Activity data for agriculture emission inventory - possible updates

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Introduction: Statistics Norway (SSB) is the activity data supplier in the preparation of the agriculture sector in the national emission inventory.

The emission inventory for agriculture is based on a wide variety of sources. While some of these are small, they can still have a significant impact on greenhouse gas emissions.

The key criteria for high-quality data and its sources are reliability and trustworthiness, comprehensive coverage of the entire population, and ensuring that the data is consistent, dependable, and robust.

In later years some of the activity data has not been updated due to changes in registrations by data suppliers, so that data is not collected anymore.

In this project SSB had the possibility to compare existing data with alternative data sources. By doing so we could both quality control these existing data as well as consider switching data sources for improved data quality.

We investigated alternative data sources for:

1. Time on pasture for dairy cows
2. Nitrogen content in roughage for cattle
3. Nitrogen content in feed concentrates for cattle
4. Slaughter weight and slaughter age for young cattle

1. Time on pasture for dairy cows

Introduction: Time spent on pasture is an important factor when it comes to emissions from animal manure. It affects both emission of nitrogen components and CH_4 from animal manure in source 3B housing and storage, 3D spreading of animal manure and 3D grazing. More time spent on pasture results in less manure for housing, storage and spreading, and since emission factors for NH_3 and N_2O are lower for grazing, this can lead to lower emissions. Less manure for housing and storage also leads to reduced CH_4 emissions from 3B housing and storage.

In today's inventory the time on pasture for dairy cows are sourced from Tine BA cow control system (Tine BA Annually), but the values in the cow control system have not been updated since 2013, therefore the value in the inventory has been kept constant since then.

In 2013 the value for time on pasture was low compared to earlier years, and since there has been increasing focus on more time on pasture in milk production and in agriculture governance, it was important with a quality control of the appropriateness of the pasture data used in the inventory.

Pasture time has been derived from information on how much animal feed originated from pasture in FEM (fôrenheter melk, eng: feed unit milk). This information came annually from the Cow control Annual Report until 2013.

It was assumed that cows also eat a supplement of 40 per cent concentrate on pasture.

Possible new data sources: Norwegian Agriculture Agency (NAA) administer a register for farming subsidies, and since the regulations on cattle farming in 2004 the NAA have data on how many cows that pastures from 12 to 16 weeks annually.

SSB has also periodically collected data on grazing practises in Norway in the national Agricultural survey (Landbruksundersøkelse) 2000, the Agricultural census (Landbrukstelling) 2010 and 2020 and the survey on manure use (Gjødselundersøkelse) 2018.

Approach: In 2004 the Regulations on the keeping of cattle (Forskrift om hold av storfé) came with a requirement for a minimum of eight weeks of grazing for cattle. In the new approach these eight weeks were held as basis time on pasture.

The annual NAA data on number of dairy cows and beef cattle (ammeku) on outfield grazing (item p410) in production subsidisation register, and on 12/16 weeks on pasture (item p411) were also available. The open source opendata/datasets/produksjon-og-avlosertilskudd at main · LandbruksdirektoratetGIT/opendata · GitHub made it possible to collect grazing data for dairy cattle, since we could select for dairy production only. We also received NAA data from SSB Division for agricultural statistics (426) to add to the time series. We focused on the p411 dataset both because observations were more frequent and because double counting is possible (the same animals are registered both in p410 and p411)

The approach was to keep 8 weeks for the whole dairy cow population and add the 4/8 exceeding weeks for the share of the population with this practise, due to the 12/16 weeks on pasture results.

Results and conclusion:

Table 1.1: Grazing data, source comparison.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Exsisting time on pasture % (Tine BA)	25.2	23.3	23.3	25.3	24	25.7	25	26.8	26.5	27.5	28.7	27.5	29.2	27.2	27.5	25.8	25.5	23.2	22.5	21.7	19.3	18.3	17.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2
Time on pasture % SSB surveys											28.9										26.9								25.46		24.72				
Time on pasture % NAA																	23.2	23.7	23.4	23.6	23.5	23.3	23.4	23.2	23.7	23.4	23.6	23.5	24.6	24.5	24.8	24.8	24.4	24.6	24.7
Time on pasture % NAA adjusted for indoor nights																									17.4	17.4	17.3	17.8	18.1	18.0	18.3	18.3	18.0	18.1	18.2

When comparing the results in table 1.1 we see that the low pasture time is extended when using the NAA data. The results from SSB are almost the same as the NAA data for 2018 and 2020. In 2000 the data from Tine and SSB is almost identical. This makes it less problematic to combine two data sources through the time series.

This provided useful quality control and showed that the NAA figures could be used as a new source. However, these data are only available from 2006.

Another question is whether the practice with indoor housing at night during grazing time should be accounted for. Traditionally in Norway dairy cows were kept indoors between evening and morning milking, and this would reduce the time on pasture and the results from NAA would give too high values. Questions on this topic were used In the Agricultural survey in 2000, where 48 %

of grazing dairy cattle were registered as indoors at night. We used this information to adjust the additional 4/6 weeks for indoor nights from 2014.

A preliminary suggestion is to use the Tine data until 2013 and use NAA data adjusted for indoor nights from 2014. Hopefully we will get more information about the indoor nights practice from Tine BA, NMBU or other expert networks in near future.

Results for emissions:

As showed in table 1.2 there were only minor changes in the emissions with updated grazing data for the period 2014-2024.

Table 1.2 Average changes in emissions between 2014-2024

	Manure management - Dairy cattle	Animal manure applied to soils	Urine and dung deposited by grazing animals	Indirect N2O*
NH3	-2 %	-1 %	2 %	
NOx	-2 %	-1 %	2 %	
N2O	-2 %	-0.7 %	2.4 %	-0.2 %
CH4	-2 %			

*The sum of N2O emissions from atmospheric deposition and leakage from manure application and grazing.

2. Protein content in cattle feed

Introduction: Protein content in both roughage and feed concentrate are parameters that affect the nitrogen excretion factors for cattle, and thereby the nitrogen emissions from manure. In recent years there has been a focus on improving roughage quality and reducing over-feeding of protein in concentrate for cattle both in practical farming and agriculture governance. Therefore, it is useful to evaluate the data possibilities for better input data that better reflect trends and practice in cattle nutrition in the emission inventory.

Data roughages: The factor for protein in roughage for cattle has been constant since 1990, based on an expert estimate as showed in table 2.1. The value for beef cattle is irrelevant in the calculation since there are constant nitrogen-factors for beef cattle.

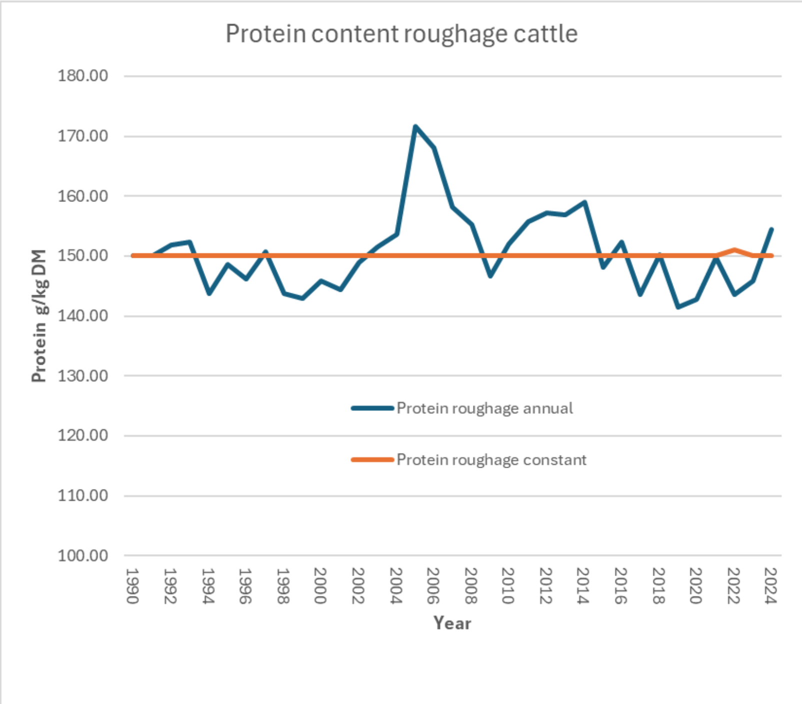
Table 2.1

Animal type	Value, protein g/kg DM*
Dairy cattle	150
Beef cattle	120
Young cattle	140

*DM=dry matter

The largest dairy company Tine BA collects data on roughage quality and protein contents from dairy farms all over Norway. These values represent the feeding of dairy cows but can also be relevant for young cattle. In this project we compared the N-factors based on changing the constant value for protein content with annual data from Tine BA.

Fig 2.1: Variation in annual protein content for roughage 1990-2024. Source (Ingun Schei, Tine BA)

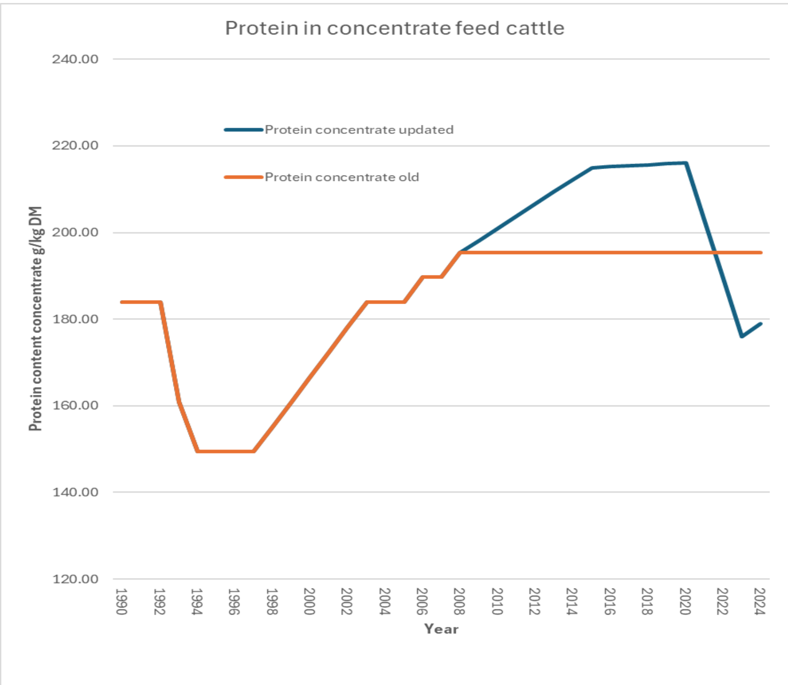


As showed in fig 2.1 there is considerable inter-annual variation in protein content for roughage.

Concentrate feed data:

The value for protein content in concentrate feed for cattle was previously annual in the emission inventory. SSB received data from Felleskjøpet Agri BA, a leading supplier of these products in Norway, until this stopped in 2010. A constant value for 2008 has been used since. In this project updated values from the same data supplier were used to make the series complete.

Fig 2.2: Comparison of protein content for concentrate feed 1990-2024. Source (Linda Karlsson, Fellekjøpet BA)



Results in emissions and conclusion:

When changing the value for protein in roughages from constant factor 150 to 154.5 for 2024 it led to 2% higher emissions from N2O and 3% higher emissions from NH3 from dairy cattle.

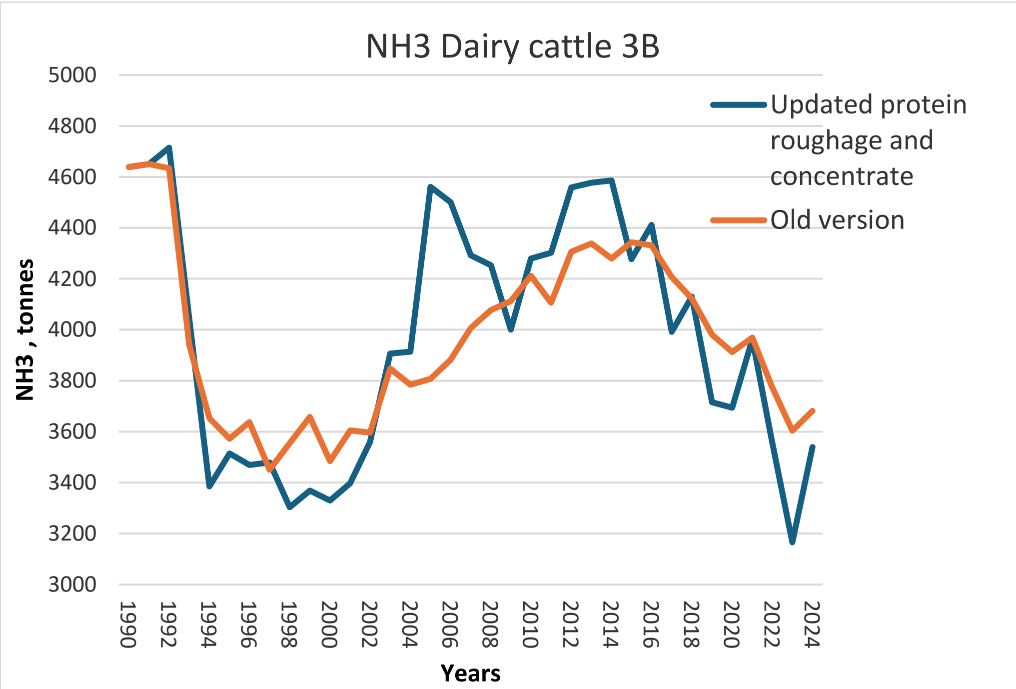
In the updated concentrate feed data, there was no clear trend in protein content. The change in 2024 from 19.5 to 17.9 % protein pr kg dry matter led to 4 % lower ammonia (NH3) emissions from dairy cattle and other cattle. For nitrous oxide (N2O) the reduction was 7 % lower for dairy cattle and 3 % for other cattle.

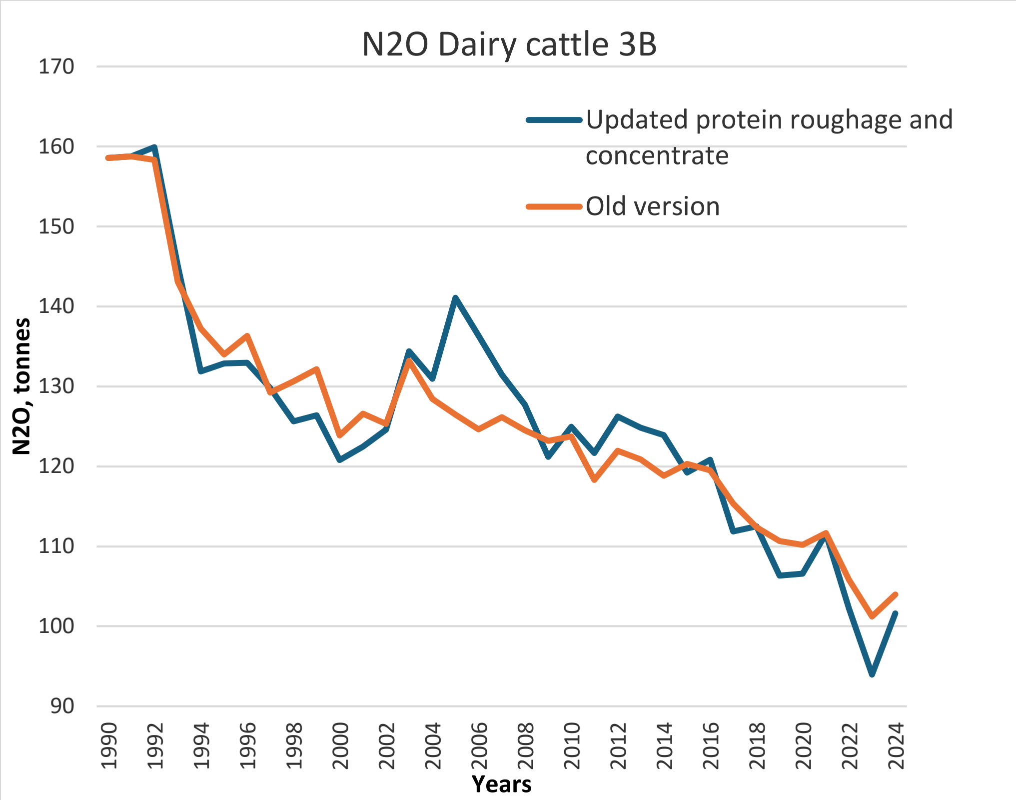
The combination of the two led to ups and downs compared to keeping existing values as showed in figure 2.3 and 2.4.

The use of annual data does not significantly change the results, nor do the annual data show any trends that are important to capture in the inventory. Keeping a fixed factor may be sufficient when the extra effort required for detailed figures is unlikely to provide benefits on accuracy or information value.

However, contact with data providers has been established, which could be useful if these areas are prioritized in the future, for example, if the trend in concentrate feeding changes.

Fig 2.3 and 2.4 Changes in ammonia and N2O emissions from housing and storage for dairy cattle due to annual protein data





3. Slaughter weight and slaughter age for young cattle

Introduction:

Calculations for enteric methane emission from young cattle depend on slaughter age and slaughter weight. These important parameters are sourced by the dairy product producer Tine / Mimiro, and as a result dairy farming practices related to young cattle are best covered. Higher slaughter weight and higher slaughter age lead to higher emissions, and since more young cattle not being used for dairy production are of heavier breeds than the traditional Norwegian milk breed, NRF (Norwegian red cattle) in the period 1990-2024, there can be a possible underestimation. The organisation for production of meat and eggs, Animalia also collects these data. In this project we studied the possibilities for using these data, and how that affected the emissions of enteric methane for young cattle.

Approach:

In the existing enteric methane model, we calculate for five different groups: breeding heifers, heifers <1 year, heifers > 1 year, bulls < 1 year and bulls > 1 year which are categorized under "young cattle" in the Common Reporting Tables (CRT) in the inventory. Tine/Mimiro provides data for these groups, except breeding heifers. Animalia provides us with data on weight at first calving and Tine/Mimiro gives us data on age at first calving.

Animalia could provide us with data for the categories calf, young bull and bull/cow (norsk: kalv, ung okse og okse/ku). Data split by sex were only available for 2022-2024, so separating heifers and bulls was difficult. To test the different slaughter weights from Animalia vs Tine/Mimiro we used the category young bull 301-730 days age at slaughter, which is comparable to weighted average of heifer and bull > 1 year in the original model.

The challenge here was fitting data from Animalia into the four slaughter animal groups. Since the enteric model is based on these groups it was necessary to adjust data from Animalia into the existing system.

Results and conclusion:

Young bulls (ung okse) from Animalia were compared to the weighted average between the two groups, heifer for slaughter > 1 year and bulls for slaughter > 1 year. As showed in figure 3.1 and 3.2 the slaughter weight was 41 % higher (2010-2024) but the slaughter age was 6 % lower (2020-2024) for Animalia data compared to Tine/Mimiro values. Since the slaughter age figures were only available for the period 2020-2024, we could only compare the emissions for those years.

Figure 3.1 Comparison of slaughter age between two data sources, 2020-2024.

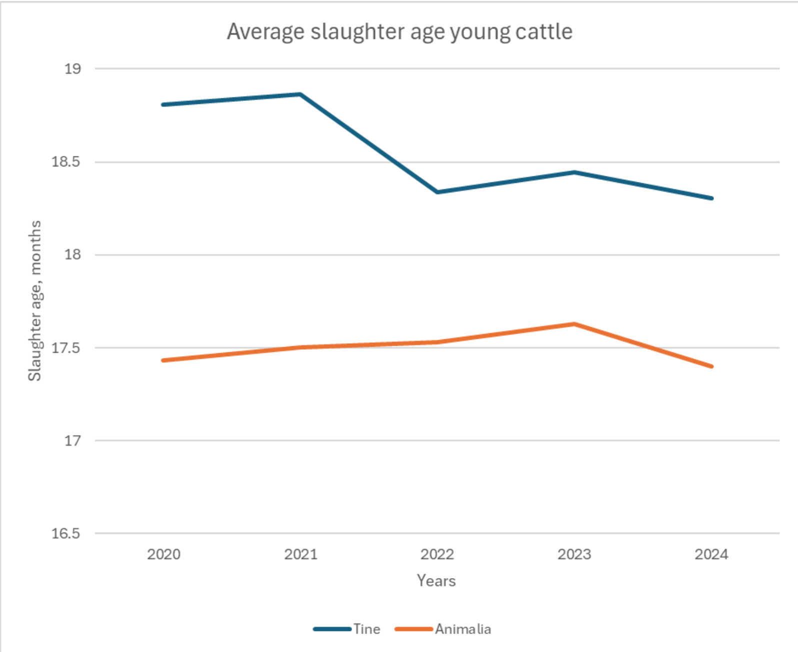


Figure 3.2 Comparison of slaughter weight between two data sources, 2020-2024.

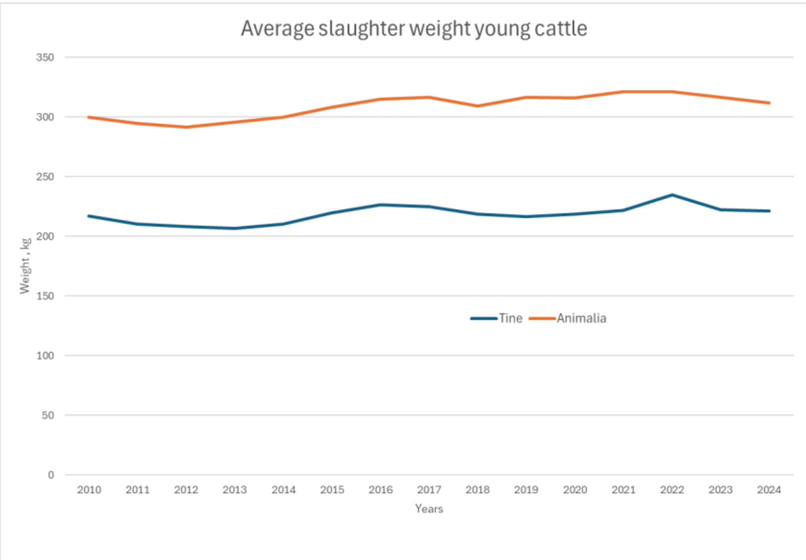
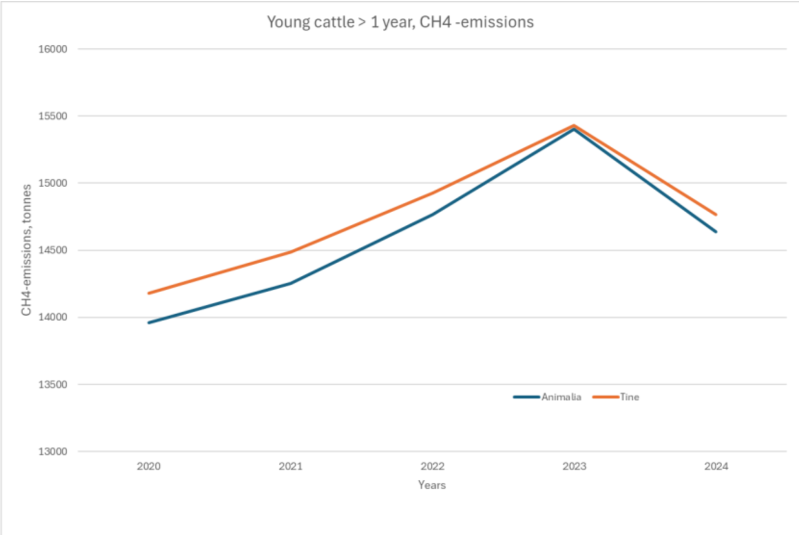


Figure 3.3 Comparison of emissions from using two different data sources.



We expected higher emissions when using Animalia data, but since the slaughter age values were lower this instead led to lower emissions in total. There are limitations, as the estimates are adjusted for heifers and bulls, while the Tine/Mimiro data is not differentiated accordingly.

We can therefore conclude that the activity data for young cattle does not cause an underestimation of emissions. Since the models differentiate between heifer and bulls it is advisable to keep the existing data source for slaughter age and slaughter weight from existing providers, Tine/Mimiro.

Summary of conclusions:

When comparing existing data with alternative data sources we found that:

1. For time on pasture for dairy cows the NAA is a possible data source from 2006. An approach is to keep Tine/Mimiro data until 2013 and update with NAA data from 2014.
2. The annual nitrogen values (protein content) in roughage for cattle varies above and below the constant factor through the time series. This gave a quality control that a constant factor is sufficient and there is no need to update activity data.
3. Nitrogen (protein) content in feed concentrates for cattle also varies around the constant factor and had no clear trend. It is therefore not advisable to update with annual data.
4. Slaughter weight and slaughter age for young cattle: Replacing activity data from Tine/Mimiro with Animalia data in the enteric methane model gave lower emissions. This means that today's inventory does not underestimate these emissions. Since the Tine/Mimiro data are adjusted for the models, we chose to keep this source unchanged.