Reducing nitrogen emissions from grazing dairy cows

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Summary

- There is an increased focus on nitrogen emissions from agricultural sources.
- Strategic low nitrogen supplementation strategies can reduce nitrogen excretion while maintaining animal performance.
- Experiments are underway, as part of a DAFM-funded project PASTURE-NUE, to further investigate the interactions involved.

Introduction

European Union policies such as the Water Framework Directive and the Nitrate Directive have increased the focus on nitrogen (N) emissions from agricultural sources. As a result, the European Green Deal and Farm to Fork Strategy have set an ambitious target to reduce nutrient losses to the environment by at least 50% by 2030. In the most recent Environmental Protection Agency report on 'Water Quality in Ireland', 47% of river sites had unsatisfactory nitrate concentrations (>8 mg/l). Irish agriculture will have to contribute towards achieving these reduction targets or be at risk of imposition of fines, limitations on overall production and reputational damage.

Nitrogen metabolism in the grazing dairy cow

Due to the high N demand of perennial ryegrass, excessive amounts of N relative to the dairy cow's requirements can accumulate in the sward. Once ingested, microbial digestion of the N increases rumen ammonia concentration with the excess ammonia being absorbed into the bloodstream, transported to the liver, and converted to urea (along with other sources) in a process termed ureagenesis. The majority of this blood urea is then circulated to the kidneys where it is destined to be excreted back onto the pasture in the form of urinary urea N. While approximately 41% of this N can be recycled through pasture uptake, 35% can be lost via ammonia, nitrous oxide and/or nitrate leaching. Although many factors affect the amount of N lost, it is critical to minimise any further excess N intake by grazing dairy cows.

Low nitrogen concentrate supplementation

On average, pasture N concentration is higher than the cow's N requirements; therefore, it is hypothesised that no additional feed N is needed. Studies have shown that reducing concentrate crude protein (CP; i.e. the amount of N in the feed multiplied by 6.25) concentration from 18%-14% CP/kg of DM, equivalent to a 1% CP reduction on a total diet basis, results in a 10% reduction in manure N excretion. The reduction in manure N was driven by a 16% reduction in urine N rather than reduced faeces N. This is important to note as the principle N component in urine; namely, urea, is more likely to be lost to the environment as it is more soluble and volatile than faecal N components, which are organically bound. Importantly, this reduction in urine N excretion was achieved while maintaining animal performance.

A number of other researchers have investigated reducing concentrate CP concentrations to grazing dairy cows, however, results are equivocal. For example, some studies found reductions in N excretion but animal performance was also reduced, whereas others found no reduction in animal performance. Across the studies, there are a number of dynamic factors such as the investigated concentrate CP concentrations, the pasture CP concentrations, level of concentrate supplementation, season/stage of lactation and method of N excretion quantification. If these interactions can be understood, it could be possible to achieve a consistent reduction in N excretion while maintaining animal performance. There is also opportunity to further reduce N excretion as there are a lack of experiments investigating concentrate CP concentration less than 14% CP/kg of DM across the grazing season.

Metabolisable protein and amino acid supply

Other experiments have demonstrated that the addition of rumen-protected amino acids can negate decreased animal performance when low N supplements are fed. This is somewhat counterintuitive as pasture CP concentration is typically on the higher side of animal requirements (i.e. >17% CP). However, pasture protein has been demonstrated to undergo extensive rumen breakdown and substantial loss before it can be absorbed at the small intestine resulting in a high dependency by pasture-fed cows on their microbial protein synthesis ability to meet metabolisable protein/amino acid requirements. Furthermore, there are a number of studies that demonstrate increased milk production performance when pasture-fed cows are supplemented with rumen-protected protein ingredients. Due to the variability in pasture CP throughout the grazing season and the extensive breakdown in the rumen, rumen-protected amino acid sources may have a role in maintaining or increasing animal performance when low N concentrate are offered to grazing dairy cows.

PASTURE-NUE

As part of a DAFM funded PASTURE-NUE project, a series of experiments are currently being conducted at the Teagasc Dairygold Farm, Kilworth. The objective of these experiments is to provide insight into strategic low N supplementation strategies. Concentrates ranging from 9%-17% CP/kg of DM are being investigated, across the grazing season, along with a concentrate containing rumen-protected amino acids. A large-scale commercial farm experiment, characterising pasture CP concentration across the grazing season, is also included in the project. Finally, experiments are underway investigating concentrate CP concentration when grass silage or grass-red clover silage are offered to lactating dairy cows in early and late lactation.

Conclusions

Pasture-based systems must reduce their N emissions to the environment. Strategic low N supplementation strategies are a promising mechanism to achieve this. Further investigations are underway in order to consistently attain reduced N excretion while maintaining animal performance.

Acknowledgements

This research is funded by the Department of Agriculture, Food and the Marine's Competitive Research Funding Programme (2021R482) and the Dairy Levy Trust administered by Dairy Research Ireland.