

envitecpolis

Greenhouse gas calculation for primary broiler production

METHODOLOGY REPORT

2025



Contents

1. Starting point.....	2
2. Calculation method and system boundary	3
3. Implementation of the calculation	5
3.1 Feed cultivation	7
3.2 Animal production	10
3.3 Electricity.....	11
3.4 Heat.....	12
3.5 Fuel	12
3.6 Cargo.....	12
3.7 Logistics.....	12



1. Starting point

The calculation described in this report concerns the greenhouse gas emissions per kilogram of carcass weight from Atria's primary chicken production. The assessment includes greenhouse gas emissions from animal production, feed production and logistics up to the gate of the Nurmo plant. The calculation takes into account the animal production chain up to the parent stock level, i.e. hen rearing, laying, hatchery and broiler breeding. In addition, animal transport at each stage of the production chain is included in the calculation. The report is part of the overall methodological reporting of greenhouse gas calculations for Atria Finland's packaged products. Slaughtering and product manufacturing are described in a separate methodology report.



Figure 1. The production chain considered in the calculation includes chick rearing facilities, laying houses, hatchery and chicken rearing. The arrows illustrate the logistics included in the assessment. The assessment ends at the gate of the Nurmo plant.

In order to carry out the calculation, farm-specific initial data is collected, on the basis of which the result for each farm participating in the calculation is calculated as a separate entity. For animals/eggs entering a farm, the emission factor used corresponds to the production-weighted average of the previous stage in the production chain. Farm-specific initial data is collected and the calculation is carried out using digital EnvitecVisio platform. From the initial data, animal and feed data is obtained directly from Atria's systems, and other necessary information is provided by the farmer. The result of the calculation is expressed as kg CO₂e / kg of carcass weight. A production-weighted average of the farm-specific results is calculated to represent the greenhouse gas emissions of broiler meat used by Atria.

The results reflect the greenhouse gas emissions from the primary broiler production of Atria's producers. They cannot be generalized to represent greenhouse gas emissions of other producers or other products.

2. Calculation method and system boundary

The calculation model follows the ISO 14040, ISO 14044 and ISO 14067 standards, as well as the GHG Protocol guidelines. In addition, the calculation largely aligns with the Product Environmental Footprint (PEF) guidelines, which define the collection of initial data and the implementation of greenhouse gas calculations in more detail than the standards. This assessment addresses the greenhouse gas emissions of products and does not consider other environmental impacts.

The assessment of primary production is based on a cradle-to-gate system boundary, meaning that the assessment ends when the animals have been delivered to the gate of the Nurmo plant. The system boundary of the calculation is presented in Figure 1. A detailed description of the parameters included in the calculation is described in Section 3, Implementation of the calculation.

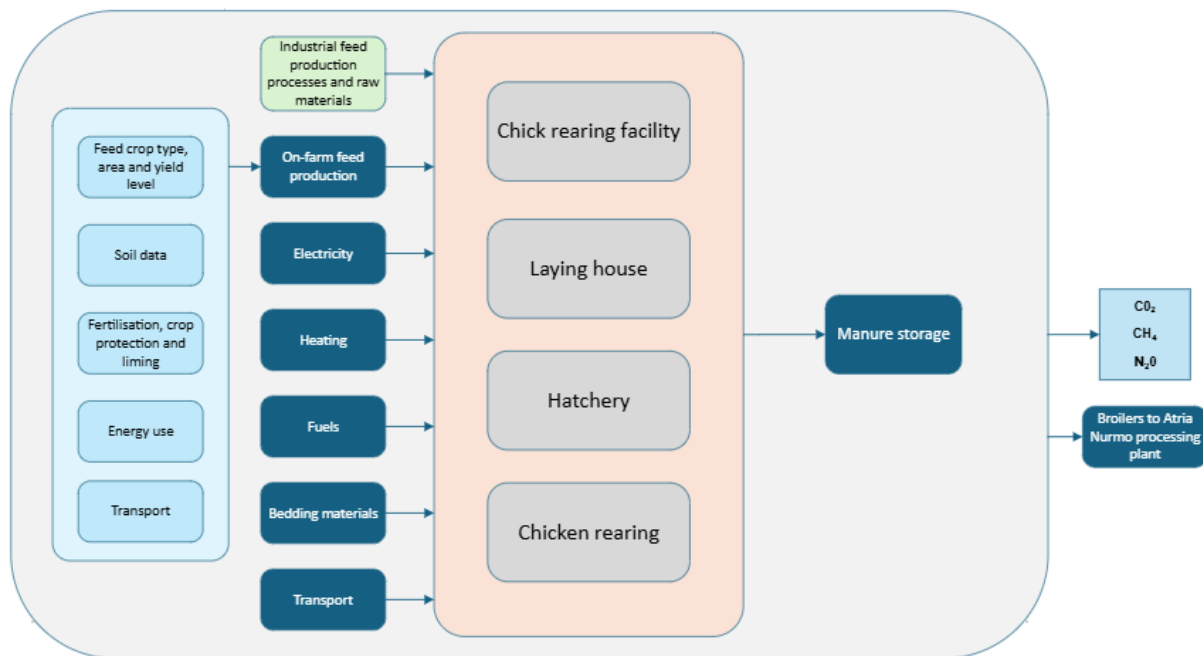


Figure 2. System boundary of primary production of broiler meat

The following are excluded from the assessment:

- Emissions from the life cycle of machinery, equipment and buildings used in primary production.
- Emissions from the life cycle of transport vehicles.

The calculation considers the most significant greenhouse gases, carbon dioxide, methane and nitrous oxide, which are converted into carbon dioxide equivalents (kg CO₂e) per kilogram of carcass weight using characterisation factors (IPCC AR6, 2019).

Characterisation factors	kg CO₂e
Carbon dioxide, CO ₂	1
Methane, CH ₄	27,9
Nitrous oxide, N ₂ O	273



3. Implementation of the calculation

The calculation of the broiler production chain is based on separate greenhouse gas calculations for pullet rearing farms, laying farms, hatchery and broiler farms. For each stage of the chain, farm-specific results are calculated and aggregated into a production-weighted average:

- Chick rearing facility: delivered animal
- Laying house: delivered egg
- Hatchery: delivered day-old chick
- Broiler farm: kg carcass weight

The calculated average is used as the emission factor for the animal/egg entering the next stage of the production chain. Losses at each production stage, as well as animals sent to slaughter, are taken into account on a farm-specific basis. In addition, the calculation takes into account the losses occurring during logistics. For broiler production farms, the calculation is based on their actual demand for day-old chicks, taking into account farm-specific losses.

The calculation is based on farm-specific primary data. Animal data and feeds supplied by A-Rehu, including quantities and emission factors, are obtained directly from Atria's systems and automatically transferred to farm-specific data. The farmer fills in the cultivation data of self-produced feed and the quantities used in feeding, as well as the quantities and emission factors of purchased feeds from other suppliers. Atria's experts review that the feed volumes correspond to the growth results. If this is not the case, the feed information is corrected in cooperation with the producer.

In addition, the farmer provides information on manure management, bedding materials and the energy and fuels used.

The assessment is carried out over a 12-month period. Depending on the farm's operations, the initial data includes:

- Animal information (incoming and outgoing amount (pcs and kg), length of rotation, carcass weight)
- Feeding (all components and quantities per component)
- Farm's own cultivation of feed grain by crop (crop species, yield level, residues in the field, fertiliser and pesticide inputs, liming)



- Soil information on the area used for the cultivation of feed grain (soil type, soil quality, pH)
- Manure management (storage method and quantity of bedding materials used)
- Electricity consumption and sources
- Heat consumption and sources
- Fuel consumption in crop cultivation and animal production
- Transport to the farm (purchased feed, bedding materials, fertilizers and lime). Animal transport is accounted for under logistics and is therefore not included in the farm-specific assessments.

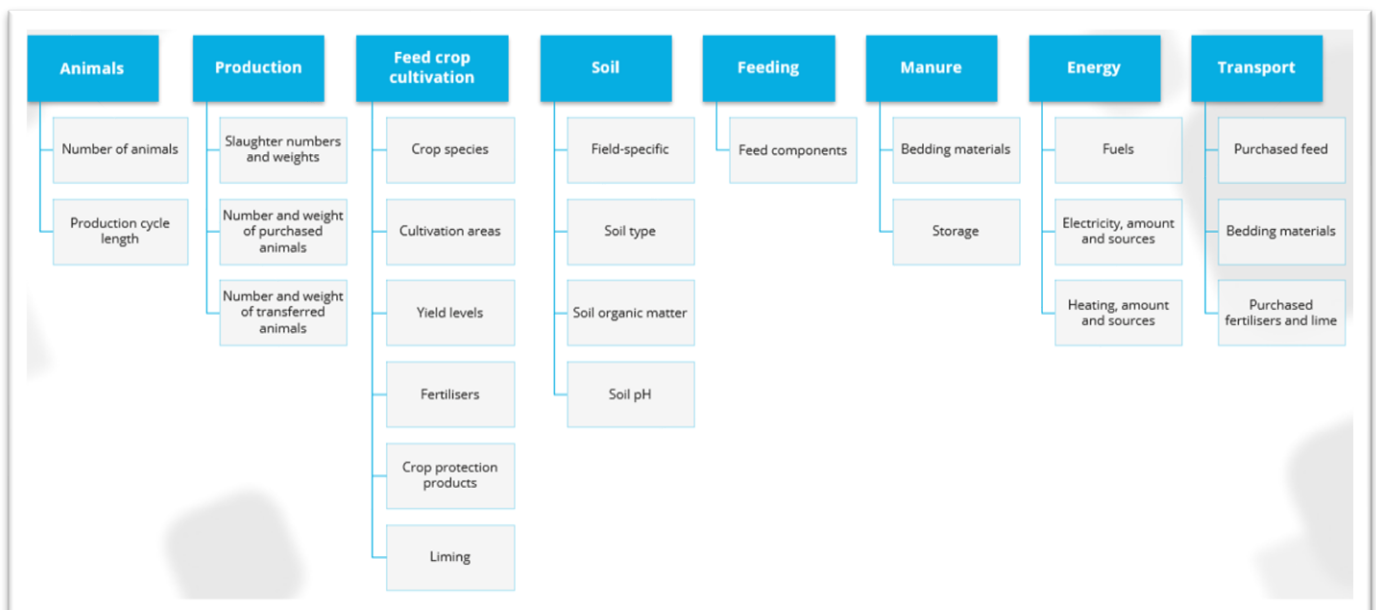


FIGURE 3. Initial data for the calculation

Emission sources to be taken into account in the calculation of the primary production production chain:

Cultivation of on-farm feed:

- Direct and indirect nitrous oxide emissions arising from soils, applied manure, fertilizers and crop residues
- Greenhouse gas emissions from the production of nitrogen fertilisers, liming materials and plant protection products
- Carbon dioxide emissions from soil resulting from liming

- Soil information for arable fields (soil type, soil organic matter, pH)
- Impacts of land use, land-use change and organic soils (changes in tillage practices, land clearance, peat soils)

Animal production:

- Greenhouse gas emissions from feeds produced on the farm: according to crop-specific calculations of emissions, kg CO₂e / consumed feed kg
- Emissions from purchased feeds: accounted for using a life cycle approach, including emissions from feed production kg CO₂/feed kg
- Emissions from manure handling and storage prior to manure use (fertiliser-related emissions are included in emissions from cultivation) and emissions caused by bedding materials according to the life cycle model

Energy inputs:

- Heating and emissions caused by incomplete combustion
- Electricity
- Fuel (fuel oil, diesel, petrol) and emissions from incomplete combustion
- Transport

3.1 FEED CULTIVATION

The calculation of feed cultivation is carried out on a crop-specific basis. If the farmer submits the data at a field parcel level, the crop-specific result is calculated as a weighted average of the field parcel level results. In the calculation of crop production, EnvitecVisio uses the Cool Farm Tool (CFT), a program owned by the Cool Farm Alliance for the calculation of farm-specific carbon footprint calculations. The Cool Farm Alliance is an organization that includes companies that use the CFT tool. Envitecpolis Oy is also a member. The organization has almost 200 members and is based in the United Kingdom. The methodological competence of the CFT is the responsibility of the International Scientific Council.

The fuel consumption of machinery used in cultivation, and any use of electricity and heating are included in the energy inputs of animal production and are not reported separately under cultivation emissions.



The result of the feed cultivation calculation is expressed as CO₂e kg/crop kg for each feed crop. The result is transferred to the calculation of animal production through the kilograms of consumed feed.

3.1.1. Crop residue management

If grain straw or other residues are shredded into the field, emissions are caused when it decomposes. The amount of residues is dependent on the plant and crop yield level, and it has been derived from the IPCC's plant-specific estimates, (2019, Vol 4, Chapter 11). If part of the residue is collected, the farmer estimates the proportion of the collected residue as a percentage. The calculation takes into account direct and indirect emissions of nitrogen.

3.1.2 Fertilisers

Greenhouse gas emissions caused by the manufacture of fertilisers are taken into account in the calculation in accordance with the Life Cycle Assessment (LCA), i.e. the generation of emissions throughout their production chain, from mining to finished product. They have been determined using the Carbon Footprint Calculator for Fertiliser Products program. The calculation is made according to the NPK ratio reported by the farmers, and the production area of the fertilisers is defined as Europe. No emissions have been allocated to the production of recycled fertilisers.

Greenhouse gas emissions during manure processing and storage have been taken into account as part of the calculation of animal production. The direct and indirect nitrogen emissions caused by the use of manure as fertiliser have been taken into account in the cultivation of feed.

Direct nitrogen emissions from fertilization have been modelled according to the IPCC Tier 1 level, taking into account the type of fertilizer used, the amount of nitrogen applied and the moisture balance of the field (2019, Vol 4, Chapter 11). Soil moisture balance is affected by regional weather conditions (precipitation and evaporation) as well as soil type and pH. Precipitation is determined using the amount in the ERAS database for the year under review.

Indirect nitrogen emissions have been modelled according to the IPCC Tier 1 level for leaching and according to the IPCC Tier 2 level for evaporation, in which case the total emission factor of the nitrogen evaporation generated is the weighted average according to the use of the fertilisers.



Emissions caused by liming are calculated according to the amount of product used and the calcium content (IPCC, 2006 (no changes to 2019), Vol 4, Chapter 11).

The fuel consumption of machinery used for the application of fertilisers and lime is taken into account in the section Fuels[AP12.1], and transport of fertilisers and lime from the manufacturer to the farm in the section Freight.

3.1.3. Plant protection products

Greenhouse gas emissions from the manufacture of pesticides are taken into account in the calculation in accordance with the Life Cycle Assessment (LCA), i.e. the generation of emissions throughout their production chain. The emission factors have been determined from the World Food Lifecycle database, taking into account the crop and the number of plant protection products used.

3.1.4 Long-term soil carbon stocks, land-use changes and organic soils

Long-term soil carbon stocks are affected by changes in tillage practices and the conversion of land to arable use. Changes in tillage practices take into account the permanent change between conventional tillage, reduced tillage, and no-till systems. Changes in land use take into account the decrease in carbon stocks resulting from the conversion of land to cropland. In both situations, the review is made 20 years back. After 20 years, it is considered that the carbon balance of the field has found a new level and the changes no longer affect the result. If there have been no changes at all, no changes are considered to have occurred in carbon stocks that would affect the result. The change in carbon stocks has been calculated in accordance with the IPCC's Tier 1 methodology and divided equally over 20 years (2019, Vol 4, Chapter 11). Since the review period is 20 years and Finnish farming includes crop rotation, all changes are considered to apply to the entire cultivation area of the farm. Therefore, the changes are calculated as a hectare share of the total hectares of cultivation, not on a crop-specific basis.

Emissions from organic soils take into account peat fields, which are defined by the Finnish soil type classification. The following soil types are considered as peatlands: BCt (brown moss-sedge peat), Ct (sedge peat), LCt (forest sedge peat), SCt (sphagnum-carex peat), Tm (peatland). The farmer is asked to report as part of the initial data the share of peat soils for each cultivated crop. With regard to emissions from peat field cultivation, greenhouse gas emissions are taken into account according to the cultivation of annual crops (IPCC, 2014).



Possible impacts from long-term carbon stocks changes, land use change, and organic soils on the results are reported in the results as a separate entity for both the farm and Atria.

3.2 ANIMAL PRODUCTION

3.2.1 Number of animals

The actual number of animals in the calculation year obtained from Atria's systems is used as the number of animals, taking into account the animals that have arrived on the farm, losses and the animals sold. The animals sold can be animals that move forward in the chain or go to slaughter. Animals to be slaughtered have also been taken into account in chick farms and laying houses, in which case greenhouse gas emissions have been allocated to the animals/eggs transferred and the carcass kilograms sold in proportion to the kilograms of live weight.

The emission factor for the animals coming to the farm is the production-weighted average calculated in the previous stage.

3.2.2 Feeding

The farm-specific feed use volume for A-rehu is obtained from Atria's systems. The emission factors have been calculated in Atria's system in accordance with the feed recipes. The emission factors of raw materials are from the GFLI emissions database and, for domestic grains, from the Natural Resources Institute Finland's research data (Hietala et al. 2022).

For other feeds, the farmer provides the quantities used in the initial data. In the case of self-grown feed crops, greenhouse gas emissions are transferred from plant-specific calculation results to feed emissions according to the kilograms input. If the farm uses feeds other than those supplied by A-feed, the feed emission factor has been requested from the feed supplier.

3.2.3 Manure and bedding

The greenhouse gas emissions of manure take into account the methane and nitrous oxide emissions caused by manure and bedding. The formation of emissions is affected by the composition of the manure characteristic of the animal species, the amount of manure, the length of the animal cycle, the form of storage of the manure and the geographical location of the farm.



Direct and indirect N₂O emissions from manure handling and storage are calculated in accordance with IPCC 2019 tier 2, taking into account the number of days the animals live, the manure treatment method, nitrogen excretion / day and the nitrogen content of the feed / day. Nitrogen excretion is in accordance with the Normilanta system (Suomen Normilanta, 2017), and the nitrogen contained in the feed has been determined by Atria's feeding planning experts and is based on Luke's animal-specific feeding recommendations. The emission factors of the manure treatment method are in accordance with Finland's national greenhouse gas inventory.

CH₄ emissions from manure handling and storage are calculated in accordance with IPCC 2019 tier 2, taking into account the number of days the animals live, the organic matter of the manure and the manure treatment method. The amount of organic matter in manure is in accordance with the Normilanta system (Suomen Normilanta, 2017). The emission factors of the manure treatment method are in accordance with Finland's national greenhouse gas inventory, and the methane conversion factor in the calculation is 0.39 (IPCC 2019).

The emission factors for bedding take into account the emissions from production in accordance with the life cycle model.

3.2.4 Metabolism

There are no calculation guidelines for the metabolic greenhouse gas emissions of broilers, which is why they are not taken into account in the calculation. Their potential impact on the result is very small.

3.3 ELECTRICITY

The farm reports the amount of electricity it uses and its sources. The emission factor for electricity production is the emission factor for the year preceding the year under review, based on Finland's national residual mix. The European Residual Mix (AIB) publication is used as the source of the emission factor. To the extent that zero-emission electrical energy verified by a guarantee of origin is in use, or the electricity has been produced with solar power or a biogas plant connected to the farm, the emission factor of the electricity consumed is zero.



3.4 HEAT

The farm reports the amount of heating fuel used. The emission factors of heating fuels (wood chips, oil, peat, wood pellets) take into account both direct CO₂ emissions from combustion (Statistics Finland, Fuel Classification) and CH₄ and N₂O emissions from incomplete combustion (DEFRA, UK Government GHG Conversion Factors for Company Reporting) converted into carbon dioxide equivalents (CO₂e).

3.5 FUEL

The farm reports the amount of fuels used (oil, diesel, petrol). Fuels used for the cultivation of self-grown feed are also taken into account in the fuels. The emission factors for fuels are in accordance with DEFRA 2024 (DEFRA, UK Government GHG Conversion Factors for Company Reporting).

3.6 CARGO

Freight transports take into account the transport of feed, fertilizers, lime and bedding. The greenhouse gas emissions of cargo are affected by the vehicle used, the weight of the cargo and the transport distance, based on which the emissions are calculated using the tonne-kilometre emission factor of the vehicle in question (DEFRA 2021). Transportation from the place of manufacture of the product to the farm is considered as the transport distance, and the distance is requested separately for each used product.

3.7 LOGISTICS

The calculation of greenhouse gas emissions caused by the logistics of primary production takes into account the transport of animals between farms and up to the gate of Atria's Nurmo plant.

The logistics assessment includes the following information:

- Transfer of chicks to laying house
- Transfer of eggs to the hatchery



- Transfer of chicks to rearing establishment
- Transfer of the hens to the slaughterhouse
- Transfer of broilers to the slaughterhouse

Farm-specific transport, cultivation and other use of machinery related to agricultural activities in primary production are not included in logistics emissions but are included in energy emissions from primary production.

