# Protected urea: what is it, does it work, and is it cost effective?

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Ireland has a very favourable climate for growing its largest crop, grass. To achieve grass growth potential, fertiliser nitrogen (N) is a key input. However, fertiliser nitrogen also plays a role in gaseous N losses and water quality. The Irish government has committed to reduce national losses of both ammonia and the potent greenhouse gas nitrous oxide (Figure 1) while achieving good status for all waters. In relation to gaseous emissions agriculture accounts for 33% of national GHG emission and 98% of ammonia emissions and as a consequence is under the spotlight to reduce emissions. The use of protected urea nitrogen fertiliser is the largest single avenue currently open to Irish agriculture to meet these commitments to reduce GHG and ammonia emissions.

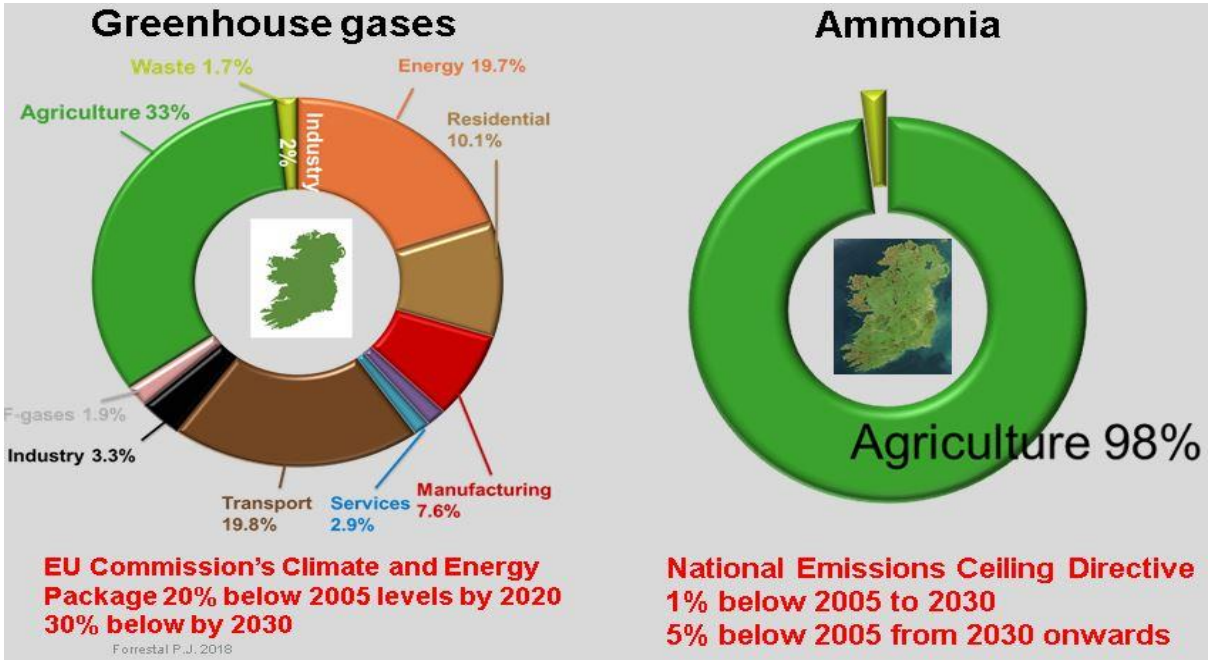


Figure 1. Greenhouse gas and Ammonia sources and reduction commitments

## Understanding protected urea and how it works

### What is protected urea?

Protected urea is urea which is treated with an active ingredient called a urease inhibitor. The urease inhibitor can be either a) coated onto the outside of the fertiliser granule or b) incorporated into the urea granule melt during manufacture.

### How does a urease inhibitor work and what role does it play in stopping ammonia loss?

Urease is the enzyme which catalyses the conversion of urea to ammonium. It is during this conversion that ammonia gas is lost from untreated urea (Figure 2). A urease inhibitor blocks the active site of the urease enzyme. This moderates the rate at which urea converts to ammonium. In so doing ammonia loss is reduced to low levels.

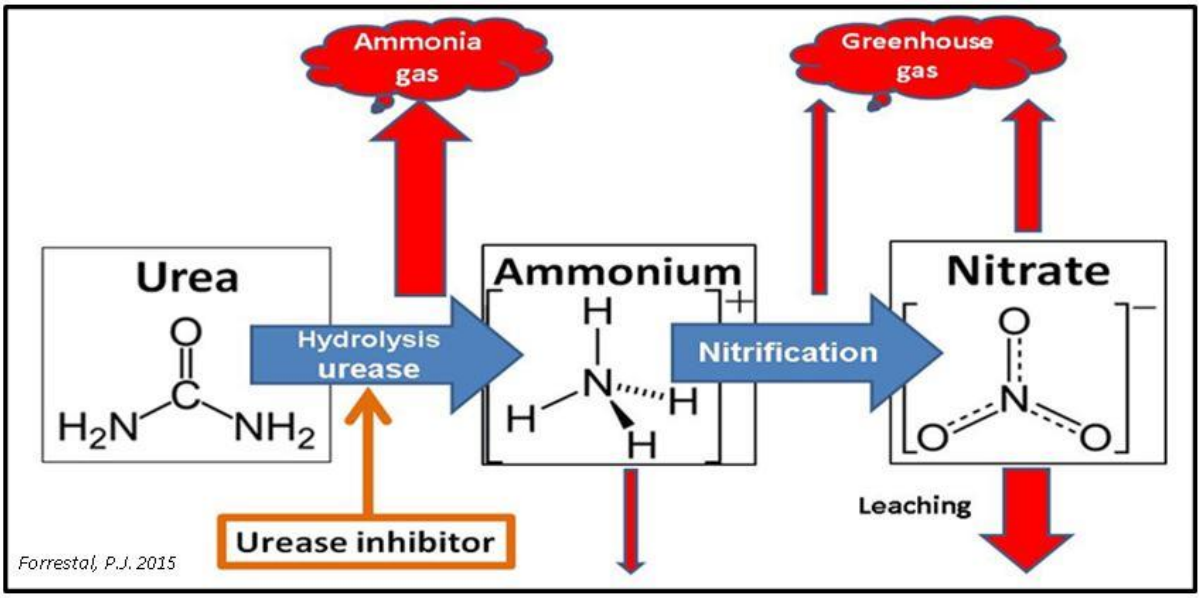


**Figure 2. Conversion of nitrogen forms and N loss avenues**

**Won't a slowing of the conversion from urea affect the availability of N for the grass crop?**
No, because the conversion of protected urea to ammonium begins as soon as the fertiliser granule starts to melt. The urease inhibitor moderates the rate at which the urea-N converts to ammonium. The result is that the conversion occurs over period of a few days rather than a few hours, as would be the case with conventional urea. Remember, when fertiliser N is applied to soil its aim is to supply the grass or crop with N over a period of days to weeks rather than hours.

**Are there different urease inhibitors used to manufacture protected urea? What are they?**
Yes, the following products are recognised as acting effectively as urease inhibitors: a) NBPT b) 2-NPT, c) NBPT+NPPT. Teagasc has conducted research with all three inhibitor options, most extensively with NBPT and NBPT+NPPT.

**Are these approved for use in Ireland?**
Yes, these active ingredients are approved for use by the European Chemicals Agency through the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) process.

**Can I spread protected urea throughout the growing season?**
Yes, you can spread protected urea across the growing season at times when you would otherwise spread calcium ammonium nitrate (CAN) or unprotected urea. This may potentially simplify the fertiliser spreading programme on the farm and setting up of fertiliser spreader for only 1 straight N product each year

## Protected urea effects on production

**Will using protected urea reduce yields?**

No, published Teagasc trials (Figure 3) have shown that protected urea consistently yields as well as CAN in Irish grasslands with no difference in annual production between the two fertilisers.

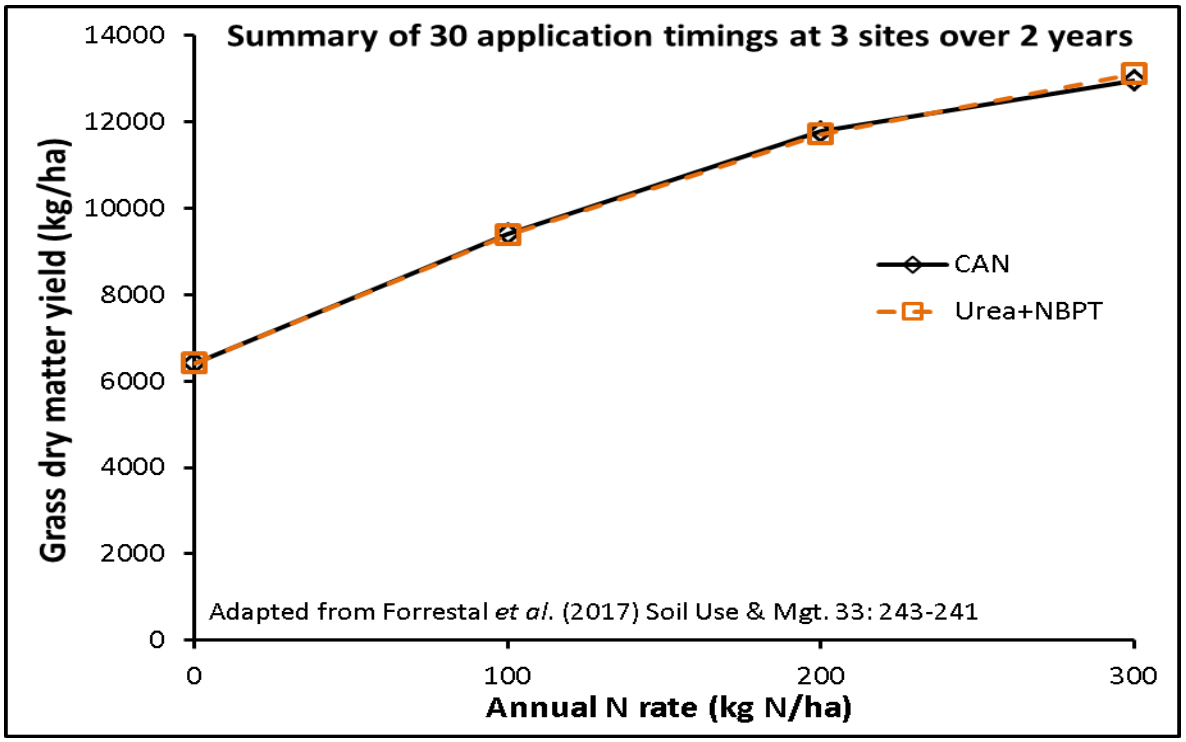


**Figure 3. Summary of total annual grass dry matter yield (kg/ha) for CAN and protected urea evaluated across 2 growing seasons (2 years) on three soils (locations)**

**Will using protected urea reduce efficiency?**

No, published Teagasc trials conducted in different areas of Ireland have shown that the nitrogen recovery efficiency of protected urea and CAN are consistently the same (Figure 4).

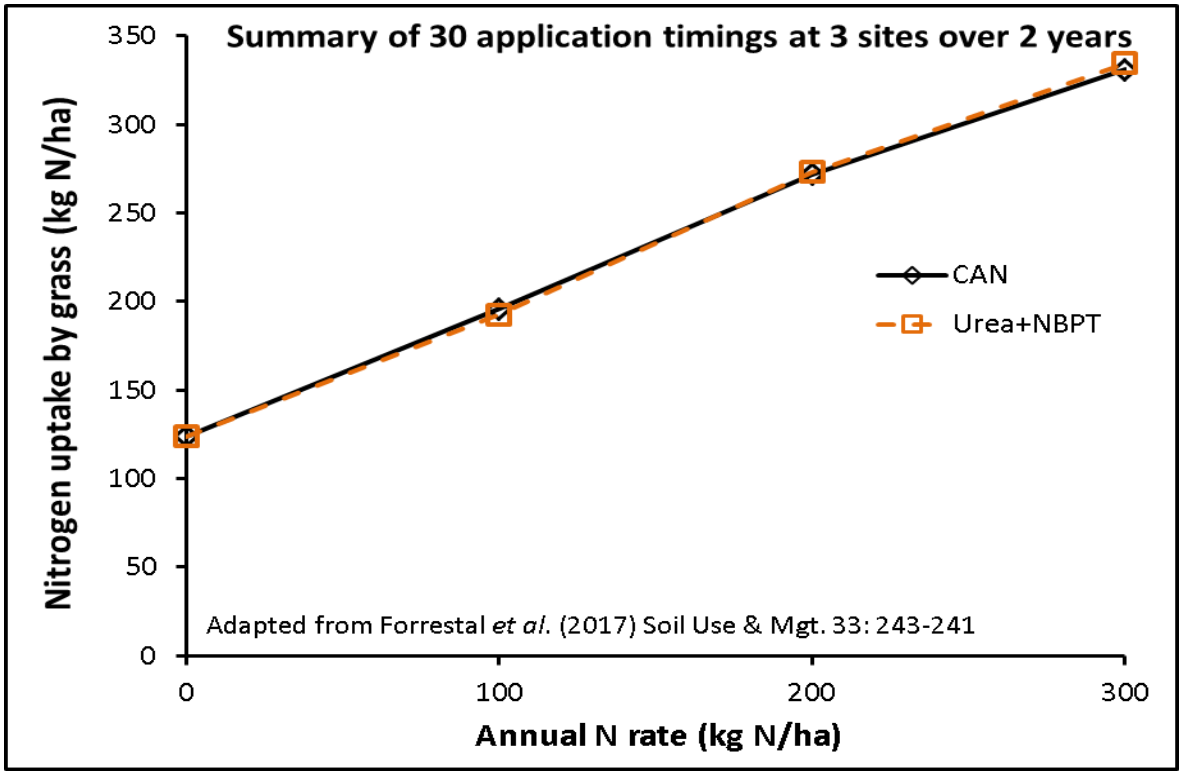


**Figure 3. Summary of N recovery (off take kg/ha N) for CAN and protected urea evaluated on 30 occasions (application timings) conducted across the growing season on three soils over two years.**

## Is protected urea cost effective?

### Is protected urea more costly?

On 14 March 2019 the following costs detailed in Table 1 were quoted. These costs show protected urea to be less costly than CAN while performing just as well in terms of yield (Figure 2) and N recovery efficiency (Figure 3). Bear in mind that fertiliser costs fluctuate but always make the cost comparison on the basis of cost per kg N for straight N products

Table 1. Prices in € per tonne fertiliser and € per kg N delivered for the three main fertiliser N types available as per 14 March 2019

| Fertiliser N product | N content (%) | Cost per tonne (€) | Cost/kg N (€) |
|---|---|---|---|
| Urea | 46% | 391 | 0.85 |
| Protected urea | 46% | 437 | 0.95 |
| CAN | 27% | 284 | 1.05 |

## Does protected urea reduce Emissions?

### Does protected urea reduce loss of the potent greenhouse gas nitrous oxide?

Yes, published Teagasc trials have shown that protected urea has 71% lower nitrous oxide emissions than CAN (Figure 4).

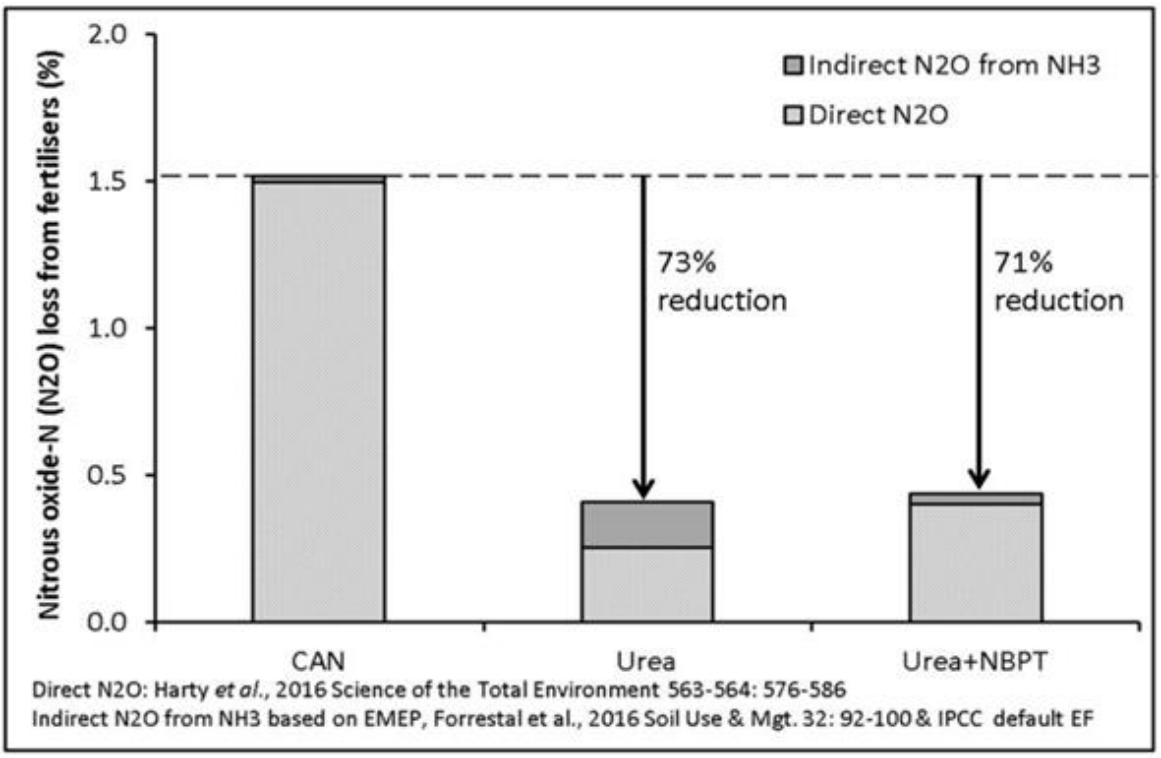


**Figure 4. Effect of fertiliser N selection on emissions of the potent greenhouse gas nitrous oxide ($N_2O$)**

**Does protected urea reduce loss of Ammonia?**

Yes, based on published Teagasc research protected urea has comparable ammonia loss to CAN and ammonia loss is reduced by 79% compared to urea (Figure 5).

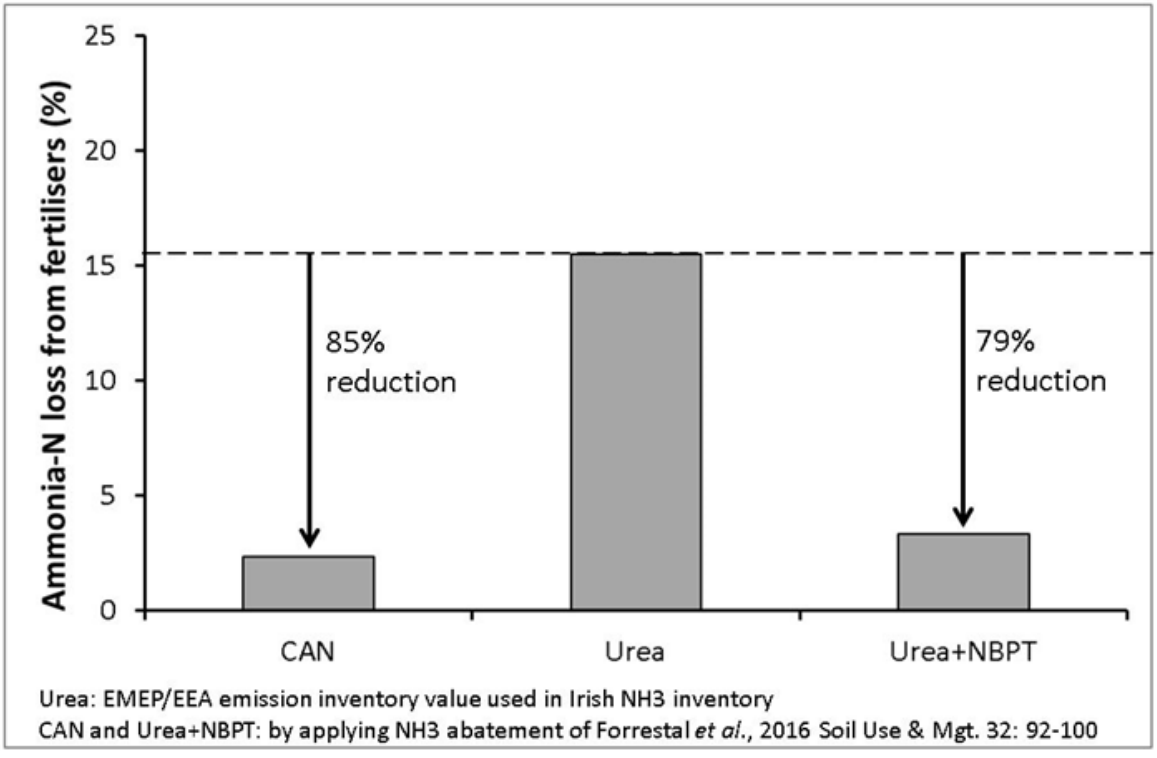


**Figure 5. Effect of fertiliser N selection on emissions of ammonia ($NH_3$)**

**Is there potential for protected urea to reduce nitrate loss to water?**

Yes, during periods when leaching occurs nitrate present in the soil is vulnerable to leaching loss. Protected urea does not deliver N directly as nitrate to the soil, therefore reducing the risk of nitrate losses occurring with rainfall post fertiliser application. Reduced ammonia loss compared to urea will also reduce the risk of ammonia N being deposited from the atmosphere onto sensitive habitats or into sensitive water bodies.

## Summary

Use of protected urea can reduce agricultural greenhouse gas emissions and ammonia emissions while maintaining yield and saving cost.

Table 2. Relative greenhouse gas and ammonia emissions from three N fertilisers

| | **Ammonia emissions** | | |
|---|---|---|---|
| | **Level** | **High** | **Low** |
| **GHG emissions** | **High** | | CAN |
| | **Low** | Urea | Protected Urea |