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# Classical and Genotypic methods of increasing grassland productivity through breeding



## Key external stakeholders:

Grassland farmers, researchers and advisors  
Irish grass seed wholesale companies  
Department of Agriculture, Food and the Marine  
Milk processors  
National Universities  
Agri-consultants and Advisors

## Practical implications for stakeholders:

The absence of herbage utilisation from National and Recommended list evaluations, and the difficulty of assessing it on large numbers of accessions has generally deterred breeders from including it in their breeding objectives. An easily measured predictor trait for grazing efficiency could overcome this limitation and promote genetic advances in this quality characteristic. Swards are known to adapt their sward structure, morphology and chemical properties in response to lower post-grazing residual (PGR) height, which is a survival mechanism to escape severe defoliation and depletion of plant reserves. This process creates a sward ideally suited and resilient to animal grazing, however varieties are not all equally able to adapt. Post-grazing compressed residual height has been reported as an indicator of this grazing efficiency characteristic, i.e., swards that can be consistently grazed to a residual of 3.5 – 4 cm consistently have a higher content of green leaf and digestible nutrients whilst having reduced stem and senescent material. The results of this work have clearly identified free leaf lamina as a key trait.

## Main results:

- This study has identified free leaf lamina, tiller mass and dry matter digestibility as key selection criteria for plant breeders to base their developments upon if grazing efficiency is imported into their breeding programs.
- Perennial ryegrass varieties were shown to differ in their level of grazing efficiency: tetraploid varieties had significantly greater grazing efficiency than diploids recording residual heights of 3.8 and 4.1 cm, respectively. Greater free leaf lamina, tiller mass and dry matter digestibility shown to significantly improve grazing efficiency.
- Developing and selecting high grazing efficient varieties can significantly increase the level of herbage utilisation and animal productivity per hectare, and result in the formation of swards with improved structure and nutritive value that will allow animals to maximise DM intake with minimal grazing effort.

## Opportunity / Benefit:

The focus of the study was to further understand the grazing efficiency of perennial ryegrass varieties and identify associated traits which could be used as selection criteria by breeders to develop varieties with improved grazing efficiency, this was achieved. The grassland industry can move forward and use these traits to select for varieties with greater grazing efficiency. The next logical step is to create a new trait within the Pasture Profit Index for grazing utilisation.

## Collaborating Institutions:

Queens University Belfast College Dublin and INRA, France

**Teagasc project team:** Dr. Michael O'Donovan (PI)  
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### 1. Project background:

Within pasture-based production systems it is generally accepted that herbage yield is only a partial predictor of the grazing value of grass. The key objective of grazing systems in Ireland is to achieve high levels of grass utilisation, as it is known to be a major driver of profit with each additional tonne of DM utilised increasing net profit by an estimated €173 per hectare (Hanrahan et al., 2017). Previous research has reported the average Irish dairy farm utilises 7.1 tonne of grass DM/ha. The efficiency of herbage utilisation in a grazing system can be defined as the proportion of the gross leaf tissue production that is removed by the grazing animals before entering the senescent state. Current grass evaluations are mainly focused on herbage yield as determined by mechanically harvesting plots. These evaluations put little emphasis on herbage utilisation. Herbage utilisation and the traits which govern its level are poorly understood, and this is difficult to include effectively as a breeding objective. In maximising the efficiency of grazing systems the interface between plant and animal is of critical importance. Evaluation systems must be responsive to changes in farm management practices. It is essential that grass variety evaluators examine traits that are associated with increased levels of grass utilization; to date this has not happened.

### 2. Questions addressed by the project:

This study investigated differences in sward structure, morphology and quality properties of perennial ryegrass varieties across different heading dates and ploidy levels under animal grazing as these properties are believed to influence grazing efficiency. The objective of the study was to further understand the grazing efficiency of perennial ryegrass varieties and identify associated traits which could be used as selection criteria by breeders to develop varieties with improved grazing efficiency.

### 3. The experimental studies:

- Fifty five perennial ryegrass varieties were examined (15 intermediate heading diploids, 10 intermediate heading tetraploids, 18 late heading diploids, 12 late heading tetraploids) which comprised both recommended and candidate varieties for the Republic of Ireland's national/recommended list sowing 2014 (where varieties have not yet been registered they are denoted by Candidate #). The experiment was a randomised complete block design with three replicates (blocks) of each variety, resulting in a total of 165 plots. These were sown in 3 m x 7 m plots in August 2014. Plots were grazed by block with lactating dairy cows, when the average herbage mass was visually estimated to be 1300 kg DM ha<sup>-1</sup>. The rotation length between grazings varied between 21 and 45 days depending on grass growth accumulation. The study took place over two years.

### 4. Main results:

High pre-grazing compressed sward height was found to have negative effects on the grazing efficiency of varieties. Diploid varieties recorded a significantly higher pre-grazing compressed sward height reducing their grazing efficiency compared to tetraploid varieties.

There was considerable genetic variation in sward characteristics as the varieties differed significantly in most and there was clear evidence that ploidy and maturity were important factors associated with the cows ability or willingness to graze tightly.

Measures of sward leafiness such as free leaf lamina and leaf proportion have served as robust indicators of intake potential. This study has shown the benefit of increased free leaf lamina, which has a significantly negative correlation with post-grazing residual. Significant differences in free leaf lamina existed between varieties, with tetraploids having significantly more. Interestingly, no differences existed between intermediate and late heading date varieties. Despite the effects of morphological characteristics no variation existed between varieties, ploidy or heading date groups for leaf and pseudostem proportions. Small variety differences existed for true stem and dead proportions.

Free leaf lamina acts as a reliable trait to select for improved grazing efficiency as it is easily measured. There is also sufficient variation between varieties to allow for selection, and leaf length has been shown to

be highly heritable. Sward morphological measurements are limited in selecting varieties with improved grazing efficiency but the various proportions will influence sward chemical composition.

#### 5. Opportunity/Benefit:

The main benefit is to create a new grazing trait for the Irish grassland industry and incorporate this trait into the PPI, this work is now underway and the industry will benefit from this research in the longer term.

#### 6. Dissemination:

##### *International conferences*

Presented at many international conferences, invited and contributed, such as the European Grassland Federation and EAAP

##### *National Conferences and seminars*

Presented at the Agricultural Research Forums through the duration of the project and at national farmer conferences.

##### *Open Day*

Presented at all Moorepark open days.

##### *Farmer discussion groups*

Discussed at many farmer discussion groups and at advisor in-service training

##### *Press*

Results regularly presented in the Irish Farmers Journal, Farming independent, Today's Farm and TResearch.

#### Main publications:

O'Donovan M, McHugh N, McEvoy M, Grogan D, Shalloo L (2017). Combining seasonal yield, silage dry matter yield, quality and persistency in an economic index to assist perennial ryegrass variety selection. *Journal of Agricultural Science* 155(4):556-568; doi 10.1017/s0021859616000587.

Byrne N, Gilliland TJ, McHugh N, Delaby L, Geoghegan A, O'Donovan M (2017). Establishing phenotypic performance of grass varieties on Irish grassland farms. *Journal of Agricultural Science* 155(10):1633-1645; doi Doi: 10.1017/s0021859617000740.

#### Popular publications:

Cashman, P. O'Donovan, M Gilliland, T. McEvoy, M. (2014) Quantifying ground score on perennial ryegrass swards exposed to different grazing regimes. *Agricultural Research Forum*, pp89.

Cashman, P. O'Donovan, M Gilliland, T. McEvoy, M. Population selection within perennial ryegrass cultivars under simulated grazing. In: *Proceedings of the 25th EGF General Meeting "EGF at 50: The Future of European Grasslands"*, *Grassland Science in Europe*, 19: 833-835. - EGF - The Future of European Grasslands, 833.

McEvoy, M. McHugh, M. O'Donovan, M Grogan, D. and Shalloo, L. (2014) Pasture Profit index; updated economic values and inclusion of persistency. In: 18th EGF Symposium "Grassland and forages in high output dairy farming systems", *Grassland Science in Europe*, 19: 843-846.

McEvoy, M. O'Donovan, M. Grogan, D. and Shalloo, L. (2014) Using the grass economic index to quantify the economic performance of perennial ryegrass cultivars. *Agricultural Research Forum*, pp55

Cashman, P. O'Donovan, M Gilliland, T. McEvoy, M. (2014) Grazing utilisation of perennial ryegrass cultivars *Agricultural Research Forum*, pp56

Cashman, P. O'Donovan, M Gilliland, T. McEvoy, M. (2014) Milk production performance of lactating dairy cows grazing four different perennial ryegrass cultivars, *Agricultural Research Forum*, pp60.

N Byrne, D Berry, A Geoghegan, L Shalloo, T Gilliland, M O'Donovan. (2015) Evaluation of fry matter yield of ryegrass varieties on Irish grassland farms. In: 18th EGF Symposium "Grassland and forages in high output dairy farming systems", *Grassland Science in Europe*, 20: 383-385.

#### 7. Compiled by: Dr Michael O'Donovan