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Short Communication: Immediate and deferred milk production responses to concentrate supplements in cows grazing fresh pasture

J. R. Roche,*[1] J. K. Kay,* A. G. Rius,* T. M. Grala,* A. J. Sheahan,* H. M. White,†[2] and C. V. C. Phyn*
*DairyNZ Ltd., Hamilton, New Zealand 3240
†Purdue University, West Lafayette, IN 47907-2053

ABSTRACT

The objective of this study was to determine the increase in milk production from supplementation that occurred after supplementation ceased. This portion of the total response (i.e., the deferred response), although accepted, is generally not accounted for in short-term component research projects, but it is important in determining the economic impact of supplementary feeding. Fifty-nine multiparous Holstein-Friesian dairy cows were offered a generous allowance of spring pasture [>45 kg of dry matter (DM)/cow per day) and were supplemented with 0, 3, or 6 kg (DM)/d of pelleted concentrate (half of the allowance at each milking event) in a complete randomized design. Treatments were imposed for the first 12 wk of lactation. Treatments were balanced for cow age (5.4 ± 1.68 yr), calving date (July 27 ± 26.0 d), and genetic merit for milk component yield. During the period of supplementation, milk yield and the yield of milk components increased (1.19 kg of milk, 0.032 kg of fat, 0.048 kg of protein, and 0.058 kg of lactose/kg of concentrate DM consumed), but neither body condition score nor body weight was affected. After concentrate supplementation ceased and cows returned to a common diet of fresh pasture, milk and milk component yields remained greater for 3 wk in the cows previously supplemented. During this 3-wk period, cows that previously received 3 and 6 kg of concentrate DM per day produced an additional 2.3 and 4.5 kg of milk/d, 0.10 and 0.14 kg of fat/d, 0.10 and 0.14 kg of protein/d, and 0.10 and 0.19 kg of lactose/d, respectively, relative to unsupplemented cows. This is equivalent to an additional 0.19 kg of milk, 0.006 kg of fat, 0.006 kg of protein, and 0.008 kg of lactose per 1 kg of concentrate DM previously consumed, which would not be accounted for in the immediate response. As a result of this deferred response to supplements, the total milk production benefit to concentrate supplements is between 7% (lactose yield) and 32% (fat yield) greater than the marginal response measured during the component experiment. Recommendations to dairy producers based on component feeding studies must be revised to include this deferred response.

Key words: milk production, body condition score, supplement

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In seasonal calving systems based on grazed pasture, cow DMI demand is matched with the profile of pasture supply through alterations in stocking rate (Macdonald et al., 2008) and calving date (Dillon et al., 1995). However, the rate of increase in pasture DM growth in spring tends to be more rapid than the increase in herd DMI demand (Dillon et al., 2005; Roche et al., 2009a); therefore, to coordinate maximum herd demand with pasture supply, management systems ensure that calving occurs before sufficient pasture is available to feed the cows fully (Dillon et al., 1995; Roche et al., 2009b). In addition, pasture-based production systems are subject to climatic variations, with pasture availability dependent on temperature and precipitation (Roche et al., 2009a). Where cow requirements are not met by pasture availability, supplements can be offered to ensure that cows are not underfed (Bargo et al., 2003). In determining the profitability of this, it is necessary to be able to predict the total response to supplements.

In a comprehensive review of the literature, Bargo et al. (2003) concluded that, on average, grazing cows produce 1 kg of milk for 1 kg of concentrate DM consumed. Responses are less than theoretically possible because cows reduce their DMI of pasture (substitution: Stockdale, 2000; Bargo et al., 2003; Sheahan et al., 2011) concurrently when offered supplements and because fiber digestion declines with the inclusion of starch in the ration (Bargo et al., 2003; Doyle et al., 2005; Nousiainen et al., 2009). However, the majority of the studies reviewed were part-lactation experiments, with responses reported only for the period of supplementation; deferred production responses (i.e., effect of supplements beyond the experimental period) were not

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[1]Corresponding author: john.roche@dairynz.co.nz
[2]Current address: Department of Animal Science, University of Connecticut, Storrs 06269-4004.

determined. In comparison, in whole-lactation studies, in which supplements are used as necessary, it is not possible to determine the deferred effect of supplement input at any one time because of other confounding effects of treatment. Studies by Kennedy et al. (2007) and McEvoy et al. (2008) indicate that feeding concentrates during early lactation results in both immediate and deferred effects on milk production; however, the relationships between timing, degree, and duration of supplementation on the deferred response remain unclear.

Nutrition is known to influence mammary cell number, secretory activity, or both (Capuco et al., 2001; Akers, 2002; Nørgaard et al., 2005). It is plausible, therefore, that supplementing grazing dairy cows with concentrates would have effects beyond the period of supplementation. Consistent with this, an anecdotal “1 in 200” rule (Hutjens, 2003) implies that every 1 kg of milk secreted at peak production will result in approximately 200 kg of milk subsequent to peak (i.e., 1 kg of milk for every additional day of lactation), suggesting that supplementation in early lactation could have far larger effects than those reported by Bargo et al. (2003) or Stockdale (2000). Van Soest (1982) hypothesized such an effect when he suggested long-term effects of early-lactation management strategies on the shape of the lactation curve. The lactation profiles of milk and milk component yields reported by Roche et al. (2006) are consistent with such an effect, but it was not possible to separate the effect of historical versus current nutrition in that study. Therefore, data generated in a previous experiment (Grala et al., 2011) and milk production data collected routinely subsequent to the completion of that experiment were used to quantify the immediate, deferred, and total effect of concentrate supplementation offered to cows grazing a generous allowance of fresh pasture in early lactation.

The experiment was conducted at Lye Farm (DairyNZ, Hamilton, New Zealand; 37°46′S 175°18′E) and experimental details were reported by Grala et al. (2011). All treatments and measurements were approved by the Ruakura Animal Ethics Committee (Hamilton, New Zealand). Fifty-nine multiparous Holstein-Friesian dairy cows were allocated to 1 of 3 feeding treatments in a completely randomized design. Treatments were imposed for the first 12 wk of lactation. Treatments were as follows: no concentrate supplementation (**C0**: n = 19), 3 kg (DM) of concentrates/d (**C3**: n = 20), or 6 kg (DM) of concentrates/d (**C6**: n = 20). Treatments were balanced for cow age (5.4 ± 1.68 yr), calving date (July 27 ± 26.0 d), and genetic merit for milk component yield. After 12 wk of supplementation, all cows were managed in a manner similar to that described by Macdonald et al. (2008).

All cows were rotationally grazed as one herd for the duration of the experiment and were provided with a generous allowance of fresh pasture (>45 kg of DM/cow per d, measured to ground level). Pasture allowance was sufficient to ensure unrestricted DMI (up to approximately 25 kg of DM/d) of fresh pasture in nonsupplemented cows. Cows had access to a fresh allocation of high-quality pasture daily throughout the experimental period (CP = 22.4 ± 2.64% DM; OM digestibility = 82.6 ± 1.42% DM; NDF = 48.3 ± 4.91% DM; ADF = 22.5 ± 1.54% DM; lipid = 4.3 ± 0.12% DM; NSC = 15.7 ± 3.94% DM; ME = 12.4 ± 0.40 MJ/kg of DM). Concentrates (32% crushed barley, 60% crushed corn, 2% wheat middlings, 6% molasses; CP = 12.9 ± 3.04% DM; NDF = 11.5 ± 1.49% DM; lipid = 2.8 ± 0.25% DM; NSC = 65.1 ± 2.12% DM) were offered individually in 2 equal allowances during milking.

Representative samples of pasture were collected daily by plucking pasture to grazing height from paddocks due to be grazed to simulate pasture selected by the cows. Samples were bulked weekly and analyzed for CP, NDF, ADF, soluble sugars, fat, ash, and OM digestibility by near infrared spectroscopy (Corson et al., 1999). The ME was derived directly from predicted OM digestibility, based on an in vitro cellulose digestibility assay (Roughan and Hollan, 1977), which was calibrated against in vivo standards (Corson et al., 1999).

Individual milk yields were recorded daily (GEA Farm Technologies, Oelde, Germany). Milk fat, CP, and lactose concentrations were determined by Milkoscan (Foss Electric, Hillerød, Denmark) on individual morning and afternoon aliquot samples collected on 1 d/wk. Milk NE_L and 4% FCM were calculated (NRC, 2001) as follows:

$$NE_L\ (\text{MJ/kg}) = 4.186 \times [(0.0929 \times \text{fat }\%) + (0.0547 \times \text{CP }\%) + (0.0395 \times \text{lactose }\%)]$$

$$4\%\ \text{FCM} = (0.4 \times \text{kg of milk/d}) + (15 \times \text{kg of fat/d}).$$

Body weight and BCS were determined weekly for the first 12 wk postcalving following the morning milking. Body condition score was assessed on a 10-point scale, where 1 is emaciated and 10 is obese (Roche et al., 2004).

Blood was sampled weekly during the first 12 wk of lactation. A 10-mL evacuated blood tube (140 IU of sodium heparin) was collected from each cow by coccygeal venipuncture before the morning milking (approximately 0730 h). Following centrifugation (1,120 × *g*, 12 min, 4°C), plasma was aspirated and stored at