PRACTICAL GUIDE / September 2025

Optimising inorganic nitrogen

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This guide discusses how you can manage nutrient application, help reduce greenhouse gas emissions and considers the use of protected urea.

Nitrogen fertilisers are frequently applied to soil to achieve high grass and arable crop yields and to replenish soil nutrients (namely nitrogen, phosphorus and potassium). To make efficient use of inorganic fertilisers and protect the environment it is important to consider the 4Rs:

Right Fertiliser Match fertiliser product to crop requirements.

Right Rate Assess soil nutrient supply and the plant demand and then apply the correct rate of fertiliser.

Right Time Time applications so that nutrients are available when the crop needs them and can utilise them.

Right Place Keep fertiliser where crops can use them and adhere to recommended buffer strips to minimise nutrient losses.

Nutrient application (whether slurries and manures or inorganic fertilisers) results in ammonia and greenhouse gas emissions during and after applications. There are also emissions associated with the manufacturing, transporting and application of inorganic fertilisers.

Greenhouse gases (GHG)

Methane is produced as fertilisers react with the soil and air.

Nitrous Oxide comes in part from the use of nitrogen fertilisers and from soil disturbance and is produced by soil microbes. The application of slurry and manure is a significant source.

Carbon Dioxide is released through burning all types of fuel and through soil disturbance. It is, however, essential for plant growth.

Ammonia is released by livestock and fertilisers - it isn't a GHG itself, but it accelerates the greenhouse effect.

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Inorganic N applications top tips

- Inorganic N Application Top tips
- Know what your crop requires and do not exceed crop requirement for nitrogen.
- Have a nutrient budget for each field and each crop (PLANET Scotland).
- Soil test every 3 - 5 years. Soil testing will indicate if some fields need work to adjust soil pH, or may need more or less nutrients than are being currently applied.
- Take account of the nutrient value in slurry and manures.
- Incorporate manures or slurries into the soil as soon as practical (ideally within 6 hours of application) to reduce nitrogen losses via ammonia volatilisation to the atmosphere and leaching or run-off to water.
- Apply when the crop is responsive and when it is actively growing.
- Coinciding nitrogen applications with soil temperatures of at least 5 degrees will ensure the plant is able to take up nutrients.
- Avoid application on windy days when ammonia losses are likely to be higher.
- Do NOT apply in wet or frozen conditions or onto saturated soils.
- Avoid applications to dry soils in very warm weather. Humid soils improve diffusion into the soil.
- Maintain fertiliser application equipment in a good state of repair and calibrate to manufacturers specifications.
- Consider using protected urea.
- Take account of NVZ Action Programme rules if you are within an NVZ area.

Planning N applications

For each field take account of:

- Soil type and soil analysis results.
- Previous crop management and crop residues.
- Crop and market requirements.
- Timing of applications.
- Winter rainfall and soil wetness.
- Organic manure application to crop to be grown and to previous crop.

Fertiliser recommendation technical notes (see links below) can be used along with PLANET Scotland, a software tool designed to plan and manage nutrient use. Effective nutrient management will help to reduce the loss of nutrients to the environment.

Timing of applications

Autumn nitrogen is NOT recommended for winter cereals, as profitable responses are not normally attained and the practice will increase N losses to the atmosphere and watercourses.

Nitrogen recommendations should be **reduced** for spring crops, which are sown ten days or more after the optimum sowing period.

For sowing **delays in excess of ten days**, reduce the N recommendation for crops by approximately 1.5 kg/ha/day for each day of delay for feed or high N malting and 2.25 kg/ha/day for low N malting.

First N application should be made when **soil temperature** reaches a minimum of 5oC at 10 cm depth on three consecutive days and ground conditions permit.

For intensive grass and some arable crops a **split application** approach should be considered.

Most nitrous oxide is produced at or near the soil surface immediately after top-dressing. Rainfall just before or just after makes emissions much higher. **Cool, dry weather with light winds is best.**

Nitrogen residues

Residual available N in the soil following harvest will vary depending on the crop type grown and the management and performance of the previous crop.

Residual N is expected to be **lower** in a high yielding season or where N application has been lower than normal, but may be **higher** than average if the crop has performed badly.

Residues following cereals are generally lower than those following break crops.

Residues are typically higher following long-term grass, brassicas and grazed fodder and lower following harvested fodder, oilseed rape, potatoes and cereals.

Residual N is expected to be **lower** following a wet winter and **higher** following a dry winter.

Soil types

Where practical, alter the rate of fertiliser N to suit the different soil types.

Mineral soils of low organic matter content: the amount of available N residue is relatively small.

Humose and peaty sites: low N malting barley is not encouraged as N release occurs late in the season and ends up in the grain.

Protected urea

Why? Switching a proportion of straight nitrogen fertiliser to protected urea has been found to reduce GHG emissions. Protected urea gives a reduction in ammonia emissions of around 78% compared to urea.

How? Protected urea contains a urease inhibitor that slows the hydrolysis of urea, therefore more time is available for diffusion into the soil. Protected urea significantly reduces ammonia volatilisation and nitrous oxide emissions, ensuring more efficient nutrient delivery to plants.

The inhibitor is added to the urea granule or coated on its surface.

Yield? Trial work by Teagasc showed that protected urea can reliably deliver yields that match calcium ammonium nitrate (CAN) and exceeds standard urea yields. Protected urea also works as quickly as CAN or Nitram.

Things to consider

- When looking at unit cost (price per kg/N) protected urea is more expensive than urea, but cheaper than CAN or Nitram.
- Highest ammonia losses usually occur in March therefore use protected urea for first or second N applications in the spring.
- Recalibrate fertiliser spread before working with urea.
- The enzyme inhibitors have a shelf life and will degrade after 6-12 months from the date of manufacture.
- The urease inhibitor is not stable when mixed with phosphate.
- Unlike ordinary urea when you should leave 4-6 weeks to apply after liming, protected urea can be applied soon after liming as the urease inhibitor controls the pH spike around the urea granules during hydrolysis.

Low carbon fertilisers

While growers can reduce their GHG emissions through improved nitrogen use efficiency, further reductions in emissions will require new technical solutions, one of which is introducing low carbon fertilisers to the market.

Low carbon fertilisers have the same composition as fertilisers produced using fossil fuels, but they are produced with renewable electricity (from wind, solar, hydro), resulting in a fertiliser that has a lower carbon footprint.

Links

Inorganic and liquid fertiliser storage and application (www.farmingandwaterscotland.org)

Technical Note (TN731): Nitrogen Recommendations for Cereals, Oilseed Rape and Potatoes

Technical note (TN726): Fertiliser recommendations for Grassland

Protected Urea - Frequently Asked Questions | Helping farmers in Scotland

Protected urea - Teagasc | Agriculture and Food Development Authority

This document references information gathered by Farming For a Better Climate (FFBC), a Scottish Government initiative that is now closed.