Using models to establish the most financially optimum expansion strategy for Irish dairy farms

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Abstract

Determining the impact of a change of management on differing farm characteristics is a significant challenge in the evolution of dairy systems, due to the interacting components of complex biological systems. In this study the impact of increased concentrate supplementation and/or an increase in grazing intensity is simulated to determine the effect on the farm system and its economic performance. Three different grazing systems (with three different stocking rates 1.9, 2.2 and 2.5 cows per hectare, three different post-grazing heights 5.2, 4.5 and 3.8 cm, three different nitrogen fertilisation rates 160, 200 and 250 kg per ha) and four different concentrate-supplementation strategies (0.0, 0.5, 1.0 and 1.5 Mg per lactation) resulting in 12 different scenarios were simulated. Three different models (Moorepark Grass Growth Model, Pasture Base Herd Dynamic Milk model and the Moorepark Dairy Systems Model) were integrated and simulated in order to simulate the different scenarios. Overall, this study has shown that increasing concentrate supplementation generally resulted in a reduction in farm profitability, while in general increasing grazing intensity resulted in an increase in farm profitability.

Keywords: grazing intensity, concentrate supplementation, models, economic

Introduction

With the end of the EU milk quota regime in 2015, dairy farmers will get an opportunity to expand their dairy enterprises unhindered for the first time in a generation. The restrictions at farm level will move most farmers from a scenario where they are limited by milk quotas to a scenario where some other features of the farm will be limiting. For most farmers this will be land. In Ireland, it is anticipated that most dairy farmers will increase the number of animals on farm, and invest in technology to increase pasture productivity, while a minority will increase the levels of concentrate supplementation to increase the overall milk outputs.

In order to investigate the optimum strategies for the farm, taking into account the various stocking rates and feeding level interactions, a mechanistic model is required which is capable of modelling the complex animal-sward interactions. The models used must be capable of simulating the complex interactions of the system, which include the effect of increasing fertiliser levels on grass growth, the effect of grazing severity on animal intake, milk yield and body condition score (BCS) and the effect of all of these characteristics on farm profitability. The objective of this study was to evaluate the impact of different system options for dairy farmers in a post-EU quota environment through combining three different models (Paillette *et al.*, unpublished data; Ruelle *et al.*, in press; Shalloo *et al.*, 2004).

The models were applied to evaluate three different levels of grazing intensity (different level of stocking rate (SR) (number of animals per unit area of land), post grazing height and nitrogen fertilisation) and four different levels of concentrate feed per lactation (0.0, 0.5, 1.0 and 1.5 Mg per cow) on overall farm biological and economic performance across a range of different milk and concentrate prices.

Materials and methods

This study focuses on simulating the complex interactions between grass growth, grass intake, animal performance and overall farm profitability to evaluate different strategies to increase milk output at farm level around grazing intensity and concentrate feeding in a post-quota environment. Three separate models developed in Teagasc Moorepark were integrated to simulate all aspects of the production system. In this study, three models are used to evaluate twelve different systems across different grazing systems and concentrate-feeding levels. The models included a grass growth model, the Moorepark Grass Growth Model (MGGM) (Paillette *et al.*, unpublished data) which is used to simulate the effect of nitrogen fertiliser and SR on grass growth, an animal intake and performance model (Ruelle *et al.*, in press) which is used to simulate the interaction between the animal and the sward across different grazing pressures and concentrate supplementation levels, with all of these data combined into the Moorepark Dairy System Model (MDSM) (Shalloo *et al.*, 2004) to evaluate the overall effect on the economic performance of the farm. The analysis was conducted with cows that have been selected for a balance of traits encompassing both milk production and fertility. The simulations were completed on a 40 ha farm with each simulation fed from one model to the other. Overall, for each simulation the farm size is fixed at 40 ha with 18 paddocks. Twelve main scenarios have been completed; three different grazing systems (GS) with different SR and grazing intensities:

- LGS: 1.9 cows per ha (76 cows), post-grazing height of 5.2 cm and nitrogen fertilisation of 160 kg per hectare;
- MGS: 2.2 cows per ha (88 cows), post-grazing height of 4.5 and 200 kg of nitrogen fertilisation;
- HGS: 2.5 cows per ha (100 cows), post-grazing height of 3.8 cm and 250 kg of nitrogen fertilisation per hectare.

Four different concentrate levels were used across the different stocking rates (objective of 0 Mg cow^{-1} (0C), 0.5 Mg cow^{-1} (LC), 1.0 Mg cow^{-1} (MC), 1.5 Mg cow^{-1} (HC) per lactation). The base milk and concentrate prices included in the analysis were 29.5c l^{-1} and €250 Mg^{-1} with sensitivity analysis completed with a milk price of 24.5 and 34.5c l^{-1} and €150 and €350 Mg^{-1} for milk and concentrate costs, respectively.

Results

At a base milk price (29.5 c l^{-1}) and an average concentrate price (€250 Mg^{-1}) all farms were profitable, with the most profitable farm generating €24,156 (MGS-0C) while the least profitable farm generated €3,914 (LGS-HC). At a low milk price most scenarios lost money, with the most profitable scenario returning a profit of €1,410 (MGS-0C) and the largest deficit being €-22,807 (HGS-HC).

Mainly the increase of concentrate level induced a decrease of the overall farm profit (average decrease of profit of €5,747 for an increase of 0.5 Mg cow^{-1} of concentrate between all scenarios and milk prices). However, in specific cases the increase of concentrate supplementation led to an increase of the farm profit. Indeed, in the case of a high milk price (34.5 c l^{-1}) in the HGS the LC farm was €2,719 more profitable than the 0C. At a low concentrate cost (€150 Mg^{-1}) increasing concentrate level from 0C to LC was beneficial at all three stocking rates (€2,032, €2,948 and €7,120 for the LGS, MGS and HGS).

Overall the increase in grazing intensity led to an increase of the profit on farm. The increase in grazing intensity is always beneficial with a high milk prices (34.5 c l^{-1}). In the case of a low milk price (24.5 c l^{-1}), the increase in grazing intensity does not result in an increase in farm profit except for the 0C or the LC between the LGS and the MGS.

Discussion

As grazing intensity and level of concentrate feed increase, there is an increase in the vulnerability of the business to variation in input and output prices. In this study at the different milk prices and concentrate supplementation levels, the most profitable system ranged from MGS-0C, HGS-LC and the HGS-MC. The MGS-0C has been the most efficient system in the case of a low or average milk price at an average concentrate price or in the case of a high concentrate price. Without any concentrate, the optimum system is at the MGS. However, we have shown that the decrease of the concentrate supplementation led to a decrease of the minimal and average BCS of the animal through the lactation which may have reproduction implications, but that have not been simulated in this study. Some studies have shown than an underfeeding in early lactation could lead to a high decrease in BCS in early lactation, which could have a subsequent impact on the fertility of the animal (Berry *et al.*, 2003).

Without taking into account the scenario with 0 concentrate the most profitable was the HGS-LC. The two exceptions are in the case of a low milk price where the MSR-LC has a lower deficit of €688 and in the case of a low concentrate price were the HSR-MC is €831 more profitable. It could be anticipated that if the analysis was completed with an animal which was selected for a higher milk yield that these animals would produce a higher milk production response than the type of cow simulated in this study (Fulkerson *et al.*, 2008). Response to concentrate has been shown to be highly dependent to the type of cow (Fulkerson *et al.*2008), level of feed offered and the level of feed deficit that was in the diet before the concentrate feed was offered.

Conclusions

This study has compared the economic efficiency of four different concentrate supplementation strategies and three different grazing intensity levels. This study has shown that systems of milk production built around matching the supply and demand of home produced feed, minimising the level of supplementary feed were the most profitable and also resulted in the least variability of profitability across different input and output prices.

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