

Addition of bedding material to NEMA

Introduction

Bedding material provided to livestock in the form of e.g. straw is a nitrogen input into the manure and contributes to N-emissions from manure during storage, treatment and application. The IPCC guidelines and EMEP guidebook both provide methods to include bedding material and all related emissions in the inventory. The Tier 1 method assumes only straw is used as bedding material. As no information is available on the usage of other forms of bedding material in the Netherlands only straw is taken into account for the calculations in NEMA. The Tier 1 methods assume a certain amount of straw to be provided per animal place per year. For grazing livestock it is assumed that no straw is provided on days with grazing. The Dutch consumption of straw, per animal place and in the case of grazing livestock per animal place per day indoors, can mainly be based on information provided by the [BedrijvenInformatieNetwerk](#) (BIN).

Overview activity data and proposal uptake in NEMA

The activity data from multiple sources have been assessed:

- BIN (unpublished)
- Danish standard figures for animal manure: [DCArapport191.pdf \(au.dk\)](#) (from page 259)
- Calculations of gaseous and particulate emissions from German agriculture 1990 – 2021: [4.2.1 N in bedding materials · Wiki · Cora Vos / EmissionsAgriculture2023 · GitLab \(thuenen.de\)](#)
- French Informative Inventory Report: [UNECE France mars2021_d.pdf \(europa.eu\)](#)
- The EMEP guidebook: <https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/4-agriculture/3-b-manure-management/view>

The following tables provide an overview of the amounts of bedding material the different sources provided per animal place or in the case of grazing livestock per day indoors. The overview shows that there is a large range of amounts used per animal place, both within countries for different housing systems and between countries. For the animal categories for which BIN had information, BIN values were used. For the other animal categories expert judgement was used to either apply one of the other sources or derive the amount of bedding material from a different animal category of the BIN.

Cattle

Table 1. Bedding material usage of cattle

	BIN	Denmark ¹	Germany ¹	France ¹	EMEP ¹
Dairy cows	218	0 - 12	5 - 8	0 - 9	8.3
Suckler cows	-	0 - 8	5 - 8	0 - 7	2.8
Young stock	-	0 - 5	2 - 6	0 - 5	2.8
Veal calves	-	0 - 4	2 - 6	0 - 2	2.8

1) kg per day housed indoors

Bedding material usage by dairy cows from the BIN is based on total purchases by dairy farms divided by Groot Vee Eenheden (large livestock units, GVE). BIN usage thus creates an overestimate per cow as the usage of young stock are also included in this value. The average herd on a dairy farm consists of 105 cows and 56 young stock. In terms of GVE: $105 \text{ GVE} + 28 * 0.5 \text{ GVE} + 28 * 0.25 \text{ GVE} = 126 \text{ GVE}$ ([cbs.nl](#)).

According to EMEP young stock use $2.8/8.3 = 0.34$ times as much straw as dairy cows

The average number of days without grazing of dairy cows is 365-155 and young stock spends 365-73 days indoors per year.

$$\begin{cases} (365 - 155) * 105x + (365 - 73) * 21y = 218 * 126 \\ 0.34x = y \end{cases}$$

$X = 1.138$ kg per day indoors per dairy cow and $y = 0.387$ kg per day indoors per young stock.

The EMEP values for usage of bedding material of suckler cows and of young stock used for fattening are the same as of young stock used for breeding. Therefore, the bedding material usage derived from the BIN is also applied for suckler cows and young stock used for fattening.

Veal calves are mostly housed on slatted floors without bedding material. Therefore the bedding material usage was set at 0 kg.

Poultry

Table 2. Bedding material usage of poultry

	BIN	Denmark	Germany	France	EMEP
Pullets	-	0.2*	0.75	-	-
Laying hens	0.03	0 - 0.5	0.5	-	-
Broilers	0.2	0.18	1.4	-	-
Turkeys	-	1.2	10.3	-	-
Ducks	-	15	22	-	-

* kg bedding material per raised pullet

BIN values can be used for laying hens and broilers. For the other poultry categories only Germany and Denmark apply bedding material. As the Danish values for laying hens and broilers closely match the values from the BIN, it was decided to apply the Danish values for the pullets, turkeys and ducks.

The bedding material usage of pullets expressed as kg per animal place per year instead of kg bedding material per raised pullet, can be calculated using the following inputs: the average occupancy rate of pullets is 0.9 and the growing period lasts 119 day.

$365 * 0.9 = 328.5$ days with pullets in the chicken house

$328.5/119 = 2.76$ rounds per year

$2.76 * 0.2 = 0.55$ kg bedding material per animal place.

Bij leghennen rekening houden met dieren in batterijsysteem zonder strooisel?

Swine

Table 3. Bedding material usage of swine

	BIN	Denmark	Germany ¹	France ¹	EMEP
Fattening pigs	0.8	0-70	0.3 - 1	0.3 - 1.9	200
Breeding pigs	0.8	0-70	0.3 - 1	0.3 - 1	200
Sows	13	0-900	0.5	2	600

1) kg per day housed indoors

The BIN can be used for bedding material usage of swine.

Goats

Table 4. Bedding material usage of goats

	BIN	Denmark	Germany ¹	France ¹	EMEP ¹
Goats	347	550	0.4	1.5	0.7
Kids	-	-	0.16	0.25 - 0.75	0.7
Buck	-	550	0.4	1.5	0.7

1) kg per day housed indoors

The BIN can be used for bedding material usage of goats.

Sheep

Table 5. Bedding material usage of sheep

	BIN	Denmark	Germany ¹	France ¹	EMEP ¹
Ewes	-	550	0.4	1.6	0.7
Lambs	-	-	0.16	0.25 - 0.75	0.7
Rams	-	550	0.4	1.6	0.7

1) kg per day housed indoors

The German values appear to be most suited to the Dutch circumstances. Using the other sources would result in bedding material usage of sheep that are higher than those of cattle, which seems unlikely. For the calculation of bedding material usage the following housing periods need to be used: 80 days housed indoors for the years 1990-2003, 75 days housed indoors for the years 2004-2008 and 35 days housed indoors for the years 2009-2022 [pdf \(overheid.nl\)](#).

Horses and Ponies

Table 6. Bedding material usage of horses and ponies

	BIN	Denmark	Germany ¹	France	EMEP ¹
Horses	-	1825	8	500	500
Ponies	-	1095	5	500	500
Donkeys	-	1095	5	500	500

1) kg per day housed indoors

EMEP default values are used for horses, ponies and donkeys.

Other animals

Table 7. Bedding material usage of other animals

	BIN	Denmark	Germany	France	EMEP ¹
Rabbits	-	-	-	-	-
Fur animals	-	0 – 10	-	-	-

As BIN and EMEP do not provide a default value for these animals no bedding material is included in the inventory.

Summary

The values from table 8 are used for the calculations of NEMA.

Table 8. Overview of bedding material usage in kg straw per animal per place.

Animal category	Bedding material usage
Cattle	
Dairy cows	1.138 ¹
Suckler cows	0.387 ¹
Young stock	0.387 ¹
Veal calves	0
Poultry	
Pullets	0.55
Laying hens	0.03
Broilers	0.2
Turkeys	1.2
Ducks	15
Swine	
Fattening pigs	0.8
Breeding pigs	0.8
Sows	13
Goats	
Goats	347
Kids	0 (Included in goats)
Bucks	0 (Included in goats)
Sheep	
Ewes	0.4 ¹
Lambs	0.16 ¹
Rams	0.4 ¹
Horses	
Horses	500
Ponies	500
Donkeys	500
Other animals	
Rabbits	0
Fur animals	0

1) Kg straw per animal place per day housed indoors

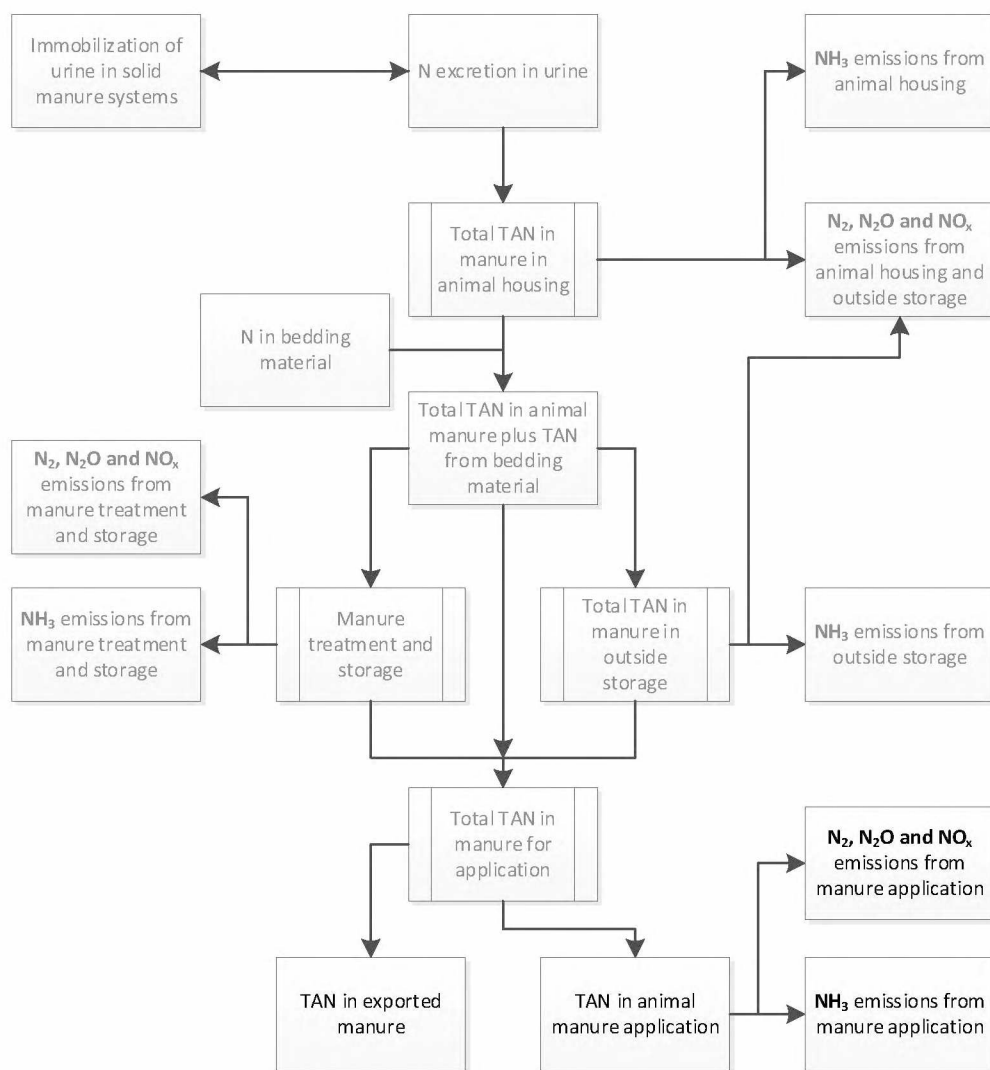


Figure 1. TAN flow in NEMA, including emissions from housing, manure storage, manure treatment and application.