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Early lactation dairy cows: Development of equations to predict intake and milk performance at grazing

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ABSTRACT

The objectives of this study were to examine the effect of parity and days in milk (DIM) on dry matter intake (DMI) and actual milk yield (MY_{Act}) of grazing spring calving dairy cows in early lactation (<100 DIM) and to develop equations to predict DMI and milk yield for grass based systems of milk production. A dataset containing 335 observations from 134 Holstein Friesian dairy cows was assembled from two early lactation grazing studies. Observations were available for primiparous ($n=130$) and multiparous ($n=205$) cows during periods of DMI measurement using the *n*-alkane technique. Animal performance was divided into two classes of DIM: less than 50 DIM (<50 DIM) or between 51 and 100 DIM (>50 DIM). Parity and DIM had a significant effect on grass DMI (GDMI), total DMI (TDMI), MY_{Act} and milk composition. TDMI increased with parity and DIM and ranged from 13.4 kg/cow per day (primiparous animals, <50 DIM) to 20.1 kg/cow per day (multiparous animals, >50 DIM). Actual MY increased with parity and decreased with DIM (range: 24.1 kg/cow per day (primiparous animals, >50 DIM) to 33.0 kg/cow per day (multiparous animals, <50 DIM)). Multiparous cows had greater bodyweight (BW) and lower BCS than primiparous cows. In the early lactation period a number of variables had a significant effect on GDMI, TDMI and milk yield. These predictor variables included BW, BCS, potential milk yield (MY_{Pot}), DIM, daily herbage allowance (DHA; >4 cm), concentrate level and parity. The equations accounted for 79%, 83% and 86% of the variation in GDMI, TDMI and milk yield, respectively. Actual milk yield was always below the MY_{Pot} of the cows, the mean difference was 5.8 kg/cow per day. As DHA and concentrate level increased, the difference between MY_{Act} and MY_{Pot} reduced. This study supports the concept that immediately post-calving offering a grass based diet with a medium level of concentrate supplementation is sufficient to support high milk production in grazing dairy cows.

1. Introduction

Early lactation feeding strategies for spring calving dairy cows under Irish conditions have undergone a transformation in recent years. Irish dairy producers have a significant comparative advantage over other EU milk producing nations due to their predominantly grass based milk production systems. With future feed costs projected to rise, increasing the proportion of grazed grass in the diet of the lactating dairy cow is a major objective for the Irish dairy industry. Current recommendations are to turn cows out to pasture directly post-calving (Kennedy et al., 2005), offer a medium daily herbage allowance (DHA; 15 kg to 17 kg DM/cow per d; >4 cm) and supplement with 3 kg DM concentrate (McEvoy et al., 2008). However, grazing pasture places a constraint on the cow and restricts her ability to achieve high intake levels which would ultimately limit the animals' capacity to achieve its potential milk yield (MY_{Pot}; Stockdale, 2004). The extent of this restriction is undefined in grazing dairy systems. Accurate

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estimation of the factors influencing DMI is essential to ensure adequate energy intake at grazing in early lactation and to identify losses in milk yield with grazing cows.

Traditionally, the motivation to investigate the factors affecting feed intake is that providing a balanced diet increases production, efficiency and hence profitability (Ingvartsen and Andersen, 2000). The quantity of feed consumed by an animal is probably the single most important factor influencing production (Wilkins, 2004). Estimating animal intake at grazing is more difficult than in confinement systems. Several models predicting and evaluating dry matter intake (DMI) in confined systems have been described (Holter et al., 1997; Roseler et al., 1997; Shah and Murphy, 2006). The availability of models predicting intake at grazing is less comprehensive (Caird and Holmes, 1986; Vazquez and Smith, 2000) with no data available for the early lactation period.

Two recent early lactation grazing studies, (Kennedy et al., 2007; McEvoy et al., 2008) had overlapping grazing treatments, examined over a similar time frame (<100 DIM). The generation of such data allowed the opportunity to amalgamate the studies into a common dataset ($n=335$) and examine the relationship between feeding management at pasture and the early lactation performance of spring calving grazing dairy cows. The objective of this study was to examine the effect of parity and days in milk (DIM) on DMI and milk yield of grazing dairy cows in early lactation and to develop equations to predict DMI and milk yield for grass based systems of milk production (<100 DIM).

2. Materials and methods

A database was assembled from two grazing studies carried out during the spring of 2005 (YI) and 2006 (YII) at Moorepark Dairy Production Research Centre, Fermoy, Co. Cork, Ireland (50° 07′N; 8° 16′W). The area used was under permanent pasture with a predominately ryegrass sward (*Lolium perenne* L.). The swards were on average three years old in YI and four years old in YII. Cultivars initially sown were cv. Twystar, cv. Cornwall and cv. Gilford.

2.1. Treatments and experimental design

2.1.1. Year 1

The experiment was a randomised block design with a 3×2 factorial arrangement of treatments. Sixty-six Holstein Friesian dairy cows were randomised across 6 treatments ($n=11$) consisting of 3 DHA (13, 16 and 19 kg DM/cow) and 2 concentrate levels (0 and 4 kg DM/cow). A full description of the experimental design, treatments, management factors and feed composition has been reported by Kennedy et al. (2007).

2.1.2. Year II

The experiment was a randomised block design with a 2×3 factorial arrangement of treatments. Seventy-two Holstein–Friesian dairy cows were randomised across 6 treatments ($n=12$) consisting of 2 DHA (13 and 17 kg DM/cow) and 3 concentrate levels (0, 3 and 6 kg DM/cow). A full description of the experimental design, treatments, management factors and feed composition has been reported by McEvoy et al. (2008).

2.2. Animal measurements

Dry matter intake was measured using the *n*-alkane technique of Mayes et al. (1986), as modified by Dillon and Stakelum (1989). The *n*-alkane concentration of the dosed pellets, faeces, herbage and concentrate were determined as described by Dillon (1993). Data were collected during two weeks in YI, at approximately 40 and 80 DIM and three weeks in YII, at approximately 35, 55 and 85 DIM. All measurements reported were collected during periods of intake measurement. Individual milk yields (kg) were recorded daily. Milk composition was calculated once during each measurement period. Bodyweight (Winweigh software package; Tru-test Limited, Auckland, New Zealand) and BCS (Lowman et al., 1976) were recorded once during each measurement period. The variation in intake and milk yield across experiments is given in Table 1.

2.3. Chemical analysis

Herbage samples were collected once per treatment and concentrate samples were collected once during each measurement period. Herbage was sampled with a Gardena (Accu 60, Gardena International GmbH, Ulm, Germany) hand shears. Herbage and concentrate samples were stored at −20 °C before being freeze-dried and milled through a 1-mm sieve. During YI herbage was bulked by period for the three DHA treatments ($n=1$) and during YII herbage samples were individually analysed for the 13 and 17 kg DHA treatments ($n=2$). Samples were analysed for OMD content (Morgan et al., 1989).

2.4. Developmental database

2.4.1. Parity

In YI thirty animals were in their first lactation (primiparous) and thirty-six animals were in their second or greater

Table 1
Description of the mean and range of cow and treatment variables in the developmental data used to evaluate prediction equations for DMI and milk yield.

Variable	Mean ($n=335$)	Maximum	Minimum	2005 ($n=130$)	2006 ($n=205$)
Herbage mass (>4 cm; kg DM/ha)	1733	2826	1107	2190	1443
Area (m^2/cow per d)	98.2	158	50.6	79.9	108.8
Allowance (>4 cm; kg DM/cow)	15.3	20.0	12.5	16.0	14.9
Days in milk	56	99	15	57	56
Milk yield actual (kg)	28.2	44.3	14.1	27.3	28.9
Fat %	3.69	5.73	2.07	3.70	3.68
Protein %	3.29	3.96	2.79	3.32	3.27
Lactose %	4.74	5.21	4.20	4.86	4.68
Bodyweight (kg)	509	696	374	509	509
Calving BCS	3.10	4.25	2.25	3.13	3.08
BCS	2.80	3.75	2.00	2.90	2.74
Grass DMI (kg/cow per d)	14.2	23.5	5.3	14.3	14.2
Total DMI (kg/cow per d)	16.8	26.5	8.5	16.3	17.1
UFL intake (cow/d)	17.7	28.7	8.8	17.3	17.9
UFL required (cow/d)	18.0	27.1	12.1	17.7	18.2
EB (UFL; cow/d)	−0.3	6.6	−7.5	−0.4	−0.3

BCS = body condition score; DMI = dry matter intake; UFL = Unité Fourragère Lait (Feed unit for milk).