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The effect of stocking rate and calving date on milk production of Holstein–Friesian dairy cows

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ABSTRACT

The objective of this study was to evaluate the effect of stocking rate (SR) and calving date (CD) on milk production, BW and BCS within grass-based production systems post-European Union milk quotas using modern grazing management practices and high genetic potential Holstein–Friesian (HF) spring calving dairy cattle over a two year period. Two groups of HF dairy cows with different mean CD were established from within the existing research herd at Moorepark (Teagasc, Ireland). Animals were assigned either to an early calving (mean CD: 12 February) treatment or a late calving (mean CD: 25 February) treatment. Animals within each CD treatment were randomly allocated to 1 of 3 SR treatments, Low (2.51 cows/hectare (ha), Medium (2.92 cows/ha) and High (3.28 cows/ha) which were designed to represent 3 alternative whole farm SR in a post-European Union milk quota, spring calving, grass-based milk production system. A total of 138 spring-calving dairy cows, comprised of two strains of HF (North American HF and New Zealand HF genetic strains), were used during 2009 and 2010, respectively. The effects of CD, SR treatment, genetic strain and their interactions on milk production per cow and per ha, body weight and body condition score were analyzed. Although reducing per animal production, increased SR resulted in increased milk and milk solids production per ha. The results also indicate that although CD had no effect on total lactation performance, adjusting mean CD may be an effective strategy to align animal requirements and grass supply and reduce the requirement for supplements at increased SR in early lactation.

1. Introduction

Worldwide demand for dairy products has been increasing rapidly as a result of projected population growth, urbanization and increases in per capita disposable income (Delgado, 2005; Rae, 2002). By 2020, it is predicted that developing countries will consume 152 m tonnes more milk compared with 2002/2003 (Delgado, 2005). Grazing systems of production, such as those in Ireland, which are characterized by seasonal calving, a prolonged grazing season and a predominantly grazed grass diet, have the potential to supply large additional volumes of high quality dairy products post-European Union (EU) milk quota abolition in 2015 (Lips and Rieder, 2005). The reform of Common Agriculture Policy and abolition of milk quotas provides EU grass-based farm systems with a unique opportunity to exploit their competitive advantages by producing increasing quantities of milk products from grazed grass through increased herbage production and utilization (Dillon et al., 2008; Shalloo et al., 2004). Consequently, reports such as Food Harvest 2020 (Department of Agriculture, Fisheries and Food, 2010) have

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projected that milk production in Ireland post EU milk quota removal could increase by up to 50% by the year2020.

Increased milk production from grass-based dairy production systems can be achieved by converting increased quantities of grazed herbage efficiently to milk (McMeekan and Walshe, 1963). Stocking rate (SR), traditionally defined as the number of animals per unit area of land used during a defined period of time (cows/ha), is acknowledged as the main driver of production from grazing systems (Baudracco et al., 2010; Hoden et al., 1991; Macdonald et al., 2008). It is widely acknowledged that increasing SR results in a reduction in milk production per cow, but an increase in milk production per ha (Journet and Demarquilly, 1979; Macdonald et al., 2008; McCarthy et al., 2011). Low-cost systems capable of producing high levels of milk and milk solids (MS; fat+protein) per ha through increased SR were advocated in Ireland prior to the introduction of EU milk quotas (Crosse, 1988).

Ultimately, achieving high levels of milk production from grazed grass with minimal supplementation occurs when the appropriate mean calving date (CD) and distribution of calving is achieved in conjunction with the optimum SR to align herbage supply to herd demand (Dillon et al., 1995). While many SR experiments have been undertaken, few have investigated the effect of SR in conjunction with CD. Dillon et al. (1995) investigated the effects of SR and CD on milk production and reported that earlier calving (mean CD 23 January) resulted in increased milk production compared with later calving (mean CD 15 March). However, the differences reported were a result of differences in both CD and feeding regime as large quantities of additional supplementary feed was required for the earlier calving treatment.

In order to investigate the interaction between SR and CD treatments on milk production from a grazing system, a range of SR and mean CD treatments must be compared on a common diet. The objective of this study, therefore, was to evaluate the effect of SR and CD on milk and MS production, BW and BCS across lactation within grass-based production systems post EU milk quotas using modern grazing management practices and high genetic potential Holstein–Friesian (HF) spring calving dairy cattle over a two year period.

2. Materials and methods

This study was undertaken at the Animal and Grassland Research and Innovation center, Teagasc Moorepark, Ireland over a two year period (2009 and 2010). A total of 272 lactations from 182 spring-calving dairy cows were analyzed, with 138 cows used in year one and two with 94 cows used in both 2009 and 2010 (McCarthy et al., 2012).

2.1. Experimental design, treatments, and herd management

The experiment was a randomized block design with a 3×2 factorial arrangement of treatments. In each year, the six experimental treatments consisted of three whole farm SR (2.51, 2.92 and 3.28 cows/ha) and two CD (12 February and 25 February). The cows used in this experiment comprised two strains of HF, North American (NA; $n=108$) and New Zealand (NZ; $n=74$). The average Economic Breeding Index (EBI), milk, fertility, calving, beef, maintenance, and health sub-indices of the NA strain were €103, 46, 46, 19, −8, 2, and −2, respectively, whereas the average EBI, milk, fertility, calving, beef, maintenance, and health sub-indices of the NZ strain was €141, 57, 103, 24, −25, 19, and −4, respectively. In year two, one cow died from hypomagnesaemia mid-way through the study and was subsequently replaced with another cow of similar BW in order to maintain the overall SR in that treatment. Neither the cow that died nor her replacement's data were included in the final analysis.

Two groups of similar high EBI HF dairy cows were established from the existing herd within Moorepark during the 2008 breeding season, prior to the commencement of the current study. One group was randomly assigned to an early calving (EC; mean CD 12 February) treatment and the other group to a late calving (LC; mean CD 25 February) treatment. The EC treatment was established by commencing the 2008 breeding season on 10 April and finishing on 10 July. The LC treatment was established by commencing the 2008 breeding season on 24 April and finishing on 24 July. In 2009 and 2010, animals were retained within their respective calving treatments by breeding the LC treatment two weeks later than the EC treatment. The alignment of mean CD and grass growth is critical to seasonal grazing systems as it determines when herd feed demand suddenly increases relative to feed supply (Holmes et al., 2002). Previous grazing studies at this research site (Coleman et al., 2010; Horan et al., 2005) have indicated that with a mean CD in mid-February, grass growth does not meet feed requirements until approximately 60 days after mean CD in mid-April. Consequently, a 14 day differential in mean CD (12 February and 26 February) between calving treatments was selected to reduce the duration of feed restriction from 60 days to 45days.

Cows within each CD were then randomly assigned pre-calving based on expected CD, parity, strain of HF and EBI to one of three SR treatments, Low (2.51 cows/ha; LSR), Medium (2.92 cows/ha; MSR) and High (3.28 cows/ha; HSR), which were designed to represent three alternative whole farm SR in a post EU milk quota spring calving grass-based milk production system. The LSR treatment was designed to allow each animal to express its potential unrestricted by limitations in feed supply. The SR of MSR and HSR treatments was 16% and 31% greater, respectively than the LSR treatment. The aim of the MSR and HSR treatments was to investigate the potential to increase production per ha by increasing SR, and as a consequence herbage utilization, by grazing to lower post-grazing residual sward heights (PGRSH; LSR=4.5–5.0 cm, MSR=4.0–4.5 cm and HSR 3.5–4.0 cm).

Concentrate supplementation was similar for each SR; however according to the supplementation plan less concentrate was fed to the LC groups. Concentrate supplementation for all treatments commenced at four kg per day