

Alternative forage systems for marginal land

Final Project Report – December 2020

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1 Introduction

The three farms involved in this project are located near Blackmill, Gilfach Goch and Heol y Cyw; all just north of Bridgend in South Wales. The three farmers proposed the project to explore the potential for alternative seed mixtures which they thought may be more resilient than standard ryegrass/clover seed mixtures in conditions of high rainfall, poorer soil quality and with lower inputs.

Seed mixtures containing a broad spectrum of grasses, legumes and herbs are becoming increasingly popular and have received much coverage in farming media. Known as herbal, multispecies or alternative leys, the underlying premise of combining a broad spectrum of species is that the mixture will provide complementary advantages in seasonality of growth patterns, different rooting depths and flowering periods. There are many anecdotal reports of improvements in yields and quality, of increased drought tolerance, and benefits to soil and animal health from multispecies leys. Scientific studies are limited, often short-term and mostly plot based. There is little hard evidence to support consistent benefits from multispecies leys, few clear guidelines on the management of the leys and certainly nothing to advocate their use in marginal areas.

In 2018 the three farms each established a new multi-species ley alongside a conventional ryegrass/white clover ley to act as an experimental control treatment. The performance of the new leys was monitored through their establishment year and through the following two years of production.

On each of the three farms around 4-5 ha was identified for reseeding. These fields were screened for Environmental Impact Assessment to make sure they were suitable for changes in management.

2018 proved to be a challenging year for agriculture in Wales, dominated by an intense summer drought. All three farms however managed to successfully reseed their field parcels, albeit at different periods of the year.

2 The Project Farms

2.1 Gellifeddgaer

Gellifeddgaer is a predominantly grass based beef and sheep unit, located near Blackmill (Fig.1). The project location straddles a ridge at 230-265m above sea level, to mitigate this the trial was split so both treatments included the north and south facing slope (Fig.2). The soil for this location is classified as Withnell 1 and is a well-drained loam over sandstone (Fig.3). It is thin in places due to the location on an exposed ridge and prone to drying on the south side. Annual rainfall for the area taken from Manner NPK is 1,385mm per annum. The soils were sampled in early 2018 at pH 5.6, P index 1 and K index 2-. Prior to establishment of the leys the field had grown stubble turnips – grazed through the autumn/winter of 2017/2018.

Figure 1 Aerial imagery of farm showing topography



Figure 1 Aerial imagery of plot

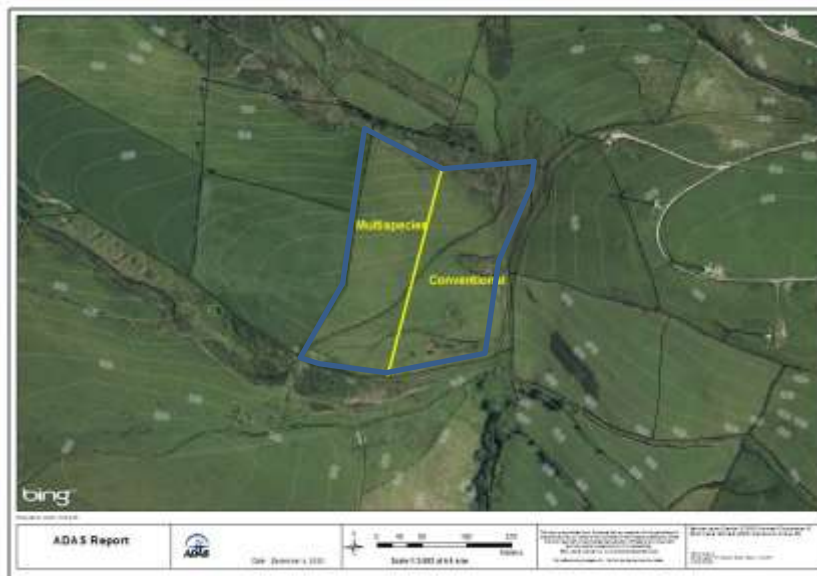
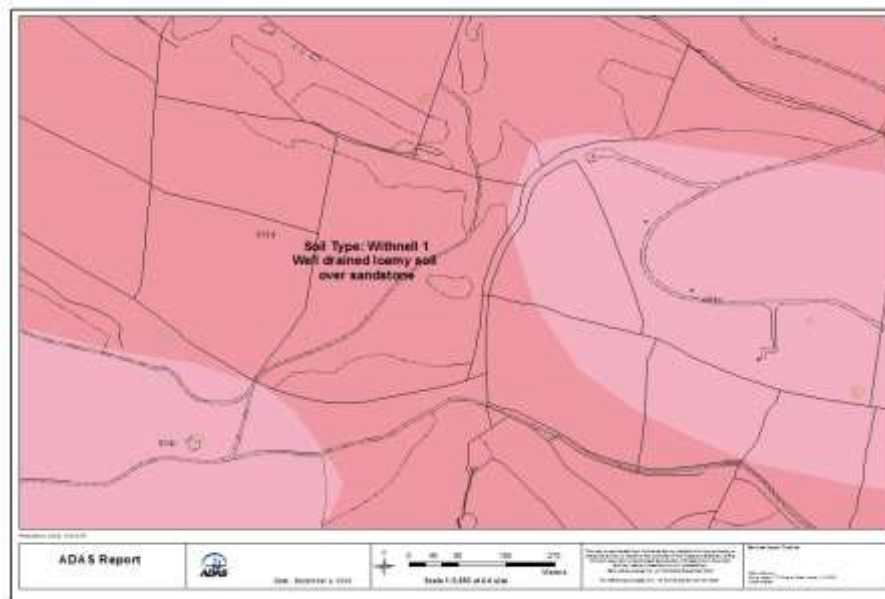


Figure 3 Soil Map of trial field



2.2 Gilfach Isaf

Gilfach Isaf is a predominantly grass based sheep unit, located near Gilfach Goch (Fig. 4). The project location is on an open south facing slope with moderate incline and 225-275 metres above sea level. The conventional seed mixture was sown on the upper half and the multi species ley on the lower half (Fig.5). The soil classification for the location is Gelligaer; loamy permeable humose sand over sandstone. A small portion of the multi species area is Wilcox 1 soil series; slowly permeable fine loam over clay, (Fig.6). Annual rainfall for the area taken from Manner NPK is 1,385mm per annum. The project field was a long-term ley that had been silaged regularly. The soils were sampled in early 2018 at pH 5.3, P index 3 and K index 2-.

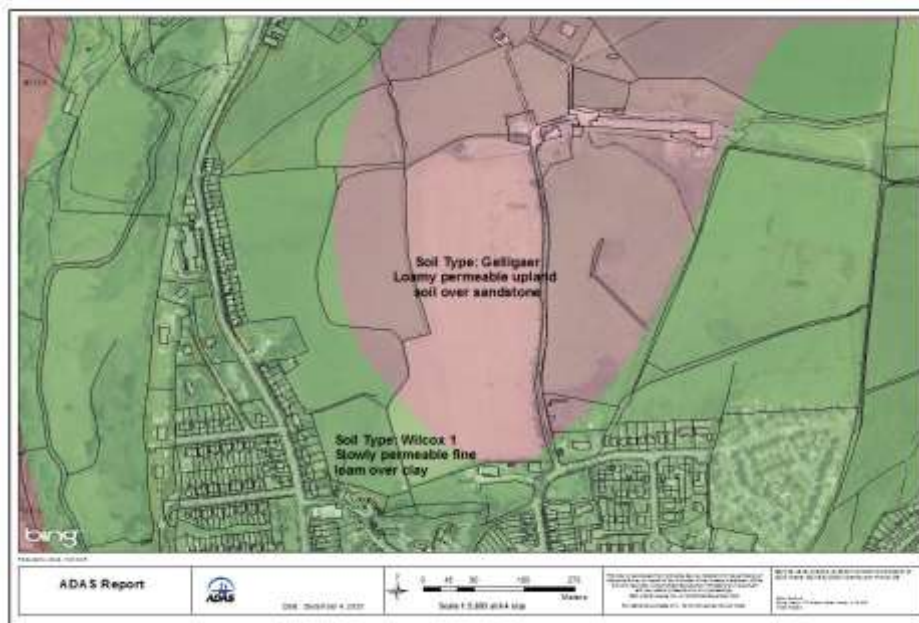
Figure 4: Aerial imagery of farm showing topography



Figure 5 Aerial imagery of plot



Figure 6 Soil map of field



2.3 Brynchwith

Brynchwith, located near Heol y Cyw, is a predominantly grass based beef and sheep unit, the farm also includes a poultry enterprise. The project on this farm is located in two fields, the conventional mixture is in the higher field at approximately 145m above sea level (asl), on moderately sloping south facing land and the multispecies ley is in the lower field at around 95m asl, this field is level, wet in places and sheltered by trees on all sides but especially to the west (Fig. 8). The upper field soil classification is Withnell 1 (well-drained loam over sandstone) and the multispecies ley field is Wilcox 1 soil series (slowly permeable fine loam over clay) (Fig.9). Annual rainfall for the area taken from

Manner NPK is 1,385mm per annum. The two fields were sampled in early 2018 – with both at pH 5.5, P Index 1 and K Index 2-.

Figure 7 Aerial imagery of farm showing topography



Figure 8 Aerial imagery of plots

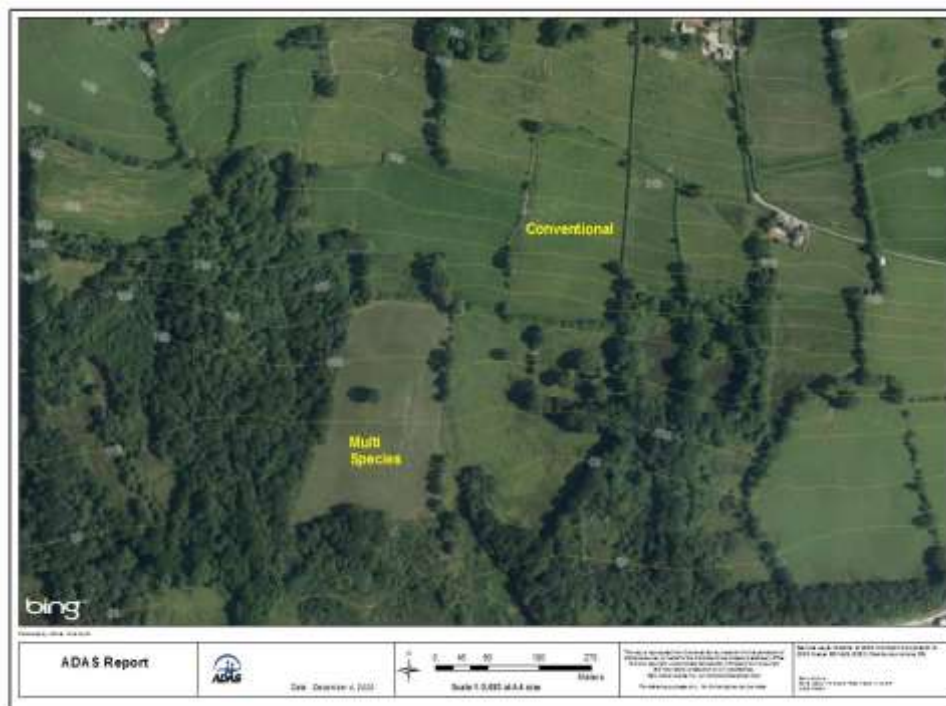
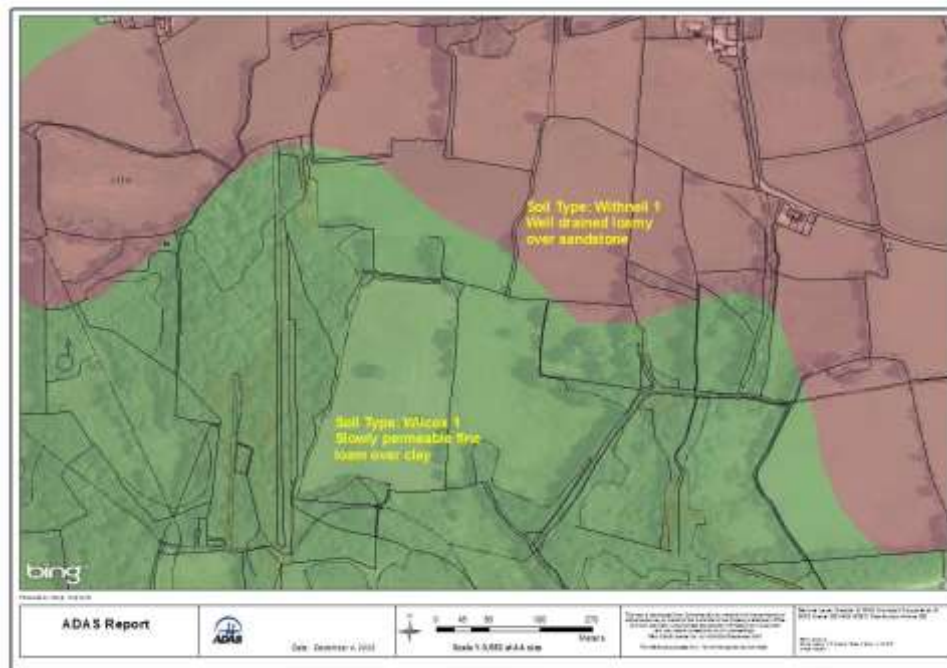


Figure 9 Soil map of field



3 Methodology

3.1 Experimental Design

In summer 2018 the three farms established a multi-species ley alongside a new conventional ryegrass/white clover ley to act as an experimental control. The performance of the new leys was monitored through their establishment year and through the following two years of production.

On each of the three farms around 4-5 ha was identified for reseeded. These fields were screened for Environmental Impact Assessment to make sure they were suitable for changes in management.

In winter 2017/18 the fields were soil sampled to assess pH and P and K status and appropriate cultivation strategies identified for each field. The fields were fertilised to match the requirements of an establishing grass ley (as stated in RB209) and limed to correct pH status to 6.0.

Fields were sprayed with glyphosate to destroy the existing sward, cultivated and sown with two seed mixtures, one half with multi-species ley (the treatment) and the other with conventional ryegrass/white clover (control). The multispecies ley included 4 grass species, 2 legumes and 2 herb species, the conventional ley is a standard ryegrass and white clover mixture, both were established at the same time.

The control seed mixture (Table 1) is typical of what would be used for an upland sheep/beef system. Heading dates reflect the later and shorter growing season of the upland areas – the balance of diploid and tetraploid varieties is in the favour of diploid to encourage sward density and promote persistence. Timothy is included as it is well suited to lower fertility situations and is recognised as performing well in wetter soil conditions and colder temperatures. The white clover blend is a mix of small and medium leaf sized varieties, suited to both tight grazing and a one cut silage system.

Table 1 Conventional long-term grass/white clover mixture

AberChoice	Late Diploid	3 kg/acre
AberWolf	Intermediate Diploid	2 kg/acre
AberGain	Late Tetraploid	3 kg/acre
AberZeus	Int Diploid	3 kg/acre
AberBite	Late Tetraploid	2 kg/acre
Presto	Timothy	1 kg/acre
Aber Pasture	Medium/small white clover mix	1 kg/acre

The multispecies mixture (Table 2) was specifically designed for this project following discussions with group members and the project Actor (Helen Mathieu from Germinal). It is typical of many mixtures on the market. This mixture has less perennial ryegrass than the control (8kg vs 13kg/acre) and includes meadow fescue, Timothy and a Festulolium. Meadow fescue is included as a grass with good ground cover and suited to lower input regimes. The Festulolium (variety AberNiche) is a hybrid of an Italian ryegrass and a meadow fescue and has been bred for improved rooting and drought tolerance. Its Italian parentage gives it quite a tussocky habit, hopefully allowing space for the other components in the mix. The Festulolium is known for its early season growth potential, but also for declining mid-season digestibility as it will be prone to multiple heading.

Inclusion rates of the herbs are lower than some mixtures on the market – but higher rates can lead to them dominating the sward resulting in a more open and less persistent ley. It was felt that the project farms would benefit from a balance of grasses/herbs/legumes that would promote a more mixed sward and encourage longevity.

Table 2 Multispecies mixture

AberLee	Late Diploid	2 kg/acre
AberGain	Late Tetraploid	4 kg/acre
AberZeus	Int Diploid	2 kg/acre
AberPaddock	Meadow Fescue	2 kg/acre
Presto	Timothy	1 kg/acre
AberNiche	Festulolium	2 kg/acre
AberChianti	Red Clover	½ kg/acre
AberClaret	Red Clover	½ kg/acre
Aber Pasture	Medium/small white clover mix	1 kg/acre
Tonic	Plantain	0.6 kg/acre
Puna II	Perennial chicory	0.4kg/acre

3.2 Monitoring programme

The key areas of monitoring and issues examined over the course of the project included:

- 1) Establishment success – how the leys established and outcompeted the undesirable weed grasses and broadleaved weeds in Year 1.

- 2) Forage production in Year 1, Year 2 & Year 3 – assessments made of dry matter production and of forage quality.
- 3) Species composition – to assess the contribution of individual components of the mixture through the project.
- 3) Animal production – assessments made of the stock carrying capacity of the new leys and stock performance.
- 4) Inventory of invertebrates - assessments were made of invertebrate populations in the new leys.

3.2.1 Establishment phase

Assessment of germination success and weed levels through the use of three random 0.1m² quadrats in each treatment on each farm. This was achieved by visual assessment of plant counts and species in each quadrat; sown grasses, weed grasses, sown herbs/legumes, broad-leaved weeds and bare ground %. Assessment of yield was achieved by herbage cuts from each of the quadrat areas which were then dried and assessed for kgDM/ha.

3.2.2 Forage production in Years 2 and 3

Recording of end of year grazing residuals (kgDM/ha) was followed by random siting of three exclusion cages on each treatment and taking herbage cuts every 4-6 weeks through the grazing season. Herbage cuts were assessed for yield and species composition; sown grasses, weed grasses, sown herbs/legumes and broad-leaved weeds by hand separation. Continuous cage measurements allow total yield figure for annual productivity.

Quality assessment of herbage at various stages through the grazing season – for energy and protein.

Second year performance includes assessment of winter survival and early season production and continuing with three grazing exclusion cages placed in each treatment on each farm (from early March). Visual assessment of species and plant counts in each treatment continued as before; sown grasses, weed grasses, sown herbs/legumes, broad-leaved weeds and bare ground % in mid-April.

3.2.3 Animal data

All farms were encouraged to keep a farm diary to try and assess stock carrying capacity on each of the fields. At Gellifeddgaer and Gilfach the two treatments were only separated with a temporary fence post-weaning. So total stock numbers cannot be apportioned to the two treatments.

3.2.4 Inventory of invertebrates

The objective of this survey was to trap and identify the numbers of pollinating insects at the project locations to establish if there were any differences in insect numbers between the two treatments on each of the three farms.

Due to differing grazing/cutting regimes at the host farms sweep netting transects were carried out after consultations with host farmers to ensure all sites were at similar growth stages.

4 Results

4.1 Year 1 establishment phase 2018

2018 proved to be a challenging year for agriculture in Wales, dominated by an intense summer drought. All three farms however managed to successfully reseed their field parcels, albeit at different periods of the year.

4.1.1 Gellifeddgaer

The first farm to reseed was Gellifeddgaer with the field established (following roots) in the beginning of June 2018, just before the intense dry spell. The farm was fortunate in that sufficient rain fell to allow the leys to establish through June and into July. It was noted that the chicory and plantain (and self-seeded yarrow) in particular thrived during the dry spell. By the winter the leys were well established (Fig. 10).

Figure 10 Gellifeddgaer ley in November 2018 showing the two seed mixtures following autumn grazing



In early August 193 lambs (Improved Welsh X Texel) were introduced to the whole of the 4.8 ha (12 acre) field across both treatments. A week later a further 87 lambs were introduced to keep on top of the growth. Lambs initially preferred the conventional ley to the chicory but soon adapted. Lambs were taken off the new leys on 20th August with 125 drawn for slaughter at 40kg.

In early September 170 sheep were re-introduced to the field for a week with 200 ewes & lambs introduced in the 3rd week of September. Additional grazing carried on until November.

Forage production through September was assessed and the herbal ley plot grew at 67kgDM/ha/day, fractionally (but not significantly) lower than the control. The dry matter content of the herbal ley was lower than that of the control; only 10% compared to 14%. The dry matter of the chicory and plantain leaf was as low as 8% - with the grasses typically between 14 and 16%.

Separations of forage material in late September revealed a high component of white clover in the conventional ley (50% white clover, 42% ryegrass and 8% weeds) – expressed on a dry matter basis. The main weeds being annual meadow grass and chickweed.

In the multispecies ley the grass and clover components were lower (28% grass, 6% white clover, 3% red clover) with the sward being dominated by the chicory (37%) and plantain (22%) (Fig. 12).

Visual ground cover assessments in late November (Table 3) revealed a stronger grass component in the conventional ley in late season as the clover growth slowed and the grasses tillered strongly (Fig. 11). There was significant variability between the three reps; Rep 1 being north facing, Rep 2 on the ridge and Rep 3 south facing.

In the multispecies ley the change in the proportions of chicory/ plantain and grass in that short autumn period was quite stark – with the chicory and red clover component dropping significantly.

This change in species composition in the early establishment phase was quite rapid and it is unclear if that was driven by grazing pressure or natural competition in the establishing ley, and the influence of the season (dry, wet, cold etc).

Table 3 Visual ground cover assessments 2018 Gellifeddgaer - Control

Control	Rep1	Rep2	Rep 3	Mean
Ryegrass	75	70	60	68
Timothy	4	2	3	3
White clover	8	12	25	15
weed grasses	5	10	2	6
broad leaved weed	0	1	0	0
bare ground	8	5	10	8
dead material	0	0	0	0

Table 4 Visual ground cover assessments 2018 Gellifeddgaer - Multispecies

Multispecies Herbal	Rep1	Rep2	Rep 3	Mean
Ryegrass	35	25	35	31.7
Timothy	4	5	2	3.7
Fescue	1	0	0	0.3
Plantain	20	35	35	30.0
Chicory	10	10	20	13.3
White clover	8	10	3	7.0
Red clover	2	0	0	0.7
weed grasses	5	5	5	5
broad leaved weed	0	0	0	0
bare ground	15	10	0	8
dead material	0	0	0	0

Figure 11 Conventional seed mixture



Figure 12 Multi species mixture



Weed levels in both types of ley were relatively low – with main weeds being chickweed and meadow grasses – although there were a couple of areas of the south facing bank where creeping thistle was present. Plans were discussed for controlling in 2019 with either a knapsack or weed wiper.

Summary: The reseed as a whole proved very successful allowing the 125 lambs to be drawn in August and good levels of grazing into the autumn. The chicory and plantain were almost too successful in the initial phase of the multispecies ley and the lambs did not initially take to it. While chicory dominated the multispecies ley, it was noted that dry matter content was low at only 10%. It was also thought that the herbs may have out competed and checked the grass development in the herbal ley as grass growth appeared better in the conventional ley. Clover levels were noted as good in both leys. Chickweed was noted in varying degrees throughout the leys which were both gappy in places.

4.1.2 Gilfach Isaf

The 5.2 ha (13 acre) field at Gilfach Isaf was established towards the end of July as the drought ended. The field had not been ploughed for some time (EIA carried out) and ground was still very dry at cultivation, but establishment was deemed acceptable (Fig. 13).

Figure 13 Multispecies ley in the foreground. Nov 2018



The two leys were open initially with docks and chickweed noted, and it was mob grazed in mid-September with approximately 250 sheep for 4-5 days. On 18th October 78 two year old Lleyn X Texel ewes were introduced with the ram to the field for 3-4 weeks. At scanning it was noted that ewes on the new ley scanned at 162%, compared with 141% for a similar batch of ewes tacked onto good ground nearby. Towards the end of November 100 ewe lambs were introduced to the field to take it down to 4cm prior to resting until the spring. This is standard practice but freshly reseeded swards may benefit from being closed up a little earlier to allow better recovery, build improved root reserves and increase the quantity and quality of grass/herbage for first turnout in the spring.

Table 5 Visual ground cover assessments 2018 - Gilfach Control

Control	Rep1	Rep2	Rep 3	Mean
Ryegrass	65	55	35	51.7
Timothy	2	3	2	2.3
White clover	20	10	22	17.3
weed grasses	7	15	3	8.3
broad leaved weed	6	15	3	8.0
bare ground	0	2	35	12.3
dead material	0	0	0	0

Table 6 Visual ground cover assessments 2018 - Gilfach Multispecies

Multispecies Herbal	Rep1	Rep2	Rep 3	Mean
Ryegrass	40	45	55	46.7
Timothy	5	3	3	3.7
Fescue	0	2	0	0.7
Plantain	7	18	15	13.3
Chicory	5	10	5	6.7
White clover	2	2	5	3.0
Red clover	1	0	2	1.0
weed grasses	5	8	10	7.7
broad leaved weed	10	10	5	8.3
bare ground	25	2	0	9.0
dead material	0	0	0	0

Ground cover assessments in November indicated a higher weed level in the conventional ley at Gilfach than Gellifeddgaer and a slightly more open sward, probably driven by drier conditions post establishment.

The multi species ley at Gilfach was less dominated by the chicory and plantain but contains more weeds.

Summary: The two leys established well although they were quite open with chickweed and docks in places, a feature perhaps of the weather at sowing and subsequent rate of establishment. Legumes and herbs both thrive in warmer soil, ryegrass (including the larger seeded AberNiche) is able to cope with lower temperatures. Meadow fescue is generally slow to germinate and establishes with less

vigour initially than ryegrass. The difference in scanning % was very interesting although not specific to any one ley, rather illustrating the benefits of reseeding in general.

4.1.3 Brynchwith

The two fields at Brynchwith were the last to be established towards the end of the season in early September. The top field was sown with the conventional ley while the lower field was sown with the multi species ley. Establishment was deemed acceptable in both fields, although they were very open in places with varying levels of chickweed.

Figure 14 Conventional ley Brynchwith (October 2018)



The lower field was considerably wetter in places (feature of soil type and location) and the grass/herb vigour was noted as poorer in the more waterlogged pockets where chickweed levels were high.

Figure 15 Multispecies ley Brynchwith (October 2018)



Each field was grazed with 65 ewes for a week in late October and late November. The fields were then rested until the spring ahead of turnout with ewes and lambs.

The ground cover assessments in late November showed that the conventional ley was quite open, although relatively clean. It was hoped that with carefully managed grazing the sward density would improve.

The multispecies ley was highly variable due to soil texture/soil moisture variation in the field. In the wetter areas there was an abundance of chickweed and a poor establishment of the plantain and chicory (rep 3). In the drier areas (rep 1 and 2) establishment was far better.

It was decided that future monitoring of sward status should be split into two areas (wetter/drier), rather than allowing one replicate to strongly influence the 'average' performance of the field and would provide useful information on how the different swards are influenced by wetter, peatier soil conditions.

Table 7 Visual ground cover assessments 2018 - Brynchwith Control

Control	Rep1	Rep2	Rep 3	Mean
Ryegrass	60	65	45	56.7
Timothy	2	3	0	1.7
White clover	5	2	5	4.0
weed grasses	3	10	5	6.0
broad leaved weed	5	0	0	1.7
bare ground	25	20	45	30.0
dead material	0	0	0	0

Table 8 Visual ground cover assessments 2018 - Brynchwith Multispecies

Multispecies Herbal	Rep1	Rep2	Rep 3	Mean
Ryegrass	50	40	25	38.3
Timothy	5	3	5	4.3
Fescue	2	2	3	2.3
Plantain	5	18	5	9.3
Chicory	10	9	2	7.0
White clover	3	5	2	3.3
Red clover	0	0	0	0.0
weed grasses	10	3	7	6.7
broad leaved weed	5	15	50	23.3
bare ground	5	5	0	3.3
dead material	5	0	1	2

Figure 18 Control ley



Figure 19 Multispecies in dry part of field



Figure 20 Multispecies in wet peaty area



Summary: Although sown later than planned, the two leys at Brynchwith established well although they remained open in places with varying levels of chickweed going into their first winter. Wetter conditions in the lower field were reflected in less vigour/poorer cover.

4.1.4 Summary of the three farms at the end of establishment year (Nov 2018)

Table 9 Summary of sward visual assessments of control leys on the three farms

Control	Gellifeddgaer	Gilfach	Brynychwith	Mean
Ryegrass	68	52	57	59
Timothy	3	2	2	2
White clover	15	17	4	12
weed grasses	6	8	6	7
broad leaved weed	0	8	2	3
bare ground	8	12	30	17

Table 10 Summary of sward visual assessments of multispecies leys on the three farms

	Gellifeddgaer	Gilfach	Brynychwith	Mean
Ryegrass	32	47	38	39
Timothy	4	4	4	4
Fescue	0	1	2	1
Plantain	30	13	9	18
Chicory	13	7	7	9
White clover	7	3	3	4
Red clover	1	1	0	1
weed grasses	5	8	7	6
broad leaved weed	0	8	23	11
bare ground	8	9	3	7
dead material	0	0	2	1

General observations

At both Gellifeddgaer and Gilfach there was a noticeable difference in the grazing heights of the two leys – with the control ley being grazed much tighter than the multispecies. It was felt that whilst the sheep had grazed the control ley down to target there was slightly too much cover on the multispecies ley when they came off.

Overall the three farmers were pleased with the establishment and relieved not to see any massive germination of annual weeds or any strong carry over of thistles or rushes. All farms were able to remove grazing animals from the reseeds in November and rest the fields ahead of spring turnout.

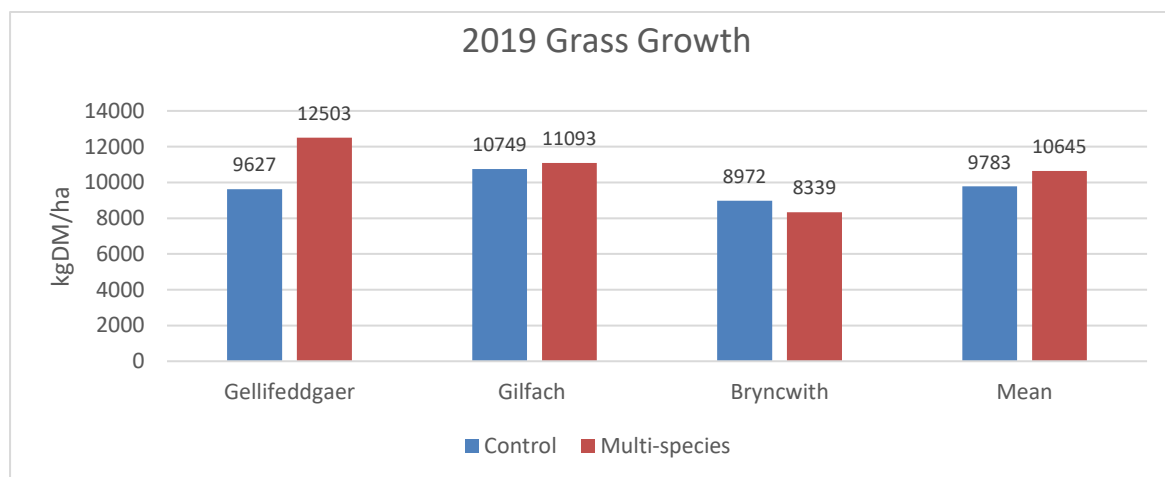
4.2 Year 2 results 2019

Grass monitoring began in late February, with a mild early spring triggering strong early season grass growth and concluded with final sampling in late November. The summer included a dry spell but no significant drought period.

4.2.1 Dry matter production

Total dry matter from cutting under cages recorded greater output from the multispecies ley at two of the farms – including 30% at Gellifeddgaer. As a project average the increase in dry matter production with multispecies is 9%. The lower level of performance at Brynchwith could be attributed to wetter/poorer soil conditions possibly a feature of later sowing giving poorer establishment of sown species, combined with less attention to sward heights (grazing at high covers/higher stocking rates). Yields have declined quickly as weed species have ingressed into the more open and less competitive sward.

Figure 21. Dry matter production for 2019 (kgDM/ha)

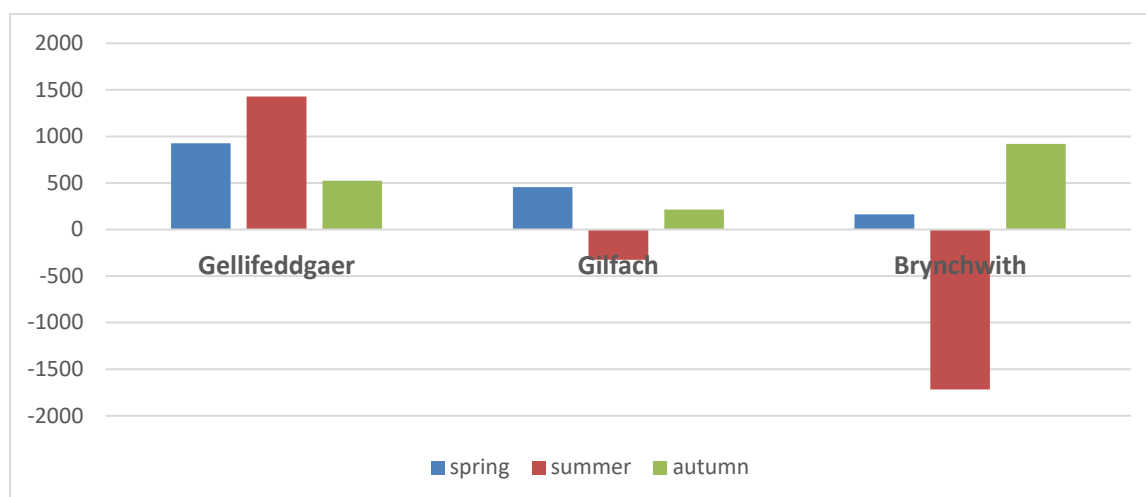


The greatest differences in production were observed in early and late season – where all three farms recorded additional growth on the multispecies leys (Figure 22). The 17% extra forage seen across the three farms in March and April on the multispecies ley is a strong positive outcome – with all sheep farmers keen to provide recently lambed ewes with good forage intakes - and offering good opportunities to reduce early season feed bills.

Wet conditions at Brynchwith meant a delay to grazing and subsequently the grass covers were strong when cattle were turned in, in April, possibly to the detriment of the herbs and legumes. This period of high covers and high stocking rates may well have driven the decline in summer growth at Brynchwith. Grazing was also slightly delayed at Gellifeddgaer where a lack of shelter and a strong easterly wind kept ewes and lambs off the field for longer than ideal, meaning sward covers were slightly strong for first grazing.

All farms also saw increased dry matter production in the autumn on the multispecies swards. The importance of late season grass for flushing ewes is also a strong positive outcome for the multispecies ley – the only issue with the extra growth on the wetter field at Brynchwith was utilising it effectively as ground conditions deteriorated through the season.

Figure 22. Yield benefit of multispecies ley vs control in kgDM/ha (+ve in favour of multispecies)



When comparing farms, it is worth noting that the three farms had slightly differing management and fertiliser strategies in 2019.

The early season growth at Gilfach was boosted with the use of 50kg N/ha in late February. Gilfach continued to use modest applications of N (60kg N/ha at closing out (late April) and a late summer application of 40kgN/ha). Maintenance dressings of P and K were also applied to replace silage offtake.

At Gellifeddgaer a small amount of nitrogen was applied in 2019 as DAP (18:46:0) – supplying 30kgN and 77kgP/ha.

At Brynchwith 100kgN/ha was applied in two dressings as NPK compound (25:5:5) – supplying 50kgN/ha in late March and 50kgN/ha in June.

4.2.2 Nutritional quality

There were no clear trends in nutritional value of the two treatments in either April or Sept 2019 other than a fairly consistent difference in dry matter content – with the multispecies ley 1 to 3 % lower in dry matter.

Table 11 Nutritional quality April 2019 obtained by wet chemistry

	DM	ME	CP	MADF
Gelli Con	22.8	12.0	26.1	20.6
Gelli MS	18.2	12.0	29.9	20.4
Gilf Con	21.7	11.7	25.2	22
Gilf MS	19.5	11.7	23.5	22.1
Bryn Con	19	11.8	24.7	21.5
Bryn MS	17.1	11.9	24	21.3

mean Con	21.2	11.8	25.3	21.4
mean MS	18.3	11.9	25.8	21.3

Table 12 Nutritional quality September 2019 obtained by NIR

	DM	ME	CP	NDF	ADF	WSC
Gelli Con	12	11.3	23.2	53.2	27.7	3.2
Gelli MS	11.9	11.2	20.4	51	28.3	3.2
Gilf Con	16.3	11.4	19.2	51.1	27.3	4.1
Gilf MS	14.9	11.6	16.9	42.5	25.4	4.5
Bryn Con	16.7	11.2	15	54	28.9	5.7
Bryn MS	15.2	11.5	18.7	45.5	25.5	5.3
mean Con	15.0	11.3	19.1	52.8	28.0	4.3
mean MS	14.0	11.4	18.7	46.3	26.4	4.3

There were some differences in the mineral status of the two leys and in June the following trends were identified, Table 13.

Greater P (Phosphorous) and K (Potassium) contents in control v multispecies – along with total Cation Anion balance (CAB).

Greater Ca (Calcium), Mg (Magnesium), S (Sulphur), Fe (Iron), Mn (Manganese), Zn (Zinc), in multispecies leys.

No consistent trends with Na (Sodium), Cl (Chlorine), Al (Aluminium), Mo (Molybdenum), Pb (Lead), Co (Cobalt), Cu (Copper) and Se (Selenium).

Table 13 Herbage mineral analysis NIR June 2019

	CA	P	MG	NA	K	S	CHLORIDE	CAB	FE	MN	CO	ZN	SE	AL	PB	MO	CU
Gelli Con	1.14	0.31	0.16	0.08	3.52	0.18	0.86	580	59.5	18.5	0.03	0.70	0.06	18.60	0.00	0.03	4.60
Gelli MS	1.22	0.28	0.17	0.12	2.51	0.19	0.86	333	130.4	37.1	0.01	41.50	0.03	48.80	0.55	0.90	4.30
Gilf Con	0.51	0.39	0.16	0.43	2.36	0.23	1.36	265	74.3	110.1	0.02	25.40	0.02	30.60	0.25	0.56	6.10
Gilf MS	0.70	0.36	0.16	0.35	2.08	0.24	1.54	100	80.5	121.6	0.06	29.00	0.03	30.30	0.24	0.44	6.80
Bryn Con	0.44	0.33	0.14	0.19	2.49	0.19	1.20	260	81.3	82.9	0.04	35.60	0.08	48.20	0.23	0.78	6.00
Bryn MS	0.78	0.31	0.18	0.25	2.35	0.23	1.35	187	222.5	123.2	0.16	36.10	0.05	396.30	0.65	1.06	6.70
Mean Con	0.70	0.34	0.15	0.23	2.79	0.20	1.14	368	71.7	70.5	0.03	20.57	0.06	32.47	0.16	0.46	5.57
Mean MS	0.90	0.32	0.17	0.24	2.31	0.22	1.25	207	144.5	94.0	0.08	35.53	0.04	158.47	0.48	0.80	5.93

(Green shading denotes >10% difference)

In September there were slightly different trends with consistently lower Mn contents and slightly higher Se levels in the multispecies leys. Ca and Mg levels were again slightly higher in the multispecies swards, Table 14.

Table 14 Herbage mineral analysis NIR September 2019

	CA	P	MG	NA	K	S	CHLORIDE	CAB	FE	MN	CO	ZN	SE	AL	PB	MO	CU
Gelli Con	1.1	0.44	0.19	0.15	2.95	0.29	1.63	179	194	49.5	0.02	126.9	0.083	86.6	1.22	0.81	6.6
Gelli MS	1.43	0.44	0.2	0.25	3.15	0.29	1.72	247	279	40.2	0.04	77.5	0.094	188.1	1.22	0.69	7.3
Gilf Con	0.89	0.38	0.19	0.38	2.24	0.28	1.31	191	307	114.4	0.06	86.7	0.062	168.5	1.6	0.68	6.3
Gilf MS	1.66	0.34	0.35	0.35	1.46	0.33	1.55	-119	133	80	0.04	87.6	0.064	55.2	1.34	0.54	8
Bryn Con	0.75	0.32	0.19	0.3	2.31	0.25	1.53	129	149	79.7	0.1	52.2	0.046	73.2	1.27	0.49	6.3
Bryn MS	0.75	0.31	0.16	0.16	2.23	0.19	1.4	125	350	71.9	0.09	46.7	0.11	297.6	1.44	0.72	4.8
Mean Con	0.91	0.38	0.19	0.28	2.50	0.27	1.49	166.33	216.63	81.20	0.06	88.60	0.06	109.43	1.36	0.66	6.40
Mean MS	1.28	0.36	0.24	0.25	2.28	0.27	1.56	84.33	254.23	64.03	0.06	70.60	0.09	180.30	1.33	0.65	6.7

4.2.3 Sward composition

Swards were visually assessed in November 2019 – with the same methodology as used in 2018.

Table 15 Visual sward assessments as % ground cover - Control plots November 2019

Control	Gellifeddgaer	Gilfach	Brynychwith	Mean
Ryegrass	74	48	66	63
Timothy	3	5	2	3
White clover	15	23	12	17
weed grasses	0	1	12	4
broad leaved weed	1	18	9	9
bare ground	7	5	0	4

Table 16 Visual sward assessments as % ground cover - Multi-species plots November 2019

Multi-Species	Gellifeddgaer	Gilfach	Brynychwith	Mean
Ryegrass	50	40	74	55
Timothy	1	4	7	4
Fescue	1	1	2	1
Plantain	19	14	1	11
Chicory	3	2	1	2
White clover	7	9	0	6
Red clover	0	0	0	0
weed grasses	1	3	4	3
broad leaved weed	0	9	6	5
bare ground	18	17	5	13

Since the previous sward assessments in 2018 there was a general trend for the multispecies leys to increase their ryegrass composition and to lose both chicory and plantain. The leys had also started to open up slightly, showing a little more bare ground – possibly the spaces previously occupied by the plantain and chicory. The control leys remained fairly static, with a small increase in broad leaved weeds and a general increase in sward density at Gilfach and Brynychwith.

Table 17 Changes in sward composition, Control leys Nov 2018 - Nov 2019

Control	Gellifeddgaer	Gilfach	Brynychwith	Mean
Ryegrass	6	-3	10	4
Timothy	0	2	0	1
White clover	0	6	8	5
weed grasses	-5	-7	6	-2
broad leaved weed	0	10	7	6
bare ground	0	-7	-30	-13

Table 18 Changes in sward composition, Multi-species leys Nov 2018 - Nov 2019

Multi-Species	Gellifeddgaer	Gilfach	Brynychwith	Mean
Ryegrass	18	-6	36	16
Timothy	-3	1	3	0
Fescue	0	0	0	0
Plantain	-11	1	-9	-6
Chicory	-10	-4	-6	-7
White clover	0	6	-3	1
Red clover	-1	-1	0	-1
weed grasses	-4	-5	-3	-4
broad leaved weed	0	1	-18	-6
bare ground	10	8	2	6

4.2.4 Animal performance

Gellifeddgaer recorded over 9000 ewe/lamb grazing days to weaning, followed by 10,300 lamb grazing days through to 4th September over the whole trial. In dry matter terms that equates to a 6400kgDM/ha – utilised.

There was little difference in animal performance between the two leys.

Both Gilfach and Gellifeddgaer reported marginally better lamb performance on the herbal ley – but both recorded fairly low lamb growth rates of between 100 and 120g/day post weaning. If each one of those grazing days recorded at Gellifeddgaer achieved the modest growth rate of 120g/day then that equates to 468kg LWG produced/ha over the whole season – which is a reasonable level of performance.

4.2.5 Inventory of invertebrates

The objective of this small survey was to trap and identify the numbers of pollinating insects on each of the two leys on each farm.

Due to differing grazing/cutting regimes at the host farms sweep netting transects were carried out after consultations with host farmers to ensure all sites were at similar growth stages.

On 8th July 2019 Aldwyn Clarke of ADAS carried out the assessment of arthropods over the three farms involved in the EIP project. The conventional and herbal leys were each walked separately and

two runs of 30 swipes were taken across a representative section of each ley with a sweep net. Arthropods captured in the net were collected and stored for future reference. Weather was warm and sunny, approximately 21 degrees Celsius with a light southerly breeze.

Gilfach – The field had been cut for silage approximately 16 days previously but there was good regrowth (100mm in the conventional ley). The field had cropped well with 15 bales/acre, 50% up on normal. Approx. 370kg/ha compound 21:8:11 had been spread in the spring.

Some signs of rutting were evident in the field along with a population of docks. Anecdotally the herbal ley seemed more advanced than the conventional ley. Chicory and plantain regrowth was evident as was ryegrass heading in the herbal ley. There was no observable difference in arthropod populations between the two leys.

Gellifeddgaer – the field had recently introduced sheep grazing (not cut) but there was plenty of grass, clover and herbs with sward height approx. 150mm in the conventional ley. The leys had received 125kg/ha TSP (46%) in the spring. There appeared no preferential grazing between the leys. Again the chicory and plantain growth was evident while yarrow was also present in abundance. There was no observable difference in arthropods numbers between the two leys.

Brynchwith – Both fields had been grazed hard with around 50mm of grass in the conventional ley. Grass had headed. Cages indicated good growth. The field with the herbal ley lies wet in winter but had turned hard at the time of the visit. Cattle had grazed the field but cages again indicated decent growth. The field required topping. Both fields had received approximately 45kg/ha N in the spring. There was no observable difference in arthropod numbers between the two leys.

Table 19 Invertebrate numbers found in 2019 sampling.

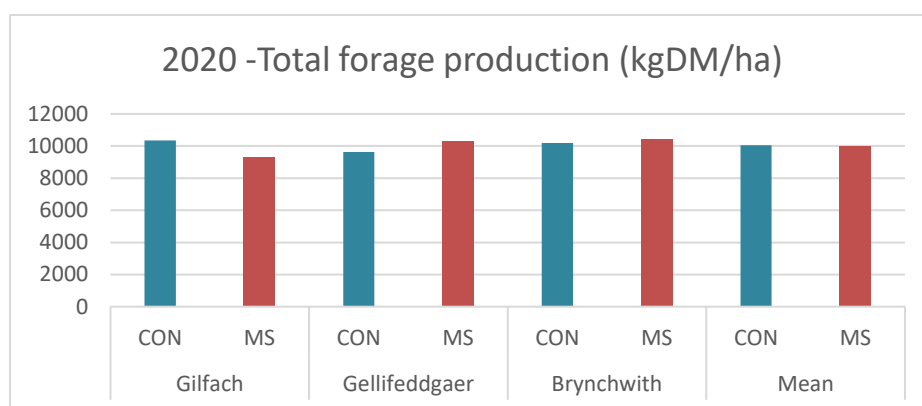
Invertebrate survey July 2019							
		Diptera	Coleoptera	Arachnids	Collembola	Dermaptera	Total
Gellifeddgaer	Con 1	463	0	3	0	0	466
	Con 2	222	3	1	0	0	226
	MS1	237	5	3	1	0	246
	MS2	501	5	3	1	1	511
Bryn Chwith	Con 1	515	6	4	0	0	525
	Con 2	291	9	3	2	0	305
	MS1	434	3	0	0	0	437
	MS2	986	6	1	0	0	993
Gilfach	Con 1	245	8	1	9	0	263
	Con 2	299	18	3	8	0	328
	MS1	187	17	0	5	0	209
	MS2	169	13	1	5	0	188
	Mean Con	339	7	3	3	0	352
	Mean MS	278	9	2	3	0	292

4.3 Year 3 Results 2020

4.3.1 Dry matter production

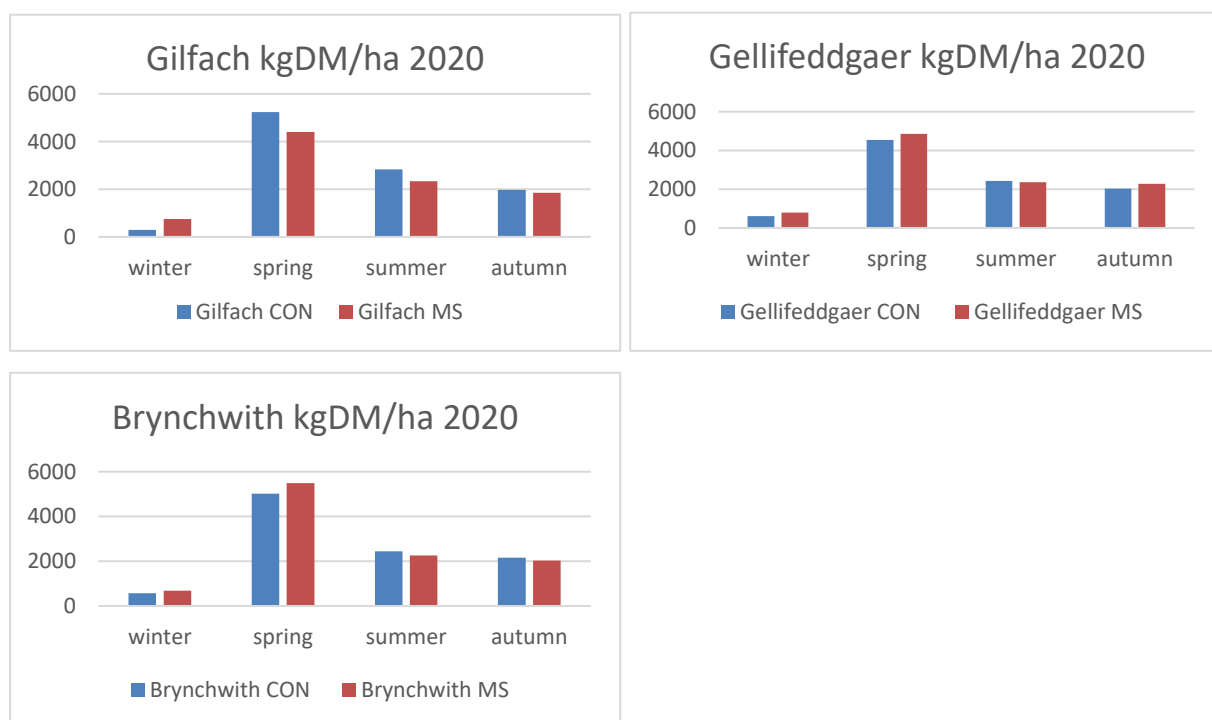
There were few differences in the total herbage production across the project in 2020 – with all of the leys averaging around the 10tDM/ha mark. This mean production is very similar to the figure recorded in 2019. As in 2019 there were variations in nitrogen regimes on the three farms, with Gilfach receiving 120kgN/ha, Brynchwith 90kgN/ha and Gellifeddgaer 30kgN/ha. Gilfach was once again cut. This level of 10tDM/ha is a very acceptable level of production for a young reseed with modest nitrogen inputs. Typically the permanent pasture production on the farms will average below 7tDM/ha.

Figure 23 Dry matter output in 2020



There was less evidence of any seasonal benefits from the multispecies ley. The performance of the multispecies ley at Gilfach was noticeably poorer through the very dry spring period – although both Gellifeddgaer and Brynchwith recorded better growth through that period.

Figure 24. Dry matter output for each of the farms



4.3.2 Nutritional quality

Herbage samples were taken in July and September and assessed for both nutritional quality and mineral status.

Table 20. Herbage nutritional quality July 2020 (NIR)

	DM	CP	NDF	Sugars
Gelli Con	18.4	17.4	47.8	4.6
Gilfach Con	21.7	13.2	53.6	6.1
Bryn Con	17.6	18.5	50.8	6.2
Mean Con	19.2	16.4	50.7	5.6
Gelli MS	16.1	19.9	41.6	4.6
Gilfach MS	21.2	14.2	46.4	4.2
Bryn MS	17.1	20.5	48.1	6.7
Mean MS	18.1	18.2	45.4	5.2

Table 21. Herbage nutritional quality July 2020 (wet chemistry)

	DM	CP	NDF	ME
Gelli Con	14.5	20.8	44.9	11.2
Gilfach Con	15.2	17.4	43.3	10.9
Bryn Con	17.9	13.4	47	10.8
Mean Con	15.9	17.2	45.1	11.0
Gelli MS	12.9	20.1	45.7	9.5
Gilfach MS	14	16.1	44.3	10.9
Bryn MS	13.8	20.2	52.3	10
Mean MS	13.6	18.8	47.4	10.1

All three sites recorded higher protein levels in the multispecies swards in July – this was repeated at Gellifeddgaer and Brynchwith in September.

The wet chemistry analysis suggested lower energy values in the multispecies sward in September.

Table 22. Herbage mineral analysis NIR July 2020

	CA	P	MG	NA	K	S	CL	CAB	FE	MN	CO	ZN	SE	AL	PB	MO	CU
Gelli Con	1.12	0.31	0.20	0.16	2.29	0.23	0.95	239	72.5	78.3	0.00	121.4	0.05	21.3	1.53	0.48	5.6
Gilf Con	0.70	0.27	0.17	0.27	2.26	0.20	1.30	205	87.9	94.3	0.02	24.6	0.04	42.4	0.45	0.23	6.4
Bryn Con	0.72	0.34	0.20	0.33	2.31	0.20	1.33	235	96.8	115.5	0.02	55.4	0.11	56.5	0.56	0.85	7.5
Mean Con	0.85	0.31	0.19	0.25	2.29	0.21	1.19	226	85.7	96.0	0.01	67.1	0.07	40.1	0.85	0.52	6.5
Gelli MS	1.10	0.24	0.16	0.13	2.25	0.19	1.10	204	108.3	33.7	0.00	94.2	0.06	61.1	0.85	0.74	6.3
Gilf MS	0.97	0.30	0.21	0.38	1.85	0.25	1.40	89	86.7	115.6	0.02	43.6	0.42	40.2	0.48	0.41	7.0
Bryn MS	0.73	0.23	0.19	0.20	2.12	0.21	1.34	117	72.9	117.3	0.04	37.2	0.08	44.4	0.56	0.73	6.2
Mean MS	0.93	0.26	0.19	0.24	2.07	0.22	1.28	137	89.3	88.9	0.02	58.3	0.18	48.6	0.63	0.63	6.5

	CA	P	MG	NA	K	S	CL	CAB	FE	MN	CO	ZN	SE	AL	PB	MO	CU
Control	0.85	0.31	0.19	0.25	2.29	0.21	1.19	226.3	85.7	96.0	0.01	67.1	0.07	40.1	0.85	0.52	6.50
Multispecies	0.93	0.26	0.19	0.24	2.07	0.22	1.28	136.7	89.3	88.9	0.02	58.3	0.18	48.6	0.63	0.63	6.50

Whilst there were a few differences between treatment means – there were no consistent trends across all three sites in any of the mineral status levels – other than higher Cation Anion Balance (CAB) figures for all three control leys.

The CAB figure is derived from a combination of Na,K:Cl,S – and all figures are within the ‘normal range’, with issues for increased risks of metabolic disorders only being associated with levels above 350meq/kg.

This result is consistent with previous mineral assessments.

In September the herbage samples were analysed by wet chemistry methods. Whilst there were some differences in treatment means, with higher levels of many minerals in the multispecies leys, often the treatment differences were not consistent across all three farms.

Table 23. Herbage mineral analysis September 2020 (wet chemistry)

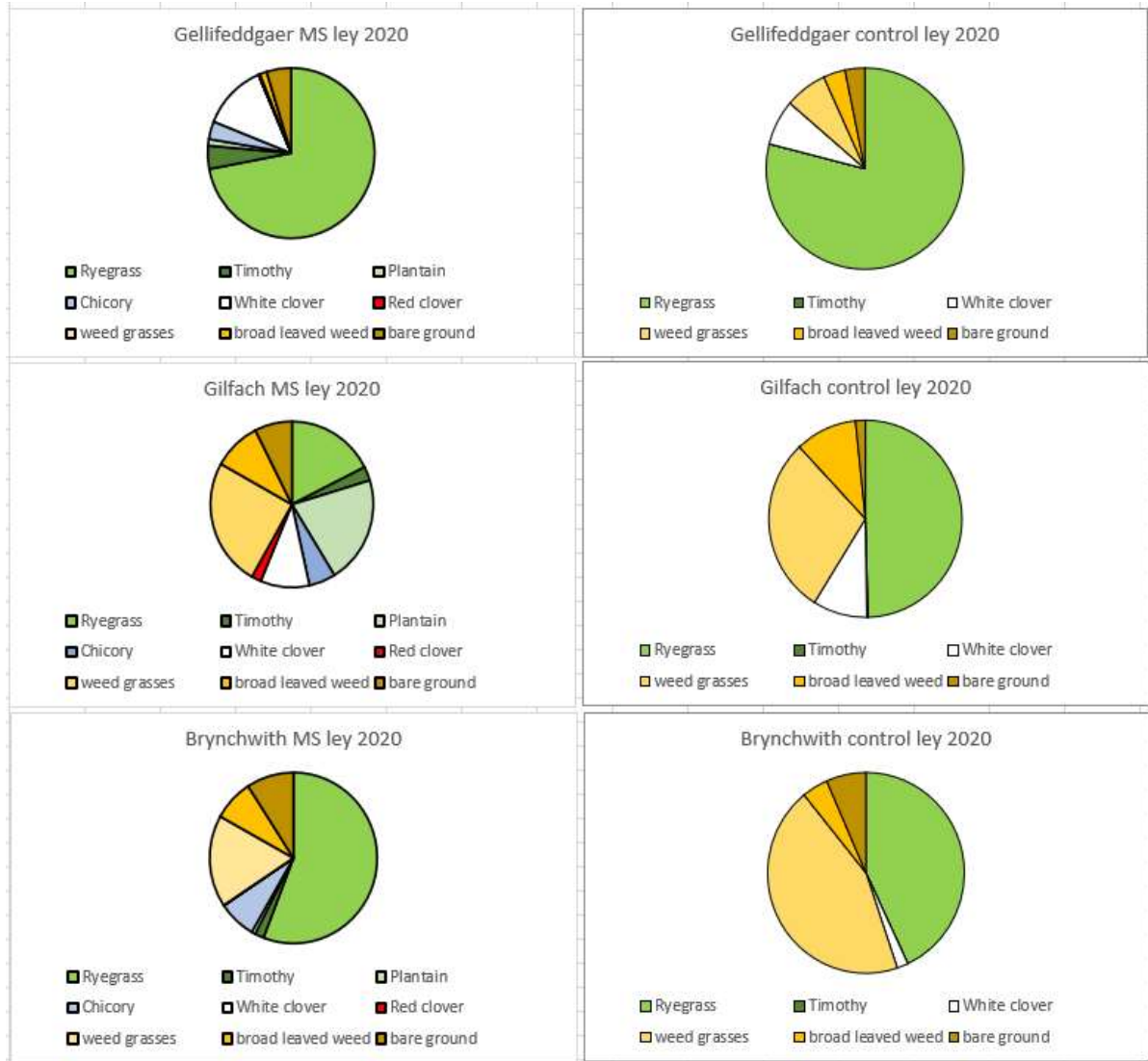
	Herbage mineral analysis Sept 2020 (wet chem)										
	CA	P	MG	NA	K	S	CL	FE	MN	ZN	CU
Gelli Con	0.88	0.32	0.19	0.12	2.76	0.24	0.79	747	52.1	90.6	8.29
Gilf Con	1.01	0.38	0.23	0.26	2.39	0.23	1.2	1290	119	75.1	9.51
Bryn Con	0.64	0.26	0.21	0.21	2.23	0.25	0.86	241	158	101	7.06
Mean Con	0.84	0.32	0.21	0.20	2.46	0.24	0.95	759	110	88.9	8.29
Gelli MS	0.99	0.39	0.2	0.19	2.95	0.23	1.23	1260	76.3	105	9.91
Gilf MS	1.14	0.41	0.28	0.51	2.25	0.3	1.37	410	208	160	9.98
Bryn MS	0.65	0.35	0.23	0.28	2.9	0.25	1.28	546	150	86.7	10.8
Mean MS	0.93	0.38	0.24	0.33	2.70	0.26	1.29	739	145	117.2	10.23

4.3.3 Sward composition

All of the cage cut samples were subjected to hand separations to identify the proportions of grass and broad-leaved species in the swards.

The samples were separated into ryegrass, Timothy, weed grasses, white clover, red clover, plantain, chicory and broad-leaved weeds which was then dried and weighed, with results presented on a dry matter basis - as a percentage of the total sample (Fig.25). The % bare ground was visually assessed at the time of collecting the sample.

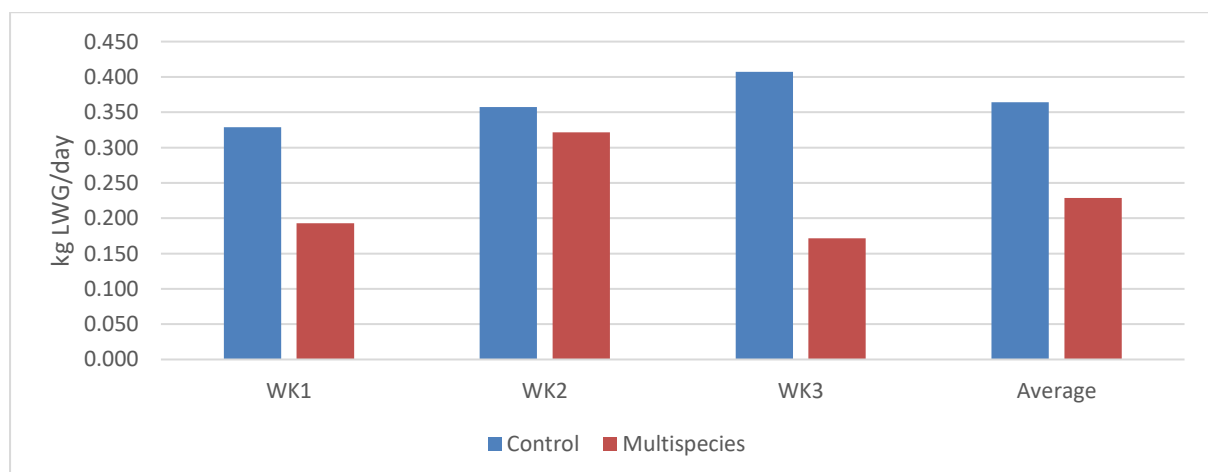
Figure 25 Sward composition for the three farms



4.3.4 Animal performance

At Gilfach a group of lambs were weighed on and off the plots in August over a three week period.

Figure 26 Gilfach lamb growth rates in August 2020



The lambs grazing the multispecies ley performed below the level of the control group, particularly through the first and third weeks.

4.3.5 Inventory of invertebrates

Figure 27 Results of the invertebrate survey August 2020

Invertebrate survey August 2020									
		Diptera	Coleoptera	Arachnids	Collembola	Aphidoidea	Hymenoptera	Lepidoptera larvae	Total
Gellifeddgaer	Con 1	89	0	1	29	2	0	1	122
	Con 2	93	0	0	15	2	0	0	110
	MS 1	32	1	1	1	2	1	0	38
	MS 2	44	2	0	38	0	0	0	84
Bryn Chwith	Con 1	128	1	1	10	6	0	2	148
	Con 2	94	0	1	1	1	0	0	97
	MS 1	203	17	1	9	0	2	0	232
	MS 2	166	4	1	9	0	0	2	182
Gilfach	Con 1	9	0	1	1	2	0	0	13
	Con 2	49	2	0	31	5	0	0	87
	MS 1	30	1	0	16	4	0	2	53
	MS 2	56	1	1	7	2	2	2	71
	Mean Con	77	1	1	15	3	0	1	96
	Mean MS	88.5	4	1	13	1	1	1	110

2020 Survey

On 20th August 2020 Aldwyn Clarke of ADAS carried out the assessment of arthropods over the three farms involved in the EIP project. The conventional and herbal leys were each walked separately and two runs of 30 swipes were taken across a representative section of each ley with a sweep net. Arthropods captured in the net were collected and stored for future reference. Weather was reasonably warm and sunny, approximately 20 degrees Celsius with a brisk southerly breeze.

Gilfach – The field had been cut for silage week beginning 20th July. Regrowth was good and lambs had been introduced.

Populations of docks, creeping buttercup, dandelion and daisy were noted in both leys. White clover (some in flower) was abundant in both leys. Plantain appeared more abundant than the chicory with limited red clover. There was no observable difference in arthropod populations between the two leys.

Gellifeddgaer – the field had recently introduced sheep grazing (not cut) but there was plenty of grass, clover and herbs. The herbal ley appeared to have been preferentially grazed over the conventional ley. Again the chicory and plantain growth was evident (lower levels than Gilfach). White clover levels were again good, although thistle levels were noted as high in the conventional ley (on the brow of the hill). There was no observable difference in arthropods numbers between the two leys.

Brynychwith – The conventional ley was not grazed at the time of the visit with 150mm regrowth following previous defoliation. Species such as common bent and crested dog’s tail were noted as frequent in certain parts of the sward. The field had a thistle population.

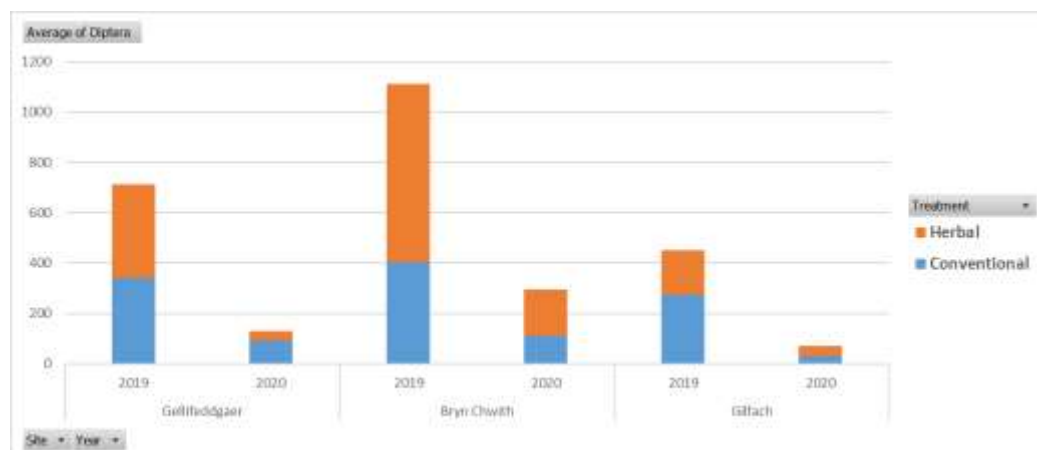
The field with the herbal ley generally lies wet. The presence of species such as Flote grass (*Glyceria fluitans*) illustrate this. Sheep were grazing the field but grass cages again indicated decent growth. The field was in need of topping, the Festulolium appeared dominant and had headed. Plantain and Chicory were observed in low numbers, while some Timothy was also noted. There did appear to be an observable difference in arthropod numbers between the two leys.

Results and conclusions

Data for all insect groups across both sample years from all three farms was analysed as a factorial data set.

- No bumble or honeybees were recorded at any site during either collection periods.
- Although a small number of wasps were recorded in the herbal mix areas of all three farms in 2020, these were not significantly different to the conventional areas.
- No adult butterflies or moths caught at any site in 2019 or 2020. However, butterfly/moth larvae were recorded in 2020 which would indicate adult activity. Although higher numbers were recorded in the herbal mixtures these were not significantly different to the conventional mixes.
- True flies (Diptera) were the most numerous insect group recorded during this survey. Diptera numbers were significantly higher in 2019 when compared to 2020. Over the two sample years there were significantly higher Diptera numbers recorded at Brynychwith when compared to Gilfach, but not when compared to Gellifeddgaer.
- Although well documented and recognised that wild and managed bees are among the most effective pollinators of global crops of economic importance, non-bee pollinators including flies, beetles, moths, butterflies, wasps, ants, birds, and bats are also important pollinators. Some published research papers report that non-bees performed 25–50% of the total number of flower visits. Although non-bees were less effective pollinators than bees per flower visit, they made more visits (Non-bee insects are important contributors to global crop pollination, PNAS January 5, 2016 113 (1) 146-151; first published November 30, 2015)
- There were no significant differences in the numbers of the other insect groups recorded.

Figure 28. Diptera species recorded at the 3 sites in 2019 and 2020



5 Discussion

There were a number of questions that this project was set up to answer within the areas of forage production and animal performance. There were several key outcomes from the project concerning multispecies leys.

- 1) Seed mixture selection
- 2) Seed bed preparation
- 3) Grazing regimes
- 4) Nutrient management regimes
- 5) Insect population benefits

5.1 Forage production

Q? Multispecies leys can yield as well or better than conventional leys?

Yes.

Yield data collected from the trial showed a clear yield benefit at Gellifeddgaer from the multispecies ley in the year post establishment, but with only marginal differences at Gilfach and Brynchwith.

In the 2nd full year of production there were no clear differences between the total yields of the multispecies and control leys.

There were clear seasonal production benefits from the multispecies leys with improved spring and autumn growth on all sites in the year post-establishment. The boost in spring performance was noted on two of the sites in the following year.

This seasonal pattern may be influenced by the presence of the Festulolium and the plantain which both appeared to grow well at lower temperatures.

Q? Multispecies leys can offer improvements in sward quality?

Not seen in this project.

For much of the project there was no clear evidence to suggest that the multispecies leys increase forage nutritional qualities or mineral status on a consistent basis at any stage of the growing season. The only parameter that consistently differed was the dry matter content of the forage, with the control being between 1 and 3% higher in dry matter at every sampling point.

Forage nutritional qualities are driven by species composition, plant growth stage/maturity and by soil nutrient and water supply. The variability of all of these elements both within and between the three farm sites may have contributed to the lack of any clear and obvious trends.

Marginal differences in protein and energy were found – but nothing consistent across the three farms. It may be that the strong clover component in the control ley matched any protein benefit from the chicory/plantain in the multispecies ley. The final analysis with wet chemistry in 2020 did find lower ME levels in the multispecies leys – possibly due to a higher proportion of weeds, the

stemmy nature of the Festulolium in late season or possibly an impact of a higher growing point at the sward base due to higher grazing residuals through the grazing season.

The lack of consistent differences in minerals and trace elements may be due to their general low background levels in the soils of south Wales. High levels of iron and aluminium that are found in these soils are known to have antagonistic effects with many other elements.

The final wet chemistry analysis did suggest a general uplift in the mineral trace element profile of the multispecies ley. It is possible that any mineral effect is only seen once the plants mature and roots extend well into the subsoil.

Q? Will the range of herbs and legumes persist in multispecies leys?

Variable.

The three leys within the project have evolved into three very different swards by the end of the project. The greatest diversity and persistence of the sown species within the multispecies leys was found at Gilfach. At Gellifeddgaer ryegrass and white clover dominated the sward by the end of Year 3 and at Brynchwith the leys became very much dominated by grasses, to the expense of the chicory, plantain and legumes.

The drivers of this sward evolution are multiple; soil water and nutrient supply, grazing management (stocking rates, stock type, entry and exit covers, grazing periods) and any cutting regime (Gilfach). It is clear (and not unexpected) that much of the sward composition is driven by establishment success.

Later sowing of the leys at Brynchwith did result in lower numbers of herbs and legumes establishing – so limiting their contribution from day one. The weed challenges were greatest at Brynchwith and Gilfach – whereas the pioneer crop of stubble turnips that preceded the spring sowing at Gellifeddgaer did result in a very low weed burden and a healthy establishment.

Both the extremes of very tight or very lax grazing seem to challenge the herbs and legumes, particularly in the early and late season.

The inclusion of a silage cut at Gilfach does not seem to have negatively influenced the sward composition of the multispecies ley, and may well have helped to enhance it. The cut was never heavily fertilised (50-60kgN/ha) or shut off for an extended period (6 weeks max), allowing the herbs and legumes to grow up with the grasses rather than being outcompeted. The cutting height was high enough (7cm) to protect the crown of the chicory and red clover plants and the aftermath grazing wasn't started until the regrowth had reached a cover of over 2000kgDM/ha – so allowing the plants to recover properly from cutting.

It is unclear as to what impact cattle grazing had on the swards compared to sheep grazing at both Gellifeddgaer and Brynchwith. At Brynchwith the sward covers were quite high for the cattle grazing (3000kgDM/ha) where as they were closer to 2400kgDM at Gellifeddgaer. The project doesn't have evidence to suggest that they are either detrimental or positive to the development and persistence of multispecies leys.

Soil nutrient status and supply has a role to play in balancing the sward composition, not least because it plays such a key role in establishment success. Higher weed levels at both Brynchwith and Gilfach

are likely to be associated with lower soil pH levels at sowing. Although both lime and phosphate were applied at establishment the time lag of the passage of these amendments into soil solution can be considerable and may have challenged the emerging seedlings.

Differing nitrogen regimes don't seem to have a huge influence on sward composition – although the low use of nitrogen at Gellifeddgaer may be a key driver behind the clover composition in the sward. What seems to be important with nutrient inputs is that they don't result in grasses becoming massively dominant and outcompeting the other sward components.

Q? Multispecies leys could be more persistent than conventional ryegrass/ clover leys in marginal land?

No.

The project found no real evidence to support the idea that the multispecies leys offer any more resilience and persistence than a standard ryegrass ley. This is borne out by the comparable yields and quality measured at the end of the project.

There is a strong possibility that the farmer's involvement in the project led to an improvement in their management of the new leys; either through an increase in their knowledge base, by an increase in pride associated with their project fields, or by the awareness that the leys and management were being regularly observed. The net result being that all the new leys were given possibly preferential treatment to previous reseedings on the farms.

5.2 Animal performance

Q? Multispecies leys offer opportunities for improvement in animal performance and animal health?

No.

The project found no strong evidence to support this statement. Whilst there were several anecdotal comments about stock performing and looking well on the multispecies leys the animal liveweight gain recordings failed to qualify this with any strong data. Two of the farmers thought the lambs were noticeably cleaner on the multispecies leys with far less daggings required.

Another [EIP project](#) is currently looking specifically at the potential impacts of multispecies leys on animal performance. Early indications from the project have shown:-

- On average the lambs on the herbal leys gained between 0.5-1kg more over the data collection period than the lambs on the conventional grass ley
- On average the FEC levels of the lambs on the herbal ley was between 30%-75% lower than the lambs on the conventional mix
- The grass quality of the herbal leys tended to have more balanced level of protein (high teens) and higher levels of sugar than the conventional mix.

As with this project the recorded animal performance benefits have so far been small – but there does appear to be a positive impact on animal worm burdens. For information on 'The Impact of herbal leys on the health and performance of grazing lambs' project please visit the Farming Connect website at www.gov.wales/farmingconnect.

5.3 Habitat and diversity

Q? Multispecies leys will increase the amount and diversity of insect species.

Not seen in this project.

There was no evidence from the invertebrate surveys to support this. However, the sampling strategy for this project attempted to assess all the leys at a similar growth stage and sward structure (late summer) to gain a true comparison. It is highly likely that there may well be benefits at different times in the growing season – particularly if the leys are allowed to flower in mid-season (a silage cut scenario).

6 Key outcomes from the project concerning multispecies leys

6.1 Seed mixture selection – species choices and mixture balance

There is currently a huge number of multispecies seed mixtures on the market – encompassing a diverse range of species and many different formulations. The seed mixture chosen needs to be suited to the environment and system into which it is being placed – and the grower needs to have clear objectives about what they wish to achieve.

For the project the farmers were keen to maintain a strong production element (so quality, yield and persistence were key demands) but also wanted to have a ley suited to lower inputs and more extensive management. Whilst they recognised there may be potential gains to animal and soil health from a broader range of herbs and legumes they elected to keep a fairly simple mixture, so opting for 4 grasses, 2 legumes and 2 herbs.

The ryegrass component of the mixture can be hugely influential on how the ley develops and how much diversity persists, particularly in higher fertility situations. The project mixture included 50% perennial ryegrass, whilst there are examples on the market of mixtures with 80% ryegrass down to as low as 4%.

The lower ryegrass percentage leys may have issues with speed of establishment and ground cover and may not maintain the yields and quality of those with a greater inclusion.

The design and selection of multispecies leys has to include an element of ‘learning on the job’. Now that the farmers have seen what species suit their particular farm they will be better informed to make decisions on what they include or omit in future seed mixtures.

The project farmers saw a benefit of including the *Festulolium* grass and were happy to sacrifice mid-season quality for early season growth. It should be noted that this *Festulolium* is quite an aggressive grass and at Brynchwith it became quite dominant in places and may have out competed the plantain and chicory. Especially as it will have coped with the late sowing better than the herbs which require a little more time to build their root reserves before the winter.

Whilst all the farmers were very keen to include Timothy in their leys, the % composition of the Timothy was low throughout the project and so didn’t contribute strongly to the sward. An ongoing EIP project in mid-Wales is looking at higher rates of inclusion of Timothy in swards and is also

struggling to establish and maintain a significant Timothy component in a marginal upland system. With a small seed and slower establishment it is possible that the Timothy can only realistically be expected to occupy small niche areas in the sward. To find out more about the '[Sustainable intensification in upland grazing production systems](#)' project visit the Farming Connect website www.gov.wales/farmingconnect.

The inclusion of 1kg of meadow fescue in the mixture also struggled to compete in the sward and was difficult to detect in the autumn sward assessments. In mid-season there were a few meadow fescue seed heads in evidence but at a very low level.

Gilfach was the only site where red clover persisted at any level, helped perhaps by the inclusion of a silage cut replacing some grazing, maybe a species to avoid on wetter fields or where there are periods of more intensive grazing. There are other legumes that may have more potential in the lower input/marginal areas such as birdsfoot trefoil and alsike clover.

The inclusion of a mixed leaf size white clover blend was very successful at Gellifeddgaer with a strong white clover component persisting through the project. White clover levels were lower at Gilfach, possibly influenced by early season nitrogen use and the inclusion of a silage cut. At Brynchwith white clover establishment was poor (there was a lot of smothering weeds in the early stages of the ley development) and it failed to persist even in the drier areas of the field. Its survival will also have been challenged with the grazing regime and higher early season sward covers.

The chicory and plantain inclusion rates were relatively low (0.4 and 0.6kg/acre respectively) as experience has shown that higher rates can result in a dominance of the two species to the detriment of other species and of ground cover. The persistence of chicory and plantain varied between the three farms. At Gellifeddgaer the chicory and plantain were very strong at establishment but declined rapidly in years 2 and 3 to a level of around 10-20 plants/m². At Gilfach the plantain was the more persistent herb, whereas at Brynchwith the chicory only persisted in the drier areas of the field. Grazing pressures are likely to be the key to persistence of the herbs and legumes, particularly in early and late season. Chicory in particular is a short lived perennial, only expected to last 2 to 3 years.

At both Gilfach and Gellifeddgaer there was significant germination of yarrow from the seed bank (we had elected not to include it in the seed mix although it is a common addition). Its contribution to the sward in the establishment year and early in year 2 was significant and maybe it is a species that warrants inclusion in future seed mixtures. Its persistence in this study though was limited and very little was observed in the autumn assessments at the end of year 2.

Discussions on the project findings with the Actor, Helen Mathieu from Germinal, and her colleagues formulated the following key issues with seed mixture choice:

- 1) The farmer needs to be clear what they want the ley to do. Multispecies mixtures can be formulated more towards production (high ryegrass component) or more towards environmental gains (less ryegrass and a broader spectrum of herbs and legumes).
- 2) More is not necessarily better. Increasing the number of species may increase costs substantially with little benefit to sward diversity beyond the establishment phase - as many herbs/legumes can be quickly outcompeted, particularly in high fertility situations. Increasing the amount (kg/acre) of individual species can also have negative effects – noticeably with

highly aggressive species such as the Festulolium or tall fescue or with chicory that can easily dominate the sward.

- 3) With growing popularity of multispecies leys there is pressure on seed supplies, particularly of UK provenance – so availability and price of the very diverse mixtures may increase significantly.
- 4) Longevity of the components in multispecies mixtures will always be limited due to the growth habits and morphology of some of the plant species. Chicory and red clover will always be strongest in the first 2 years of the ley and decline quite rapidly thereafter – for other species their place in the ley may be limited to its first year.

6.2 Seed bed preparation and timing

There is no question that an early establishment is preferable, to allow all the species in the mix to germinate and reach a significant size prior to the first winter. Early sowing also allows the farm to take advantage of first season grazing (either lambs or flushing) with the added benefits of a low worm burden. The September establishment at Brynchwith limited the options for early grazing, the grasses didn't tiller, and herbs were maybe unable to reach a viable size, so allowing more bare ground and more opportunities for weed ingress.

Cultivation methods were not a crucial factor in establishment; although the combination of a pioneer stubble turnip crop and a minimal surface cultivation at Gellifeddgaer did seem to limit weed numbers. There is always the danger of the small seeds in a multispecies mix being placed too deeply in the soil, so it is crucial that the seedbed is tight but not over worked. Broadcasting the seed seemed to result in good even coverage and avoided the risk of a drill placing the seed too deep.

The discussions with the Germinal team also concluded that earlier sowing offered key benefits in terms of establishing large healthy plants going into the first winter. Earlier establishment allow the farmer to make maximum use of the multispecies ley at its prime and also benefit from the low worm burden associated with a young ley in its early grazings.

6.3 Grazing regimes and sward height management

All the project farmers were mentored in ideal grazing management and sward height regimes to help encourage and promote diversity within the multispecies leys and optimise sward quality. It was suggested that swards should be maintained between 4cm and 12cm for sheep grazing and 5-28cm for cattle, with a graze/rest cycle preferred to a continuous grazing regime.

At Gilfach and Gellifeddgaer stock had access to both treatments for much of the grazing season (temporary fencing was included post weaning) and the farmers reported that grazing patterns were uneven, with stock reluctant to graze the multispecies ley as tight as the control. On turning stock into the multispecies leys they also noted an acclimatisation period – where stock would initially graze the control ley in preference to the multispecies.

These grazing behaviours on multispecies swards present some potential issues for grazing management guidelines; in terms of target sward heights and also in the length of grazing period.

If an acclimatisation period does occur then it would be sensible to keep individual animals on the

sward for as long as possible – to avoid any stop/start check of moving to and from a multispecies sward. Continual grazing isn't advised on the multispecies leys (preferential grazing of the herbs and no recovery time), so the best solution would be subdivision of the multispecies ley, to allow rotational grazing through the one field. Such a grazing regime requires a certain amount of infrastructure and management time; so maybe could reduce the appeal of including a multispecies ley on a farm.

Early in the project it became clear that the use of a rising plate meter to assess sward mass on the multispecies ley was problematic and that they did not measure accurately. The presence of the chicory and plantain (quite erect in their growing habit) and the lower dry matter content of the sward led to "over reading" in many instances. Whilst efforts have been made (Massey University) to produce new calibration equations for plate metering multispecies leys they seem to be very field specific, depending on species present, their % composition, their growth stage and the dry matter content. This project would advise that growers use quadrat cuts to assess dry matter covers and use sward height measurements to determine residuals for moving stock on.

All the farmers were adamant that a winter break is essential for the multispecies leys – an opinion echoed by all in the Germinal team.

All involved also recommended that the leys are best grazed on a rotational basis rather than continuously set stocked.

All thought that overgrazing was detrimental (below 5cm) and that strong early season covers were likely to suppress the growth of the legumes and herbs. For this reason the group felt that early season silage cuts (closing March/April) would be inappropriate for a multispecies ley – but the 6 week mid-season shut that happened at Gilfach was a suitable management option, as long as the crop wasn't cut too low (5cm+).

6.4 Nutrient management regimes

Establishing multispecies leys on marginal land (thin soils, high rainfall, short growing season) still requires a suitable level of soil fertility for rapid germination and weed suppression and there seems no reason to diverge from standard RB209 recommendations for soil nutrient requirements for grassland establishment; soil pH between 6 and 6.5 and P index 2 and K index 2- should still be the requirement. Nitrogen inputs to the seed bed should also be based on previous cropping history and seasonality, as outlined in RB209.

All of the project farms followed RB209 recommendations for the supply of maintenance P and K and the replacement of any crop P and K offtake. Gellifeddgaer favoured the use of DAP (18:46:0) in early spring (75kg/acre) whilst Gilfach and Brynchwith used NPK compounds throughout the year, with FYM being returned to Gilfach post-silage.

The grass production from Gellifeddgaer on minimal nitrogen inputs (30kgN/ha/yr) was consistently above 10tDM/ha over the duration of the project and a clear demonstration that, with sufficient legume inclusion, nitrogen fixation can support a high production capacity. At Brynchwith additional nitrogen was required to support yields in the absence of a healthy clover population – but at rates below RB209 recommendation (90kgN/ha vs recommended 130kgN/ha). Nitrogen rates to support a silage cut at Gilfach were typical of many upland sheep farms at between 50 and 60kgN/ha. These

would be slightly below RB209 recommendations for grassland, but making allowance for the legume component.

The final sward composition of the multispecies ley at Gilfach would suggest that modest nitrogen inputs don't compromise their diversity – as long as early season sward heights are controlled to avoid shading of the herbs and legumes.

7 Messages from the project for policy makers

The project team have been contacted by the Welsh Land Management Reform Group to help them formulate future agricultural support schemes that may include the use of multispecies leys. The main ideas discussed included:

- 1) There is no reason why any farm in Wales couldn't benefit from a multispecies ley. Any proposed scheme involving multispecies leys could be cross-sector and pan-Wales.
- 2) There is a need to not be too prescriptive with the seed mixtures – allow the farmers to select multispecies mixtures that suit their farm and system.
- 3) It is difficult to see how all sown components can be expected to remain in swards for the duration of a five year scheme – some flexibility is needed in how the leys will be assessed. Every farm will be different in how the leys develop.
- 4) Although new schemes are keen to avoid over regulation (strict dates and sward height regulations) there will be a need to provide good clear guidance of which management practices will promote the success and longevity of the multispecies leys.
- 5) Additional benefits such as soil health, increased carbon sequestration and biodiversity are still being researched – but early results seem to be positive. There is a lack of any long-term data.

8 Messages from the project for farmers

- 1) Multispecies leys have performed as well as traditional ryegrass leys when sown on three upland livestock farms in south Wales.
- 2) They have provided yield benefits in early and late season production.
- 3) Wet soils and poorly drained land are probably not best suited for multispecies leys.
- 4) Seed mixture selection can be difficult due to the huge choice – seek out advice from local seed merchants and others that have already tried multispecies leys. Be clear in your mind what you want to achieve.
- 5) Early establishment is beneficial. Make sure that the soil chemistry is corrected in the seedbed and P and K levels maintained.
- 6) Rotational grazing is preferred to continuous to prevent plants from being grazed out.
- 7) Avoid prolonged tight grazing and under-grazing in spring.
- 8) Winter rest period is important to allow the legumes and herbs to persist.
- 9) A single silage cut (mid-season) seems to have no detrimental effect on the ley.
- 10) Benefits for animal performance and animal health from grazing multispecies leys are unclear from this project – but have been reported from other work.

9 Acknowledgements

The project is indebted to the co-operation and dedication of the three farmers and their families; Richard Morgan, Gellifeddgaer, Ed Roberts, Gilfach and Phil Thomas, Brynchwith. All three remain keen and enthusiastic about multispecies leys and are looking forward to establishing their next ones.

Monitoring work was carried out by independent grassland consultant Chris Duller and the project was brokered by Will John (ADAS).

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