J. Dairy Sci. 90:4304–4312
doi:10.3168/jds.2006-788


# Effects of Pasture Feeding During the Periparturient Period on Postpartum Anovulation in Grazed Dairy Cows[1]

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## ABSTRACT

Extended postpartum anovulatory intervals (PPAI) are a major contributor to infertility in seasonal dairy systems constrained to 365-d calving intervals. This study was conducted to evaluate the effects of pasture-based dietary energy intakes during the transitional calving period on PPAI. Sixty-eight multiparous Holstein-Friesian cows were assigned to high [11.9 kg of dry matter (DM)/d] or low (4.8 kg of DM/d) pasture intakes for 29 ± 7.7 d prepartum. After calving, cows within each prepartum diet were assigned to either a high (13.5 kg of DM/d) or low (8.6 kg of DM/d) pasture intake for 35 d in a 2 × 2 factorial arrangement. Progesterone concentrations were measured in milk samples collected twice weekly to determine PPAI, which was defined as the day on which progesterone level was elevated to ≥3 ng/mL with subsequent concentrations being consistent with an ovulatory cycle. Blood samples were collected before initiation of treatments, and at d −21, −14, −7, 0 (day of calving), 1, 2, 3, 4, 7, 14, 21, 28, and 35 in all cows. The PPAI was associated with body condition score, concentrations of plasma insulin and insulin-like growth factor-I, and growth hormone. Postpartum intake did not affect these metabolic hormones or PPAI, but yield of FCM during the first 35 d was reduced by 23% among cows on a restricted intake. No relationships were found between PPAI and milk production characteristics. These data demonstrate that when pasture is the sole dietary source during the calving transition period, PPAI may be influenced by prepartum intake levels, whereas postpartum intake influences milk yield, but not PPAI. The underlying mechanism(s) that associates the prepartum period to PPAI may involve the sensitivity of the growth hormone–insulin-like growth factor axis to dietary intake levels. Nonetheless, PPAI in grazing multiparous dairy cows appears largely unresponsive to intake levels during the calving transition period.
**Key words:** postpartum anovulation, metabolic hormones, reproduction, nutrition

## INTRODUCTION

Prolonged postpartum anovulatory intervals (**PPAI**) are a major risk factor for reduced reproductive performance in dairy herds, particularly in seasonal systems with a confined breeding period based on calendar dates and optimized for a 365-d calving interval. Cows with prolonged PPAI are less likely to be mated within the early part of the breeding period (Macmillan, 2002), have reduced conception rates (Darwash et al., 1997; Westwood et al., 2002), and are more likely culled (Opsomer et al., 2000). Several factors can prolong PPAI and result in high anestrous rates in grazing dairy cows (Macmillan, 2002; Rhodes et al., 2003). These can be animal characteristics such as age, breed, and genetic strain within breed (Burke et al., 1995; McDougall et al., 1995b; McNaughton et al., 2003), features of the farm system, such as stocking density and feeding level (Grainger and Wilhelms, 1979; McDougall et al., 1995b), and interactive factors such as disease (McDougall et al., 2007) and body condition (Grainger et al., 1982; Roche et al., 2007).

The physiological effects of nutritional stress on ovarian follicular function and postpartum anestrus were reviewed (Jolly et al., 1995; Diskin et al., 2003). Although large dominant follicles reestablish on the ovaries within several days after calving (McDougall et al., 1995a), endocrine conditions required for final maturation and first ovulation postpartum are influenced by body fat reserves, energy balance, and metabolic state (Grainger et al., 1982; Butler and Smith, 1989). An understanding of how these nutritional considerations influence reproductive events is building (Robinson et al., 2006), but the mechanisms remain complex and inadequately understood.

The issue of calving transition (−3 wk to +3 wk of calving) management on fertility was reviewed (For-

Received November 26, 2006.
Accepted May 30, 2007.
[1]This study was funded by the New Zealand Foundation for Research, Science and Technology through Contract DRCX0204 and by New Zealand dairy farmers through Dairy InSight.
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migoni and Trevisi, 2003; Rhoads et al., 2005), indicating that energy deficit coupled with a period of suppressed immune function is largely responsible for compromised reproductive performance. With the exception of some early studies involving cows with a 1970s genetic base (Grainger and Wilhelms, 1979; Grainger et al., 1982), there are no controlled studies that specifically investigate the effects of pre- and postpartum DMI levels, and their interaction, on PPAI of lactating dairy cows in a seasonal system. This study was designed and conducted to evaluate the effect of pre- and postpartum levels of pasture feeding on PPAI of seasonally managed lactating dairy cows. To better understand the mechanisms underlying these outcomes, an objective was to investigate the association between PPAI and metabolic indicators.

## MATERIALS AND METHODS

This study was conducted at Dexcel, Hamilton, New Zealand (37°46′ S, 175°18′ E) between July and September 2004. All procedures had prior approval of the Ruakura Animal Ethics Committee, New Zealand.

### *Experimental Design and Cow Management*

At 29 ± 7.7 d (mean ± SD) prepartum, 68 multiparous Holstein-Friesian cows predicted to calve within the first 21 d of a seasonal calving period were randomly allocated either a high (**PreH**; 11.9 kg/d DM) or low pasture intake (**PreL**; 4.8 kg/d DM), while ensuring treatment groups were balanced for milk yield in the previous lactation, BW, BCS, age, and predicted calving date. At calving, half of the cows within each prepartum feeding treatment were randomly allocated to either a high (**HH** and **LH**; 13.5 kg/d DM) or low pasture intake (**HL** and **LL**; 8.6 kg/d DM) for 35 d, as a 2 × 2 factorial arrangement with 17 cows per treatment cell. At 35 d postpartum, all cows were grouped as a single herd on fresh pasture supplemented with pasture-silage (6.1 ± 1.7 kg/d DM) for 3 wk and thereafter managed solely on fresh pasture.

Detailed descriptions of grazing management, measurements of pasture intakes, and milk production characteristics have been published (Roche, 2007). Briefly, animals were rotationally grazing through 56 paddocks, with a fresh grazing area offered twice daily. Pasture consisted mostly (≥85%) of perennial ryegrass (*Lolium perenne* L.). Treatment groups grazed within the same paddock at all times, but within a defined grazing area to achieve differential intakes. Pre- and postgrazing herbage masses and grazing area allocations were used to control average pasture intakes for cows within treatments. Herbage masses were assessed using a Rising Plate Meter (Farmworks, Palmerston North, New Zealand), which measures compressed pasture height. These measurements (100 per treatment before and after grazing) were calibrated to DM yields from cut and dried pasture samples (20 × 0.125 $m^2$ quadrats per treatment) thrice weekly. On each of these occasions, a "hand-plucked" sample to grazing height was collected. These samples were bulked at 2 weekly intervals and analyzed for DM content and nutrient composition. Average (± SD) ME estimates of pasture for PreH and PreL were 11.6 ± 0.31 and 11.7 ± 0.09 MJ/kg of DM, respectively. Respective values after calving for high and low pasture intake treatments were 12.1 ± 0.21 and 12.3 ± 0.07 MJ/kg of DM. A detailed description of botanical and nutrient composition of the pasture fed during the current study is in Roche (2007).

Individual BW and BCS (1 to 10 scale; Roche et al., 2004) were measured weekly throughout the study. Individual milk yields were measured at each milking and compositional characteristics were determined twice weekly until 35 d postpartum.

### *Blood Sampling Regimen*

Blood samples were collected from all cows by coccygeal venipuncture into evacuated tubes containing sodium heparin before treatment allocation on d −21, −14, −7, 0 (day of calving), 1, 2, 3, 4, 7, 14, 21, 28, 35, and weekly thereafter for individuals until confirmed as cycling. Sampling time was approximately 0730 h. Plasma was harvested after centrifugation (1,120 × *g* for 12 min) and stored at −17°C.

### *PPAI Determination*

Progesterone was measured in a composite of milk samples collected at the Monday p.m.–Tuesday a.m. and Thursday p.m.–Friday a.m. milking each week from calving until cows were confirmed as cycling. Progesterone content was determined using an ELISA kit (Ridgeway Sciences, Gloucestershire, UK) validated for use in cattle (Sauer et al., 1986). The PPAI was defined as the interval from calving to the first day that progesterone concentration increased to ≥3 ng/mL, with subsequent concentrations being consistent with the onset of ovulatory cycles. The PPAI was not measured in 6 cows (last sampled 51 to 77 d postpartum; HH, 2; LH, 3; HL, 0; LL, 1), but PPAI estimates were generated using the CENSOR procedure (GenStat 5.4.1, GenStat for Windows, 9th ed., VSN International Ltd., Hemel Hempstead, UK). These cows had not ovulated before onset of the seasonal breeding pe-