Making urea more sustainable

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Technical Research Briefing

As fertiliser prices continue to track upwards and the industry is pushed to reduce ammonia emissions, what can growers do to make the most of their fertiliser, with minimal environmental impact? *CPM* investigates.

By Ruth Wills

The UK is legally obliged to reduce ammonia emissions by 16% by 2030 — a requirement which will undoubtedly impact on the agricultural sector. Indeed, 87% of the UK’s ammonia emissions come from farming, of which 18% is attributed to inorganic fertiliser application, with solid urea fertilisers accounting for 8% of the UK’s total ammonia emissions.

As a result, Defra is considering three options for reducing ammonia emissions:

- Banning the use or sale of solid urea fertilisers
- Obligatory use of urease inhibitors
- Restricting spreading of solid urea to between 15 January and 31 March.

In response to the Defra consultation, the NFU and Agricultural Industries Confederation (AIC) have said that banning solid urea fertiliser is unwarranted. So what role can urease inhibitors play?

One product on the market is Limus (NBPT+NPPT), available as Limus Clear for use with UAN and Limus protected urea, which involves a treatment applied to solid urea.

“We treat urea with the inhibitor, so when it’s applied to the field the Limus inhibits an enzyme in the soil, which reduces ammonia volatilisation by up to 98%,” explains Richard Corden, business development manager at BASF. “So, for solid fertiliser, this means you get the benefits of urea without needing to ban anything.”

With the climbing fertiliser prices, inhibitors may be an appealing option. “If you’re getting losses in the form of ammonia, you’re effectively losing nitrogen to the atmosphere, for which you’ve paid a lot of money.”

Cost benefit

There’s another benefit to the purse strings, he says. “In a typical year, urea is usually the cheapest form of nitrogen, but it can have these losses. Upgrading to inhibited urea is normally still cheaper than ammonium nitrate.

“By minimising ammonia losses from the urea, you get the nutrient performance of ammonium nitrate, while cutting pollution — so it’s a win for the farmer, the environment and the crop.”

The ammonia reduction targets have been issued as a part of EU legislation and within that each country could choose a different target. As the UK is yet to decide on its approach, how have other countries pledged to cut ammonia emissions? For a start, Germany has proposed to treat all urea with an inhibitor, explains Richard.

“But Ireland has a couple of different issues — almost all ammonia emissions and around a third of its greenhouse gas emissions come from agriculture. The majority of greenhouse gas emissions arise from its economically important dairy industry, with methane accounting for 65% of this total.”

Use of protected urea has been identified as the largest single avenue to help Irish agriculture meet commitments to reduce greenhouse gas and ammonia emissions. Research by Teagasc has shown that switching from calcium ammonium nitrate (the most popular synthetic fertiliser in Ireland) to protected urea will reduce nitrous oxide emissions by 71%, while switching from urea to protected urea will reduce ammonia emissions by 79%.

The Irish government therefore wants to shift from calcium ammonium nitrate to protected urea by 2030 in a bid to reduce both nitrous oxide and ammonia emissions. “That way a reduction in nitrous oxide emissions can be achieved, while also ensuring there isn’t a swing upwards in ammonia emissions, which would happen if the switch was to standard urea instead,” says Richard.

“It’s also cost effective, as it’s one of the few technologies where farmers can switch and save emissions without extra cost.”

In Ireland in 2020, sales of protected urea increased significantly, with almost 40,000t ▸

Limus urease inhibitor cuts ammonia losses from applied urea by temporarily binding the naturally occurring urease enzyme in soils – benefiting the environment and potentially improving crop profits too.

▸ sold compared with 21,000t in 2019.

For New Zealand, the use of protected urea has been increasing year-on-year. "Up to 35% of its urea is now treated with a urease inhibitor," says Richard.

"We feel like urease inhibitors are finally having their day, partly driven by legislation and the need for controlling ammonia emissions and Limus is a nice technology fix, without imposing a legislative burden on farmers or trying to ban things. Finally, after many years this technology might come to the forefront and become a standard, so that when you get urea — it will be protected."

There can be some misunderstanding over how urease inhibitors work and how they might impact soil health. Urease inhibitors, like Limus, temporarily bind to the urease enzyme that naturally converts urea into ammonium. ''We are most familiar with enzymes in biological washing powder, where they break down dirt and stains.

Limus Clear agronomic trial results

Site	Yield benefit (t/ha)	Statistically significant	MOIC (£/ha)
Essex, 2019	0.29	Y	+ £39
Rutland, 2019	0.17	Y	+ £20
Bedford, 2019	0.57	N	+ £82
Essex, 2019	0.30	Y	+ £41
Shropshire, 2020*	0.00	N	-£7
Norfolk, 2020	0.08	N	+ £4
Cross-site analysis	**0.23**	**Y**	**+ £30**

Across six tramline trials Limus Clear delivered an average yield benefit of 0.23t/ha and an average Margin Over Input Cost (MOIC) of £30/ha.*Site yielded lower than predicted, meaning excess nitrogen had been applied.

Source: ADAS, 2021

Limus protected urea trial results

Site	Crop	Relative yield (t/ha) of Limus
N. Yorkshire 2020	Winter barley	+0.72
Berkshire 2020	Winter wheat	+0.28
Kent 2020	Winter wheat	+0.24
Hampshire 2020	Winter wheat	+0.19
Berkshire 2020	Winter barley	+0.13
Cambridgeshire 2020	Winter wheat	-0.11
Nottinghamshire 2020	Winter wheat	-0.32
Yorkshire 2020	Winter wheat	-0.35
Coventry 2020	Winter wheat	-0.44
Cross-site analysis		**+0.06**

Across nine sites, on average, Limus protected urea delivered an equivalent yield (+0.06t/ha) and protein performance to ammonium nitrate.

Source: ADAS, 2021

Grower sees a clear benefit

James Faulkner has benefited from more flexible urea application windows when using Limus.

One farmer involved in evaluating Limus is James Faulkner, who farms 1,350ha at Brickhouse Farm, Colchester, Essex. He came across it at a Frontier meeting after seeking some new fertiliser options. "They were comparing two products and Limus Clear was significantly outperforming the other, so I asked if I could try some. BASF and ADAS got involved and we started doing trials for them."

James was already using liquid UAN, so added Limus Clear to compare untreated and treated tramlines.

"On average it was giving 0.3t/ha benefit in our wheat trials. By the second year we were so happy with the results that we ended up using it on the whole farm," he adds.

James then went on to trial it on forage maize. "The untreated dry matter yield was 52t/ha and the treated 58t/ha."

Aside from the yield he found some other significant benefits. "It widens the application window; we can't always spread all our fertiliser before the rain. It just makes me happier that we're putting on UAN at a time when you wouldn't be putting on straight urea.

"It also allows me to put nitrogen on the maize earlier, which means there is less scorch. And I have the confidence it will still be there when it needs it," he says.

Another benefit is that it's easy to use. "It's applied at a low rate; some of the other products have to be put on separately, which is a nuisance."

Farm facts:

- James farms alongside his wife, Zena, and his aunt and uncle
- 1,350ha - some owned and some contract farmed
- 300ha forage maize, plus milling wheat, peas and barley
- Foraging business.

How to use Limus Clear

- Fill spray tank with half the desired amount of fertiliser
- Add the correct rate of Limus Clear and mix thoroughly
- Continue mixing while adding remaining fertiliser
- Use tank mix within five days.

On-farm benefits

Benefits of Limus:
- Improves nitrogen use efficiency by reducing ammonia emissions by up to 98%
- Contains two actives: N-(n-butyl) thiophosphoric triamide (NBPT) and N-(n-propyl) thiophosphoric triamide (NPPT), enabling it to bind to a wide variety of urease enzymes

Benefits of Limus protected urea:
- Increases yield by 5% compared to standard urea.
- Improves performance of urea to the level of ammonium nitrate
- 12 month storage stability

Benefits of Limus Clear:
- Increases yield compared to untreated liquid fertiliser
- Fully compatible with liquid fertiliser – straight N and NS grades
- Flexible risk management tool – can decide on the day whether to include if risks of volatilisation are high.

Enzymes are essentially nature's catalysts," he explains.

Urease enzymes are abundant in the environment. It's estimated that 79-89% of urease activity is derived from enzymes bound to the soil; this makes them easy to target with an inhibitor, believes Richard When urea is broadcast, ammonia emissions can be reduced by adding small amounts of inhibitors (parts per million) directly to the fertiliser.

"Inhibitors only need to work in the 'fertisphere' — the 2-5mm of soil around each granule, where the urea is first converted to ammonium. The artificially high concentration of fertiliser present, triggers a very localised pH spike, leading to nitrogen losses in the form of ammonia.

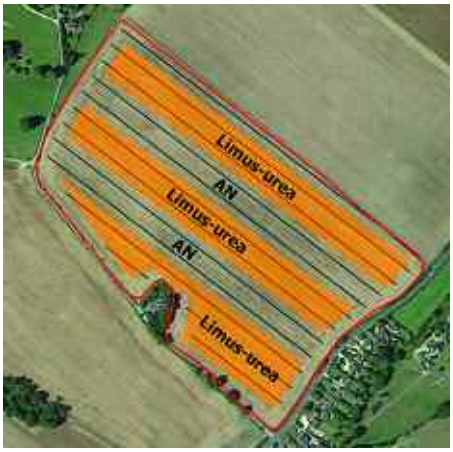
"Inhibitors delay the conversion to ammonium and protect against losses; once washed into the soil, other urease enzymes quickly convert the urea into ammonium," he explains.

Since 2017, ADAS has been running agronomic trials on combinable crops and analysing yield map results — it began working with BASF on Limus Clear trials in 2019. "The farmers compared liquid nitrogen fertiliser — straight or with Limus Clear — at the same rates and timings," explains Susie Roques, research consultant at ADAS. "The fields were split into tramlines of untreated UAN and treated UAN."

Yield benefit

The solid fertiliser trials have only been running for two years (2020 and 2021), so results from 2021 are not yet finalised. "Most of the solid trials have compared ammonium nitrate with Limus treated urea. For those, we work in double tramline plots; because of the spinning disc fertiliser spreader there are areas of overlap and we have to exclude the yield data from them," says Susie.

The hope was to find a yield benefit with Limus Clear and no difference in the solid trials — to show that Limus treated urea is as good as ammonium nitrate. Both aims were achieved. "The results we have are consistent with last year. For Limus Clear



ADAS trials in winter wheat have helped to show the merits of Limus.

with UAN, we saw a 0.2t/ha yield benefit.

"For the solid trials there is no difference on average between the ammonium nitrate and Limus treated urea."

This might make a big difference in years when farmers are reining back on fertiliser applications. "Those who usually apply their fertiliser generously probably wouldn't expect to see much of a benefit from adding a urease inhibitor, because if they're losing a bit to the air, they have plenty anyway," says Susie. "But if people are reducing application rates, then saving every bit of nitrogen rather than losing it to ammonia is worthwhile."

A similar product to Limus is Vizura, a nitrification inhibitor which is mixed with slurry. "Once mixed and applied it reduces nitrous oxide emissions by up to 50%," explains Polly Lawman, market approach manager, agricultural solutions, at BASF.

"The second benefit is that it delays ammonium turning into nitrate, so it gives the crops more time to take the fertiliser as ammonium. Without the inhibitor it tends to transform in two to four weeks," she says.

It should also reduce leaching. "If there is less nitrate, there will be less washing into ground water and fewer nitrous oxide emissions in the atmosphere."

Nitrification inhibitors are one of the key technologies that can help farmers reduce their greenhouse gas emissions. "BASF are committed to providing sustainable solutions," says Polly.

"Every product in our portfolio is evaluated for its contribution to sustainability. Products like Limus and Vizura are 'accelerator' products, meaning they make a substantial contribution to sustainability in the value chain. BASF is committed to researching and developing more sustainable solutions that help farmers move towards becoming carbon neutral." ■

Research Briefing

To help growers get the best out of technology used in the field, manufacturers continue to invest in R&D at every level, from the lab to extensive field trials. *CPM* Research Briefings provide not only the findings of recent research, but also an insight into the technology, to ensure a full understanding of how to optimise its use.

CPM would like to thank BASF for sponsoring this Research Briefing and for providing privileged access to staff and material used to help bring it together.

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