BRIEF COMMUNICATION: Maintenance energy requirements of non-lactating, pregnant dairy cows

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Introduction

A number of estimates of metabolisable (ME) and net energy (NE) requirements for maintenance, activity, reproduction and productive purposes have been published (AFRC 1995; ARC 1980; CSIRO 2007; NRC 2001). The most appropriate recommendations for New Zealand systems have been compiled by Nicol & Brookes (2007).

Anecdotal reports that dry cows lose condition when fed maintenance allowances according to current recommendations of ME intake per unit liveweight$^{0.75}$ (Nicol & Brookes (2007) indicate a possible underestimation of energy requirements for the non-lactating pregnant cow. This underestimation of energy requirements was reported by Holmes & Grainger (1985), but little has been done to quantify the deficiency. In developing the most recent recommendations for New Zealand dairy cows, Nicol & Brookes (2007) increased the energy requirements for production by 10%, recognising a need to adjust energy demands upwards.

The objective of this study was to determine the ME intake associated with zero energy balance in non-lactating, pregnant dairy cows consuming fresh pasture.

Materials and methods

As part of a larger experiment, 52 non-lactating, pregnant Holstein-Friesian and Holstein-Friesian/Jersey-cross dairy cows were housed in the DairyNZ Lye Farm Calan Gate facility for 38 ± 2 days (mean ± standard deviation). Mean estimated day of gestation (DOG) was 191 ± 19 days, live-weight (Lwt) was 523 ± 50 kg, and age was 6 ± 2 years). Cows were previously trained in the feeding facility with the procedures approved by the Ruakura Animal Ethics Committee.

In four experimental periods, cows were offered individual daily allowances of fresh perennial ryegrass (*Lolium perenne* L.) ranging from one to two and a half times (7.2 ± 2.2 kg to 11.8 ± 3 kg DM/day) estimated maintenance (i.e. 0.55 MJ ME/kg Lwt$^{0.75}$/day; Nicol & Brookes 2007).

Following feeding, cows were released to a bare paddock until the following morning.

The amount of fresh pasture offered and refused was recorded daily for each cow. Individual dry matter intake (DMI) was calculated as pasture DM offered minus DM refused. Daily samples of pasture offered were dried at 60°C, bulked weekly, and analysed at Dairy One (Ithaca , NY, USA) for dry matter digestibility (DMD) by wet chemistry as *in vitro* true digestibility after 24 hours of incubation (ANKOM Technology Method 3).

Metabolisable energy (ME) content was estimated from DMD by the equation:

$$ME = DMD \times 0.172 - 1.707 \qquad \text{(CSIRO 2007)}$$

Mean ME content ± the standard deviation of the pasture over the four periods was 12.4 ± 0.6 MJ ME/kg DM. Individual Lwt was recorded once per week in 2009 and three times per week in 2011. Body condition score (BCS) was assessed on a 1–10 point scale (Roche et al. 2004) once per week in both years.

Daily change in gravid uterus weight (GUW) was estimated as:

$$\Delta GUW \text{ (kg/day)} = ((0.664 \times DOG) - 102) \times (CBW/46) - ((0.664 \times (DOG - 1)) - 102) \times (CBW/46) \qquad \text{(Bell et al. 1995)}$$

where DOG = Day of gestation (Mean ± standard deviation of 208 ± 18 days in this experiment) and CBW = Calf birth weight (Mean ± standard deviation of 39 ± 7 kg in this experiment).

Daily energy requirements for the gravid uterus (GUER) were estimated as:

$$GUER \text{ (MJ ME/day)} = (((0.00159 \times DOG^2 - 0.0352 \times DOG - 35.4) \times 4.186 \times CBW/46) - ((0.00159 \times (DOG-1)^2 - 0.0352 \times (DOG-1) - 35.4) \times 4.186 \times CBW/46))/0.14$$

(derived from Bell et al. 1995)

A value of 0.14 was used as the efficiency with which ME is used for pregnancy (Ferrell et al. 1976; NRC 2001).

Liveweight gain per day for each period was estimated by regressing Lwt against day using linear models. Individual daily ME intake was calculated as the product of pasture ME and daily DMI for each cow within each period. The associations between mean ME intake and Lwt change, and between mean ME intake/kg Lwt$^{0.75}$ and Lwt change were estimated using linear models by fitting a regression line with Lwt change as the dependent variable and daily ME intake and ME intake/kg Lwt$^{0.75}$ as the independent

Figure 1 The relationship between metabolisable energy consumed (MJ ME/day) and daily liveweight change (kg/day) for non-lactating, pregnant Holstein-Friesian dairy cows weighing 526 ± 55 kg at 208 ± 17 days of gestation. Dashed line indicates point of zero live weight change.

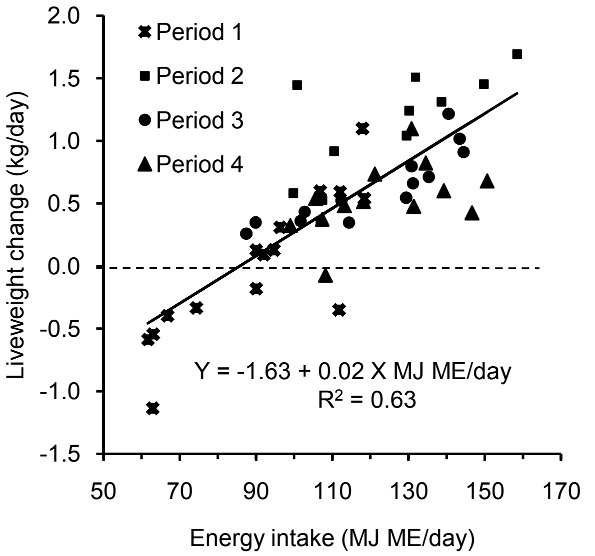
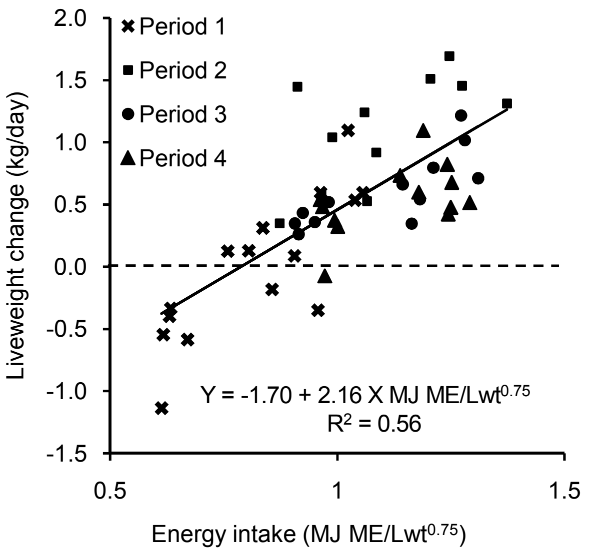


Figure 2 The relationship between metabolisable energy consumed per kg of metabolic liveweight (MJ ME/kg Lwt$^{0.75}$/day) and daily livedweight change for non-lactating, pregnant Holstein-Friesian dairy cows weighing 526 ± 55 kg at 208 ± 17 days of gestation. Dashed line indicates point of zero live weight change.



variables. Parallel lines were then fitted by including period into the model. To obtain daily maintenance requirements, ME intakes and ME intakes/kg Lwt$^{0.75}$ were calculated from the fitted equation to achieve the daily Lwt gain equivalent to the estimated growth of the gravid uterus corresponding to zero energy balance for the cow.

Results and discussion

Associations between ME intake/cow/day, ME intake/kg Lwt$^{0.75}$/day and Lwt gain are presented in Figs. 1 and 2, respectively. Average Lwt was 526 ± 55 kg. Based on average CBW and average DOG, the GUW was estimated to be 30.6 kg, and the increase in GUW was estimated to be 0.6 kg/day. Daily gravid uterus growth rate was assumed to be the cow's Lwt change associated with zero energy balance (Bell et al. 1995). Using these assumptions, the cumulative ME requirement (mean ± standard error) for maintenance, activity and pregnancy was 117 ± 3 MJ ME/cow/day (128 ± 7, 93 ± 7, 119 ± 5 and 127 ± 5 MJ ME/cow/day for Periods 1 to 4, respectively). This is equivalent to 1.07 ± 0.03 MJ ME/kg Lwt$^{0.75}$ (1.13 ± 0.06, 0.84 ± 0.06, 1.10 ± 0.04 and 1.16 ± 0.05 MJ ME/kg Lwt$^{0.75}$ for Periods 1 to 4, respectively).

To estimate ME requirements for maintenance alone, ME requirements for activity and pregnancy must be deducted from these values and the weight of the gravid uterus must be removed from the Lwt of the cow. The average ME requirement for pregnancy and the activity allowance for 1 km walked/day have been estimated to be 15.8 MJ ME/cow/day (Bell et al. 1995) and 2 MJ ME/cow/day (Nicol & Brookes 2007), respectively. With these adjustments and subtracting the weight of the gravid uterus from the cow's Lwt, daily maintenance requirements derived from the data presented here are 0.94 MJ ME/ kg Lwt$^{0.75}$. Although current maintenance energy estimates (0.55 MJ ME/ kg Lwt$^{0.75}$) are 41% less, these results are consistent with anecdotal reports of cows losing BCS when offered published requirements for maintenance, activity and pregnancy. These results also agree with the conclusions of Holmes & Grainger (1982) that the feed requirements of pregnant, dry cows fed on pasture are considerably higher than predicted from the international literature (~0.42 MJ ME/kg Lwt$^{0.75}$).

The reason for the greater maintenance energy requirements reported in this study is not clear. Bruinenberg et al. (2002) reported a 10% increase in ME requirements in lactating cows. In line with this, Yan et al. (1997) stated maintenance requirements of 0.60 MJ ME/kg Lwt$^{0.75}$ and Agnew & Newbold (2002) summarised recent work in lactating dairy cows reporting requirements of 0.63 MJ ME kg Lwt$^{0.75}$. These values are derived from lactating cows and possibly include support maintenance for the lactating udder. However, Yan et al. (1997) also proposed that the efficiency of utilisation of energy for tissue retention was 18% lower in dry cows than milking cows, consistent with a greater maintenance requirement. In addition, Ferrell & Jenkins (1984) and Garrett (1971) both reported greater maintenance requirements of 13% to 16% of higher genetic merit breeds compared with lower genetic merit breeds. Maybe genetic selection towards higher production since the calorimetry experiments of the 1960s/1970s, has resulted in increased metabolic rates. Combined with inefficiencies in the use of energy for maintenance in non-lactating cows compared with lactating cows, this has created a greater requirement for energy in the modern dairy cow.

Despite limitations in methodology, the data presented here indicate that maintenance energy requirements of non-lactating, pregnant dairy cows are greater than proposed at present. This trend suggests that research should be undertaken to further evaluate the maintenance energy requirements of non-lactating pregnant dairy cows under farm management conditions.

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