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Effect of stocking rate and animal genotype 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 objective of the experiment was to quantify the effect of stocking rate (SR) and animal genotype on milk production, dry matter intake (DMI), energy balance, and production efficiency across 2 consecutive grazing seasons (2014 and 2015). A total of 753 records from 177 dairy cows were available for analysis: 68 Holstein-Friesian and 71 Jersey × Holstein-Friesian (JxHF) cows each year of the experiment under a pasture-based seasonal production system. Animals within each breed group were randomly allocated to 1 of 3 whole-farm SR treatments defined in terms of body weight per hectare (kg of body weight/ha): low (1,200 kg of body weight/ha), medium (1,400 kg of body weight/ha), and high (1,600 kg of body weight/ha), and animals remained in the same SR treatments for the duration of the experiment. Individual animal DMI was estimated 3 times per year at grass using the n-alkane technique: March (spring), June (summer), and September (autumn), corresponding to 45, 111, and 209 d in milk, respectively. The effects of SR, animal genotype, season, and their interactions were analyzed using mixed models. Milk production, body weight, and production efficiency per cow decreased significantly as SR increased due to reduced herbage availability per cow and increased grazing severity. As a percentage of body weight, JxHF cows had higher feed conversion efficiency, higher DMI and milk solids (i.e., kg of fat + kg of protein) production, and also required less energy intake to produce 1 kg of milk solids. The increased production efficiency of JxHF cows at a similar body weight per hectare in the current analysis suggests that factors other than individual cow body weight contribute to the improved efficiency within intensive grazing systems. The results highlight the superior productive efficiency of high genetic potential crossbred dairy cows within intensive pasture-based milk production systems at higher SR where feed availability is restricted.
Key words: stocking rate, crossbreeding, dry matter intake, production efficiency

INTRODUCTION

High-productivity grazing systems depend on achieving the correct balance between the competing objectives of managing swards to achieve high pasture growth, feed quality, and utilization while maintaining relatively high levels of individual cow DMI. Within such systems, grazed grass is the cheapest feed source, providing a comparatively inexpensive and high-quality nutrient supply (Shalloo et al., 2004; Finneran et al., 2010). Consequently, maintaining a high proportion of overall milk production from grazed grass has a pervasive antagonistic effect on both direct and overhead milk production costs within such systems (Dillon et al., 2008; Ramsbottom et al., 2015). Moreover, although productivity within such systems is frequently measured in terms of milk solids (**MS**; fat plus protein) production per hectare, such analysis belies the significant effects of pasture productivity and utilization, and feed supplementation on farm system performance (Holmes et al., 2002). Within intensive predominantly grazing systems, pasture production and utilization limit milk productivity, and consequently, more recent studies have defined productive efficiency at a grazing systems level in terms of milk production per unit of pasture eaten and per unit of pasture used (Prendiville et al., 2009; Coleman et al., 2010; McCarthy et al., 2012).

Improving the efficiency of forage conversion to milk by grazing dairy cows has been extensively studied within the literature, and significant effects of overall grazing system design, animal nutrition, and animal

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breed and genetic merit have been widely reported (Tozer et al., 2004; Macdonald et al., 2008a; Prendiville et al., 2009; McCarthy et al., 2013). Foremost among these factors, the inverse relationship between stocking rate (**SR**) and individual animal productivity is now well understood (for review, see McCarthy et al., 2011). An overall medium SR provides an appropriate trade off to realize high pasture utilization and efficient conversion of nutrients to product in such systems (Tozer et al., 2004).

As pasture productivity limits have constrained the performance of intensive grazing systems, increasing emphasis has been placed on the selection of dairy cows capable of increased feed conversion efficiency (**FCE**) within intensified systems. The inclusion of gross feed efficiency measures within breeding objectives for grazing systems has received much attention albeit with variable success (Berry and Crowley, 2013; Pryce et al., 2015). Individual cow BW has been widely used as a predictor of FCE as the lower maintenance requirements of lighter cows was considered desirable ceteris paribus (Stakelum and Connolly, 1987; Veerkamp, 1998; Horan et al., 2006). More recently, considerable evidence has suggested that, in comparison with Holstein-Friesian (**HF**) cows of similar overall genetic merit, Jersey × Holstein-Friesian crossbred (**JxHF**) cows characterized by lower BW, increased intake per unit BW, and greater efficiency of utilization of feed for milk and tissue production, may be more suited to intensive grazing systems on an individual cow basis (Goddard and Grainger, 2004; Prendiville et al., 2009; Vance et al., 2012; Beecher et al., 2014). Notwithstanding these reported benefits, there is a paucity of research evaluating the potential advantages of JxHF cows with enhanced intake capacity and ability to consume roughage within pasture-based systems.

Identifying the appropriate SR is the principal decision to managing a sustainable pasture-based system. Stocking rate has implications for pasture production and utilization as well as individual cow performance among other factors that influence the pasture-livestock relationship (McCarthy et al., 2015). Although the results of animal genotype (**BR**) comparison experiments are unequivocal in observing improved grazing and milk production efficiency among JxHF cows, it is also widely acknowledged that comparing animals of differing BW (and associated maintenance requirements) on an individual animal basis confers a systemic advantage to the smaller animal (McCarthy et al., 2013; Dong et al., 2015). Consequently, it is unclear if the superior FCE of JxHF animals is retained within intensified grazing systems where SR may be defined in terms of BW per hectare.

The objective of the present experiment was to investigate the effects of SR and BR on DMI, milk production, and FCE within pasture-based systems wherein SR is defined in terms of kilograms of BW per hectare across 2 consecutive grazing seasons.

MATERIALS AND METHODS

The present experiment was undertaken at the Animal & Grassland Research and Innovation Center, Teagasc Moorepark, Ireland (50°7N; 8°16W), over a 2-yr period (2014 and 2015). It formed part of a larger systems experiment designed to examine the biological and economic effect of alternative SR and BR combinations. The on-site swards used were predominantly perennial ryegrass (*Lolium perenne* L.) and had been reseeded over the previous 10 yr.

Experimental Design, Treatments, and Animals

The experiment was a randomized block design with a 3 × 2 factorial arrangement of treatments. The 6 experimental treatments consisted of 3 SR: low SR (**LSR**; 1,200 kg of BW/ha), medium SR (**MSR**; 1,400 kg of BW/ha), and high SR (**HSR**; 1,600 kg of BW/ha) and 2 BR: HF and JxHF. Treatment farmlets were 9.17, 7.87, and 7.01 ha in size for each BR in LSR, MSR, and HSR treatments, respectively. The LSR treatment group was designed to allow individual cows achieve high DMI and milk production while the MSR and HSR measured potential milk production and herbage utilization per hectare. In total, 177 spring-calving dairy cows were used as part of the experiment; 68 HF and 71 JxHF were used in each year of the experiment (2014 and 2015; Table 1). The replacement rate of the experimental herd was approximately 27% across the 2-yr DMI measurement period. Cows were culled as a result of failure to establish or maintain pregnancy, lameness, and mastitis. The crossbred cows were JxHF 50/50 F1 and were produced from HF dairy cows sired by Jersey bulls. The average economic breeding index (**EBI**), milk, fertility, calving, beef, maintenance, management, and health sub-indices of the HF cows were €205, 64, 103, 33, −12, 16, 2, and −1, respectively, whereas the average EBI, milk, fertility, calving, beef, maintenance, management, and health sub-indices of the JxHF cows were €198, 68, 89, 30, −23, 32, 3, and −1, respectively. The average EBI of the cows during the experiment (ICBF, 2015) ranked them in the top 1% of the national dairy herd during the same period. Cows within each BR group were randomly assigned precalving (based on expected calving date, parity, and EBI) to 1 of the 3 SR treatments. Cows were retained