J. Dairy Sci. 100:1–16
https://doi.org/10.3168/jds.2016-11588

Ability of dairy cows to ensure pregnancy according to breed and genetic merit for production traits under contrasted pasture-based systems

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ABSTRACT

The present study aimed to assess and measure the effects of breed, genetic merit for production traits, and feeding systems (FS) on the ability of dairy cows to ensure pregnancy through its components (fertilization, embryonic losses, recalving). An experiment was conducted over 9 yr on Normande and Holstein cows assigned to contrasted FS. Diets were based on maize silage in winter and grazing plus concentrate in spring in the high FS group, and on grass silage in winter and grazing with no concentrate during spring in the low FS group. Within breeds, cows were classified into 2 groups with similar estimated breeding values (EBV) for milk solids: 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. Holstein cows produced more milk throughout lactation than Normande cows (the differential was greater in the high FS group, +2,294 kg, compared with +1,280 kg in the low FS group) and lost more body condition to nadir (the differential was greater in the high FS group, −1.00 point, compared with −0.80 point in the low FS group). Within breeds, milk solids production was similar between genetic groups. Cows in the high FS group produced more milk (+2,495 kg for Holstein and +1,481 kg for Normande cws) and had a higher body condition score at nadir (+0.40 point for Holstein and +0.60 point for Normande) than cows in the low FS group. Holstein cows had a lower recalving rate than Normande cows (−19 percentage units). We found no effect of genetic group and FS on fertility of Normande cows. However, according to FS, Holstein cows in the content group exhibited different fertility failure patterns. In the low FS group, Holstein cows in the content group had more nonfertilizations or early embryo mortality (+26 percentage units at first and second services) than Holstein cows in the milk group. In the high FS group, Holstein cows in the content group had a higher proportion of late embryo mortality than in the milk group (+10 percentage units at first and second services). We observed no effect of FS on recalving rate; however, indicators of energy balance (protein content or body condition score) were positively associated with successful conception and pregnancy. This suggested a link between genetic merit for fat and protein content and lower ability of dairy cows to ensure pregnancy because of more nonfertilizations and early or late embryo mortality.
Key words: dairy cow, genetic merit, fertilization, pregnancy loss

INTRODUCTION

In the past decades, reproductive performance of dairy cows has been declining and the strong genetic selection that was applied on production traits is considered to be responsible for this. Each step of the reproductive step has been affected: abnormal ovarian activity is more common in the current population (Gautam et al., 2010), the duration and intensity of estrus has markedly decreased (Kerbrat and Disenhaus, 2004), and the occurrence of pregnancy losses has increased (Grimard et al., 2006). The consensus in the literature is that fertility is impaired by a lack of energy because dairy cows are investing it in milk production, and that this competition is both genetically and nutritionally driven (Royal et al., 2000; Friggens et al., 2010; Walsh et al., 2011).

In various regions, the valuable milk components are fat and protein. Two possible ways exist to produce fat and protein, either through high milk yield or through high fat and protein contents. In the literature, most studies investigating the effect of genetics on production and reproduction performance compared either high and low genetic merit for milk yield (Kennedy et al., 2003; Horan et al., 2004), or high and low genetic

Received June 10, 2016.
Accepted December 12, 2016.
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merit for milk solids yield (Fulkerson et al., 2001; Pollott and Coffey, 2008). To our knowledge, a comparison of high genetic merit for milk yield and high genetic merit for fat and protein contents at identical global genetic merit for milk solids has never been investigated before. At identical milk solids yield, dairy cows with high genetic merit for fat and protein contents should have a lower peak milk yield and lower lactose yield than cows with high genetic merit for milk yield. Therefore, cows with high genetic merit for fat and protein contents are expected to invest less energy in milk than cows with high genetic merit for milk yield. It can be hypothesized that dairy cows with high genetic merit for fat and protein content preserve their reproductive performance while producing the same amount of milk solids than cows with high genetic merit for milk yield. A previous study showed that primiparous dairy cows with high genetic merit for fat and protein content had an earlier commencement of luteal activity than those with high genetic merit for milk yield in 2 contrasted breeds (dairy vs. dual purpose cows) and 2 contrasted feeding systems (high vs. low inputs; Bedere et al., 2016a). This was a promising result to establish strategies to cope with reproductive decline and maintain productive performance. However, knowledge concerning the ability of this type of cows to ensure pregnancy is lacking. The present study aimed to assess and measure the effects of breed, genetic merit for production traits, and feeding systems on the fertility of dairy cows. Our hypotheses were that (1) high genetic merit for milk yield is unfavorably associated with the ability to ensure pregnancy, and (2) according to genetic characteristics, dairy cows under nutrient restriction are either preserving body reserves or milk production.

MATERIALS AND METHODS

Experimental Design

An experiment was conducted from 2006 to 2014 at the INRA dairy research farm of Le Pin-au-Haras (latitude 48.724986, longitude 0.185428; Normandy, France). Dairy cows were equally distributed over 2 breeds and 2 feeding systems (**FS**) each experimental year. A total of 296 lactations from 132 Normande cows (dual-purpose cows) and 240 lactations from 128 Holstein cows (dairy cows) were recorded throughout the trial. Within breeds, cows were classified into 2 groups according to their EBV for milk yield or fat and protein contents, as these 2 groups are capable of producing the same milk solids quantity in different manners. Estimated breeding value for each trait were obtained by combining within herd information analyzed with a BLUP animal model with national EBV of the sires and grandsires. The model of analysis of cow performance over 3 lactations included usual fixed environmental effects (year, lactation number, calving age, calving month, drying off period length, and permanent environment effect) and the feeding system (H. Larroque, INRA UMR 1388 GenPhySE, Toulouse, France, personal communication). Within breed and experimental year, nulliparous cows with EBV for milk yield higher than average and EBV for fat and protein contents lower than average constituted a milk group. Nulliparous cows with EBV for milk yield lower than average and EBV for fat and protein contents higher than average constituted a content group. The other nulliparous cows (with 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 (Table 1). There were 116 lactations from 56 Holstein cows and 147 lactations from 65 Normande cows recorded under a high FS that enabled high milk yield while limiting body condition loss; there were 124 lactations from 72 Holstein cows and 149 lactations from 67 Normande cows recorded under a low FS that limited milk yield while inducing a large body condition loss. Diets are presented in Table 2. Cows remained in their FS until they were culled due to infertility, severe health problem, or death. Among the 536 lactations recorded in this study, 15 were removed because the cows could not be milked and 21 were removed because of severe health problems. Finally, 500 lactations, including 207 from first-lactation cows, were included in the analyses of the present study.

Reproductive Management

The herd was managed under a 3-mo compact calving system (January–March). After calving, uterine involution was checked by rectal palpation 25 to 30 d postpartum. When involution was achieved, AI were performed on spontaneous estrus if expressed at least 40 d postpartum and during the breeding period (April–June). If cows were not expressing new estrus in the 35 d following a service, ultrasonography was conducted to diagnose pregnancy status. If the first one was positive, a second diagnosis was performed 60 d after last service. Insemination outcomes were classified by combining information from progesterone (**P4**) profiles and ultrasonography examinations (Humblot, 2001; adapted by Cutullic et al., 2011; Table 3) as nonfertilization or early embryo mortality (**NF/EEM**), late embryo mortality (**LEM**), fetal death (**FD**), abortion, and calving.