A clear solution for farmers
CATCHMENT SENSITIVE FARMING

Reducing Ammonia Emissions from Dairy Farms through Livestock Feeding Strategies

Why is ammonia a problem?

Ammonia is a key air pollutant that can affect both the environment and human health. Ammonia emissions are one of the largest contributors to acidification of soils and eutrophication of habitats and water bodies. Ammonia emissions combine with pollution from industry and transport (e.g. diesel fumes) to form very fine particulate matter ($PM_{2.5}$), which can then be transported significant distances in the air adding to background levels to which people are exposed. When inhaled particulate matter can contribute to cardiovascular and respiratory disease.

In the UK around 87 per cent of ammonia emissions come from agriculture. Dairy farms are responsible for 28 per cent of the emissions produced by agriculture; around 70 per cent of input nitrogen (protein from the ration) is excreted in urine as urea. This urea volatilises to ammonia in the air. There is scope to reduce input nitrogen, improve the efficiency of utilisation of input nitrogen and, therefore, reduce output urea. This urea is converted to ammonia and lost to the air. This contributes to a collaborative approach (between input nitrogen, storage of manure and spreading of manure) in the reduction of ammonia emissions from dairy farming.

This case study presents the approach, decision making and experience of a dairy farm in the south west of England. The farm is situated in Somerset and the land drains into the Huntspill River, which is a tributary of the River Parrett. The farm is in an Nitrate Vulnerable Zone (NVZ) – Figure 1.

The business supports approximately 150 dairy cows and 100 youngstock. The farm is 99 hectares (ha) in total, growing 40 ha of maize, and the remainder is grassland. The dairy cows are grazed for around five months of the year and are housed in sand cubicles during the winter. All of the youngstock and dry cows are loose housed in straw yards. Annual yield is 8,500 litres, with a butterfat of 4.13 per cent and milk protein of 3.34 per cent, on an autumn block calving system.

Figure 1 - Geographical location of case study farm.
Source: Magic Maps: Groundwater & Surface Water Nitrate

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Options for reducing input nitrogen

A high proportion of maize silage in the partial mixed ration lends itself to the autumn block calving system where the majority of energy for milk and fertility is required during the housed period. The farm currently implements an in parlour “feed to yield” system (Figure 2) and cows have access to blended and molasses feed. The partial total mixed ration (TMR) is mixed via a mixer wagon and fed out once a day in a single feed trough.

Any farmer seeking to explore feed options should seek appropriate technical advice from a registered Feed Adviser (FAR).

Figure 2: Feed to yield operating system in parlour

Changing rations to reduce input nitrogen options

- Reduce blend protein input – the current blend consists of 50 per cent rapemeal and 50 per cent maize distillers grains (crude protein 33 per cent) fed at 2 kg/head/day in the partial TMR in the feed trough.
- Reduce the parlour cake protein input – the current parlour cake is 18 per cent crude protein, and is fed up to 11.5 kg/head/day to cows yielding over 22 litres.
- Reduce the molasses protein input – the current molasses spec is ReguMaize 44 (crude protein 44 per cent) and is fed at 1.5 kg/head/day in the partial TMR in the feed trough.
- Reduce the grass silage protein input – the current grass silage is 27 per cent dry matter and 13 per cent crude protein, and is fed at 20 kg/head/day. Maize silage contributes to the remaining forage input in the feed trough.

How did this farm assess and quantify the most appropriate reduction in input nitrogen?

Initially the farm requested technical adviser support to accurately quantify the requirements of the ration for all stages of lactation in order to assess whether existing feeding strategies were meeting requirements.

The advisor reviewed existing livestock numbers, liveweight and yield of the cows, stage of lactation, calving interval, number of months housed and grazing, the volume of forage in storage and the margin over purchased feed.

High yielding, early lactation cows on this farm receive sufficient energy for 42 litre lactation requirements (11.71 MJ/kgDM and a crude protein of 17.7 per cent). The parlour cake is gradually reduced to 0 kg at 22 litres. This results in late lactation cows consuming a ration at the feed trough with a crude protein of 16 per cent. Due to the 2018 summer drought, silage stocks are not as high as usual. The current cost per litre at 42 litres is 8.51 ppl.

Options around the most effective feeding system change to reduce input nitrogen were considered and the confirmed ‘Best Available Technique’ was reducing crude protein percentage content of parlour cake to 16 per cent.

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What were the benefits and costs of reducing input nitrogen through the parlour cake on the farm?

Benefits

For the case study farm there were a range of positive benefits which contributed to the decision to change parlour cake crude protein levels as demonstrated in Figures 3 and 4. These were:

- Reduction in ammonia emissions from urine.
- Reduction in environmental impacts on local environmental sites.
- Improved ration balancing and maintaining milk yield. This was demonstrated by a reduction in milk urea from 24 mg/l to 20 mg/l whilst milk yield in terms of volume and solids (fat and protein) remained constant.
- Maximised nutrient management to reduce feed costs.

Using the approximation that ration crude protein equates to 16 per cent nitrogen, it has been quantified that nitrogen in urine, and therefore risk to ammonia emissions, has reduced from 549 g per day to 508 g per day, equating to a 5 per cent potential reduction in emissions.

A reduction in milk urea also demonstrates benefits to cow health and fertility. An analysis of 21 studies by Lean et al (2012) found cows were 9 per cent less likely to conceive on a high protein diet. It is too early to judge the effect of this study on fertility on this farm.

	Current diet	Changed diet
	42 litre target	42 litre target
Crude protein (per cent)	17.7	16.7
Energy MJ/kg dry matter	11.71	11.79
Cost per litre ppl	8.51	8.37
Maize silage kg fresh weight	20	20
Grass silage kg fresh weight	20	20
Blend kg	2	2
Molasses (ReguMaize 44) kg	1.5	1.5
Butterfat extra kg	0.25	0.25
18% dairy cake HE – 12.7MJ kg	11	0
16% dairy cake HE – 12.9MJ kg	0	11

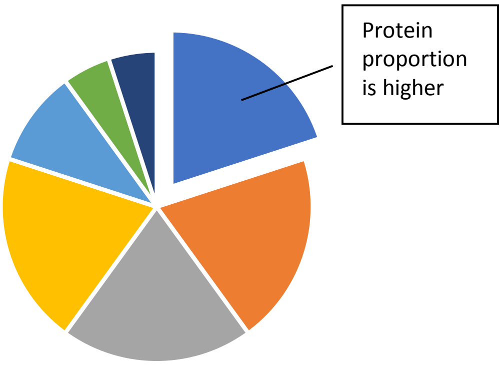

Figure 3: 18 per cent crude protein dairy cake 12.7 ME

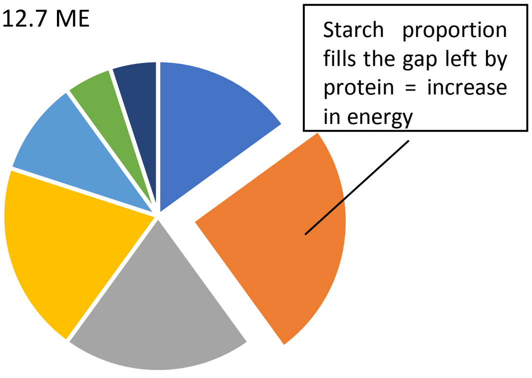

Figure 4: 16 per cent crude protein dairy cake 12.9 ME

Costs

The reduction in parlour cake cost due to the reduction of 2 per cent protein was £5 per tonne.

The farm currently averages 2.18 t concentrate/cow/annum with a herd size of 150 cows. This leads to an annual cost benefit of parlour cake protein reduction of £1,635.

The positive outcome cost benefit, although small, demonstrates the potential for change for environmental benefit.

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Importance of utilising best practice feeding strategies when reducing ration protein

If the farm proposes a reduction in dietary protein, it is important to appreciate that this can reduce appetite and therefore dry matter intake (DMI). A recent study by Nottingham University, in collaboration with Harper Adams University, reduced crude protein to 15 per cent but experienced a DMI reduction of 0.3 kg/head/day.

This needs careful energy density balancing within the ration. If this energy balance is not retained, the cost benefits associated with feed cost, and fertility, will not be seen. Moreover, milk yield depressions may be seen if energy is not balanced.

Key contacts and information

Catchment Sensitive Farming (CSF) is able to provide events, tailored advice, individual visits and grant support to farmers on air quality measures and reducing water pollution on farm.

A registered Feed Advisor can be found through the AIC's Feed Adviser Register (FAR).

The energy in this case study was balanced using the space created by reducing protein within the dairy cake formulation.

By implementing this route of ration protein reduction, it can also be maintained when the cows are turned out to grass, where there is limited buffer feed. There may be scope to reduce protein further on this farm in the winter diet.

Three 'take-away' messages

1. Although small, there are ammonia emission reduction benefits to reducing ration nitrogen, as well as benefitting nutrient management. Compared with the other ammonia mitigation techniques on farm such as covering slurry stores, it is a cost beneficial option. However, it should not be implemented on farm without technical advice.

2. It is essential that ration energy density is balanced otherwise any savings made from parlour cake protein reductions are lost. Protein reduction benefits to fertility could be negated with a reduction in ration energy density. Milk yield is likely to also be lost if the ration energy density is not balanced.

3. Cost benefits and environmental benefits can be experienced by implementing this feeding strategy. The right ration is important and it could require additional management; it is important to take account of all cows at all stages of lactation into consideration. Reducing protein in late lactation cows could result in weight gain, yield loss and increase risk of ketosis.

Department for Environment, Food and Rural Affairs (Defra) published a new code of good agricultural practice for reducing ammonia emissions in 2018.

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