Achieving high milk production performance at grass with minimal concentrate supplementation with spring-calving dairy cows: actual performance compared to simulated performance

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Abstract

The aim of high-profitability grazing systems is to produce milk efficiency from grazed pasture. There is very limited information available on the milk production capacity of dairy cows offered a grass-only diet for the main part of her lactation. In this study, spring-calving dairy cows were managed to achieve high milk production levels throughout the grazing season without supplementation. The calving date of the herd was 12 April; the herd had access to grass as they calved and remained full-time at grass until 20 November. During this period the herd produced 5,513 kg milk, while receiving 130 kg concentrate supplementation. The herbage mass offered was maintained at 1,490 kg dry matter ha^{-1} (>3.5 cm) and the herd grazed to 4.5 cm across the grazing season. The weekly milk production performance achieved was then compared to the Herd Dynamic Milk model. The root mean square error (RMSE) and relative predicted error (RPE) for milk yield (as expressed weekly across lactation) was 1.47% and 6.09%, respectively, for body condition score the RMSE and RPE were 0.093% and 4.14% respectively. Offering spring-calving cows high levels of high quality grass resulted in excellent animal performance, however, this can be achieved with very good daily grazing management.

Keywords: potential, grass milk, dairy production, herd dynamic milk model

Introduction

Grazed grass is the cheapest feed source available to Irish dairy farmers, with a relative cost ratio of grazed grass to concentrate of 1:2.4 (Finneran *et al.*, 2010). Increasing the proportion of grazed grass in the dairy cow diet will reduce the dependence on purchased feed, which is subject to substantial price volatility. Grass dry matter intake has a major effect on the production performance of grazing dairy cows (Dillon *et al.*, 2005) and dairy farm profitability (Shalloo *et al.*, 2009). As a result increasing the proportion of grazed grass in the dairy cow diet results in lower costs of milk production and increased profitability. Grass, when managed well, is a high quality feed that can maintain high levels of milk production performance. There has been little research work, or indeed modelling research, to establish what is the potential performance achievable when cows are offered high levels of pasture. The objective of this work was to create an experiment which offered a spring-calving herd high levels of grass and a low level of concentrate, but still targeted high grass utilization and milk production across the grazing season. The measured performance was then compared to a dairy simulation model (Herd Dynamic Milk model or HDM) (Ruelle *et al.*, 2014).

Materials and methods

The experiment was conducted at Fermoy, Co. Cork, Ireland (52°16' N, 8°25' W), on a free-draining soil comprising acid brown earth with a sandy loam-to-loam texture. Thirty mixed-age Holstein-Friesian cows were selected for the experiment. Seven were second lactation, eleven were third lactation, and the remainder fourth to eighth lactation. Mean lactation number was 3.5 (standard deviation (s.d.) = 1.38) and mean calving date was 12 April (s.d. = 15.88). The experiment took place over a 39-week period from 27 February to 20 December. Grass intake measurements were undertaken during two periods in

weeks 14 (May 21) and 20 (July 10) of the study. As animals calved they were offered 4 kg of concentrate for the first week of lactation and then 1 kg until 27 May; thereafter, they were unsupplemented until 4 November, when they were offered 1.5 kg concentrate day^{-1} to the end of lactation. The cows were grazed on a *Lolium perenne* pasture (on average nine years old, with no clover present). The animals were grazed as one herd. Grazing (full time) started on 10 March as the first cow calved, the herd was housed by night on 20 November, but the herd continued to graze by day until 8 December. Only milk production from a grazing diet is reported in this paper. The grazing area consisted of ca. 12 ha sub-divided into 10 paddocks. Cows were grazed in a rotational system. Paddocks were strip-grazed using temporary fences. Cows had access to the previous day's allocation, as paddocks were grazed for 2-3 days and no back fences were erected in the main grazing season. Nitrogen (N) fertiliser (calcium ammonium nitrate) was applied following grazing to supply 230 kg N ha^{-1}.

Results and discussion

Cows were offered a pre-grazing herbage mass (>3.5 cm) of 1,490 kg dry matter (DM) ha^{-1} (s.d. 310.55), pre-grazing height 8.8 cm (s.d. 1.87) and daily herbage allowance 16.9 kg DM cow^{-1} day^{-1} (s.d 4.32). The herd grazed to a post-grazing height of 4.4 cm (s.d. 0.76) during the study. Over the study the mean grazing area per cow was 114.4 m^2 (s.d. 32.44). Mean milk production performance was 5,513 kg milk (s.d. 665.06), Milk fat % was 4.31 (s.d. 0.321), Milk protein % was 3.56 (s.d. -0.155), Milk lactose was 4.64%, s.d. 0.107), Total fat was 236 kg (s.d. 27.46), Milk protein was 196.2 kg (s.d. 21.5). In May, total DM intake measured was 17.7 kg DM cow^{-1} day^{-1}, grass dry matter intake was 16.7 (s.d. 2.45) kg DM cow^{-1} day^{-1}. In early July, grass dry matter intake was 21.0 kg DM cow^{-1} day^{-1} (s.d. 2.07). Concentrate input per cow was <130 kg DM cow^{-1} for the study.

The HDM is a dynamic and stochastic model capable of simulating the performance of dairy animals individually, with a daily time step. The simulation of the milk production per day is calculated as an interaction between the energy intake by the cow, the change of body condition score (BCS) and the individual animal theoretical milk potential. If the energy intake allows a lower production than the potential, the cow will mobilize body reserves (lose BCS), which will allow her to produce more milk than would be possible through feed alone. If the energy intake allows a higher milk production than the cow's potential, part of this energy is used to increase the body reserves of the cow (regain of BCS) and the other part will go for additional milk production. The model was used to recreate this study's experiment. The model has been initialised with the description of the herd at the beginning of lactation. The weekly herbage allowance and grass quality has been set as an input to reproduce the actual experiment execution. The daily and individual output in terms of milk production (Figure 1) and

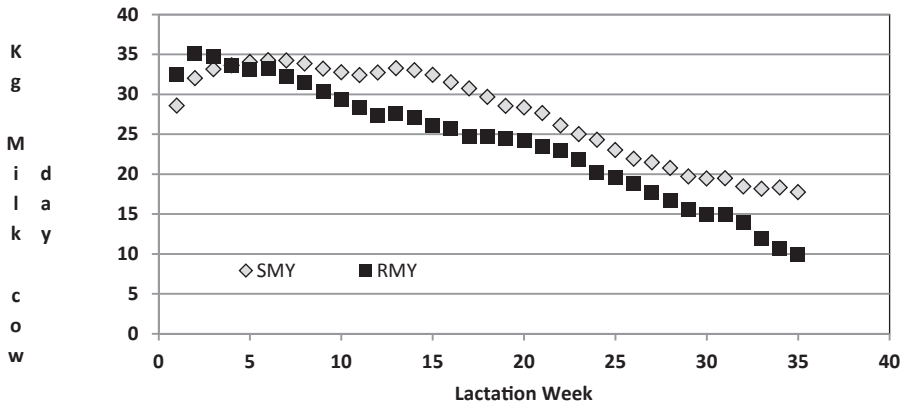

Figure 1. Comparison of mean milk yield of the herd as measured against the simulated performance by Herd Dynamic Model. SMY = simulated milk yield; RMY = recorded milk yield.

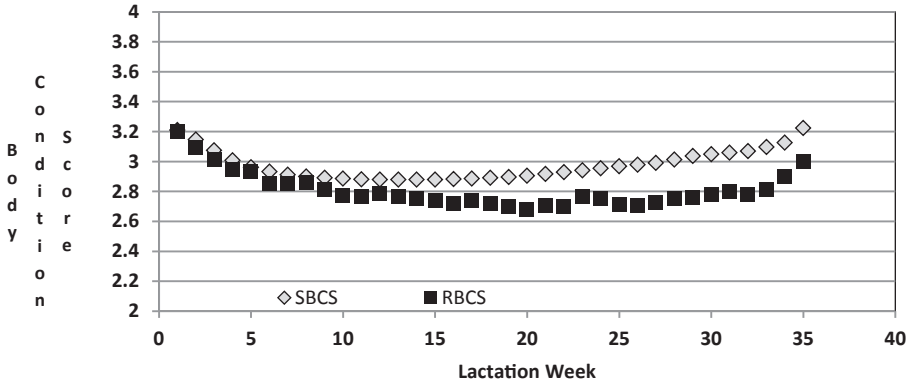

Figure 2. Mean body condition of the herd and its simulated body condition score using the Herd Dynamic model. SBC = simulated body condition score; RBCS = recorded body condition score.

BCS (Figure 2) have been extracted and averaged by week of lactation for the dairy cows to permit the comparison against the measured data. The root mean square error (RMSE) and relative predicted error (RPE) for milk yield (as expressed weekly across lactation) was 1.47 and 6.09, respectively, for BCS the RMSE and RPE were 0.093 and 4.14, respectively.

Conclusions

Offering spring-calving cows high levels of high quality grass resulted in high animal production performance achieved with minimal levels of supplementation offered. The simulation of the herd performance with the HDM model was precise and shows that grazing herd performance can be simulated accurately with the model. High milk production performance can be achieved at pasture with very good daily grazing management.

References

Dillon P., Roche J.R., Shalloo L. and Horan B. (2005) Optimising financial return from grazing in temperate pastures. In: Murphy J.J. (ed.) *Utilisation of grazed grass in temperate animal systems*. Proceedings of a satellite workshop of the 20th International Grassland Congress, Cork, Ireland, July 2005. Wageningen Academic Publishers, Wageningen, the Netherlands, pp. 131-147.

Finneran E., Crosson P., O'Kiely P., Shalloo L., Forristal D. and Wallace M. (2010) Simulation modelling of the cost of producing and utilising feeds for ruminants on Irish farms. *Journal of Farm Management* 14, 95-116.

Ruelle E., Delaby L., Wallace M. and Shalloo L. (2014) Development and evaluation of the Herd Dynamic Milk (HDM) Model for Dairy Systems. *Agricultural Systems*, submitted.

Shalloo L. (2009) Pushing the barriers on milk costs/outputs. In: *Teagasc National Dairy Conference*, Mullingar and Killarney, Ireland, 18 Nov 2009. Teagasc, Carlow, Ireland, pp. 19-39.