

2026

# Agri-footprint 8 Methodology Report

## Part 1: Methodology and basic principles

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Agri-footprint

# About us

**Agri-footprint** is a high-quality, comprehensive life cycle inventory (LCI) database focused on the agriculture and food sector. It covers data on agricultural products: food, feed, and agricultural intermediate products. Since its conception in 2014, Agri-footprint has been critically reviewed and is now widely accepted by the food industry, LCA community, scientific community, and governmental institutions.

**Mérieux NutriSciences | Blonk** is a leading international expert in food system sustainability, inspiring and enabling the agri-food sector to give shape to sustainability. Our purpose is to create a sustainable and healthy planet for current and future generations. We support organizations in understanding their environmental impact in the agri-food value chain by offering advice and developing tailored software tools based on the latest scientific developments and data.


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# 1. Introduction

The Agri-footprint database is a relevant source of LCA information for agricultural production and processing of commodities for a wide range of different users. Since the first release in 2014 the database has been expanded and updated 7 times to arrive at the current Agri-footprint 8 version. Now, Agri-footprint has become the core database to be used in (carbon) footprinting reports and footprint declarations for several industrial sectors. It is particularly of interest for the feed sector since it's the source database for the Global Feed Lifecycle Institute (GFLI) database, the European Commission EF feed databases, and therefore for all animal sectors that want to generate compliant foot printing studies.

Agri-footprint aims to be compliant with the most widely used methodology standards for agricultural and food LCA and footprinting by connecting to data from leading statistical institutes (such as FAO and Eurostat), industry publications, and scientific literature. For agricultural modelling, the product environmental footprint calculation rules are followed as published in the latest PEF guidelines, (EU) 2021/2279 "Commission Recommendation of 15 December 2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organizations."

Agri-footprint for purchase via our Sales representatives, is available as a library within SimaPro, OpenLCA Nexus, HiQLCD and Earthster. It is expected that Agri-footprint users have a basic understanding of life cycle assessment concepts. Blonk can also provide bespoke training sessions to build capacity in other organizations at request. General information, FAQ, Update Logs, Issue Trackers, and reports are publicly available on www.agri-footprint.com. Agri-footprint users can also ask questions via this website or by sending inquiries to tools@blonksustainability.nl.

Agri-footprint is published by Mérieux NutriSciences | Blonk. More information on Mérieux NutriSciences | Blonk and Agri-footprint can be found at blonksustainability.nl and blonksustainability.nl/agri-footprint.

This document contains background information on the methodology, calculation rules and data that are used for the development of the data published in the Agri-footprint database. It will be updated whenever new or updated data is included in a new release of Agri-footprint.

Part 1 of the Agri-footprint methodology describes the main methodological principles for the setup, development, and maintenance of the Agri-footprint data. In Part 2, more detailed information is given on the specific methodological assumptions and data used for developing the different datasets**.** In Part 3, more detailed information can be found in the impact of the latest update, comparing Agri-footprint 7 versus the latest Agri-footprint 8.

# 2. Using the Agri-footprint data

## 2.1 Target users

The Agri-footprint database is useful for all parties that want to study and report on the LCA impact of products and services originating from agriculture and fisheries. This can be:

- LCA researchers and consultants, government research organizations, academia
- Operators that conduct product or company footprints, research and development
- Service providers (e.g. software developers) that develop tools for footprinting-related decision support
- Database developers that provide secondary data for certain related industries

For all use cases there are specific License Agreements. The 5 license types are the Research License, Commercial License, Consultancy License, Developer License, and Enterprise License. More information on the license offering can be found at www.blonksustainability.nl/agri-footprint.

The Agri-footprint database contains agriculture crop data, data from fisheries, data on animal production systems, and data on processed commodities and ingredient products. In addition, it contains market and production averages for raw and processed commodities. Typical users include LCA practitioners, food and feed manufacturers, and agrifood companies modelling the environmental footprint of raw or complex, multi-ingredient products.

## 2.2 Intended use

In accordance with the International Reference Life Cycle Data System (ILCD) guidelines (JRC-IES & European Commission, 2010), Agri-footprint is designed to support both Situation A ('Micro-level decision support') and Situation C ('Accounting') applications. For accounting purposes, this includes both systems with market interactions (Situation C1) and existing isolated systems (Situation C2). Agri-footprint is based on an attributional approach. This means that the results give an impression of the environmental impact of a product in the current situation. Agri-footprint does not aim to support type B ("Meso/macro-level decision support"), where LCI modelling exclusively refers to those processes that are affected by large-scale consequences. The processes in Agri-footprint are not modelled in a consequential way.

Table 1: ILCD archetypal goal situations and Agri-footprint compatibility

| ILCD Goal Situation | Application Type | Decision Context & Scope | Primary Modeling Principle | Agri-footprint Applicability |
|---|---|---|---|---|
| Situation A | Micro-level decision support | Product- or process-level decisions with limited, non-structural consequences on the wider market (e.g., ecodesign, process optimization). | Attributional | Supported |
| Situation B | Meso- / Macro-level decision support | Strategic decisions or policy choices causing structural, market-wide shifts in supply and demand. | Consequential | *Not primary scope* |

| | | | | |
|---|---|---|---|---|
| Situation C1 | Accounting (interactions included) | Retrospective or current footprinting/accounting of systems that interact with external systems or markets. | Attributional | Supported |
| Situation C2 | Accounting (isolated) | Accounting or environmental reporting of an existing, isolated system without market-mediated substitutions. | Attributional | Supported |

Agri-footprint can be used as a secondary data source to support comparisons or comparative assertions across systems (e.g. products). In case an LCA should be used to make public claims, it is the responsibility of the practitioner to ensure ISO 14040:2006/14044:2006 compliance (through an ISO review of the study). Furthermore, Agri-footprint agricultural modelling is fully compliant with the Product Environmental Footprint (PEF) guidelines (Commission Recommendation (EU) 2021/2279). This document provides all relevant information to facilitate this process, through transparent documentation of methodological choices and through description of data sources and modelling (see Agri-footprint 8 - Part 2 – Description of data). In some comparative LCA cases, a consequential approach may be more appropriate. In that case, the user may need to modify the LCIs to accurately reflect marginal effects.

More specifically, potential applications of Agri-footprint may be:

- The identification of key environmental performance indicators of a product group
- Hotspot analysis of a specific agricultural product
- Benchmarking of specific products against a product group average.
- Provide policy information for identifying product groups with the largest environmental impact in a certain context
- Carbon footprints and other partial footprints
- Environmental product declarations (EPD)

In addition, a separate Agri-footprint ‘FLAG” database has been developed, using linear amortization of land use change emissions. This specific version of the database has specific reporting requirements from SBTi (Greenhouse Gas Protocol, 2026; SBTi, 2026) and can be used for:

- SBTi target setting and reduction, using contribution results specifically modelled using FLAG pathways.

Agri-footprint may also support other applications; however additional modelling (or modification of datasets) will be required:

- Strategic decision-making through forecasting and analysis of the environmental impact of raw material strategies and identification of product groups or raw materials with the largest environmental improvement potential
- Detailed product design of food products, in which the data from Agri-footprint can be used as a starting point which can be partially replaced by primary or more specific data where needed

- The development of life cycle-based Eco label criteria, but does not provide Eco label criteria directly
- Agri-footprint can be referred to as a prescribed secondary data source to be used in life cycle based environmental declarations of specific (food) products under the Product Environmental Footprint (PEF) framework, or in Product Category Rules (PCRs).

Agri-footprint is not intended to be used:

- As the only source for green public or private procurement, as Agri-footprint does not (yet) provide sufficient data on supplier- or brand-specific products (although this may change in the future, as incorporation of supplier-specific data is desired).
- Agri-footprint is not intended for corporate or site-specific environmental reporting or environmental certification of specific life cycles, although Agri-footprint may be used as a source for background data.

Agri-footprint provides LCI datasets which were modelled on the unit process level using models and data that were developed by Blonk. The database is available in three versions: Impact Result Level, System Process Level, and Unit Process Level. Agri-footprint unit processes are linked so that detailed, interconnected, LCI models can be applied directly as input into LCAs.

Agri-footprint uses some background data from other databases such as Ecoinvent. A list of these datasets is provided in the data report (Agri-footprint 8 - Part 2 – Description of data).

# 3. Methodology and scope

## 3.1 Life Cycle Assessment (LCA) framework for agriculture

Life cycle assessment (LCA) is a methodological framework for assessing the environmental impacts that can be related to the production and use of a product or service. Examples of environmental impacts are climate change, toxicological stress on human health and ecosystems, depletion of resources, water use, and land use.

There are several LCA protocols and guidelines, such as the ISO standards, for practitioners that give directions on how to conduct an LCA.

Important LCA standards and handbooks that were used as a basis for the LCIs in Agri-footprint are:

- The ISO 14040/44 series (ISO 14040, 2006; ISO 14044, 2006, 2020)
- Product Environmental Footprint (PEF) methodology (European Commission, 2018a)
- Several Product Environmental Footprint Category Rules PEFCRs such as feed, dairy and pet-food
- Forest, land and agriculture science based target-setting guidance (Greenhouse Gas Protocol, 2026; SBTi, 2026) for FLAG emission reporting of the AFP FLAG variant.

The ISO 14040 series (ISO 14040, 2006) describe the basic requirements for performing an LCA study. This includes, among other things, directions on how to define the functional unit of a product, how to determine which processes need to be included or excluded, and how to deal with co-production situations where elementary flows need to be allocated to the different products. However, the ISO standards can still lead to different methodological decisions, depending on the LCA practitioner's interpretation. This means that applying the ISO standards may still result in different approaches and different quantitative results.

That's why the more specific methodologies as defined in the PEF framework are relevant. They define in more detail how to model emissions in agriculture and other aspects such as system boundaries and allocation. Agri-footprint aligns to these specific requirements.

## 3.2 Included processes

Agri-footprint contains LCIs of animal and plant agricultural production, fisheries and derived processed products. Furthermore, it contains datasets for transport, energy production and some chemicals that are used to produce these products. These unit processes are linked in Agri-footprint to produce commonly used agricultural commodities. The system boundaries are from cradle to the exit gate of the plant-based or animal-based food commodity as shown in the figures of Section 3.6 System Boundaries. Retail, preparation by the consumer, and waste treatment after use are not incorporated in Agri-footprint. Consumer and distribution packaging this is not included in Agri-footprint, apart from pesticide packaging. However, for several commodities and regions Agri-footprint provides market and production mixes based on production and import statistics (see Agri-footprint 8 - Part 2 – Description of data).

The processes in Agri-footprint reflect an average performance for a defined region, for instance wheat cultivation in the Netherlands, or crushing of soybeans in the United States. The data description section of the report (Agri-footprint 8 - Part 2 – Description of Data) gives

more detail on how the data is generated. For the United States of America and Australia state specific datasets are available for some cultivations.

## 3.3 Consistency of methods, assumptions, and data

The data in Agri-footprint are derived from different sources. The LCIs for the animal production systems, transport, auxiliary materials, fertilizers, etc. have been developed based on own work of Blonk Sustainability. In these studies, data were collected mainly from the public domain (scientific literature, FAOstat, Eurostat, etc.) or from public or confidential research initiated by the industry and conducted by Blonk Sustainability. Where possible, the data has been reviewed by industry experts. Data gaps were filled with estimates, which were based on industry expert opinions as much as possible. The assumptions are documented in Part 2 and clearly identified in the database.

## 3.4 Function, functional unit, and reference flow

Products can fulfill different functions, which depend on the context in which they are used. It is therefore not possible to define a complete functional unit for every product in the database. Rather, reference flows can be defined which can fulfill different functions in different contexts. To allow for maximum modelling flexibility, multiple properties of the reference flows are provided in the database. For example, the main reference flow for crop cultivation is 1 kg of crop, but the dry matter and energy content are given as additional properties. The general principle used in Agri-footprint is that the reference flows of products reflect 'physical' flows as accurately as possible, i.e. reference flows are expressed in kg product "as traded"; including moisture, formulation agents etc., with product properties listed separately in the process name and/or comment fields.

## 3.5 Multi-functional processes

According to the ISO14044:2006 standard (ISO 14044, 2006), allocation should be avoided whenever possible by dividing the unit multi-output process into two or more sub-processes and collecting the inventory data related to these sub-processes separately. In practice this is, however, not possible and therefore allocation keys are used to divide impact of the process and precursor processes in the supply chain over the co-products. Agri-footprint provides three types of allocation: *mass allocation, energy allocation and economic allocation*.

- **Mass allocation**: For the crops and the processing of the crops, mass allocation is based on the mass of the dry matter of the products. For animal products, mass allocation is based on the mass as traded.
- **Gross energy allocation**: For the crops and the processing of the crops, gross energy allocation is based on the gross energy of products. For more information on the data behind the gross energy of products see 'Agri-footprint 8 - Part 2 – Description of Data'.
- **Economic allocation**: For the crops and the processing of the crops the economic value of the products is largely based on (Vellinga et al., 2013). For the other products, the references to the economic value are given in the chapters on these products in 'Agri-footprint 8 - Part 2 – Description of data'. Economic allocation is the preferred allocation method, since it is PEFCR Feed compliant (PEFCR, 2018a).

For some specific products the Economic allocation applied is "0" as a results, this happens when the economic value of it is not present, it is applied for a few co-products, for example:

- Sunflower hull
- Vinasse wet
- Pig co-product, other
- Beef co-product, other (from various systems)
- Dairy cow co-product, other
- Egg losses
- Groundnut shells
- Sugar beet pulp wet

Allocation is applied without the use of cut-offs for so-called residual product streams whenever possible. There are four exceptions to this allocation rule:

- Brewer's grains, wet
- Citrus pulp, wet
- Animal manure
- Offal, from fishery

These exceptions are according to the recommendations of the PEFR Feed, FAO LEAP (Livestock Environmental Assessment and Performance Partnership) guidelines for feed and animal systems. Citrus pulp, wet brewer's grain, offal from fishery and manure do not include any inputs from previous life cycle stages. Dried citrus pulp only includes the energy required for drying.

In accordance with the limits of our system, we consider animal manure a waste product, meaning it does not carry any environmental impacts from the livestock stage. Therefore, while the impacts of manure storage are attributed to the animal system, the emissions from its application in the fields correspond exclusively to the cultivation process.

Products are considered residual when they have the following characteristics:

- Former food product for feed
- Marginal revenue share
- Production volume is independent of the demand for the rest-product
- Often products with limited shelf life, e.g. wet materials

## 3.6 System boundaries

Agri-footprint includes the interventions between technosphere and ecosphere that occur during normal operation (thus excluding accidents, spills, and other unforeseeable incidents). For agricultural soil which is partly technosphere and partly ecosphere Agri-footprint follows the definitions of the PEF impact models used for modelling ecotoxicity and eutrophication.

The LCI data is 'cradle-to-gate', where the gate is dependent on the process analyzed. No data on distribution to retail, retail, consumer use or end-of-life (after the use phase) are provided (but treatment of waste generated during processing is included). All processes that are relevant for analysis on an attributional basis are included. Any omission or deviation is documented in the documentation of the specific process.

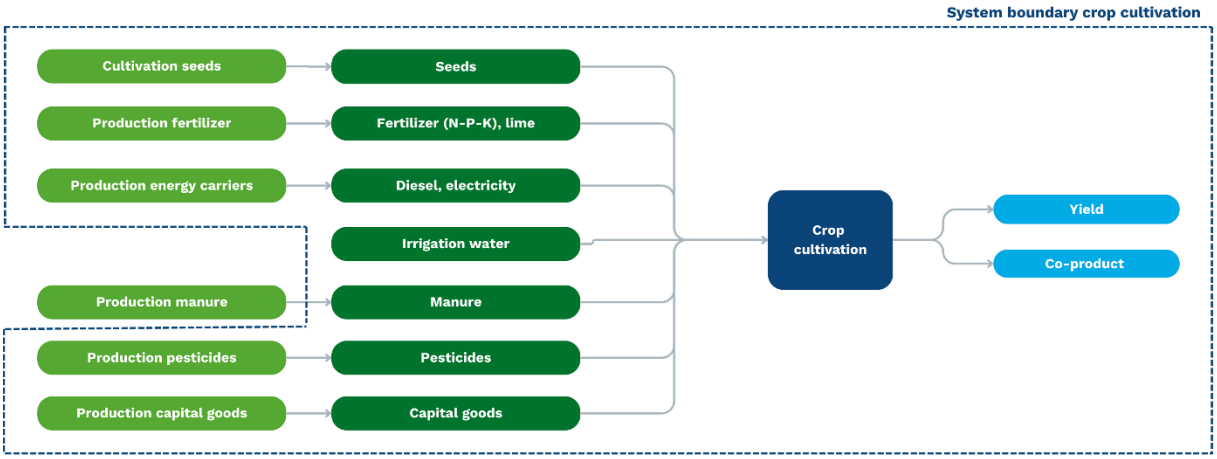



Figure 3-1: System boundary for crop cultivation.

Crop cultivation (Figure 3-1) is modelled on the country-level (with country specific crop yields, fertilizer composition and application rates and energy use). Carbon storage in crops for feed, animals and milk is not included in Agri-footprint because this carbon is part of the short-term carbon cycle. Because of this, the carbon dioxide emissions at the end of the life cycle (e.g. emitted during fermentation or digestion) should not be modelled as a $CO_2$ emission contributing to climate change except when the stored carbon is released as methane due to, for instance, enteric fermentation or manure management and storage, which is inventoried as 'methane, biogenic'. After cultivation some crops undergo a country-specific processing stage (e.g. crushing of palm fruit bunches), see Figure 3-2.

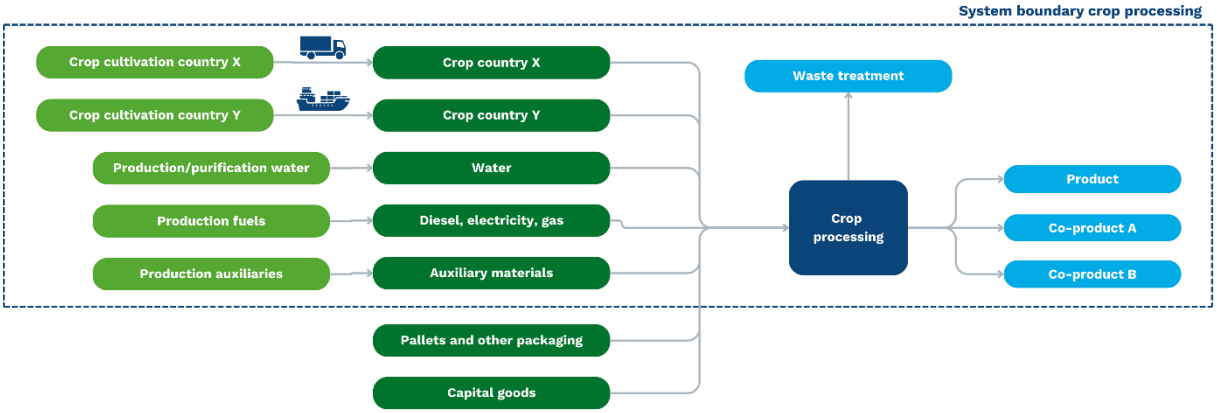



Figure 3-2: System boundary for crop processing.

Production of fuels, auxiliaries, and transport of crops and materials to the crop processing site are included. Intermediate packaging and capital goods are excluded from the system boundaries. The partially processed product may then be exported to another country for further processing or be processed further domestically (e.g. palm oil refining). After this second processing step, country-specific crop product mixes may flow into various feed ration mixes (e.g. cattle compound feed). The feeds are an input for the animal husbandry, see Figure 3-3.

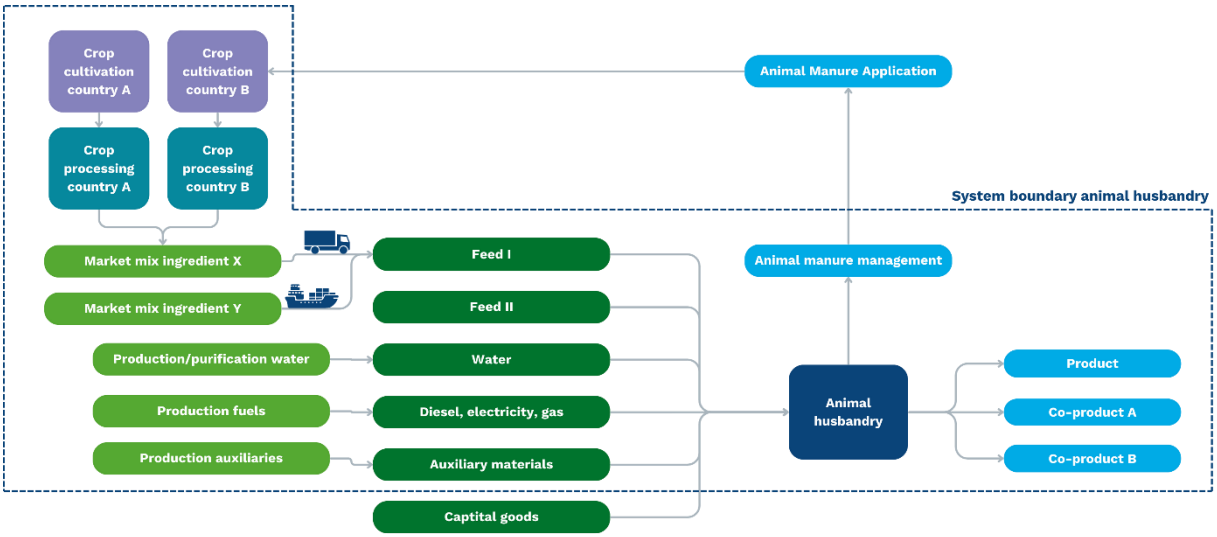



Figure 3-3: System boundaries for animal husbandry.

In Agri-footprint, market mixes are derived for many feed materials that are used for the compound feeds fed to chicken, pigs and cattle. Emissions due to the management of manure on the farm are included within the system boundaries, but the emissions due to application of manure are attributed to the crop cultivation stage. This is not done via a loop, but when a crop is cultivated using manure this is modelled within the crop cultivation itself, not considering any emissions from animal husbandry. So, the manure is treated via a cut-off. Emissions due to animal manure transport to the field are 100% allocated to crop cultivation.

Plant and animal products can be further processed into food ingredients, see Figure 3-4. For food ingredients that originate from the processing of crops, the system boundary is drawn after the processing into 'generic' ingredients (e.g. into starch, sugar, vegetable oil etc.). These products are often processed further into food products (e.g. bread, soft drinks). This further processing is not included in Agri-footprint.

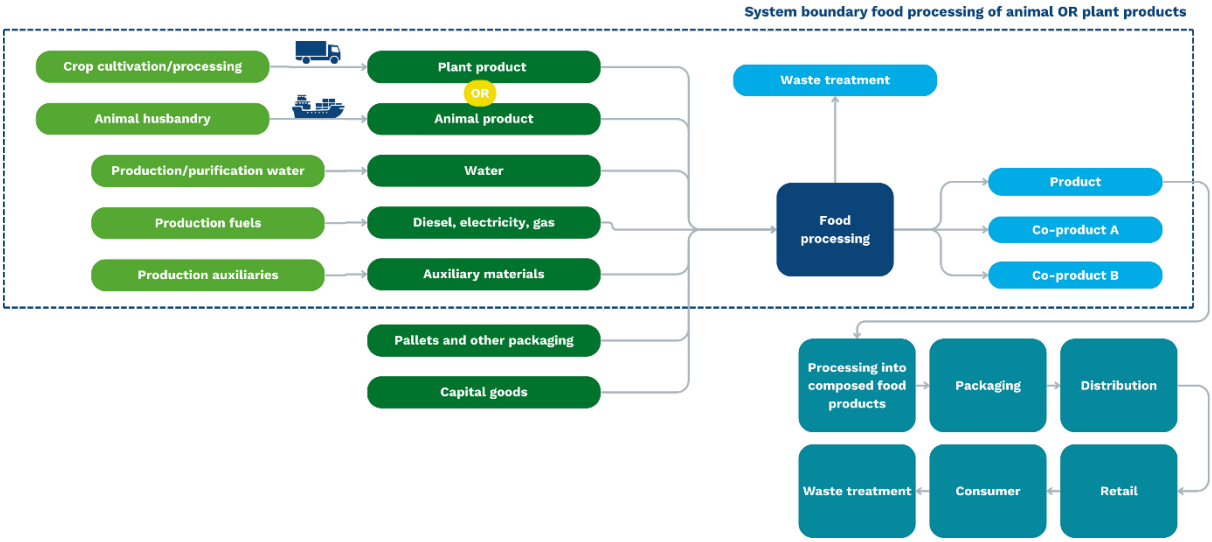



Figure 3-4: System boundaries for food processing.

For meat, the processing of fresh product means that the animal is slaughtered and fresh meat is produced, but further processing into specific meat products and packaging for retail is not included. Agri-footprint excludes packaging, distribution, retail, consumer handling and waste treatment of the final product.

Some processes may be excluded from the system, because there is only a remote relation to the most important processes in the lifecycle of the product. A key consideration here is the use of capital goods (e.g. tractors, barns, farmstead, processing plants, mills, trucks, ships). The energy and materials production in the supply chain of capital goods often make a negligible (not substantial or significant) contribution to the LCA results and have been incorporated into Agri-footprint in a limited way, more detailed information in Agri-footprint 8 – Methodology part 2..

## 3.7 Cut-off

The cut-off criteria for the inclusion of inputs and outputs were based on mass and/or energy consumption. It is estimated that elementary flows representing not more than 2% of the cumulative mass and energy flows were omitted.

## 3.8 Basis for impact assessment

The LCIA methods ReCiPe 2016 v1.13 (M. Huijbregts et al., 2016), the Blonk version 4.2.0, based on ReCiPe 2016 v1.13 (SimaPro adapted) and the EF 3.1 (SimaPro adapted) method were considered when developing Agri-footprint, but Agri-footprint may also support other impact assessment methods.

In Agri-footprint, climate change due to land use change and peat has been modelled separately to show its contribution to the climate change impact category. This makes it possible to report on the effects of land use change and peat emissions separately. Land transformations are also modelled in $m^2$ land transformation in the known inputs from nature. Although $m^2$ land transformation contributes to other environmental indicators than carbon dioxide, please keep in mind that double counting of the impact of land use change should be avoided.

Agri-footprint makes use of other databases such as Ecoinvent to provide data for some background processes. If LCIs of other databases are used, it is possible that errors have occurred during the implementation of those datasets into third party LCA-software. It remains to the user of Agri-footprint to select the impact categories that are environmentally relevant for the analyzed products or systems and to check which impact categories are endorsed by other bodies of the relevant region. The inventories in Agri-footprint support the calculation of the midpoint impact categories proposed in the EU PEF.

## 3.9 Treatment of uncertainty

Uncertainty in inventory data exists in many ways and there are many factors determining the level of uncertainty in LCA (M. A. J. Huijbregts et al., 2001). Most of the inventory data in Agri-footprint are not the result of actual measurements but of models that compute inventory data in relation to activity data that are measured or estimated. We use the following classification derived from (M. A. J. Huijbregts, 2001) to explain the different types of uncertainties and how we have treated and estimated uncertainties:

1. Uncertainty due to LC modelling choices which are related to the simplifications made in modelling the lifecycles, for instance by using cut-off rules for marginal inputs and outputs or excluding not common situations in defining the average lifecycle;
2. Data uncertainty which encompasses inaccuracy of data and lack of (representative) data;

3. Emission model and parameter uncertainty which refers to the many emissions which are calculated by combining primary activity data with an emission factor that is the result of a parameterized model;
4. Spatial variability refers to the variation in conditions (soil, climate) and applied technologies (age, type, abatement techniques, etc.) the region under study;
5. Temporal variability refers to variation in time related to variation in natural conditions over the years (climate, pests, capacity usage, calamities, et cetera).

### 3.9.1 Which uncertainty types are included and how

In Agri-footprint, uncertainty distributions are defined for specific input or output data of LCI processes that incorporate some main factors defining uncertainty and variability around the average. There we focus on key parameters related to the average efficiency of processes in the regions for which average process data are derived. This overall distribution combines the variability in technology, processing conditions and management, which may have a spatial correlation in that region (see Table 3-1 for further explanation).

Table 3-1: Overview of applied uncertainty models and parameters in Agri-footprint

| Process group | Parameters that define process efficiency | Explanation |
|---|---|---|
| Cultivation | Yield (kg crop/ha) | In a defined cropping system where agricultural practices are more or less the same (for instance conventional winter wheat grown in the Netherlands), the differences in emissions and resource use per unit product are strongly related to differences in yield. Yields vary in relation to differences in climate and local growing conditions with same inputs and related emissions per hectare (at least if we assume that emissions are not related to factors that also explain the variation in yield, e.g. rainfall can affect yields but also runoff of N-fertilizer). Of course, yields are also correlated with agronomic inputs such as fertilizers. This change in yields per hectare caused by a change in inputs per hectare causes mostly a smaller effect on emissions and resource use per kg product, because of the yield responses to marginal inputs. Since emissions in cultivation are all related to agronomic inputs and these inputs are, in turn, related to yield, we decided not to introduce variations on inputs and yields at the same time. The distribution around the average yield gives a first proxy for many of the inputs and related emissions. |

# 4. Data development and procedure

A four-stage data development procedure is used for the development of the Agri-footprint database. Each stage of the procedure focusses on different aspects, to ensure an efficient but at the same time robust work procedure. Each step of the procedure.

1. Establish the unit process baseline model
2. Identify data sources and aggregation level of data
3. Fill data gaps with best available data
4. Consistency checks

## 4.1 Establish the unit process baseline model

For all processes, a default model is used consisting of calculation rules that transfer the input data into the interventions. Together they form the unit process. In Agri-footprint, the unit process data is not pre-allocated which allows the user to adapt the allocation factors. These models have been developed in the past and are compliant to the PEF methodology and the GFLI handbook (European Commission, 2018b; GFLI, 2020a, 2020b).

Agri-footprint contains attributional LCIs, which means generally average mixes are considered that are representative for the specific crop, process, transport modality, product or location.

## 4.2 Selection of data sources and aggregation of data

For Agri-footprint, we aim to use consistent data for all crops and regions covered. For example, all fertilizer application rates, fertilizer types, water use etc. are based on the same methodologies and data sources for all crops.

The main baseline data source is statistics available in the public domain (Scientific literature, FAOstat, Eurostat, etc.). Data from the public domain is assessed based on representativeness (time-related coverage, technical coverage and geographical coverage), completeness, consistency and reproducibility. For a part of the data, we cannot rely on statistics. There we use literature data and models developed by Blonk (for instance for energy use at the farm). For processing, we rely on literature and industry data (either published or collected by Blonk). Where possible, the data has been reviewed by industry experts.

For state level data from the United States and Australia, specific data from USDA (Taylor, et. al. 2025) and AusLCI was used (AusLCI, 2026) Which makes these datasets inconsistent with the data sources used for all other generic AFP datasets, but these state specific datasets are considered to be more precise.

Fertilizers production was modeled based on the latest available literature and the modeling of a specific fertilizer product. Auxiliary materials were based on the Ecoinvent database or literature sources.

Processing inventories were initially drawn from the feedprint study (Vellinga et al., 2013). These inventories are generic for all provided countries and regions. These processes are either largely similar between countries or the data available was not specific enough to create country/ region specific processes. These generic processes are regionalized by adapting emissions and inputs for energy consumption to the country or region where the processing takes place. This means that the processing (mass balances, inputs etc.) is the same for all regions. Therefore, the representativeness may have decreased for these processes (as the

geography of the data is “other region assumed similar”). During the development of Agri-footprint releases, many of these ‘feedprint’ processes have been replaced by higher quality processes using region specific / higher quality data (see Part 2 of the report).

Transport distances and modes from and to the processing plant are also country specific. We connect her to the modelling rules as defined in the Feed PEFCR (European Commission, 2018b).

The aim for the LCI data is to be as recent as possible, which means that when better quality data or statistics on the processes/ systems are available, these will be incorporated in Agri-footprint, generally using five-year averages. To ensure the best time-related representativeness, data will be updated regularly.

## 4.3 Filling data gaps using best available data

LCIs have been developed specifically for Agri-footprint or as part of previous confidential or public studies conducted by Mérieux NutriSciences | Blonk. These LCIs are fully reported or referred to in part 2.

Data gaps are filled with estimates, which are as much as possible based on expert opinions and previous experiences. The assumptions are documented in part 2 and clearly identified in the database. When fit, the uncertainty range reflects the fact that assumptions have been made.

Many unit processes require energy consumption (e.g. natural gas), fertilizers (e.g. Calcium Ammonium Nitrate) or auxiliary materials (e.g. hexane). Energy related LCIs are taken from the Ecoinvent database. These are consumption mixes for specific countries or regions.

## 4.4 Data quality checks during modelling

As the original data has been compiled in different software programs and data structures, it is important to check consistency and correctness of all the data during the implementation process (the migration to a SimaPro database). Quality checking has been done iteratively. (Parts of) the database were exported to SimaPro, checked, errors or inconsistencies corrected, and data gaps identified. When identified issues were resolved, a new SimaPro export was made, this was again checked. This process continues until all identified errors and data gaps were resolved. The checking process involves:

- Check naming
- Remove duplicate processes, or processes that were very similar (e.g. wheat starch slurries with slightly different starch contents).
- Check correct linking
- Remove empty processes whenever possible
- Check if newly added processes or flows are applied consistently throughout the database.
- Mass balances
    - Balances; the amount of dry matter going in should be the same as dry matter going out as product or waste/emission. The total matter ‘as is’ should be balanced as well. Sometimes it was possible to also calculate balances of substances (e.g. hexane make-up should be balanced by hexane emissions during crushing).
    - Appropriate waste flows

- Transport included in all processes
- Logical differences between countries (yields, fertilizer application rates, et cetera)
- Consistent calculation methodology
- Compare results to existing data from other sources.

## 4.5 Data Quality Ratings (DQR)

New data quality rating system for Agri-footprint will be implemented in the next versions, based on the new EF Data Quality Rating rules for datasets that have been developed by the JRC for Environmental Footprint compliant datasets.

## 4.6 External Review

Agri-footprint 8 was externally reviewed by Agroscope, the Swiss federal center of excellence for agricultural research. Led by senior researcher Dr. Thomas Nemecek.
This critical review was performed to ensure compliance with ISO 14040 (ISO, 2006a), 14044 (ISO, 2006b).

- ISO 14040/14044: the assessment verified the database's data collection, modelling consistency, allocation logic, and transparency against ISO 14040/14044 standards adapted for background LCI databases.
- The full, signed review statement is included in this report as Appendix I
- For a detailed description of the review process, methodology and ISO adaptations, please refer to Methodology Report Part 1, chapter 4.6, Appendix I.

# 5. Limitations of Agri-footprint

There are a number of limitations that should be considered when using Agri-footprint. Some additional limitations apply to specific processes; these limitations are reported in the data description section of that specific dataset (in 'Agri-footprint 8 - Part 2 – Description of data').

Agri-footprint provides LCIA results with a standard reference unit of 1 kg "as is", for all mass-based products. Other processes, like transport, heat and electricity datasets use have different functional units (tkm, MJ and MJ respectively). It is the responsibility of the user to determine an appropriate basis for comparison (functional unit).

The impact categories of ReCiPe and EF were considered when developing Agri-footprint. Agri-footprint uses some background data that is sourced from Ecoinvent. Where LCIs of other databases are used, it is possible that errors have occurred during the development of those datasets or during implementation into third party LCA-software, the correction of these errors is beyond the control of the Agri-footprint development team.

Elementary flows have been collated to align with requirements of ReCiPe and EF method. Other LCIA methods may assess substances which are not included in Agri-footprint.

There are methodological limitations of LCA, which are not specific to Agri-footprint, but which are relevant for all agricultural and food product life cycle inventories:

- Use of statistical data for crop yields, (artificial and organic) fertilizer application rates, when there is not specific data available.
- Data availability is also limited in relation to production and the use of pesticides (impacting on eco-toxicity), but an approach was developed to estimate the impact on ecotoxicity of agricultural cultivation.

The system boundaries which are supported by Agri-footprint are from cradle (cultivation) to factory or farm gate. The processes can be used to support LCAs from cultivation to end-of-life, but Agri-footprint does not contain processes for life cycle phases such as packaging, distribution and retail, consumer storage and preparation or waste treatment.

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# Appendix I Critical Review

An independent critical review of the Agri-footprint 8 database was conducted by the Life Cycle Assessment (LCA) Research Group at Agroscope in Zurich, Switzerland. The primary aim of this evaluation was to verify whether the methodology, data, and reporting of Agri-footprint 8 fulfil the international standards set by ISO 14040 and ISO 14044 for generic life cycle inventory databases. Agroscope assessed the database's methodological documentation, database-wide statistical balances, and 14 detailed representative datasets spanning diverse geographic locations, product groups, and supply chain stages.

Agroscope concluded that Agri-footprint 8 is compliant with ISO 14040 and ISO 14044 guidelines, with its methodology and limitations transparently documented. Providing over 10,000 datasets covering 1,400 products across 142 countries, the database ensures comparability between datasets and alignment with global figures by relying mainly on international statistics, such as FAOSTAT, and standard emission modelling guidelines from IPCC and EEA/EMEP. Consequently, the review confirms that AFP8 is suitable for use as a secondary background database in life cycle assessment studies across the agri-food sector.

The review statement, and the authors response have been included below.

*Note on digital signatures: the review statement included in the following pages was officially signed using qualified electronic signatures (QES). Because appending the report into this document alters document, cryptographic validation cannot be performed on the merged version. The original, unmerged document is available upon request by contacting info@blonksustainability.nl and can be validated at validator.ch.*

# Authors response

Mérieux NutriSciences | Blonk welcomes the independent critical review of Agri-footprint 8, conducted by the LCA Research Group at Agroscope under the leadership of senior researcher Dr. Thomas Nemecek.

Agri-footprint is developed to provide the LCA and agri-food communities with transparent and methodologically consistent environmental data. Independent critical review plays a crucial role in ensuring the database continues to meet requirements and practical needs of its users. The Agroscope review provides an external assessment of these aspects.

The review process resulted in improved documentation transparency, metadata clarity and helped resolve technical issues. While Agri-footprint 8 represents a major step forward, the review also highlights methodological choices and data limitations that users should consider when applying the database in LCA studies. We highlight two considerations:

- Data quality indicators: In this version, uncertainty distributions are defined around five-year crop yield variations only. Because parameter-level distributions are not yet uniform across all secondary inputs, running database-wide Monte Carlo simulations is currently not recommended.
- Data quality ratings (DQR): A DQR implementation aligned with the latest PEF DQR specification has been added to our development roadmap and will likely be included in the next major update of Agri-footprint.

We thank the Agroscope review team for their thorough assessment and constructive contributions. The review provides valuable input for further strengthening Agri-footprint and guiding its future development. We remain committed to developing Agri-footprint as a transparent and methodologically consistent source of environmental data for agricultural production and food systems worldwide.

The Agri-footprint team

Mérieux NutriSciences | Blonk, Rotterdam, October 2026

# Critical review of Agri-footprint V8 by Agroscope

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The reviewers declare no conflicts of interest related to this review.

## 2. Aim and scope of the review

### *2.1 Aim and scope*

The aim of this review was to verify, whether the Agri-footprint database version 8 (AFP8) meets the requirements for methodology, data and reporting defined by the ISO 14040/44 standards. The criteria of the ISO standards were considered to the extent they are applicable to a generic LCI database. We have reviewed the documentation of the database, selected datasets and the calculated environmental impacts, as described in Section 3.

### *2.2 Out of scope*

The following aspects and tasks were out of scope for this review:

- Detailed check of each dataset in the database.
- Check of all inventory flows by independent recalculation.
- Check of the compliance with the guidelines for Forest, Land and Agriculture (FLAG) of the Science Based Targets Initiative.
- Check of the compliance with guidelines for the Product Environmental Footprint (PEF) of the EU, including specific category rules (PEF-CR).
- Alignment of the AFP8 elementary flows with LCIA methods.
- Systematic comparisons of AFP8 with other databases, the literature or previous AFP versions.
- Datasets for Australia in AFP8 were excluded from the review, as they were not finalised at the time of the review.
- The different calculation engines, used for the calculation of the inventories were not verified. Only the documentation of the emission calculations was reviewed, as far as relevant for this review.

- The mass and energy allocated versions of AFP8 were excluded from the review; only the version with economic allocation was reviewed. Yet, the values used for the calculations for all three versions in the methodology reports were checked.
- Part 3 of the documentation was not reviewed.

# 3. Review procedure

## *3.1 Procedure and timeline*

9 June 2026: Kick-off
24 June 2026 Progress meeting
16 July 2026 Progress meeting
19 August 2026 Progress meeting
23 September 2026 Finalisation of the review report.

Review comments were provided by Agroscope to "Mérieux NutriSciences | Blonk" (hereafter called Blonk MXNS) in two rounds. Collaborators of Blonk MXNS have responded to the comments. Comments that could be satisfactorily resolved during the review project are not mentioned in this report.
The review refers to the documents, datasets and environmental indicators made available to the reviewers at the time of the review (see Annex 6.2). Possible later changes of the documentation, data values, meta-data or plans for future developments were not considered.

In addition, optional suggestions for future developments of the Agri-footprint database were provided by the reviewers, which were not part of this review.

## *3.2 Review criteria*

The criteria for this review were derived from the ISO 14040/44 standards and are listed in Annex 6.1.

## *3.3 Selection of datasets for detailed review*

A representative sample of inventory datasets was selected for the review based on three criteria:

1. Geographical diversity: ensuring that reviewed datasets covered different countries and world regions,
2. Product diversity: including a variety of food groups, such as cereals, fruits, vegetables, meat and fish,
3. Life cycle stage diversity: covering all stages in the database, i.e., primary production, processing, market mix, production mix and storage.

Five datasets were proposed by Blonk MXNS, and nine selected by Agroscope. The list of the 14 reviewed datasets, together with the rationale for their selection, is provided in the Appendix 6.3.

## *3.4 Statistical evaluation of environmental impact indicators*

Agroscope conducted three systematic checks across the entire inventory database:

1. Land Transformation Balance: checked whether the sum of "transformation, to (…)" values always equaled the "transformation, from (…)" values in the biosphere flows. A tolerance of $10^{-6}$ m² was applied to allow for rounding.

2. Balance Land Occupation & Infrastructure: checked whether the sum of total land occupation always equaled the area of "Basic infrastructure".
3. GWP disaggregated impact results: Agroscope checked whether the sub-categories of the GWP impact category (i.e. "excl. LUC and peat oxidation", "only LUC", "only peat oxidation") add up to the reported GWP incl. LUC and peat oxidation.

# 4. Results of the review

## *4.1 Types of review comments*

Three types of review comments were made:

1. Major comments: relevant criteria of the ISO standards which are not or not fully met.
2. Minor comments: minor inconsistencies or errors, unclear parts of the reports, etc.
3. Suggestions: proposals on how the database could be further improved in the future, such as using new/better data sources, models, emission factors, new modelling approaches. These suggestions are not reported in this review statement.

## *4.2 General assessment*

AFP8 is a comprehensive database for the agri-food sector, providing more than 10,000 datasets for a total of 1400 products and 142 countries. It comes with extensive documentation, consisting of meta-data contained in each of the datasets and several reports, available to the users. The documentation is generally detailed, comprehensive and transparent.
Input use modelling mainly relies on international statistics, where available, which ensures the consistence with global figures and comparability between countries. Emissions are modelled in a systematic way, which safeguards comparability between datasets. For crop production, greenhouse gases and some related emissions are largely modelled using Tier 1 methodology from IPCC, which ensures the consistency with IPCC guidelines for national GHG inventories. For emissions from crop production, relatively simple Tier 1 emission factors and models are used, e.g. for P emissions or nitrate leaching. This causes to some extent a lack of specificity; more detailed models and data are available at national and regional levels, which are not taken into account. Modelling for animal systems is more detailed and specific than modelling of crop production and mostly follows relevant guidelines from IPCC and EEA/EMEP.
The target users and intended applications are specified. Main limitations are mentioned in various chapters of the methodological reports, which helps users to evaluate the usability of the datasets for their specific purposes.
Data quality indicators are missing. AFP8 only provides uncertainty indicators for crop yields.

## *4.3 Detailed assessment*

- Capital goods: AFP8 includes basic infrastructure of agricultural land, tractors and silos. Other capital goods (such as animal housings, farm equipment, etc.) are not considered, so that the impacts may be underestimated.
- Fertiliser modelling relies on recent georeferenced maps for fertiliser doses and harvested areas of crops. The calculated amounts of fertilisers are crop and country specific.
- Pesticides: the amounts of pesticides applied per crop and country are among the most relevant data gaps in LCI databases. AFP8 uses FAOSTAT data for the quantities of pesticide used per group and per country. Data from France, the Netherlands and the United States are used to disaggregate the pesticide quantities per crop group and to define the active ingredients applied within each crop group for the countries considered in AFP8. This procedure provides robust estimates, which has some limitations in terms of specificity to crop-country combinations (see below).

- Water use: the modelling has been updated and extended; now it also includes capillary rise, which we consider as an important innovation.
- Transports: AFP8 includes a detailed modelling of transport modes. Transports are considered in a systematic way per life cycle stage.
- Market and production mixes: the market and production mixes are updated in AFP8. A detailed description and visual representation of how these are modelled is provided in the report, along with the approach to dealing with missing data, and the transportation requirements.
- Emissions from the cultivation of drained peat soils are now included in AFP8. The estimates are based on the National Inventory Reports (NIR) for GHG. The average estimates were corrected by using other sources to derive crop-country specific emission values. The method ensures consistency with the NIRs.
- US LCI: the emissions of the original datasets from the American Feed Industry Association (AFIA) were recalculated, using the AFP8 methodology, which ensures consistency with other datasets in the database.
- Allocation procedures: AFP8 provides three allocated versions (economic, mass and gross energy). The allocation is applied systematically to all datasets in the database, so that consistency is ensured across all datasets.

### *4.4 Statistical evaluation results*

1. Land Transformation Balance: five inventories exceeded the defined tolerance.
2. Balance Land Occupation & Infrastructure: the sum of total land occupation always equaled the area of "Basic infrastructure" for all food inventories.
3. GWP disaggregated impact results: the sub-categories of the GWP impact category (i.e. "excl. LUC and peat oxidation", "only LUC", "only peat oxidation") add up to the reported GWP incl. LUC and peat oxidation for all datasets.

### *4.5 Notes for users of the database*

- Capital goods: apart from basic infrastructure of agricultural land, tractors and silos, no other infrastructure is included.
- Pesticide active ingredients have a limited specificity to crops; therefore, datasets may include active ingredients that are not applied or not registered for that crop in the respective country.
- Seed: some seed quantities were found to be unrealistic. Generally, seed impacts make up a few percent of the impacts of crop cultivation.
- Cooled and frozen transports are not considered. In cases, where goods need to be cooled or frozen during transport, the related impacts could be underestimated.
- Euro emission standards for transports (e.g., Euro 3, Euro 4, Euro 5) are not differentiated across datasets locations. This may lead to over- or underestimation of impacts, as older standards (e.g., Euro 3) have higher emissions and remain prevalent in developing regions (e.g., Africa, Asia, Latin America), for which AFP8 includes inventories.
- Since data quality indicators are generally missing from the database, users should not perform Monte Carlo analyses with AFP8 in its current state, since the analysis will not provide meaningful results.

## 5. Conclusion

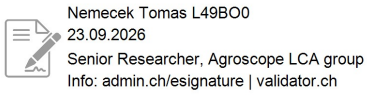
APF8 is a comprehensive database for the agri-food sector, with significant updates using recent sources. Dataset generation follows systematic procedures, to a large extent based on global statistics, ensuring comparability across datasets and consistency with global statistics.

Systematic allocation procedures safeguard the allocation rules throughout the database. AFP8 is compliant with the ISO 14040 and 14044 guidelines and the limitations are transparently documented.
The database is suitable for the use as background database in LCA studies for the agri-food sector. Users looking for very specific information (e.g., a single ingredient dominating the impact) are advised to thoroughly check the underlying data and the suitability for their specific goal and scope and – where needed – adapt or complement the datasets with primary data.

Agroscope, Life Cycle Assessment Research Group

Zurich, September 2026

Dr. Thomas Nemecek




Dr. Mara Petruzzelli




Clara Payró




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# 6. Annexes

## *6.1 Detailed listing of review criteria*

### 6.1.1 Methodology reports

General:

- Clarity, completeness and transparency of the documentation

Goal and scope:

- Suitability to the intended applications
- Target audiences
- Definition of functional units/reference flows
- System boundaries
- Omissions of life cycle or processes clearly documented
- Description of cut-off criteria and assumptions

Life cycle inventory:

- Data collection procedures
- Qualitative and quantitative description of unit processes
- Sources of published literature
- Calculation procedures
- Data quality analysis
- Treatment of missing data
- Proxy definition adequate and clearly documented
- Documentation and justification of allocation procedures
- Uniform application of allocation procedures

### 6.1.2 Selected datasets

- Naming of the dataset
- Meta-data, general description: does it contain the information relevant for the users
- Meta-data: comments to individual flows
- Consistency between the dataset contents and the methodology reports
- Plausibility of the numerical values
- Uncertainty information

## *6.2 Documents received*

The data of delivery of the documents is given in [brackets].

Main reports:

- Agri-footprint 8 - Methodology Report - Part 1 Methodology and Basic Principles MxNS branding.docx [9 June 2026; 19 August 2026]
- Agri-footprint 8 - Methodology Report - Part 2 - Description of Data MxNS Branding.docx [9 June 2026; 19 August 2026]

Supporting documents:

- APS Beef Documentation.pdf [9 June 2026]
- Memo on Blonk-selected processes for review.docx [9 June 2026]
- Memo on the blonk-made adaptations to the ReCiPe method.docx [9 June 2026]
- Memo-Beef datasets review.docx [9 June 2026]
- 20260422 Crop Life Cycle Engine.pdf [25 June 2026]
- APS Beef Documentation.pdf [25 June 2026]
- APS Dairy Documentation - July 2024.pdf [25 June 2026]

- APS pigs Documentation - System definition and methodology 20250825.pdf [25 June 2026]
- AFIA Data-in Project Documentation for GFLI Review (Updated_1-23-2026).docx [2 July 2026]
- WRI Phase 1 review of LUC tool_211113.xlsx [2 July 2026]
- animal-systems-comment-mapping.xlsx [8 July 2026]
- Selective updates of parts of the documentation [August-September 2026]

Data files and database access:

- AFP8_SP_10_4.csv [9 June 2026]
- AFP8_impacts.xlsx [9 June 2026]
- Blonk method 4.2.0 - based on ReCiPe 1.13.CSV [9 June 2026]
- AFP8_adaptation_to_SP10_3.XLSX [9 June 2026]
- AFP8_SP_10_4_adapted.csv [9 June 2026]
- Blonk method 4.2.0 - based on ReCiPe 1.13_adapted.CSV [9 June 2026]
- AFP8_impacts.xlsx [19 August 2026]
- Access to the internal database [19 August 2026]

### *6.3 Datasets reviewed in detail*

| Suggested by | Dataset Name | Location | Stage | Reason for selection |
|---|---|---|---|---|
| Agroscope | Soybeans, at farm | BR | at farm | Soybean in Brazil is a main crop. This dataset is reviewed in parallel with soybean meal |
| Agroscope | Bananas, at orchard | ET | at orchard | Represents a location different from other production countries for a widely modelled product within the database (n=58), and provides a dataset from an African country |
| Agroscope | Milk raw, at farm | FR | at farm | A dairy dataset that is reviewed in parallel to cheese production. |
| Agroscope | Watermelons, production mix, at farm | GLO | at farm | A fruit inventory, representing a widely modelled inventory within AFP8 and that is similar to some vegetable crops such as cauliflower. This dataset is also a production mix, which is a new concept added to the database. |
| Agroscope | Maize, dried, market mix, at regional storage | PL | at regional storage | A market mix of a widely modelled product food product within AFP8. |
| Agroscope | Wheat grain, winter, at farm | US-ID | at farm | A cereal product in the US, as the US are modelled differently from other countries. |
| Agroscope | Cod edible part, at processing | NO | at processing | A fish inventory and a processing inventory |
| Agroscope | Cheese, from cheese production, at processing | FR | at processing | A dairy product, including milk production, and a post-harvest level process, to cover all modelled life cycle stages |
| Agroscope | Ammonia, as 100% NH3 (NPK 82-0-0), at plant | FSU | at plant | A high-impact process of high complexity |
| Blonk MXNS | Rice, at paddy | CN | at paddy | An arable crop that reflects most of the methodological improvements developed for this AFP version. Specifically for rice cultivation, methane emission modelling from paddy fields was updated |
| Blonk MXNS | Apples, at orchard | NL | at orchard | This is a new process, part of the fruits and vegetable scope extension of the AFP8 database |
| Blonk MXNS | Pig fattening, at farm | DK | at farm | All animal systems were remodelled for AFP8. For pigs, the Danish system is representative of how all pig systems in the database were modelled |

| Suggested by | Dataset Name | Location | Stage | Reason for selection |
|---|---|---|---|---|
| Blonk MXNS | Beef cow finished, suckler extensive, at farm | FR | at farm | The animal system scope was expanded to include beef systems. This specific dataset is representative of a cow-calf closed system, including both breeding and growing stages. It incorporates both single ingredients and compound feed ingredients. This system is further connected to fattening systems, representing the selling of beef calves to be fattened and finished in Italy. |
| Blonk MXNS | Soybean meal (solvent), at processing | BR | at processing | One of the most important datasets in the database with respect to feed production |