Note last page, effuent storage and N volatilisation

PAUL MARTIN

REPORT ON EUROPEAN STUDY TRIP

This article is based on a report compiled at the completion of a recent European study trip undertaken by Paul Martin, 2017 DairyNZ Dairy Rural Professional of the Year. The trip was funded by his prize from this competition.

In late May 2018, I travelled to The Netherlands and Northern Germany. My trip included visiting a range of research institutions, meeting with researchers and dairy farmers, visiting biogas plants and farm effluent processing facilities, and meeting with farm consultants, farm environmental advisors and an agricultural extension body. After driving more than 1200 km, I departed Amsterdam with more questions than necessarily concrete answers, but with a lot of ideas.

De Marke research farm

My study trip began in The Netherlands by visiting the De Marke research farm. De Marke is one of two off-campus research facilities owned by Wageningen University. Located in the Eastern Netherlands, relatively close to the German border, De Marke conducts farm systems research. Currently, De Marke is set up to demonstrate what might be possible under a Dutch dairy farming system which uses some cow pasture grazing to qualify for a milk company premium (120 days a year for six hours a day), has very low nutrient losses including leaching, run-off and gases, is carbon neutral, and makes limited to no use of chemical sprays.

I met with the research manager of De Marke, Zweir Van de Vegte. This was my first taste of Dutch dairy farming and, in what was to be repeated throughout the week, it was noticeable how much emphasis they place on minimising ammonia volatilisation. This focus includes how they apply effluent and store effluent, and how they crop paddocks and feed their cows. Key points of interest that I observed at De Marke were:

Grazing cows in Germany

Bedding trial

Dairy farmers in the EU may only apply 170 kg N/ha per year from effluent, and due to their stocking rates many farms have far more effluent nitrogen than land to spread it on.

- They aim for a milk urea concentration of under 20 consistently to ensure they have optimised the use of feed protein and minimised urea excretion in the urine. The target crude protein level of the diet is 14.5-15.0%, which includes a measurement of the grass protein levels
- An injection of effluent slurry at 35 m³/ha, preferably (for less ammonia volatilisation) diluted 1:1 with water and injected at twice that rate
- A focus on measuring and using deep mineral N in the soil with maize crops, thus reducing the use of nitrogen fertiliser on maize. No solid fertiliser is placed in the first year, only injected slurry either side of the maize rows two days before planting. GPS is heavily used in The Netherlands
- Reliance on deep ploughing (20-25 cm) for weed control, and also to mineralise soil nutrients so that they are available for the plants in the absence of fertiliser
- An Italian ryegrass 'catch crop' is sown between the maize rows, with an air seeder, six weeks after the maize was planted
- An on-farm biogas plant selling biogas into the local grid was interesting, although not producing sufficient return on investment to make it a commercially viable project.

Veenhuis machinery factory

Following De Marke, I visited the Veenhuis machinery factory. They make effluent equipment, in particular slurry wagons and the associated application booms for either effluent injection or 'dribble bar' application. For a machinery sales company, they have carried out significant research into reducing ammonia volatilisation, as well as proof of placement technology. They have recently released a state-of-the-art attachment that can be fitted to their machines. This uses near-infrared spectroscopy (NIRS) to assess the nitrogen, ammonia, phosphorous, potassium and dry matter content of effluent slurry in real time, and to adjust application rates to apply nutrients at the precise level desired.

These are not small slurry wagons, most of them having 1.6 m diameter tyres, one to four axles, and holding up to 40,000 litres of slurry. The largest wagon requires a 350 HP tractor to tow it. Even the mid-size slurry wagons were priced at 130,000 Euro (NZD$220,000), so while the technology would be valuable in New Zealand, I struggle to see a business case for that level of investment in machinery. It is also debatable how these machines would cope with anything more than the slightest slope or variable contour in a paddock. Use of slurry wagons with a spreader plate as we do in New Zealand is banned in The Netherlands and it is soon to be banned in Germany, hence their use of effluent injection and dribble bars.

ry Campus

My next visit was to Dairy Campus, the second off-campus research facility of Wageningen University. Located in Northern Holland, this is an impressive applied research facility which was built two years ago. A variety of research trials are undertaken there, with many of them focusing on reducing greenhouse gas (GHG) and ammonia production (10% of the EU's GHG production is from agriculture).

I toured the facility with one of the university's researchers, Harm Wemmenhove. Key points of interest that I observed at Dairy Campus were:

- They are finding lower GHG emissions off deep litter wood chip floors compared to slatted, solid or straw covered floors
- Methane emissions have been shown to decrease when a lower fibre diet is fed to the cows, although predictably they ran into acidosis issues with this diet
- Pumping air into the slurry stored under the floor of the sheds decreases ammonia volatilisation (they are repeating this trial to clarify the results)
- I saw a very impressive artificial wetland system, which was being used to treat all run-off from cow yards (not the cow houses) and races. The water passed through two wetlands followed by a long shallow pond before being allowed to discharge into a waterway.

Manure Tailored Project

From Northern Holland I travelled into Northern Germany and embarked on a very busy tour of a variety of dairy farms, as well as organisations and facilities connected with cutting edge nutrient management. Compared with The Netherlands, Germany seemed to have less focus on ammonia, but a significant focus on the full-farm nutrient cycle, largely due to stricter government regulations than in The Netherlands.

I met with members of the 'Mest op Maat' (Manure Tailored) Project, which is investigating ways of using effluent nutrients off-farm. This project has developed a system using either a centrifuge system on the back of a truck, or else a press sieve also on the back of a truck, to separate dairy effluent on-farm. These separators are operated by contractors and they arrive on-farm, suck effluent out of holding tanks on the property, take away the solid fraction and leave the liquid fraction for use on-farm.

The solid waste is trucked to a commercial biogas plant, which uses it as digesta in the generation process. Farmers pay for this service, largely due to the fact that under the nutrient rules they cannot apply all their effluent nutrients on their own farms. Dairy farmers in the EU may only apply 170 kg N/ha per year from effluent, and due to their stocking rates many farms have far more effluent nitrogen than land to spread it on.

.ommercial biogas plant

I subsequently visited a commercial biogas plant using dairy effluent solids to produce 400 kV/hour of electricity. This business was commercially viable, processing 20 tonnes/day of solid waste from dairy farms, which

Mest op Maart Project press sieve solids separator

Slurry wagon

On-farm screw press solids separator

Artificial wetland system for nutrient removal

Covered effluent pond

the dairy farms provided for free. In a continuous operation, the solid waste passes through two 1,000 m^3 digesters over a period of 60 days before the resulting slurry is stored and transported back to the dairy farms.

Currently, electricity is generated by burning off the methane produced by the biogas digestor, but the business foresees that producing biogas for cars may be the best future path. There are 1,600 biogas plants in Lower Saxony, which is the region of Northern Germany that I was visiting. It was baffling to hear that 30% of all maize grown in Germany goes into biogas production – it was previously 50%.

Wider dairy farm operation learnings

In my tour of dairy farm operations in Germany, and meetings with rural professionals, I observed a number of approaches:

Effluent

The measured methane loss from an unroofed effluent pond was quoted as being 10%, reducing to 2% with a roof. Slurry tanks using a spreader plate, as in New Zealand, are quoted to have 80% ammonia loss from the slurry. If effluent is applied to a sprayed-out paddock, the paddock must be cultivated within one hour. The German government is moving towards full traceability of effluent from extraction to spreading. Soon effluent will not be able to be applied within 10 m of a waterway if the slope is greater than 10%. Denmark adds sulphuric acid to effluent, to lower the pH in an effort to increase ammonium, and thus decrease ammonia release.

Material flow balance sheet

The German government has advisors who visit every farm each year, and construct a 'material flow balance sheet' for the farm. This counts all nutrients in and out of the farm system, with the allowable nutrient surplus being 50 kg/ha P and 10 kg/ha N. From this balance sheet, they give each farm an annual fertiliser plan for each paddock separately.

Nitrogen and potassium

There are groundwater N targets of below 50 mg/litre. The groundwater in the areas I visited is currently well in excess of 100 mg/litre. Minimum storage capacity for liquid manure is six months and two months for solids. No nitrogen is allowed on grassland for November, December, January (May, June, July our time), and it is also not allowed to be applied in October (April our time) for arable land. The German government is heading towards longer periods of restriction due to weather. Potassium is measured, but is not regulated with regard to nutrient losses.

Recycling

Silage wrap is all collected by truck and recycled in China. All feed bags are paper with a plastic liner. Both the paper bag and the plastic bag liner are recycled.

Annual Nutrient Cycling Assessment (ANCA) tool

Back in The Netherlands, I visited the main campus of Wageningen University. There I met with a soil scientist, Gert-Jan Noij. He talked me through a nutrient modelling program called the ANCA tool. In the same vein as Overseer, this model has been developed by the Dutch dairy industry. Interestingly, their motivation seemed to be more so that they could convince the EU that they could apply more nutrients on some farms. Key points of interest that I noted in my discussions at Wageningen University were:

- Dutch dairy farm soils average 5.0-5.5 pH
- The concern over ammonia volatilisation comes from acid rain concerns, as well as problems with eutrophication when the ammonia is taken up by soil and plants
- With high water tables, 50% of soil N surplus is leachable, while with lower water tables this is closer to 100% due to more aerobic conditions. Under anaerobic conditions, denitrification takes place. Interestingly, denitrification can leak nitrous oxide, which is an important concern as a GHG
- The ANCA model demonstrates that the biggest effector of farm nitrogen use efficiency is soil N use efficiency. Thus N applied when grass is most active is most efficiently used
- Minimal amounts of artificial N are used on maize crops in The Netherlands. Rather, effluent is applied at sowing at around 100-150 kgN/ha
- A Farm Water Index tool is being developed by the university researchers to produce an assessment of whole-farm nutrient cycling and efficiency down to the paddock level. This tool takes data from ANCA, combined with a soil type map, a water table map and information on: soil organic matter levels, contours and drainage, drain types, rainfall, topsoil condition and soil biodiversity. The tool is at the stage of Beta testing, but my assessment was that the use of the tool by farmers required a lot of time. However, it has the potential to identify areas for attention on-farm.

Conclusions

Compared to European farmers, most New Zealand dairy farmers currently have little knowledge of the nutrient content of their effluent. We need to become more precise in our effluent application, to optimise nutrient usage and minimise losses. Knowing nutrient application rates based on the nutrient content of the effluent will help to allow farmers to defend continued effluent application to land into the future.

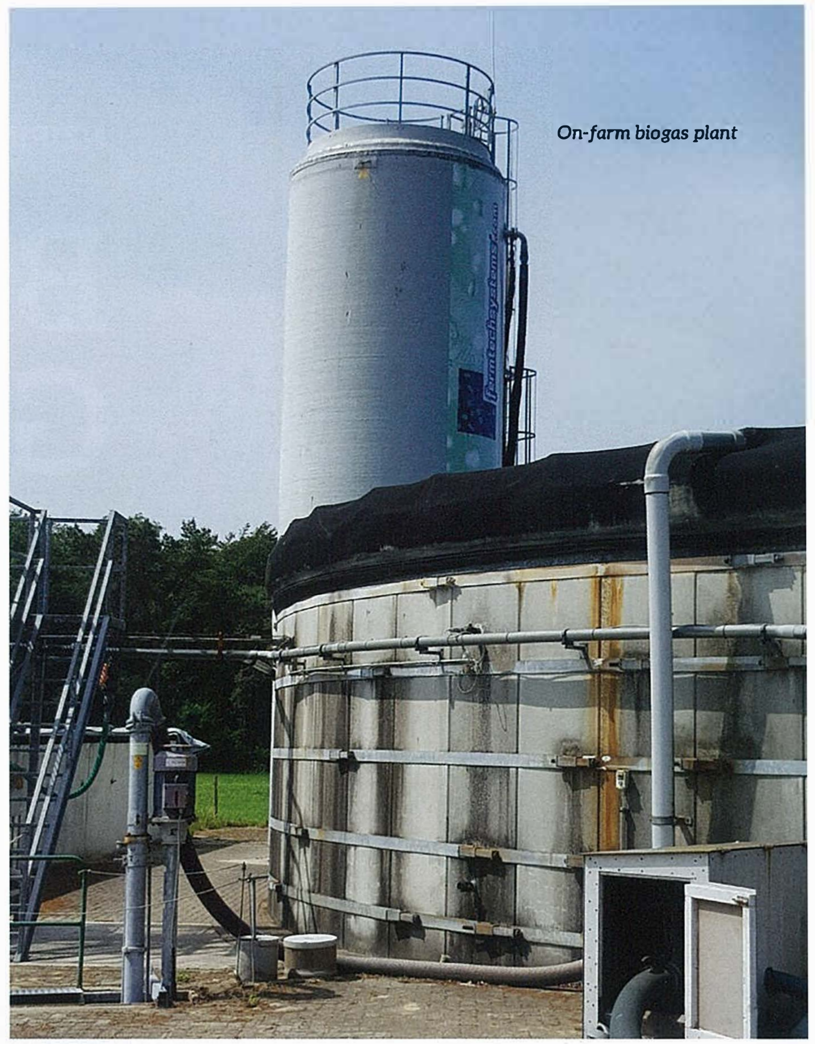
In New Zealand we do not focus on ammonia volatilisation from effluent, seeming to only worry about volatilisation from urea applications.

> Can we afford to ignore our gas losses from effluent, both during storage and application?
>
> ✓ I cannot see how, long term, New Zealand dairy farms can continue to have uncovered effluent ponds. Can we still accept the gas losses from an effluent pond? Also rainfall capture is leading to a requirement for larger holding facilities than would otherwise be required.

It is inevitable that in the future farmers will need increased effluent storage capacity on New Zealand dairy farms, to reduce leaching from effluent irrigation onto saturated winter soils. This will make solids separation an attractive option to reduce the liquid storage capacity requirement.

More work needs to be done before on-farm biogas generation is economically viable, and only rising electricity prices is likely to drive more research and investment in this area. NIWA is currently doing some work on this option. We need to measure deep mineral N more frequently, and adjust our cropping fertiliser applications accordingly.

GPS technology on machinery needs to become the norm, and with some haste, because we are missing out on the gains that it allows farmers to make in precision nutrient placement and cropping. The uptake of GPS technology in New Zealand is patchy, with it already being



On-farm biogas plant

We are already grass-fed in New Zealand, even with the average dairy farm feeding 10-20% of the diet as supplements. If 120 days a year for six hours a day qualifies for a grass-fed label overseas, then even New Zealand's most highly supplemented farm qualifies easily. Friesland Campina is paying approximately a 5% premium for grass-fed milk under the criteria mentioned above. Are our dairy companies doing enough to extract a premium for our milk? New Zealand dairy companies, and our industry, need to do a better job of advertising our grass-fed status on our products. We are already feeding our cows more grass than almost any other dairy exporting country, so we need to stop getting hung up on the finer points of what grass-fed means because no-one else is.

I believe we are taking our grazing management knowledge in New Zealand for granted, but it is so far in front of what I saw of European farming that we should pat ourselves on the back, We are doing really well in New Zealand dairy farming (that is not saying we cannot improve), and I certainly don't think we want to go down the housed cows route like Europe.

Acknowledgements

I would like to extend my sincere thanks to all the sponsors of the DairyNZ Dairy Rural Professional of the Year competition: DairyNZ, NZIPIM, Farmax, MPI and Beef & Lamb. Without the generous support of these organisations this study trip would not have been possible.

Paul Martin is a Farm Management & Nutrition Consultant based in Northland. Email: perenphord@xtra.co.nz. J