrats collected on each farm, as this test does not require even sample sizes. Shannon's Diversity Index was used to compare the diversity of species and swards between farms, with a score calculated for each sward.

4 Results and discussions (total 1,500 to 2,000 words not including graphs, tables etc)

Firstly, it is important to note that data collection across the group was somewhat variable and that accessing the results has resulted in some limitations on what can be analysed. Farmers are busy people and although farmers were willing and keen to be involved, actually carrying out detailed and unfamiliar tasks requires time and effort that farmers didn't always find time for. Methodologies were demonstrated by the researcher early on in the project, but not all farmers had the skills (particularly species identification) to carry out effective monitoring alone. Suggestions for simplification of protocols were put forward (i.e., not identifying to species, but rather to group – legume/grass/broadleaved plant) but farmers still found it hard to find time to observe the detailed 'scientific' approaches that fit with quantitative testing. In several cases monitoring was carried out by the researcher jointly with farmers, where possible, and with the student researcher, towards the end of the project. Analysis of the farmer questionnaire (included throughout below and in 4.4) sheds some light on the farmers' experiences of being involved with the project.

It should be noted that ambitions for biomass monitoring (described above) were not fulfilled – with most farmers not managing to carry this out and insufficient data to discuss

here. Chemical soil analysis was originally carried out in 2019 at Lancrop Labs with farmers paying for them themselves. Subsequent sampling at the end of the project came through project funds administered through the Farmer Network, with analysis again carried out by Lancrop Labs. Whilst the second set of results have been easy to access, the results for 2019 are less complete. Analysis of changes in soil chemistry is only covered briefly below.

The following section outlines and displays the results obtained from the vegetation quadrats and the VESS tests together with data from the questionnaires.

4.1 Sward Diversity (vegetation quadrats)

Results

Changes in sward diversity for each farm between 2019-2020, are shown in *Figure* 1. Four of the five farms showed an increase in their total species. Farm D showed a small (4.5%) decrease in species between 2020 and 2022.

According to information from the questionnaire, 3 of the farmers said that they noticed an increase in sward diversity across this period.

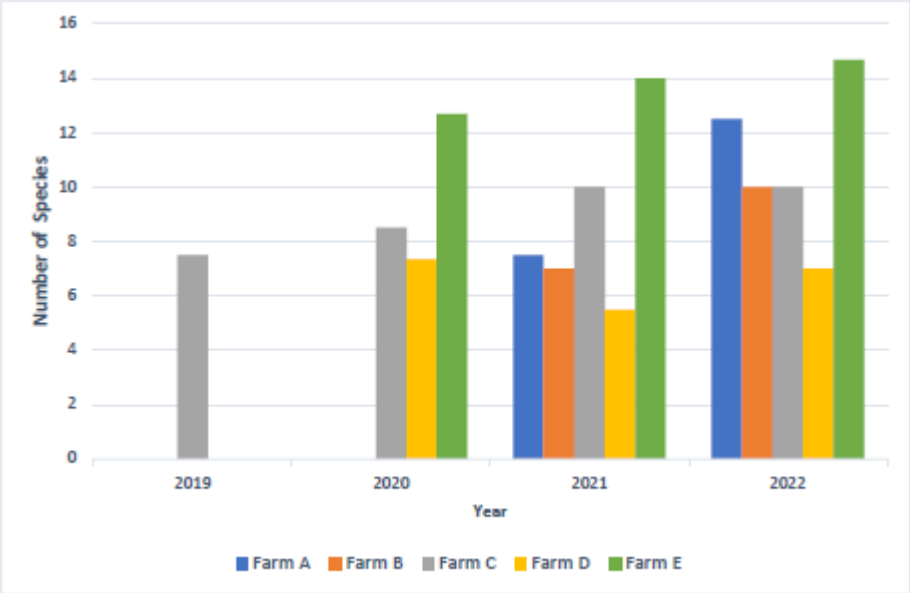

Figure 1: The number of species on each farm between 2019-2022. NB. Not all farms started recoding data in 2019, with most starting in 2020 or 2021.

A statistical analysis to test whether the diversity of species differed between farms showed two things:

1) Different farms had significantly different numbers of species (highly significant, p>0.001)
2) Farm A (who sampled field with 3 quadrats) had very different numbers of species in quadrats (by up to 10 species) sampling different parts of the field and in different years.

Shannon's Diversity Index (SDI) was used to assess the diversity of species and swards between farms, with a score calculated for each sward. The higher the score calculated, the greater the diversity. The highest sward richness in any year was achieved by Farm E in 2022, with an SDI of 2.14, whilst the lowest yearly farm average (0.690) was achieved by Farm D in 2021 (Figure 2). Farm D had the highest variability in SDI scores, but scores were

generally low. The most diverse individual quadrat (on farm E) and the least diverse quadrat (farm D) are shown in Figure 2.

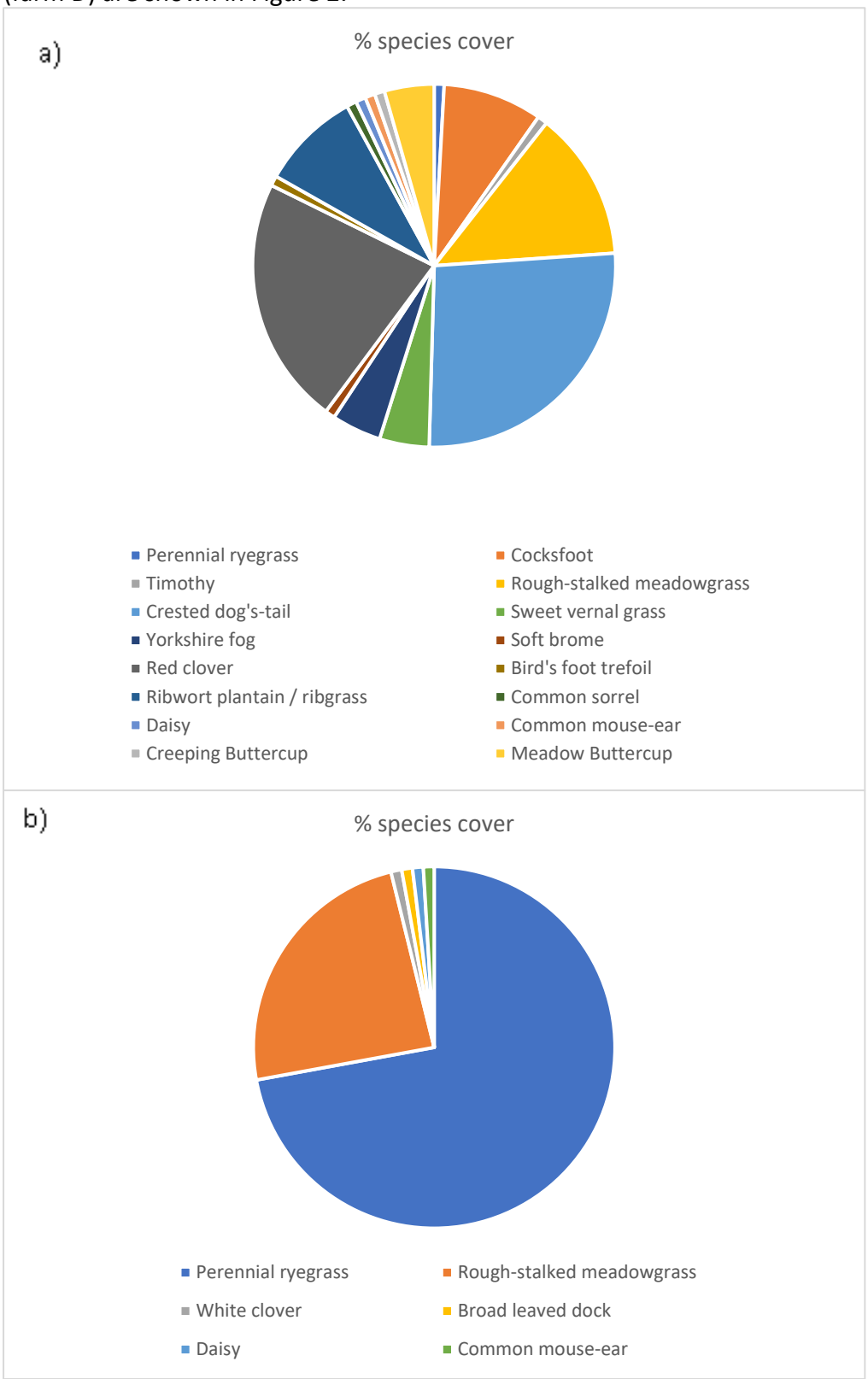

Figure 2: a) The most diverse quadrat recorded in the study (Farm E) and b) the least diverse quadrat recorded in the study (Farm D).

Discussion

Differences between farms in vegetation diversity will be partly due to differences in soil type, geology, aspect, and altitude as well as grassland history. Data from the questionnaires showed that some of these farmers had previously sown leys and others were attempting to diversify existing swards of permanent grassland. On top of those background differences, farmers were using different techniques and combinations of techniques to diversify their swards and had different desired outcomes for their swards in terms of livestock feed. For most farms an increase in species is likely to indicate positive benefits of changed management approaches. In some cases, more species may equal more weeds, which is less desirable. In terms of diversity farm E outperformed the other farms with the grassland measured in farm D being the least diverse. The influences of management practices on these differences are investigated below.

It is also worth noting that weather events prior to sampling (including in the previous year) can impact on findings, such as a general dip in species numbers in 2021. In 2021 there was an extremely wet period in January (O'Driscoll, 2021) and a cold a dry period in April (Met Office, 2021) with the majority of Cumbria experiencing less than 33% of its average monthly rainfall (Farrow, 2021). Such conditions may have impacted on species numbers.

4.2 Sward diversity and management

Results

In order to gain some insight as to the impacts of different farming approaches on sward diversity, the following key management groupings were looked at:

- Farming type (livestock-only versus mixed livestock and arable)
- Organic versus inorganic farming
- Individual grassland management techniques

<u>Farming Type</u>

Sward diversity was higher on 'livestock only' farms than it was on 'mixed' farms (Figure 3). The slight dip in diversity noted above, was evident in both farm types.

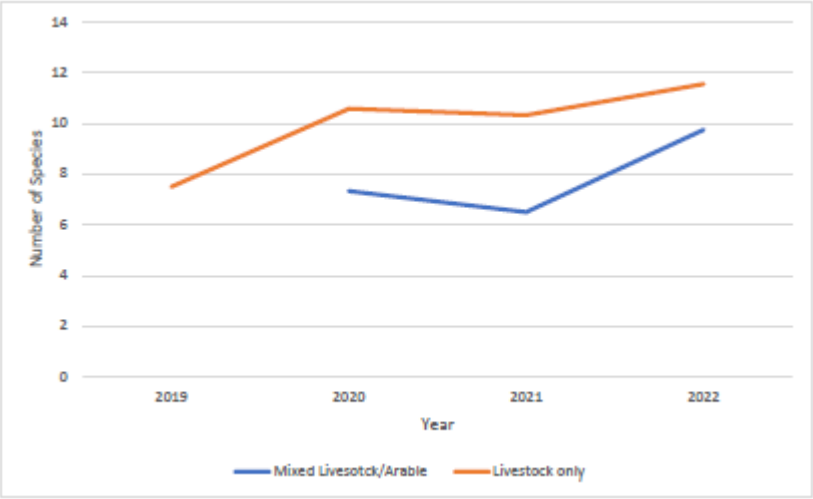

Figure 3: Average sward diversity on 'livestock only' and 'mixed' farms between 2019-2022 (note, there were small samples sizes in 2019 and 2020)

Organic versus inorganic farming

Data from the questionnaires showed that only one of the five farms was registered as organic (A), a further two farms run their businesses on organic principles (C and E) and two farms are broadly conventional (B and D). There were clear differences within years and over time between the numbers of grassland and broadleaved (including legumes) species on farms run organically versus those run conventionally (Figure 4), although for broadleaved species differences were minimal by 2022.

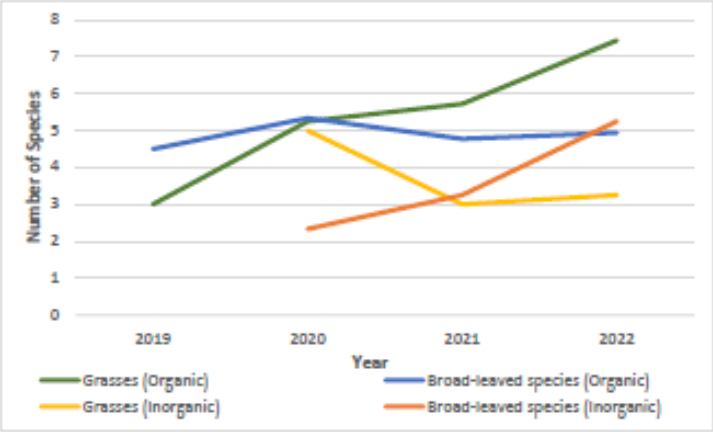

Figure 4: Numbers of grassland and broadleaved species on organic and conventionally managed farms between 2019 and 2023.

Individual grassland management techniques

Data from the questionnaires showed that, of the ten different management techniques used, rotational grazing and sowing a diverse mix were the most popular options, each used on three farms. In contrast, improving drainage, alternating stock, and spreading muck were each used by one farmer only (Figure 5).

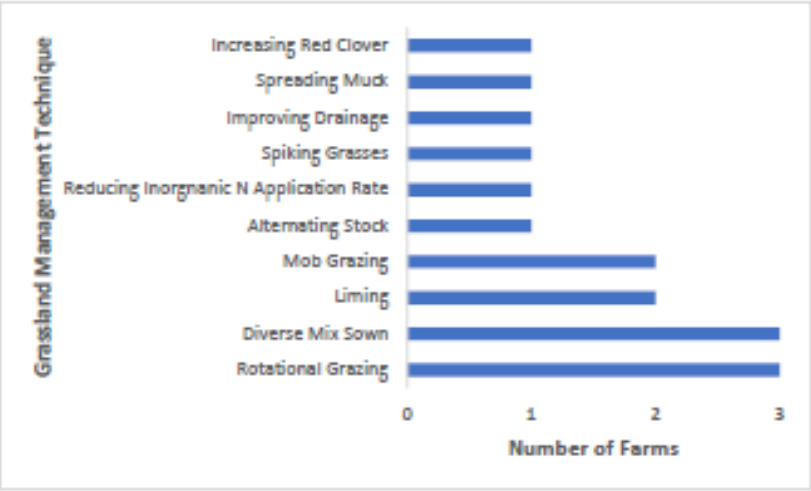

Figure 5: Numbers and types of management techniques used by the 5 farmers.

All five farmers used either rotational or mob grazing. Farm E (with the most diverse swards, see figure 1 and 2) used both rotational grazing and had sown a diverse sward mix prior to the study, to which other species have added themselves. The farm was also managed in line with organic principles and was a livestock only farm. Farm B, in contrast, used the same management practices and is livestock only but uses conventional inputs and had a much-lower number of species despite a more open sward (5% bare ground).

Farms which did not sow a diverse mix and were looking to enhance diversity in their permanent pastures (Farm A and C) were either organic or run on organic principles. These farms both had higher diversity than the non-organic sown leys and showed some indication of increased sward diversity under management approaches (rotational grazing (A & C) and improved drainage (A)), although farm C had seen a levelling off of species number. Farm D had the least diverse sward (Figure 2), this farm is a mixed conventional farm which had planted a ryegrass/clover mix which had not established well. The sward on this farm was open with 15% bare ground and species present, other than sown species, were primarily annual weeds of open ground and docks.

Discussion

Four of the five farms showed an increase in species indicating that attention towards sward diversity may be having a beneficial effect regardless of farm type, organic status and chosen management practices. Sowing leys can enhance species richness in both conventional and organic systems, but this is likely to depend on successful establishment. Organic systems consistently out-perform conventional in species numbers. Rotational grazing may enhance species richness, even in permanent pasture which is more difficult to shift due to closed or 'tight' swards which reduce seed to soil contact.

4.3 Soil Health

Results

Each farm was awarded a score of between 1 'very good' or 2 'good' for soil structure, despite each farm initially seeming to have very different soil, both by sight and smell.

Table 1 VESS Scores

Average VESS (Visual Examination of Soil Structure) scores for each farm from 2020-2022			
	Year		
Farming Practice	2020	2021	2022
Farmer A		1	1.5
Farmer B		1	1
Farmer C		1	1
Farmer D	2	1	2
Farmer E	2	1	1

Soil chemistry data for 2023 showed differences between the farms in the study and some differences between the years (Table 2). Farm D had low scores for organic matter and carbon stock and high scores for soil phosphorus (P) as may be expected for a mixed conventional farm and a field which has been cropped previously. Farm B is also a conventionally managed field recently sown with a ley with relatively high P, but has higher levels of soil carbon than farm D. The permanent pastures (A and C) had the highest carbon

stocks, but farmer E also had high carbon. High soil Carbon has been shown previously to be associated with high species diversity (Norton et al. 2022).
Soil P was lowest on the organic farm (A), but perhaps surprisingly high on farm C which is organically managed, but had been managed conventionally until 2018.
Changes between years are harder to interpret and are in general very similar between years. Only farm C shows something of a difference in levels of organic matter in the target field. Continued testing will help establish whether this is part of a trend or results from variability within the field.

Table 2 Soil chemistry measures for participating farms in 2023 and in 2019

	2019			2023			
Farm	PH	org matter (DUMAS %)	P (ppm)	PH	org matter (DUMAS %)	org Carbon stock (t/ha)	P (ppm)
A	No change			6.7	7.9	89.6	9
B	5.8	6.1	51	6.1	6	68	49
C	5.3	5.8	23	5.8	6.5	79.4	43
D	No data			5.8	4.8	54.4	52
E	6.2	6.1	31	6.1	6.4	72.6	19

Results from the questionnaire indicated that farmers – 3/5 believed that their management practices had improved soil health, for example by enhancing worm numbers or improving drainage.

Discussion
VESS scores indicate little difference between farms and relatively little change over time which could be definitively attributed to farm type, farming strategy or management change. Soil chemistry results are broadly as expected from the practices employed on the fields. It is unlikely that soil conditions will change rapidly on permanent pastures without drastic management interventions, but it would still be valuable to establish any changes in soil chemistry on all fields using previous soil tests if data can be located and properly compared.

4.4 Questionnaires

As well as information on practices the questionnaire provided background information on farm sizes etc. This information showed that all farmers were over 40 and 3 were over 60. Only two farms, those which are conventionally managed (B and D) stated that farming was their main income source. These farms were the largest, at 38 (beef only) and 500Ha (beef and sheep) respectively and had the most livestock.

When asked where they learnt about novel management approaches for enhancing species diversity in swards farmers cited a variety of sources, chiefly books, short videos, neighbours and farmer networks.

When the farmers were asked whether they would continue using the same techniques for managing their swards, 60% said they would and 40% wanted to try something different.

In terms of the monitoring process and how easy they found it was to do, most commented on how time-consuming it was. Farmer E made the following comment:

'It is a bit of a faff, but the more you do it, the more you want to do it, and it becomes easier'.

The owner of Farm A stated that the monitoring:

'Makes you look at stuff you wouldn't ordinarily'.

The overall consensus of farmers for the project in terms of trying techniques and monitoring their effects was very positive with all farmers stating that it had been beneficial for the field and the farm and for themselves in terms of making them think more broadly about biodiversity and soil health.

5 Conclusions (up to 500 words)

No clear trends were associated with particular management practices, farmers were trialling a range of measures and on most farms, they were trialling several concurrently. However, all farmer's trialled rotational grazing approaches and those applying chemical inputs reduced them. The most diverse swards were associated with sown multispecies mixes, no chemical inputs and rotational grazing. However almost all farms showed some increase in sward biodiversity, perhaps indicating that placing an emphasis on it and trying different management approaches to enhance it is positive step to improving it. The quadrat sampling method provided valuable quantitative information on slight increases in species numbers on the target fields over the period of the study, which farmers said that they had not noted with general observation. Soil testing, using VESS (Visual Evaluation of Soil structure) did not show any change in soil structure as a result of different sward management approaches between 2019/20 and 2022, but VESS tests on all farms indicated that soils were either in 'very good' or 'good' condition. All farmers reported that the process of looking more closely at their swards (using quadrats), whilst time consuming, was valuable.

All farms and farmers are different, influenced by both their physical settings and social and economic factors. In this study the smaller farms, where income was less reliant on farming, tended to have the most biodiverse swards and the highest soil quality. Two of these farms also had permanent pasture which tends to be both more species rich (due to time influencing the likelihood of recruitment of other species from the seedbank or from seeds being carried in from elsewhere) and to have higher stocks of soil carbon. The farmers were interested in monitoring their maintenance of nutritious and productive species, alongside deeper rooting and more resilient species in their diverse swards. The productivity of the swards was particularly difficult to assess when sampling was done only once per year and stocking levels, grazing and resting periods varied over the 3 years.

All farmers felt that they had gained from being encouraged to continue to observe and monitor their swards and their soils and to keep records on their monitoring in relation to their management practices and any changes they make to them. Evidence from this study did however indicate that this is difficult to do on top of other tasks, with farmers often requiring support for both monitoring and record keeping (e.g., on soil tests). Being part of a network of like-minded farmers and continuing to learn from a variety of sources were clearly very important in influencing the practices of these farmers. This was also true for the wider group of farmers in the Grassroots Club, many of whom tried their own multi-species mixes, or diversifying their swards through management approaches and attended meetings with the core group and researcher.

6 Tips and recommendations

- Record, Record, Record
- Build in support for recording at the start of the project and encourage participation through one-to-one support on farm to gather relevant information including regular recording of field management options and decisions.
- Encourage farmers to learn from ecologists/naturalists and become familiar with a few species and characteristics to look for.
- Source simple species guides like the FSC guides[3]

7 Further reading.

Hunter, L. (2023) How do different grassland management techniques influence soil health and sward diversity in Cumbria? Thesis submitted in part fulfilment of the requirements for the B.Sc. in *Physical Geography* at the University of Lancaster.

Norton, L. R., Maskell, L. C., Wagner, M., Wood, C. M., Pinder, A. P., & Brentegani, M. 2022. **Can pasture-fed livestock farming practices improve the ecological condition of grassland in Great Britain?** Ecological Solutions and Evidence, 3, e12191. 10.1002/2688-8319.12191

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Farm A – Low Stanger
Farm B – Watson
Farm C – Lewis
Farm D – Morton
Farm E – Gascoyne

[3] https://www.field-studies-council.org/shop/publications/grassland-plants-2-guide/?gclid=CjwKCAjwq4imBhBQEiwA9Nx1Br-8liPL0MDUiuvL-PCbXTFnok7MZcrx1mDEyFaoyuZ1crBrLoYBvRoCuhYQAvD_BwE