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Toward improved postpartum cyclicity of primiparous dairy cows: Effects of genetic merit for production traits under contrasting feeding systems

N. Bedere,*† L. Delaby,*† V. Ducrocq,‡ S. Leurent-Colette,§ and C. Disenhaus*†[1]
*INRA UMR 1348 PEGASE, F 35590 Saint-Gilles, France
†Agrocampus-Ouest UMR 1348 PEGASE, F 35000 Rennes, France
‡INRA UMR 1313 GABI, F 78352 Jouy-en-Josas, France
§INRA UE 326 Domaine Expérimental du Pin-au-Haras, F 61310 Exmes, France

ABSTRACT

Milk genetic merit is known to affect commencement of luteal activity (C-LA) in dairy cows. This effect is considered to be due to energy exported in milk production. The present study aimed to identify and quantify the effects of genetic characteristics [breed and estimated breeding value (EBV) for milk yield and fat and protein contents] and feeding system on C-LA of primiparous cows. From 2006 to 2013, an experiment was conducted on 97 primiparous dairy (Holstein) and 97 primiparous dual-purpose (Normande) cows. Within breed, cows were classified into 2 groups: cows with high EBV for milk yield were included in a "milk group" and those with high EBV for fat and protein contents were included in a "content group." Within breed, exported energy in milk and body weight (BW) loss were similar for both genetic groups. Two grazing-based strategies were used, a high feeding system (maize silage in winter and grazing plus concentrate) and a low feeding system (grass silage in winter and grazing with no concentrate). Interval from calving to C-LA was studied performing survival analyses. Milk progesterone profile, milk yield, and body condition were analyzed using χ^2-test and analysis of covariance. Holstein cows produced more milk (+1,810 kg in the high feeding system and +1,120 kg in the low feeding system) and lost more BW from wk 1 to 14 of lactation (−1.4 kg/wk) than Normande cows, whereas Normande cows had earlier C-LA than Holstein cows. Within breed, cows in the content group had earlier C-LA (associated hazard ratio = 2.0) than cows in the milk group. Body weight at calving and loss from wk 1 to 14 of lactation tended to be associated with later C-LA. Cows in the high feeding system produced more milk (+2,040 kg for the Holstein cows and +1,350 kg for Normande cows) and lost less BW from wk 1 to 14 of lactation (+3.8 kg/wk) than cows in the low feeding system. No effect of feeding system or milk yield was observed on C-LA. Prolonged luteal phases were frequent (18% of cows) and were not associated with either breed or genetic group. Ovarian cycles were longer for Holstein than for Normande cows (+1.7 d) because of a longer luteal phase and a longer interluteal interval. Results of the study could be useful to establish strategies to manage declining reproductive performances at genetic and environmental levels. This study showed that cows with a genetic predisposition to export milk energy through fat and protein contents had earlier C-LA than predisposed to export milk energy through yield.

Key words: dairy cow, cyclicity, genetic merit, primiparous

INTRODUCTION

In dairy cows, milk production and reproduction are concomitant. Reproductive performance has been declining while milk production has been increasing (Friggens et al., 2010). Failure in reproduction causes economic losses, disturbs the working plan (e.g. breeding calendar), and represents a mental load (i.e., the stress of missing estruses) for farmers.

In spring-calving pasture-based systems, cows are under the constraint of a breeding period because feed demand needs to be adjusted to grass supply. The ability of cows to resume normal ovarian cyclicity on time is required and it affects the subsequent steps of the reproductive process (Darwash et al., 1997; Gautam et al., 2010). Abnormal ovarian activity is common in the current dairy cow population: only 60% of Holstein cows have normal cyclicity, and the major abnormal cyclicity pattern is delayed commencement of luteal activity (**C-LA**; Petersson et al., 2006; Windig et al., 2008; Cutullic et al., 2011). In most countries, dairy

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[1]Corresponding author: catherine.disenhaus@agrocampus-ouest.fr

cattle include a large proportion of primiparous cows because the replacement rate is high (from 20 to 40%; Le Cozler et al., 2008). Lactation number is one of the factors influencing milk production and reproduction. Primiparous cows have lower milk yield and experience delayed C-LA compared with multiparous cows (Opsomer et al., 1998; Taylor et al., 2003). When cows are still growing, they have different metabolic status, endocrine responses, and partitioning of nutrients toward organs during their first lactation than during subsequent ones (Taylor et al., 2003; Coffey et al., 2006).

Thirteen to 30% of the observed variance of C-LA is due to genetics and C-LA is unfavorably genetically correlated with milk yield (Veerkamp et al., 2000; Royal et al., 2002b; Petersson et al., 2007). For instance, breeds selected for milk yield have later C-LA than dual-purpose (milk and meat production) breeds. Holstein cows show more abnormal cyclicity profiles than others, especially delayed first ovulation (Petersson et al., 2006; Cutullic et al., 2011; Piccand et al., 2013). However, the deleterious effect of high genetic merit for milk yield on cyclicity is not always clear (Horan et al., 2004; Pollott and Coffey, 2008; Windig et al., 2008).

A key environmental factor affecting dairy cow milk production and reproduction is nutrition (Canfield et al., 1990; Burke and Roche, 2007; Chagas et al., 2008). In early lactation, dairy cows require a large amount of nutrients to ensure milk production. Their intake capacity is too low to fulfill these requirements and they experience a negative energy or protein balance. To cope with this deficit, cows mobilize body reserves. Low body reserves at calving or high mobilization at the beginning of lactation are risk factors for later C-LA. In addition, cows that are too fat at calving experience more abnormal cyclicity patterns (Cutullic et al., 2012). Even though body condition and body condition loss influence C-LA, milk yield per se does not. However, the occurrence of prolonged luteal phase (**PLP**) may be related to milk yield (Royal et al., 2002b; Kafi et al., 2012).

The present study aimed to identify and quantify the effect of breed, genetic merit for milk yield, and feeding system on postpartum cyclicity of primiparous dairy cows. Our hypotheses were that (1) cows with genetic characteristics (breed and genetic merit) in favor of milk yield have deteriorated cyclicity; (2) feeding systems affect milk production and body condition (reserves) and mobilization, which are related to cyclicity. Results of the study could be useful to establish strategies to cope with declining reproductive performances at genetic and environmental levels.

MATERIALS AND METHODS

Animals and Experimental Design

Starting in 2006, an experiment was conducted at the dairy research farm of Le Pin-au-Haras (Normandy, France). At the beginning of the experiment, animals were equally distributed among genetic characteristics (2 breeds, 2 genetic groups) and feeding strategies (2 feeding systems).

A total of 97 primiparous Normande (dual-purpose cows) and 97 primiparous Holstein (dairy cows) were involved in the trial. Within breed, cows were classified into 2 groups according to their EBV for milk yield and fat and protein contents as 2 groups capable of producing the same solid milk quantity in a different manner. The EBV for each trait was evaluated by using a BLUP animal model that included the sire and grandsire's genetic evaluation, the dam's performance over 3 lactations, the classical fixed environmental effects (year, lactation number, calving age, calving month, length of drying off period, and permanent environmental effect) and the feeding system (H. Larroque, INRA UMR 1388 GenPhySE, Toulouse, France; personal communication). For Holstein cows, EBV for milk yield varied between +1,726 and +3,966 kg, EBV for fat content varied between −6.9 and +3.5 g/kg, and EBV for protein content varied between −0.8 and +3.8 g/kg. For Normande cows, EBV for milk yield varied between +948 and +2,815 kg, EBV for fat content varied between −4.2 and +5.7 g/kg, and EBV for protein content varied between −0.8 and +4.7 g/kg. Within breeds and experimental years, nulliparous cows with higher EBV for milk yield than the average and lower EBV for fat and protein contents than the average were classified in the milk group (**MG**). Nulliparous cows with lower EBV for milk yield than the average and higher EBV for fat and protein contents than the average were classified in the content group (**CG**). The other nulliparous animals (high EBV for milk yield and high EBV for fat and protein contents or low EBV for milk yield and low EBV for fat and protein contents) did not enter the experiment. Fifty-two Holstein and 44 Normande were classified in MG and 45 Holstein and 53 Normandewere classified in CG. Table 1 describes the diet fed to cows in each feeding system. In both breeds, 44 cows were managed under a "high" feeding system that enabled high milk yield while limiting body condition loss; and 53 cows were managed under a "low" feeding system that limited milk yield while inducing high body condition loss. Cows remained in their feeding system until they were culled due to lack of