Low-input, high-output grass-based dairy-beef heifer systems

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Summary

- Dairy-beef heifers consuming herbage from perennial ryegrass (PRG)-only swards, PRG + Clover (CLOVER) swards, and multispecies swards (MSS) achieved carcass weights of 243, 250 and 249 kg, at 19.6, 19.2, and 19.2 months of age, respectively.
- Similar herbage production was achieved for all three pasture types, despite a 75 kg/hectare reduction in annual chemical nitrogen (N) application to the CLOVER and MSS treatments.
- Incorporating legumes and herbs into pasture reduces the requirement for chemical fertiliser nitrogen and concentrate supplementation in grass-based dairy-beef heifer systems.

Introduction

Nationally, dairy-beef heifers have the highest probability of failing to meet 'overall' carcass specifications (i.e. weight, conformation score, fat score and age at slaughter) (Kenny et al., 2020). This reduced ability to meet carcass specification has likely contributed to the relatively older age of these heifers at slaughter (i.e. between 24 and 26 months, generally during a 'second' winter indoors or a 'third' grazing season). Research has shown that younger slaughter ages are possible, during the 'second' grazing season or following a shorter indoor feeding period, although at a lower carcass weight compared to dairy-bred steers or suckler-bred cattle. Despite a comparatively lower carcass weight potential, grass-based dairy-beef heifer systems have the potential for very high carcass output/hectare (ha) due to increased numbers of animals finished at younger ages from pasture, thus eliminating or reducing the need for an indoor finishing period. Carcass output and the level of inputs needed can be optimised by grazing highly productive and high nutritive value pastures.

In recent years, there has been an unprecedented rise in the cost of fertiliser, feed and fuel, which has subsequently resulted in significantly increased cost of feed production on beef farms. In a study conducted by Doyle et al. (2022), the cost of producing one tonne grass dry matter (DM)/ha in 2022 was €121, representing an increase of 29% on 2021 prices. As feed provision accounts for 75% of total variable costs on Irish beef farms (McGee et al., 2017), thus, efficient utilisation of the cheapest feed source, grazed grass, is vital for the financial resilience of dairy-beef farms. However, nationally many farms are only achieving 50-60% of their grass growth potential (O'Donovan et al., 2021), indicating scope for improving pasture production, and consequently animal and farm performance.

Perennial ryegrass (PRG; *Lolium perenne L.*) is the most commonly sown grass species in Ireland, with the potential to grow up to 15 tonnes of DM annually of a highly-digestible forage over a minimum of 10 years (O'Donovan et al., 2011). However, PRG pasture is highly dependent on the application of chemical nitrogen (N) for growth, which can have a negative impact on ground water quality and gaseous emissions. Nitrogen fertiliser is also one of the most expensive input costs in a grass-based system (Wall et al., 2014). One of the key factors in addressing the sustainability challenges associated with ruminant livestock production is reducing reliance on inputs of chemical fertilisers. This is reiterated in the EU Farm to Fork Strategy, where there is a commitment to reducing chemical fertiliser use by 30% for all EU member states by 2030 (EC, 2020). This policy has led to renewed interest in incorporating legumes and herbs into pasture-based production systems.

Clover-based swards have shown many benefits in terms of sward nutritive value, animal intake and performance, and increased biological fixation of N (Enriquez-Hidalgo et al., 2018). Similarly, multi-species swards (MSS) containing clover have shown potential to increase sward DM production under reduced chemical N application rates (Grace et al., 2018). However, the herbage composition of more diverse swards changes throughout the grazing season and over the years and there is limited data available on the persistency of mixed swards in livestock production systems, especially when a 10-year grazing cycle is the aim. Thus, the performance of dairy-beef cattle consuming contrasting pasture types requires further investigation.

Johnstown Castle Study

The objective of the study was to evaluate the physical and financial performance of early-maturing breed dairy-beef heifers consuming pastures based on PRG, PRG and clover, or multi-species swards (MSS). In 2021 and 2022, 105 and 108 dairy × beef heifer calves, respectively, were purchased at approximately 20 weeks of age and were assigned to one of three pasture treatments: 1.) PRG-only, receiving 150 kg total N/ha/annum (i.e. on the grazing + silage land area), 2.) CLOVER (red and white; *Trifolium repens* and *Trifolium prantense*), receiving 75 kg total N/ha/annum, and 3.) MSS (PRG, red and white clover, plantain (*Plantago lanceolate*), and chicory (*Cichorium intybus*)) swards receiving 75 kg total N/ha/annum. The sire breeds were Hereford and Angus and all progeny were from Holstein-Friesian dams. The calves were balanced across treatments based on breed, date of birth (mean 16 Feb), and live weight (mean 159 kg at arrival on farm). Each pasture type had its own independent 'farmlet' of 10 ha. All treatments were stocked at 2.5 LU/ha equivalent to 182 kg organic N/ha. The individual paddocks were evenly distributed among the different sward treatments to account for varying soil types and conditions. The online tool "PastureBase Ireland" was used as an aid for grazing management for each pasture treatment.

During the first grazing season, calves were supplemented with 1 kg of concentrate (fresh weight basis) daily and fresh herbage was offered every 48 hours. Swards were rotationally grazed. The target pre-grazing herbage mass offered to the calf and yearling heifers during the grazing season ranged from 1300 to 1600 kg DM/ha. Pre-grazing herbage mass was measured in each paddock prior to grazing. The target post-grazing sward height was 5 cm for all pasture treatments, and this was measured using a rising plate meter. Botanical composition of the CLOVER and MSS swards was measured prior to each grazing, by cutting and separating herbage samples into grass, legume and herb fractions, followed by drying to determine the DM proportions.

Calves were housed indoors in November, when grazing conditions deteriorated or when target closing farm cover (450 kg DM/ha) was achieved. During the first winter, the

calves were offered grass silage *ad libitum*, from their respective pasture treatment, along with 1.25 kg concentrate/head daily. Yearlings were turned out to pasture in early March, and were weighed fortnightly over the grazing season and drafted for slaughter when they reached a target fat score of between 3- and 3 +, determined by body condition scoring. Carcass conformation and fat scores were determined using the EUROP grid classification system. Any heifers not slaughtered off grass were housed in October, and commenced their 'finishing' diet of 4 kg concentrate /head daily and silage *ad libitum* until slaughter.

Herbage production

There were no significant differences observed for pre-grazing herbage mass, pre-grazing height or post-grazing height (Table 1). In 2023, the PRG, CLOVER and MSS pastures produced similar DM yields of 11.9, 11.5 and 11.4 tonnes of DM/ha, respectively. Despite an additional fertiliser application of 75 kg N/ha to the PRG treatment compared to the CLOVER and MSS treatments (i.e. 150 vs. 75 kg N/ha), the similar annual DM yields for the three pasture types implies that the inclusion of legumes and improved species diversity can reduce the need for chemical N application. This is a huge benefit in terms of reducing costs and the environmental impact of dairy-beef production.

Table 1. Effect of pasture type - perennial ryegrass-only swards (PRG), PRG plus red and white clover swards (CLOVER) and multispecies swards (MSS) - on grazing characteristics

	PRG	CLOVER	MSS	sem	Sig.
Pre-grazing herbage mass (kg DM/ha)	1455	1638	1578	127.8	NS
Pre-grazing sward height (cm)	8.2	8.4	9.0	0.30	NS
Post-grazing sward height (cm)	5.0	4.9	4.9	0.09	NS
Density (kg DM/ha/cm)	480[a]	489[a]	384[b]	34.3	*

The monthly clover percentage in the CLOVER pasture is presented in Figure 1, and the average botanical composition of the MSS pasture in 2023 is presented in Figure 2. Over the entire grazing season, the average clover content was 22% and 21% for the CLOVER and MSS pastures, respectively. These clover proportions are similar to the inclusion recommendations (20%) by Andrews et al. (2007) necessary to achieve an animal performance production benefit. The botanical composition of the CLOVER and MSS swards changed throughout the year. Both treatments observed peak clover content in July at 30.8% and 37.3%, for CLOVER and MSS, respectively. The plantain and chicory content of the MSS pasture peaked in March and October, respectively.

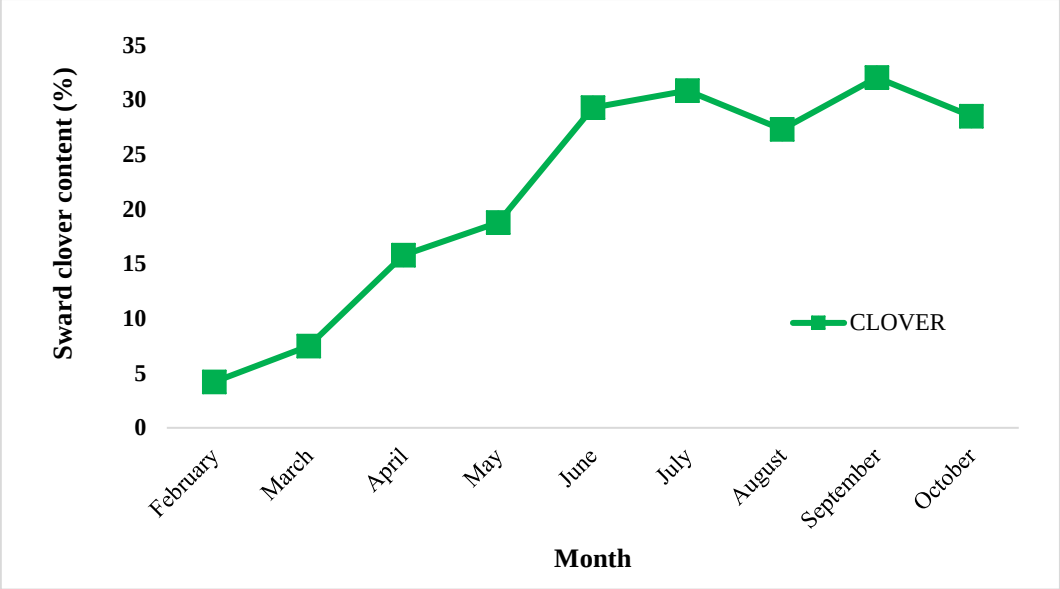

Figure 1. Monthly clover percentage in the CLOVER pasture during 2023.

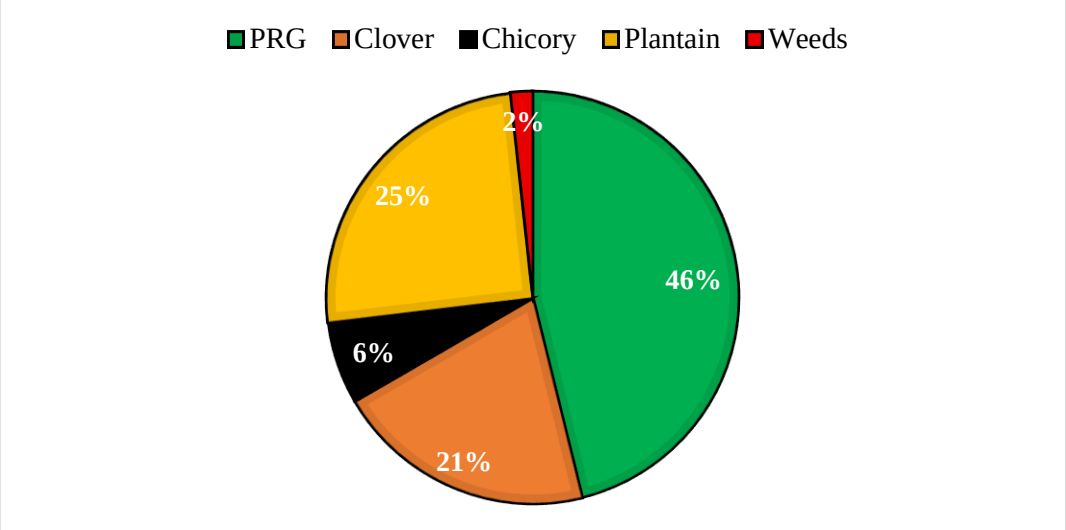

Figure 2. Average botanical composition of the multi-species swards (MSS) for the 2023 grazing season.

Throughout the grazing season, the average herbage DM concentration was lowest for MSS (16.6%), intermediate for CLOVER (18.5%) and highest for PRG (19.3%) pastures, with this ranking observed throughout most of the grazing season (Figure 3).
Despite, agronomic and animal performance benefits of more species-rich swards, the long-term persistency of clover and herbs needs to be evaluated under Irish production conditions, as the benefits of these more diverse swards may only be evident for five years or less (Li et al., 1997). There is also concern among farmers regarding the lack of availability of a post-emergence herbicide for swards containing herbs.

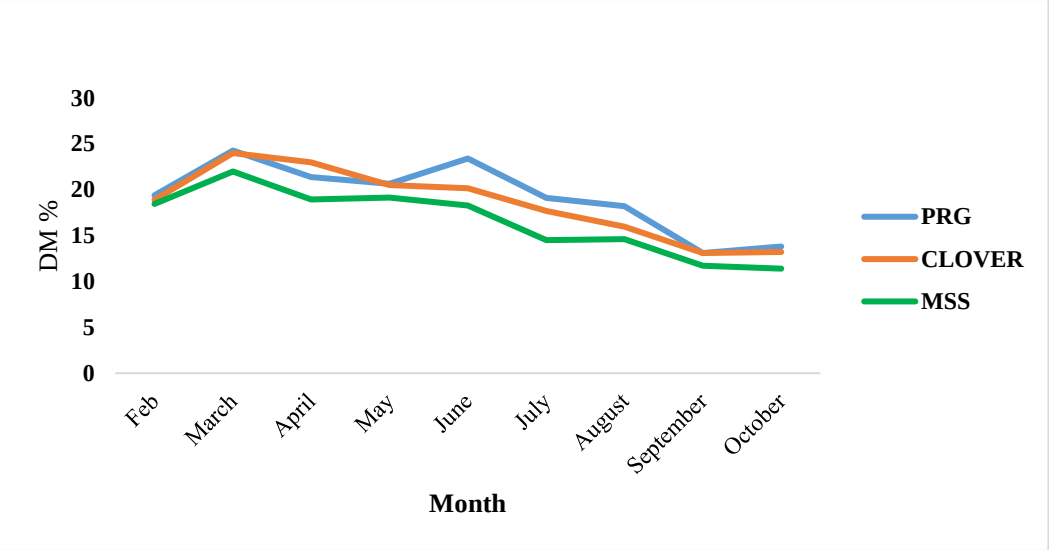

Figure 3. Average monthly dry matter percentage of the three pasture types - perennial ryegrass-only swards (PRG), PRG plus red and white clover swards (CLOVER) and multispecies swards (MSS) - in 2023.

Animal performance

The effects of pasture type on animal live weight gain and slaughter traits are presented in Tables 2 and 3. The results of the current study indicated that dairy-beef heifers achieved the greatest performance as calves on the MSS pastures, while as yearlings they performed best while consuming the CLOVER herbage (Table 2). Although the PRG treatment performed similarly to the other two pasture treatments during the first indoor winter period, performance at pasture for PRG was lower than that achieved by the MSS treatment during both the first and second grazing season, and lower than the CLOVER treatment during the second grazing season. Overall, this resulted in a lower lifetime daily live weight gain, and a numerically higher age of slaughter for the heifers consuming the PRG herbage. This lifetime daily live weight gain advantage of the CLOVER and MSS treatments over that of the PRG treatment is in line with studies conducted by UCD at the Lyons research farm (Boland et al., 2022).

Table 2. Effect of pasture type - perennial ryegrass-only swards (PRG), PRG plus red and white clover swards (CLOVER) and multispecies swards (MSS) - on daily live weight gain (ADG, kg) of dairy-beef heifers slaughtered from pasture.

	PRG	CLOVER	MSS	sem	Significance
ADG (kg)					
1st grazing season	0.61[a]	0.62[a]	0.79[b]	0.052	***
1st winter	0.65	0.65	0.68	0.031	NS
2nd grazing season	0.81[a]	0.92[b]	0.87[b]	0.019	***
Lifetime	0.74[a]	0.78[b]	0.79[b]	0.010	**

Overall, a greater number of heifers were slaughtered off pasture for the CLOVER and MSS treatments, compared to the PRG treatment (86 vs. 75 vs. 68%, respectively). Thus, the indoor finishing concentrate requirement was lower for the CLOVER (25 kg) and MSS (34 kg) treatments compared to PRG (62 kg), which represents a significant saving in feed costs and housing-related costs. Despite more PRG heifers requiring housing and higher concentrate inputs to achieve the target fat score of between 3- and 3+, they were still half a fat grade leaner ($P<0.05$) than the CLOVER and PRG heifers (Table 3). The CLOVER and MSS heifers were heavier at slaughter compared to the PRG heifers, resulting in a heavier carcass ($P<0.05$).

Thus, a 'potential' blueprint for dairy-beef farmers would be to have a proportion of the farm with MSS pastures for the calves to graze during the 'first' grazing season, and to have clover incorporated on the remainder of the grazing area for the yearlings to graze during the 'second' grazing season.

Table 3. Slaughter and carcass traits of dairy-beef heifers finished from the three pasture types - perennial ryegrass-only swards (PRG), PRG plus red and white clover swards (CLOVER) and multispecies swards (MSS)

	PRG	CLOVER	MSS	sem	Significance
Slaughter age (months)	19.6	19.2	19.2	6.5	NS
Slaughter weight (kg)	482[a]	492[b]	490[b]	5.4	*
Kill-out (%)	50	51	51	0.1	NS
Carcass weight (kg)	243[a]	250[b]	249[b]	2.7	*
Conformation score (1-15)	5.0	5.2	5.2	0.11	NS
Fat score (1-15)	8.0[a]	8.5[b]	8.6[b]	0.19	**

Conclusions

Reduced chemical N fertiliser use, improved lifetime ADG and carcass weight of cattle are key mechanisms for improving both profitability and the environmental footprint of pasture-based dairy-beef production. The incorporation of clover into PRG swards offers farmers an opportunity to improve efficiency, while also striving to meet sectorial climate targets.

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