

Enhanced Efficiency Fertilizers: a solution for European agriculture?

Nitrogen has long been a powerful input, but it has also been one of its most persistent problems. Essential for yield and crop quality, much of what farmers apply can often fail to reach the crop. Across Europe, that inefficiency is no longer being tolerated. Regulatory limits are tightening, sustainability targets are hardening, and application rates are being cut - even as yield expectations remain unchanged. The challenge for farmers is becoming ever clearer - produce the same - or more - but with less nitrogen and lower emissions. According to ICL, the solution is not to walk away from nitrogen, but to use it far more intelligently. That was the focus of a recent ICL webinar exploring how Enhanced Efficiency Fertilizers (EEF) are helping farmers navigate Europe's stricter nutrient rules while maintaining productivity.

Improving nutrient use efficiency has become urgent across Europe, where policy is now directly influencing practice, explained Ronald Clemens, Global Portfolio Manager for EEF at ICL.

The European Commission's Fit for 55 package aims to cut net greenhouse gas emissions by at least 55% by 2030, reduce total nutrient losses by 50%, and curb fertilizer use by

around 20%, targets that apply to both mineral and organic fertilizers.

For farmers, this shift is already being felt on the ground. In the Netherlands, a country which Ronald described as having a nitrogen issue - decades of high nutrient inputs, especially from manure, have left soils and groundwater saturated.

"If you look into current legislation coming from the European Commission, translated into legislation from the Dutch government," he said. "You see that already all kinds of regulations have taken place."

Large areas are now classified as nutrient-polluted, requiring farmers to reduce nutrient inputs by around 20% compared with previous application rates.

"This means that farmers are not able to use their normal application rates



(left) Ronald Clemens, Global Portfolio Manager for EEF at ICL
(right) Tanguy Martignon, ICL's Global Portfolio Agronomist

Figure 1. Enhanced Efficiency Fertilizers: How best to utilise – there's more than one solution



The goal of EEFs is to improve NUE – so use them in the optimum way – use their strengths



Focus on their functionality and in which application they fit best



What do you want to achieve: reduce N losses, improve yields, lower inputs?



Are EEF combinations making sense?



Can EEFs be combined with alternative ways to create high efficiency?

to achieve their maximum yields." The problem, he stressed, is that yield expectations remain unchanged, and farmers must still deliver productivity but with significantly less nitrogen.

Stabilised nitrogen fertilizers rely on chemical inhibitors to slow nitrogen transformations in the soil

The scale of nitrogen inefficiency

Even without regulatory constraints, nitrogen is far from efficient. Despite improvements over recent decades, nitrogen fertilizers remain highly prone to loss. On average, only 40-60% of applied nitrogen is taken up by the crop, depending on factors such as the location and the type of soil. The rest is lost.

Those losses occur through multiple pathways; Ammonia volatilisation releases nitrogen into the air, nitrate leaching contaminates groundwater, runoff affects surface water and denitrification produces nitrous oxide, one of agriculture's most potent greenhouse gases.

The environmental consequences are well-known, but Ronald was clear that inefficiency is also an economic issue. Every kilogram of nitrogen lost is a kilogram that has been paid for but never used by the crop. In a system where inputs are restricted and margins are tight, that inefficiency is becoming increasingly difficult to tolerate.

EEFs are designed to address this inefficiency, but there's no single solution. "Each technology has its own characteristics and advantages," said Ronald. "Farmers need a toolbox approach, combining technologies to suit crops, soils, and climate conditions.

Two main EEF technologies dominate - stabilised nitrogen fertilizers and coated controlled-release fertilizers.

Stabilised nitrogen fertilizers rely on chemical inhibitors to slow nitrogen transformations in the soil. This technology allows urea to remain in its original form for longer or ammonium fertilizers to remain in ammonium form for longer. Urease inhibitors reduce ammonia volatilisation by slowing urea breakdown, while nitrification inhibitors slow the conversion of ammonium to nitrate, thereby reducing leaching and nitrous oxide emissions. Some products combine both inhibitors to provide what he described as 'double inhibition.'

Controlled-release fertilizers work differently. "By using a membrane around the granule, you can clearly improve the efficiency," he said. "A thin coating - sometimes no thicker than a human hair - isolates the nutrient from the surrounding soil. As soon as water penetrates through the coating, the nutrients will start to dissolve. Osmotic pressure then drives a slow, controlled release that aligns more closely with crop demand."

Efficiency in practice

Drawing on global research, Ronald explained how different EEF technologies influence nitrogen loss pathways in various ways. Stabilised products are highly effective at reducing ammonia volatilisation, while nitrification inhibitors strongly reduce nitrate leaching. Controlled-release fertilizers, by contrast, offer protection across multiple loss pathways.

The practical implication is that efficiency gains can be achieved either by maintaining yields with lower

While stabilised nitrogen is well suited to in-season top dressings, controlled-release fertilizers are especially valuable in longer-cycle crops, where they can reduce the number of applications required

nitrogen inputs or by increasing yields at the same application rate. In some systems, combining technologies can further enhance performance, particularly when temperature, soil type, or irrigation practices increase the risk of nitrogen loss.

Ronald also highlighted the importance of matching the technology to the cropping system. While stabilised nitrogen is well suited to in-season top dressings, controlled-release fertilizers are especially valuable in longer-cycle crops, where they can reduce the number of applications required. In Europe, these products are already widely used in potatoes, rice, onions and forestry, and increasingly in arable crops such as maize and wheat.

Looking ahead, regulation is also reshaping technology and practice. From 2028, EU fertilizer rules will require the use of fast biodegradable coatings, a significant shift for controlled-release products.

ICL's response is the development of eqo.x, a new technology featuring a double coating of sulphur and a fully biodegradable material. Developed to meet the requirements of the new Fertilizer Regulation, eqo.x is already certified and can be applied to nutrients such as urea. For Ronald, it represents a necessary evolution - maintaining agronomic performance while aligning with regulatory and environmental expectations.

ICL's Global Portfolio Agronomist, Tanguy Martignon, turned attention to measurement, verification

and value. As he explained, demonstrating environmental benefits requires robust data, and that data must be credible at field level.

ICL works closely with specialised research institutes across Europe to measure nitrogen losses under both laboratory and field conditions. In Hungary, for example, trials using closed-chamber systems have allowed researchers to capture and analyse ammonia emissions following fertilizer application. These studies have confirmed that controlled-release fertilizers can reduce nitrogen leaching by up to 55%.

Beyond the lab, ICL runs extensive field trials across Europe in crops including potatoes, wheat, maize, rice, onions and sugar beet. These trials consistently show improved nutrient-use efficiency, reduced application frequency, and stable or increased yields when controlled-release fertilizers are used.

For growers, this translates into more cost-effective fertilization programmes, fewer field passes and better alignment between nutrient supply and crop uptake.

Carbon savings at field level

Tanguy placed particular emphasis on reducing carbon footprints, an area where efficiency gains deliver tangible economic value. While fertilizer production and transport contribute to emissions, he explained that most fertilizer-related

greenhouse gas emissions occur at the field level.

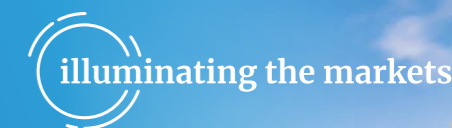
By reducing nitrogen losses and the frequency of applications, controlled-release fertilizers significantly lower these emissions. In France, case studies show savings of up to 56kg of CO₂ equivalent per tonne of grain. In Dutch potato production, savings of up to 18kg of CO₂ equivalent per hectare have been recorded.

As carbon accounting moves down the supply chain, farmers using controlled-release fertilizers can benefit directly. Improved yields, lower input losses and verified emission reductions open the door to carbon credit schemes and sustainability premiums.

In practical terms, Tanguy explained, growers can generate additional income both through higher crop value and through participation in certified carbon programmes. For many, efficiency is no longer just about compliance, it is becoming a new revenue stream.

Taken together, the presentations were unequivocal in highlighting that nitrogen efficiency is no longer a niche product but central to the future of European agriculture. EEFs offer a way to maintain productivity while responding to regulatory pressure, environmental responsibility and economic reality.

“There is no single best solution,” Ronald concluded. “But by using the right tools, in the right place, at the right time, nitrogen can be made to work harder for crops, farmers and the environment.” ■



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