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The effect of early lactation concentrate build-up strategy on milk production, reproductive performance and health of dairy cows

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ABSTRACT

The objective of this study was to examine the effect of two early lactation concentrate build-up strategies on cow performance, fertility and health. The study was undertaken on five Northern Ireland dairy farms, and involved 385 multiparous Holstein-Friesian cows. Cows were allocated to either an 'Immediate' or 'Delayed' concentrate build-up strategy postpartum. All cows were offered a 'basal' diet comprising forage and concentrates (mean, 7.4 kg concentrate/cow/day), with a target crude protein (CP) and starch concentration of 145 and 170 g/kg dry matter (DM), respectively. An additional 7.0 kg of concentrate (mean across the five farms) was then introduced into the diet of each cow, at an incremental rate of approximately 0.5 kg/day, over days 1–14 of lactation ('Immediate build-up') or over days 21–35 of lactation ('Delayed build-up'), with the target CP and starch concentration of the total diet being 175 and 200 g/kg DM, respectively. While average daily milk yield and fat-plus-protein yield was reduced ($P < 0.05$) during weeks 2 to 5 of lactation with the Delayed concentrate build-up strategy, treatment had no effect on milk yield, milk composition or milk fat and protein concentration over the first 305 days of lactation. Cows on the Delayed build-up strategy produced milk with a higher somatic cell score ($P < 0.05$), while no treatment × time interactions were observed on body condition score during the experimental period. Conception rate to first service was higher with the Delayed build-up strategy ($P = 0.047$), although treatment had no effect on conception to first and second service, calving interval and cows confirmed pregnant during the study ($P > 0.05$). The Delayed build-up strategy tended ($P = 0.051$) to reduce the incidence of fertility related health issues within the first 30 days of lactation, but increased the incidence of mastitis ($P < 0.05$). Treatment had no effect on any other health measures, the reasons that cows were culled, or the stage of lactation when cows were culled ($P > 0.05$). Although concentrate build-up strategy had short-term effects on milk yield and fertility in early lactation, no long term benefits in performance, fertility, health or survival were observed with the Delayed Build-up strategy.

1. Introduction

Within the annual production cycle of a dairy cow, the period immediately prior to calving and the period immediately post-calving (transition period) presents the greatest nutritional challenges (Roche et al., 2013). In addition, genetic selection has resulted in increasing milk yields in many countries (Ingvartsen and Moyes, 2013), especially during this early lactation period. As a consequence, during the first eight weeks of lactation high yielding dairy cows are generally unable to consume enough dry matter (DM) to meet their energy requirements for milk production, and may enter a period of negative energy balance. The prevalence of negative energy balance (NEB) has been well documented (Mulligan et al., 2006; Ingvartsen and Moyes, 2013; Roche et al., 2009; Reksen et al., 2001; Crowe et al., 2014; Drackley and Cardoso, 2014), and many authors have reported the detrimental effect that NEB, and the associated mobilisation of body tissue, have on the subsequent health, production, fertility and longevity of dairy cows. As a consequence, high yielding cows suffer a much greater incidence of health problems during the first few weeks post-calving than at any other time during lactation (Ingvartsen, 2006; Drackley and Cardoso, 2014).

To help meet the nutrient requirements of high yielding cows in early lactation, concentrate inclusion amounts in dairy cow diets have increased considerably in recent years. Although the inclusion of concentrate feeds can improve the energy density of the diet, offering high amounts of concentrates can have a

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detrimental effect on rumen health. Sub-acute rumen acidosis (Krause and Oetzel, 2006; Kleen et al., 2003) occurs when rumen pH is depressed to between 5.5 and 5.0, and in this environment intake can be adversely affected as fibre digestion and rumen microbial activity are impaired. Furthermore, although there is evidence that increased amounts of concentrate feed normally leads to improved nutrient intakes (Ferris et al., 2001), energy balance may not necessarily improve dramatically as cows with a high genetic potential for milk production may exhibit a milk yield response to the additional concentrates offered.

Given that there is evidence (Ingvartsen, 2006) that the risk of disease is related to the rate of acceleration in milk production during the early lactation period, a reduction in this acceleration in milk yield could have beneficial effects on cow health. It is known that dietary energy (Law et al., 2011b) and protein concentration (Law et al., 2009; Gilmore et al., 2011; Sinclair et al., 2014; Whelan et al., 2014) can be used to modify the milk yields of cows in early lactation, while Law et al. (2009) demonstrated that dietary protein concentration can be reduced from 173 to 144 g/kg DM without any detrimental effect on total dry matter intake, with these levels adopted up to 150 days post-calving. These authors also reported that increases in dietary protein content decreased average daily energy balance. Thus it may be possible, by diet manipulation, to reduce the rate at which milk yield increases postpartum, and thus delay the attainment of peak-yield, with peak yield being better aligned with maximum DM intake. Practically, this approach could be administered by making changes to concentrate supplementation during early lactation (Ingvartsen et al., 2001; Kokkonen et al., 2004; Law et al., 2011a; Andersen et al., 2012). For example, reducing dietary protein concentration, and delaying the build-up of concentrates in the diet from immediately postpartum to day 28 postpartum, reduced the acceleration of milk yield in early lactation, but had no detrimental effect on milk production when considered over the full lactation (305 days) (Law et al., 2011a). Furthermore, the authors reported an improvement in forage intake when concentrate allocation was delayed.

Despite evidence that a delayed concentrate allocation strategy, combined with lower protein diets, can reduce the duration and severity of negative energy balance and reduce the acceleration in milk yield (Law et al., 2011a), there is little evidence of benefits in cow health and fertility. Thus the current study, which was conducted on five commercial dairy farms to increase the number of cows involved, was designed to examine the effect of two contrasting early lactation concentrate build-up strategies on cow performance, health and fertility. The study was designed to test two hypotheses; 1. Adoption of a delayed concentrate build-up strategy post-calving can reduce the rate of increase in milk production in early lactation, without having a detrimental effect on overall milk yield or quality during the lactation, compared to an immediate concentrate build-up strategy; 2. A reduction in the rate of increase in milk production post-calving has beneficial effects on cow health and fertility.

2. Materials and methods

2.1. Participating farms and cows

This experiment was conducted on five Northern Ireland dairy farms between October 2012 and June 2014. During the year prior to the study, average annual concentrate inputs and milk outputs on the five farms were 2880 (s.d., 81) kg/cow and 8780 (s.d., 1112) litres/cow, respectively.

The study involved 385 multiparous Holstein-Friesian cows (mean parity 3.0; s.d. 0.87), which calved between October 2012 and April 2013, with all cows calving during this period (with the exception of primiparous cows) eligible for inclusion within the study. Cows that were identified as 'to be culled' during the subsequent lactation, based on a number of factors including their history of chronic health issues, were not allocated to the study. Cows were allocated to one of two experimental treatments at calving, comprising either an 'Immediate' or 'Delayed' concentrate build-up strategy. Treatment groups on each farm were balanced for parity, for body condition score assessed approximately two weeks prior to the expected calving date, calving interval, calving date, and milk yield (305 days), milk composition and somatic cell count during the previous lactation. There were 57, 75, 67, 72 and 114 experimental cows on Farms 1 to 5, respectively.

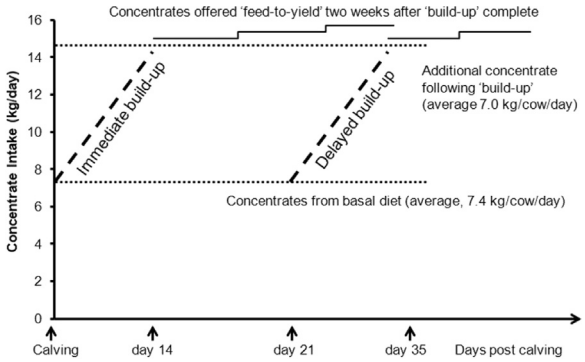

Fig. 1. An overview of the two early lactation concentrate build-up strategies imposed on the five farms during this study.

2.2. Experimental design

Following calving all experimental cows were offered a 'basal' diet (Fig. 1), with this diet comprising conserved forage (either grass silage only, or grass silage mixed with maize silage or whole crop wheat silage) and concentrates. The concentrate inclusion rate (as fed) within the basal diet ranged from 6.0–9.0 kg/cow/day across the five farms (mean; 7.4 kg/cow/day), while the target CP, starch and metabolisable energy (ME) concentration of the basal diet was 145 g/kg DM, 170 g/kg DM and 12.2 MJ/kg DM. Rations offered were formulated by each farms own nutritionist, in conjunction with the lead researcher, with each farm using a different nutritionist. Ration formulation was based on the equations contained within 'Feed Into Milk' (Agnew et al., 2004), the current UK dairy feed rationing system, and the ME and intake potential of the forages available on each farm, as determined by near-infra-red reflectance spectroscopy (Gordon et al., 1998). Predicted forage intakes were monitored by the nutritionist against actual group intakes being achieved.

Cows managed on the 'Immediate' build-up strategy had additional concentrates introduced into the diet ('build-up' concentrate) during the first 14 days post-calving, with concentrates being increased in 0.5 kg increments daily (approximately), up to an average of 7.0 kg/cow/day (range across farms, 6.0–8.0 kg/cow/day). Cows managed on the 'Delayed' build-up strategy were not offered additional concentrates until day 21 postpartum, with concentrates then introduced gradually into the diet of these cows in 0.5 kg increments daily (approximately) during a 14-day period (days 21–35 postpartum), to achieve the same concentrate amount as adopted with the Immediate build-up strategy (on each farm). These build-up concentrates were offered either in-parlour during milking or via out-of-parlour feeders, with total daily concentrate allowance being 14.0, 14.0, 14.0, 15.0 and 15.2 kg/cow across the five farms. Within one to two weeks of cows reaching their full 'experimental' concentrate allocation (day 14 (Immediate) and day