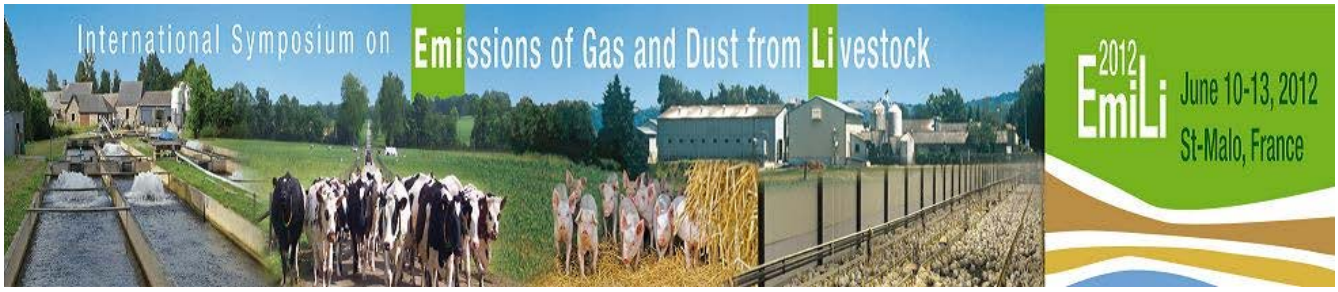
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AMMONIA EMISSIONS FROM DUTCH AGRICULTURE IN 2020 ESTIMATION AND UNCERTAINTIES

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ABSTRACT The results show that ammonia emissions from agriculture in The Netherlands amounts 100m kg in 2020. Compared to 2007, ammonia emissions will fall by 20m kg. This drop in ammonia emissions is primarily the result of low-emission animal housing (a decrease of 10m kg) and the application of animal manure (a decrease of 9m kg). The estimated ammonia emissions in 2020 can differ by a range of approximately 5%. Important uncertainties are: the developing of manure processing, the number of dairy cattle, and whether or not to continue the derogation. For the reducing goals of the ammonia emission the Netherlands Environmental Assessment Agency requires insight into ammonia emissions from agriculture in 2020. The ammonia emission depends on agricultural practices and legislation, that's why they had to be taken into account for future developments. Analysed in this study is:

- What the ammonia emissions will be in 2020;
- What the effects of uncertainties are on the ammonia emissions in 2020.

The ammonia emissions are calculated with MAMBO, a model that simulates supply and demand of manure on the Dutch manure market. The number of animals and crop acreages are derived from the LEI study of Silvis et al (2009).

Keywords: Ammonia emission, prediction 2020, The Netherlands, modeling, uncertainties

INTRODUCTION For the reducing goals of the ammonia emission the Netherlands Environmental Assessment Agency requires insight into ammonia emissions from agriculture in 2020. The ammonia emission depends on agricultural practices, number of animals, crop acreages and legislation, that's why they had to be taken into account for future developments. Therefore the next questions are analysed:

- What are the ammonia emissions in 2020 and what are the fundamental assumptions?
- What effects do the uncertainties have on for a number of relevant parameters and on the ammonia emissions in 2020?

The objective of the paper is to present a method to calculate future ammonia emissions including the development of the agriculture structure, the technological development and relevant legislation. In the next section the used method and data are described. Paragraph two describes and discusses the results. This paper ends with the conclusions of the study.

1. MATERIAL AND METHODS

1.1 Activity data

In order to be able to calculate the ammonia emission in 2020 assumptions should be made concerning the development of the agricultural farm structure, technological development and the amount of legislation. From a study aimed at the development of the agricultural sector (Silvis et al., 2009) the next assumptions are derived:

- The lifting of the milk quota in 2015;
- A 16% increase in national milk production between 2007 and 2020;
- A 1.1% increase in milk production per animal per year;
- The lifting of the animal permit requirement for pigs and poultry in 2015;
- Usage norms from the 4th Dutch Nitrate action programme;

- The amount of manure processing.

Next the ammonia emission reducing effects of policy and new technology are estimated and an inventory is made about the expected activity data in 2020 (Hoogeveen at al., 2010) of:

- Low emission housing. In 2013, at least all pig and poultry farms must have housing systems with low ammonia emissions, due to the 'housing system decision' of the Dutch government. Farms around Natura 2000 areas and farms who want to keep more animals, have to go even further: they need air washers. Dairy farms with newly build stables that keep the animals inside must keep them in housing systems with low ammonia emissions. With this information experts estimate that in 2020 about one third of the pigs and poultry is housed in stables with air washers and two third in housing systems with low ammonia emissions. It is expected that 30% of the cattle is housed in housing systems with low ammonia emissions and 70% in traditional housing systems;
- Grazing time of grazing animals. With drawing true of trends it is estimated that in 2020 37% of the dairy cattle will be kept the whole year inside;
- Application techniques. The application techniques that are used in 2020 are based on an inventory from 2005 and the changes in the government rules for manure application in 2008;
- Emission factors for housing and application. The emission factors from housing systems are all based on the RAV (Regeling Ammoniak en Veehouderij) and for application on Van der Hoek, 2002.

1.2 Method

At the beginning of the 1980s, LEI started with the development of the 'Manure model' (Wijnands at al., 1984). After big model revisions in 1988, 1997 and 2007 (Kruseman at al., 2008), nowadays the calculations take place with the fourth model generation (MAMBO). MAMBO can be used to calculate nutrient flows, ammonia emissions, dust and the greenhouse gases methane, dinitrogenoxide and nitrogen oxide (Luesink at al., 2007; Kruseman at al., 2008). It has recently been used in Reidy et al., 2009 to compare national ammonia (NH3) emission models with each other. In MAMBO five key processes are included.

- Manure production on farms. In this part the ammonia emission from housing, storage and pasture at farm level are calculated as a function of the number of animals, animal types, types of feed, housing types, storage types and grazing time;
- On farm maximum allowed application of manure within statutory and farm level constraints;
- Manure excess at farm level;
- Manure distribution between farms;
- Application of manure resulting in soil loads with minerals. At this place in MAMBO at municipality level the ammonia emission from the application of manure and mineral fertilizer are calculated. The ammonia emission from application is a function of application technique, spreading time, amount of nitrogen and manure type.

2. RESULTS AND DISCUSSION

2.1 Ammonia emissions in 2020

Ammonia emissions from agriculture are estimated at 100m kg of ammonia in 2020. That is lower than the expected policy goal, which is not yet sure, of 104m kg in 2020. The majority of ammonia emissions in 2020 comes from animal manure (90%) and the remaining part (10%) from artificial fertilizers. Animal housing (54%) and application of animal manure (34%) are the major sources of ammonia emission from manure (Table 1). Emissions from grazing and storage of manure will be relatively low. Grazing animals are responsible for almost two third of the ammonia emission, pigs for 23% and poultry and other animals for 12% in 2020.

Table 1. Ammonia emission from animal manure in The Netherlands in 2020 in m kg of NH3

Source	Animal kind			
	Grazing	Pigs	Poultry	Total

	animals		and other	
Housing	28.4	11.6	6.8	46.8
Storage	0.8	0.3	3.5	4.6
Grazing	6.5	-	-	6.5
Application	22.3	8.9	0.4	31.6
Total	57.9	20.9	10.7	89.5

2.2 Changes in ammonia emissions between 2007 and 2020

Compared to 2007, ammonia emissions from animal husbandry will fall by 18% (Table 2). This drop in ammonia emissions is primarily the result of low-emission animal housing from pigs and poultry (a decrease of 10m kg) and of application of animal manure (a decrease of 9m kg). Due to the lower usage norms the amount of manure that can be applied in The Netherlands goes down. In this situation it is no longer possible to apply manure from poultry and a part of the manure from pigs on Dutch agriculture. This manure is processed into energy or manure products which are exported to other countries. Still more cows are kept inside during summertime, with the effect of lower emissions from grazing and higher housing and storage emissions. Since the first of January 2012 it is no longer allowed to keep chickens in cages. This results in higher storage emissions from poultry.

Table 2. Changes in ammonia emission from animal manure in The Netherlands between 2007 and 2010 (2007= 100)

Source	Animal kind			
	Grazing animals	Pigs	Poultry and other	Total
Housing	104	59	68	82
Storage	114	100	121	118
Pasture	83	-	-	83
Application	94	57	31	78
Total	97	58	75	82

2.3 Uncertainties

With scenario analyses it is estimated that the ammonia emissions in 2020 can differ by a range of approximately 5%. Important uncertainties are:

- If manure processing does not develop further, livestock numbers will shrink, which gives a decrease in ammonia emissions by 2.4m kg;
- The number of dairy cattle may increase by an extra 8%, which gives an increase in ammonia emissions by 2.5m kg;
- No derogation results in increased pressure on the manure market and a decrease in livestock numbers, which give a decrease in ammonia emissions by 4.2m kg.

3. CONCLUSIONS

Ammonia emissions from agriculture in The Netherlands are estimated at 100m kg of ammonia in 2020 and can be differ by a range of approximately 5%. Due to low emission housing from pigs and poultry and decline of the usage norms, the emissions drop with 20m kg, compared to 2007.

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