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Effect of stocking rate and calving date on dry matter intake, milk production, body weight, and body condition score in spring-calving, grass-fed dairy cows

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ABSTRACT

The primary objective of the study was to quantify the effect of stocking rate (SR) and calving date (CD) on milk production, dry matter intake (DMI), energy balance (EB), and milk production efficiency over 4 consecutive years (2009 to 2012). Two groups of Holstein-Friesian dairy cows with different mean CD were established from within the existing research herd at Moorepark (Teagasc, Ireland). Animals were assigned to either an early calving (mean CD February 14) treatment or a late calving (mean CD March 2) treatment. Animals within each CD treatment were randomly allocated to 1 of 3 whole-farm SR treatments: low (LSR; 2.51 cows/ha), medium (MSR; 2.92 cows/ha), and high (HSR; 3.28 cows/ha), and animals remained on the same farmlet for the duration of the study. Individual animal DMI was estimated 3 times per year at grass using the n-alkane technique in March (spring), May (summer), and September (autumn), corresponding to, on average, 45, 132, and 258 d in milk, respectively. A total of 138 spring-calving dairy cows were used during each year of the study. The effects of SR, CD, season, and their interaction were studied using mixed models. Individual animal milk production, body weight, body condition score, and the efficiency of milk production were significantly decreased as SR increased due to a reduction in herbage availability. The existence of CD × SR × season interactions for production, DMI, and EB indicate that delaying the herd mean CD can be an effective strategy to minimize the reduction in animal performance, particularly in spring at higher SR. This study further confirms the benefits of a new approach to the evaluation of herbage allowance known as the individual herbage allowance, which encompasses the 3 main factors restricting DMI in rotational grazing; namely, the average daily herbage allowance of the group, the intake capacity of the individual animal within the group, and the relative intake capacity of the animal within the competing herd.

Key words: stocking rate, calving date, dry matter intake, feed efficiency

INTRODUCTION

The imminent abolition of European Union (**EU**) milk quotas in 2015 creates exciting and challenging opportunities for Ireland's grass-based dairy industry. The medium- to long-term outlook for efficient, grass-based milk production is positive because of lower costs of production associated with grazed grass systems (Dillon et al., 2008), and recent studies evaluating the potential effect of EU milk quota abolition indicate that milk production in Ireland could increase by between 30 and 50% post-quotas (Lips and Reider, 2005; DAFM, 2010). The realization of increased overall milk production within Irish grazing systems will necessitate increased operational scale and improved production efficiency on existing dairy farms. Productivity within such systems depends on achieving a balance between the competing objectives of high individual animal grass DM and milk production conversion efficiency and maximizing grass production, quality, and utilization (Penno et al., 1996; Peyraud et al., 1996; Prendiville et al., 2011).

Individual animal intake at grazing and milk production efficiency is governed by multiple factors including animal genotype (Horan et al., 2005), grazing stocking rate (**SR**) and grazing intensity (McCarthy et al., 2013b), herd mean calving date (**CD**) and calving rate (Dillon et al., 1995; Garcia and Holmes, 2005), and feed allocation rate and quality (Dalley et al., 1999; Peyraud et al., 1996; Stakelum and Dillon, 2007). Stocking rate (cows/ha), defined as the number of animals per unit area of land used during a specified defined period of time (Allen et al., 2011), is widely acknowledged as the main driver of productivity from grazing systems

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(Hoden et al., 1991; Macdonald et al., 2008; Baudracco et al., 2010). A recent review of SR experiments for which no additional supplement was fed as the SR increased reported a 0.20 increase in milk production per hectare arising from an increase in SR of 1 cow/ha (McCarthy et al., 2011). Increasing SR is usually associated with an increase in grazing severity, and many studies have attributed the increased productivity of higher SR systems to an improvement in herbage utilization (McMeekan and Walsh, 1963; Hoden et al., 1991; Macdonald et al., 2008). However, Horan et al. (2004) and Leaver (1985) observed a significant reduction in grass DMI at higher SR because of a reduction in daily herbage allowance (**DHA**; kg of DM offered/cow per day; Greenhalgh et al., 1966) where strategies were imposed to increase milk production per hectare and improve sward quality. In contrast, other studies have indicated that maximum grass DMI is reached at high DHA (27 to 33 kg of DM/cow per day above 4 cm; Leaver, 1985; Peyraud et al., 1996), which are unattainable at higher SR where feed supply is restricted (Macdonald et al., 2008).

In addition to SR, CD is an important determinant of milk production and feed utilization through its effect on the alignment between feed demand and supply. Altering the mean CD of the herd may have a role in reducing the reliance of grass-based farm systems on purchased feeds, particularly at higher SR. However, few studies have attempted to quantify the effect of mean CD in spring on DMI or elucidate any potential interactions with SR. Dillon et al. (1995) observed that delaying calving until March achieved a better alignment of dairy herd requirements and grass growth, increased milk production from grazed grass, reduced the requirement for purchased supplements, and achieved a greater efficiency of energy utilization particularly at higher SR.

In a post-quota scenario, where land availability is the greatest limitation to milk production, both McCarthy et al. (2007) and Patton et al. (2012) concluded that Irish dairy farms will need to increase overall farm SR from the current mean SR of 1.78 cows/ha (O'Donnell et al., 2008) and mean CD of March 17 (National Farm Survey, 2009) to realize greater levels of milk and milk solids (**MS**; kg of fat + protein) production per hectare. The objective of this study, therefore, was to evaluate the effect of SR and CD on grass DMI and milk production efficiency of high-genetic-potential Holstein-Friesian (**HF**) spring-calving dairy cattle over 4 full grazing seasons.

MATERIALS AND METHODS

This study was undertaken at the Animal and Grassland Research and Innovation Center, Teagasc Moorepark, Ireland (50°7N; 8°16W), over a 4-yr period (2009 to 2012). It formed part of a larger study designed to examine the biological and economic effects of alternative SR and CD combinations in the context of the removal of EU milk quotas. A more detailed description of the animals, treatments, and experimental design has been reported previously (McCarthy et al., 2013b). The on-site swards used were predominantly perennial ryegrass (*Lolium perenne* L.) and had been reseeded over the previous 1 to 9 yr.

Feed System Treatments

The experiment was created in a split-plot design with a 3 × 2 factorial arrangement of treatments. The entire experimental area was sub-divided into 18 geographically distinct blocks, each of which comprised 3 paddocks each, to which the whole-plot factor (3 levels of SR) were assigned randomly. Each of these paddocks (within blocks) was then further subdivided into 2 (sub-plots) and the 2 levels of CD were assigned randomly to these sub-plots. The 6 experimental treatments consisted of 3 whole-farm SR (2.51, 2.92, and 3.28 cows/ha) and 2 mean CD (February 14 and March 2) and were designed to represent alternative spring-calving, grass-based milk production models following removal of the EU milk quota. Two groups of high Economic Breeding Index (**EBI**) HF dairy cattle were established from within the existing Moorepark herd before the commencement of the 2008 breeding season based on parity, BW, EBI, and previous lactation milk production. The average EBI, milk, fertility, calving, beef, maintenance, and health sub-indices of the trial animals were €148, €59, €78, €27, −€23, €16, and −€3, respectively. In each year of the study, one group was bred to AI over a 13-wk period between April 10 and July 10 to establish the early calving (**EC**; mean CD February 14) treatment. The second group were bred to AI over a 13-wk period between April 24 and July 24 to establish the late calving (**LC**; mean CD March 2) treatment. In the 4 yr of the trial, animals were retained within their respective CD and SR treatments by breeding the LC treatment within each SR 2 wk later than the EC treatment. Cows within each CD group were then randomly assigned precalving (based on expected CD, parity, genetic strain, and EBI) to 1 of 3 SR treatments, low (2.51 cows/ha; **LSR**), medium (2.92 cows/ha; **MSR**), and high (3.28 cows/ha; **HSR**). The SR were 16 and 31% greater in the MSR and HSR treatments than in the LSR treatment. The LSR treatment was designed to allow each animal to express its potential at high herbage allowances of high quality grass and small amounts of concentrates, whereas the aim of the MSR and HSR treatments was to investigate