Greenhouse gas emissions from raw milk and dairy products supplied to Frieslandcampina: methodology and results

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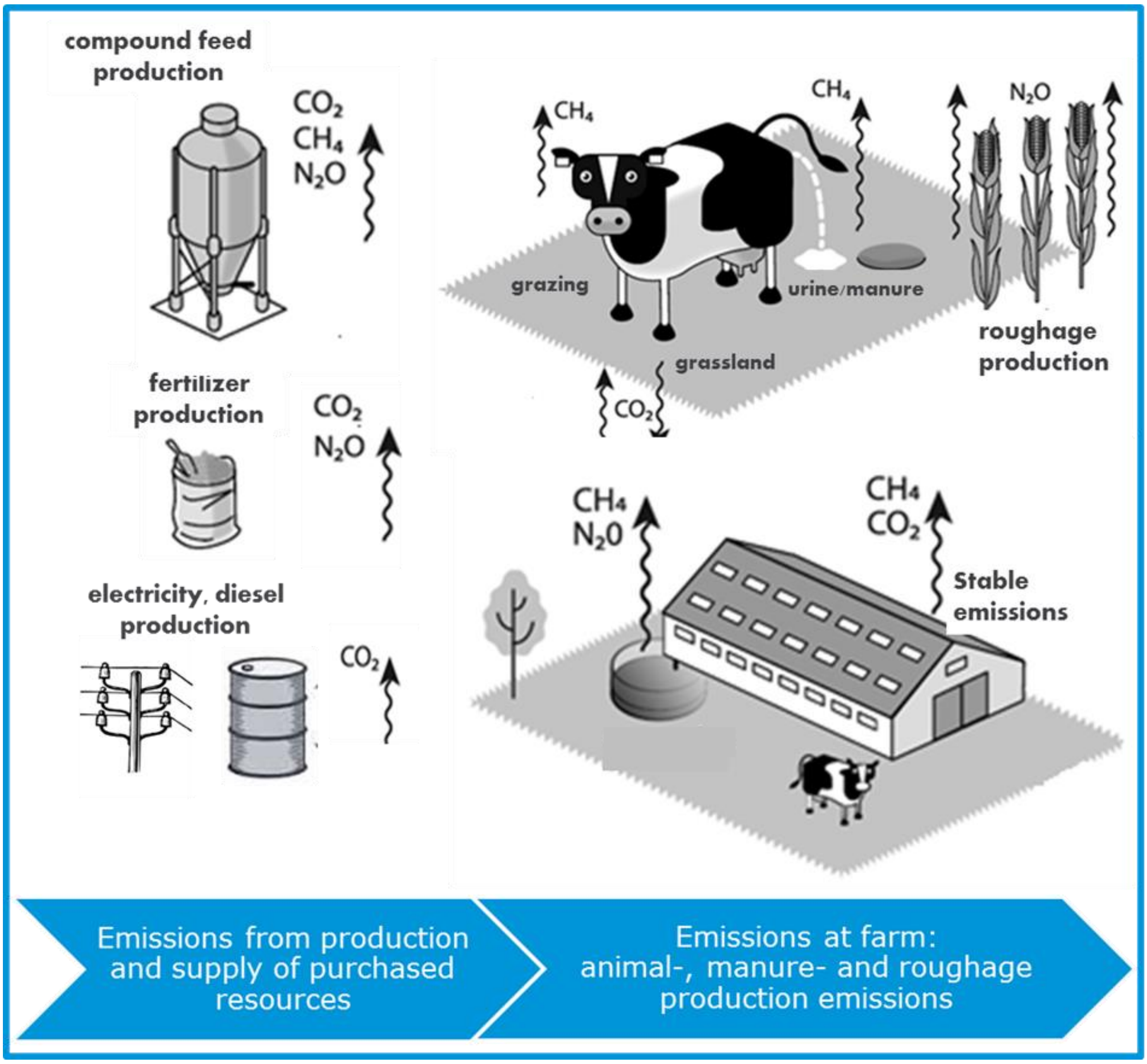

J.A.J. Hospers
I.L. Janssens

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How is annual development of the carbon footprint of raw milk from member and non-member dairy farms monitored?

J.A.J. Hospers[1], I.L. Janssens[1]

This report describes the methodology used to monitor the annual development of the weighted average carbon footprint of raw milk and dairy products supplied to FrieslandCampina since 2015.

[1] FrieslandCampina Research and Development, FrieslandCampina Innovation Centre, Wageningen, The Netherlands

Wageningen, February 2025

FrieslandCampina

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Glossary

ANCA	=	Annual Nutrient Cycling Assessment (NL: KringLoopWijzer or KLW).
Carbon Footprint	=	Total greenhouse gas emissions caused by an individual, event, organization, or product, expressed in carbon dioxide equivalents.
CDKLW	=	Central Database KringLoopWijzer; database where data of Dutch dairy farmers is centrally collected.
CH_4	=	Methane; a greenhouse gas
CO_2	=	Carbon dioxide; a greenhouse gas
N_2O	=	Nitrous oxide; a greenhouse gas
CO_2-eq.	=	Carbon dioxide equivalents: a measure used to compare the emissions from various greenhouse gases based on their global warming potential
Farm Specific Carbon Footprint	=	Greenhouse gas emission per kg fat and protein corrected milk (gram CO_2/kg FPCM), calculated with farm specific data.
FPCM	=	Fat and Protein Corrected Milk; a unit to account for variability of milk composition.
Greenhouse gas	=	Any of the atmospheric gases that contribute to the greenhouse effect by absorbing infrared radiation produced by solar warming of the Earth's surface.
GWP	=	Global Warming Potential: a relative measure of how much heat a greenhouse gas traps in the atmosphere.
IDF	=	International Dairy Federation: IDF is the leading source of scientific and technical expertise for all stakeholders of the dairy chain. Since 1903, IDF's network of dairy experts has provided a mechanism for the dairy sector to reach global consensus on how to help feed the world with safe and sustainable dairy products.
KLW	=	KringLoopWijzer (EN: annual nutrient cycling assessment or ANCA); a tool to calculate a farm-specific nutrient balance.
LCA	=	Life Cycle Assessment: an integral method that evaluates the environmental impact resulting from the entire life cycle of a product.
PEF	=	Product Environmental Footprint: European Commission initiative to develop harmonized methodology for the calculation of the environmental footprint of products, based on transparent methodology.
PEFCR	=	Product Environmental Footprint Category Rules: definition of the rules and requirements for LCA-based environmental product declarations of a certain product category.
WEcR	=	Wageningen Economic Research; social-economic research institute. Amongst others involved in annual sector report on average carbon footprint of Dutch raw milk.
WUR	=	Wageningen University and Research center; a university and research Centre in the Netherlands that focusses specifically on the theme 'healthy food and living environment'.

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1. Introduction

FrieslandCampina works on reducing greenhouse gas emissions throughout its production chain. After reaching its climate neutral growth target in 2020, FrieslandCampina has set new climate targets towards 2030 in its climate plan (Het klimaatplan | FrieslandCampina NL). The targets are to reduce 63% of the scope 1 and 2 emissions and 37,5% of the scope 3 emissions by 2030 from baseline emissions in 2015. These targets have been validated by SBTi. Furthermore, the long-term ambition is set to achieve net zero emissions in 2050. Part of these targets is the reduction of absolute greenhouse gas emissions from milk production at member dairy farms with 33% by 2030 compared to 2015.

FrieslandCampina discloses progress on its climate targets each year in its annual report. In the annual report absolute cradle to farm gate greenhouse gas emissions (kton CO2-eq.) from raw milk production at member and non-member dairy farms and procured dairy are disclosed.

Up to the annual report of 2021, the annual carbon footprint of raw milk from Dutch milk originated from the annual sector report published by Wageningen Economic Research (WEcR). WEcR reports the average carbon footprint of raw milk based on a weighted sample of dairy farms representing the average dairy farm in the Netherlands. This figure was used for all dairy from The Netherlands, Belgium and Germany. Greenhouse gas emissions were calculated as the average carbon footprint multiplied by the mass of milk or dairy product sourced by FrieslandCampina.

From 2022 onwards FrieslandCampina bases its reporting of greenhouse gas emissions of milk production at FrieslandCampina member dairy farms on farm specific carbon footprints rather than on a sector average. From 2018 onwards a farm specific carbon footprint of raw milk is calculated for each dairy farm in the Netherlands within the Annual Nutrient Cycling Assessment (ANCA; Dutch: KringLoopWijzer). The farm specific carbon footprint model in ANCA ensures the most accurate and complete calculation of the carbon footprints of raw milk from individual dairy farms and is transparent and compliant with international standards[1].

The carbon footprint of raw milk from all other countries, up to the annual report of 2023, is based on a study published by the Food and Agriculture organization of the United Nations (FAO and GDP, 2019). For procured dairy products such as milk powders and whey regionalized carbon footprints are estimated based on the regionalized carbon footprints of raw milk (FAO and GDP, 2019) and a modelled carbon footprint of processing based on internal data.

As of 2024, FrieslandCampina has updated the carbon footprint of the procured raw milk for eight countries. For six countries the update is based on a study executed by Blonk Consultancy. For two countries this based on Agri-footprint (Blonk Sustainability, 2022).

In this report the methodology to report greenhouse gas emissions of FrieslandCampina member dairy farms, based on farm specific carbon footprints, is explained and the development of the carbon footprint of member and non-member raw milk since 2015 is reported as well as the carbon footprints of procured dairy.

[1] *Contrary to international standards, the carbon footprint of raw milk calculated in ANCA excludes emissions from peat oxidation due to the lack of reliable data to calculate these emissions at a farm specific level. ANCA and data collection processes are currently being extended and inclusion of peat oxidation emission is foreseen in the near future.*

2. Greenhouse gas monitoring of dairy farms supplying to FrieslandCampina

FrieslandCampina discloses the development of greenhouse gas emissions at dairy farms in its annual report. Greenhouse gas emissions of dairy farms are calculated by multiplying the carbon footprint per kg milk (gram CO_2-eq./kg fat and protein corrected milk (FPCM)) with the amount of milk delivered to FrieslandCampina (kg FPCM). Table 1 gives an overview of the information sources for greenhouse gas emissions of different countries.

For all German and Belgian milk, the carbon footprint of raw milk is assumed to be the same as that of Dutch milk as production systems are similar. For six countries of sourcing the carbon footprint of raw milk is based on a study executed by Blonk Sustainability (2024). For all other countries the carbon footprint is based on the study from FAO and GDP (2019). For procured finished dairy product such as milk powders and whey regionalized carbon footprints are estimated based on the regionalized carbon footprints of raw milk and modelled carbon footprint of processing based on internal data (see Annex 3).

Table 1. Overview of sources on which country-specific carbon footprints are based.

<table>
<tr><th></th><th>NL, BE, DE</th><th>Europe excl. NL, BE, DE</th><th>France, Ireland</th><th>Nigeria, Pakistan, Indonesia, Malaysia, Vietnam, Thailand</th><th>Other countries</th></tr>
<tr><td>2015</td><td rowspan="4">Doornewaard et al., 2022</td><td rowspan="10">FAO and GDP (2019)</td><td rowspan="9">FAO and GDP (2019)</td><td rowspan="9">FAO and GDP (2019)</td><td rowspan="10">FAO and GDP (2019)</td></tr>
<tr><td>2016</td></tr>
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<tr><td>2019</td><td rowspan="6">ANCA</td></tr>
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<tr><td>2024</td><td>Agri-footprint 6</td><td>Blonk Sustainability (2024)</td></tr>
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2.1 Greenhouse gas emissions of member milk

The development of the carbon footprint of raw milk from 2015 to 2019 is based on the average carbon footprint of raw milk for Dutch dairy farms, reported by Wageningen Economic Research (WEcR) (Doornewaard et al., 2022). WEcR reports a carbon footprint of raw milk based on data of a weighted sample of approximately 300 dairy farms deemed representative for the average Dutch farm.

For each Dutch dairy farm a farm specific carbon footprint is calculated since 2018 and with consent historically available since 2019. This carbon footprint is calculated within the ANCA (see Van Dijk et al., 2023). This enables FrieslandCampina to use farm specific carbon footprints of raw milk specifically for Dutch member dairy farms delivering to FrieslandCampina. The methodology of deriving an average from farm-specific carbon footprints is described in Chapter 3. For raw milk from Belgium and Germany the carbon footprint of raw milk is assumed to be the same as that of Dutch milk.

2.2 Greenhouse gas emissions for non-member milk and procured dairy

Up to the annual report of 2023, the carbon footprint of milk sourced from non-member farms was derived from regionalized carbon footprints reported by FAO and GDP (2019). These carbon footprints were also used to calculate the carbon footprints of purchased dairy products from the respective regions.

As of 2024, FrieslandCampina has updated the carbon footprint of the procured raw milk for eight countries. For six countries (Indonesia, Malaysia, Nigeria, Pakistan, Thailand and Vietnam) the update is based on a study executed by Blonk Sustainability (2024). For two countries (France and Ireland) the update is based on Agri-footprint (Blonk Sustainability, 2022).

2.3 Inclusion of estimation of emissions from peat oxidation

Peat mineralization is farm-specifically included in ANCA, however peat oxidation is not. From the annual report of 2023 and onwards, FrieslandCampina wants to report on its emissions coming from peat oxidation of its member farms. At the moment it is not possible yet to reliably calculate farm-specific emissions from peat oxidation. However, developments are ongoing (e.g., the Somers model (NOB, 2024)) and FrieslandCampina wishes to use farm-specific reporting in the future. For the time being an absolute estimation of emissions from peat oxidation will be given. The methodology for this estimation is explained in Chapter 3.5.

3. Methodology based on farm specific footprints

3.1 Farm specific carbon footprints calculated within ANCA

3.1.1. ANCA carbon footprint calculation
ANCA is a tool that calculates different environmental indicators specifically per farm once a year. One of the environmental indicators ANCA calculates, is the carbon footprint of raw milk, i.e., greenhouse gas emission per unit of milk produced (gram CO2-eq./kg FPCM). Since 2018, all FrieslandCampina dairy farmers fill the ANCA tool annually. The calculation rules and methodology are maintained by Wageningen Research to align the calculations with 1) the latest insights in science and farm practice and 2) international standards for carbon footprinting (Product Environmental Category Rules for Dairy (PEFCR dairy; EDA, 2018; International Dairy Federation guide to standard life cycle assessment methodology (IDF, 2022). A detailed methodology report of ANCA and the calculation of the carbon footprint is available and updated each year (latest version: Van Dijk et al., 2023). The carbon footprint calculation is performed with a Life Cycle Assessment (LCA) approach and calculates all greenhouse gas emissions from cradle to grave[2]. Milk losses occurring at farm are not estimated within the ANCA tool, as these are not of significance (<1%).

3.1.2. Activity data
The calculations within ANCA are performed with farm specific activity data. These data are collected in a central database. A large part of the activity data originates from automated interfaces with third parties, such as feed companies, laboratories, and governmental organizations. After authorization by the farmer these third parties deliver data of amongst others the amount and type of feed delivered, laboratories results of roughage quality and animal numbers present at the farm. This data from third parties is considered accurate. Another part of data originates from manual entry by the farmer. The central database is connected to a frontend on a website where dairy farmers enter their activity data in the ANCA tool (Home - Mijn Kringloopwijzer). In all cases the dairy farmer is responsible and in charge of the data used in calculation within ANCA. Furthermore, by using the tool, each farmer states that he or she enters data truthfully.

For all data, either manually filled or data originating from automated interfaces, ANCA signals unrealistic data to the farmer. The farmer in return validates data and can replace incorrect data.

Besides data checks in ANCA, FrieslandCampina checks farms based on a risk assessment for unrealistic data. In this process the farmer needs to provide explanations for exceptional data and may correct incorrect data.

3.1.3 Data management
After authorization by individual farmers, FrieslandCampina annually receives ANCA data of (only) member dairy farms of FrieslandCampina . ANCA data used for reporting greenhouse gas emissions in the annual report are anonymized.

3.2 Reliability of farm specific carbon footprints

3.2.1. Reliability checks of individual carbon footprints: Tukey Fences test
As a final step in reliability assurance, next to the checks mentioned above, farm specific carbon footprints of all dairy farms are checked for reliability with a statistic test. This

[2]*In the contrary guidelines to internationals standards, the carbon footprint of raw milk calculated in ANCA excludes emissions from peat oxidation due to the lack of reliable data to calculate these emissions at a farm specific level. ANCA and data collection processes are currently extended and inclusion of peat oxidation emission is foreseen in the near future.*

statistic test (Tukey Fences Test, Tukey, 1977) was applied in consultation with ANCA experts and WEcR.

For normal distributed data the Tukey fences method determines a lower and upper bound for realistic data within the range of the carbon footprint values. FrieslandCampina uses this lower and upper bound to determine realistic farm specific carbon footprints. With this, all "unlikely" and "very unlikely" farm specific carbon footprints are excluded from further analysis (see Figure 1).

The carbon footprint of dairy farms with organic soils contains peat mineralization as significant source of additional greenhouse gas emission compared to farms on mineral soils. Therefore, the lower and upper bound for realistic carbon footprint is determined separately for farms with 100 percent mineral soils and farms (partly) located on organic soils.

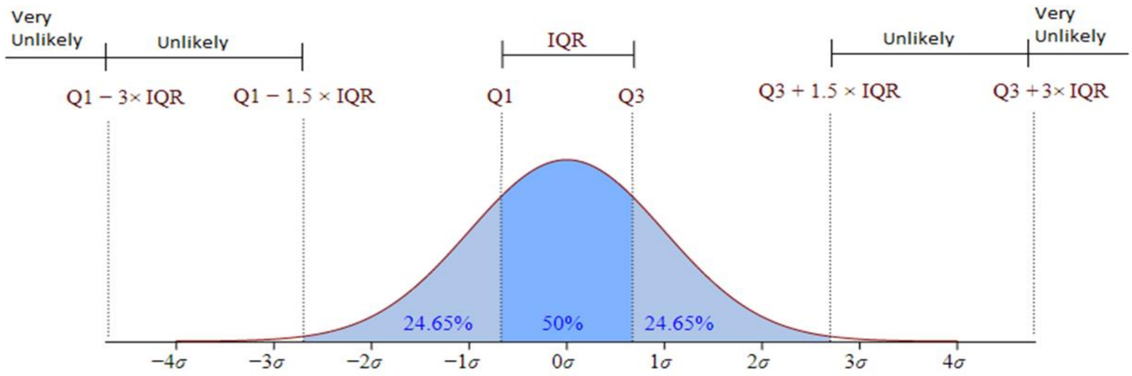

Figure 1. *Principle of the Tukey Fences method for determining outliers.*

Not all dairy farms deliver the same amount of FPCM. Therefore, a weighted average carbon footprint of all dairy farms is calculated for all dairy farms with realistic farm specific carbon footprints. This weighted average includes both farms on mineral and organic soils.

3.3 Correcting the trend of carbon footprint for methodological changes and back casting towards 2015

Each year the ANCA methodology is updated based on the latest scientific insights, international standards for carbon footprinting and developments in farm practice and data availability. Therefore, for each reporting year an updated calculation engine is used to calculate the carbon footprint of milk. Annual methodological updates also affect carbon footprints reported previously. Because of the annual alignment of the ANCA methodology, part of the difference between the most recent carbon footprint and the carbon footprint of last year may be explained by methodological changes instead of actual changes in farm management.

Next to the farm specific carbon footprint of the latest reporting year, ANCA reports farm specific carbon footprints of the previous year calculated with the same, most recent methodology (i.e., for example the 2023 version is used to restate 2022 carbon footprints). Farm specific carbon footprints (including restated carbon footprints of the previous year) are available and used for all FrieslandCampina dairy farms from 2019 onwards.

To be able to separate greenhouse gas emission development (reduction or increase) from methodological changes, FrieslandCampina R&D uses the actual development between years to determine the trend in the carbon footprint per farm (carbon footprint development factor). This carbon footprint development factor is simply the difference between the latest reporting year and the previous year, both calculated with the latest and same methodology, and is used to back cast carbon footprints to 2019.

For backcasting from 2019 towards 2015, the carbon footprint development factor is determined based on WEcR (Doornewaard et al., 2022). WEcR annually reports the carbon footprint of raw milk for all years since 2011 with the same, latest methodology. The carbon footprint development factors based on Doornewaard et al. (2022) are used to backcast carbon footprint from 2019 to 2015.

For farms that start to deliver milk to FrieslandCampina the latest farm specific carbon footprints are used. For farms that have stopped delivering milk to FrieslandCampina, the average percentual carbon footprint change due to methodological difference between (yearly) ANCA instances is used to approximate the carbon footprint of those farms for the latest ANCA methodology.

In Annex 1 an explanation of determining the development of the carbon footprint of raw milk of FrieslandCampina farms is given.

3.4 Prognosis of carbon footprint of the reporting year

FrieslandCampina annually discloses the development of greenhouse gas emission of the previous year in the first months of the year. At the moment of finalizing the annual report, farm specific carbon footprints of raw milk of that year are not available from ANCA yet. This is because the deadline for filling ANCA is set at the 15^{th} of May the next year. Therefore, a FrieslandCampina weighted average carbon footprint of raw milk cannot be determined for the reporting year yet. The carbon footprint of the reporting year is assumed to be equal to that of the previous year until shown otherwise by the result of ANCA.

3.5 Calculation of emissions from peat oxidation

In the ANCA, emissions from peat mineralization are calculated using a default value of 4.7 kg N_2O-N = 7.3 kg N_2O = 2201 kg CO_2-eq per hectare of peat per year. This is the average mineralization per hectare of peat in the Netherlands per year. This originates from the publication of Kuikman et al. (2005) which reports total emissions from organic soils in the Netherlands. Similarly, average emissions originating from oxidation can be retrieved from Kuikman et al. (2005). Table 6 in Kuikman et al. (2005) presents the total annual CO_2 emissions from peat oxidation (4.25 Mtonne CO_2) and the total hectares of peat (223147 ha) in the Netherlands, which equates to an average of 19030 kg CO_2 per hectare of peat. To estimate the emissions from peat oxidation for FrieslandCampina member farms, this average is multiplied with the total hectares of peat of FrieslandCampina member farms. It is likely that this estimation is an overstatement of emissions from peat oxidations for several reasons:

a) Within the output data of ANCA, information about hectares used for secondary activities (i.e., activities outside of the dairy system, such as other livestock or crop production) is not included. The emissions from peat oxidation shown in this report therefore include the peat surface used for non-dairy production as well, leading to a slight overestimation of emissions from peat oxidation of dairy production land.
b) The estimation does not consider allocation of emissions to meat output. Since the methodology of emissions from peat oxidation is for the moment based on a rough estimation, it was decided to not include the allocation factor for milk.

Developments with regards to farm-specific monitoring of emissions from peat oxidation are ongoing (e.g., the Somers model (NOB, 2024)) and FrieslandCampina wishes to use farm-specific reporting in the future. For the time being an absolute estimation of emissions from peat oxidation will be used.

3.6 Carbon footprint of raw milk originating from non-members and outside the Netherlands

In 2016 FrieslandCampina R&D calculated the carbon footprint of raw milk in Belgium for the dairy pilot of the Product Environmental Footprint project of the European commission. This study showed that the carbon footprint of raw milk production in Belgium is very similar to the carbon footprint of raw milk in the Netherlands. This validated the current practice in our monitoring to use the Dutch carbon footprint of raw milk also for Belgium and Germany, as no yearly monitoring of raw milk from Belgium and German member farms was available and farming practices were similar to the Netherlands. Moreover, the effect of this assumption is limited because, relatively, only a small fraction of raw milk intake of FrieslandCampina originates from Germany and Belgium. In both Germany and Belgium national monitoring tools for greenhouse gas emissions are being developed. With those, FrieslandCampina aims to gather farm-specific data from these countries in the future.

FrieslandCampina also purchases raw milk and intermediate dairy products from the European and global market. The greenhouse gas emissions from the purchased raw milk and resulting intermediate dairy products is part of the greenhouse gas emission monitoring of FrieslandCampina. The carbon footprint of the production of raw milk from Indonesia, Malaysia, Nigeria, Pakistan, Thailand and Vietnam is based on a study executed by Blonk Sustainability (2024). The carbon footprint of production of raw milk from Ireland and France is based on Agri-footprint 6 (Blonk Sustainability, 2022). The carbon footprint of the production of raw milk from different global regions (excluding previously mentioned countries) is based on FAO and GDP (2019) (see annex 2).

3.7 Carbon footprints of procured (semi) finished dairy products

Besides raw milk FrieslandCampina purchases concentrated whey, skimmed milk powder, whole milk powder, cream, casein powder and AMF from third parties. The greenhouse gas emissions from production of these products are included in the greenhouse gas emission monitoring of FrieslandCampina. Although these products are produced by other companies, the carbon footprint estimate is based on data available from FrieslandCampina factories. There are three reasons to base this estimate on internal data:

1. Most companies from which we buy these products do not have company specific carbon footprints of their products available.
2. If companies from which we buy these products have a carbon footprint of their products available, the methodology and data have not been documented and validated.
3. If companies from which we buy these products have a documented and validated carbon footprint of their products available, the used methodology may not be in line with our own methodology.

The carbon footprint of concentrated whey, skimmed milk powder, whole milk powder, cream, casein powder and AMF is specified per global region. Results include impact from the cradle to the gate of the product delivering factory but excludes transport to FrieslandCampina. Processing variables remained equal for all years because we do not know how processing of other companies changes over time. However, this is not expected to have a large effect on the carbon footprint of the aforementioned products, because processing only contributes to a small extent to the carbon footprint of these products.

4. Results 2015-2024

4.1 Results carbon footprint of raw Dutch member milk 2015-2024.
In Table 2 and Figure 2 the carbon footprints of 2015 to 2024 are presented. Results show that the carbon footprint of raw milk from FrieslandCampina dairy farms has reduced by 22 percent in 2024 compared to 2015. The reduction towards 2024 showed fluctuations. In the years 2015 to 2018 the carbon footprint was affected by (anticipation on) the implementation of the phosphate regulation in 2018. As farmers were either reducing their herds and or replacing youngstock animals for lactating dairy cows within their phosphate production ceiling emissions associated with milk production were reducing. In 2019 emissions increased due to additional emissions from purchased youngstock for replacement. In anticipation on phosphate regulation some farmers sold too much youngstock which led to a shortage of youngstock for replacement some years later.

Figure 3 shows that the trend between 2019 and 2024 is primarily caused by the reduction of the emissions from purchased resources. More specifically the emissions from purchased feed (concentrates) reduced significantly in this period. From 2020 onwards feed companies started reporting product specific carbon footprints for individual feed products. Furthermore, feed companies started delivering compound feeds without products associated with deforestation (land use change emissions; ForFarmers, 2022), which, for some farms, significantly reduced the contribution of emissions from purchased feed to the total carbon footprint of feed. From 2022 to 2023 the reduction is mostly explained by a) further reduction of carbon footprints of purchased resources such as compound feed and artificial fertilizer and b) optimal growth circumstances leading to good quality of roughage feed.

Results are shown following the Global Warming Potentials of the 6th Assessment Report of the IPCC (IPCC, 2023) with 100-year time horizon. In the previous years, FrieslandCampina reported with the Global Warming Potentials of the 5th Assessment Report (IPCC, 2014).

Table 2. *Results weighted average carbon footprint of FrieslandCampina raw milk from member dairy farms.*

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Carbon footprint of raw milk[1,2]										
Carbon footprint raw milk Friesland Campina	1120	1080	1020	1000	1020	990	960	930	870	870
Relative develop ment of carbon footprint compare d to 2015	100%	96%	91%	89%	91%	89%	86%	83%	78%	78%

[1]*weighted average carbon footprint for Dutch FrieslandCampina dairy farms.*
[2]*unit: gram CO_2-eq./kg FPCM.*

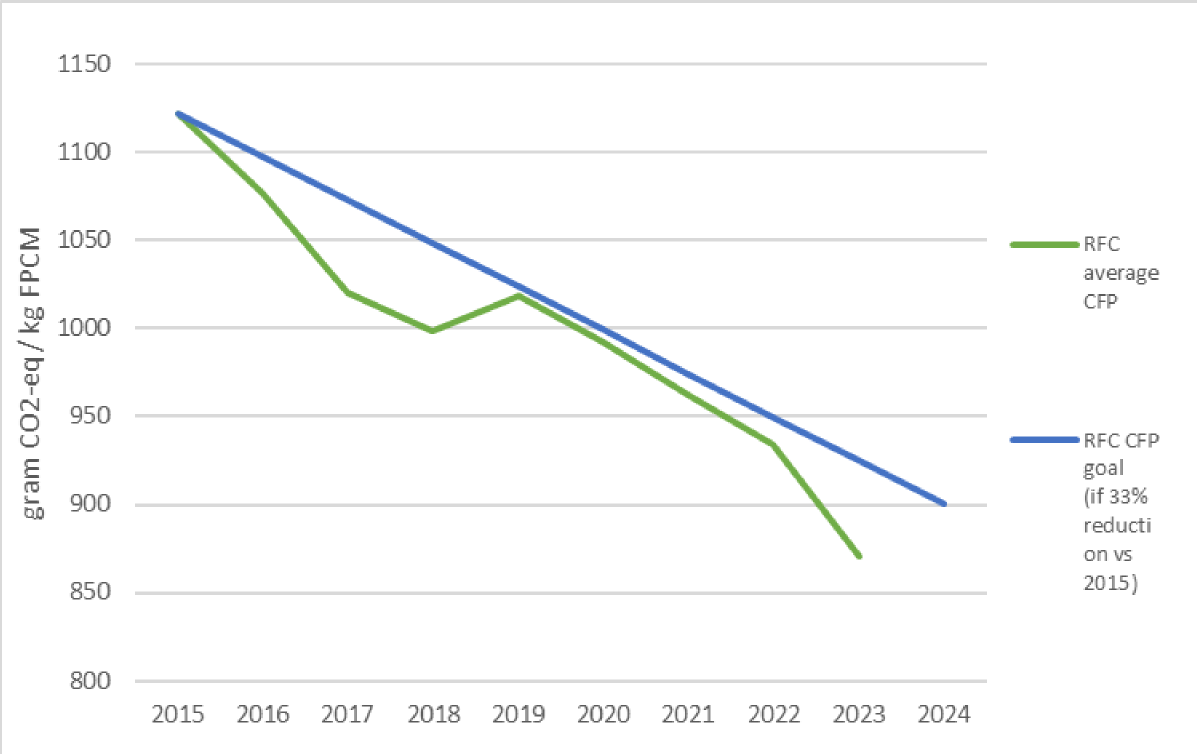

Figure 2. *Development of carbon footprint of FrieslandCampina dairy farms from 2015 onwards and FrieslandCampina goal of 33% reduction in 2030 compared to 2015.*

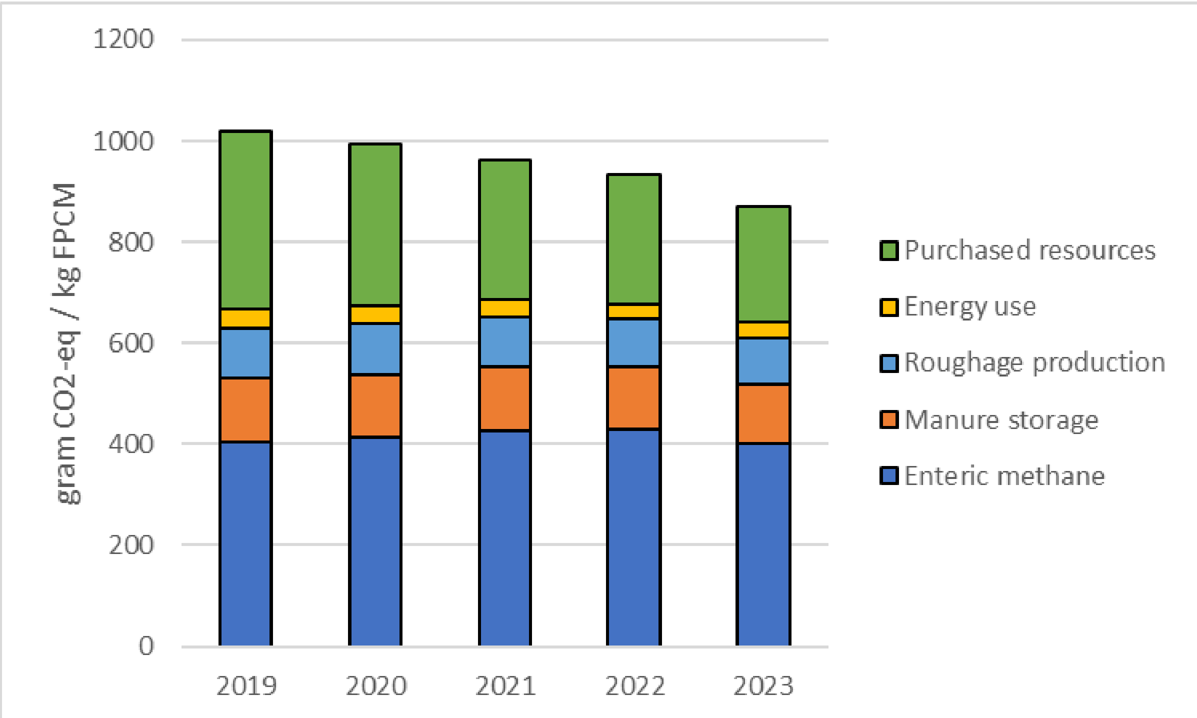

Figure 3. *Carbon footprint of FrieslandCampina farms in ANCA 2019, 2020, 2021, 2022, 2023.*

4.2. Emissions from peat oxidation

Figure 4 provides the estimated absolute emissions in kilotonnes from peat oxidation of organic soils from the Dutch dairy farmers of FrieslandCampina, for the years 2019 to 2023. About 12% of the land of FrieslandCampina's member farmers in the Netherlands consists of organic soils, which stays relatively consistent over all five years.

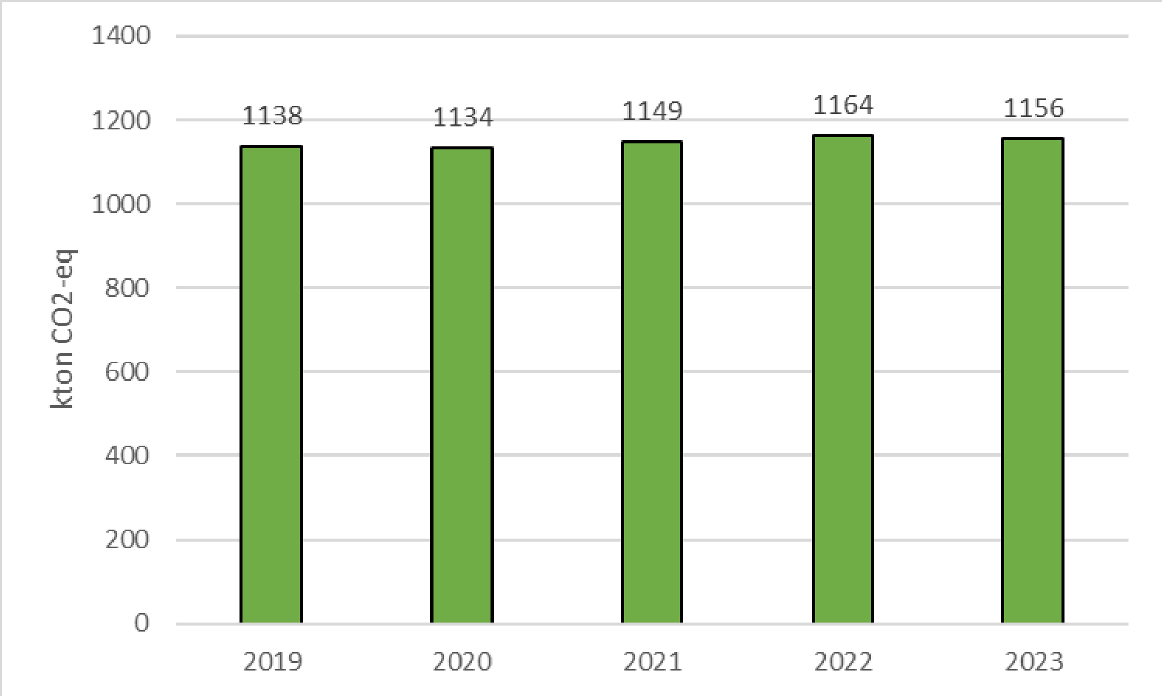

Figure 4. *Total emissions from peat oxidation in kton of FrieslandCampina farms with ANCA 2019, 2020, 2021, 2022, 2023 and Kuikman et al. (2005).*

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Annex 1. Extended explanation for determining the development of the carbon footprint of raw milk of FrieslandCampina farms.

FrieslandCampina reports its greenhouse gas emissions of raw milk from 2015-2019 based on the average Dutch carbon footprint of raw milk. From 2019 and onwards the development of greenhouse gas emissions of raw milk is based on farm-specific carbon footprints, i.e., based on carbon footprints of raw milk of all individual member-farms. This annex explains the detailed process, from the source of data to the determination of the trendline, in simplified context.

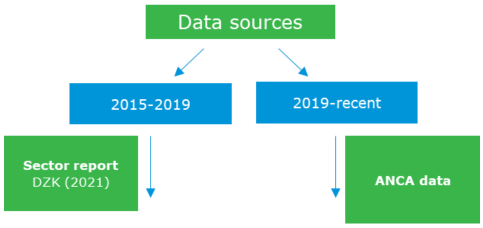

Figure A1.1

Data sources

- From 2019 onwards a farm-specific carbon footprint for all member-dairy farms is available.
- For 2015, 2016, and 2017 no farm-specific carbon footprints are available for all member-dairy farms. For 2018 farm-specific carbon footprints exist but not always available due to limited data-usage consent.
- Therefore, we base the development of raw milk emissions for 2015-2019 on the sector reporting of WEcR and for 2019-2022 (and onwards) on farm-specific carbon footprints from ANCA.

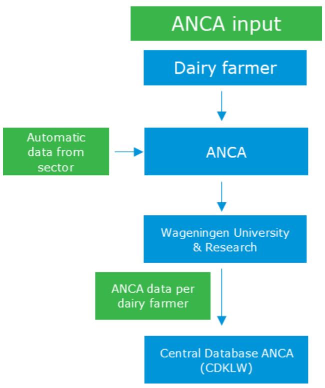

Figure A1.2

Data validation

- Dairy farmers enter data in the ANCA tool annually.
- Data is partly entered manually and partly loaded via automatic interfaces from the sector (e.g., feed industry). This data from third parties is considered accurate.
- ANCA tool signals potential unrealistic data and redirects farmers to potential incorrect input data, leading to possible corrections.
- Based on the entered data ANCA calculates sustainability performance indicators, a.o. a carbon footprint of raw milk. This is done according to a calculation engine, developed by Wageningen University and Research and aligned with latest scientific insights and international standards for carbon foot printing (IDF, 2022; EDA, 2018; Van Dijk et al., 2023).
- FrieslandCampina screens ANCA data for individual dairy farms based on a risk profile for unrealistic data and outcome-driven input of ANCA.

Data connection

- An automatic data connection is in place from the Central Database ANCA (CDKLW) to FrieslandCampina database.
- FrieslandCampina R&D receives carbon footprint data from ZuivelNL for all member-dairy farms of FrieslandCampina from 2019-2022 and onwards for which an active authorization for data-use is in place.

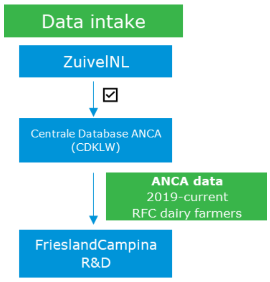

Figure A1.3

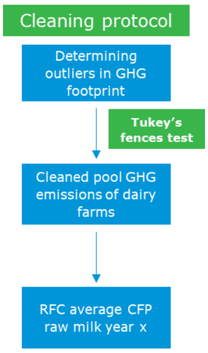

Figure A1.4

Cleaning protocol

- A cleaning protocol for farm-specific carbon footprints was developed in consultation with ANCA experts and WEcR.
- A statistic test (Tukey's Fences test, Tukey 1977) is used to find unrealistic outliers in individual carbon footprints which are then excluded from reporting.
- Annually approximately 5 percent of carbon footprints is excluded from the FrieslandCampina weighted average carbon footprint based on the statistic test.

Determining the emission trend

- For 2015-2019 the carbon footprint series reported by WEcR serves as basis to determine:
  - Development percentage 2015-2016
  - Development percentage 2016-2017
  - Development percentage 2017-2018
  - Development percentage 2018-2019
- For 2019-2021 (and onwards) the cleaned ANCA data is used:
  - First, methodological differences of ANCA calculation engines between different years are determined (see Figure A1.6)
  - Then, year-to-year development factors are computed
- Based on cleaned ANCA selection of farms the absolute value for the reporting (most recent) year is determined.

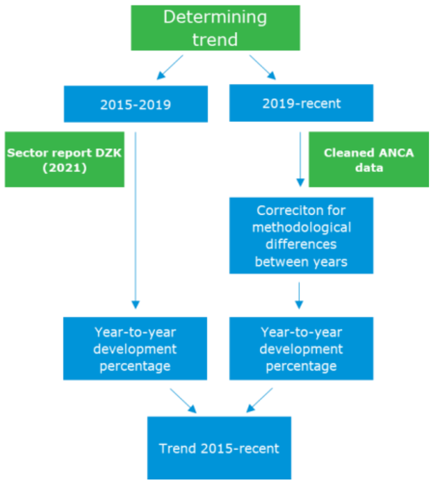

Figure A1.5

Determining the emission trend – how does it work?

In (indicative) Figure A1.6 we show step by step how the trend is being calculated while correcting for methodological differences between years with different calculation engines. For the sake of simplicity, the figure only shows three years (2019, 2020, 2021), however this methodology is also used for all years after 2021.

(a) For each year the ANCA calculates individual carbon footprints based on the latest scientific insights. For every year we therefore have a value based on its own calculation rules. Comparing between these values would lead to wrong conclusions (example: when GWP factors change).

(b) The ANCA also reports the carbon footprint of the previous year with the newest calculation engine. For example, for 2020 we have a carbon footprint with the calculation engine of 2020, and a carbon footprint with the 2020 data but the calculation engine of 2021.

(c) The difference between two different calculation engines, for example 2020 and 2021 – but the same 2020 data – leads to a *methodological difference* between calculation engines 2020/2021.

(d) The difference between two years – 2020 data and 2021 data – with the same calculation engine of 2021 leads to a *development percentage* between 2020 and 2021. We determine this development percentage between all years.

(e) As the carbon footprint of 2019 data in the 2021 calculation engine is not available, we use the development percentage of 19/20 to determine the 2019 footprint with the most recent calculation engine.

(f) Leading to an emission trendline that has been corrected for methodological changes over the years. The reporting of emissions becomes more transparent and it allows for distinction between improvement due to methods versus actual reduction activity.

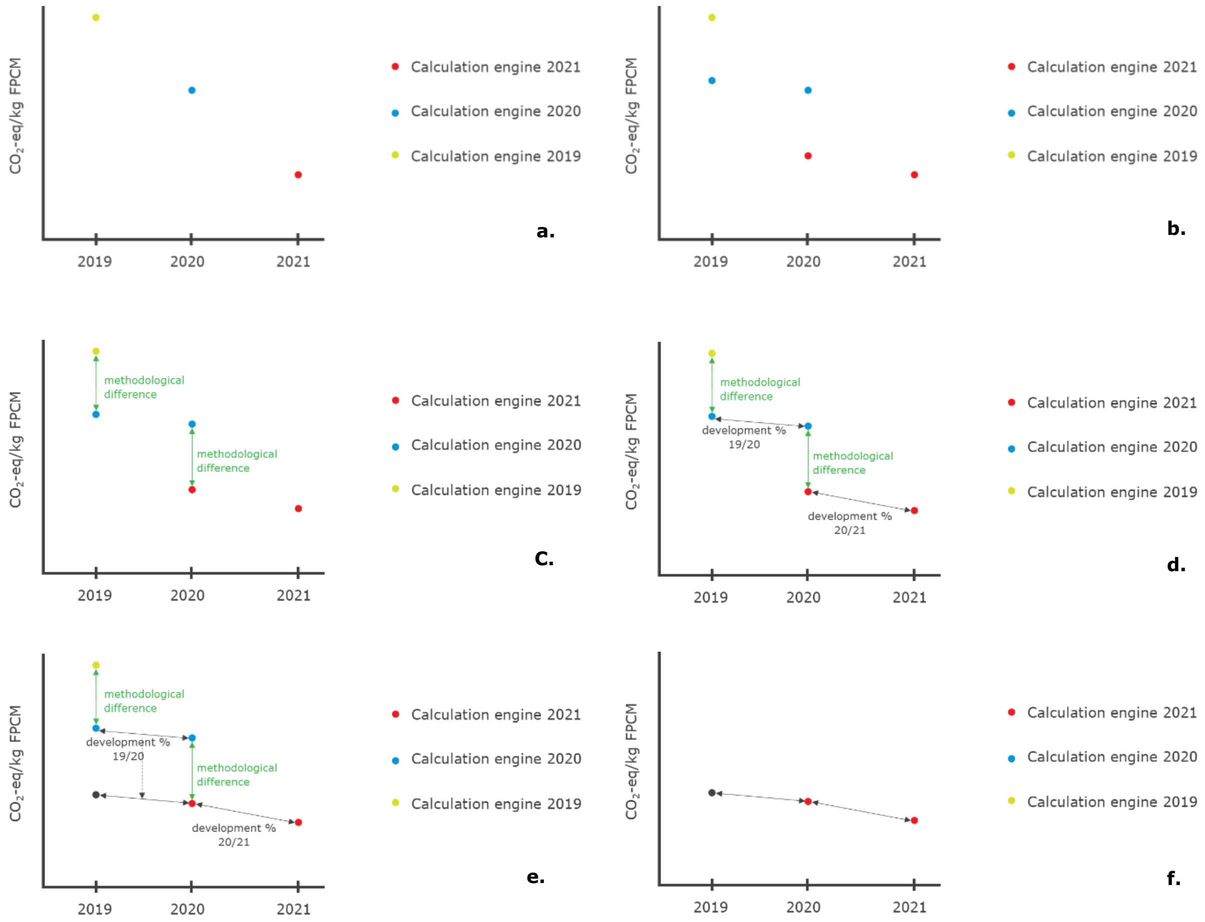

Figure A1.6