Suggestion for ammonia emission reduction using a boom

Holland is unique in that they are the only country in EU that has mandatory use for injection for slurry.

This was introduced in 1996 as a measure to reduce ammonia emissions and it remains the only way to apply slurry.

The Dutch administration has commissioned a program – Bemest op z´n Best – from 2020 to 2024.

"In 2020, the Remkes Commission recommended reducing nitrogen emissions by at least 50% between 2019 and 2030. The package of measures presented by the government in October 2020 aims to achieve a reduction below the critical N deposition values for 50% of the surface area of Natura 2000 areas."

An application for In Field Acidification was made in 2021. This resulted in a suggestion of several laboratory tests without any protocol for approval of a "Low emission status" for the system. Thus, the decision to participate was not pursued any further.

An invitation to participate in a program using Sod injection was offered in 2024. This was also declined because In Field Acidification must use a boom! When Sulphuric acid is injected into the slurry, the bicarbonate in the slurry reacts within milliseconds, which results in a foaming of the slurry

Foaming of slurry

Bicarbonate relase from slurry buffer

Process like pressurerised mineral water

NB – temporay increase of pH. Min. ½ l acid for neutral result.

Foaming of slurry with acidificaiton

Commercial use of foam as ammonia emission reduction.

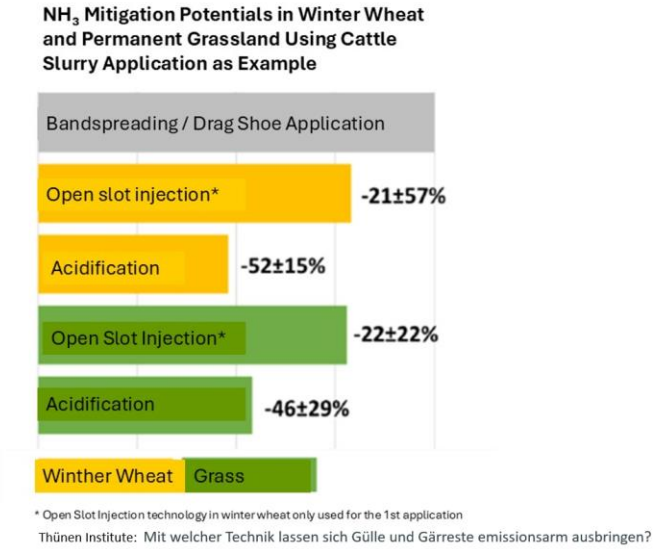
3 litter sulphuric acid creates total foam ability in slurry

In Field Acidification is the only technology that can reduce the emission in the Natura 2000 areas as required by the Dutch Commission. This is well documented by Thünen Institute in Germany in 2022:

Comparison of Open Slot injection to Acidification with 24 m bandspreading

Thünen Institute 2022

Comparison of acidification to Open slot Injection



There are two obstacles for the use of In Field Acidification in Holland:

- The System utilizes a dragging foot Boom instead of an open slot injection system (mandatory in Holland)
- According to Wageningen, the system uses too much Sulphur to be recommended for use

Above are political problems. There are no legal restrictions on the use of Sulphate in Holland and it is an issue for the administration to change the legislation and provide access to the use of a dragging foot boom for use with acidification.

But the administration must be informed. Unfortunately, they have been given bad advice from Wageningen to the CDM committee

On the use of Sulphur:

In a test performed by Wageningen in 2014, The In Field Acidification was tested and performed very poorly. The System was provided by a Dutch contract partner on behalf of the manufacture.

Unfortunately, the purpose of the test became a means to prevent market access to the Dutch market for the technology. A very poor result was obtained by severe underdosage of acid, which lead to a conclusion that the effect from the system was not high enough and that the system used too much Sulphur and thus a disqualification from “low emission status”.

Wageningen has since refused to re-evaluate its decision on several occasions.

In 2025, The EU nitrogen directive is ending its clause of derogation and the use of nitrogen from organic source (slurry) is now limited to 170 kg. pr. ha.

This presents a new situation for In Field Acidification with no excess use of Sulphate:

Change to Dutch Policy – End of Derogation and reduction in livestock

Holland: After Derogation max. 170 Kg N pr. Ha, 3.5 Kg N pr. m3 = 48 m3 pr. Ha

Holland: After reduction of diary cows with 50 % = 24 m3 pr. Ha

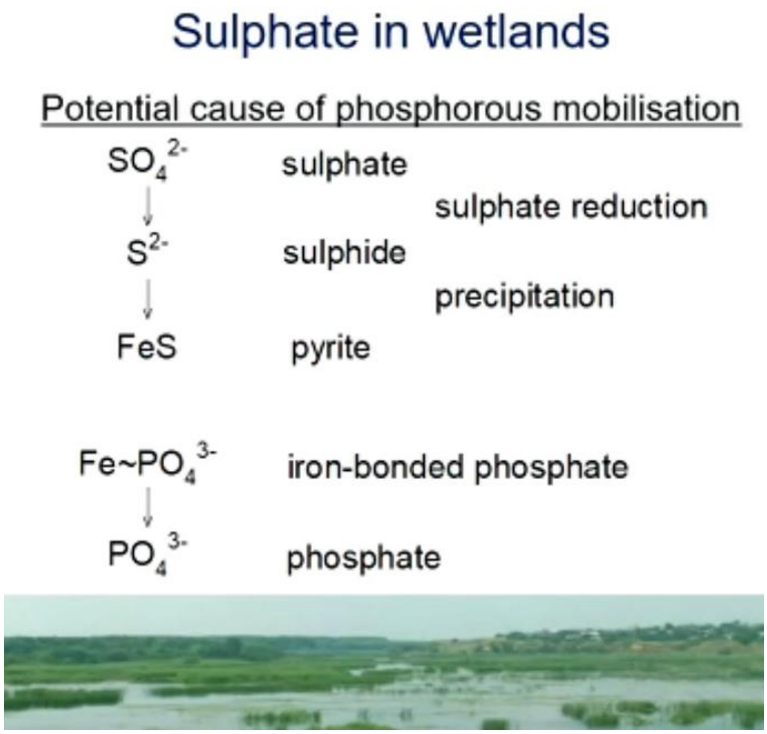
Danish legislation – 6 l pr. m3 40 m3 pr. Ha

	48 m3	24 m3	40 m3 (Denmark)
Acid use pr m3	1.7 l	3.4 l	6.0 l
Total volume acid pr. ha	82 l	82 l	240 l
Volume of SO_4^{2-} pr. l	0.577 kg	0.577 kg	0.577
Total volume of SO_4^{2-} pr ha	48 kg	48 kg	138 kg
Agronomic SO3 recommendation:	40 kg	40 kg	40 kg
Agronomic SO4 recommendation:	48 kg	48 kg	48 kg
Sulphur Surplus:	**0 kg**	**0 kg**	**90 kg**
Slurry pH	**6.4**	**5.5**	**>4**
Emission reduction	**50 %**	**90 %**	**100 %**

This means that the use of Sulphate pr. ha is reduced by +40 %. Add to that the much higher performance found over 3 years from In Field Acidification, and the system can increase the ammonia emission reduction over open slot injection by more than 50 % - ref. enclosed Thünen Institute 3-year test of In Field Acidification compared to Sod Injection.

In addition, the argument of using too much Sulphate with In Field acidification, is seriously flawed.

The use of Sulphate on polder soil has the potential to increase subsidence and Sulphate is therefore recommended not to exceed the plant uptake. However, this argument is not used against Sod injection despite a higher release of Sulphate than In Field Acidification. The injector discs opening of polder soils 3-5 times a year increases the area for atmospheric oxidation, which constitutes 90 % of the polder subsidence. The increased mineralization also releases an additional amount of Sulphate, so the end result is that Sod injection leaves more Sulphate than In field Acidification. And It is not just pollution swapping - it is a significantly increase in subsidence and a release of CO_2 from the Polder soil, resulting in + 1 Million ton of CO_2 emission.



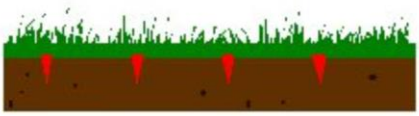
The potential Chemical reaction on Polder soil

The volume of Sulphate from In Field Acidification is sustainable because it is applied at a time when the crops need the Sulphate. Sulphate from mineralization is not sustainable because the release happens all year round and thus leaches to the aquifer.

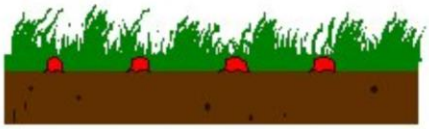
Polder Soils – Environmental differences

Status of soil threat - Subsisdence

Subsidence is nowadays about 1 cm/y. This means an annual loss per hectare of about 12.2 ton OM or about 22.6 ton CO2 or 6.7 ton C https://www.recare-hub.eu/case-studies/veenweidegebied-the-netherlands?utm_source=chatgpt.com



+ 58 % increased area for oxidisation



0 % increased area for oxidisation

Sod Injection:

Disc distance - 18 cm. With 3 cm. V shaped depth - 5 cm

- 58 % increase in area for Oxidisation +1 Mio ton CO2
- Unsustainable Increase in mineralisation of Sulphate
- Unsustainable Increase in compaction – 50 % to 66 %
- Accelerated Subsidence
- Ammonia emission reduction 25 %

Acidification:

Dragging shoe boom – 12 – 36 m

- Reduction in N leaching (Yield increase)
- Sustainable use of Sulphate
- Minimal compaction

- Ammonia emission reduction 25 % (1.7 l)
- Ammonia emission reduction 50 % – 100 % (3.4l)

The Wageningen CDM report to the administration in 2014 was addressed by the German National Julius Kühn institute, in which the leading European Sulphur expert stated:

"Agriculture needs to be correct and scientifically proven informed. The S related chapter above shows significant lack of knowledge by the authors which results in false information and misleading of the public and policy makers"!

We believe above is the explanation for Wageningen refusal to re-evaluate their position. It is also the reason why subsidence was not included in the evaluation in 2014, and the test did not include a comparison to the effect from Sod injection.

In 1996 or 2014, the focus on CO_2 emission had not started. The above injection praxis results in massive increased CO_2 emission. App. 40-50 % of Dutch CO_2 emission is from low land soils. This is seriously aggravated by the injection of slurry.

An injector is used min. 3 times/year from February to September – 8 months of the year.

Subsidence 22.6-ton CO_2 pr. ha/year

The increase in oxidation area with injection: 58 %.

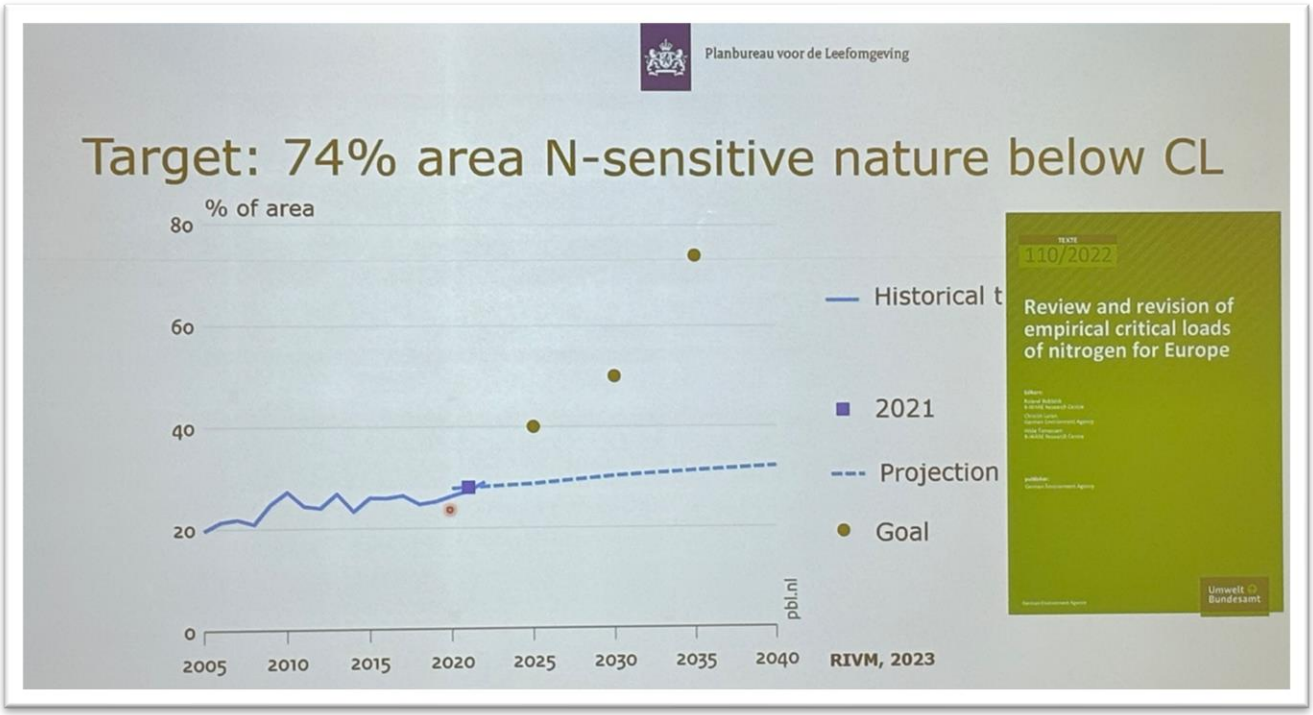
Polder soil area in Holland: 830.000 ha

Reduction in subsidence from injection to surface acidification estimated at 40 %

The estimated CO_2 emission reduction based on the given parameters is approximately 3,601,536 tons of CO_2 per year.

There is good reason to believe that the use of acidification with a dragging shoe boom will be permitted in Holland. Not just because of the above attractive CO_2 reduction because of the legal requirements for ammonia emission reduction.

Holland target:



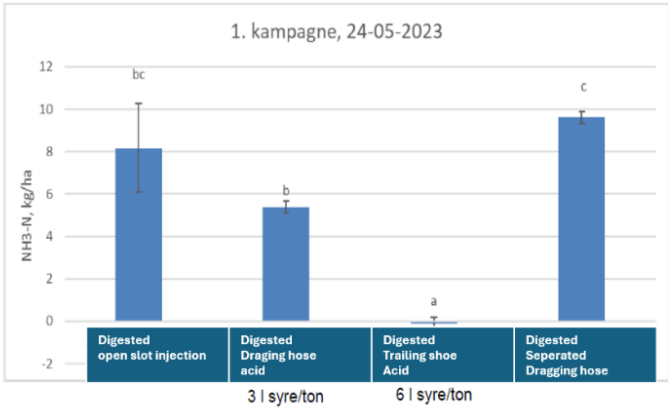
The Netherlands is aiming to bring down nitrogen deposits near Natura-2000 nature reserves, designated under a European conservation plan, below the so-called critical deposition value at 74% of sites by 2030.

Already in 2025, the Dutch administration is well short of target dictated by the Dutch High court as the Bemest op Zn Best program has not delivered any results.

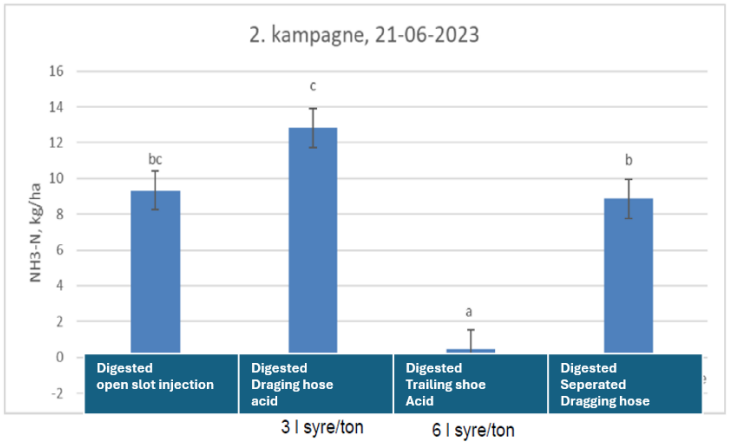
In Field acidification can be a critical element for fulfillment of the legal obligations in Holland. And it can be scaled up very quick and with very positive consequences for the Dutch livestock farmers

Test of In Field Acidification in Denmark yielded very convincing results:

Suggestions: Acidification in Denmark with 2.5 l and 6 l



With the use of 5 l acid pr. m3, the In Field Emissions are eliminated:



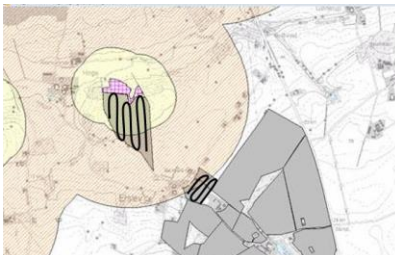
SEGES INNOVATION

Since most Natura 2000 areas with CL load are located on acidic soils – not Polder soils - there are reason to expect a hugely positive effect from using In Field Acidification. Even at small dosage like 2-liter acid, the

soil low pH effect will cooperate with the slurry low pH and practically eliminate all ammonia emission – because there is no ammonia – The ammonia has been converted to ammonium in the slurry and will remain so because of the low soil pH.

A higher dosage rate of Sulphuric acid could be used selectively in the Natura 2000 buffer zones. Since this is not wetlands, there is no danger from the use of Sulphate:

Suggestions: Automatic dosage rate adjustment in Natura 2000 bufferzone of 1000 m



Bufferzone I + II distance from Natura 2000 area

60 % ammonia emission fallout within 1000 m from source

13.29 % of Holland covered by Natura 2000 habitat
In a Total of 160 areas comprising 569.139 ha.

Natura 2000 Bufferzone 1 = 60 % of ammonia emission CL- Critical Load - from slurry application.
Total area app. 288.000 ha

Natura 2000 Bufferzone of 1000 m = 60 % of ammonia emission CL - Critical Load from slurry application.

Dosage rate of acid can be automatic geofenced with a variable rate in- and outside of the bufferzone. CL ammonia emission can be documented and use for a selective application according to emission

Table 5 *The number of hectares dedicated to arable, pastoral, or mixed agriculture in the 1000- or 2000-m buffer zones surrounding the Natura 2000 sites.*

Buffer zone	Unknown	Arable	Pastoral	Mixed	Total
1000 m	96,818 ha	63,054 ha	117,140 ha	11,171 ha	288,182 ha
2000 m	182,995 ha	121,416 ha	217,641 ha	19,877 ha	541,930 ha

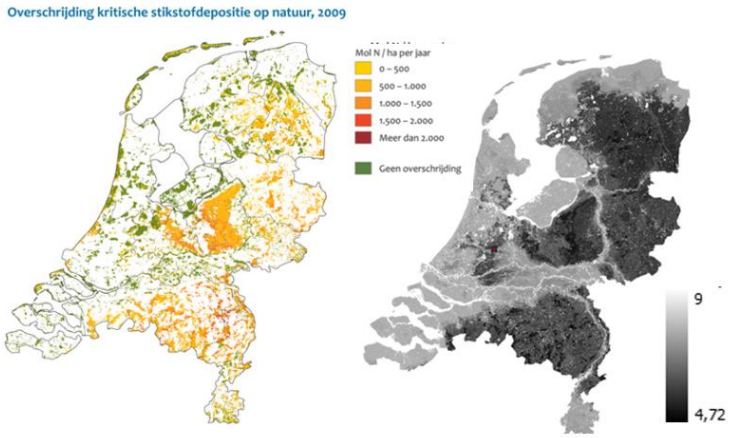
Generally, the Critical load ammonia emission zones are not located on the polder soil as is seen from below:

Analysis of data – emission problem areas

Dutch ammonia emission problem is is differeintiated between high- and low pH soils.

Effect of acidification in yellow and red zones likely to be > 90 % because of low pH soil

Impact of open slot injection in yellow and red zones likely to be poor <50 % because of hard soil conditions.



This raises questions as to why Wageningen has so much focus on polder soil. The current practice is accelerating the subsidence and there is no need to increase the use of Sulphur on polder soils above the recommended agronomic level. Use of 1.7-liter acid pr. m3 is certified by Aarhus University to yield 90 % certainty of 25 % reduction in ammonia emission. That is better than Sod injection and with no negative environmental- and climate consequences like Sod injection, leaving a win-win situation.

Since slurry application takes place in the buffer zones next to the Natura 2000 areas, there is an over proportional ammonia emission reduction in the Natura 2000 areas. Science literature mentions a 40 % to 80 % reduction in dry deposition from application of slurry. Below is calculated with a 40 % reduction.

Suggestions: Ammonia emission challenge by numbers in Holland

Dutch ammonia emission from agriculture 2018:		120 Kt NH_3
Dutch ammonia emission from application of slurry – 40 %		48 Kt
Existing ammonia emission from application of slurry	Volume	Reduction
Use of open slot injection		
1. Polder soil - reduction 60 %	9.5 Kt	6.0 Kt
2. Acidic soil - reduction 60 %	9.5 Kt	6.0 Kt
3. Bufferzone - reduction 60 %	29.0 Kt	18.0 Kt
Total ammonia emission from application:	48. 0 Kt	-30.0 Kt
Additional reduction with use of acidification		
1. Polder soil - reduction 80 %	9.5 Kt	1.5 Kt
2. Acidic soil - reduction 80 %	9.5 Kt	1.5 Kt
3. Bufferzone - reduction 100 %	29.0 Kt	0.0 Kt
Total ammonia emission from application:	48. 0 Kt	-45.0 Kt
Additional ammonia reduction		-15.0 Kt

NB! 60 % of ammonia emission from slurry settel within 1000 m. - 60 % CL load from bufferzone. 40 % CL load from polder + acidic soil
Ammonia emission reference - band spreading

The enclosed suggestions will result in the reduction of the total load of ammonia emission in Holland as specified. It is achievable well before 2030 and will exceed the needs, leaving only 3.0 Kt ammonia emission from field applied slurry.

Provided the Dutch government will follow this advice and enable the legislation to permit In Field Acidification with a boom in all of Holland on a permanent basis, the needed machines can be provided within 2 years. The alternative is to add “or use of other approved technology” to the legislation text that leaves use of Sod injection in Holland as mandatory technology.

It is assumed that a population of 500 units in use with contractors is adequate for the above emission reduction. With an estimated cost of 80.000 € pr. unit, the total investment will be 40 Mio €. This will reduce the ammonia emission deposition in Natura 2000 areas with an additional 30 % over what is happening today. With a budget of 25 billion € for agricultural emission reductions, this is equivalent to cost savings of 7 billion €.

A very recent video made by a user of In Field Acidification in 2025, can be viewed on this link:

https://youtu.be/YgA2A2EmF0Y