# Fully biodegradable coating technology brings controlled release fertilizers into a new era

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14th Dahlia Greidinger conference Feb-March 2023

# **Biodegradable** coatings for **Controlled Release Fertilizers**

*What is the background?*

1. Existing coatings for CRFs are inert and degrade slowly
2. Fertilizer Product Regulation (2019/1009) in Europe set standards for polymers to be used in CRFs and puts a sunset date in for non degradable polymers by 2026.
3. New coating materials will have to comply by July 2026 with criteria and test methods which will be defined by July 2024
4. For soil grown crops ICL developed **eqo**.x technology which is fast degradable

# Biodegradation Criteria still need to be set

The text in the FPR (2019/1009) describes in Article 42

6. By 16 July 2024, the Commission shall assess biodegradability criteria for polymers referred to in point 2 of component material category 9 in Part II of Annex II and test methods to verify compliance with those criteria and, where appropriate, shall adopt delegated acts pursuant to paragraph 1 which lay down those criteria.

Such criteria shall ensure that:

(a) the polymer is capable of undergoing physical and biological decomposition in natural soil conditions and aquatic environments across the Union, so that it ultimately decomposes only into carbon dioxide, biomass and water;

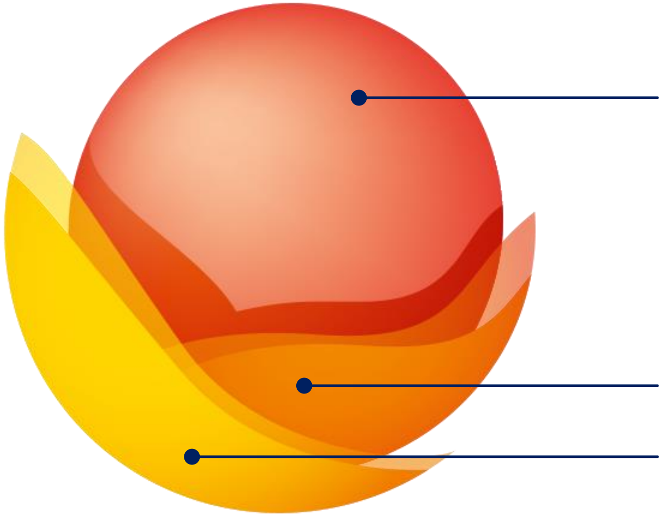
(b) the polymer has at least 90 % of the organic carbon converted into carbon dioxide in a maximum period of 48 months after the end of the claimed functionality period of the EU fertilising product indicated on the label, and as compared to an appropriate standard in the biodegradation test; and

(c) the use of polymers does not lead to accumulation of plastics in the environment.

eqo.x® ICL

# eqo.x

## The technology explained




**eqo**.x is a patent pending and proprietary technology of ICL.

# Background for selection of the technology

**Base layer:**

- Sulphur is a known* good barrier for water permeation
- Sulphur is a nutrient
- Sulphur does not require biodegradation data
- Sulphur oxidizes in soil

**Top layer:**

- Easily biodegradable polymer
- Needs to seal cracks in the sulphur layer
- Needs to ensure that the product is free flowing

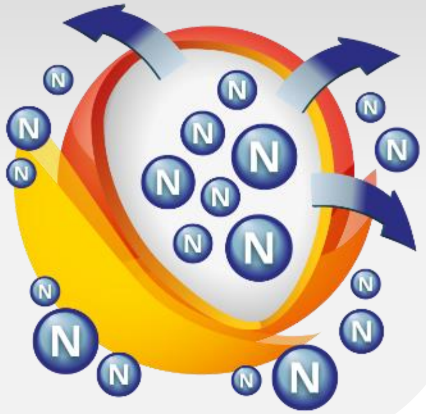

* See for instance patent application: US 3295950, May 3, 1965

# Working principle of **eqo**.x release technology

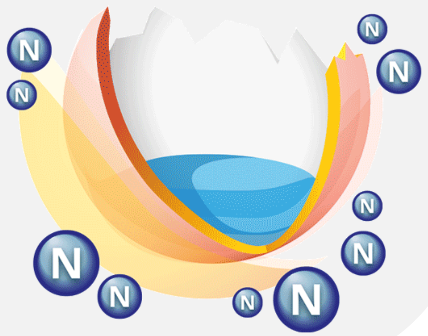
*The engine in our Agrocote and Agromaster products*

Once applied in the soil, moisture penetrates the biodegradable coating and reaches the nutrient core


Nutrients inside the granule start to dissolve and begin to release back into the root zone by diffusion




Influenced by soil t°, nutrient solution is released day-by-day through the coating thus reducing nutrient losses

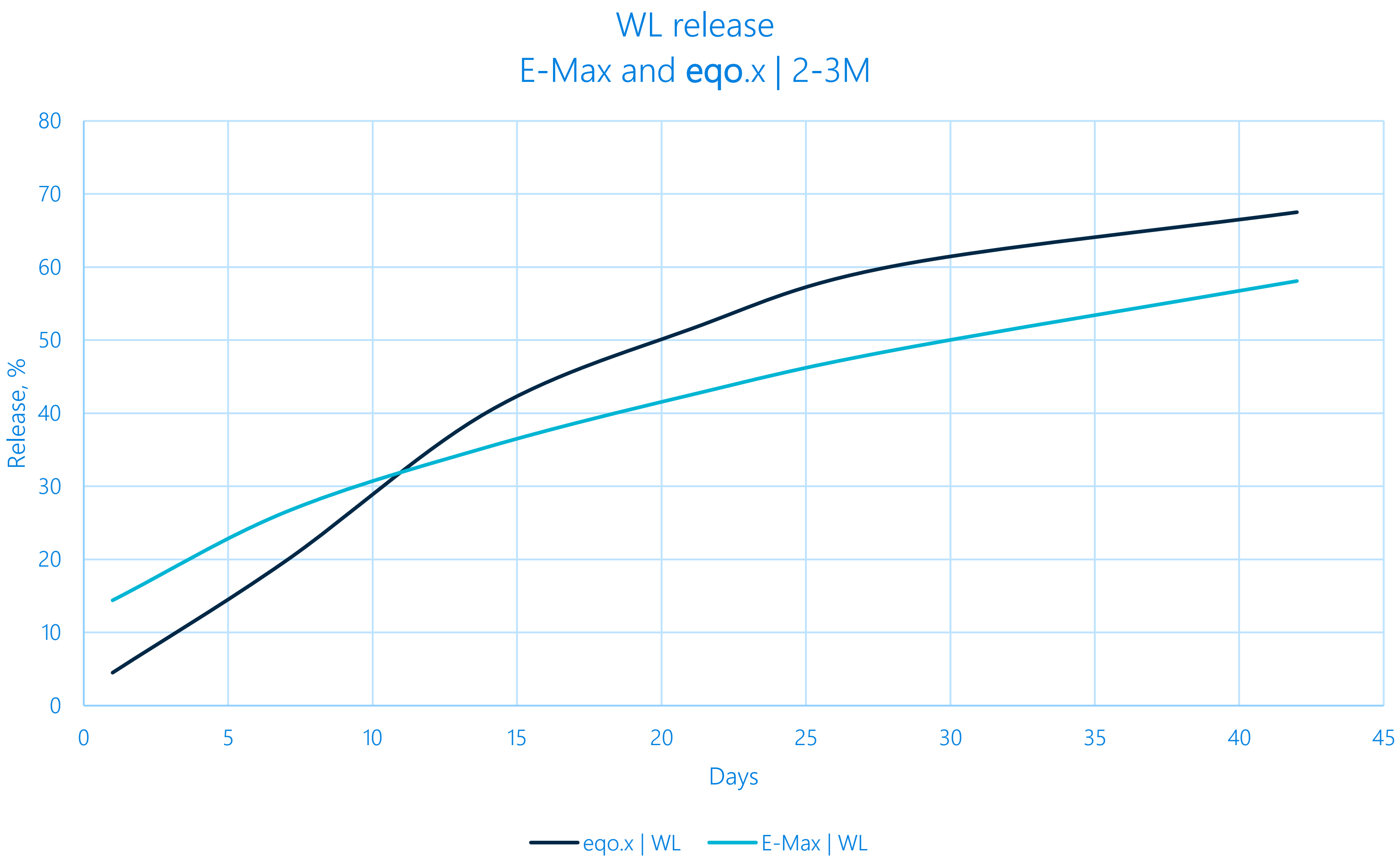



The coating shell degrades in soil into $CO_2$ and water, offering a sustainable solution for future farming

# Nutrient release in lab conditions

## WL, 21°C

- More like in a S-shape
- It has lower initial release




WL = water leached

# Biodegradation research

- Soil 25°C (ISO 17556:2019) micronized and coated glass
- Fresh water 21°C (ISO 14851:2019) micronized

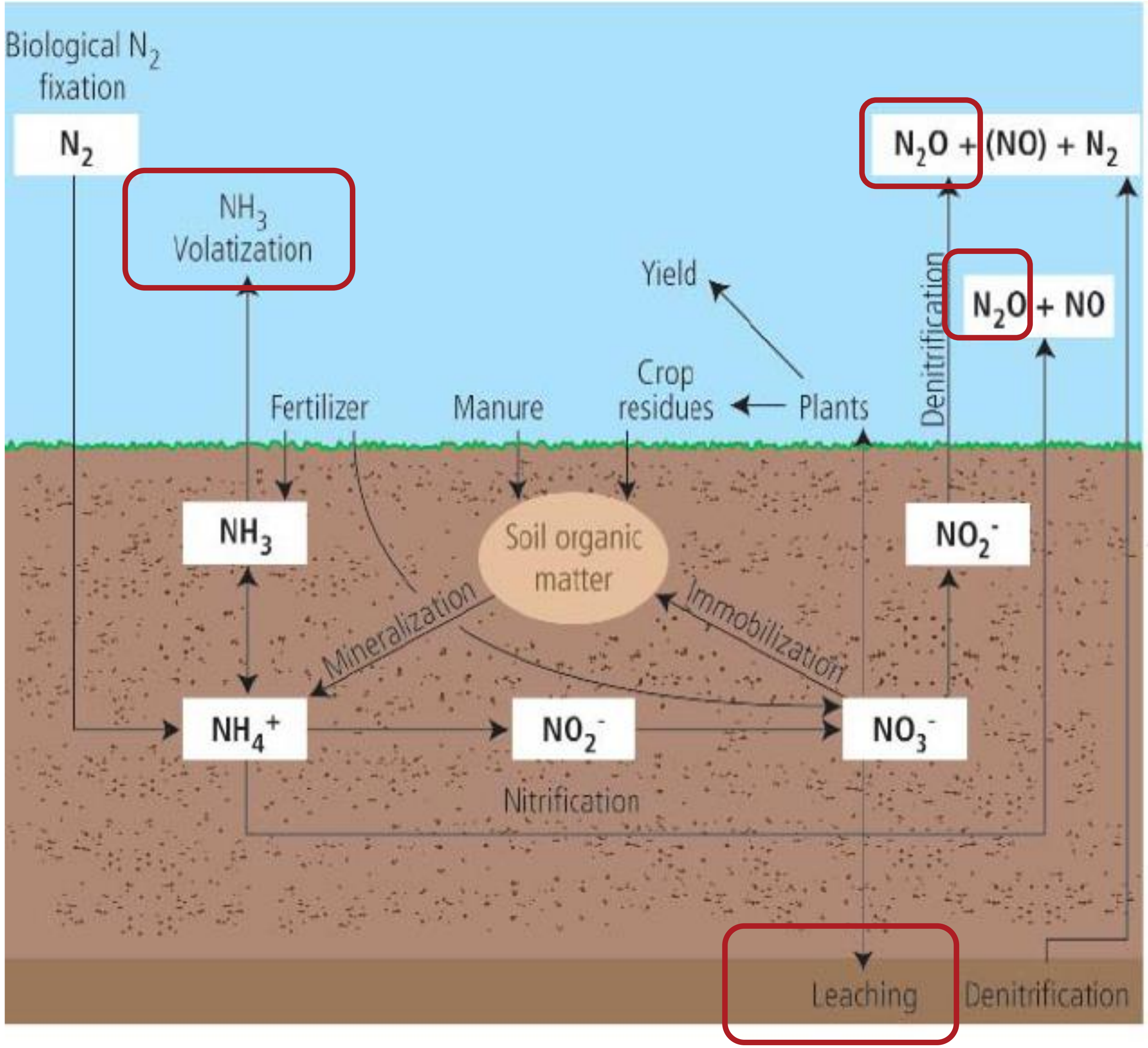
Conclusion: coating degrades well in soil and water

WL = water leached


# Lab trial results

@Nutrient Management Institute, Wageningen, NL

# Nitrogen losses




Graph from: Sustainable Management of the Nitrogen Cycle in Agriculture and Mitigation of Reactive Nitrogen Side Effects, IFA Task Force on Reactive Nitrogen (2007)

# Measuring nitrogen losses

## Experimental design

A pot experiment with red beet (*Beta vulgaris vulgaris)* is setup using a loamy sandy soil with pH above 7.

The trial has 4 treatments using the following fertilizers:

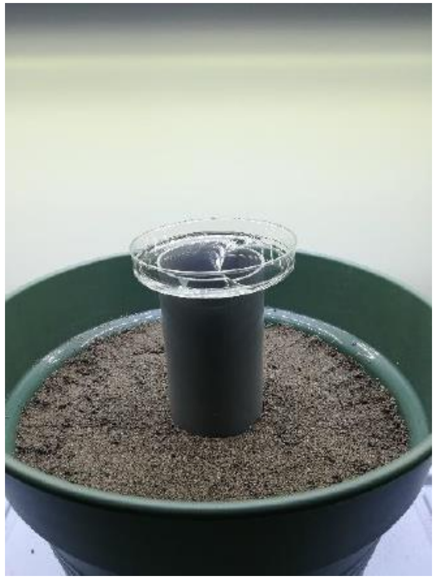
1. Zero N (control)
2. Urea | 1 x N
   (46-0-0 | full N rate > as base fertilizer)
3. Urea | 2 x N
   (46-0-0 | split N rate > 50% as base + 50% top dress)
4. E-Max | 1 x N
   (44-0-0 | full N rate > as base fertilizer)
5. **eqo**.x | 1 x N
   (40-0-0 | full N rate > as base fertilizer)

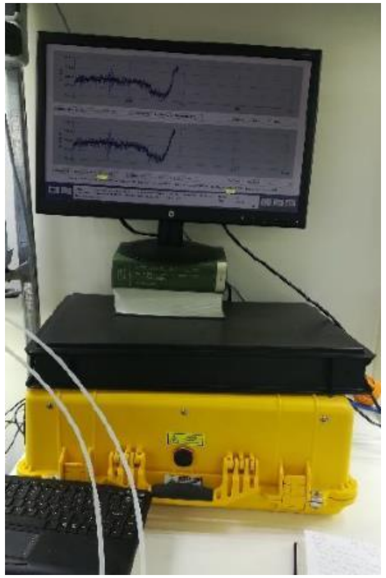
> Full N rate = 150 kg/ha

> top-dressing was done after 5-6 weeks from seeding

# Measurements

## N losses by





### Leaching

The leachate is collected in a plastic plate below the pot.

To achieve this the pot was placed on 3 small cubes in plate to ensure free drainage.

A sub-sample of approximately 20 mL is collected, filtered (0.45 µm) and stored in testing tubes at -20ºC until analyses. The leachate is analyzed for $NO_3$, $NO_2$, $NH_4$ with ICP-MS technique at the AgroCares lab.

### $NH_3$ volatilization

Volatilization of $NH_3$ was measured following an enclosure method (Yang et al., 2018) by placing an acid trap 10 cm above the soil surface. The acid trap consisted of a 8.5 cm (diameter) Petri dished filled with 15 ml of 0.025M HCl. Once the acid was placed the pots were closed with the same static chambers used for $N_2O$ measurements

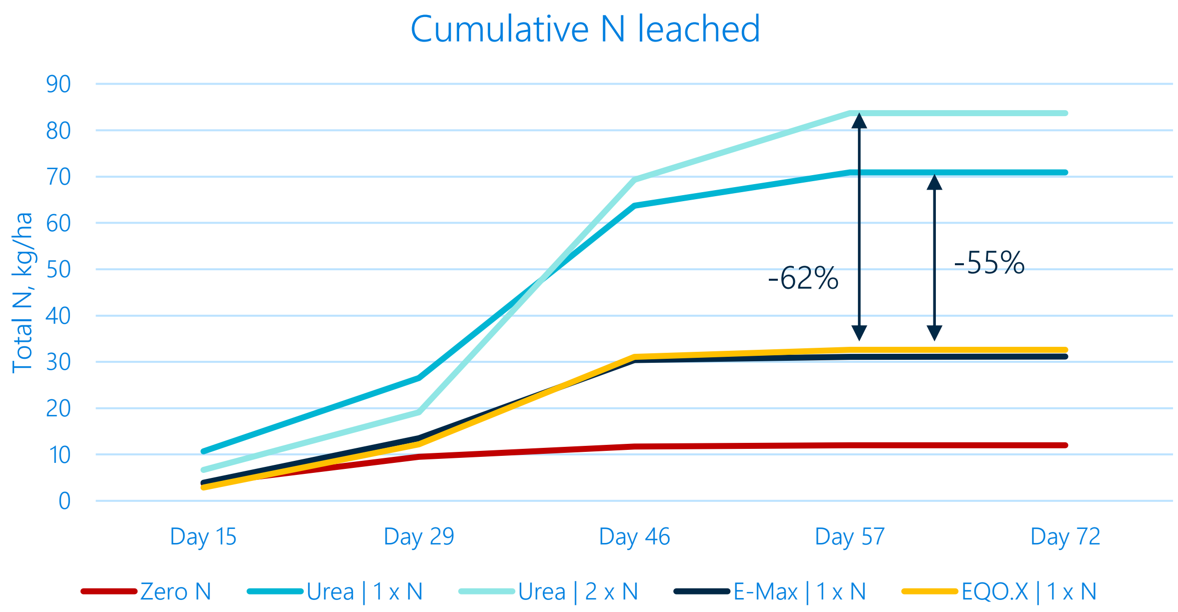
### $N_2O$ emissions

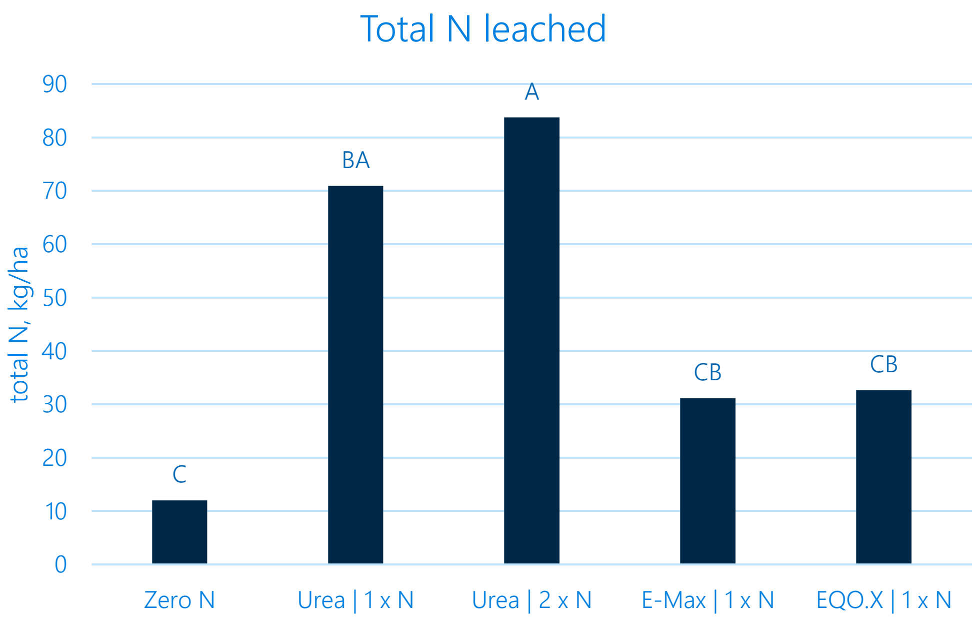
The protocol followed for $N_2O$ measurements was similar as for previous studies (Abalos et al., 2014; Abalos et al., 2018; Lubbers et al., 2015).

Static flux chambers (12.2 cm radius and 23.8 cm height) were placed on top of the pots. The chambers had two openings which were connected with the gas analyzer creating in this way a closed loop.

# Results

## Total N leached - $NO_3$, $NO_2$, $NH_4$

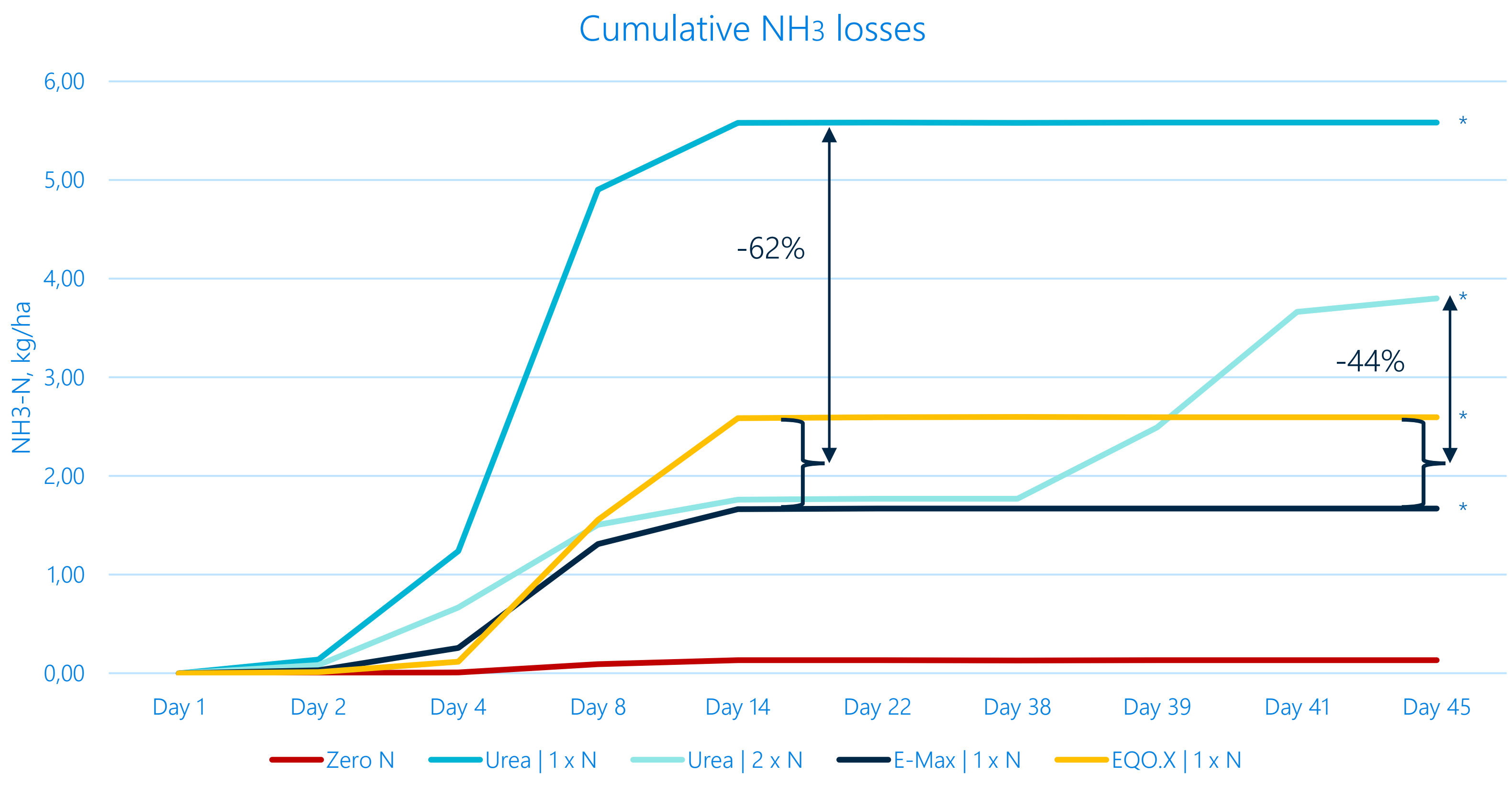



Both coating technologies performed similar in respect of N losses by leaching.
After 72 days, by using CRF (coated urea), total N lost by leaching was reduced, in average, by 59% compared to conventional urea

# Results

## $NH_3$ losses



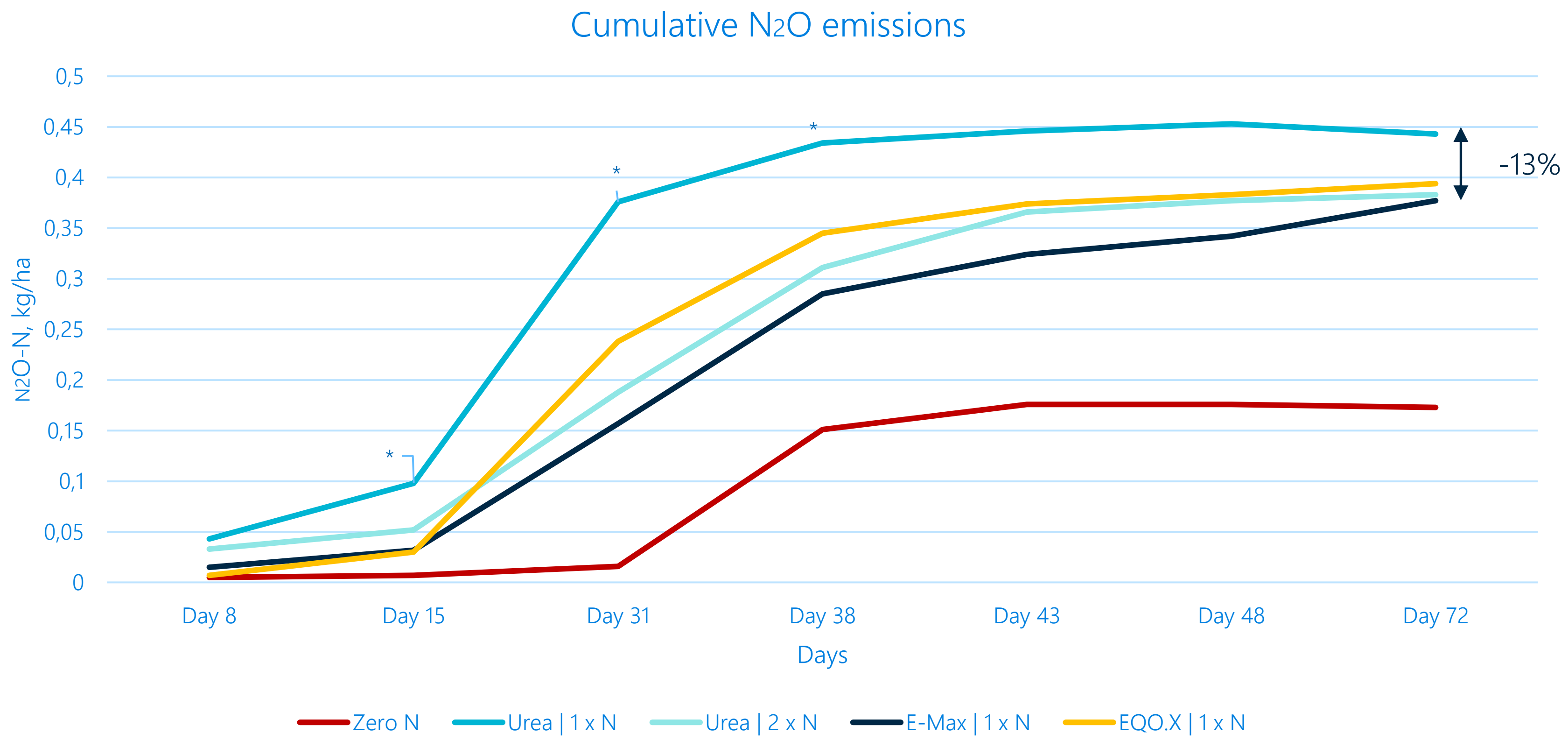

After 14 days, N losses as $NH_3$ volatilization were significantly reduced by **62%** comparing CRF (average of both E-Max and **eqo**.x) with conventional urea, applied at the same time and rate, and overall, by **44%** when comparing CRF (average of both E-Max and **eqo**.x) to split application of urea

Second application of urea was done 38 days after seeding.

** Statistically significant difference, $P < 0.05$*

# Results

## $N_2O$ emissions

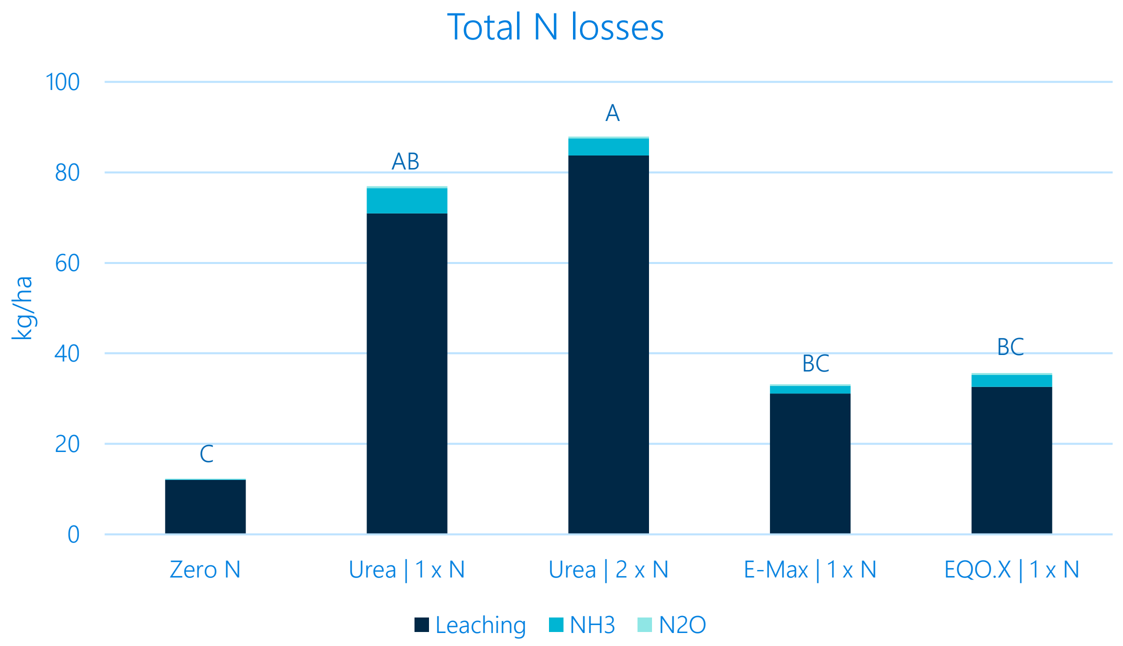


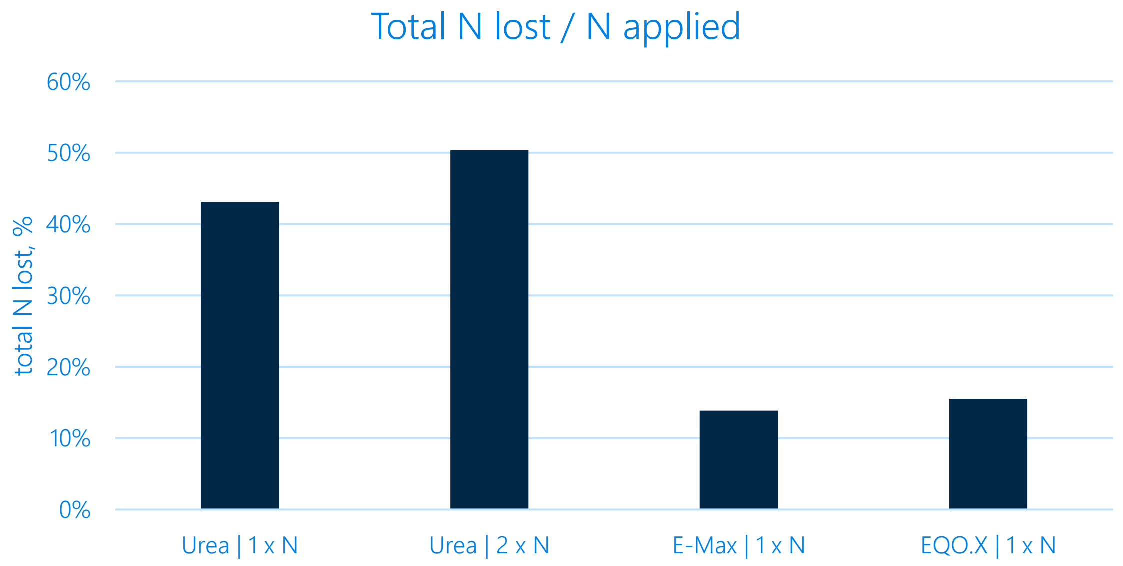

In the first 30-40 days, N losses as $N_2O$ were significantly higher for conventional urea applied at the same rate per ha as CRF.

However finally there was no significant difference in this trial

** Statistically significant difference, P <0.05*

# Overall N losses



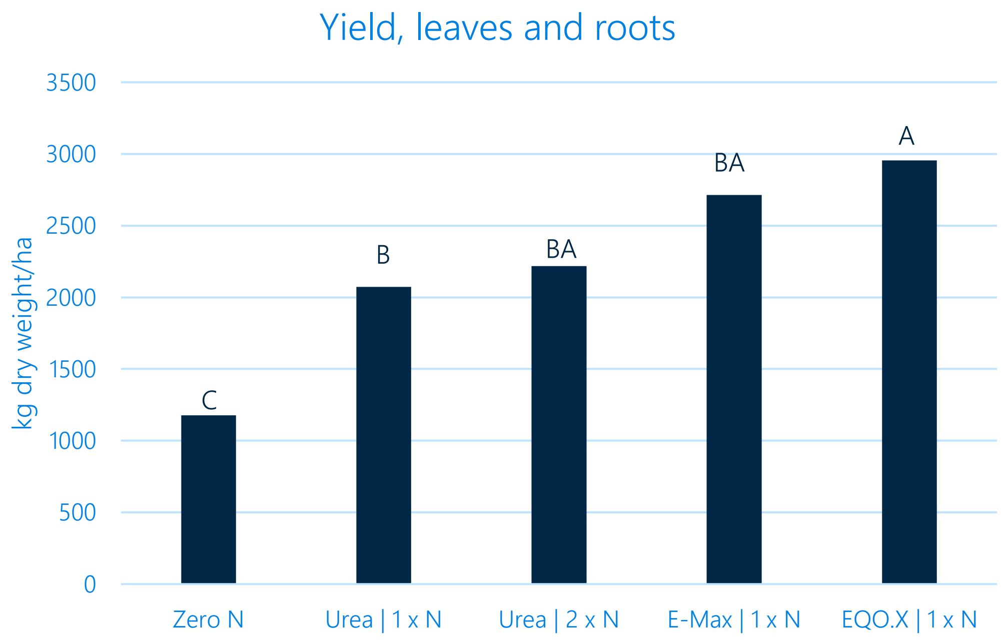



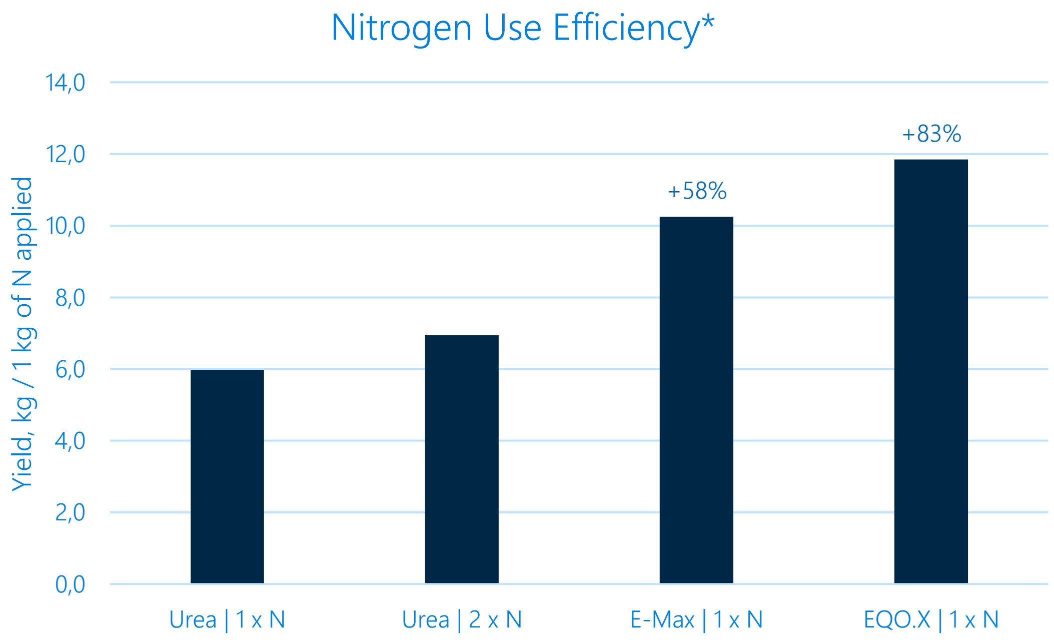

Using conventional urea, 40-50% of N applied is lost to the environment.
With CRF, N losses are limited to only 14-16% of total N applied

In light soil conditions

# Improved Nitrogen Use Efficiency

## Yield and NUE




Nitrogen Use Efficiency, calculated as Agronomy Efficiency = (Y–Y0)/F
Y = Yield of harvested portion of crop when the said nutrient is applied
Y0 = Yield of harvested portion of crop when the said nutrient is not applied
F = Application rate of said nutrient

# Summary of the **eqo**.x

## Compared to conventional urea in Nutrient Management Institute, Wageningen trial

1. Reduces **N leaching**

2. Reduces **$NH_3$ volatilization**

3. More replicates needed to enable better statistics

4. Solid performance as CRF

# **eqo**.x release technology

## Benefits for field grown crops

**eqo**.x technology supplies sustainable solutions - improving nutrient use efficiency to be ready for the Future!

**Biodegradable** release technology for **sustainable farming**

**Consistent and predictable nutrient release**, steered by soil temperature

**Reduction** in number of **fertilizer applications**

**Reduces nutrient losses** to environment

**Increases Nutrient Use Efficiency**

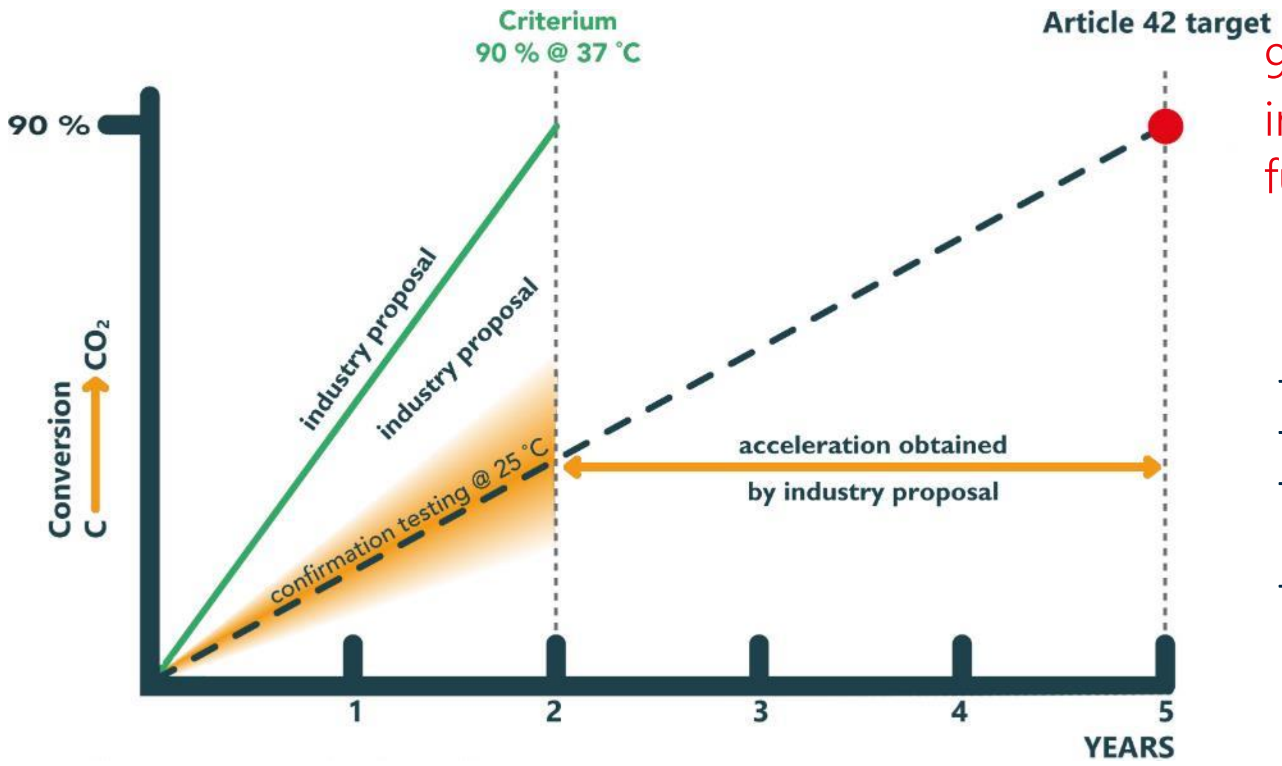
eqo.x®

We are ready
for a sustainable future
NOW!


**Thank you for your attention**

# Proposal for soil biodegradation

Proposal was made by Jana Sera et al. (1)




90 % degradation in 4 years + functionality period

Principle: 'Plastics – Determination of the ultimate aerobic biodegradability of plastic materials in soil by measuring the oxygen demand in a respirometer or the amount of carbon dioxide evolved' (EN ISO 17556:2019);

- Cryogenically milled samples
- Specific requirements for polymer properties
- Specific requirements for biodegradation rate at 25 ˚C compared to 37 ˚C
- To be determined reference material

(1) https://doi.org/10.1016/j.polymdegradstab.2019.109031