

“ Ammonia losses represent inefficient use of an input you've bought. ”

Spotlight falls on ammonia emissions

Technical Take control

With the Government poised to regulate further on fertiliser use, now's a good time to review your choices and take control. In the third of this series of articles, *CPM* focuses on nitrogen use efficiency.

By Tom Allen-Stevens

Before you order your nitrogen fertiliser for next spring, there's a sentence in the Government's Clean Air Strategy, published earlier this year, that may cause you to completely rethink what you buy:

"We propose to introduce ... a requirement to spread urea-based fertilisers in conjunction with urease inhibitors, unless applied by injection on appropriate land by 2020," it says.

Yara UK's Natalie Wood explains: "On the face of it, that means if you're planning to buy uninhibited urea for next spring, you won't be allowed to spread it.

"In practice, this is a draft strategy the Government's consulting on, and the industry isn't yet geared up to supply all of the UK's urea requirement in the form it proposes. But there's a big spotlight on agriculture as we're responsible for 88% of UK ammonia emissions, with 23% down to fertiliser use, which is the source that's easier to manage.

"What's more, ammonia losses represent inefficient use of an input you've bought, so there's an economic benefit from taking control of your losses and addressing

nitrogen use efficiency (NUE)."

NUE represents the difference between the nitrogen you apply and what's actually taken up and utilised by the crop. It's influenced by soil type and crop cover, as well as soil and weather conditions, but one of the biggest factors is the type of N you use, explains Natalie.

"Extensive Defra-funded trials undertaken around 15 years ago show that on average 22% (range 2 to 43%) of urea applied to arable crops is lost through volatilisation. This compares with ammonium nitrate that averages 3% (range -3 to 10%) and liquid UAN at 14% (range 5.5 to 19%)."

Soil bacteria

Applied urea is converted to ammonia (NH_3) or ammonium ion (NH_4^+) by naturally occurring soil bacteria. While ammonium can be taken up by the crop, ammonia is often lost as gas, particularly if it's warm and windy. Applied AN, by contrast, is readily taken up by the plant.

"Volatilisation losses are highly dependent on soil and weather conditions. If the soil is healthy with plenty of organic matter and micro-organisms, this will speed up the conversion to ammonia, although it will also accelerate the nitrification process undertaken by ammonia-oxidising bacteria."

Weather is a key driver, and warm conditions will increase volatilisation. "Many growers using urea tend to apply early doses in this form and then switch to AN later in the season. But I wonder how much ammonia was lost during the early hot spell we had this year, for example." Rain, soon after urea applications, tends to hold more ammonium in its aqueous form, with less

converted to ammonia gas.

But volatilisation isn't the only form of preventable nitrogen loss that reduces NUE, notes Natalie. "There's also leaching. There's little point in applying fertiliser, especially AN, when the crop isn't ready to take it up, or applying an inappropriate amount for the crop cover you have."

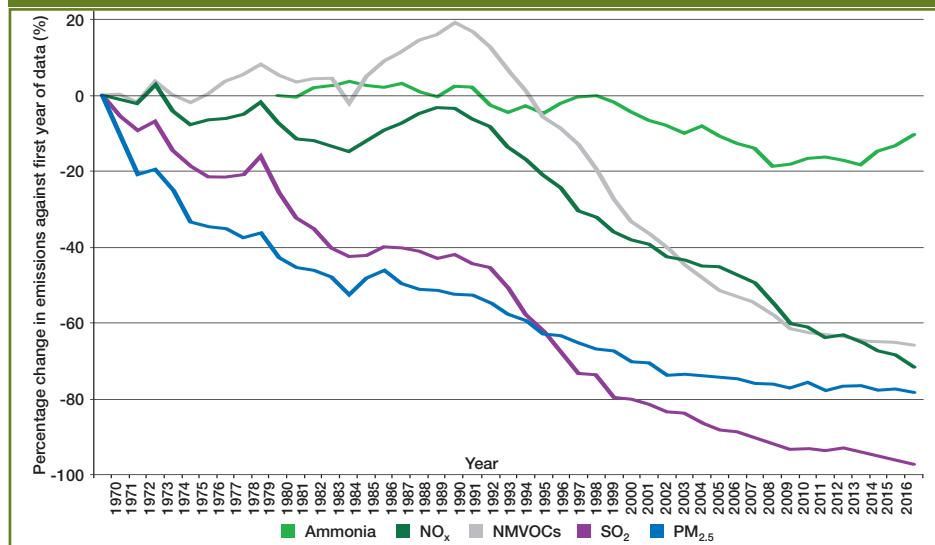
While it's readily taken up by plant roots, nitrate (NO_3^-) is highly mobile in the soil, she explains, and will be washed into drains by heavy rain if applied to bare soil or when crops aren't actively growing. "The N Sensor is by far the best way to tailor applications to actual crop growth, but satellite services are also available. With Yara's Atfarm now bringing satellite-generated NDVI biomass maps to all UK farmers free of charge, there's really no excuse for NUE reduction through leaching."

The final way growers can improve NUE is through a greater focus on how the plant itself processes nutrients, says Natalie. "There's a very strong relationship between sulphur and nitrogen — if a plant has



One of the biggest factors affecting NUE is the type of N you use, say Natalie Wood

Change in emissions of air pollutants since 1970 (since 1980 for ammonia)



Ammonia emissions haven't reduced as fast as other air pollutants, and agriculture is responsible for 88% of these. Source: Defra, 2019

insufficient S it cannot process the N. This is why we always recommend that growers use granular compound fertilisers, such as Axan (27% N + 9% SO₃)."

Yara's own trials as well as independent testing (see panel on p62) bear this out. What's more, tissue testing has revealed other nutrients may be lacking in crops

(see panel on p62), which will also reduce NUE, she adds.

So should you make any changes to how you fill your shed with fertiliser for next season? "While it's in the shed, every kg of N fertiliser is potentially 100% efficient," says Hutchinsons' fertiliser manager Tim Kerr. "It's only when it's spread that it



It's only when fertiliser's spread that it loses its efficiency, says Tim Kerr.

loses its efficiency."

Having said that, he does believe growers using untreated urea should rethink their options. "I don't believe a ban will be introduced this year, but it will pay growers to understand the options available to them and which are most suitable for their circumstances."

One option is urea treated with a urease inhibitor. Here the granules are coated with ▶

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Tissue testing exposes crop nutrient deficiencies

Tissue testing of wheat samples this year have indicated that two thirds of crops are short of magnesium and three quarters are low in zinc. 92% of oilseed rape crops are low in magnesium, according to results from Yara's nutrient-testing lab at Pocklington, near York.

"We offered the tissue-testing service to YEN growers free of charge to help inform their nutrition choices, and these results have been drawn together with other samples sent in from across the UK," explains Natalie.

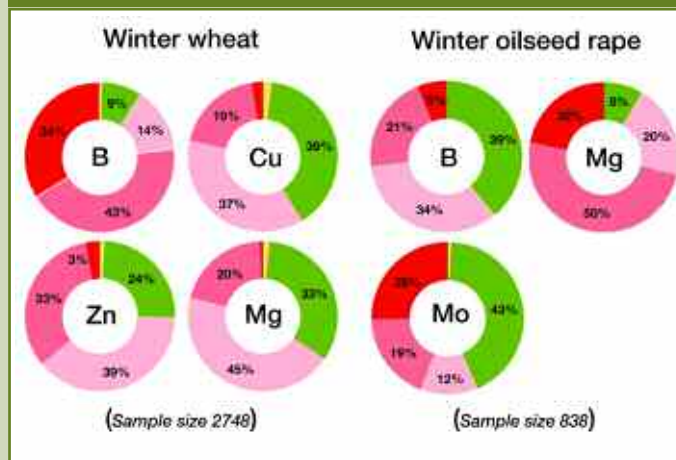
"These are quite worrying statistics, particularly when it comes to Mg. Figures last year suggest just 40% of crops were deficient. The drier conditions could have led to

crops depleting soil reserves."

Mg is an essential component of chlorophyll, used by the plant to photosynthesise, while Zn is used across a number of plant processes. "More than nine in ten wheat crops are low in boron which is important for pollination and flower development. Yara trials have shown significant yield increases where boron has been added as a foliar feed," she adds.

"Many of the nutrients needed by the crop don't necessarily contribute directly to NUE, but if they're lacking, the crop won't perform at its best and will therefore be unable to process the N available to it. That will compromise yield potential, and applied N fertiliser will be going to waste," concludes Natalie.

Crop nutrient levels across the UK



Source: Leaf samples sent to Yara for analysis, 2019; Green indicates normal, light pink – slightly low, salmon pink – low, red – very low; Anything not in the green range is classed as deficient; B – boron, Cu – copper, Zn – zinc, Mg – magnesium, Mo – molybdenum.

▶ inhibitor or it can be included within the production itself. Urease is the enzyme used by soil micro-organisms during hydrolysis, so the inhibitor slows the process and this has been shown in Defra-funded trials to effectively reduce volatilisation losses.

"It's worth noting that once applied to the urea granules, the efficacy of some inhibitors can reduce relatively quickly. So don't be afraid to ask the question before you commit to treated urea — it's important to understand the shelf life and what actually

represents good value," advises Tim.

He believes growers are better off buying AN and AN+S compound fertilisers. "For those growers wedded to urea, it's crucial to think about applying it in the best conditions, and that means avoiding periods of warm

Trials focus on NUE

Trials carried out by Hutchinsons suggest that applying nitrogen fertiliser on its own in the spring may not be the most efficient way to use it.

The fully replicated trials, conducted jointly with Yara, started in 2017 at two sites with different soil types in West Norfolk and Lincs and continued last year at the same site in Norfolk and in Wilts. "We've been looking at sulphur rates and the benefits of applying phosphate and potash in the spring," reports Tim Kerr of Hutchinsons.

"We've also been using the hand-held N-tester, with some of the trials specifically looking at how it can be used to fine-tune the final N application."

Preliminary results from the first year of the trials show responses to applications of S. "They also suggest a benefit from applying P and K in the spring, although the results are not statistically

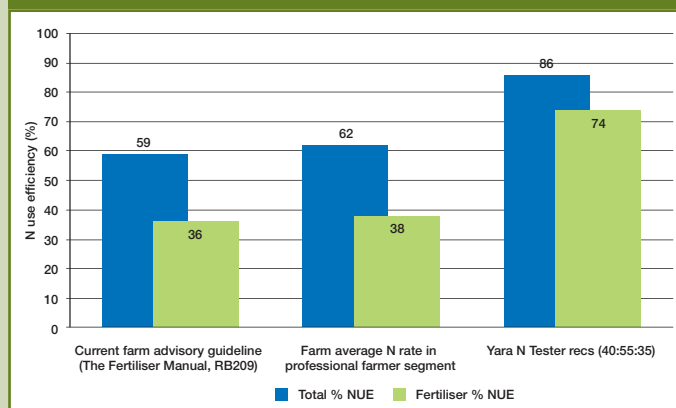
significant. We need to conduct more work before we can confirm the consistent responses Yara has found through its own trials," notes Tim.

"But we're finding the N-Tester is really useful for fine-tuning N applications and allowed us to make adjustments to bring the overall rate applied close to the optimum N for the crop, with resulting improvements in N-use efficiency (see chart)."

The results from years of response trials carried out by Yara make perfect sense to Tim. "There are very few situations where growers aren't applying enough N, but what's underestimated is the contribution other nutrients make to how that N is used by the crop. N and S in particular behave very similarly, so there's a good argument for applying a measure of S with every N application."

It's common practice to do this

Calculated nitrogen use efficiencies



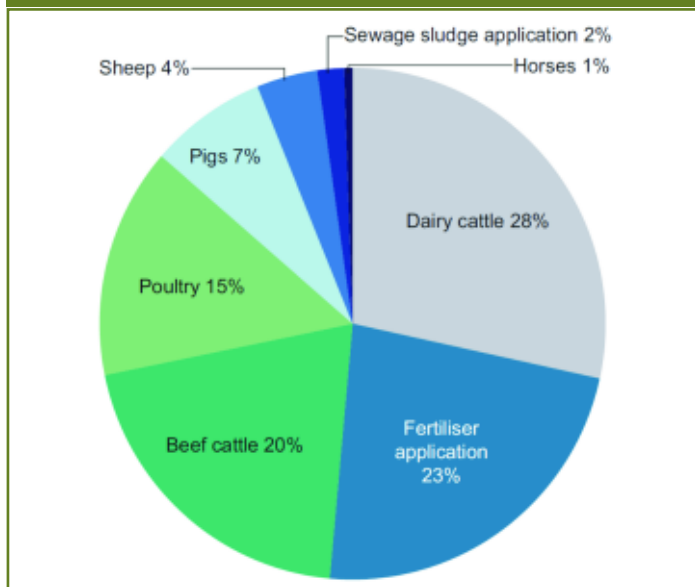
Source: Yara/Hutchinsons 2017

with liquid applications, he points out. "However, where S is applied to wheat with solid fertiliser, however, this tends to go on in one hit at the start of the season. But sulphate is prone to leaching."

While the same theory holds true of P and K, and Yara trials again back this up, Tim sees the

Hutchinsons' trials as a long-term project, and doesn't expect to have definitive data for another two or three years. "But in-season monitoring is proving to be a valuable way to improve NUE, and I can see we'll be making much greater use of the N-Tester in years to come."

UK agricultural ammonia emissions (2016)



The 23% down to fertiliser use is the source that's easier to manage.

Source: Defra, 2019

and windy weather. Perhaps a good option is to start the season with an AN+S compound, then move to urea, and then back to AN."

While it's often price that dictates how you fill your shed, Tim strongly advises growers to retain some flexibility. "It's good practice to buy a third early, with further purchases split into chunks as opportunities arise. But aim to build up a good choice that will provide different options for feeding next year's crops. It's worth considering including NPK compounds, and definitely an idea to review how you apply your S."

Growers are increasingly switching over to liquid, he notes. "There's been shift as bout widths are increasing over 32m. It's worth noting that urea is less dense than AN and as a result it's more challenging to spread accurately over large bout widths. Liquid also allows a consistent dose right up to field edges without losing N into the hedgerow."

Natalie points out that UAN liquid products are 50% urea. "The industry is currently seeking clarification, but we don't believe these are included in the proposed legislative change." ■

Take control

When Britain exits the EU, the move will create unprecedented uncertainty and change for farmers. While much of the change is beyond the control of the average arable business, it highlights the importance of those elements that can be managed.

Few aspects of crop production are more critical than a plant's nutrition, which is why CPM has teamed up with Yara in a series of articles that brings in some of the latest understanding to build on established knowledge. The aim is

to take back control of how a plant draws in and assimilates nutrients to optimise every aspect of crop and field performance.

With decades of evidence-based knowledge, Yara continues to be at the forefront of crop macro and micronutrient advice. Investment in technology has resulted in world-leading products that support in-field decision-making and precision nitrogen application.



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* DEFRA, NT2605

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