Sward diversification for pollinators

Purpose of this document

We have put together this document to summarise the results of a trial where we increased the plant diversity of an agricultural grassland to boost nectar and pollen resources for pollinators and to see if the introduced species persisted under grazing and if sowing new species reduced or increased the digestibility of the sward.

Summary

Agri-environment prescriptions to boost pollinator resources are focussed on arable field margins and other ungrazed habitats. However, there are many grazed habitats lacking in pollinator resources, and this experiment aimed to assess the possibility of increasing them.

- Establishment was very variable between species. White clover established well, but the only other legume to establish significantly was Bird's foot trefoil. Of the other sown species, yarrow was the best species to establish but a range of other flowering species established and persisted through the experiment.
- Sowing species into the sward increased resources for pollinators, with the main contributions coming from White clover, Bird's foot trefoil and Selfheal.
- Diversifying the sward had no detectable impact on the numbers of pollinators observed on the different treatments. It is likely that there were insufficient rest periods between grazing periods to fully develop flowers but also possible that the numbers of pollinators present in the vicinity of the experiment were too limited to show a strong response or that there was better resources elsewhere.
- Sowing White clover improved forage quality by reducing fibre and increasing protein, though lignin increased. The diverse legume mix increased lignin but raised protein content, whilst the diverse forb mix reduced overall fibre but increased lignin, whilst marginally increasing protein.
- Sward diversification needs to be integrated with existing farm management, so there are potential trade-offs that need to be considered alongside the initial costs. Adding white clover increased the quality of the sward as animal forage, whilst the other seed mixes had limited effect on this. Hence the main trade-off is whether there is the time available between grazing periods to allow flowering to benefit pollinators.

The experiment

The experiment was established at the Glensaugh Research Farm on a pasture dominated by brown bent (*Agrostis capillaris*), rye-grass (*Lolium perenne*) and white clover (*Trifolium repens*). The chosen field was grazed by 38 yearling red deer hinds.

The experiment was set up with a randomised block design with four blocks, each of five 20 m x 5 m plots. Five treatments were randomly allocated to one of the plots in each block: (1) No disturbance – the sward left untouched, (2) No seed added but disturbed, (3) White clover added after disturbance, (4) Diverse mix of legume species added after disturbance and (5) Diverse mix of forb (flowering plants) added after disturbance. The treatments were established on 18 May 2018 using an Opico grass harrow and air seeder run three times across each plot. Plots were lightly rolled after disturbance.

Vegetation and pollinator surveys were carried out after a three-week rest period to allow flowering and to simulate normal rotational grassland management. Vegetation was monitored on five fixed 50 cm x 50 cm quadrats per plot using visually assessed cover and also a count of individual flowers /flower heads (comparisons of flowering are not straightforward due to the different floral structures in different species). Pollinators were surveyed by Flower-Insect Timed Counts (FIT Counts) of five 1 m x 1 m quadrats per plot noting pollinator species, abundance and insect-flower interactions. Forage quality was assessed by taking "grab" samples across the plot at the point of vegetation sampling. These were made up of c. 50 random handfuls of leaf material. These samples were dried, milled and then NIR spectra were recorded between 1100 and 2500 nm on a FOSS NIRS 5000 spectrometer. The spectra were run through an existing calibration to predict fibre and nitrogen content. Due to problems with Covid-19 restrictions affecting sales, some rest periods were not possible and hence data were not collected.

The findings

Establishment and persistence

As there was white clover in the sward already, this species was treated separately to the other sown species. Only the diverse forb mixture resulted in good establishment of the other sown species (Figure 1). A number of species persisted, but yarrow (*Achillea millefolium*, < 40 % of total cover) was

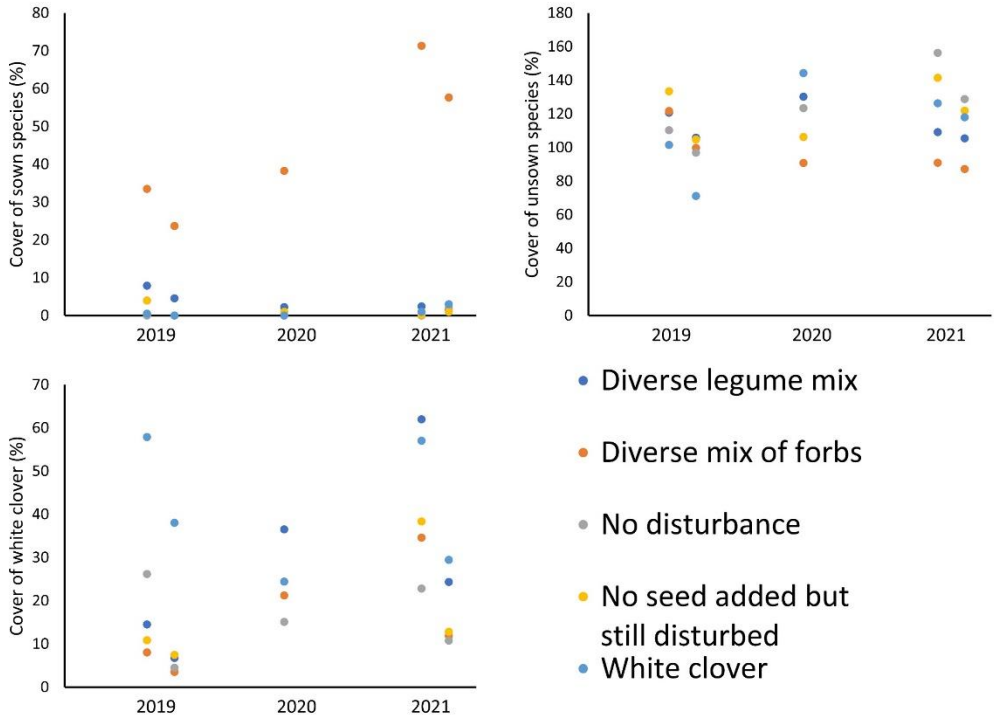

Figure 1. Establishment and persistence of sown species (top left), white clover (bottom left) and the persistence of the unsown species (top right).

the main constituent of the established forbs. A range of other species did establish and persist including Lady's bedstraw (*Galium verum*), Cat's ear (*Hypochaeris radicata*), Bird's foot trefoil (*Lotus corniculatus*), Selfheal (*Prunella vulgaris*), Sorrel (*Rumex acetosa*) and Tufted vetch (*Vicia cracca*) but all at less than 5 % of cover. Red clover *(Trifolium pratense*) failed to persist, Devil's bit scabious (*Succisa pratensis*) did not establish at all, and meadow vetchling (*Lathyrus pratensis*) and Autumn hawkbit (*Scorzoneroides autumnalis*) only established rarely.

The diverse legume mix only saw some establishment of Bird's foot trefoil (~2%), low levels of Tufted vetch and meadow vetchling (*Lathyrus pratensis*), whilst red clover failed to persist.

White clover (*Trifolium repens*) established well where it was sown alone or in the diverse legume mix, but less well in the diverse forb mix, presumably due to competition with the yarrow. Disturbance also helped increase its cover in the later periods of sampling.

Sowing either of the seed mixes or the White clover alone reduced the cover of the species present before sowing, mainly due to the presence of White clover and Yarrow.

Flowering

It took three years from sowing to see significant flowering in the sown species (Figure 2). Despite good establishment, yarrow did not flower (possibly the interval between grazing periods is not long enough), and the main flowering species were Bird's foot trefoil and Selfheal. Similarly, White clover took three years to produce significant numbers of flowers.

Disturbance increased flowering in the unsown species, with Mouse-ear (*Cerastium fontanum*), Creeping buttercup *(Ranunculus repens*) and Nettle (*Urtica dioica*) flowering in all the treatments, though less so in the undisturbed plots.

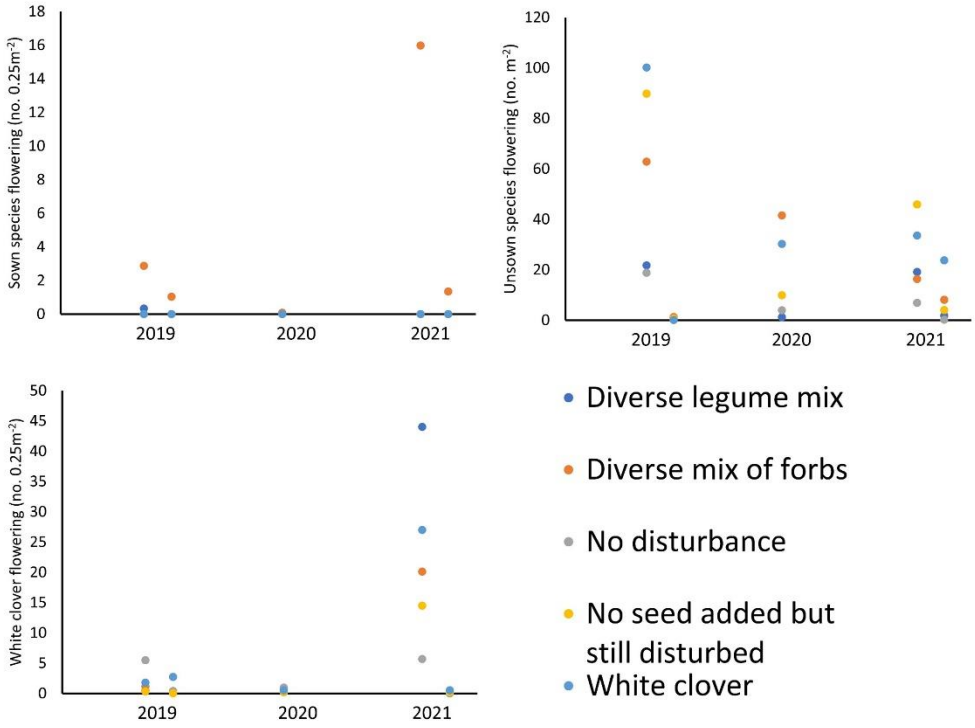

Figure 2. Numbers of flowers or flowering heads of the sown species (top left), white clover (bottom left) and the unsown species (top right).

Pollinators

There was no detectable difference between the treatments in terms of the pollinators observed vising the plots. Numbers were very variable between years, but higher in June than August. The lack of response of the pollinators could be a result of there being only a small pollinator population locally

to take advantage of the increased resources as the farm is dominated by grazed habitats. Also, the rest period between grazing periods may have been insufficient to increase resources sufficiently to attract pollinators. The good establishment but lack of flowering of yarrow would support the latter point.

Diet quality

Sowing white clover or the diverse forb mix reduced the levels of neutral detergent fibre, but only sowing white clover reduced acid detergent fibre (Figure 3). Both types of fibre comprise cellulose and lignin, whilst neutral detergent fibre also includes hemicellulose. High fibre contents represent forage that is difficult to digest. However, all treatments increased the amount of lignin compared to the original vegetation, with a substantial increase in the diverse forb plots.

Sowing white clover alone substantially increased the protein content of the forage (measured as percentage nitrogen), whilst there was an increase in forage protein in the diverse legume mix and a weak increase in the diverse forb mix, probably largely due to the presence of white clover.

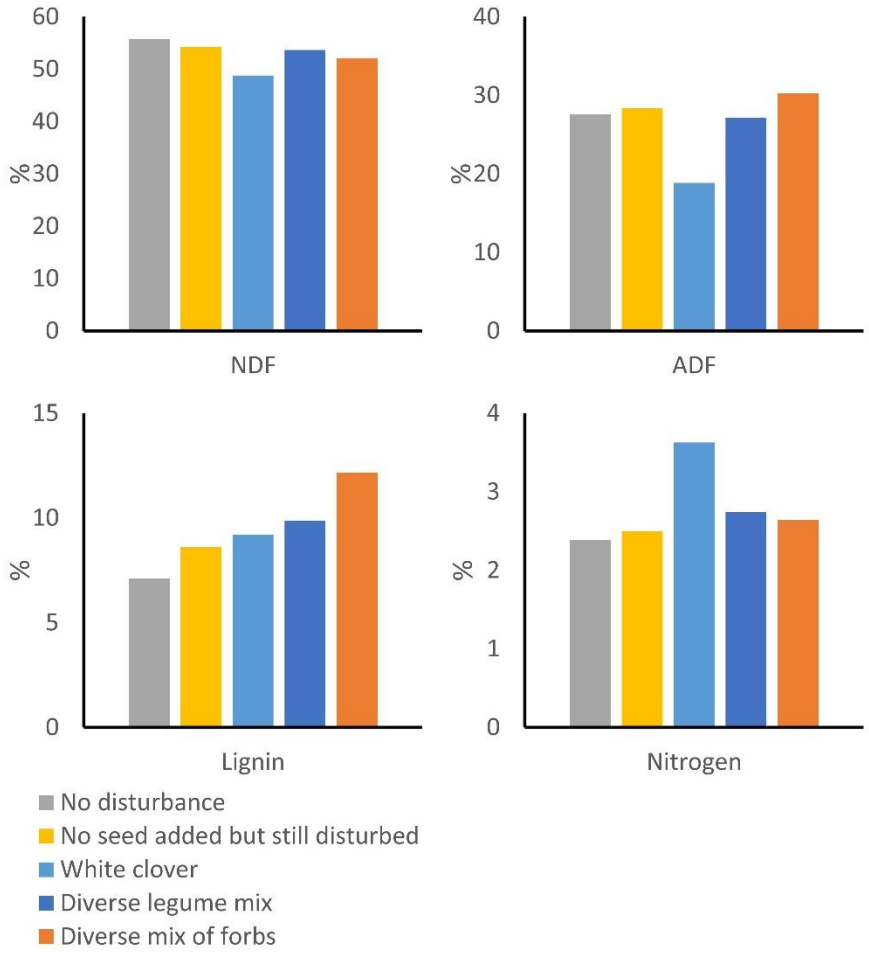

Figure 3. Forage digestibility measures: NDF neutral detergent fibre (top left), ADF acid detergent fibre (top right), lignin (bottom left) and nitrogen (bottom right).

Into practice

We sowed in the spring of 2018 which was late and then dry; potentially this slowed or even reduced the establishment of the sown species which might have been better in other years. However, the sowing itself was technically straightforward and should be easy to do in most situations.

The choice of species is a key part of improving the diversity of grasslands. The ideal species establish well and flower profusely. Interestingly, yarrow was the best sown species in terms of establishment, but it was never recorded as flowering, whilst Bird's foot trefoil and Selfheal were much poorer in establishing but provided most of the floral resources beyond those provided by White clover. Where flowering is restricted to rest periods in rotational grazing, species with a long flowering period and relatively low-cost and quick emerging flowers need to be part of the mix.

We need to refine the approach here to assess the benefits to pollinators. For instance, trialling different length rest periods to assess if longer periods are necessary to generate the necessary floral resources to attract pollinators would be a useful first test. Also, diversifying the sward across multiple fields will be necessary to provide the summer long resources needed to boost local populations of pollinators.

Sowing White clover into established swards is an established method of sward diversification to improve the nutritional quality of forage and it turned out to be better at this than the other diversification treatments which were largely neutral in their effect on quality.

Concluding remarks – does it work?

Partly. We've demonstrated that some of the sown species establish and persist under grazing and that there are either improvements in the digestibility of the forage or no real change depending on the mixture. The latter means that any agri-environment support payments need to only take account of the initial costs and do not need to cover lost opportunity cost. Unfortunately, we were unable to demonstrate benefits to pollinators. We need further assessment to identify if this could be remedied by a longer rest period or if trials in a more pollinator rich site would see differences. Further trials will be starting in 2022 to see if sward diversification can benefit animal performance as well as biodiversity.

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