TFRN Informal document:

National experience of implementing mandatory measures for low ammonia emission spreading techniques: Response from the Netherlands.

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The aim of this questionnaire was to learn from the experience of countries that have already implemented national mandatory requirements to use low ammonia emission spreading techniques. This should provide valuable information to inform the discussion with experts in TFRN and with policy makers in WGSR.

Question 1. What are the minimum standards that most Dutch farmers should follow in regards of spreading of liquid manure to land?
(Where possible it would help to relate these to the "splash plate spreader" as the reference method in the UNECE Ammonia Guidance Document.) e.g. is there a near universal requirement to use low emission spreading methods, and if so, which level of ambition? (specified by % reduction standard to the reference or list of acceptable technologies).

First of all there is the time window. As from 2012, the spreading of liquid manure is restricted to:

February 1 to August 1	on arable land
February 1 to September 1	if a fallow crop or bulbs are grown
February 1 to August 1	on grassland on sand and loess
February 15 to September 1	on grassland on clay and peat

The rationale for this window is the prevention of nitrogen leaching as crops will not take up nitrogen beyond this period. As from 2010, the restriction is combined with a manure storage requirement for all types of manure good for 7 months.

Secondly, there is a requirement to use low emission spreading methods. The requirement is specific for grassland and arable land, but not for soil type.
<u>Permanent grassland</u>: the manure should be laid down in bands on the soil surface between the grasses or in shallow furrows in the ground. The bands or furrows should not be wider than 5 cm and should be 15 to 30 cm apart. These bands would typically result from using a trailing shoe spreader. Trailing hose spreaders are not allowed. Application of manure in furrows would result from using a shallow injector machine, either disk or tine. Deep (15 to 20 cm) injection of manure has never been used in the Netherlands.
<u>Arable land</u>: the manure may either be surface-spread and immediately incorporated afterwards (in one operation) or be injected.
<u>Remark</u>: Control of proper application of legal standards for manure spreading on grassland is based on judgment of the result of the manure spreading and not on application of the machinery itself. This enables inspection also (days) after the actual spreading.

List of techniques and volatilization percentage VP.
Source: Huijsmans and Vermeulen, 2008.

Technique	Land use	VP
Splash plate	Grass	74%
Trailing shoe	Grass	26%
Shallow injection	Grass	19%
Splash plate	Arable	69%
Incorporation in two operations	Arable	46%
Incorporation in one operation	Arable	22%
Injection	Arable	2%

Question 2. What are the minimum standards that most Dutch farmers should follow in regards of spreading of solid manure (farmyard manure) to land?
(e.g. requirements to incorporate manure to arable land within a certain time scale?)

There are no standards regarding the spreading of solid manure.

Question 3. Are there additional higher standards required by some farmers in some sensitive situations? (As this could get complicated, a brief answer here is sufficient. Our main emphasis is on national scale mandatory requirements).

No. In the future the use of trailing shoe spreaders will not be allowed on sandy soils.
Remark: This is a preventive measure as very few trailing shoe spreaders are in use on sandy and loessal soils.

Question 4. Are some exemptions allowed to farmers to the minimum standards specified in Questions 1 and 2?
Please specify any exemptions, and any relevant thresholds: e.g. for small farm holdings (small number of animals, small area of agricultural land)?
* fields with stony soils (where injection methods not possible)?
* fields with steep slope ? (It may be that you conclude no slurry should be applied anyway to such fields * due to nitrates policy)
* emergency application e.g. during extreme weather events.
* Any use of ammonia emission forecasting systems?

Neither of these challenges has been exempted. However, there is possibility for exemption when farmer participate in research on alternative spreading techniques or nitrogen management. In particular, to farm management that would lead to the same emission as the application of low ammonia emission manure spreading techniques, e.g. low protein feed, spreading water on the field after manure spreading. The area, to which this exemption applies, has been restricted to 2500 hectare, which is about 0.25 % of the area in agricultural use.

Due to the risk of erosion of the fragile sandy soil, low emission spreading is not mandatory on the arable land of the Isle of Texel.

Currently, there are no forecasting systems or advisory services available to promote manure spreading under weather conditions unfavourable for ammonia emission. Additional constraints allowing manure spreading only under favourable weather conditions would require large storage facilities.
Also, the efficacy of manure spreading techniques builds on the database of some 200 controlled experiments carried out in the time period 1998 through 2003. However, this database is not without bias. Experiments all started in the morning hours and without rain. [Rain later during the experiment would not stop the experiment.] So the database does not comprise experiments

starting in the late afternoon or while raining, which are typical favourable weather conditions.
Developing a forecasting system that accounts for atmospheric mixing length, rain, soil permeability, soil pH, and so on would be most interesting.

Question 5. Optional question: Do you have estimates on the additional costs of spreading manure by using low emission methods? If so, please provide.

The table below specifies the cost estimates of manure spreading (euro (2005) per tonne of animal manure).

Technique	Land use	Lower estimate	Higher estimate
Splash plate	Grass	1.2	1.6
Trailing shoe	Grass	1.9	2.6
Shallow injection	Grass	2.2	3.0
Splash plate	Arable	1.2	1.6
Incorporation in two operations	Arable	2.8	3.8
Incorporation in one operation	Arable	2.0	2.7
Injection	Arable	2,1	2,9

Question 6. What benefits have been considered as important in consideration of these measures? Have additional unexpected co-benefits been observed?
e.g. ammonia emissions, nitrate pollution, odour, better agronomic efficiency, saving costs of mineral fertilizers, better agronomic flexibility etc.

Low emission spreading of manure may generate considerable benefits. First of all, it reduces mineral fertilizer requirement. On a national scale savings on mineral fertilizer use outweigh the extra costs of low emission techniques. So for farmers - with enough scale or sharing the machinery – low emission spreading of manure can be profitable.

> Remark
> As a matter of fact, using low emission techniques should always be combined with a reduction of chemical fertilizer input as otherwise the risk of nitrogen losses – leading to nitrogen leaching or N_2O emission- increases.

It has been shown that applying 100 kg manure N with a trailing shoe spreader may save the equivalent of 24 (47-23=24, see list below) kg of mineral N as compared with applying the same amount of manure with a splash plate. Using the present price of fertilizer N of one euro per kg and an estimated application of 250 kg N (on grassland!) manure per hectare, the per hectare savings amount 250/100*1*24=60.

List of techniques and computed mineral fertilizer savings kg N per 100 kg of manure N.
Source: Huijsmans et al., 2008.

Technique	Land use	kg fertilizer N per 100 kg manure N
Splash plate	Grass	23
Trailing shoe	Grass	47
Shallow injection	Grass	52
Splash plate	Arable	39
Incorporation in one operation	Arable	66
Injection	Arable	78

Secondly, low ammonia emission spreading reduces ammonia and odour emission. Thirdly, it reduces the need for chemical fertilizer production. During the production process greenhouse gases are emitted. Emission is estimated at 1 to 2 kg CO_2 eq. per kg mineral N produced (Wood and Cowie, 2004). However, as a result of manure incorporation into the soil, nitrous oxides emission may increase.

Question 7. What are the challenges that the Netherlands has faced in implementing such mandatory requirements? Specifically, were difficulties encountered in specifying any exemptions from the requirements?

In general, the introduction of low emission spreading techniques has been well accepted in the Netherlands. However, occasionally low emission spreading of manure unfortunately became the metaphor of unnecessary governmental interference. As a consequence, some farmers resisted to comply and continued to use the splash plate. They face considerable fines. They obtained support from academic circles, which ended up in the research exemptions mentioned above. The non-compliants brought forward that low emission spreading would have negative side-effects. It would compact the soil, affect the sward, endanger soil biodiversity, ruin bird nests and on.
Recent research showed that if these effects occur, they result from the increasing farm mechanisation rather than from low emission spreading and that the effects are temporary. The admission of the trailing shoe spreader prevents problems on waterlogged soils as these spreaders require hardly – 10% - more pulling power than conventional machines. With regard to soil compaction, the weight of the manure container – and not of the spreader - determines the pressure on the soil.

Question 8. Were there some difficulties that were not foreseen that the TFRN should particularly consider in developing the description of manure spreading options?

The difficulty is the – lack of – acceptance by farmers. Therefore, the TFRN may consider investigating whether, throughout Europe, low emission spreading is as profitable for farmers as it is for the environment, as was shown for the Dutch case. The enhanced use of animal manure and the restricted use of chemical manures may require that farmers adapt their manure and soil management to keep the reactive nitrogen availability to the usual level. This adaptation will meet less resistance if it is clear from the beginning that the interests of farmers and the environment parallel.

Question 9. Are there other points that need to be considered when designing options for mandatory requirements to use low emission manure spreading methods?

[No answer supplied]

Supplementary Question in the light of the answer given to Question 6.

Question 6 b. Can this nitrous oxides increase be [partly?] off-set by the accompanying reduction in secondary N_2O emissions associated with reduced ammonia emission and deposition?

Indeed, the extra emission is partly offset by a reduction elsewhere. Below we assess the (dis)advantages of less NH_3 and more N_2O. The answer will be given in two steps: the first step is to estimate the emissions of NH_3 and N_2O per kg of N in manure for both 'splash plate' and low-emission techniques; the second step is to estimate the damage in monetary terms € per kg emitted for NH_3 and N_2O. The first step builds on IPCC rules for the inventory of greenhouse gases and reported by Klaas van der Hoek (RIVM report 680125003) for the Netherlands, the second step builds on the ExternE (www.externe.info) research project of the European Commission.

Step 1.
The splash plate generates 0.41 kg of NH_3 and 0.068 kg of N_2O per kg N in manure, whereas low-emission techniques generate between 0.06 and 0.17 kg of NH_3 and about 0.090 kg of N_2O per kg N in manure (assuming 60% TAN).

N_2O from 3 sources:

- directly after manuring [1% or 2% of N in manure]
- indirectly after deposition of emitted ammonia [1% of NH_3 emitted after manuring]
- indirectly after leaching + run-off [2.5% of 30% of N in manure].

Step 2.
The damage by the emission of 1 kg of NH_3 is 13 €, while the damage by the emission of 1 kg of N_2O is 6.2 € (it is 20 € per tonne of CO_2 equivalent).

Putting these results together we see that if using low emission techniques the gain by NH_3 (13€ x ~0.30kg) is about 30 times as big as the loss by N_2O (6.2€ x 0.022kg).
So, indeed there are extra N_2O emissions. But these should not stop one from using low-emission techniques, while the advantages are greater than the disadvantages. However, the data are uncertain and the damages are hard to compare.

[A small excel spreadsheet was also provided to illustrate the trade offs]

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