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An evaluation of production efficiencies among lactating Holstein-Friesian, Jersey, and Jersey × Holstein-Friesian cows at pasture

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ABSTRACT

The objectives of this study were 1) to investigate production and energetic efficiencies among lactating dairy Holstein-Friesian (HF), Jersey (J), and Jersey × Holstein-Friesian (F_1) cows over a total lactation at pasture and 2) to measure the associations among efficiency variables and performance traits. Data from 110 cows were available (37 HF, 36 J, and 37 F_1). Breed groups were not balanced for parity; 16 HF, 10 J, and 9 F_1 were in parity 1, whereas the remainder were in parity 2. Milk production, body weight (BW), body condition score (BCS), and estimates of dry matter intake (DMI) corresponding to 51, 108, 149, 198, and 233 d in milk were available. Breed group had a significant effect on all the production parameters investigated: milk yield, solids-corrected milk (SCM), milk fat, protein and lactose concentrations, and milk solids (MLKS; fat + protein yield). Daily MLKS yield was similar for HF and J (1.33 and 1.28 kg/d, respectively). There was a tendency for F_1 (1.41 kg/d) to produce more MLKS compared with HF. The HF breed had higher BW throughout the study compared with F_1 and J. Mean BCS was higher for F_1 (3.00) and J (2.93) compared with HF (2.76). Mean DMI was similar with HF (16.9 kg) and F_1 (16.2 kg) and was lowest with J (14.7 kg). Breed group had a significant effect on all the efficiency parameters investigated: total DMI per 100 kg of BW, SCM per 100 kg of BW, MLKS per 100 kg of BW, and MLKS per total DMI, which tended to be highest for J. Production efficiency based on net energy intake per MLKS was most favorable for F_1 and J compared with HF [12.5, 13.0, and 14.1 UFL, respectively, where 1 UFL is defined as the net energy content of 1 kg of standard barley for milk production (O'Mara, 2000)]. Significant estimates of hybrid vigor were evidenced for milk yield, milk lactose content, SCM, MLKS, net energy for lactation, BW, BCS, and net energy intake per MLKS. The correlations examined indicated that production efficiency was positively associated with MLKS yield.

Key words: Jersey, feed efficiency, crossbreeding, hybrid vigor

INTRODUCTION

Efficient conversion of feed input to product is critical to economic profitability of the dairy production business. Total feed costs account for approximately 80% of the total variable costs associated with milk production (Shalloo et al., 2004). Therefore, in theory, overall farm profit could be increased by improving cow efficiency with regard to the conversion of energy intake to milk production. Breeding objectives globally have evolved of late, with increased emphasis being placed on survival and functional (health) traits as well as on production performance (Miglior et al., 2005). Selection in dairy cattle, for the most part, has not incorporated feed intake or feed efficiency as selection traits per se, predominantly because of a lack of information on nutrient intake and utilization by individual cows (Ngwerume and Mao, 1992).

Production efficiency can be defined in various ways. Gross efficiency, a commonly used measure of efficiency for lactating dairy cows, is usually expressed as the ratio of milk yield or milk solids (**MLKS**; kg of fat and protein) per unit of feed intake (Lopez-Villalobos et al., 2008). Other studies use net efficiency, which represents, in some form, the ratio of milk energy to total energy intake, having accounted for the energy required for maintenance, BW change, and other energy uses (Schwager-Suter et al., 2001). Alternatively, residual feed intake (**RFI**), first proposed by Koch et al. (1963), is the unexplained (remaining) energy from the total net energy intake (**NEI**), having accounted for all net energy uses. The RFI value denotes the difference in the utilization of energy by the cow relative to the population or group mean. Usually, it is represented as the difference between actual feed intake and that predicted based on the requirements for maintenance, milk production, BW, BW change, and, where appropriate, stage of pregnancy, with a more negative value signifying greater efficiency.

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Differences in DMI and varying measures of feed conversion efficiency (**FCE**) between dairy cows of various pure breeds have been reported previously (Oldenbroek, 1988; Mackle et al., 1996; Rastani et al., 2001). Although many studies deal with comparisons between Holsteins (**H**) and Jerseys (**J**), the majority date back to the late 1980s and early 1990s (Grainger and Goddard, 2004) and few include the J × Holstein-Friesian (**F$_1$**). The review by Grainger and Goddard (2004) reported that in 8 out of 11 studies, pure J cows consumed more DM per 100 kg of BW compared with H or Friesian (**F**) cows. These studies represented evaluations undertaken from 14 to 300 DIM and varied from farm system comparisons over 3 yr to short-term calorimetry experiments. Furthermore, studies varied from indoor experiments, where cows were offered a TMR diet, to pasture-based environments. The mean result indicated that J cows consumed 5.1% more than H and F cows when expressed as DM per kilogram of metabolic BW. This implies that J cows have a high intake capacity per unit of BW.

Concern for decreased additive genetic merit for fertility and health within the H breed has resulted in renewed global interest in crossbreeding (Hansen, 2006; Walsh et al., 2007). In Ireland, interest in crossbreeding with J is fueled by inadequate reproductive performance within Holstein-Friesian (**HF**) herds, a need to maximize MLKS production per hectare, and, more recently, the introduction by most milk processors of a multicomponent index system of milk payment (Shalloo, 2007). A 5-yr study evaluating the performance of HF, J, and F$_1$ under Irish grass-based production conditions was established by Teagasc Moorepark at the Ballydague research farm in 2006. This study provided a unique opportunity to investigate the reputed feed efficiency differences between the HF and J and, importantly, their cross.

The difficulty in measuring feed intake, especially from pasture-based environments, might imply that efficiency measures, particularly RFI, may not be economically viable in dairy breeding schemes (McNaughton and Pryce, 2008). Efficiency measurements taken at one point in time, when considered over the total lactation or total lifetime, may not hold true. Because estimating feed efficiency is a costly process, it is of considerable interest to elucidate whether relationships exist between feed efficiency and traits that can be easily measured (or that are already included in selection goals), such as production potential. The objectives of this study were therefore 1) to estimate production and energetic efficiencies among lactating dairy HF, J, and F$_1$ cows over a total lactation at pasture and 2) to measure the associations among the efficiency variables and performance traits that might elucidate relationships between efficiency and more easily measured traits, such as milk production.

MATERIALS AND METHODS

Data from 110 cows were available: 37 HF, 36 J, and 37 F$_1$. Breed groups were not balanced for parity; 16 HF, 10 J, and 9 F$_1$ were in parity 1, whereas the remainder were in parity 2. Mean calving date for all cows was February 18. A total of 13, 13, and 6 sires were represented in the HF, J, and F$_1$, respectively. All F$_1$ animals were sired by J bulls and out of HF cows. The HF sires were of North American HF (84%) and New Zealand (16%) origin. The proportion of HF in the trial HF cows was 89% (SD 11.3). The mean PTA (across breed) and standard deviations (in parentheses) for the HF sires used were as follows: +179 kg (110.3), +10 kg (4.7), +9 kg (3.1), +0.06% (0.11), and +0.06% (0.05) for milk yield, fat yield, protein yield, and fat and protein concentration, respectively (http://www.icbf.com; accessed April 2009). Comparable PTA for the J sires (SD in parentheses) were as follows: −364 kg (164), +12 kg (8), −1 kg (7), +0.59% (0.20), and +0.25% (0.08). The J sires were of New Zealand (64%) and Danish (36%) origin. Of the 13 J sires, 4 were represented in both the J and F$_1$ cows. These 4 sires accounted for 21 and 31 of the J and F$_1$ cows, respectively. All sires were representative of the sires commonly used in Ireland.

Feeding System and Cow Management

The experimental region was a permanent grassland site consisting of a sward with almost 100% perennial ryegrass (*Lolium perenne* L.). The soil type on the farm was free-draining acid brown earth of sandy loam to loam texture. Cows were turned out to grass in early February until mid-November and were housed during the winter months. A 10-wk dry period was given to first-lactation animals, whereas an 8-wk dry period was deemed sufficient for multiparous animals. During the winter, all animals were offered grass silage ad libitum and dry cow minerals at a rate of 100 g/cow per day. During the risk periods (February to May and September to November) calcined magnesite (Nutribio, Cork, Ireland) was dusted on the paddocks at a rate of 60 g/cow per day to prevent magnesium deficiency. Cows grazed as a single herd under a rotational grazing system, as described by Dillon et al. (1995). The cows were allocated fresh pasture every 24 h. Concentrate supplementation over the lactation totaled 240 kg of DM/cow, and it was offered as a supplement in early lactation until pasture growth met demand (Kennedy et al., 2007). All concentrate supplementation was offered