

Organic Producers' Conference

Practical research and innovation - diversity in practice

Review of research on legumes and grasses for forage and grazing *(Leg-Link /SOLID)*

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Leg-Link Project

Using legume-based mixtures to enhance the nitrogen use efficiency and economic viability of cropping systems

- To demonstrate that:
 - ◆ **species-rich legume-based leys** can maximise pasture productivity and other ecosystem services
 - ◆ **Functional diverse plant species mixtures** can be optimised and fine-tuned to farm-specific needs



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- Replicated field experiments over three years
 - ◆ Multiple locations across the UK
 - ◆ Trials tested the performance of different species
 - Sown in monocultures or Mixtures
 - ◆ The study mixture was compared to conventional mixtures



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- Conclusions and implications -

1. Characteristics of legume species used

- ◆ No single species scored high on all evaluation criteria
- ◆ Large degree of functional complementarity among the legume species.

Table S3. Ranks of species performance (WP1); high ranks show high performance; empty cells indicate lack of sufficient data.

Criterion	AC	BM	BT	CC	LT	LU	MP	RC	SC	SF	WC	WV
Early development	5	6	2	12	1	11	8	10	9	7	3	4
Productivity	7	9	8	6	1	10	3	12	4	5	11	2
Weed suppression	7	11	8	3	5	9	1	12	4	6	10	2
Flowering	6	11	8	8	2	2	1	6	2	2	8	1
Pre-crop value	5	8	10	3	7	12	2	11	4	6	9	1
Resistance to decomposition	5	4	9	1	10	3		7	6	8	2	
Perform. following crop	7	9	10	2	4	11	1	8	3	6	12	5
Average rank	6.0	8.3	7.9	5.0	4.3	8.3	2.7	9.4	4.6	5.7	7.9	2.5

Black Medic Birdsfoot Trefoil

Lucerne

Red Clover

White Clover



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- *Conclusions and implications* -

2. Benefits of mixing species

- ◆ **Increased above-ground biomass** compared to monocultures
- ◆ **Productivity increases over time**
- ◆ Greater **stability of biomass production**
- ◆ Effects are more profound on **less fertile soils** (low organic matter)
- ◆ Mixing species with different properties allows **better weed control** throughout the season.



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- *Conclusions and implications* -

2. Benefits of mixing species

- ◆ **Greater resilience** to variable weather, climate and management conditions
- ◆ Inclusion of species with slower N release can result in **lower N losses and better utilisation**
- ◆ Nitrogen losses from ***White clover*** and ***Red clover*** were 2–3 times greater than those from either ***Black medic*** or ***Lucerne***



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- *Conclusions and implications* -

3. Species with useful characteristics

- ◆ Mixes with high agronomic productivity function containing both ***Lucerne*** and ***White Clover***
- ◆ Overall performance improves by including a **third or fourth** legume species
- ◆ The three best multifunctional mixtures all contained ***Black medic, Lucerne*** and ***Red clover***
- ◆ Some species show low performance (almost) everywhere: ***Meadow pea, Winter vetch, Large birdsfoot trefoil***



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- *Conclusions and implications* -

3. Key points for designing a mixture

- ◆ Consider **functional diversity** rather than **species diversity**
- ◆ Criteria for species choice include
 - Residue properties
 - Biomass potential
 - Response to management, climate and soil conditions
 - Nutritional value for livestock
- ◆ Some species show marked differences in performance depending on region (**i.e. Sainfoin**)

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Diverse swards and mob grazing for dairy farm productivity

- *To assess the productivity and composition of grazing diverse swards*
- *To compare diverse sward productivity with that of ryegrass-white clover*



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Measurements

- ◆ Forage Productivity



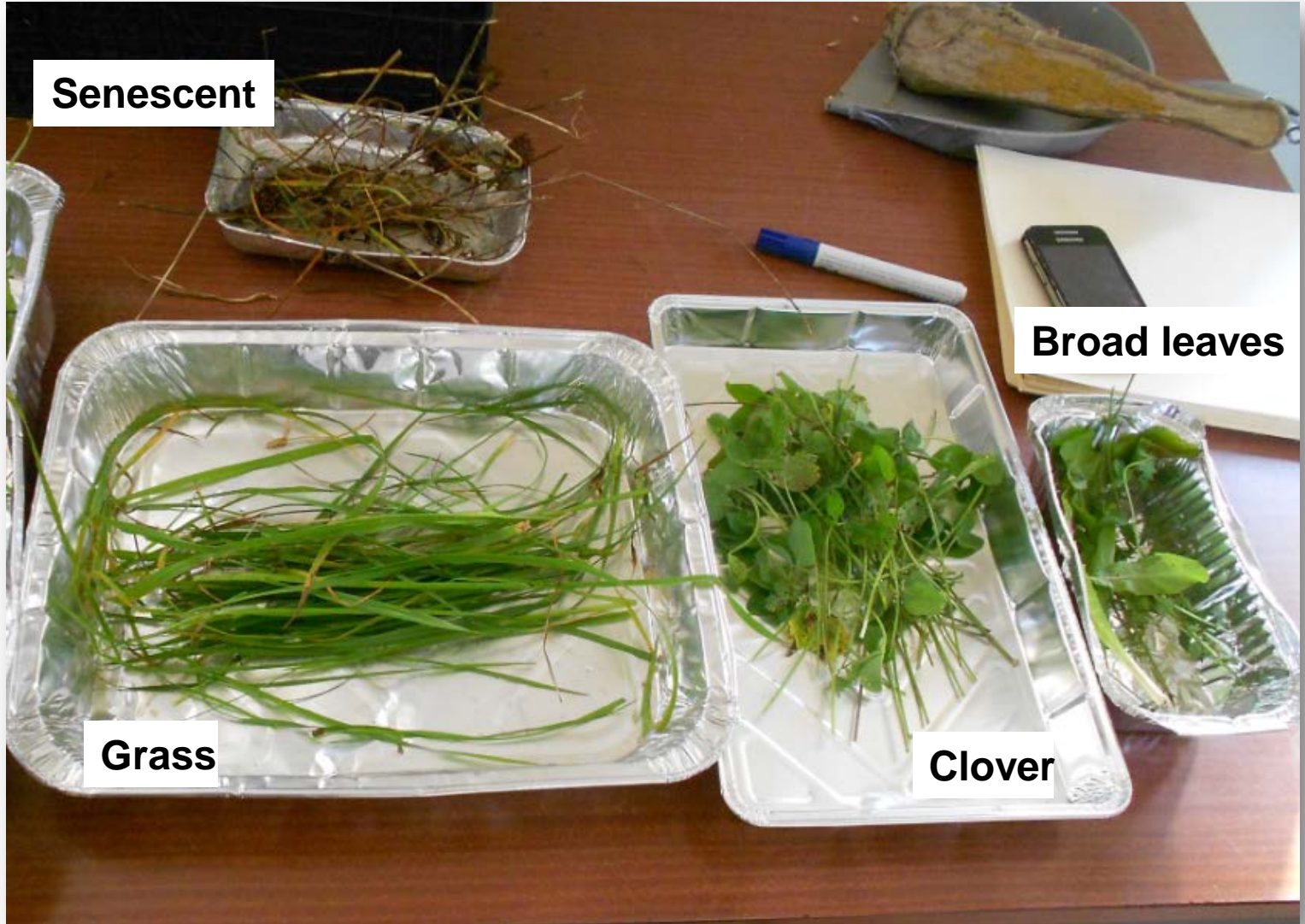
Ungrazed paddock



Grazed paddock

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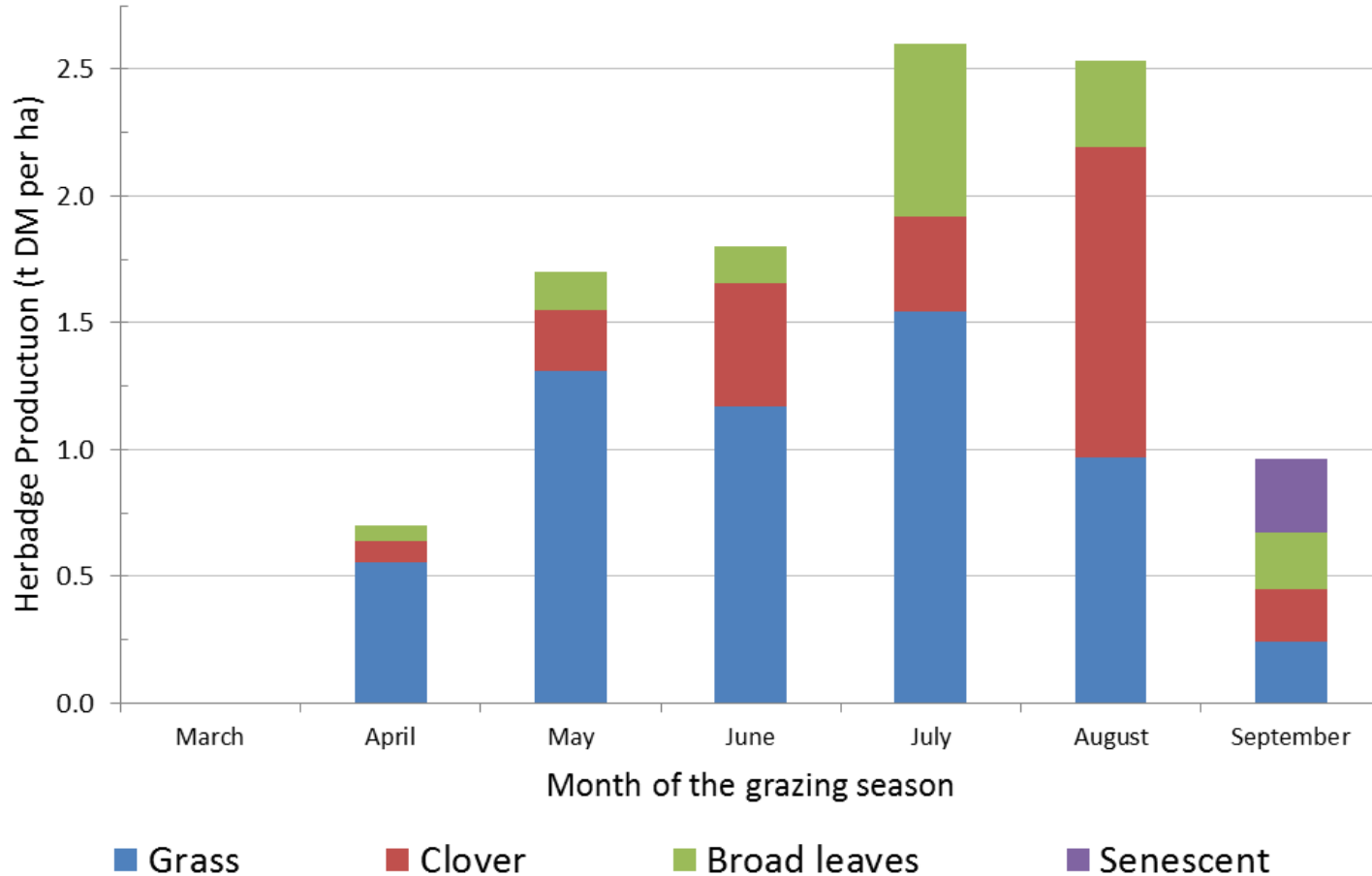
Senescent

Broad leaves

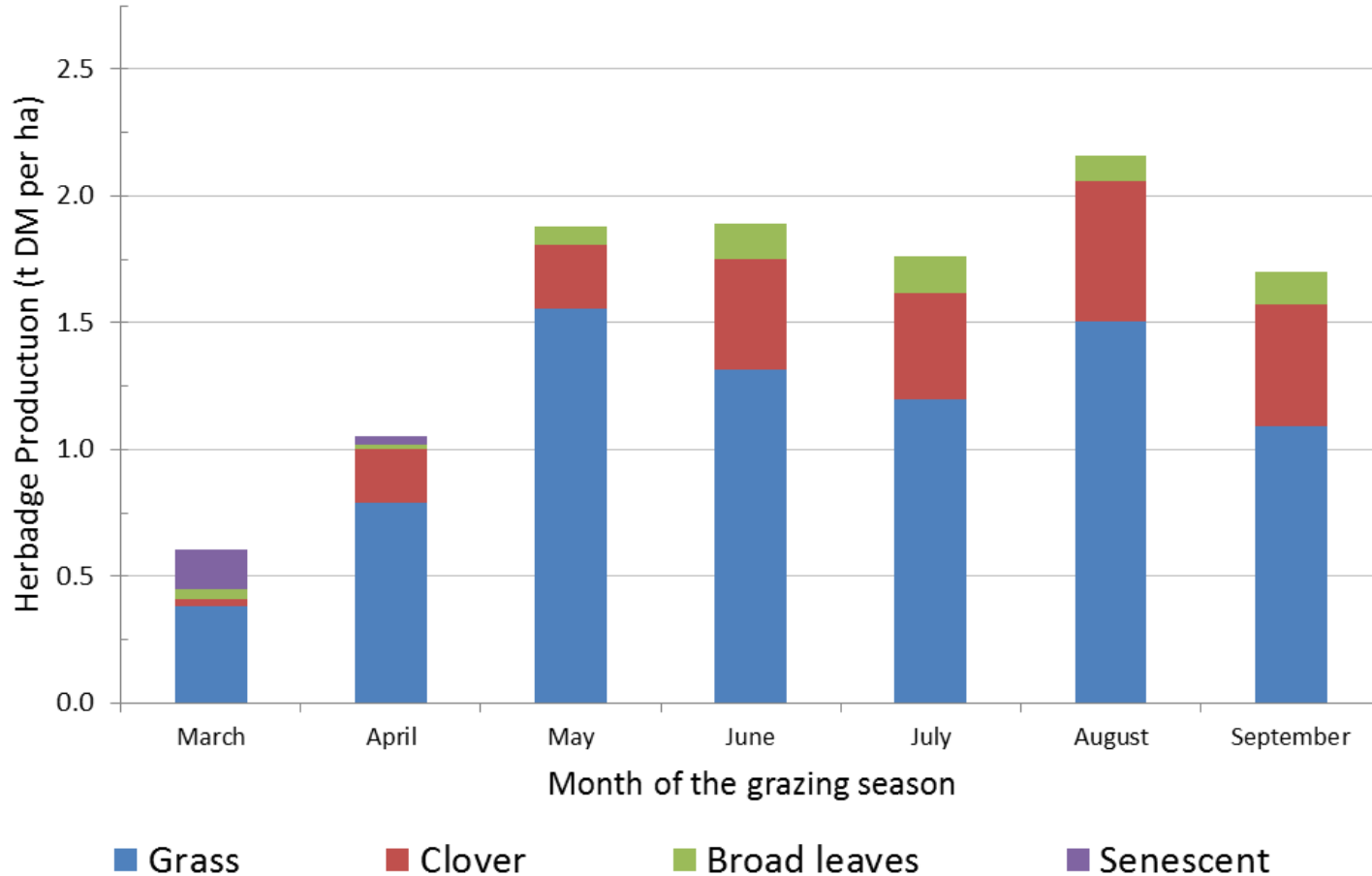
Grass

Clover

Composition & DM Productivity (year 1)



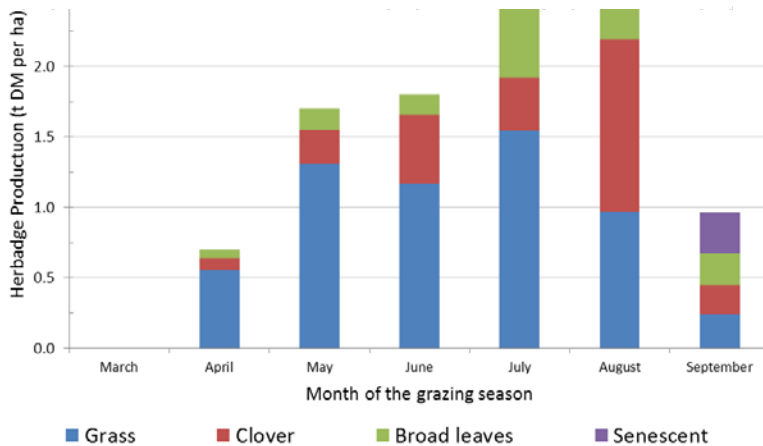
Composition & DM Productivity (year 2)



Forage DM Productivity

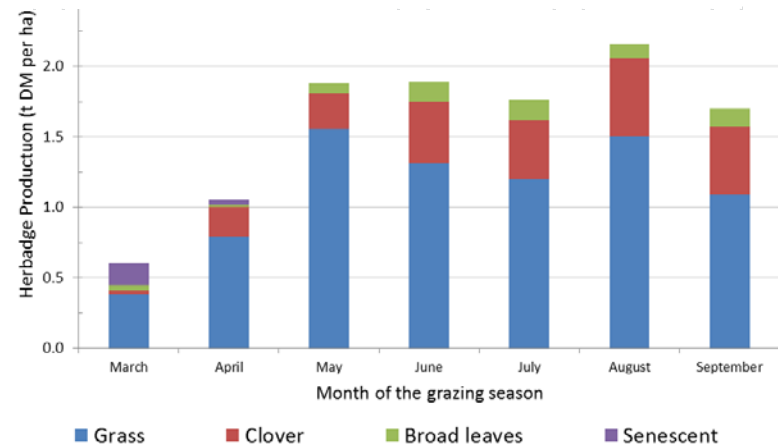
Total Production (year 1)

<u>Plant Species</u>	<u>tonnes</u>	<u>%</u>
Grass	5.79	56%
Clover	2.61	25%
Broad leaves	1.61	16%
Senescent	0.30	3%
Total Production	10.3	100%



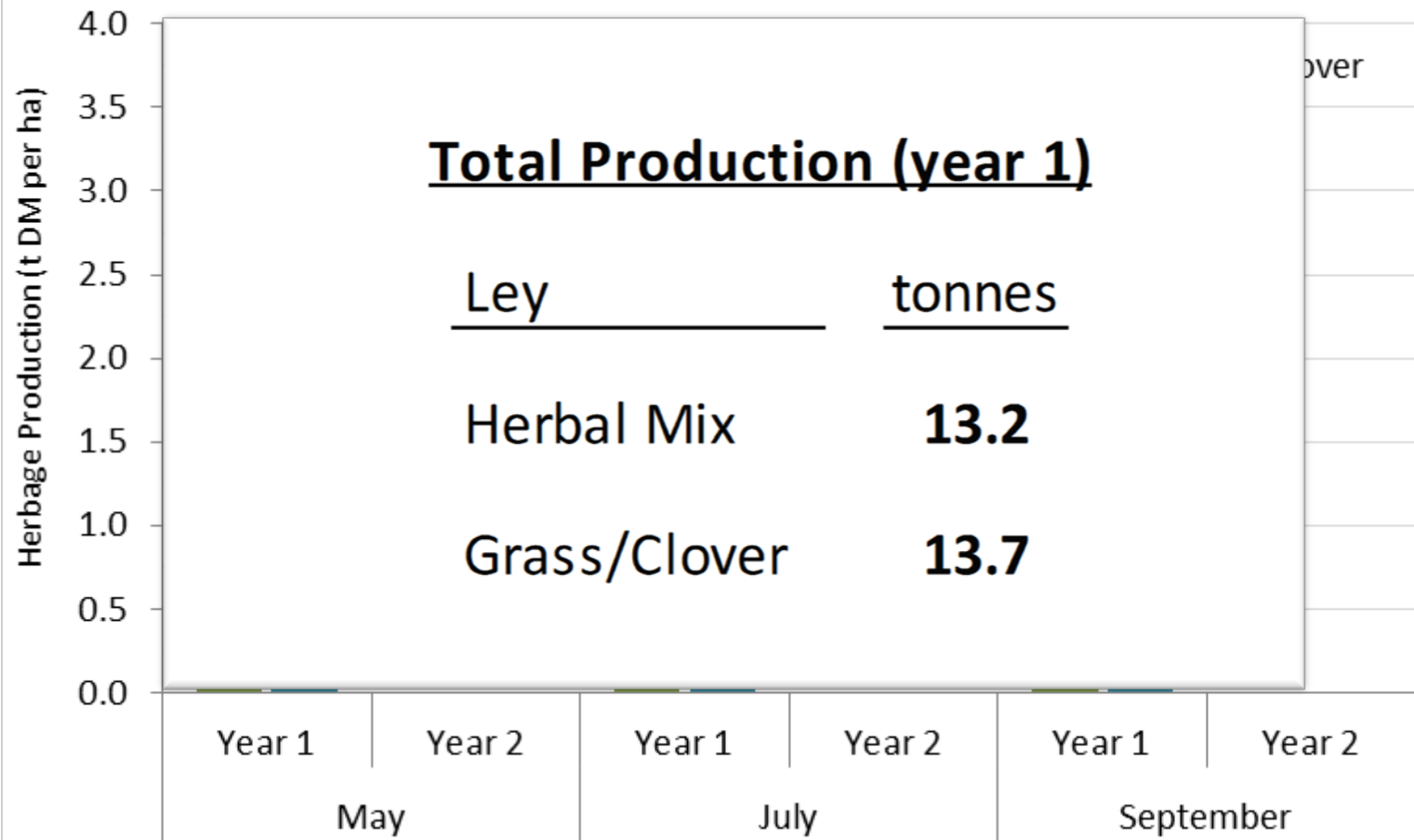
Total Production (year 2)

<u>Plant Species</u>	<u>tonnes</u>	<u>%</u>
Grass	7.84	71%
Clover	2.38	22%
Broad leaves	0.65	6%
Senescent	0.19	2%
Total Production	11.0	100%



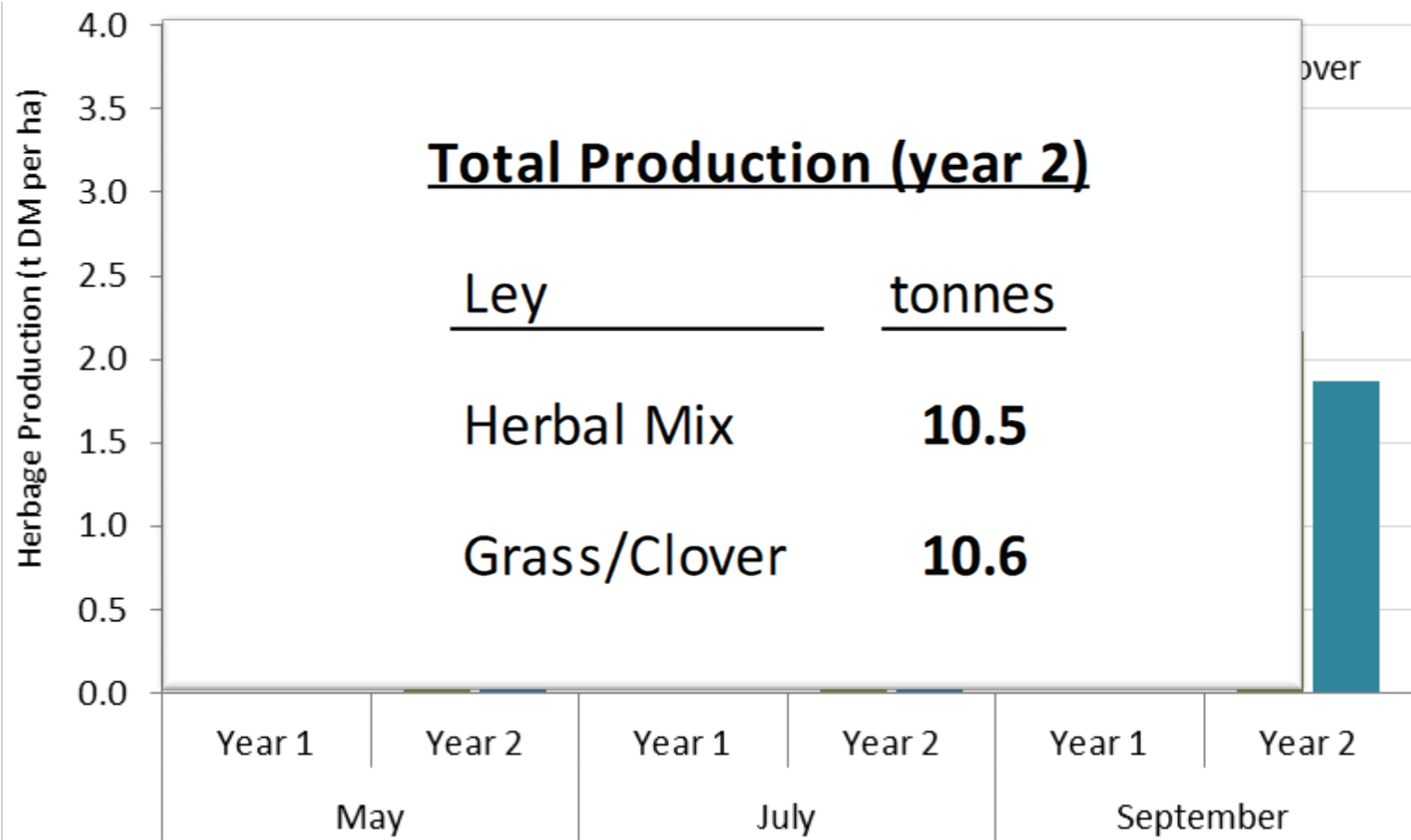
Grass/Clover vs. Diverse Sward

(year 1)



Grass/Clover vs. Diverse Sward

(year 2)



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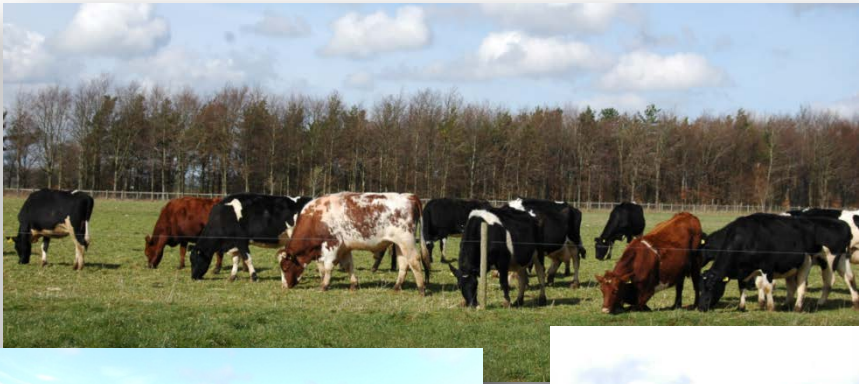
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Conclusions

- ◆ There was a large variation in herbage composition between months and years of sampling
- ◆ No significant difference in DM yield was found between the two mixtures compared
- ◆ Diverse swards can serve as a viable alternative to traditional pastures
- ◆ Soil samples will be analysed later this year to determine Soil Organic Mater

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Thank you

Results – Forage Production Y2

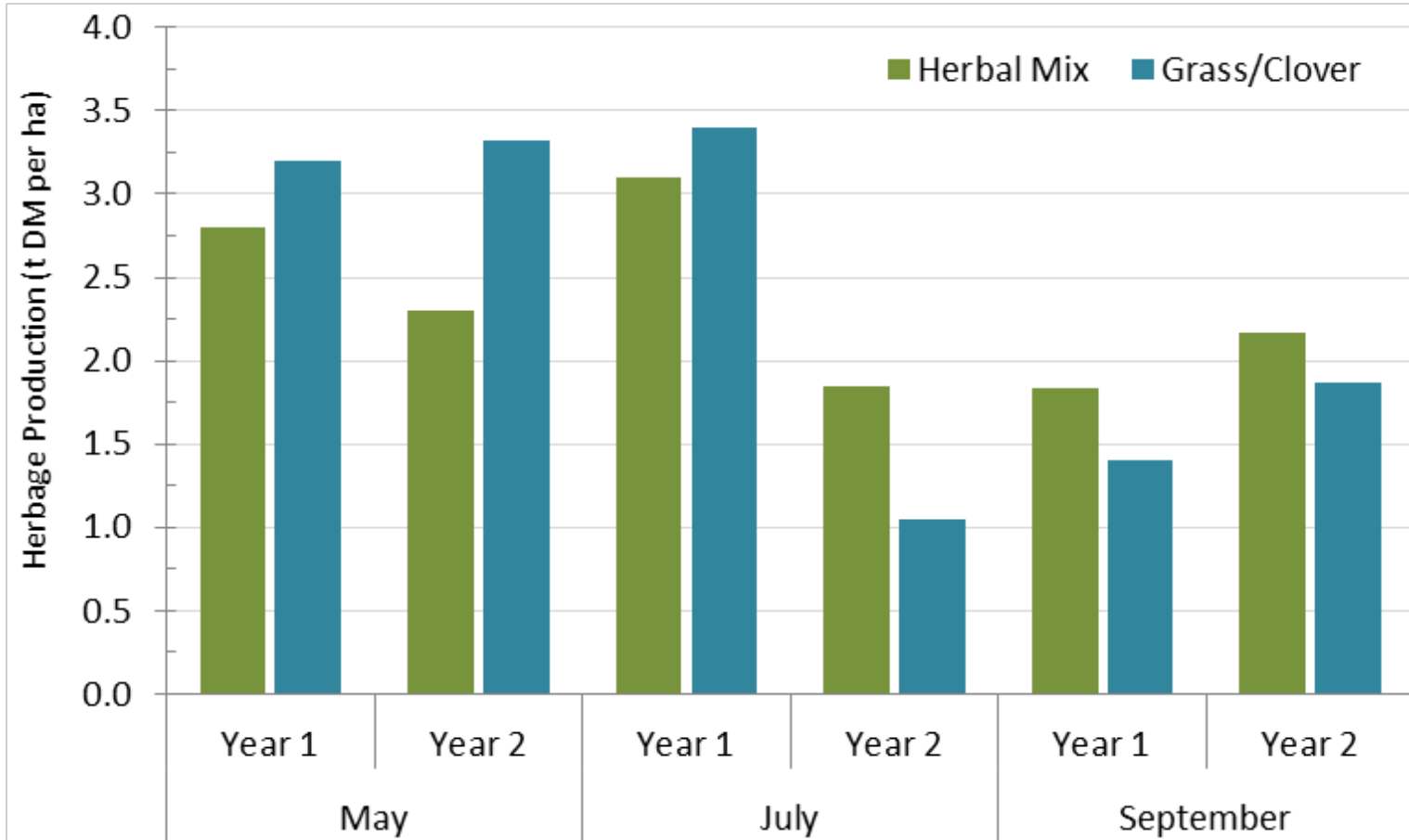


Table S1. Legume and grass species included in the trials: Scientific and common name; inoculation and seed rate (in kg/ha) in the monoculture plots (Monoc.) and in the All Species Mix (ASM).

Abbreviation	Scientific name	Common name	Inoc.*	Seed rate (kg/ha)	
				Monoc.	ASM
AC	<i>Trifolium hybridum</i>	Alsike clover	C	10	1.25
BT	<i>Lotus corniculatus</i>	Birdsfoot trefoil	-	12	2.5
BM	<i>Medicago lupulina</i>	Black medic	L	15	2.5
CC	<i>Trifolium incarnatum</i>	Crimson clover	-	18	2.25
IR	<i>Lolium multiflorum</i>	Italian ryegrass	-	33	1
LT	<i>Lotus pedunculatus</i>	Large birdsfoot trefoil	-	12	2.5
LU	<i>Medicago sativa</i>	Lucerne	L	20	2.5
MF	<i>Festuca pratensis</i>	Meadow fescue	-	25	1.25
MP	<i>Lathyrus pratensis</i>	Meadow pea	V	75	3.25
PR	<i>Lolium perenne</i>	Perennial ryegrass	-	33	2.5
RC	<i>Trifolium pratense</i>	Red clover	C	18	2.5
SF	<i>Onobrychis viciifolia</i>	Sainfoin	-	80	5
TY	<i>Phleum pratense</i>	Timothy	-	10	0.5
WC	<i>Trifolium repens</i>	White clover	C	10	1.5
SC	<i>Melilotus alba</i>	White sweet clover	L	18	-
WV	<i>Vicia sativa</i>	Winter vetch	V	100	-

* Inoculated with clover inoculant (C), lucerne inoculant (L) or vetch inoculant (V).

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Mod grazing is characterised by **high grazing pressure for a short time** to remove forage rapidly as a management strategy

- ◆ Pastures are allowed to grow taller than the traditional height (i.e. long resting periods)
- ◆ Animals consume and trample the sward for a short period of time (i.e. are moved to a new paddock within 24h)

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- Conclusions and implications -

4. Species with useful characteristic



- » **Red clover** (*Trifolium pratense*)
High yield
High yield of subsequent crop

Performance 9.4



- » **White clover** (*Trifolium repens*)
High yield
High yield of subsequent crop

Performance 7.9

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- Conclusions and implications -

4. Species with useful characteristics



- » **Black medic** (*Medicago lupulina*)
Resistance to decomposition (lignin content and C:N ratio)
High yield of subsequent crop

Performance 8.3



- » **Birdsfoot trefoil** (*Lotus corniculatus*)
High yield
High yield of subsequent crop

Performance 7.9

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- Conclusions and implications -

4. Species with useful characteristics



- » **Lucerne** (*Medicago sativa*)
 - High yield
 - Resistance to decomposition
 - High yield of subsequent crop
 - Prefers high pH

Performance 8.3



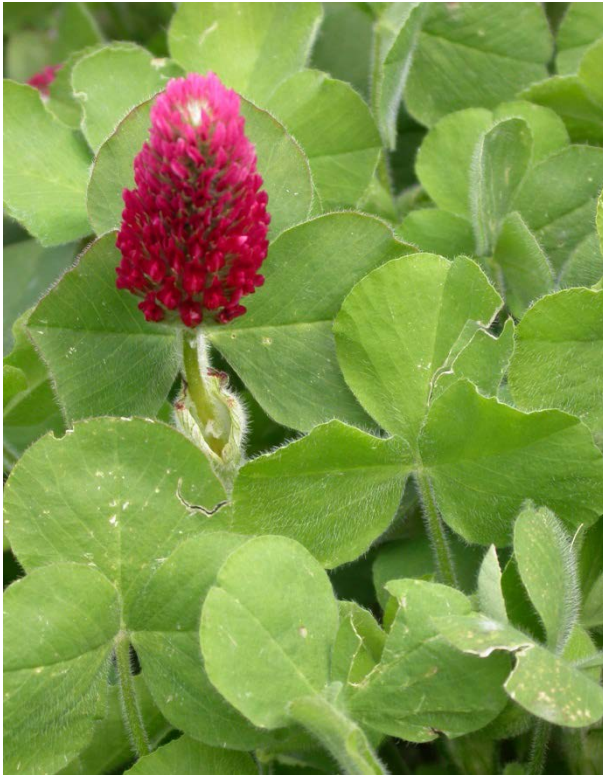
- » **Sainfoin** (*Onobrychis viciifolia*)
 - Moderate yield
 - Resistance to decomposition

Performance 5.7

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- Conclusions and implications -

4. Species with useful characteristics



- » **Crimson clover** (*Trifolium incarnatum*)
 - High yield
 - High value for pollinators

- Performance 5.0

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Diverse swards and mob grazing for dairy farm productivity

- ***Diverse swards consist of***
 - ***10 grass species***
 - ***6 legumes and***
 - ***5 herbs***
- ***Mob grazing was introduced as an approach to increase Soil Organic Matter***





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- Conclusions and implications -

1. Characterisation of legume species

Table S3. Ranks of species performance (WP1); high ranks show high performance; empty cells indicate lack of sufficient data.

Criterion	Black Medic		Birdsfoot Trefoil	Lucerne			Red Clover			White Clover		
	AC	BM	BT	CC	LT	LU	MP	RC	SC	SF	WC	WV
Early development	5	6	2	12	1	11	8	10	9	7	3	4
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Flowering	6	11	8	8	2	2	1	6	2	2	8	1
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Average rank	6.0	8.3	7.9	5.0	4.3	8.3	2.7	9.4	4.6	5.7	7.9	2.5

- ◆ No single species scored high on all evaluation criteria
- ◆ Large degree of functional complementarity among the legume species.



Leg-Link Project

- *Conclusions and implications* -

1. Characteristics of legume species used

- ◆ Range of currently used species in farms is relatively narrow:
 - *White Clover / Red Clover*

- ◆ Several other species show great potential to increase the productivity and provision of ecosystem services
 - *Black medic, Birdsfoot trefoil, Crimson clover, Lucerne, Sainfoin*

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Measurements

- ◆ Forage Productivity
- ◆ Herbage composition
- ◆ Yield comparison Grass/Clover and Diverse Sward
- ◆ Evaluate the Plate Meter method for DM determination