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Comparison of Techniques for Estimating Herbage Intake of Grazing Dairy Cows

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ABSTRACT

For estimating herbage intake during grazing, the traditional sward cutting technique was compared in grazing experiments in 2002 and 2003 with the recently developed n-alkanes technique and with the net energy method. The first method estimates herbage intake by the difference between the herbage mass before and after grazing and the regrowth between the 2 points in time. The second technique estimates herbage intake by the ratio of a dosed even-chain synthetic n-alkane (C_{32}) and a naturally occurring odd-chain n-alkane (C_{31} or C_{33}) in the herbage and feces. The third technique calculated the intake from the animal's energy requirements for milk production and maintenance. The sward cutting technique estimated herbage intake with the highest coefficient of variation and had different results in the 2 experimental years. The n-alkanes method yielded less variable results, whereas the net energy method gave the least variable results. In 2002, the estimates of the alkane ratio C_{32}:C_{33} were best related with estimations of the net energy method. In 2003, the estimates of the alkane ratio C_{32}:C_{31} were best related. The estimate based on the alkane ratio C_{32}:C_{33} had a lower coefficient of variation than the one based on the alkane ratio C_{32}:C_{31}. Therefore, the C_{32}:C_{33} alkane method was considered to be a better direct estimator for herbage intake by grazing lactating dairy cows.

(**Key words:** dairy cow, herbage intake, sward cutting, n-alkanes)

Abbreviation key: FPCM = fat- and protein-corrected milk, **LINGRA** = light interception and utilization simulator for grasslands.

INTRODUCTION

Limited herbage intake is considered one of the main constraints for ruminant production (milk, meat, and wool) (Forbes, 1995). The measurement of DMI during grazing is, however, still not very accurate. The classical method to determine intake is the so-called sward cutting method. A measured proportion of the area allotted to the animals is harvested, and the total herbage offered to the animal can be calculated. The residual herbage after grazing is determined in a similar manner. The difference between these 2 herbage masses and a correction for the regrowth provides an estimate of the herbage consumed in the area grazed (Meijs, 1981; Macoon et al., 2003). The sward cutting method can provide reliable estimates of intake when short grazing periods are applied and when a large part of the offered herbage is consumed (Walters and Evans, 1979; Meijs, 1981). However, this method has large variation (Meijs et al., 1982; Reeves et al., 1996) and is mainly used to determine herbage intake for groups of animals.

In the late 1980s and early 1990s, a new method for herbage intake was developed, the n-alkanes method (Mayes et al., 1986; Dove and Mayes, 1991; Dillon, 1993). The n-alkanes are long-chain (C_{25} to C_{35}) hydrocarbons present in the cuticular wax of plants. In grassland species, the odd-numbered chain length alkanes (especially C_{29}, C_{31}, and C_{33}) are present in much greater amounts than the even-numbered chain length (Tulloch, 1976; Dove and Mayes, 1991). Herbage intake could be estimated by using the n-alkanes as fecal markers. Animals are dosed with a synthetic even-numbered alkane and consume herbage with a certain content of naturally occurring odd-numbered alkane. Herbage intake can be calculated from the alkane dose, the alkane content in the herbage, and the ratio of the dosed and natural alkanes in the feces. Although the fecal recovery of alkanes might not be complete, alkanes of adjacent chain length (e.g., C_{32} and C_{33}) have similar recoveries (Mayes et al., 1986; Stakelum and Dillon,

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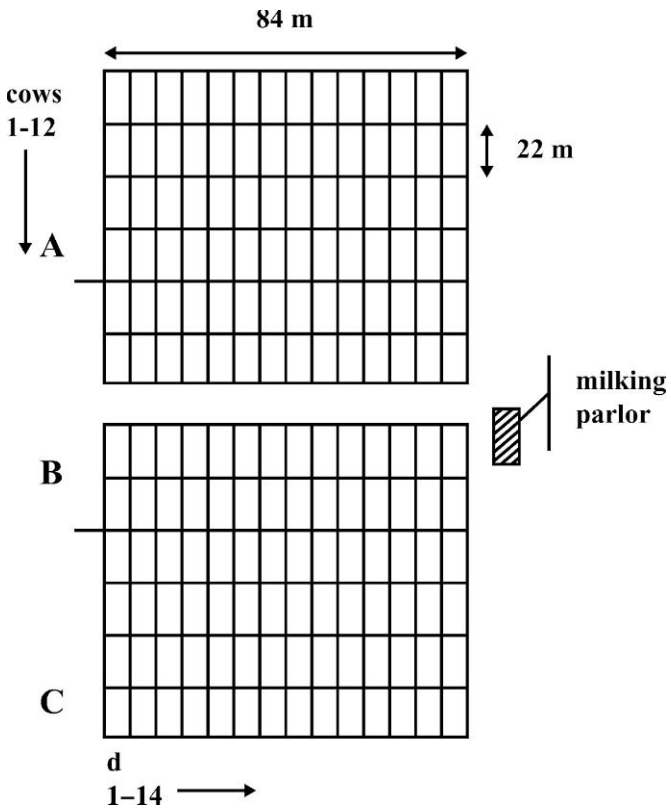

Figure 1. Experimental set-up of the grazing trial.

1990), and it was shown that herbage intake of dairy cows could be estimated accurately (Dillon, 1993; Lippke, 2002).

The aims of this paper were to measure DMI of grazing dairy cows using the 2 methods and compare their estimates. Furthermore, the estimates of the 2 methods were compared with a calculated DMI based on the energy requirements for lactation and maintenance ($NE_{L,\ required}$) of the cows and the net energy content (NE_L) of the herbage.

MATERIALS AND METHODS

Experimental Set-Up

During the summers of 2002 and 2003, similar grazing experiments were conducted. Twelve dairy cows were used in each experiment. Two paddocks were sown with 4 perennial ryegrass cultivars in a randomized block design with 3 replicates. Each paddock consisted of 12 strips that were 22 m wide and 84 m long. The strips were divided into 14 plots that were 22 × 6 m each (Figure 1). The experiment was designed as a strip-grazing system, and each cow was allowed to graze individually a plot during 24 h. A mobile fencing system was used, and each cow was moved daily to a new plot at 1200 h. In total, each experiment consisted of 4 periods of 14 d.

Animals

Twelve multiparous Holstein Friesian dairy cows were used. In 2002, cows were 67 ± 4.2 DIM, and in 2003, cows were 114 ± 3.7 DIM. The BW was recorded every week. Pre-experimental BW was 528 ± 2.0 and 549 ± 4.2 kg in 2002 and 2003, respectively. Animals were milked twice a day at 0600 and 1600 h. Milk yield was recorded after every milking. Daily samples of milk were analyzed for fat and protein content. Milk production is expressed as fat- and protein-corrected milk (**FPCM**). The Institutional Animal Care and Use Committee of Wageningen University approved the experiment.

Sward Cutting Method

Herbage allowance. On d 10, 11, 12, and 13 of each experimental period, fresh herbage yield, DM percentage, and DM yield were measured before the cows were allowed grazing (pregrazing). Fresh herbage yield was measured by cutting at least 5% of the total area with a mowing machine (Agria 3200; Agria-Werke, Möckmühl; cutter bar, 1.25 m) at a stubble height of 4 cm. In 2002, in periods 1 and 2, in total 7 m^2 was cut in one strip, and in periods 3 and 4, in total 14 m^2 was cut in 2 strips of 7 m^2 each. In 2003, in all periods, in total 7 m^2 was cut in 2 strips of 3.5 m^2 each. The cut herbage was collected, weighed, and sampled for DM determination. Duplicate core samples of approximately 200 g of fresh material were taken and dried at 70°C for 24 h.

Herbage residual. On d 11, 12, 13, and 14 of each period, the residual herbage (postgrazing) was measured as described for the herbage allowance, but now twice the amount of strips was cut (10% of the area) (Green, 1949; Meijs, 1981). Herbage samples were collected and processed as described for the herbage allowance.

Herbage accumulation. Herbage accumulation was calculated using the light interception and use simulator for grasslands (**LINGRA**) (Schapendonk et al., 1998), which calculates daily regrowth of perennial ryegrass swards using the meteorological data [daily photosynthetic radiation ($MJ/m^2/d$) and temperature (°C)] of the Haarweg meteorological station, located 500 m from the experimental fields. The LINGRA successfully predicted growth and development of perennial ryegrass in a vegetative stage at the level of potential and water-limited production (Barrett et al., 2004). Herbage