# Improving dietary nitrogen use in dairy cattle: reducing protein intake in growing heifers – can we maintain production performance?

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Take home messages:

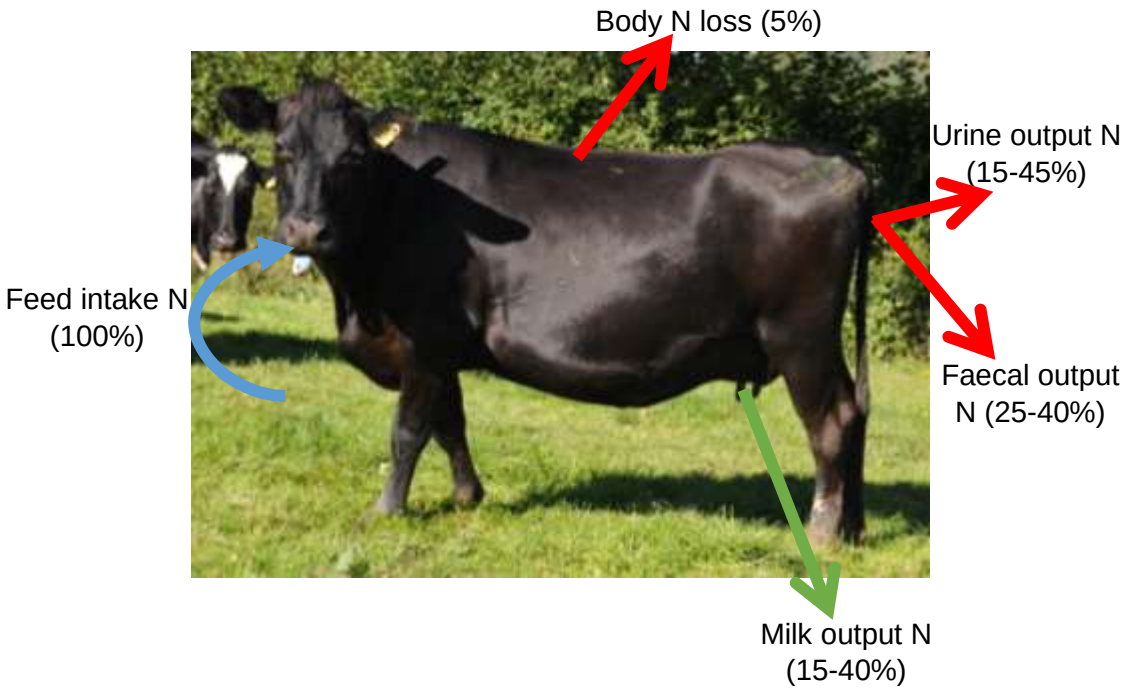
- On average, 75% of total nitrogen consumed by cattle is lost through excretion.
- Nitrogen use efficiency can be improved (to maintain production) and emissions reduced when crude protein content in the diet is reduced.
- Researchers in IBERS are investigating the production-based effects of reducing dietary crude protein provision to heifers from weaning through to the end of their second lactation.

Nitrogen emissions from agriculture are a serious environmental issue, being the main cause of eutrophication and acidification. Due to a heavy reliance on fertilisers, loss of nitrogen to the environment through agricultural processes has received a great deal of attention in terms of reducing the need for fertilisers and mitigation of nitrogen emissions. More information on the issues surrounding nitrogen and nitrate vulnerable zones can be found in the Farming Connect article: 'Nitrate Vulnerable Zones (NVZs)'.

There is a direct loss of nitrogen from livestock themselves in the form of compounds such as urea in urine. Nitrogen is a key component of amino acids, which are the structural units of proteins, and therefore all animals consume nitrogen through the protein in their feed. Protein is necessary for general animal maintenance as well as production, and protein requirements are higher in lactating dairy cows compared to heifers and dry cows, due to the increased need for amino acids in milk protein synthesis. However, there are also losses of nitrogen to the environment, Box 1 shows that cattle can loose on average 75% of their total consumed nitrogen through waste pathways – mainly faeces and urine.

Nutritional recommendations for livestock give dietary crude protein (CP) levels that should be maintained for the general health and welfare of the animal, and also for production. It is known that if these levels are exceeded, nitrogen emissions increase, yet milk yield does not increase in dairy cattle – thus the nitrogen efficiency of the animal is reduced. By reducing the CP intake in a well formulated diet, nitrogen excretion can be reduced with only limited effects on milk yield or composition, meaning that nitrogen use efficiency is improved. Recent research has also shown that if grazed dairy cows are fed a low protein (14.1% CP) concentrate supplement, nitrogen excretion can be shifted towards faeces rather than urine. Such a finding is beneficial for environmental considerations, because nitrogen in faeces is

less volatile and therefore will convert at a much slower rate to harmful products such as ammonia and nitrous oxide (a potent greenhouse gas) compared to urine. However, larger scale trials are needed to test this work further as well to investigate the long-term effects on farm production.



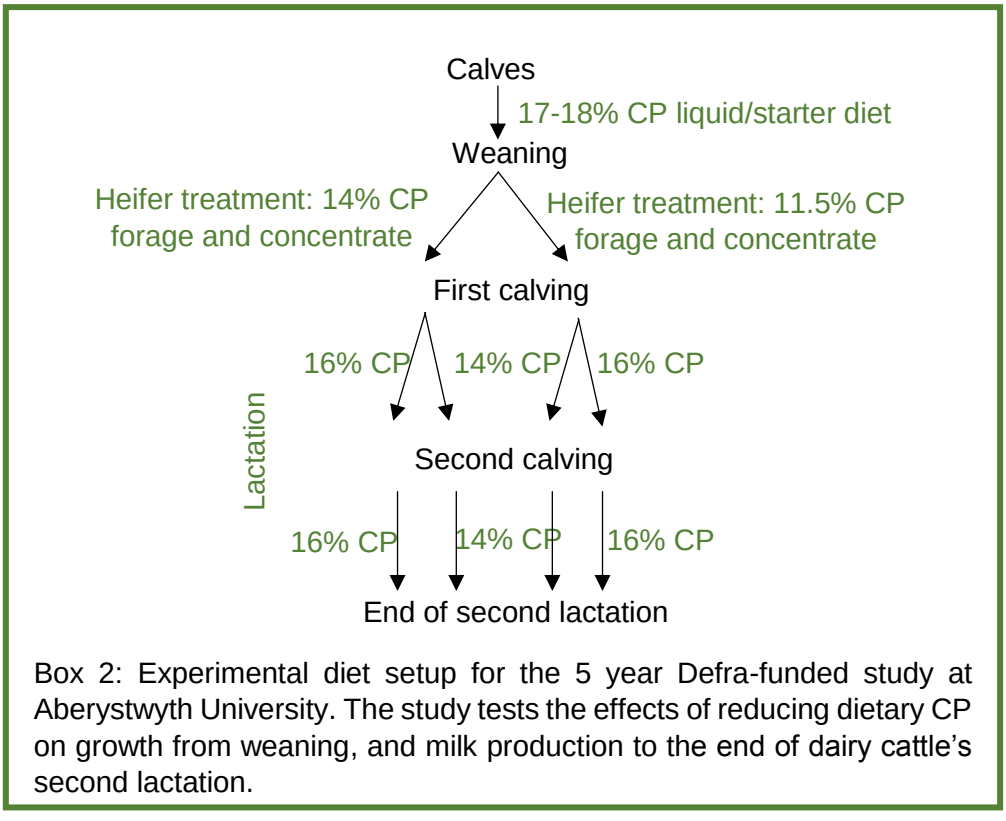

Box 1: Average nitrogen use efficiency of dairy cattle. Around 75% of consumed nitrogen is lost as waste.

The relative proportions of the types of protein fed are also important. In relation to utilisation in the rumen, protein can be classified as either rumen-degradable (RDP) or undegradable protein (RUP). Ruminants must be fed a proportion of RDP that microbes in the rumen utilise, not doing so has adverse effects on fermentation of dietary fibres in the rumen and consequently there is poor use of feed and reduced provision of microbial protein to the small intestine. Yet overestimating the provision needed by the rumen, or not supplying sufficient readily fermentable energy in the diet, results in an excess of nitrogen that can lead to increased nitrogen emissions in urine. Thus, both the protein and energy sources should be considered when reducing dietary CP concentrations, including RUP whilst reducing RDP to an acceptable level, to ensure a good amino acid supply for good milk yields.

It is clear that there is a case for reducing the CP concentrations of dairy cow feeds to reduce nitrogen emissions and therefore help to improve the environmental sustainability of dairy farming. Yet many of these studies have been completed in lactating cows, and replacement heifers, which comprise a substantial proportion of dairy herds, must also be considered. Although some research has been carried out to show reducing dietary nitrogen in heifers also reduces excreted nitrogen (mainly by reducing output in urine), there was no supporting data on production performance, such as animal growth and future milk production.

*Work at IBERS, Aberystwyth University.*

Researchers at IBERS are involved in a Defra-funded project that is investigating the effects of reducing CP intakes of growing heifers on their future production performance. Box 2 details the experimental setup, showing that low-CP diets were compared with standard diets from weaning through to the end of 2nd lactation. To measure the effects of reducing CP intake on the first 4+ years of life, the following data were recorded: growth, health, fertility, 1st and 2nd lactation performance, and whole body nitrogen partitioning. 100 heifers were recruited onto the study to give 25 in each of the 4 final treatment groups.




Box 2: Experimental diet setup for the 5 year Defra-funded study at Aberystwyth University. The study tests the effects of reducing dietary CP on growth from weaning, and milk production to the end of dairy cattle's second lactation.

The project has found no overall effect of reducing heifer diets from about 14% CP to about 11.5% CP on growth. Body weight, condition scores, wither height, girth circumference, back length and hip width were measured whilst heifers were growing and there was no effect of diet on any of these measurements. Therefore reducing protein in the diet did not have an effect on the growth of the heifers.

Fertility and reproductive performance were also recorded. There was little difference in the age at first calving with the control group average at 28.3 months and the low protein group at 27.7 months. Therefore, in terms of the animals reaching puberty and the ability to conceive, there was no effect of reducing the dietary protein. It appeared that heifers given the lower protein diet had a slightly better conception rate at first service compared to the heifers fed the control diet, although this needs further research with more animals. Furthermore, reduction in protein for heifers had no influence on calf weight or calving issues, such as dystocia. Therefore, feeding a diet with a reduced protein concentration of 11.5 % CP to heifers from weaning has no overall effect on growth or reproductive performance, suggesting it to be a viable management system to reduce nitrogen emissions from replacement heifers.

The project is currently collecting data from the lactating cows and so a full data set is not yet available to draw any conclusions on the long-terms of effect of reducing protein during heifer growth. However, preliminary data suggests that there is no substantial effect on lactation performance. Look out for further information over the coming year for the final results from this project at IBERS.

## Think Climate

*Reducing the CP content of dairy cattle rations to a percentage that supports maintenance and production will:*

- *Reduce nitrogen excretion and any subsequent eutrophication and acidification from conversion into ammonia, as well as reducing conversion into nitrous oxide (potent greenhouse gas).*
- *Reduce our reliance on protein sources such as soya from South America, thus helping to reduce the associated land use changes and greenhouse gas emissions from soya production.*

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