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Effect of stocking rate on milk and pasture productivity and supplementary feed use for spring calving pasture fed dairy systems

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ABSTRACT

The productivity of grazing systems is primarily limited by the scale and efficiency of systems applied to the grazable land platform adjacent to the milking parlor. The objective of this study was to compare forage production, utilization and quality, milk production, and requirement for supplementary feeds for 2 different grazing platform stocking rate (GPSR) treatments over 4 yr. Animals were randomly allocated to 1 of 2 GPSR treatments: high-closed (HC; 3.1 cows/ha) and high-open (HO; 4.5 cows/ha), which were designed to represent alternative GPSR in a post-European Union milk quota, spring calving, pasture-based milk production system. Animal production data were analyzed using Proc MIXED of SAS with GPSR, year, and parity included as fixed effects in the final model. Within a seasonal spring calving grazing system, at high GPSR and offering moderate amounts of additional supplements based on pasture supply deficits, both systems produced more milk and fat plus protein per hectare in comparison with Irish commercial dairy farms. Although requiring additional supplementation, increased GPSR resulted in increased milk production per hectare but also in an increased requirement for concentrate and forage supplementation during lactation. No significant influence of GPSR was found on body weight and body condition score or reproductive performance during the 4-yr study period. In addition, GPSR also had no effect on pasture production, utilization, or quality during the study period. The strategic use of additional supplements with restricted pasture availability at higher GPSR maintained milk production per cow and significantly increased milk production per hectare.

Key words: grazing platform stocking rate, milk production, pasture-based system

INTRODUCTION

Temperate grazing systems of production are characterized by a prolonged grazing season (>275 d) and a predominantly grazed pasture diet (Dillon et al., 2005; Läpple et al., 2012). Such systems, based on a comparably cheap grazed feed source, provide pasture-based milk producers worldwide with a competitive economic advantage over other production systems based on high milk output per hectare with reduced fixed and variable costs (Finneran et al., 2010). Indeed, it is widely acknowledged that the quantity of grazed pasture utilized per hectare is the most important factor influencing operating profit and, therefore, return on capital, on grazing farms (Shalloo et al., 2004; Dillon et al., 2008).

Stocking rate (**SR**) has been acknowledged as the key factor influencing productivity per hectare on pasture-based dairy farms for many years (Hoden et al., 1991; Macdonald et al., 2008; McCarthy et al., 2011). The aforementioned studies have demonstrated that higher SR result in a reduction in milk production per cow, but an increase in pasture utilization and milk production per hectare (Macdonald et al., 2008; McCarthy et al., 2011). Milk productivity per hectare is the product of SR, expressed as cows per hectare and milk production per cow, and increasing either or both will increase milk production per hectare provided that sufficient feed per hectare is provided (Macdonald et al., 2008).

Many pastureland farms consist of multiple discrete land parcels that are frequently removed from the milking parlor and consequently, cannot be grazed by the dairy herd. In such situations, the productivity of the grazing dairy farm is primarily limited by the scale, and efficiency of systems applied to the grazable land platform adjacent to the milking parlor, whereas the other land parcels are used as young stock rearing and conserved forage production support blocks (O'Donnell et al., 2008; del Corral et al., 2011). Recent studies have acknowledged that, in comparison with grazable area accessible to the milking herd (known as the grazing platform), external land parcels are associated with increased foraging costs, increased management com-

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plexity, and reduced farm productivity (del Corral et al., 2011). Given such limitations, many studies have highlighted the necessity for pasture-based farmers to develop improved agronomic management practices to increase pasture productivity on each existing hectare of grazing platform (Macdonald et al., 2008; McCarthy et al., 2013). Furthermore, the use of imported supplementary feeds to sustain high animal productivity at high grazing platform SR (**GPSR**) has recently received more attention (Bargo et al., 2003; Coleman et al., 2010; Fariña et al., 2011). Both Coleman et al. (2010) and Baudracco et al. (2010) suggested that increased supplementation coupled with increased overall SR, can efficiently support high fat plus protein production per cow and per hectare at higher SR while also achieving high levels of pasture utilization compared with lowly supplemented lower SR systems. Equally, however, previous studies have also indicated that the efficiency of pasture utilization and milk production by grazing animals is diminished within systems based on increased supplementation and such systems need careful management to control substitution rates and minimize the decline in pasture utilization (Bargo et al., 2003; Ramsbottom et al., 2015). When supplements are consumed by grazing cows, pasture DM intake is usually reduced due to the partial displacement (substitution) of grazed forage from the diet of supplemented animals (Kellaway and Porta, 1993; Bargo et al., 2003). However, few studies have investigated the effects of increased supplementation of grazing animals on cumulative pasture production, quality, and utilization efficiency within complete farm systems.

Knowledge of the relationship between SR, feed system (**FS**), and sward productivity is fundamental to the sustainable management of intensified grazing systems. Despite its critical importance, few studies have quantified the biological effectiveness of systems combining increased GPSR with increased supplementation on both milk productivity and pasture utilization efficiency. Consequently, the objective of this study was to compare pasture production, utilization, and quality, milk production per cow and per hectare, and requirement for supplementary feeds for 2 different GPSR treatments within integrated grazing systems over 4 consecutive years.

MATERIALS AND METHODS

This study was carried out at Ballyhaise College (54°051′N, 07°031′W) in the Republic of Ireland over a 4-yr period from 2008 to 2011. The experimental site comprises a variety of soil types including alluvial, brown earth, brown podzolic, and gley on a lower Silurian sandstone bedrock. The topography ranges from alluvial flatlands (along the Annalee River, which transects the site) to various shaped, recurrent drumlins with steep slopes (9–18°) and intervening U-shaped valleys.

Animals

The data presented were collected from 97, 110, 115, and 120 animals in 2008, 2009, 2010, and 2011, respectively. During the 4 yr of the study, the experimental herd consisted of Holstein-Friesian (58%), Holstein-Friesian Jersey crossbred (32%), and Holstein-Friesian Norwegian Red crossbred animals (10%), and all animals had received genetic evaluation values using the Irish genetic evaluation system (economic breeding index; **EBI**). The average overall EBI, milk sub-index, and fertility sub-index of the animals over the period was €103, €35, and €59, respectively, during the study period (ICBF, 2009). In yr 1, the experimental animals were assigned to 1 of the 2 GPSR groups before calving based on breed, parity, calving date, previous lactation milk yield, BCS, BW, and EBI. All multiparous animals were subsequently retained on the same GPSR system for the duration of the study. Primiparous animals entering the study were randomly assigned to GPSR treatment based on EBI, breed, calving date, and precalving BW and BCS.

Feed Systems

All multiparous animals were randomly allocated to 1 of 2 possible grazing platform pasture-based feed systems (**GPFS**), namely a high closed feed system (**HCFS**), which had an overall GPSR of 3.1 cows per hectare, or a high open feed system (**HOFS**), which had an overall GPSR of 4.5 cows per hectare. The HCFS was designed as a predominantly self-sufficient GPFS based on high levels of pasture utilization and whereby purchased forage and concentrates would not exceed 30% of total feed requirements. In contrast, the HOFS was created as a high-productivity pasture system to increase milk output per hectare by increasing GPSR and supplementing animals with additional forage and concentrates to meet the additional feed requirements particularly in spring and autumn, corresponding to early and late lactation when pasture growth was reduced. The HOFS was designed to increase productivity on fragmented land holdings where winter feed can be imported from external land parcels. Additional grass silage required for both GPFS was conserved from similar pastures adjacent to the experimental area. The ingredient composition of the concentrate feed (kg/t as