New insights into the feeding value of grazed pasture

A TEAGASC collaborative project with Cornell University is examining the true nutritive value of grazed pasture, and its role in dairy cow diets.

Introduction

The population of the world is projected to surpass 9.6 billion by 2050. This may reduce availability of human-edible cereal and protein products (e.g., maize and soybean) as feeds for livestock production. To maintain a significant contribution to net food production, ruminant production systems may need to increase reliance on the unique ability of ruminants to convert the most abundant human-inedible organic compound on earth, cellulose, into human-edible food. A primarily pasture-based diet provides an efficient and robust system to optimise this ability, as it involves the consumption of home-grown human-inedible forage, which minimises environmental impact, and supports a resilient business model for the farmer. There are, however, opportunities to increase the efficiency and productivity of pasture-based systems by incorporating more nutrients (i.e., nitrogen and carbon) into milk and meat products. Here we describe a collaborative project with Cornell University that is actively exploring new nutritional management tools for pasture-based dairy production systems to increase the capture of nutrients into milk.

Nutritional modelling

Nutritional modelling provides greater understanding of the balance between nutrient supply from the diet and the animal's requirements. The Cornell Net Carbohydrate and Protein System (CNCPS) is a tool that is used widely for diet formulation in the US, with growing usage across the world. Requirements for energy, protein, vitamins and minerals are quantified based on inputs from the user describing the cow, her environment and her current level of milk production. The supply of each of these nutrients is also quantified based on the animal's intake and the characteristics of the diet the cow is consuming. In pasture-based systems, there are a number of dietary strategies available to enhance the capture of nutrients, such as improved pasture management techniques, optimising concentrate supplementation, breeding more suitable plants, and the development of mono- or multi-species swards. To select the optimal strategy, however, quantitative knowledge of how the diet interacts with the host and the nutrients it supplies is critical. The CNCPS can help to provide this increased understanding through the combination of mathematical modelling allied with in-depth feed chemistry analysis.

There are opportunities to increase the efficiency and productivity of pasture-based systems.

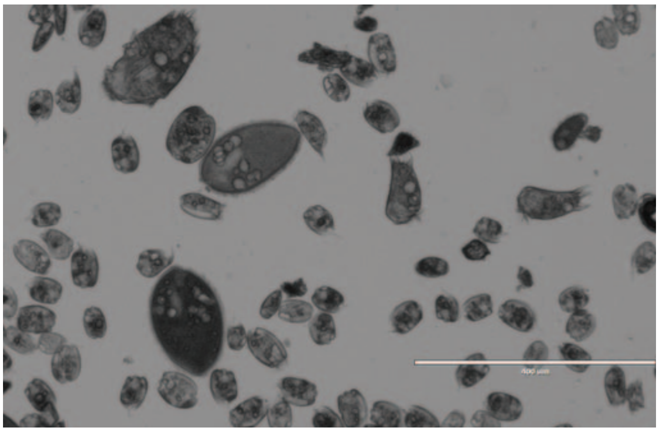

FIGURE 1: Mixed protozoa, a subset of rumen microbes that contribute to the nutrient supply of ruminants.

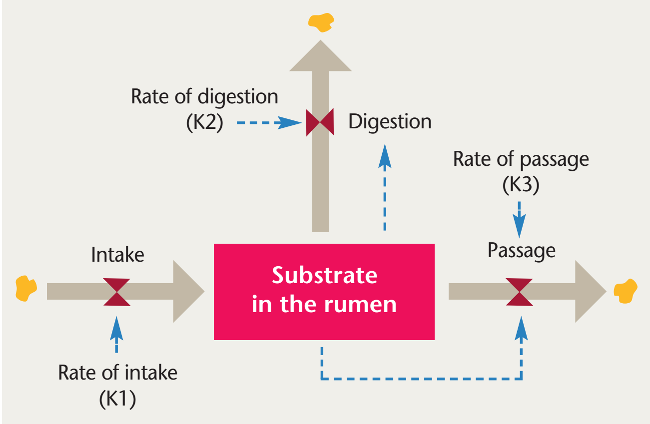

FIGURE 2: Diagram of the mathematical modelling approach utilised by the CNCPS to represent the dynamics of digestion in the rumen.

To optimise microbial output and the capture of nutrients within the rumen, it is essential that the grazing animal consumes large quantities of highly digestible material.

Feed chemistry

A major strength of the CNCPS is the feed chemistry it utilises to characterise each feed and hence the animal's diet. For example, the measurement of crude protein is differentiated into five fractions that differ in the rate at which they degrade in the rumen, their digestibility in the small intestine, and their potential amino acid (AA) contribution to the animal. This suite of chemistry analysis was carried out on Irish perennial ryegrass (PRG) swards, and the results were entered into the CNCPS. The model predicted that a large proportion of the PRG AA would be digested in the rumen, and hence contribute poorly to absorbable AA supply.

To evaluate this prediction, a digesta flow experiment was conducted in Teagasc Moorepark. In the experiment, we observed that 88 % of the PRG AA was degraded by the microbial population in the rumen, with only 12 % escaping to the small intestine. Therefore, a large proportion of the actual AA absorbed by the grazing cow was in the form of microbial AA washing out of the rumen (**Figure 1**) rather than coming directly from the feed eaten by the cow.

To optimise microbial output and the capture of nutrients within the rumen, it is essential that the grazing animal consumes large quantities of highly digestible material. The capability to achieve this is strongly influenced by the quantity and quality of the plant cell wall in the diet, measured as neutral detergent fibre (NDF). Animal experiments support the theory that faster rumen degradation of the NDF fraction of the feed will reduce physical fill over time, and allow greater voluntary feed intake to be achieved. A laboratory procedure to describe this degradability has recently been developed at Cornell University. The CNCPS combines outputs from this laboratory analysis with other pre-defined experimental relationships in a computer program (**Figure 2**) to predict animal outcomes. Results from the digesta flow experiment indicate that the CNCPS can predict this behaviour in pasture-fed dairy cows with high precision (< 2 % error). The ability to carry out these new feed chemistry analysis techniques is currently being developed at Teagasc Moorepark.

Implications

The new tools described can provide greater understanding of the nutrition of grazing dairy cows. Through precise quantification of the nutritional interactions involved, strategic supplementation or diet optimisation can be implemented to increase the efficiency and productivity of pasture-based systems. These new tools can also provide far-reaching insights; for example, to describe future plant breeding objectives or the screening of pasture species in multi-species swards. Improved swards, optimised for traits such as reduced ruminal digestion of plant AA, could increase net human food production, lower environmental impacts, and increase the financial resilience of pasture-based systems.

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