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# IS IT COSTLY TO EXPAND YOUR LIVESTOCK FARM NEAR A NATURA 2000 AREA IN THE EU?

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# IS IT COSTLY TO EXPAND YOUR LIVESTOCK FARM NEAR A NATURA 2000 AREA IN THE EU?

**Abstract**

*Natura 2000 areas are designated according to the EU's Birds and Habitats Directives in order to protect particular habitats and species from deposition of nitrogen caused by ammonia emissions. Livestock farming is the primary source of this pollution. The purpose of the analysis is to compare the costs of reaching the ammonia emission targets for different livestock farms near Natura 2000 sites in the Netherlands, Schleswig-Holstein, and Denmark. The analysis looks at regulatory aspects, the emission requirements and the cost of implementing the technologies to reduce emissions. The selected case farms are a finisher farm, a dairy farm and a broiler farm, and the distance to a Natura 2000 site is 400 metres. In all three countries, a relatively low share of livestock farms is situated near Natura 2000 areas. The regulatory approach is very different in the three countries and key issues are additional deposition from projects, neighbouring livestock farms, the inclusion of background deposition and the critical load levels used. The findings suggest that the requirements near Natura 2000 in many cases can be so high that farms will expand at a different site instead.*

**Keywords**: Natura 2000, Ammonia, costs, livestock regulation, deposition

## 1. Introduction

Natura 2000 areas are designated according to the EU Birds and Habitats Directives, with the objective to protect particular habitats and species. A variety of these habitats and species are particularly sensitive to deposition of nitrogen, caused by ammonia emissions, which primarily comes from livestock farming (EEC, 2017). The EU Clean Air Policy Package from 2013 aims to reduce ammonia emissions not only in order to preserve and improve nature sites, but also to improve human health through the reduction of air pollution as ammonia contributes to the background concentration of particulate matter across the EU (EEC, 2013; Whitfield and McIntosh, 2014).

Typically, most of the nitrogen deposition at a given location originates from emissions far from the locality and often from other countries. Only 23% of the Danish ammonia emissions originate from the Danish land area, while the corresponding figure for Germany is 49%, and for the Netherlands it is 28% (EMEP, 2014 and DCE, 2015). Conversely, ammonia emissions from larger point sources (livestock facilities, manure storages and application of manure) could dominate the local load within some miles around the source. Therefore, to protect the sensitive nature types, both local and international initiatives are necessary to reduce ammonia emissions.

As over 90% of the ammonia emissions originate from agriculture, the key to reduction is on livestock farms in Europe. Several places in Europe including countries like The Netherlands, Belgium (Flanders), parts of Denmark, Brittany in France, parts of Germany, as well as Lombardy in Italy and Catalonia in Spain all have high ammonia ($NH_3$) depositions as a consequence of high livestock intensity.

Protecting Natura 2000 sites requires local regulation of livestock farms to reduce the local deposition of ammonia. A severe national regulation for all livestock farms will be able to reduce national emissions and thus also reduce local deposition rates, but the associated costs might be high. On the other hand, a very targeted regulation approach will restrict local expansion and deposition, but will perhaps not reduce the national emissions and the base deposition much (Hicks et al., 2011).

The purpose of this paper is therefore to briefly describe the regulatory approaches used in Germany (Schleswig-Holstein), the Netherlands and Denmark; and link this to the expected reduction requirements and the costs for selected case farms. Which emission levels and deposition levels are allowed locally and which key regulatory approaches are used? Can the costs be prohibitively high in a given location leading to an expansion of the livestock farms far away from nature sites?

The outline of the paper is as follows. Section 2 provides a short review of the respective regulatory setup in the three countries. Section 3 describes the analytical approach and methods; this includes a short description of three case farms: finisher production, a dairy farm, and a farm with broilers. The three farms are subjected to two stylized investment scenarios of critical neighbourhoods: a doubling of their livestock operations in 400 metres distance from Natura 2000 sites. Based on the national regulatory setup, we calculate in section 4 the ammonia reduction requirements for each farm. Section 5 assesses the costs of compliance with the regulatory requirements and compares them across the three countries. Finally, conclusions are drawn as to the relationship between farm location (distance from Natura 2000 sites), regulatory approach, reduction requirements and costs in the three countries.

## 2. Reducing ammonia emissions and the regulatory setup

### 2.1. Regulation

With more than 2.6 million hectares, Denmark has the largest agricultural area of the three regions analysed, whereas the Netherlands have the most livestock intensive production. The Dutch livestock intensity is twice the level of Denmark and three times the level of Schleswig-Holstein (Jacobsen and Ståhl, 2018b; Santonja et al., 2017).

In the Danish context, the Best Available Technologies (BAT) are listed on the Technology List, which includes technologies that have been approved, meaning that they have both a certified effect on ammonia emissions and a reasonable cost for farmers (Jacobsen, 2012a+b, Mikkelsen and Albrektsen, 2017). Denmark and the Netherlands have converted the BAT requirements into emission requirements, which in many cases determines the technology chosen, whereas in Germany, the allowed emissions (TA air) are higher, but in specific cases additional technology is required (e.g. air scrubber). The Danish BAT levels are based on an assessment of the acceptable cost level or BATNEEC to ensure that the costs are not excessive. A limit of 8 DKK per finisher has been set as one of these cut-off levels (Jacobsen, 2012b).

Table 1 provides an overview of the regulation of livestock production near nature areas. There are clear differences between the systems and the values used, and it should be noted that the Dutch approach includes emissions from other sectors, which is why the allowed emissions are in mole N per ha. The limit of 1 mole per ha is the same as 14 gram N or 0.014 kg N per ha, which is a very low level compared to levels used in e.g. Denmark, where the number of livestock farms nearby is important. As a result, the requirements have an impact on farm expansions in a large area in the Netherlands.

The German approach include the initial load plus the additional load due to the project and this is then compared with the critical load on the location in an FFH assessment (Flora Fauna Habitat). If the initial load is higher than the critical load, the project can only be approved if the additional project-related nitrogen deposition at the FFH site remains below 0.3 kg N/ha and below 3% of the Critical Load (CL)

**Table 1. Natura 2000 assessment/permit criteria regarding ammonia/nitrogen**

| Denmark | Germany | Netherlands |
|---|---|---|
| "Ammonia-sensitive" habitats (category 1)<br><br>Permit thresholds:<br>• Total load below 0.2-0.7 kg N/ha/year (cumulation model)<br><br>(Livestock Installations Act – category 1) | Critical Loads (CL) for "nitrogen-sensitive" habitats (not binding)<br><br>Assessment thresholds (cut-off/de minimis – no further assessment needed):<br>• Additional load below 0.3 kg N/ha/year (cut-off), or<br>• Additional load below 3% of CL (de minimis) | PAS ("nitrogen sensitive" habitats):<br><br>Cut-off assessment threshold (no permit requirement):<br>• Additional load below 1 mole N/ha/year (or 0.05 mole N/ha/year if there is no or little "room for development" left)<br><br>Permit threshold:<br>• within "room for development" (maximum additional load of 3 mole N/ha/year) |

Source: Anker et al., 2018

In the Netherlands, only nitrogen-sensitive Natura 2000 sites are included in the PAS policy. The PAS policy is an integrated approach to nitrogen deposition. It aims to achieve the objectives of the European Nature policy, while creating the necessary room for development and livestock production (Wimot et al., 2016; Anker et al., 2018; Luesink and Michels, 2018a+b).

## 3. Material and methods

### 3.1. Case farms

The case farms used in the analysis are described in Table 2. The expansion is assumed to be 100% compared to the present farm.

**Table 2. Livestock production on case farms before and after expansion**

| | Before expansion | After expansion |
|---|---|---|
| Finishers | Annual production of 7,215 finishers of 32-107 kg. *)<br>33% drained floor and 66% slatted floor. Slurry tanks with a required cover. | Annual production of 14,430 finishers of 32-107 kg.<br><br>New building has to be decided upon |
| Dairy cows | 120 dairy cows without heifers.<br>Cubicles with slatted flooring and a recirculation manure pit.<br>Slurry tanks with a required cover. | 240 dairy cows.<br>New building has to be decided upon |
| Boilers | A production of 300,000 broilers annually.<br>A loose housing system.<br>Solid manure | A production of 600,000 broilers annually.<br>New building has to be decided upon |

*Note: For the Dairy farm calculations have been made with and without heifers and calves as heifers and calves are not included in the Dutch case, but they are included in the German case.*
**) The finishers in Denmark, Germany and the Netherlands have different weight intervals.*
*Source: Jacobsen and Ståhl (2018b)*

### 3.2. Calculation approach used

The method adopted here is to calculate the additional costs of ammonia abatement near Natura 2000 sites compared to the requirements related to BAT which has to be met by all livestock farms. In that way the calculation describes the additional costs of expanding a livestock farm near Natura 2000 areas in the three regions.

The costs are calculated as the annual costs using the lifetime of the asset (building) or the technology and the interest rate. The interest rate used follows the country specific standard; 4% in the Danish case, 2% in the German case and 3.5% in the Dutch case. This means that the annual costs for the same investment calculated in Denmark are roughly 10% higher than in Germany, which should be noted when costs are compared.

In the analyses in the different countries, important parameters are used to incorporate variation due to specific regulation. In Denmark, this is the number of livestock neighbours; in Germany it is the difference in initial load versus critical load; and in the Netherlands, it is the level of room for development. The German cases are situated in Schleswig-Holstein, the Dutch cases are based on the situation in the province of Overijssel, whereas the Danish case is based on a national approach. The case farms have been chosen to illustrate the typical situation for different types of farms at different locations, but it does not aim to cover all likely outcomes of reduction requirements and costs.

## 4. The reduction requirements for the case farms

The reduction requirements for the Danish case farms are described in Table 3. The first level is the BAT emission requirements which have to be met by all farms. The next level are the allowed emissions related to the farm's proximity to nature sites and the number of livestock farms near category 1 and Natura 2000 sites. The allowed emission levels were calculated by the Danish Environmental Protection Agency using the online electronic application system located on the homepage www.husdyrgodkendelse.dk (see more in Jacobsen and Ståhl, 2018a). The assessment in Denmark is based on the total deposition from the farm after the expansion. As shown in Table 1, the allowed depositions are 0.7 kg N per ha with no livestock farms nearby, 0.4 kg N per ha with one livestock farm nearby and 0.2 kg N per ha with two or more livestock farms nearby (see more Jacobsen and Ståhl, 2018a; Anker et al., 2018). The inclusion radius of the nearby farms depends on the size of the farms.

The requirements related to the TA air requirement in Schleswig-Holstein are translated into a minimum distance from nitrogen sensitive areas. The calculations for the finisher farm (Table 2) give a minimum distance of 870 metres when the initial emission is 18,200 kg $NH_3$ (3.64 kg $NH_3$/place * 5,000 places) (see Latacz-Lohman, 2017).

The ammonia assessment in Germany comprises three steps:
1. Is the current background load including the project before expansion larger than the critical load?
2. Does the additional deposition at the Natura 2000 site exceed 0.3 kg N per ha? ("de minimis" rule)
3. Does the project result in an increase in ammonia deposition of less than 3% of the critical load? ("Bagatelia")

If the initial deposition (e.g. 15 kg N per ha) is lower than the critical load (e.g. 20 kg N per ha), the additional deposition from the project is limited to 5 kg N/ha. If the initial load is higher than the critical load of around 5-20 kg N/ha depending on the area and nature type, the expansion may only increase N deposition by 3% of the critical load or less than 0,3 kg N per ha. It should be noted that a calculation as above is based on the total emission from the farm, assuming that the pre-existing animal house was erected **after** registration of the FFH site in 2004.

Table 3 shows the overall allowed $NH_3$ emissions for the three case farms in the three countries with a distance of 400 metres from Natura 2000 sites. The actual emission from the technologies implemented are also included in parentheses below the allowed level. It is noticeable that the base emission for finishers in Schleswig-Holstein is much higher than in the other countries. In the Danish and Schleswig-Holstein case, the strict conditions imply that the emissions are lower than before the expansion (a reduction of over 50%). Note that in the Netherlands there are reduction requirements for farms of 400 metres, but in case the farm was further away a similar reduction would be required.

**Table 3. Allowed emissions in kg $NH_3$ per year and at 400 m from nature sites for case farms in Denmark, Netherlands and Schleswig-Holstein. () indicate actual emission from given technology.**

| Country and nature type | Name Neighbouring TL/CL levels Development room | Baseline before BAT | BAT | Light 0 Neig TL<CL 100%[a)] | Medium 1 neig | Strict 2 neigh TL>CL 0% |
|---|---|---|---|---|---|---|
| Denmark, cat. 1 | Finishers | 6,900 | 6,120 (5,727) | 3,630 (3,740) | 1,994 (1,518) | 1,014 (7,59) |
| | Dairy farm | 3,987 | 3,139 (3,267) | 3,411 (2,451) | 1,933 (1,633) | 1,277 (1,225) |
| | Broilers | 4,661 | 4,038 (3,961) | 3,525 (3,263) | 2,389 (--)* | 1,194 (--)* |
| Netherlands | Finishers | | 7,225 | 7,225 (7,225) | --- | 3,500 (2,688) |
| | Dairy farm | | 2,064 | 2,064 (2,064) | --- | 1,320 (1,164) |
| | Broilers | | 2,880 | 2,880 (2,880) | --- | 1,480 (1,320) |
| Schleswig-Holstein | Finishers | 18,200 | 3,640 | 2,462 (2,462) | --- | 147 |
| | Dairy farm | 3,983 | 3,983 | 2,462 (2,390) | --- | 147 |
| | Broilers | 3,880 | 3,880 | 2,462 (2,527) | --- | 147 |

Source: : Luesink, H. and Michels, R. (2018a); Jacobsen and Ståhl (2018); Latacz-Lohmann (2017)
Note: The Danish Dairy and the Dutch Dairy case is without heifers and calves
Note: The Danish emission has been converted from $NH_3$-N to $NH_3$ (divided by 0.8235).
Note: The () value are the actual emissions based on the technology implemented. * indicate that no technology is available.
Note: 0/1/2 Neig is short for 0, 1 or 2 livestock neighbours as use in the Danish regulation. TL and CL are the total load and the critical load. 100% and 0% show the share of room for development in the Netherlands.
[a)] The extra nitrogen deposition on Natura 2000 regions is maximum 3 mole per ha.

## 5. Cost of abatement technologies used on case farms

The focus here is on finishers and dairy farms.

### 5.1. Denmark

For the finishers, the additional costs of complying with Natura 2000 specific ammonia requirements are calculated as the costs of the specific technology necessary in each case minus the costs of the baseline technology (BAT).

The required emission reductions for finishers in relation to ammonia sensitive nature are achieved by installing chemical air cleaning in the stable (sometimes both the old and new stable). This will entail yearly net costs of € 6-32,000 per year or € 0.8 - 4.4. per finisher (increased production).

For the dairy farm to adhere to the BAT requirements when expanding from 120 to 240 dairy cows (without heifers), the dairy farm needs to achieve ammonia reductions of 24% compared to the baseline stable of 2,690 kg $NH_3$-N. This can be done by installing wire drawn dredgers in both the old and the new stable. Another option is to install low emission flooring with dredgers in the new stable which reduces emissions by 50%, thus achieving a total reduction of 25% for the entire farm.

### 5.2. Schleswig Holstein

In Germany two situations are considered: one where the critical load of nitrogen deposition is already exceeded and another where the current deposition is below the critical load. In case the current deposition is below the critical load only a smaller reduction is required. For the finisher farm the costs of in-field acidification are € 2.3 per finisher for the additional production or a total of €16,500. For the dairy farm, the annual cost of in-field acidification is €8,250 for the entire farm or €68 per cow for the additional production. An air filter with 100% capacity is installed on the broiler farm and the emission will be 2,527 kg $NH_3$ (-35%) resulting in a reduction in deposition of around 5 kg N/ha. The total cost is €6,679 per year or € 0.022 per broiler produced extra or €4.91 per kg $NH_3$ abated (Latacz-Lohmann, 2017).

### 5.2.3. The Netherlands

The costs for expanding the finisher farm at the baseline following BAT requirements are € 27,500 per year; these costs are based on installing air scrubbers in the existing building and cooling in the new building. These costs also hold if the farm can obtain room for development. Without room for development, the costs of additional air scrubbers etc. will increase to € 47,825 per year, which is an additional cost compared to the costs regarding the BAT requirements of € 20,325. This equals € 2.8 per extra produced finisher.

For the dairy farm, the costs for the measures to fulfil the BAT requirement are limited; the additional costs compared to the basic investment are € 2,100 per year. With no room for development, the costs will increase to € 17,925, as air scrubbers are introduced. The additional costs are € 15,825 per year or € 132 per cow (additional production). For both finishers and dairy cows, the costs in the case of no room for development, are so high that an expansion is probably not realized. For broilers, the production increases from 300,000 to 600,000, requiring an increase of 40,000 places. The requirements to reach the BAT level indicate that the farmer might gain from including heaters on the farm. In the case of no room for development, the inclusion of heat exchangers might also be beneficial (negative costs). In the further calculations, the costs are set at €0, as not all farms will be able to gain from heat exchangers.

When looking at the costs at the farm level, it turns out to be costly and technically difficult to find solutions that can reduce emissions enough to meet the strict requirements for farms that are 400 metres from Natura 2000 in the three countries. It also shows that the costs vary as the regulatory approaches adopted in the three countries also differ.

***Table 5. Extra yearly costs (euro/farm) for the case farms in the vicinity of nature areas in Denmark, the Netherlands and Schleswig-Holstein compared to the farms with no significant negative impact on nitrogen-sensitive habitats for different situations where the farms expand by 100%. The costs are compared to BAT requirements or similar.***

| **Country and nature type** | Neighbouring farms/development room | Finisher 400 m | Dairy 400 m | Broiler 400 m |
|---|---|---|---|---|
| DK, cat. 1 | No neighbour | 6,479 | 0 | 4,323 |
| | 1 neighbour | 18,463 | 12,096 | Not possible |
| | >1 neighbour | 31,767 | 14,278 | Not possible |
| Netherlands | 100% room* | 0 | 0 | 0 |
| | No room | 20,325 | 15,825 | 0 |
| Schleswig Holstein | TL < CL | 16,500 | 8,250 | 6,679 |
| | TL > CL | Not possible | Not possible | Not possible |

Source: Luesink, H. and Michels, R. (2018a); Jacobsen and Ståhl (2018a); Latacz-Lohmann (2017)
Note: The costs for broilers can be negative as the heat exchangers can save money and, therefore, are cheaper than traditional housing.
In the case of Schleswig Holstein TL and CL are Total Load and Critical Load
No additional costs as other Nature sites are not included in the PAS regime.
*) The maximum additional load of 3 mole N deposition per ha has not been included in this calculation

## 6. Conclusions

This paper has compared the costs of reaching the ammonia emission targets for different farms near Natura 2000 sites based on expert reports from the Netherlands, Germany (Schleswig-Holstein) and Denmark. The analysis is based on the ammonia reduction requirements for selected case farms 400 metres from Natura 2000 in the three countries.

For farms near nature sites (Natura 2000 or other nature sites), there are stricter requirement related to the allowed ammonia emissions in order to improve nature quality. The regulation approaches applied in the three countries are very different. The Danish approach is based on the total $NH_3$ load from the farm after expansion in relation to deposition standards based on the number of nearby livestock farms.

The analyses show that the allowed emissions for farms 400 metres from Natura 2000 require large reductions and so the implications, in most situations, will be that the expansion in all three countries will not take place at this location. The strictest requirement is found in Schleswig Holstein when the initial load (from farms and other sources) is larger than the critical load (additional emission below 0.3 kg N/ha). In the Netherlands, the emission does not need to be lower than the emission before the expansion, as the focus in the assessment is on the additional amount and not the total deposition. The cost is therefore lower than in the other cases where the farm is near Natura 2000. In the Netherlands the total deposition is in many cases higher than the critical load and so farms further from stricter requirements than in the other countries.

For the different farms, the costs vary from €0 to €30,000 per year. The costs are in the order of €1-4 per finisher, € 70-130 per dairy cow, and € 0-22 per 1000 broilers for the additional production. The total costs are highest for the finisher farms, followed by the dairy farms, and the broiler farms respectively.

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