PEFCR Feed for food-producing animals

Version 4.2

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3) Acronyms

AF	Allocation Factor
AR	Allocation Ratio
B2B	Business to Business
B2C	Business to Consumer
BoC	Bill of Components
BoM	Bill of Materials
BP	Bonne Pratique
CF	Characterization Factor
CFF	Circular Footprint Formula
CFF-M	Circular Footprint Formula – Modular form
CMWG	Cattle Model Working Group
CPA	Classification of Products by Activity
DC	Distribution Centre
DMI	Dry Matter Intake
DNM	Data Needs Matrix
DQR	Data Quality Rating
EA	Economic Allocation
EC	European Commission
EF	Environmental Footprint
EI	Environmental Impact
EoL	End-of-Life
FU	Functional Unit
GE	Gross Energy intake
GR	Geographical Representativeness
GFLI	Global Feed LCA Institute
GHG	Greenhouse Gas
GWP	Global Warming Potential
HD	Helpdesk
ILCD	International Reference Life Cycle Data System
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
JRC	Joint Research Centre
LCDN	Life Cycle Data Network
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LT	Lifetime
NDA	Non-Disclosure Agreement
NGO	Non-Governmental Organisation
NMVOC	Non-methane volatile compounds
P	Precision
PCR	Product Category Rules
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
RF	Reference Flow
RP	Representative Product
SB	System Boundary

SC	Steering Committee
SMRS	Sustainability Measurement & Reporting System
SS	Supporting study
TAB	Technical Advisory Board
TeR	Technological Representativeness
TiR	Time Representativeness
TS	Technical Secretariat
UNEP	United Nations Environment
UUID	Universally Unique Identifier

4) Definitions

Activity data - This term refers to information which is associated with processes while modelling Life Cycle Inventories (LCI). In the PEF Guide it is also called “non-elementary flows”. The aggregated LCI results of the process chains that represent the activities of a process, are each multiplied by the corresponding activity data[1] and then combined to derive the environmental footprint associated with a process (See Figure 7.6.1-1). Examples of activity data include quantity of kilowatt-hours of electricity used, quantity of fuel used, output of a process (e.g. waste), number of hours equipment is operated, distance travelled, floor area of a building, etc. In the context of PEF the amounts of ingredients from the bill of material (BOM) shall always be considered as activity data.

Aggregated dataset - This term is defined as a life cycle inventory of multiple unit processes (e.g. material or energy production) or life cycle stages (cradle-to-gate), but for which the inputs and outputs are provided only at the aggregated level. Aggregated datasets are also called "LCI results", “cumulative inventory” or “System processes” datasets. The aggregated dataset can have been aggregated horizontally and/or vertically. Depending on the specific situation and modelling choices a "unit process" dataset can also be aggregated. See Figure 7.6.1-1[2].

Application specific - it refers to the generic aspect of the specific application in which a material is used. For example, the average recycling rate of PET in bottles.

Benchmark – A standard or point of reference against which any comparison can be made. In the context of PEF, the term ‘benchmark’ refers to the ***average*** environmental performance of the representative product sold in the EU market. A benchmark may eventually be used, if appropriate, in the context of communicating environmental performance of a product belonging to the same category.

Bill of materials – A bill of materials or product structure (sometimes bill of material, BOM or associated list) is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts and the quantities of each needed to manufacture an end product.

[1] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World resources institute, 2004).
[2] Source: UNEP/SETAC “Global Guidance Principles for LCA Databases"

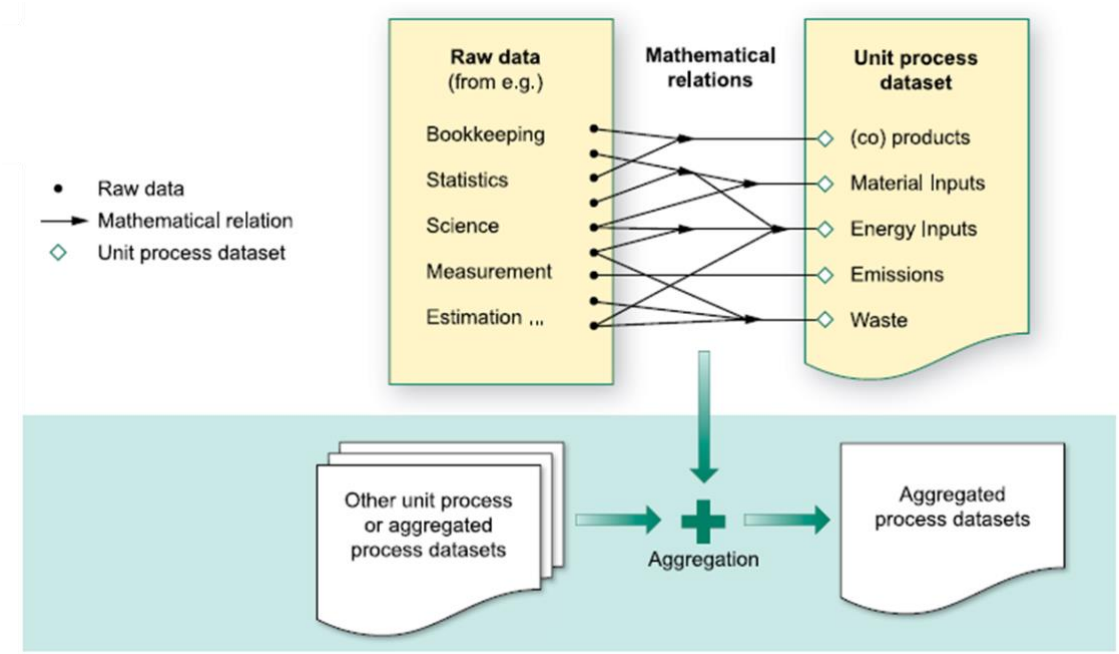

Figure 7.6.1-1: Definition of a unit process dataset and an aggregated process dataset

Business to Business (B2B) – Describes transactions between businesses, such as between a manufacturer and a wholesaler, or between a wholesaler and a retailer.

Business to Consumers (B2C) – Describes transactions between business and consumers, such as between retailers and consumers. According to ISO 14025:2006, a consumer is defined as "an individual member of the general public purchasing or using goods, property or services for private purposes".

Commissioner of the EF study - Organisation (or group of organisations) that finances the EF study in accordance with the EF Guide, EF Guidance and the relevant PEFCR, if available (definition adapted from ISO 14071/2014, point 3.4).

Company-specific data – it refers to directly measured or collected data representative of activities at a specific facility or set of facilities. It is synonymous to "primary data".

Comparative assertion – environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function (adapted from ISO 14025:2006).

Comparison – A comparison, not including a comparative assertion, (graphic or otherwise) of two or more products based on the results of a PEF study and supporting PEFCRs or the comparison of one or more products against the benchmark, based on the results of a PEF study and supporting PEFCRs.

Data Quality Rating (DQR) - Semi-quantitative assessment of the quality criteria of a dataset based on Technological representativeness, Geographical representativeness, Time-related representativeness, and Precision. The data quality shall be considered as the quality of the dataset as documented.

Direct elementary flows - All emissions and resource use (also named elementary flows) that arise directly in the context of a process. Examples are emissions from a chemical process, or fugitive emissions from a boiler directly onsite. See Figure 2.

Disaggregation - The process that breaks down an aggregated dataset into smaller unit process datasets (horizontal or vertical). The disaggregation can help making data more specific. The process of disaggregation should never compromise or threat to compromise the quality and consistency of the original aggregated dataset

EF communication vehicles - It includes all the possible ways that can be used to communicate the results of the EF study to the stakeholders. The list of EF communication vehicles includes, but it is not limited to, label, environmental product declarations, green claims, website, infographics, etc.

EF report - Document that summarises the results of the EF study. For the EF report the template provided as annex to the PECFR Guidance shall be used. In case the commissioner of the EF study decides to communicate the results of the EF study (independently from the communication vehicle used), the EF report shall be made available for free through the commissioner's website. The EF report shall not contain any information that is considered as confidential by the commissioner, however the confidential information shall be provided to the verifier(s).

EF study - Term used to identify the totality of actions needed to calculate the EF results. It includes the modelisation, the data collection, and the analysis of the results.

Electricity tracking[3] - Electricity tracking is the process of assigning electricity generation attributes to electricity consumption.

Elementary flow - Material or energy entering the system being studied that has been drawn from the environment without previous human transformation, or material or energy leaving the system being studied that is released into the environment without subsequent human transformation.

Environmental aspect – element of an organization's activities or products or services that interacts or can interact with the environment (ISO 14001:2015)

External Communication - Communication to any interested party other than the commissioner or the practitioner of the study.

Feed ingredient - These are either feed materials or feed additives. Ingredients are of plant, animal or aquatic origin, or other organic or inorganic substances and include:

- **Feed materials**[4] - means products of vegetable or animal origin, whose principal purpose is to meet animals' nutritional needs, in their natural state, fresh or preserved, and products derived from the industrial processing thereof, and organic or inorganic substances, whether or not containing feed additives, which are intended for use in oral animal-feeding either

[3] https://ec.europa.eu/energy/intelligent/projects/en/projects/e-track-ii

[4] As defined in Regulation (EC) No 767/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 July 2009 on the placing on the market and use of feed, amending European Parliament and Council Regulation (EC) No 1831/2003 and repealing Council Directive 79/373/EEC, Commission Directive 80/511/EEC, Council Directives 82/471/EEC, 83/228/EEC, 93/74/EEC, 93/113/EC and 96/25/EC and Commission Decision 2004/217/EC

directly as such, or after processing, or in the preparation of compound feed, or as carrier of pre-mixtures;

- **Feed additive**[5] - means substances, micro-organisms or preparations, other than feed material and pre-mixtures, which are intentionally added to feed or water in order to perform, in particular, one or more of the functions

Food producing animals - refers to any animal that is fed, bred or kept for the production of food for human consumption, including animals that are not used for human consumption, but that belong to a species that is normally used for human consumption. It includes fish from aquaculture.

Foreground elementary flows - Direct elementary flows (emissions and resources) for which access to primary data (or company-specific information) is available.

Independent external expert - Competent person, not employed in a full-time or part-time role by the commissioner of the EF study or the practitioner of the EF study, and not involved in defining the scope or conducting the EF study (adapted from ISO 14071/2014, point 3.2).

Input flows – product, material or energy flow that enters a unit process. Products and materials include raw materials, intermediate products and co-products (ISO 14040:2006).

Intermediate product - an intermediate product is a product that requires further processing before it is saleable to the final consumer.

Lead verifier - Verifier taking part in a verification team with additional responsibilities compared to the other verifiers in the team.

Life Cycle Inventory (LCI) - The combined set of exchanges of elementary, waste and product flows in an LCI dataset.

Life Cycle Inventory (LCI) dataset - A document or file with life cycle information of a specified product or other reference (e.g., site, process), covering descriptive metadata and quantitative life cycle inventory. A LCI dataset could be a unit process dataset, partially aggregated or an aggregated dataset.

Material-specific - it refers to a generic aspect of a material. For example, the recycling rate of PET.

Output flows – product, material or energy flow that leaves a unit process. Products and materials include raw materials, intermediate products, co-products and releases (ISO 14040:2006).

Partially disaggregated dataset - A dataset with an LCI that contains elementary flows and activity data, and that only in combination with the complementing aggregated datasets that represent the activities yields a complete aggregated LCI data set. We refer to a partially disaggregated dataset at level 1 in case the LCI contains elementary flows and activity data, while at least some of the complementing sub-processes are in their aggregated form (see an example in Figure 2). The underlying sub-processes should be based on EF-compliant secondary datasets (if available).

[5] as defined in Regulation (EC) No 1831/2003 of the European Parliament and of the Council of 22 September 2003 on additives for use in animal nutrition

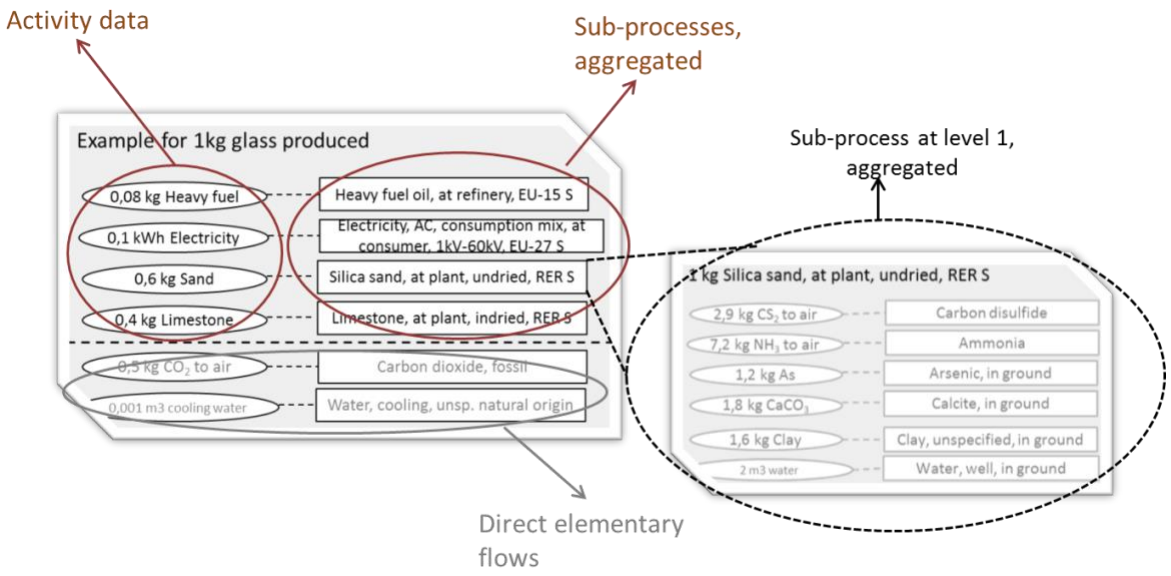

Figure 7.6.1-2: An example of a partially aggregated dataset, at level 1.

The activity data and direct elementary flows are to the left, and the complementing sub-processes in their aggregated form are to the right. The grey text indicates elementary flows

PEFCR Supporting study – the PEF study done on the basis of a draft PEFCR. It is used to confirm the decisions taken in the draft PEFCR before the final PEFCR is released.

PEF Profile – the quantified results of a PEF study. It includes the quantification of the impacts for the various impact categories and the additional environmental information considered necessary to be reported.

PEF screening – a preliminary study carried out on the representative product(s) and intended to identify the most relevant life cycle stages, processes, elementary flows, impact categories and data quality needs to derive the preliminary indication about the definition of the benchmark for the product category/sub-categories in scope, and any other major requirement to be part of the final PEFCR.

Population - Any finite or infinite aggregation of individuals, not necessarily animate, subject to a statistical study.

Practitioner of the EF study - Individual, organisation or group of organisations that performs the EF study in accordance with the EF Guide, EF Guidance and the relevant PEFCR if available. The practitioner of the EF study can belong to the same organisation as the commissioner of the EF study (adapted from ISO 14071/2014, point 3.6).

Primary data[6] - This term refers to data from specific processes within the supply-chain of the company applying the PEFCR. Such data may take the form of activity data, or foreground elementary flows (life cycle inventory). Primary data are site-specific, company-specific (if multiple sites for a same product) or supply-chain-specific. Primary data may be obtained through meter readings, purchase records, utility bills, engineering models, direct monitoring, material/product balances, stoichiometry, or other methods for obtaining data from specific processes in the value chain of the company applying the PEFCR. In this Guidance, primary data is synonym of "company-specific data" or "supply-chain specific data".

Product category – Group of products (including services) that can fulfil equivalent functions (ISO 14025:2006).

Product Category Rules (PCR) – Set of specific rules, requirements and guidelines for developing Type III environmental declarations for one or more product categories (ISO 14025:2006).

Product Environmental Footprint Category Rules (PEFCRs) – Product category-specific, life-cycle-based rules that complement general methodological guidance for PEF studies by providing further specification at the level of a specific product category. PEFCRs help to shift the focus of the PEF study towards those aspects and parameters that matter the most, and hence contribute to increased relevance, reproducibility and consistency of the results by reducing costs versus a study based on the comprehensive requirements of the PEF guide.

Refurbishment - is the process of restoring components to a functional and/or satisfactory state to the original specification (providing the same function), using methods such as resurfacing, repainting, etc. Refurbished products may have been tested and verified to function properly.

Representative product (model) - The “representative product” may or may not be a real product that one can buy on the EU market. Especially when the market is made up of different technologies, the “representative product” can be a virtual (non-existing) product built, for example, from the average EU sales-weighted characteristics of all technologies around. A PEFCR may include more than one representative product if appropriate.

Representative sample - A representative sample with respect to one or more variables is a sample in which the distribution of these variables is exactly the same (or similar) as in the population from which the sample is a subset

Sample - A sample is a subset containing the characteristics of a larger population. Samples are used in statistical testing when population sizes are too large for the test to include all possible members or observations. A sample should represent the whole population and not reflect bias toward a specific attribute.

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[6] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World resources institute, 2004).

Secondary data[7] - refers to data not from specific process within the supply-chain of the company applying the PEFCR. This refers to data that is not directly collected, measured, or estimated by the company, but sourced from a third-party life-cycle-inventory database or other sources. Secondary data includes industry-average data (e.g., from published production data, government statistics, and industry associations), literature studies, engineering studies and patents, and can also be based on financial data, and contain proxy data, and other generic data. Primary data that go through a horizontal aggregation step are considered as secondary data.

Sub-population - In this document this term indicates any finite or infinite aggregation of individuals, not necessarily animate, subject to a statistical study that constitutes an homogenous sub-set of the whole population. Sometimes the word "stratum" can be used as well.

Sub-processes - those processes used to represent the activities of the level 1 processes (=building blocks). Sub-processes can be presented in their (partially) aggregated form (see Figure 2).

Sub-sample - In this document this term indicates a sample of a sub-population.

Supply-chain - refers to all of the upstream and downstream activities associated with the operations of the company applying the PEFCR, including the use of sold products by consumers and the end-of-life treatment of sold products after consumer use.

Supply-chain specific - it refers to a specific aspect of the specific supply-chain of a company. For example the recycled content value of an aluminium can produced by a specific company.

Type III environmental declaration – An environmental declaration providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information (ISO 14025:2006). The predetermined parameters are based on the ISO 14040 series of standards, which is made up of ISO 14040 and ISO 14044.

Unit process dataset - Smallest element considered in the life cycle inventory analysis for which input and output data are quantified (ISO 14040:2006). In LCA practice, both physically not further separable processes (such as unit operations in production plants, then called “unit process single operation”) and also whole production sites are covered under "unit process", then called “unit process, black box” (ILCD Handbook).

Verification report - Documentation of the verification process and findings, including detailed comments from the *Verifier(s)*, as well as corresponding responses from the *commissioner of the EF study.* This document is mandatory, but it can be confidential. However, it shall be signed, electronically or physically, by the *verifier or in case of a* verification panel, by the lead verifier.

Verification statement - Conclusive document aggregating the conclusions from the *verifiers* or the verification team regarding the EF study. This document is mandatory and shall be electronically or physically signed by the *verifier or in case of a* verification panel, by the lead verifier. The minimum content of the verification statement is provided in this document.

[7] Based on GHG protocol scope 3 definition from the Corporate Accounting and Reporting Standard (World resources institute, 2004)

Verification team - Team of verifiers that will perform the verification of the EF study, of the EF report and the EF communication vehicles.

Verifier - Independent external expert performing a verification of the EF study and eventually taking part in a verification team.

5) Introduction

The Product Environmental Footprint (PEF) Guide provides detailed and comprehensive technical guidance on how to conduct a PEF study. PEF studies may be used for a variety of purposes, including in-house management and participation in voluntary or mandatory programmes.

For all requirements not specified in this PEFCR the applicant shall refer to the documents this PEFCR is in conformance with (see section 6.7)

The compliance with the present PEFCR is optional for PEF in-house applications, whilst it is mandatory whenever the results of a PEF study or any of its content is intended to be communicated.

It is written according to the PEF Guide requirements and follows the template provided in Annex B of the Guidance (version 6.3). Where the requirements in this PEFCR are in line with but more specific than those of the PEF Guidance, such specific requirements shall be fulfilled.

This PEFCR aims at providing guidance on how to assess the environmental performance of compound feed in a harmonised way. Considering the relative importance of compound feed in the environmental footprint of animal products, it is justified to harmonize the feed-specific aspects of the methodology across all food-producing animals.

Since feed is an intermediate product, this PEFCR is applicable in different contexts:

- For PEF studies for food producing animals (according to a specific PEFCR or the PEF Guide if no PEFCR is available). For this use, this PEFCR provides the requirements for accurate transfer of LCI information.
- For cradle to gate feed PEF studies (for in-house application or for external use)

This PEFCR supports therefore the following purposes:

1) Provision of LCI information on compound feed in the context of PEF studies of animal products;
2) Cradle to gate PEF studies of compound feed for either internal or external use but without comparison
3) Cradle to gate PEF studies of compound feed for comparison, either between alternatives (e.g. feed ingredient, sourcing,..) or over time (e.g. trend monitoring).

Terminology: shall, should and may

This PEFCR uses precise terminology to indicate the requirements, the recommendations and options that could be chosen when a PEF study is conducted.

- *The term "shall" is used to indicate what is required in order for a PEF study to be in conformance with this PEFCR.*
- *The term "should" is used to indicate a recommendation rather than a requirement. Any deviation from a "should" requirement has to be justified when developing the PEF study and made transparent.*
- *The term "may" is used to indicate an option that is permissible. Whenever options are available, the PEF study shall include adequate argumentation to justify the chosen option.*

6) General information about the PEFCR

6.1 Technical secretariat

The Technical Secretariat of the feed pilot consisted during the drafting of this PEFCR of the following members:

Name of the organization	*Type of organization*	*Participation since*
AB AGRI	Industry (feed company)	March 2014
AGRAVIS Raiffeisen AG	Industry (feed company)	September 2015
Agrifirm Group	Industry (feed company)	March 2014
AIC – Agricultural Industries Confederation	Industry (national feed association)	March 2014
Ajinomoto Eurolysine	Industry (feed company)	September 2015
Assalzoo - Associazione Nazionale tra i Produttori di Alimenti Zootecnici	Industry (national feed association)	March 2014
Blonk consultants	Consultancy	March 2014
Cargill Animal Nutrition	Industry (feed company)	December 2015
Cargill Aqua Nutrition Norway, formerly EWOS AS	Industry (feed company)	March 2014
Dakofo, The Danish Grain- and Feed Trade Association	Industry (national feed association)	March 2014
DENKAVIT	Industry (feed company)	March 2014
Deutsche Tiernahrung Cremer GmbH & CO.KG	Industry (feed company)	March 2014

DSM Nutritional Products AG	Industry (feed company)	March 2014
DVT - Deutscher Verband Tiernahrung e. V.	Industry (national feed association)	March 2014
Elanco Animal Health	Industry (feed company)	December 2015
Evonik Industries AG Nutrition and Care Division	Industry (feed company)	March 2014
FAO, Food and Agriculture Organisation of the United Nations	International organization	March 2014
FEAP – Federation of European Aquaculture Producers	Industry – EU supply chain partner organization	March 2014
FEDIOL, the EU Proteinmeal and Vegetable Oil Industry	Industry – EU supply chain partner organization	March 2014
FEFANA, EU association of Specialty Feed Ingredients and their mixtures	Industry – EU specialty feed ingredients associations	March 2014
FEFAC, European Feed Manufacturers Federation	Industry – EU feed association – TS coordinator	March 2014
NSF – The Norwegian Seafood Federation	Industry – supply chain partner organization industry (national feed association)	March 2014
ForFarmers N.V	Industry (feed company)	March 2014
Nevedi - Dutch Feed Industry Association	Industry (national feed association)	March 2014
Sanders	Industry (feed company)	March 2014
SNIA, Syndicat National de l'Industrie de la nutrition	Industry (national feed association)	March 2014

UECBV - European Livestock And Meat Trades Union	Industry – EU supply chain partner organization	March 2014
Union Agricole Holding AG	Industry (feed company)	March 2014

6.2 Consultations and stakeholders

This PEFCR has been developed in a transparent manner and the different steps were made available on the dedicated wiki page of the EU pilots' website: https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/PEFCR+Pilot%3A+Feed+for+food-producing+animals
The Technical Secretariat of the PEF pilot on feed for food producing animals has on several occasions invited relevant stakeholders to participate in the PEFCR development.

The relevant stakeholders for the PEFCR development include representatives from feed ingredients suppliers, farm and trade associations, compound feed producers, consumers, government representatives, non-governmental organizations (NGOs), public agencies and independent parties and certification bodies. The identified relevant stakeholders were proactively informed by the Technical Secretariat about the opportunity to take part in the different public consultations.

The following public consultations were organised during the development of this PEFCR. All the comments received and a description of how they have been addressed is available on the Feed PEF pilot wiki page.

- A first virtual consultation was organised in October 2014 on the scope and representative product of the Feed pilot (Technical Secretatiat for the Feed pilot, 2014). This consultation phase also included a physical consultation which took place on 28 October 2014. During this first consultation, fifty comments were received from four different stakeholders: European Commission Technical Helpdesk, European Crop Protection Association (ECPA), SOLTUB, Starch Europe.

- The second public virtual consultation was organised from 4 September 2015 to 3 October 2015. The purpose of this consultation was to gather feedback on the screening report (Technical Secretariat for the Feed Pilot, 2015) and the first draft PEFCR prepared by the Feed Pilot Technical Secretariat. Fifty-three comments were received on the screening report and twenty-three on the draft PEFCR, from four different stakeholders. The following stakeholders contributed to the second public consultation: ADEME, BASF, Ostfold Research AS, WWF. The updated first draft PEFCR was then approved by the EF Steering Committee on 18 November 2015 (Technical Secretatiat for the Feed pilot, 2015).

- Final public consultation from 22 July 2016 to 9 September 2016, on the final draft PEFCR took into account the feedback from the supporting studies. Nine different stakeholders provided one hundred and thirteen comments on the draft PEFCR during this final public consultation.

The following stakeholders contributed to the final public consultation: ADEME, Eastman Chemical Company, Emmanuelle Neyroumande (independent consultant), European Commission (DG Environment), European Environmental Bureau (EEB), European Former Foodstuffs Processors Association (EFFPA), VIDO, Primary Food Processors (PFP), SOLTUB.

All along the pilot phase, the Technical Secretariat created and maintained a log of the stakeholders that have been communicated with and responded to.

6.3 Review panel and review requirements

The external review panel for this PEFCR is composed of the following members

Name of the member	***Affiliation***	***Role***
Sébastien Humbert	Quantis	LCA expert, Chair of the review panel
Theun Vellinga	Wageningen University	Feed expert
Cécile Schneider	Conservation International	Civil society expert

The reviewers have verified that the following requirements have been fulfilled:

- *The PEFCR has been developed in accordance with the requirement provided in the PEFCR Guidance 6.3, and where appropriate in accordance with the requirements provided in the most recent approved version of the PEF Guide, and supports creation of credible and consistent PEF profiles,*
- *The functional unit, allocation and calculation rules are adequate for the product category under consideration,*
- *Company-specific and secondary datasets used to develop this PEFCR are relevant, representative, and reliable,*
- *The selected LCIA indicators and additional environmental information are appropriate for the product category under consideration and the selection is done in accordance with the guidelines stated in the PEFCR Guidance version 6.3 and the most recent approved version of the PEF Guide,*
- *The benchmark(s) is(are) correctly defined*: this requirement does not apply to feed which is an intermediate product
- *Both LCA*-based *data and the additional environmental information prescribed by the PEFCR give a description of the significant environmental aspects associated with the product.*

The detailed review report is provided in Annex 3.

6.4 Review statement

This PEFCR has been developed in compliance with Version 6.3 of the PEFCR Guidance, and with the PEF Guide adopted by the Commission on 9 April 2013.

The representative product correctly describes the average product sold in Europe for the product group in scope of this PEFCR.

PEF studies carried out in compliance with this PEFCR would reasonably lead to reproducible results and the information included therein may be used to make comparisons and comparative assertions under the prescribed conditions (see chapter on limitations).

The review panel would like to emphasize the very positive and constructive attitude of the TS and his leader in the course of the critical review process.

6.5 Geographic validity

This PEFCR is valid for products in scope sold or consumed in the European Union + EFTA.

Almost all compound feed consumed in the EU is produced and sold in the EU. This PEFCR is valid for all compound feed sold in the EU, including the associated supply chains inside and outside the EU.

Each PEF study shall identify its geographical validity listing all the countries where the product object of the PEF study is consumed / sold with the relative market share. In case the information on the market for the specific product object of the study is not available, Europe +EFTA shall be considered as the default market, with an equal market share for each country.

6.6 Language

The PEFCR is written in English. The original in English supersedes translated versions in case of conflicts.

6.7 Conformance to other documents

This PEFCR has been prepared in conformance with the following documents (in prevailing order):

- *PEFCR Guidance 6.3*
- *Product Environmental Footprint (PEF) Guide; Annex II to the Recommendation 2013/179/EU, 9 April 2013. Published in the official journal of the European Union Volume 56, 4 May 2013*
- The Guidelines for assessment of environment performance of animal feed supply chains, released in April 2015 by the FAO-led Livestock Environmental Assessment and Performance partnership (LEAP) (FAO LEAP, 2015) were also an important methodological input for the development of this PEFCR. These guidelines are less prescriptive than what is needed in this PEFCR. Many of the suggestions on how calculations should be done in the LEAP guidelines are therefore translated to requirements that shall be fulfilled in this PEFCR.

7) PEFCR scope

The scope of the PEFCR is compound feed provided as a partial or complete ration to food-producing animals

7.1 Product classification

The CPA code for the products included in this PEFCR is CPA 10.91 product group "Manufacture of prepared feeds for farm animals (Eurostat ISSN 1977-0375)"

The total CPA 10.91 includes:

- manufacture of prepared feeds for farm animals
- preparation of unmixed (single) feeds for farm animals
- treatment of slaughter by-products to produce animal feeds and explicitly excludes:
    - production of fishmeal for animal feed, see CPA 10.20
    - production of oilseed cake, see CPA 10.41
    - activities resulting in by-products usable as animal feed without special treatment

The PEFCR for feed focuses on compound feed produced in a feed mill because it is the predominant industrial product that farmers buy as an external input. Moreover, the majority of feed products sold by EU feed manufactures are compound feeds. Code 10.91 is a close reference, but the scope of this PEFCR is a bit narrower.

Following this reasoning, the following products do not formally belong to the scope of this PEFCR, although there are no methodological reasons for treating them differently when assessing their impact as part of a feed ration:

1. Single feed materials products, i.e. products that originate at a specific food, drink or biofuel processing plant and are sold directly to farmer (e.g. soybean meal, wet gluten feed and distillers supplied to dairy farms).
2. Feed materials that are produced on (or under the control of) the animal farm such as grass (silage), maize (silage) or grains fed directly to farm animals.

The feed PEFCR provides consistent methodological requirements for the entire upstream cradle to gate LCA of feed ingredients. Therefore, the feed PEFCR can also be used by the operators that produce single feed ingredients, either industrially or on the farm. The PEFCR is therefore useful for other CPA codes, such as 10.20; 10.41 and 10.61, but it is not intended to be "the" PEFCR for these sectors, for reasons of representativeness of the Technical Secretariat. In other words, in the absence of PEFCR for home-mixing and straight-purchased feed ingredients, the feed PEFCR can be used for these products.

7.2 Representative product

The representative product is a virtual compound feed. The composition of the representative product (i.e. the reference flow) has been determined using statistics for consumption of feed ingredients in Europe. It is based on a five-year average (2009-2013) in order to limit the impact of variations linked to price fluctuations and availability of ingredients for the European market. The origin of feed ingredients production has been determined based on statistics on production, import and export in the EU.

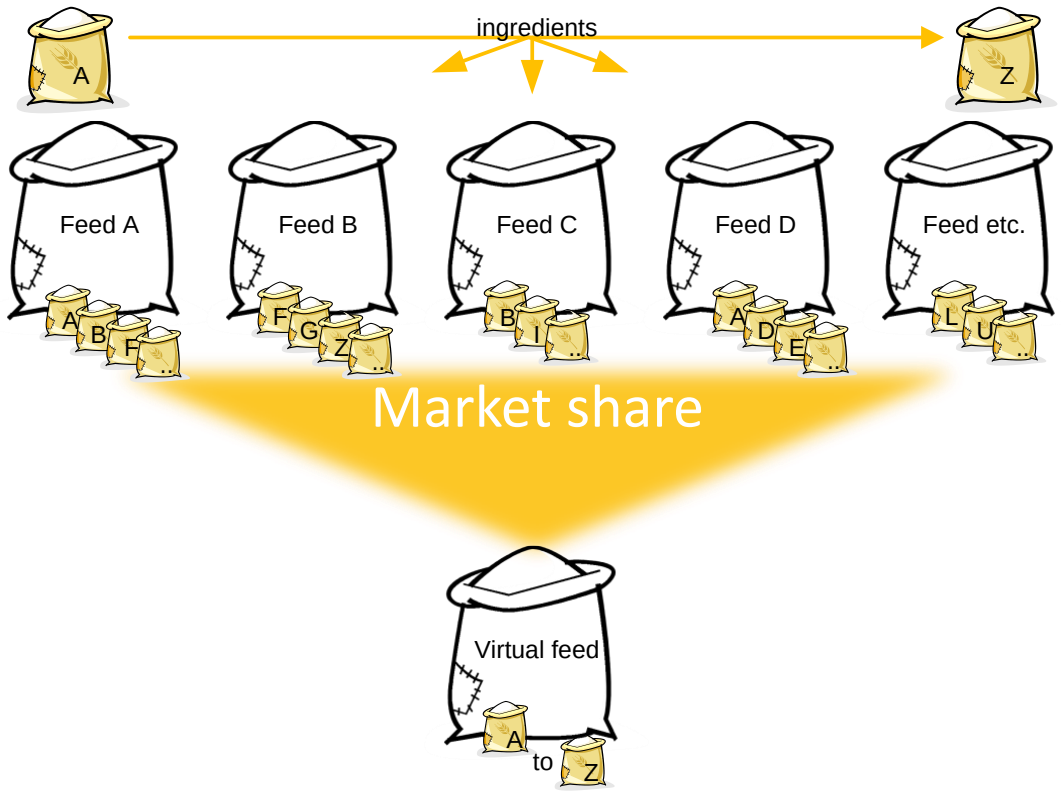

Figure 7.6.1-1 : Composition of the representative product

As feed is an intermediate product, the representative product does not correspond to a functional benchmark. Benchmarking is not allowed for intermediate products according to Guidance 6.3.

The representative product is further described in annex 7 and in the screening study report prepared during the development of this PEFCR. The screening study is available upon request to the TS coordinator[8] that has the responsibility of distributing it with an adequate disclaimer about its limitations.

[8] fefac@fefac.eu

7.3 Functional unit and reference flow

Feed is an intermediate product which means that no functional unit is considered as such. The declared unit (equal to reference flow) is considered instead. The reference flow is 1 tonne of animal feed product as fed and delivered to the livestock farm (or fish farm) entry gate. *All quantitative input and output data collected in the study shall be calculated in relation to this reference flow.*

Table 7.6.1-1: Key aspects of the Functional Unit[9]

What?	Animal feed for food-producing animals
How much?	1 tonne animal feed as fed
How long?	Minimum storage life as defined in article 17 of Regulation (EC) No 767/2009 of the European Parliament and the Council of 13 July 2009 on the placing of the market and use of feed.[10] Feed is normally consumed in a short period after delivery. Losses during storage are uncommon and may be neglected.

7.4 System boundary

The system boundaries are described in the figure below. The figure shows all the different routes for feed production, the grey fields relate to the production of compound feed and are in the scope of this PEFCR.

[9] Feed being an intermediate product, there is no "how well" defined in the reference flow.
[10] Available at http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0767&from=EN

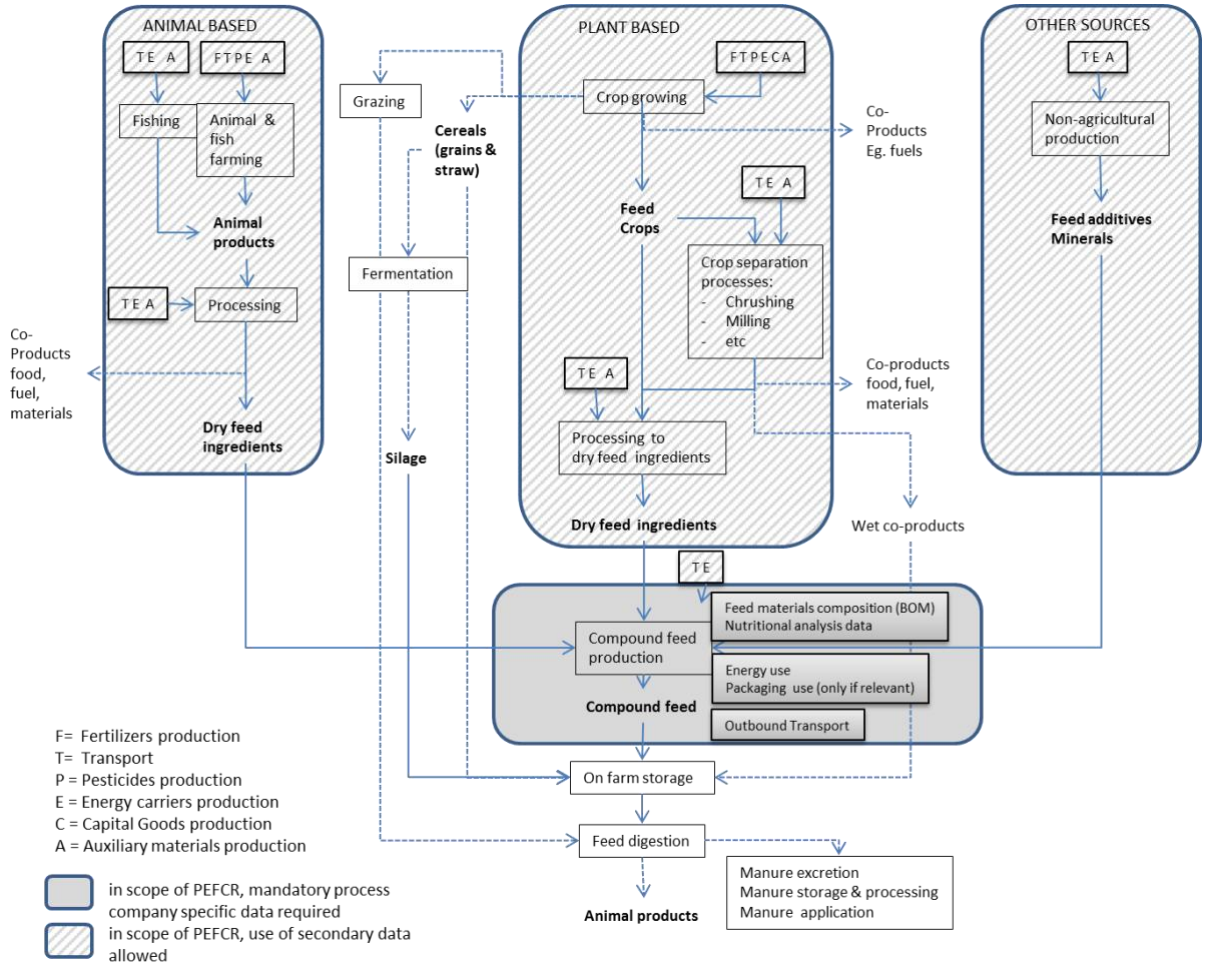

Figure 7.6.1-1: System boundaries of the feed PEFCR, including indication of the processes for which company-specific data are mandatory

The following life cycle stages and processes shall be included in the system boundary:

Table 7.6.1-1: Life cycle stages

Life cycle stage	***Short description of the processes included***
Production of feed ingredients	The majority of feed ingredients used in compound feed originate from crop cultivation in its broad sense. The cultivation of crops requires the input of manure and fertilisers as well as energy carriers, water, crop protection products and auxiliary materials and may involve land transformation. The full lifecycle of the production of these products, including transport and depreciation of capital goods is in the scope of this

	PEFCR[11]. The crop products and/or co-products may be used as such as feed ingredients or further processed. Processing usually requires energy, water and auxiliary materials (e.g. solvents for oilseed processing). Waste water from processing will require treatment. Other feed ingredient sources are, by-products from animal products processing and feed additives which partly originate from industrial processes. Minerals are also used as feed ingredients.
Transport of feed ingredients to the feed mill	The delivery of the feed ingredients to the feed mill is part of the feed life cycle. It can consist of several transportation steps.
Feed production	Feed compounding is the next phase, in which two or more feed materials (with or without feed additives) are mixed together to produce a compound feed for food producing animals.
Feed delivery to the farm	The delivery of the feed to the farm also belongs to the scope of this PEFCR. Delivery is mostly done by trucks except for fish-feed that is be delivered by boat.

According to this PEFCR, the following processes may be excluded based on the cut-off rule: capital goods for processing of feed ingredients, including feed mill operations.

Each PEF study done in accordance with this PEFCR shall provide in the PEF study a diagram indicating the organizational boundary, to highlight those activities under the control of the organization and those falling into Situation 1, 2 or 3 of the data need matrix (see section 9.5).

[11] Following the 1% cut-off rule, capital goods are excluded for processing but included for cultivation.

7.5 EF impact assessment

Each PEF study carried out in compliance with this PEFCR shall calculate the PEF-profile including all PEF impact categories listed in the Table below.

Table 7.6.1-1: List of the impact categories to be used to calculate the PEF profile

Impact category	***Indicator***	***Unit***	***Recommended default LCIA method***
Climate change (total)	*Radiative forcing as Global Warming Potential (GWP100)*	*kg $CO_{2\ eq}$*	*Baseline model of 100 years of the IPCC (based on IPCC 2013)*
- Climate change-biogenic (methane)			
- Climate change – land use and land			
Ozone depletion	*Ozone Depletion Potential (ODP)*	*kg CFC-11 $_{eq}$*	*Steady-state ODPs 1999 as in WMO assessment*
*Human toxicity, cancer**	*Comparative Toxic Unit for humans (CTU_h)*	*CTUh*	*USEtox model (Rosenbaum et al, 2008)*
*Human toxicity, non-cancer**	*Comparative Toxic Unit for humans (CTU_h)*	*CTUh*	*USEtox model (Rosenbaum et al, 2008)*
Particulate matter	*Impact on human health*	*disease incidence*	*UNEP recommended model (Fantke et al 2016)*
Ionising radiation, human health	*Human exposure efficiency relative to U^{235}*	*kBq U^{235} $_{eq}$*	*Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000)*
Photochemical ozone formation, human health	*Tropospheric ozone concentration increase*	*kg NMVOC $_{eq}$*	*LOTOS-EUROS model (Van Zelm et al, 2008) as implemented in ReCiPe*
Acidification	*Accumulated Exceedance (AE)*	*mol H+ $_{eq}$*	*Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)*
Eutrophication, terrestrial	*Accumulated Exceedance (AE)*	*mol N $_{eq}$*	*Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)*
Eutrophication, freshwater	*Fraction of nutrients reaching freshwater end compartment (P)*	*kg P $_{eq}$*	*EUTREND model (Struijs et al, 2009b) as implemented in ReCiPe*
Eutrophication, marine	*Fraction of nutrients reaching marine end compartment (N)*	*kg N $_{eq}$*	*EUTREND model (Struijs et al, 2009b) as implemented in ReCiPe*
*Ecotoxicity, freshwater**	*Comparative Toxic Unit for ecosystems (CTU_e)*	*CTUe*	*USEtox model, (Rosenbaum et al, 2008)*
Land use	• *Soil quality index*[12] • *Biotic production*	• *Dimensionless (pt)*	• *Soil quality index based on LANCA (EC-JRC)*[14] • *LANCA (Beck et al. 2010)*

[12] This index is the result of the aggregation, performed by JRC, of the 4 indicators provided by LANCA model as indicators for land use

[14] Forthcoming document on the update of the recommended Impact Assessment methods and factors for the EF

Impact category	*Indicator*	*Unit*	*Recommended default LCIA method*
	• *Erosion resistance* • *Mechanical filtration* • *Groundwater replenishment*	• *kg biotic production*[13] • *kg soil* • *m^3 water* • *m3 groundwater*	• *LANCA (Beck et al. 2010)* • *LANCA (Beck et al. 2010)* • *LANCA (Beck et al. 2010)*
*Water use***	*User deprivation potential (deprivation-weighted water consumption)*	*m^3 world $_{eq}$*	*Available WAter REmaining (AWARE) Boulay et al., 2016*
Resource use, minerals and metals	*Abiotic resource depletion (ADP ultimate reserves)*	*kg Sb $_{eq}$*	*CML 2002 (Guinée et al., 2002) and van Oers et al. 2002.*
Resource use, fossils	*Abiotic resource depletion – fossil fuels (ADP-fossil)*	*MJ*	*CML 2002 (Guinée et al., 2002) and van Oers et al. 2002*

*Long-term emissions (occurring beyond 100 years) are excluded from the toxic impact categories. Toxicity emissions to this sub-compartment have a characterisation factor set to 0 in the EF LCIA (to ensure consistency). If included by the applicant in the LCI modelling, the sub-compartment 'unspecified (long-term)' shall be used.

**The results for water use might be overestimated and shall therefore be interpreted with caution. Some of the EF datasets tendered during the pilot phase and used in this PEFCR/OEFSR include inconsistencies in the regionalization and elementary flow implementations. This problem has nothing to do with the impact assessment method or the implementability of EF methods, but occurred during the technical development of some of the datasets. The PEFCR/OEFSR remains valid and usable. The affected EF datasets will be corrected by mid-2019. At that time it will be possible to review this PEFCR/OEFSR accordingly, if seen necessary.

The impact category score for 'climate change' shall be broken down in three sub-categories:

- Climate change – fossil
- Climate change – biogenic methane emissions (main source palm oil production)
- Climate change – land use and land transformation

No biogenic CO2 uptake and capture shall be recorded, following the simplified approach for biogenic carbon reporting of the PEF Guidance 6.3.

It is important to mention that the methods used to assess the different impact categories are not equally robust (PEF Guidance 6.3). According to the European Commission, the impact assessment

[13] This refers to occupation. In case of transformation the LANCA indicators are without the year (a)

methods used to calculate the EF of a product can be classified in three groups, from the more robust to the less robust:

- Group I: climate change, ozone depletion, particulate matter
- Group II: Ionising radiation, *Photochemical ozone formation, Acidification, Eutrophication (terrestrial, marine and freshwater),*
- Group III: land use, water use, resource use (mineral and energy carriers), ecotoxicity, human toxicity (cancer and non-cancer)

The differences of robustness have been taken into account by the European Commission to determine the weighting factors, when weighted PEF results are calculated.

The full list of normalization factors and weighting factors are available in Annex 1 (section14).

The full list of characterization factors (EC-JRC, 2017a) is available at this link http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml

7.6 Limitations

7.6.1 Assumptions

- This PEFCR assumes that the user has access to the mandatory company-specific data mentioned in section 9.1.
- This PEFCR is technology neutral from the perspective of the production of feed ingredients. If there are differences between production techniques (such as tillage versus no-tillage for the crop production, or rainfed versus irrigated agriculture) in terms of environmental performance and if the PEFCR is applied properly with sufficient access to data, these differences will be identified in the results.

7.6.2 PEFCR Limitations

- By definition, a cradle-to-gate Feed PEF study would not capture the consequences of modifications in feed formulation on animal performance, in particular when the nutritional performance of the feed product is modified. This would require including feed utilisation (e.g. digestion and the resulting production response of the animal) in the study, which is formally outside the scope of this PEFCR. There are other situations in which a cradle-to-gate study may not be sufficient. An overview of these situations is provided in Annex 5.
- Not all impact assessment methods listed in section 7.5 are equally robust. This should be taken into account in the interpretation of the PEF results, prior to the weighting. In addition, the lack of specific impact assessment method to address depletion of marine resources needs to be mentioned.
- The consequences of allocation choices described in section 9.8 and 9.9 may not be captured properly when only one allocation method is used. The operator of the PEF study should therefore include a sensitivity assessment in the limitation section of the PEF study by testing

two physical alternatives for allocation in addition to the allocation methods recommended in this PEFCR.

7.6.3 Comparison of cradle to gate feed PEF profiles

Feed is an essential input to produce food-producing animals. It is an intermediate product whose composition varies depending on the desired response of the animal and associated nutritional requirements depending and the availability and prices of feed ingredients. Measuring the impacts associated with the production of feed, as well as the feed performance on the farm is necessary in order to achieve meaningful LCAs of food-producing animals.

The feed performance in terms of production per unit of feed is closely linked with farm management practices and genetic potential of the livestock. In other words, the performance of the same feed used in two similar farms can vary significantly according to the farm's specific conditions (breed, animal health status; etc.…) and management. This is extremely important to bear in mind when considering the comparison of the environmental performance of feed products. Reducing the environmental footprint of a feed without taking into account the potential consequences on its efficiency in the use phase could be very counterproductive.

The comparison of the PEF profiles of different feeds shall therefore:

- only take place when it is clear that they fulfil the same function and animal response, i.e. in the context of cradle to grave PEF study of identical animal products (e.g. one kilogramme of eggs on similar farms with two types of feed) and;
- only be interpreted as part of the complete interpretation of the PEF profile of the animal product at stake.

8) Most relevant impact categories, life cycle stages and processes

8.1 Most relevant impact categories

The most relevant impact categories for the product group in scope of this PEFCR are the following:

1. Climate change
2. Particulate matter
3. Acidification terrestrial and freshwater
4. Land use
5. Eutrophication terrestrial
6. Water scarcity

These impact categories have been identified by following the procedure described in the PEF Guidance 6.3.

Feed being an intermediate product, all impact categories mentioned in section 7.5 shall be included in a Feed PEF study.

The sub-indicators 'Climate change - biogenic' and 'Climate change - land use and land transformation' shall be reported separately because their contribution to the total climate change impact, based on the benchmark results, is more than 5% each.

8.2 Most relevant life cycle stages

The most relevant life cycle stage *for the product group in scope of this PEFCR* is the production of feed ingredients[15] (i.e. raw material acquisition and pre-processing as defined in the PEF Guidance version 6.3)

8.3 Most relevant processes

The most relevant processes for the product group in scope of this PEFCR are the following, from the largest to the smallest contribution (based on the representative product)

Table 7.6.3-1: List of the most relevant processes

Life cycle stage is identified by (P =Production of feed ingredients, T = Transport of feed ingredients to the feed mill, F = Feed production, D=Feed delivery to the farm).

Impact category	***Processes***
Climate change	Soybean meal| from crushing (pressing and extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Fatty acid blend| production mix, technology mix| at plant| {EU+28} [LCI result] Soybean meal| from crushing (pressing and extraction with solvent), production mix| at plant| {GLO} [LCI result] [P] Maize (corn grain) production| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Wheat grain| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Rapeseed expeller| from crushing (extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Electricity grid mix 1kV-60kV| AC, technology mix| consumption mix, at consumer| 1kV - 60kV {EU-28+3} [LCI result] [F] Whey powder| from cheese production| at dairy| per kg {EU-28+3} [LCI result] [P] Soybean protein concentrate| from crushing (extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Milk powder| skimmed| at dairy| per kg {EU-28+3} [LCI result] [P]

[15] This is consistent with pre-existing knowledge

Impact category	*Processes*
	Maize gluten feed| from wet milling (gluten feed production, with drying), production mix| at plant| {GLO} [LCI result] [P] Barge| technology mix, diesel driven, cargo| consumption mix, to consumer| 1500 t payload capacity {EU-28+3} [LCI result] [T] Crude palm oil| technology mix| at plant| {ID} [LCI result] [P] Green pea| technology mix, production mix| at farm| {GLO} [LCI result] [P] Articulated lorry transport, total weight >32 t, mix Euro 0-5| diesel driven, Euro 0 - 5 mix, cargo| consumption mix, to consumer| more than 32t gross weight / 24,7t payload capacity {EU-28+3} [LCI result] [T/D]
Particulate matter	Fatty acid blend| production mix, technology mix| at plant| {EU+28} [LCI result] [P] Maize (corn grain) production| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Wheat grain| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Soybean meal| from crushing (pressing and extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Barge| technology mix, diesel driven, cargo| consumption mix, to consumer| 1500 t payload capacity {EU-28+3} [LCI result] [T] Rapeseed expeller| from crushing (extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Green pea| technology mix, production mix| at farm| {GLO} [LCI result] [P] Soybean meal| from crushing (pressing and extraction with solvent), production mix| at plant| {GLO} [LCI result] [P] Whey powder| from cheese production| at dairy| per kg {EU-28+3} [LCI result] [P] Barley grain| technology mix| at farm| {ES} [LCI result] [P] Wheat bran| from dry milling, production mix| at plant| {EU+28} [LCI result] [P] Triticale| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Barley grain| technology mix| at farm| {DE} [LCI result] [P] Oat grain production| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Freight train, diesel traction| diesel driven, cargo| consumption mix, to consumer| average train, gross tonne weight 1000t / 726t payload capacity {EU-28+3} [LCI result] [T] Milk powder| skimmed| at dairy| per kg {EU-28+3} [LCI result] [P] Maize gluten feed| from wet milling (gluten feed production, with drying), production mix| at plant| {GLO} [LCI result] [P]
Acidification terrestrial and freshwater	Fatty acid blend| production mix, technology mix| at plant| {EU+28} [LCI result] [P] Maize (corn grain) production| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Wheat grain| technology mix, production mix| at farm| {EU+28} [LCI result] [P]

Impact category	*Processes*
	Rapeseed expeller| from crushing (extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Soybean meal| from crushing (pressing and extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Green pea| technology mix, production mix| at farm| {GLO} [LCI result] [P] Whey powder| from cheese production| at dairy| per kg {EU-28+3} [LCI result] [P] Barley grain| technology mix| at farm| {ES} [LCI result] [P] Soybean meal| from crushing (pressing and extraction with solvent), production mix| at plant| {GLO} [LCI result] [P] Wheat bran| from dry milling, production mix| at plant| {EU+28} [LCI result] [P] Triticale| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Barley grain| technology mix| at farm| {DE} [LCI result] [P] Oat grain production| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Milk powder| skimmed| at dairy| per kg {EU-28+3} [LCI result] [P] Barley grain| technology mix| at farm| {FR} [LCI result] [P] Barge| technology mix, diesel driven, cargo| consumption mix, to consumer| 1500 t payload capacity {EU-28+3} [LCI result] [T] Freight train, diesel traction| diesel driven, cargo| consumption mix, to consumer| average train, gross tonne weight 1000t / 726t payload capacity {EU-28+3} [LCI result] [T]
Land use	Fatty acid blend| production mix, technology mix| at plant| {EU+28} [LCI result] [P] Soybean meal| from crushing (pressing and extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Wheat grain| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Maize (corn grain) production| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Soybean meal| from crushing (pressing and extraction with solvent), production mix| at plant| {GLO} [LCI result] [P] Rapeseed expeller| from crushing (extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Green pea| technology mix, production mix| at farm| {GLO} [LCI result] [P] Triticale| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Barley grain| technology mix| at farm| {ES} [LCI result] [P] Sunflower seed meal| from crushing (pressing and extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Oat grain production| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Sunflower seed meal| from crushing (pressing and extraction with solvent), production mix| at plant| {GLO} [LCI result] [P]

Impact category	*Processes*
Eutrophication terrestrial	Fatty acid blend| production mix, technology mix| at plant| {EU+28} [LCI result] [P] Maize (corn grain) production| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Wheat grain| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Rapeseed expeller| from crushing (extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Soybean meal| from crushing (pressing and extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Green pea| technology mix, production mix| at farm| {GLO} [LCI result] [P] Whey powder| from cheese production| at dairy| per kg {EU-28+3} [LCI result] [P] Barley grain| technology mix| at farm| {ES} [LCI result] [P] Wheat bran| from dry milling, production mix| at plant| {EU+28} [LCI result] [P] Soybean meal| from crushing (pressing and extraction with solvent), production mix| at plant| {GLO} [LCI result] [P] Triticale| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Barley grain| technology mix| at farm| {DE} [LCI result] [P] Oat grain production| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Barge| technology mix, diesel driven, cargo| consumption mix, to consumer| 1500 t payload capacity {EU-28+3} [LCI result] [T] Milk powder| skimmed| at dairy| per kg {EU-28+3} [LCI result] [P] Barley grain| technology mix| at farm| {FR} [LCI result] [P]
Water use	Maize (corn grain) production| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Fatty acid blend| production mix, technology mix| at plant| {EU+28} [LCI result] [P] Mineral premix| production mix, technology mix| at plant| {EU+28} [LCI result] [P] Oat grain production| technology mix, production mix| at farm| {EU+28} [LCI result] [P] Sunflower seed meal| from crushing (pressing and extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P] Barley grain| technology mix| at farm| {ES} [LCI result] [P] Soybean meal| from crushing (pressing and extraction with solvent), production mix| at plant| {EU+28} [LCI result] [P]

9) Life cycle inventory

All newly created processes shall be EF-compliant.

Sampling is allowed for the collection of primary data. When sampling is used, it shall be done according to the requirements defined in section 7.5 of the PEF Guidance Version 6.3 (implemented in annex 8 of this PEFCR). Description of the population and of the selected sample used for the EF study shall be clearly described in the EF report.

9.1 List of mandatory company-specific data

There are four data-points for which it is mandatory to use company-specific data (e.g. primary data). Not using primary data for these processes means that the PEF study is not compliant with this PEFCR. These four data points are:

- The list of feed ingredients (Bill of Materials, BoM)
- The nutritional analysis of the feed ingredients (hereafter referred to as nutritional analysis data)
- Energy consumption in feed mill operations
- Outbound transport to livestock farm

9.1.1 List of feed ingredients

The list of feed ingredients entails the following data:

- Types and quantities of feed materials
- Types and quantities of feed additives
- Type and quantities of pre-mixtures

The reference to define the feed materials is the EU Catalogue of feed materials[16] and to define the feed additives it is the EU Register of Feed Additives[17]. Both documents can be used as a reference to define pre-mixtures.

The bill of materials shall add up to 100% of the weight of the compound feed. No cut-off is allowed. Feed ingredients shall be specified to product names[18] that can be unambiguously linked to a type of production process, this means

- detail on production process and composition,
- trade names shall not be used

The list of feed ingredients shall also be consistent with the nutritional analysis data (see section 9.1.2).

For crops and processed feed ingredients used in the feed mill the country of origin shall be recorded if this information is provided in the transaction to the feed business operator. See section 9.3 and 9.6 for further guidance on how to deal with missing or incomplete information on origin of production.

The feed ingredients list shall be the weighted average composition of a feed reflecting the practice of producing feed for the farms of food producing animals in scope. The weighted average shall be determined by taking time related variation and the variation of geographical origin for supply into

[16] *Commission Regulation (EU) No 68/2013 of 16 January 2013 on the Catalogue of feed materials*
[17] *http://ec.europa.eu/food/food/animalnutrition/feedadditives/docs/comm_register_feed_additives_1831-03.pdf*
[18] The Catalogue of feed materials can be used as reference

account where necessary as defined in Table 9.1.1-1 . Combining different geographical origins of supply in the calculation of the weighted average does not negatively affect the data quality rating. The purpose and scope of the PEF study determine the time period for deriving the weighted average as indicated in Table 9.1.1-1.

Table 9.1.1-1: Time period in relation to purpose and scope of the PEF study

Purpose	Scope	Time period for deriving weighted averages	Reporting requirements
1. Cradle to gate PEF compliant information for studies on food producing animals	Determined by PEF study on food producing animals	According to specifications of PEF study on food producing animals	Record and communicate time period of setting weighted average.
2.Cradle to gate PEF study on compound feed, without comparison	Feeds on the market with fixed nutritional specifications for more than a year (such as standard or supplier specified dairy and pig fattening feed)	1 year feed ingredient weighted average or longer up to 3 years if longer term market cycles occur in feed materials production	Report a time period of 1 year and if appropriate, justify the use of a longer period.
	Feeds on the market with nutritional specifications fixed for period shorter than a year.	Use the longest possible time period	Report and justify the chosen time period.
3a. Cradle to gate PEF study including product comparison	To show if an innovative feed performs better than the alternative	Use a time period to derive feed composition for making a fair comparison	Report and justify the chosen time period.
3b. Cradle to gate PEF study for performance tracking	To show developments and/or improvements in performance over time	Two options (can be combined): No averaging if trend analysis aims to show actual fluctuations (also related to market fluctuations and not to actual changes in composition). Rolling weighted averages to correct for market fluctuations.	Report on trends and changes in feed materials composition and nutritional analysis data.

It is not a requirement to use primary data for the production the different feed ingredients, but this option remains nevertheless available (see sections 10.1 and 10.2 for further details).

When no primary data is used for the production of the feed ingredients, the next step in the modelling of the feed under study is to connect each ingredient in the list to a default dataset.

9.1.2 Nutritional analysis data

The nutritional analysis data is especially relevant for PEF studies of animal products. The nutritional analysis data needed for the purpose of the PEF study are:

- Nitrogen (N), Phosphorus (P) content in g/kg
- Ash (g/kg)
- Copper (Cu), Zinc (Zn) content in g/kg (from all sources)
- Gross Energy (MJ/kg gross calorific value or HHV) and digestible energy fraction[19] (% of gross energy)
- Fossil carbon content

Some specific elements of the feed composition may require some differentiation of the nutritional modelling associated with the use stage (e.g. effect on enteric fermentation or effect on animal performances). It that case, this information should be communicated to the downstream partner involved in LCA modelling, and shall be properly justified.

Feed companies have access to the nutritional analysis data. When the Feed PEF study is not performed directly by a feed company, the commissioner of the study should contact the feed company at stake to obtain the nutritional analysis data. Considering the sensitive nature of this information, it is recommended to use confidentiality agreements for the transfer of information.

Typical nutritional analysis data can be found in country datasets or if not available at http://www.feedipedia.org/. Actual nutritional analysis data are those measured by the feed company. The method chosen to report nutritional analysis data, (i.e. using typical or actual values) shall be reported.

The nutritional analysis data shall be reported as additional technical information, see section 11.3.

9.1.3 Energy consumption in feed mill operations

The data mentioned in **Error! Reference source not found.** shall be collected. The data should be r ecorded according to the format in the table. In the fourth column, the method of measurement shall be explained. This includes the sources of information and any conversion of information and related assumptions.

Table 9.1.3-1: Collection of activity data at the feed mill

[19] The digestible energy varies per animal species.

Activity data	Unit per tonne of feed out	Quantity	Source and method of measurement (if relevant)
Electricity use	kWh		
Gas use	MJ LHV		
Heat use	MJ LHV		
Other energy inputs	MJ LHV (specify type)		

The activity data need then to be linked with the secondary data for energy provided in the excel file[20] accompanying this PEFCR.

Data can be derived on different levels of accurateness which needs to be determined in relation to the scope of the study.:

- If the feed operation is not part of assessing differences in a comparison between alternatives or changes in time the minimum level of accurateness shall be ***average feed mill data***[21] determined for 1 year of normal operation (Normal operation is data corrected for calamities).
- If comparisons are made (between alternatives or in time) that include changes in the feed mill operation (e.g. pelleting or not, temperature, pressure etc.) ***specific feed mill*** processing data shall be collected (e.g. production line or sub-production line). This can preferably be done based on measurements or if measurements are not possible on the basis of an analysis where use of energy and auxiliary materials is derived from technical specifications of equipment[22]. Also, if specific data are collected all use of energy and auxiliary materials of the feed mill shall be divided over the specific products (see sections 9.8 and 9.9 for allocation rules). Thus, any estimate of specific energy and auxiliary materials use for a feed product shall be done based on allocating the use of the complete factory to sub-processes. How this is done shall be motivated and recorded.

Completeness of data

Data on electricity, fuel, heat and water use shall always be recorded and collected based on annual usage data based on consolidated information from feed mill's bookkeeping (see sections 9.8 and 9.9 on how to allocate this data).

[20] Feed for food-producing animals V4.1 – Life Cycle inventory (23-01-2018).xls
[21] Average feed mill data refers to a situation where the energy consumption cannot be measured per production line or per production step (grinding, mixing, pelleting,…)
[22] The method chosen shall be reported

9.1.4 Outbound transport

Primary data shall be collected for outbound transport (i.e. feed delivery to the livestock or fish farm). This may be done with different levels of accuracy, as indicated in the hierarchy below from the most accurate to the least accurate, depending on data availability.

1. Fuel consumption for farm-specific delivery and transport means
2. Farm specific delivery distance and transport mean
3. Average fuel consumption per tonne delivered, for the feed type under study and transport means (the average is specific to the feed under study, but the farm specific delivery distance is not available)
4. Average distance from mill to farms in scope, per type of feed (ruminants, poultry, pork, fish; other) and transport mean (the average is not specific to the feed under study and the farm specific delivery distance is not available, but the average is at least distinguished according to the main feed types)

The data availability determines the level of accuracy.

The quality of data collected for outbound transport is proportionate to the level of accuracy, as indicated in section 9.4.1.

If actual fuel use data of outbound transport can be collected, because there is a suitable accounting system in place, these data shall be used. Fuel use data will be connected to secondary LCI data for fuel production and combustion. See Table 9.1.4-1 for a format that can be used for data collection.

Table 9.1.4-1: Data collection for feed transport to farm if fuel use can be collected

Activity data	Unit	Quantity	Technology (EURO-class 1, 2, 3, 4,5)	Utilisation Ratio	Source and method of measurement
Fuel use (type 1)	unit/tonne delivered feed (specify unit)				
Fuel use (type 2)	unit/tonne delivered feed (specify unit)				
Fuel use (type 3)	unit/tonne delivered feed (specify unit)				
Fuel use (type 4)	unit/tonne delivered feed (specify unit)				

The next step is to link the data collected in Table 9.1.4-1 to the parameterized transport datasets as available in the EC datasets on transport *http://lcdn.thinkstep.com/Node/*.

If the utilisation ratio is not available, 0.85 shall be used as a default (as used in the original processes at the Thinkstep node).

If data on actual fuel use are not available, then the outbound transport shall be assessed through distances according to steps 2, 3 or 4 of the hierarchy above and the default datasets for lorry transport in the accompanying excel file shall be used.

9.2 List of processes expected to run by the company

Assuming that mainly feed companies will implement this PEFCR, water use in feed mills is seen as a process expected to be run by the company. This means that it is recommended to use company specific data for water use, but that it is not mandatory. The typical use of water in a feed mill is for steam generation.

The default value to be used when no primary data is available is 0,13 m^3 per tonne of feed as fed.

When primary data are available for water use in feed mills, it shall be collected as follows

Table 9.1.4-1: Data collection requirements for water use in feed mills

Activity data	Unit per tonne of feed as fed	Quantity	Source and method of measurement
Water consumption[23] in the feed mill	m^3		

The activity data need then to be linked with the secondary data for water consumption provided in the excel file accompanying this PEFCR.

9.3 Data gaps

Two types of data gaps need to be distinguished:

1. Data gaps on the company specific data to be collected (list of feed ingredients, nutritional analysis data, energy consumption in feed mills, outbound transport)
2. Data gaps in the secondary datasets

9.3.1 Data gaps on mandatory company-specific data

As mentioned in section 9.1, there are four data points for which it is mandatory to use company-specific data. The procedure to deal with data gaps for these mandatory company-specific data is explained in the following sections.

[23] For simplification reasons, consumption is considered equal to withdrawal.

9.3.1.1 List of feed ingredients

The list of feed ingredients (i.e. the bill of materials) shall add up to 100% of the weight of the compound feed, meaning that no data gap is allowed. It is also not allowed to use assumptions regarding the list of feed ingredients

9.3.1.2 Nutritional analysis data

The nutritional analysis data is calculated for the list of feed ingredients (see section 9.1.2) which means that no data gaps should be encountered here.

9.3.1.3 Energy consumption in the feed fill

Two situations shall be distinguished:

- There is no information at all on the energy consumption in the feed mill: in that case, it is not possible to conduct a PEF study compliant with this PEFCR
- There is only information available on the average energy consumption per tonne of feed[24]: in that case, it is possible to conduct a PEF study compliant with this PEFCR, but without comparison based on the energy consumption in the feed mill (purposes 1 and 2 defined in the introduction are supported but not purpose 3).

9.3.1.4 Outbound transport

Again, two situations shall be distinguished

- There is no information at all on outbound transport: in that case, it is not possible to conduct a PEF study compliant with this PEFCR.
- When information is available on outbound transport, it can be available with different levels of accuracy as explained in the hierarchy described in section 9.1.4. The lowest level of accuracy which is acceptable to conduct a PEF study which is compliant with this PEFCR is the average distance from feed mill to farm, per type of feed (ruminant, poultry, pig, fish, other) and transport means.

9.3.2 Data gaps on secondary datasets

Different types of secondary datasets are recommended in this PEFCR:

[24] This refers to average feed mill data described in section 9.1.3, i.e. a situation where the energy consumption cannot be measured per production line or per production step (grinding, mixing, pelleting,…)

9.3.2.1 Secondary data for the production of feed ingredients

- The list of feed ingredients purchased by the European Commission to support the implementation of this PEFCR is available in the accompanying excel file. This source of data is always the preferred option recommended in this PEFCR but may not contain all necessary datasets.
- The Global Feed LCA Institute[25] (GFLI) is the other source of datasets recommended in this PEFCR. The GFLI datasets follow the modelling rules described in this PEFCR and are compliant with the ILCD entry level requirements.

The procedure to define which datasets to use is defined in section 9.6. The use of non-EF compliant datasets shall be reported as datagap.

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9.3.2.2 Secondary data for energy and transport

The datasets purchased by the European Commission shall be used as reference for secondary data for energy and transport. In case of a gap for a specific country transport or energy mix, the continental average shall be used and the global average if the continental average is not available.

9.3.2.3 Secondary data for packaging materials

For feed delivered in bags (very low market share), the packaging datasets purchased by the European Commission shall be used as reference for secondary data. It contains datasets for paper bags and plastics bags therefore no data gaps should be encountered.

9.4 Data quality requirements

The data quality of each dataset and the total EF study shall be calculated and reported. The calculation of the DQR shall be based on the following formula with 4 criteria:

$$DQR = \frac{\overline{Te_R}+\overline{G_R}+\overline{Ti_R}+\overline{P}}{4} \qquad \text{Equation 1}$$

where TeR is the Technological-Representativeness, GR is the Geographical-Representativeness, TiR is the Time-Representativeness, and P is the Precision/uncertainty. The representativeness (technological, geographical and time-related) characterises to what degree the processes and products selected are depicting the system analysed, while the precision indicates the way the data is derived and related level of uncertainty.

[25] www.globalfeedlca.org

The next chapters provide tables with the criteria to be used for the semi-quantitative assessment of each criterion. If a dataset is constructed with company-specific activity data, company -specific emission data and secondary sub-processes, the DQR of each shall be assessed separately.

For each dataset, the DQR shall be reported per criterion and as final result using equation 1.

9.4.1 Company specific datasets

The score of criterion P cannot be higher than 3 while the score for TiR, TeR, and GR cannot be higher than 2 (the DQR score shall be ≤1.6). The DQR shall be calculated at the level-1 disaggregation, before any aggregation of sub-processes or elementary flows is performed. The DQR of company-specific datasets shall be calculated as following:

1) Select the most relevant sub-processes and direct elementary flows that account for at least 80% of the total environmental impact of the company-specific dataset, listing them from the most contributing to the least contributing one.

2) Calculate the DQR criteria TeR, TiR, GR and P for each most relevant process and each most relevant direct elementary flow. The values of each criterion shall be assigned based on Table B.5.

> *2.a) Each most relevant elementary flow consists of the amount and elementary flow naming (e.g. 40 g carbon dioxide). For each most relevant elementary flow, evaluate the 4 DQR criteria named $Te_{R\text{-}EF}$, $Ti_{R\text{-}EF}$, $G_{R\text{-}EF}$, P_{EF} in* Table 9.4.1-1*. It shall be evaluated for example, the timing of the flow measured, for which technology the flow was measured and in which geographical area.*

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> *2.b) Each most relevant process is a combination of activity data and the secondary dataset used. For each most relevant process, the DQR is calculated* by the applicant of the PEFCR *as a combination of the 4 DQR criteria for activity data and the secondary dataset: (i) Ti_R and P shall be evaluated at the level of the activity data (named $Ti_{R\text{-}AD}$, P_{AD}) and (ii) Te_R, Ti_R and G_R shall be evaluated at the level of the secondary dataset used (named $Te_{R\text{-}SD}$, $Ti_{R\text{-}SD}$ and $G_{R\text{-}SD}$). As Ti_R is evaluated twice, the mathematical average of $Ti_{R\text{-}AD}$ and $Ti_{R\text{-}SD}$ represents the Ti_R of the most relevant process.*

3) Calculate the environmental contribution of each most-relevant process and elementary flow to the total environmental impact of all most-relevant processes and elementary flows, in % (weighted using 13 EF impact categories, with the exclusion of the 3 toxicity-related ones). For example, the newly developed dataset has only two most relevant processes, contributing in total to 80% of the total environmental impact of the dataset:

- *Process 1 carries 30% of the total dataset environmental impact. The contribution of this process to the total of 80% is 37.5% (the latter is the weight to be used).*
- *Process 1 carries 50% of the total dataset environmental impact. The contribution of this process to the total of 80% is 62.5% (the latter is the weight to be used).*

4) Calculate the Te_R, Ti_R, G_R and P criteria of the newly developed dataset as the weighted average of each criterion of the most relevant processes and direct elementary flows. The weight is the relative contribution (in %) of each most relevant process and direct elementary flow calculated in step 3.

5) The applicant of the PEFCR shall the total DQR of the newly developed dataset using the equation B.2, where $\overline{Te_R}, \overline{G_R}, \overline{Ti_R}, \overline{P}$ are the weighted average calculated as specified in point 4).

$$DQR = \frac{\overline{Te_R}+\overline{G_R}+\overline{Ti_R}+\overline{P}}{4} \qquad \text{Equation 2}$$

NOTE: in case the newly developed dataset has most relevant processes filled in by non-EF compliant datasets (and thus without DQR), then these datasets cannot be included in step 4 and 5 of the DQR calculation. (1) The weight of step 3 shall be recalculated for the EF-compliant datasets only. Calculate the environmental contribution of each most-relevant EF compliant process and elementary flow to the total environmental impact of all most-relevant EF compliant processes and elementary flows, in %. Continue with step 4 and 5. (2) The weight of the non-EF compliant dataset (calculated in step 3) shall be used to increase the DQR criteria and total DQR accordingly. For example:

- *Process 1 carries 30% of the total dataset environmental impact and is ILCD entry level compliant. The contribution of this process to the total of 80% is 37.5% (the latter is the weight to be used).*
- *Process 1 carries 50% of the total dataset environmental impact and is EF compliant. The contribution of this process to all most-relevant EF compliant processes is 100%. The latter is the weight to be used in step 4.*
- *After step 5, the parameters $\overline{Te_R}, \overline{G_R}, \overline{Ti_R}, \overline{P}$ and the total DQR shall be multiplied with 1.375.*

Table 9.4.1-1: How to assess the value of the DQR criteria for datasets with company-specific information

	P_{EF} and P_{AD}	$Ti_{R\text{-}EF}$ and $Ti_{R\text{-}AD}$	$Ti_{R\text{-}SD}$	$Te_{R\text{-}EF}$ and $Te_{R\text{-}SD}$	$G_{R\text{-}EF}$ and $G_{R\text{-}SD}$
1	*Measured/calculated and externally verified*	*The data refers to the most recent annual administration period with respect to the EF report publication date*	*The EF report publication date happens within the time validity of the dataset*	*The elementary flows and the secondary dataset reflect exactly the technology of the newly developed dataset*	*The data(set) reflects the exact geography where the process modelled in the newly created dataset takes place*
2	*Measured/calculated and internally verified, plausibility checked by reviewer*	*The data refers to maximum 2 annual administration periods with respect to the EF report publication date*	*The EF report publication date happens not later than 2 years beyond the time validity of the dataset*	*The elementary flows and the secondary dataset is a proxy of the technology of the newly developed dataset*	*The data(set) partly reflects the geography where the process modelled in the newly created dataset takes place*
3	*Measured/calculated/literature and plausibility not checked by reviewer OR Qualified estimate based on calculations plausibility checked by reviewer*	*The data refers to maximum three annual administration periods with*	*Not applicable*	*Not applicable*	*Not applicable*

	P_{EF} and P_{AD}	$Ti_{R\text{-}EF}$ and $Ti_{R\text{-}AD}$	$Ti_{R\text{-}SD}$	$Te_{R\text{-}EF}$ and $Te_{R\text{-}SD}$	$G_{R\text{-}EF}$ and $G_{R\text{-}SD}$
		respect to the EF report publication date			
4-5	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

Table 9.4.1-2: How to assess data quality for the Feed mill operations

Quality rating	P_{EF} and P_{AD}	$Ti_{R\text{-}EF}$ and $Ti_{R\text{-}AD}$	$Ti_{R\text{-}SD}$	$Te_{R\text{-}EF}$ and $Te_{R\text{-}SD}$	$G_{R\text{-}EF}$ and $G_{R\text{-}SD}$
1	*Measured/calculated and externally verified*	Data cover the time period in the scope of the study as defined in Table 9.1.1-1 and refer to the most recent annual administration period	*The EF report publication date happens within the time validity of the dataset*	The technology(ies) are specific for the feed product(s) in scope and based on production line specific information	The data concern the specific feed mill production plant(s) in scope in their weighted share of production
2	*Measured/calculated and internally verified, plausibility checked by reviewer*	Data cover the time period in the scope of the study as defined in Table 9.1.1-1and refer to the previous annual administration period	*The EF report publication date happens not later than 2 years beyond the time validity of the dataset*	The data reflect the average feed mill operations data and are not from the specific production lines	The data concern unweighted averages of the feed mill locations where the production of feed in scope takes place
3	*Measured/calculated/literature and plausibility not checked by reviewer OR Qualified estimate based on calculations plausibility checked by reviewer*	No PEF	No PEF	No PEF	No PEF
4	No PEF	No PEF	No PEF	No PEF	No PEF
5	No PEF	No PEF	No PEF	No PEF	No PEF

Table 9.4.1-3: How to assess data quality for Outbound transport

Quality rating	P_{EF} and P_{AD}	$Ti_{R\text{-}EF}$ and $Ti_{R\text{-}AD}$	$Ti_{R\text{-}SD}$	$Te_{R\text{-}EF}$ and $Te_{R\text{-}SD}$	$G_{R\text{-}EF}$ and $G_{R\text{-}SD}$
1	*Measured/calculated and externally verified*	Data cover the time period in the scope of the study as defined in	*The EF report publication date*	The technology(ies) and logistics are specific for the	The data concern the specific feed mill production plant(s) location

		Table 9.1.1-1 and refer to the most recent annual administration period	*happens within the time validity of the dataset*	feed product(s) in scope and based on fuel consumption measurements	and its logistics in scope in their weighted share of production
2	*Measured/calculated and internally verified, plausibility checked by reviewer*	Data cover the time period in the scope of the study as defined in Table 9.1.1-1 and refer to the previous annual administration period	*The EF report publication date happens not later than 2 years beyond the time validity of the dataset*	The technology(ies) and logistics are specific for the product(s) in scope based on distance estimation.	The data concern unweighted average logistics of the feed mill plants where production of feed in scope takes place
3	*Measured/calculated/literature and plausibility not checked by reviewer OR Qualified estimate based on calculations plausibility checked by reviewer*	No PEF	No PEF	No PEF	No PEF
4	No PEF	No PEF	No PEF	No PEF	No PEF
5	No PEF	No PEF	No PEF	No PEF	No PEF

Table 9.4.1-4: How to assess data quality for Inbound transport

Quality rating	P_{EF} and P_{AD}	$Ti_{R\text{-}EF}$ and $Ti_{R\text{-}AD}$	$Ti_{R\text{-}SD}$	$Te_{R\text{-}EF}$ and $Te_{R\text{-}SD}$	$G_{R\text{-}EF}$ and $G_{R\text{-}SD}$
1	*Measured/calculated and externally verified*	Data cover the time period in the scope of the study as defined in Table 9.1.1-1 and refer to the most recent annual administration period	*The EF report publication date happens within the time validity of the dataset*	The technology(ies) and logistics are specific for the feed product(s) in scope and based on distance estimation	The data concern the specific feed mill production plant(s) location and its logistics in scope in their weighted share of production
2	*Measured/calculated and internally verified, plausibility checked by reviewer*	Data cover the time period in the scope of the study as defined in Table 9.1.1-1 and refer to the previous annual administration period	*The EF report publication date happens not later than 2 years beyond the time validity of the dataset*	The technology(ies) and logistics are based on the default logistics .parameters in annex 5	The data concern unweighted average logistics of the feed mill plants where production of feed in scope takes place
3	*Measured/calculated/literature and plausibility not checked by reviewer OR Qualified estimate*	No PEF	No PEF	No PEF	No PEF

	based on calculations plausibility checked by reviewer				
4	No PEF	No PEF	No PEF	No PEF	No PEF
5	No PEF	No PEF	No PEF	No PEF	No PEF

The DQR for cultivation when primary data are collected is determined with Table 9.4.1-1

However, not all activity data inputs for cultivation datasets have the same weight in the overall environmental impact. Moreover, data can originate from different sources. Therefore, the data quality score of cultivation shall be first determined per data point using Table 9.4.1-1 and then multiplied by the weight factor provided in Table 9.4.1-5 to determine the overall DQR scores.

Table 9.4.1-5: Weighting factors for deriving data quality for cultivation

	Weight of activity data DQR in DQR calculation
Yield	12.5
Allocation data	2.5
Fuel Use	11.4
Electricity	6.7
NPK fertilizers	43.7
Organic fertilizer	9.1
Lime use	2.6
Seed use	0.9
Pesticides use	3.7
Water use for irrigation	1.8
Capital goods	5.1
	100.0

Also for processing of feed ingredients the contribution of the activity data differ significantly. The DQR for the processing of feed ingredients shall be determined using Table 9.4.1-6

Table 9.4.1-6: Weighting factors for deriving data quality for cradle to gate processing of feed ingredients

Activity data	**Weight of activity data DQR in DQR calculation**	
Mass balance	2.5%	
Allocation data	10.0%	
Crop mix	5.0%	
Transport modalities mix	2.5%	
Production of crops	61.9%	DQR either based on primary data or DQR from secondary dataset
Transport	3.6%	
Fuel use	3.7%	

Electricity use	7.9%	
Water use	0.1%	
Other raw materials use	1.0%	
Waste water	1.7%	

9.5 Data needs matrix (DNM)

All processes required to model the product and outside the list of mandatory company-specific (listed in section 9.1) shall be evaluated using the Data Needs Matrix (see Table 0-1*). The DNM shall be used by the PEFCR applicant to evaluate which data is needed and shall be used within the modelling of its PEF, depending on the level of influence the applicant (company) has on the specific process. The following three cases can be found in the DNM and are explained below:*

1. ***Situation 1****: the process is run by the company applying the PEFCR*
2. ***Situation 2****: the process is not run by the company applying the PEFCR but the company has access to (company-) specific information.*
3. ***Situation 3****: the process is not run by the company applying the PEFCR and this company does not have access to (company-)specific information.*

Table 0-1 Data Needs Matrix (DNM)[26] *Disaggregated datasets shall be used.

		Most relevant process	Other process
Situation 1: process run by the company applying the PEFCR	**Option 1**	Provide company-specific data (as requested in the PEFCR) and create a company specific dataset partially disaggregated at least at level 1 (DQR ≤1.6). Calculate the DQR values (for each criteria + total)	
	Option 2		Use default secondary dataset in PEFCR, in aggregated form (DQR ≤3.0). Use the default DQR values
Situation 2: process not run by the company applying the PEFCR but with access to (company-)specific information	**Option 1**	Provide company-specific data (as requested in the PEFCR) and create a company specific dataset partially disaggregated at least at level 1 (DQR ≤1.6). Calculate the DQR values (for each criteria + total)	
	Option 2	Use company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply-chain specific PEF compliant datasets (DQR ≤3.0).* Re-evaluate the DQR criteria within the product specific context	
	Option 3		Use company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply-chain specific PEF compliant datasets (DQR ≤4.0). Use the default DQR values
Situation 3: process not run by the company applying the PEFCR and without access to (company)-specific information	**Option 1**	Use default secondary dataset, in aggregated form (DQR ≤3.0). Re-evaluate the DQR criteria within the product specific context	
	Option 2		Use default secondary dataset in PEFCR, in aggregated form (DQR ≤4.0) Use the default DQR values

It is expected that this PEFCR will be mainly applied by feed companies. For that reason, and as an example, the Data Needs Matrix has been implemented from the perspective of a feed company in annex 3

9.5.1 Processes in situation 1

For each process in situation 1 there are two possible options:

[26] The options described in the DNM are not listed in order of preference

- *The process is in the list of most relevant processes as specified in the PEFCR or is not in the list of most relevant process, but still the company wants to provide company specific data (option 1);*
- *The process is not in the list of most relevant processes and the company prefers to use a secondary dataset (option 2).*

Situation 1/Option 1

For all processes run by the company and where the company applying the PEFCR uses company specific data. The DQR of the newly developed dataset shall be evaluated as described in section 9.4.1.

Situation 1/Option 2

For the non-most relevant processes only, if the applicant decides to model the process without collecting company-specific data, then the applicant shall use the secondary dataset listed in the PEFCR together with its default DQR values listed here.

If the default dataset to be used for the process is not listed in the PEFCR, the applicant of the PEFCR shall take the DQR values from the metadata of the original dataset.

9.5.2 Processes in situation 2

When a process is not run by the company applying the PEFCR, but there is access to company-specific data, then there are two possible options:

- *The company applying the PEFCR has access to extensive supplier-specific information and wants to create a new EF-compliant dataset[27] (Option 1);*
- *The company has some supplier-specific information and want to make some minimum changes (Option 2).*
- *The process is not in the list of most relevant processes and the company prefers to use a secondary dataset (option 3).*

Situation 2/Option 1

For all processes run by the company and where the company applying the PEFCR uses company specific data. The DQR of the newly developed dataset shall be evaluated as described in section 9.4.1.

Situation 2/Option 2

Company-specific activity data for transport are used and the sub-processes used for electricity mix and transport with supply-chain specific PEF compliant datasets are substituted starting from the default secondary dataset provided in the PEFCR.

Please note that, the PEFCR lists all dataset names together with the UUID of their aggregated dataset. For this situation, the disaggregated version of the dataset is required.

[27] The review of the newly created dataset is optional

The applicant of the PEFCR shall make the DQR values of the dataset used context-specific by re-evaluating Te_R and Ti_R, using the tables provided. The criteria G_R shall be lowered by 30%[28] and the criteria P shall keep the original value.

Situation 2/Option 3

For the non-most relevant processes, the applicant may use the corresponding secondary dataset listed in the PEFCR together with its DQR values.

If the default dataset to be used for the process is not listed in the PEFCR, the applicant of the PEFCR shall take the DQR values from the original dataset.

Table 9.5.2-1: How to assess the values of the DQR criteria when secondary datasets are used.

	TiR	TeR	G_R
1	*The EF report publication date happens within the time validity of the dataset*	*The technology used in the EF study is exactly the same as the one in scope of the dataset*	*The process modelled in the EF study takes place in the country the dataset is valid for*
2	*The EF report publication date happens not later than 2 years beyond the time validity of the dataset*	*The technologies used in the EF study is included in the mix of technologies in scope of the dataset*	*The process modelled in the EF study takes place in the geographical region (e.g. Europe) the dataset is valid for*
3	*The EF report publication date happens not later than 4 years beyond the time validity of the dataset*	*The technologies used in the EF study are only partly included in the scope of the dataset*	*The process modelled in the EF study takes place in one of the geographical regions the dataset is valid for*
4	*The EF report publication date happens not later than 6 years beyond the time validity of the dataset*	*The technologies used in the EF study are similar to those included in the scope of the dataset*	*The process modelled in the EF study takes place in a country that is not included in the geographical region(s) the dataset is valid for, but sufficient similarities are estimated based on expert judgement.*
5	*The EF report publication date happens later than 6 after the time validity of the dataset*	*The technologies used in the EF study are different from those included in the scope of the dataset*	*The process modelled in the EF study takes place in a different country than the one the dataset is valid for*

9.5.3 Processes in situation 3

When a process is not run by the company applying the PEFCR and the company does not have access to company-specific data, there are two possible options:

- *It is in the list of most relevant processes (situation 3, option 1)*
- *It is not in the list of most relevant processes (situation 3, option 2)*

[28] In situation 2, option 2 it is proposed to lower the parameter G_R by 30% in order to incentivize the use of company specific information and reward the efforts of the company in increasing the geographic representativeness of a secondary dataset through the substitution of the electricity mixes and of the distance and means of transportation.

Situation 3/Option 1

In this case, the applicant of the PEFCR shall make the DQR values of the dataset used context-specific by re-evaluating Te_R, Ti_R and G_r, using the tables provided. The criteria P shall keep the original value.

Situation 3/Option 2

For the non-most relevant processes, the applicant shall use the corresponding secondary dataset listed in the PEFCR together with its DQR values.

If the default dataset to be used for the process is not listed in the PEFCR, the applicant of the PEFCR shall take the DQR values from the original dataset.

9.6 Which datasets to use?

The secondary datasets to be used by the applicant are those listed in this PEFCR. Whenever a dataset needed to calculate the PEF-profile is not among those listed in this PEFCR, then the applicant shall choose between the following options (in hierarchical order):

1. *Use an EF-compliant dataset available on one of the following nodes:*
    a. *http://eplca.jrc.ec.europa.eu/EF-node*
    b. *http://lcdn.blonkconsultants.nl*
    c. *http://ecoinvent.lca-data.com*
    d. *http://lcdn-cepe.org*
    e. *https://lcdn.quantis-software.com/PEF/*
    f. *http://lcdn.thinkstep.com/Node*
2. *Use an EF-compliant dataset available in a free or commercial source;*
3. *Use another EF-compliant dataset considered to be a good proxy. In such case this information shall be included in the "limitation" section of the PEF report.*
4. *Use an ILCD-entry level-compliant dataset. In such case this information shall be included in the "data gap" section of the PEF report.* The Global Feed LCA Institute[29] is a freely available source of ILCD-entry level-compliant datasets for the production of feed ingredients recommended for the implementation of this PEFCR. The GFLI also provide references for ILCD-entry level compliant datasets which are in the process of being implemented in the GFLI database and can be used with this PEFCR during this transitory implementation phase. A typical lack of data relative to the production of feed ingredients would be the country of origin. The decision tree below shall be followed to identify which datasets to use, without prejudice to the above-hierarchy.

[29] www.globalfeedlca.org

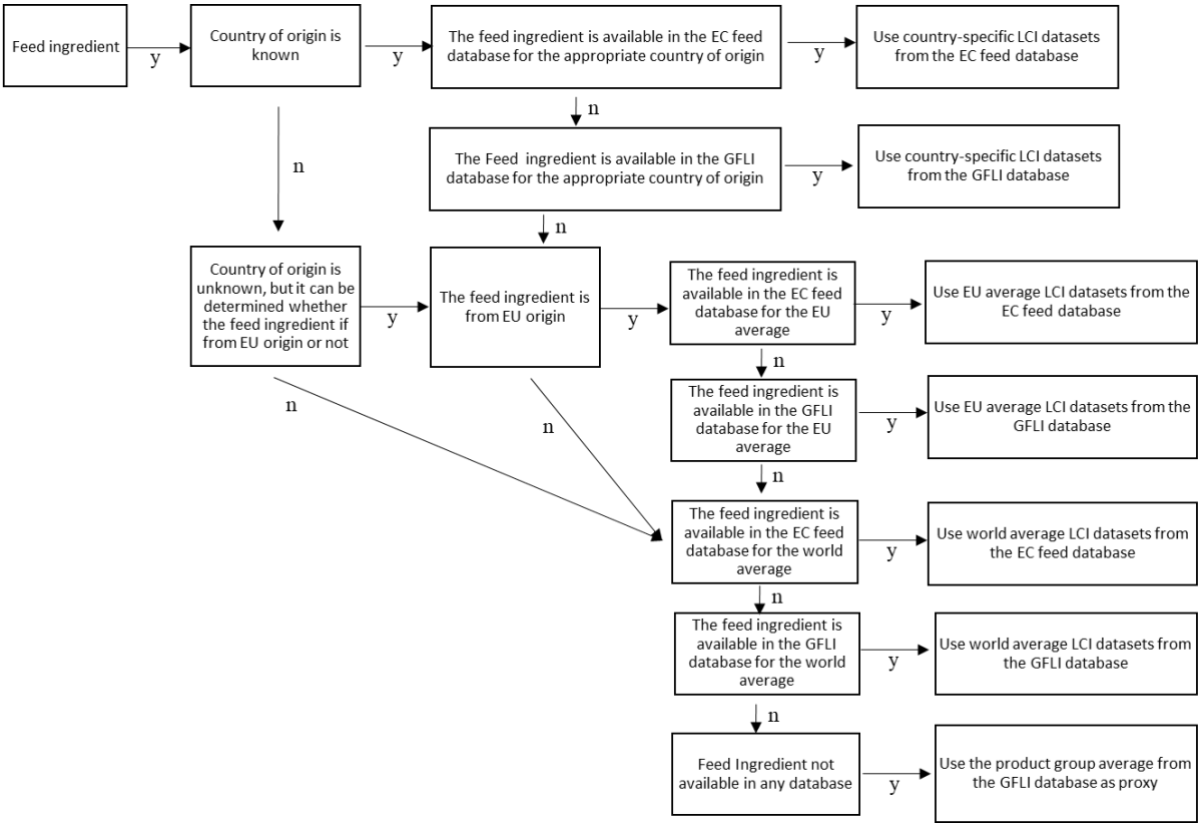

Figure 9.5.3-1: Decision tree on how to deal with missing data for feed ingredients (the availability of a dataset shall be understood as readily available from the GFLI database or referenced by the GFLI)

In some cases, no data is available in the EC or GFLI databases. In that case proxies (regional or global average for the feed ingredient at stake or product group average) need to be used, as mentioned in the decision tree above. Using proxies always triggers lower data quality (i.e. higher DQR).

Case 1: the ingredient is available in the EC or GFLI database, but not for the appropriate origin (e.g. corn from Mexico. Data on corn may be available but not for corn from Mexico)

Proxy: Use the world average for the same ingredient and modify data quality

Case 2: for a given ingredient (processed or unprocessed), there is no data available in the EC database nor in the GFLI database

Proxy: Use the average of the appropriate group of ingredients according to GFLI classification and modify data quality

Group average data sets are available from the GFLI database (e.g. a proxy dataset for “Vegetable meals”).

The use of proxy data shall be reported in the “limitation” section of the PEF report.
The use of ILCD-entry level-compliant datasets shall be reported as data gap.

The consequences of the choice of the datasets on the data quality are explained in section 9.5 and in annex 4.

9.7 How to calculate the average DQR of the study

The average DQR of the study (DQR_{total}) shall be calculated per DQR criterion and as final result using equation 1 page 43 and the following formula:

$$DQRtotal = \overline{DQRfm} * a + \overline{DQRo} * b + \overline{DQRfi} * c + \overline{DQRfip} * d + \overline{DQRfis} * e$$

Where:

- DQRfm = average DQR of feed mill operation data(s); a =contribution of feed mill operation(s) to single Environmental Impact (EI) score
- DQRo= average DQR of outbound transport(s); b = contribution of outbound transport(s) to EI score
- DQRi = average DQR of inbound transport(s); c = contribution of inbound transport(s) to EI score
- DQRfip = average DQR of feed ingredient(s) primary data; d = contribution of feed ingredient(s) for which primary data are used to EI score
- DQRfis = average DQR of feed ingredient(s) secondary data; e = contribution of feed ingredient(s) for which secondary data are used to EI score

The five DQRs (feed mill, outbound transport, inbound transport, feed ingredients primary data when applicable and feed ingredients secondary data) and the DQR total shall be reported weighted to determine the overall DQR. The minimum data quality requirements per life cycle process are listed in Table 9.5.3-1.

Table 9.5.3-1: Data quality requirements (the lower the score, the better)

	DQR Total	DQRfm Feed mill	DQRo Outbound transport	DQRi Inbound transport	DQRfip Feed ingredient primary	DQRfis Feed ingredient secondary
Required score without comparison	**<3**	**<1.6**	**<1.6**	**<3**	**<1.6**	**<3**
Required score for comparisons	**<2**	**<1.6**	**<1.6**	**<3**	**<1.6**	**<3**

9.8 Allocation rules

Allocation shall be conducted according to the table below:

Table 9.5.3-1: *Allocation rules*

Process	***Allocation rule***	***Modelling instructions***

Transport	Physical allocation	Allocation of transport emissions to transported products shall be done on the basis of physical causality, such as mass share, unless the density of the transported product is significantly lower than average so that the volume transported is less than the maximum load. Allocation of empty transport kilometers shall be done on the basis of the average load factor of the transport that is under study. If no supporting information is available, it shall be assumed that 100 percent additional transport is needed for empty return, which equals the utility rate of 50% (Guidance 6.3)
Allocation of co-products from a crop at the farm	Economic allocation .	Economic allocation shall be conducted on the basis of the method and default allocation factors (see accompanying excel file) If primary data are collected for feed ingredients economic allocation shall be done according to the procedure described in the LEAP feed guidelines
Processing of feed ingredients	Economic allocation	Economic allocation shall be conducted on the basis of the method and default allocation factors (see accompanying excel file and recommendations of the CMWG). If primary data are collected for feed ingredients economic allocation shall be done according to the procedure described in the LEAP feed guidelines
Feed mill operations, i.e. compound feed production (electricity, gas, water use,…)	Two situations shall be distinguished for the feed mill operations:	

	1) Specific feed mill data are available (see section 9.1.3): no need to allocate 2) Average feed mill data are available (see section 9.1.3): mass allocation shall be used (average consumption per tonne of feed produced)	

9.9 Electricity modelling

The guidelines in this section shall only be used for the processes where company-specific information is collected (situation 1 / Option 1 & 2 / Option 1of the DNM), i.e. electricity consumption at the feed mill.

The following electricity mix shall be used in hierarchical order:

(i) Supplier-specific electricity product shall be used if:
- *(a) available, and*
- *(b) the set of minimum criteria to ensure the contractual instruments are reliable is met.*

(ii) The supplier-specific total electricity mix shall be used if:
- *(a) available, and*
- *(b) the set of minimum criteria that to ensure the contractual instruments are reliable is met.*

(iii) As a last option the 'country-specific residual grid mix, consumption mix' shall be used (available at http://lcdn.thinkstep.com/Node/). Country-specific means the country in which the life cycle stage occurs. This can be an EU country or non-EU country. The residual grid mix characterizes the unclaimed, untracked or publicly shared electricity. This prevents double counting with the use of supplier-specific electricity mixes in (i) and (ii).

Note: if for a country, there is a 100% tracking system in place, case (i) shall be applied.

The environmental integrity of the use of supplier-specific electricity mix depends on ensuring that contractual instruments (for tracking) ***reliably and uniquely convey claims to consumers****. Without this, the PEF lacks the accuracy and consistency necessary to drive product/corporate electricity procurement decisions and accurate consumer (buyer of electricity) claims. Therefore, a set of minimum criteria that relate to the integrity of the contractual instruments as reliable conveyers of environmental footprint information has been identified. They represent the minimum features necessary to use supplier-specific mix within PEF studies.*

Set of minimal criteria to ensure contractual instruments from suppliers:

A supplier-specific electricity product/mix may only be used when the applicant ensures that any contractual instrument meets the criteria specified below. If contractual instruments do not meet the criteria, then 'country-specific residual grid mix, consumption mix' shall be used in the modelling.

A contractual instrument used for electricity modelling shall:

1. *Convey attributes:*
    - *Convey the energy type mix associated with the unit of electricity produced.*
    - *The energy type mix shall be calculated based on delivered electricity, incorporating certificates sourced and retired on behalf of its customers. Electricity from facilities for which the attributes have been sold off (via contracts or certificates) shall be characterized as having the environmental attributes of the country residual consumption mix where the facility is located.*
2. *Be a unique claim:*
    - *Be the only instruments that carry the environmental attribute claim associated with that quantity of electricity generated.*
    - *Be tracked and redeemed, retired, or cancelled by or on behalf of the company (e.g. by an audit of contracts, third-party certification, or may be handled automatically through other disclosure registries, systems, or mechanisms).*
3. *Be as close as possible to the period to which the contractual instrument is applied.*

<u>Modelling 'country-specific residual grid mix, consumption mix':</u>

Datasets for residual grid mix, per energy type, per country and per voltage have been purchased by the European Commission and are available in the dedicated node (http://lcdn.thinkstep.com/Node/). In case the necessary dataset is not available, an alternative dataset shall be chosen according to the procedure described in section B.5.8. If no dataset is available, the following approach may be used:

Determine the country consumption mix (e.g. X% of MWh produced with hydro energy, Y% of MWh produced with coal power plant) and combined them with LCI datasets per energy type and country/region (e.g. LCI dataset for the production of 1MWh hydro energy in Switzerland):

- *Activity data related to non-EU country consumption mix per detailed energy type shall be determined based on:*
    - *Domestic production mix per production technologies*
    - *Import quantity and from which neighbouring countries*
    - *Transmission losses*
    - *Distribution losses*
    - *Type of fuel supply (share of resources used, by import and / or domestic supply)*

  These data can be found in the publications of the International Energy Agency (IEA).
- *Available LCI datasets per fuel technologies in the node. The LCI datasets available are generally specific to a country or a region in terms of:*

- *Fuel supply (share of resources used, by import and / or domestic supply),*
- *Energy carrier properties (e.g. element and energy contents)*
- *Technology standards of power plants regarding efficiency, firing technology, flue-gas desulphurisation, NOx removal and de-dusting.*

Allocation rules for electricity consumption in the feed mill

Two situations shall be distinguished for the amount of electricity to be used:

- Specific feed mill data are available for electricity consumption (see section 9.1.3): no need to allocate.
- Average feed mill data are available for electricity consumption (see section 9.1.3): mass allocation shall be used (average electricity consumption per tonne of feed produced).

If the consumed electricity comes from more than one electricity mix for the type of electricity mix to be applied, each mix source shall be used in terms of its proportion in the total kWh consumed. For example, if a fraction of this total kWh consumed is coming from a specific supplier a supplier-specific electricity mix shall be used for this part. See below for on-site electricity use.

A specific electricity type can be allocated to one specific product in the following conditions:

a. The production (and related electricity consumption) of a product occurs in a separate site (building), the energy type physical related to this separated site can be used.

b. The production (and related electricity consumption) of a product occurs in a shared space with specific energy metering or purchase records or electricity bills, the product specific information (measure, record, bill) can be used.

c. All the products produced in the specific plant are supplied with a public available PEF study. The company who wants to make the claim shall make all PEF studies available. The allocation rule applied shall be described in the PEF study, consistently applied in all PEF studies connected to the site and verified. An example is the 100% allocation of a greener electricity mix to a specific product.

On-site electricity generation:

If on-site electricity production is equal to the site own consumption, two situations apply:

- *No contractual instruments have been sold to a third party: the own electricity mix (combined with LCI datasets) shall be modelled.*
- *Contractual instruments have been sold to a third party: the 'country-specific residual grid mix, consumption mix' (combined with LCI datasets) shall be used.*

If electricity is produced in excess of the amount consumed on-site within the defined system boundary and is sold to, for example, the electricity grid, this system can be seen as a multifunctional situation. The system will provide two functions (e.g. product + electricity) and the following rules shall be followed:

- *If possible, apply subdivision.*

- *Subdivision applies both to separate electricity productions or to a common electricity production where you can allocate based on electricity amounts the upstream and direct emissions to your own consumption and to the share you sell out of your company (e.g. if a company has a wind mill on its production site and export 30% of the produced electricity, emissions related to 70% of produced electricity should be accounted in the PEF study.*
- *If not possible, direct substitution shall be used. The country-specific residual consumption electricity mix shall be used as substitution[30].*
- *Subdivision is considered as not possible when upstream impacts or direct emissions are closely related to the product itself.*

9.10 Climate change modelling

The impact category 'climate change' shall be modelled considering three sub-categories:

1. *Climate change – fossil: This sub-category includes emissions from peat and calcination/carbonation of limestone. The emission flows ending with '(fossil)' (e.g., 'carbon dioxide (fossil)'' and 'methane (fossil)') shall be used if available.*
2. *Climate change – biogenic: This sub-category covers carbon emissions to air (CO_2, CO and CH_4) originating from the oxidation and/or reduction of biomass by means of its transformation or degradation (e.g. combustion, digestion, composting, landfilling) and CO_2 uptake from the atmosphere through photosynthesis during biomass growth – i.e. corresponding to the carbon content of products, biofuels or aboveground plant residues such as litter and dead wood. Carbon exchanges from native forests[31] shall be modelled under sub-category 3 (incl. connected soil emissions, derived products, residues). The emission flows ending with '(biogenic)' shall be used.*

   A simplified modelling approach shall be used when modelling the foreground emissions: Only the emission 'methane (biogenic)' is modelled, while no further biogenic emissions and uptakes from atmosphere are included. When methane emissions can be both fossil or biogenic, the release of biogenic methane shall be modelled first and then the remaining fossil methane."

   The biogenic carbon content at factory gate (physical content and allocated content) shall be reported as 'additional technical information'.

3. *Climate change – land use and land transformation: This sub-category accounts for carbon uptakes and emissions (CO_2, CO and CH_4) originating from carbon stock changes caused by land use change and land use. This sub-category includes biogenic carbon exchanges from deforestation, road construction or other soil activities (incl. soil carbon emissions). For native forests, all related CO_2 emissions are included and modelled under this sub-category (including connected soil emissions, products derived from native forest[32] and residues), while their CO_2 uptake is excluded. The emission flows ending with '(land use change)' shall be used.*

[30] For some countries, this option is a best case rather than a worst case.

[31] Native forests – represents native or long-term, non-degraded forests. Definition adapted from table 8 in Annex V C(2010)3751 to Directive 2009/28/EC.

[32] Following the instantaneous oxidation approach in IPCC 2013 (Chapter 2).

For land use change, all carbon emissions and removals shall be modelled following the modelling guidelines of PAS 2050:2011 (BSI 2011) and the supplementary document PAS2050-1:2012 (BSI 2012) for horticultural products. PAS 2050:2011 (BSI 2011): Large emissions of GHGs can result as a consequence of land use change. Removals as a direct result of land use change (and not as a result of long-term management practices) do not usually occur, although it is recognized that this could happen in specific circumstances. Examples of direct land use change are the conversion of land used for growing crops to industrial use or conversion from forestland to cropland. All forms of land use change that result in emissions or removals are to be included. Indirect land use change refers to such conversions of land use as a consequence of changes in land use elsewhere. While GHG emissions also arise from indirect land use change, the methods and data requirements for calculating these emissions are not fully developed. Therefore, the assessment of emissions arising from indirect land use change is not included.

The GHG emissions and removals arising from direct land use change shall be assessed for any input to the life cycle of a product originating from that land and shall be included in the assessment of GHG emissions. The emissions arising from the product shall be assessed on the basis of the default land use change values provided in PAS 2050:2011 Annex C, unless better data is available. For countries and land use changes not included in this annex, the emissions arising from the product shall be assessed using the included GHG emissions and removals occurring as a result of direct land use change in accordance with the relevant sections of the IPCC (2006). The assessment of the impact of land use change shall include all direct land use change occurring not more than 20 years, or a single harvest period, prior to undertaking the assessment (whichever is the longer). The total GHG emissions and removals arising from direct land use change over the period shall be included in the quantification of GHG emissions of products arising from this land on the basis of equal allocation to each year of the period.

1) Where it can be demonstrated that the land use change occurred more than 20 years prior to the assessment being carried out, no emissions from land use change should be included in the assessment.

2) Where the timing of land use change cannot be demonstrated to be more than 20 years, or a single harvest period, prior to making the assessment (whichever is the longer), it shall be assumed that the land use change occurred on 1 January of either:

- *the earliest year in which it can be demonstrated that the land use change had occurred; or*
- *on 1 January of the year in which the assessment of GHG emissions and removals is being carried out.*

The following hierarchy shall apply when determining the GHG emissions and removals arising from land use change occurring not more than 20 years or a single harvest period, prior to making the assessment (whichever is the longer):

1. *where the country of production is known and the previous land use is known, the GHG emissions and removals arising from land use change shall be those resulting from the change in land use from the previous land use to the current land use in that country (additional guidelines on the calculations can be found in PAS 2050-1:2012);*

2. *where the country of production is known, but the former land use is not known, the GHG emissions arising from land use change shall be the estimate of average emissions from the land use change for that crop in that country (additional guidelines on the calculations can be found in PAS 2050-1:2012);*
3. *where neither the country of production nor the former land use is known, the GHG emissions arising from land use change shall be the weighted average of the average land use change emissions of that commodity in the countries in which it is grown.*

Knowledge of the prior land use can be demonstrated using a number of sources of information, such as satellite imagery and land survey data. Where records are not available, local knowledge of prior land use can be used. Countries in which a crop is grown can be determined from import statistics, and a cut-off threshold of not less than 90% of the weight of imports may be applied. Data sources, location and timing of land use change associated with inputs to products shall be reported.

It is not recommended to model, calculate and report soil carbon storage as additional environmental information.

The sum of the three sub-categories shall be reported.

The sub-category 'Climate change-biogenic' shall be reported separately (methane)

The sub-category 'Climate change-land use and land transformation' shall be reported separately.

9.11 End of life modelling for packaging materials

This section is mainly relevant for PEF studies involving feed delivered in bags to the livestock farm, for the end of life of the packaging. This represents a very limited market share.

According to the PEF Guidance 6.3, *The Circular Footprint Formula is used to model the End-of-Life of products as well as the recycled content and is a combination of "material + energy + disposal", i.e.:*

Material $(1-R_1)E_V + R_1 \times \left(AE_{recycled} + (1-A)E_V \times \frac{Q_{Sin}}{Q_p}\right) + (1-A)R_2 \times \left(E_{recyclingEoL} - E_V^* \times \frac{Q_{Sout}}{Q_P}\right)$

Energy $(1-B)R_3 \times (E_{ER} - LHV \times X_{ER,heat} \times E_{SE,heat} - LHV \times X_{ER,elec} \times E_{SE,elec})$

Disposal $(1-R_2-R_3) \times E_D$

With the following parameters:

A: *allocation factor of burdens and credits between supplier and user of recycled materials.*

B: *allocation factor of energy recovery processes: it applies both to burdens and credits.*

Qs_{in}: *quality of the ingoing secondary material, i.e. the quality of the recycled material at the point of substitution.*

Qs_{out}: *quality of the outgoing secondary material, i.e. the quality of the recyclable material at the point of substitution.*

Q_p: *quality of the primary material, i.e. quality of the virgin material.*

R_1: *it is the proportion of material in the input to the production that has been recycled from a previous system.*

R_2: *it is the proportion of the material in the product that will be recycled (or reused) in a subsequent system. R2 shall therefore take into account the inefficiencies in the collection and recycling (or reuse) processes. R2 shall be measured at the output of the recycling plant.*

R_3: *it is the proportion of the material in the product that is used for energy recovery at EoL.*

$E_{recycled}$ (E_{rec}): *specific emissions and resources consumed (per unit of analysis) arising from the recycling process of the recycled (reused) material, including collection, sorting and transportation process.*

$E_{recyclingEoL}$ (E_{recEoL}): *specific emissions and resources consumed (per unit of analysis) arising from the recycling process at EoL, including collection, sorting and transportation process.*

E_v: *specific emissions and resources consumed (per unit of analysis) arising from the acquisition and pre-processing of virgin material.*

E^*_v: *specific emissions and resources consumed (per unit of analysis) arising from the acquisition and pre-processing of virgin material assumed to be substituted by recyclable materials.*

EER: *specific emissions and resources consumed (per unit of analysis) arising from the energy recovery process (e.g. incineration with energy recovery, landfill with energy recovery, …).*

$E_{SE,heat}$ and $E_{SE,elec}$: *specific emissions and resources consumed (per unit of analysis) that would have arisen from the specific substituted energy source, heat and electricity respectively.*

ED: *specific emissions and resources consumed (per unit of analysis) arising from disposal of waste material at the EoL of the analysed product, without energy recovery.*

$X_{ER,heat}$ and $X_{ER,elec}$: *the efficiency of the energy recovery process for both heat and electricity.*

LHV: *Lower Heating Value of the material in the product that is used for energy recovery.*

The default approach for the implementation of the CFF in this PEFCR is the following

- Set the parameters R_1, R_2, R_3 to 0. The CFF becomes $E_V + E_D$ (simplified approach assuming no recycling and no use of recycled material for the production of bags following annex C of Guidance 6.3). See the accompanying excel file for the secondary datasets to be used for E_V and E_D

It is possible to deviate from this default approach when more information is available on the recycling of bags used to deliver the feed. In that case, primary data shall be used for the parameters of the circular footprint formula and the recommendations of the Guidance 6.3 shall be followed.

10) Life cycle stages

The PEF study operator shall report the DQR values for all the datasets used.

10.1 Raw material acquisition and processing (i.e. production of feed ingredients)

The processes taking place at this life cycle stage are

- cultivation of plant-based feed ingredients
- production of animal-based feed ingredients
- production of other types of feed ingredients (minerals, additives such as enzymes, vitamins or amino-acids,…)
- processing of feed ingredients
- production of packaging in case feed is delivered in bag (very limited number of situations)
- Inbound transport (to feed mill)

The environmental footprint of a cradle to gate feed product is mainly determined by the environmental footprint of its feed ingredients. In many cases secondary data will be used, as the process is not run or under the control of the company applying the PEFCR. However, when considered relevant and feasible, it is possible to model the production of feed ingredients and to use primary data instead of secondary data. Replacing secondary data with primary data for feed ingredients shall fulfil the requirements described below.

10.1.1 Cultivation of plant-based feed ingredients

The modelling requirements of this section shall apply to any primary data for cultivation replacing default secondary data for cultivation of plant-based feed ingredients

It is the choice of the operator of the study to decide whether or not to use primary data for the cultivation of plant-based feed ingredients, if feasible and relevant. When deciding to use primary data, the following requirements shall be applied.

This section summarizes and translates the Guidance 6.3 into PEFCR requirements. The detailed requirements from Guidance 6.3 on agricultural modelling are listed in section 10.2. Further guidance on how to do the assessment in practice can be found in the LEAP guidelines[33] (FAO LEAP, 2015).

Cultivation includes all field and storage operations until the product is being sent for transport to the processing or to the feed mill. Cultivation may also involve land use change. For land use change, the modelling guidelines of PAS 2050:2011 and the supplementary document PAS 2050-1:2012 for horticultural products shall be applied, as described in the previous section on climate change modelling (section 9.10).

[33] Available at http://www.fao.org/3/a-i6433e.pdf

The following inputs shall be quantified per hectare of crop cultivation:

- Seeds, NPK-fertilizers, manure, fuels, irrigation water, crop protection product(s), chemicals, auxiliary materials taking into account crop rotation and steady state of production (averaging over more years, see Guidance 6.3 and PAS2050/1 (BSI, 2012) for further guidance in case of perennial crops)

- For the LCIs of production and logistics of agricultural inputs (fertilizers, crop protection products, fuels etc.) the secondary data provided in the PEFCR shall be used (see the accompanying excel file)

The following economic outputs shall be quantified per hectare:

- Main crop product (mass, DM, financial value, gross energy content)
- Co-product(s) (mass, DM, financial value, gross energy content)
- Residual materials that remain on the field or in soil (mass, DM)
- Residual materials that are burnt and associated emissions
- Waste flows and destination

The following background information shall be collected on region of cultivation and farm management:

- Country of production
- Irrigation water use in country/region of production
- Land transformation in past 20 years according to PAS2050/1 (BSI, 2012)
- Description of farm practices (as meta information)
    - Farm rotation scheme
    - Tillage/ no tillage
    - Method of crop protection products application
    - Method of manure/fertilizers application

The following outputs shall be quantified per hectare in compliance with the modelling requirements defined in Guidance 6.3

1. Emissions from combustion of fuels
2. CO_2 emissions related to application of fossil carbon containing products (lime, peat, etc.)
3. N_2O emissions related to manure and fertilizer application and to crop residues NH_3 emissions related to manure and fertilizer application
4. NO_3 emissions to water related to manure and fertilizer application
5. P emissions to soil and water related to manure and fertilizer application
6. Heavy metals emissions related to manure and fertilizer application on basis of mass balance approach
7. Crop protection products emissions

All economic inputs and elementary flows (resource use and emissions) per hectare shall be related to the net yields (after losses) per hectare.

Allocation in case of crop rotation and co-production (e.g. wheat and straw) shall be treated according to the decision-tree and recommendations mentioned in the LEAP guidelines, as explained in section 9.8 on allocation.

10.1.2 Production of animal-based feed ingredients

In the cradle to gate approach followed in this PEFCR, the production of livestock products does not belong to the life cycle stages under consideration. It belongs nevertheless to the life cycle of animal products for which this PEFCR is an important module or building block.

Animal products can re-enter the lifecycle at the compounding of feed as feed ingredients from the processing of animal products from the slaughterhouse for instance, e.g. plasma protein or the dairy processing industry such as whey powders. In that case and in order to avoid creating loops in the model, these products shall be modelled using 'average' data as an attributional approach as prescribed in the PEF (thus using an 'average' LCI of the animal product).

10.1.3 Production of other types of feed ingredients

The FAO-led LEAP will develop recommendations on how to model the production of specialty feed ingredients. When available, these recommendations shall be used.

In the meantime, primary data may be used for the production of specialty feed ingredients, provided the modelling choices are transparently reported. Secondary data may also be used.

10.1.4 Processing of feed ingredients

The modelling requirements of this section shall apply to any primary data for processed feed ingredient replacing default secondary data for processed feed ingredient.

Like for plant-based feed ingredients, it is the choice of the operator of the study to decide whether or not to use primary data for processed feed ingredients. When deciding to use primary data, the following requirements shall be applied and combined with previous requirements when applicable.

The following inputs shall be quantified per tonne of feed ingredient input: fuels, electricity, auxiliary materials taking into account steady state of production (averaging over appropriate period).

For the LCIs of production and logistics of these inputs the EC acquired PEF datasets or the GFLI dataset shall be used.

The following outputs shall be quantified, following a mass balance approach:

- Product of interest (mass, DM, financial value, gross energy content (LHV))
- Co-product (mass, DM, financial value, gross energy content (LHV))

- Residual materials that are considered to have zero value (mass, DM)
- Waste flows and destination

The following background information shall be collected on region of production:

- Country of production
- Blue water consumption in country/region of production

The following outputs shall be quantified

- Emissions from the combustion of fuels
- Process specific emissions to water, air and soil

10.1.5 Packaging production

Since feed delivered in bag represents only a small market share, this PEFCR does not request the use of primary data for packaging production.

The packaging datasets available on the node shall be used. See the accompanying excel file for further instructions.

When supplier-specific information is available, the packaging production may be modelled according to section 7.16 of the PEF Guidance version 6.3.

10.1.6 Inbound transport

Since inbound transport does not belong to mandatory company-specific data, the modelling requirements of this section shall apply to any primary data replacing default secondary data for inbound transport.

It is the choice of the operator of the study to decide whether or not to use primary data for inbound transport feed ingredients. When deciding to use primary data, the following requirements shall be applied

Feed business operators producers shall collect the following information of logistics from their suppliers of feed ingredients when possible

- The last production location of the feed ingredient before transport to the feed mill and its distance to the feed mill (in case of a processed material this is the processing plant[34], in case of a crop this is the location of cultivation).
- The average transport scenario of the feed ingredient differentiated per transport means.

An example is provided in the table below

Table 10.1.6-1: Example of transport data to be collected from suppliers of the feed materials per feed material.

[34] For processed ingredient, the first step of transport, from the place of cultivation to the place of processing is covered by the secondary databases for feed ingredients.

Feed Material	Supplier		D (km)	Share (%)	Name of EC transport dataset(s)
Feed Material A	Supplier 1	Truck total	800		Transport outside EU: Default biggest lorries LCI results for North America (NA), South America (SA), Asia (RAS) or rest of world (ROW). Transport within EU Default: Articulated lorry transport, Total weight >32 t, mix Euro 0-5; diesel driven, Euro 0 - 5 mix, cargo; consumption mix, to consumer; more than 32t gross weight / 24,7t payload capacity, see also accompanying spreadsheet Parameterised processes can be used for EU transport according to if data is available. A default utilisation ratio of 85% shall be used. This utilisation ratio includes empty return trips (reference to PEF guidance 6.3 section 7.14.1.1)
		• Truck >32 Euro 0		30%	
		• Truck >32 Euro 1		50%	
		• Truck >32 Euro 2			
		• Truck >32 Euro 3			
		• Truck >32 Euro 4		20%	
		• Truck >32 Euro 5			
		Barge	140	100%	Barge; technology mix, diesel driven, cargo; consumption mix, to consumer; 1500 t payload capacity
		Freight train	400	100%	Freight train, diesel traction; diesel driven, cargo; consumption mix, to consumer; average train, gross tonne weight 1000t / 726t payload capacity
		Sea vessel	11000	100%	Transoceanic ship, bulk; heavy fuel oil driven, cargo; consumption mix, to consumer; 100.000- 200.000 dwt payload capacity, ocean going

If the feed business operator cannot determine the transport distances and modes, default data on distances and modes shall be used (however production location still needs to be known), see annex 6.

10.2 Agricultural modelling

10.2.1 Handling multi-functional processes

The rules described in the LEAP Guideline shall be followed: 'Environmental performance of animal feeds supply chains (pages 36-43), FAO 2015, available at http://www.fao.org/partnerships/leap/publications/en/'.

10.2.2 Crop type specific and country -region-or climate specific data

Crop type specific and country-region-or-climate specific data for yield, water and land use, land use change, fertiliser (artificial and organic) amount (N, P amount) and pesticide amount (per active ingredient), per hectare per year, should be used.

10.2.3 Averaging data

Cultivation data shall be collected over a period of time sufficient to provide an average assessment of the life cycle inventory associated with the inputs and outputs of cultivation that will offset fluctuations due to seasonal differences:

- *For annual crops, an assessment period of at least three years shall be used (to level out differences in crop yields related to fluctuations in growing conditions over the years such as climate, pests and diseases, et cetera). Where data covering a three-year period is not available i.e. due to starting up a new production system (e.g. new greenhouse, newly cleared land, shift to other crop), the assessment may be conducted over a shorter period, but shall be not less than 1 year. Crops/plants grown in greenhouses shall be considered as annual crops/plants, unless the cultivation cycle is significantly shorter than a year and another crop is cultivated consecutively within that year. Tomatoes, peppers and other crops which are cultivated and harvested over a longer period through the year are considered as annual crops.*
- *For perennial plants (including entire plants and edible portions of perennial plants) a steady state situation (i.e. where all development stages are proportionally represented in the studied time period) shall be assumed and a three-year period shall be used to estimate the inputs and outputs[35].*
- *Where the different stages in the cultivation cycle are known to be disproportional, a correction shall be made by adjusting the crop areas allocated to different development stages in proportion to the crop areas expected in a theoretical steady state. The application of such correction shall be justified and recorded. The life cycle inventory of perennial plants and crops shall not be undertaken until the production system actually yields output.*

[35] The underlying assumption in the cradle to gate life cycle inventory assessment of horticultural products is that the inputs and outputs of the cultivation are in a 'steady state', which means that all development stages of perennial crops (with different quantities of inputs and outputs) shall be proportionally represented in the time period of cultivation that is studied. This approach gives the advantage that inputs and outputs of a relatively short period can be used for the calculation of the cradle-to-gate life cycle inventory from the perennial crop product. Studying all development stages of a horticultural perennial crop can have a lifespan of 30 years and more (e.g. in case of fruit and nut trees).

- *For crops that are grown and harvested in less than one year (e.g. lettuce produced in 2 to 4 months) data shall be gathered in relation to the specific time period for production of a single crop, from at least three recent consecutive cycles. Averaging over three years can best be done by first gathering annual data and calculating the life cycle inventory per year and then determine the three years average.*

10.2.4 Crop protection products

Emissions shall be modelled as specific active ingredients. As temporary approach, the pesticides applied on the field shall be modelled as 90% emitted to the agricultural soil compartment, 1% emitted to water and 9% emitted to air.

10.2.5 Fertilisers

Fertiliser (and manure) emissions shall be differentiated per fertilizer type and cover as a minimum:

- *NH_3, to air (from N-fertiliser application)*
- *N_2O, to air (direct and indirect) (from N-fertiliser application)*
- *CO_2, to air (from lime, urea and urea-compounds application)*
- *NO_3, to water unspecified (leaching from N-fertiliser application)*
- *PO_4, to water unspecified or freshwater (leaching and run-off of soluble phosphate from P-fertiliser application)*
- *P, to water unspecified or freshwater (soil particles containing phosphorous, from P-fertiliser application).*

The LCI for P emissions should be modelled as the amount of P emitted to water after run-off and the emission compartment 'water' shall be used. When this amount is not available, the LCI may be modelled as the amount of P applied on the agricultural field (through manure or fertilisers) and the emission compartment 'soil' shall be used. In this case, the run-off from soil to water is part of the impact assessment method.

The LCI for N emissions shall be modelled as the amount of emissions ending up in the different emission compartments per amount of fertilisers applied. The nitrogen emissions shall be calculated from Nitrogen applications of the farmer on the field and excluding external sources (e.g. rain deposition).

Table 10.2.5-1: Parameters to be used when modelling nitrogen emission in soil.

Emission	***Compartment***	***Value to be applied***
N_2O (synthetic fertiliser and manure; direct and indirect)	*Air*	*0.022 kg N_2O/ kg N fertilizer applied*
NH_3 (synthetic fertiliser)	*Air*	*kg NH_3= kg N * FracGASF= 1*0.1* (17/14)= 0.12 kg NH_3/ kg N fertilizer applied*

Emission	*Compartment*	*Value to be applied*
NH_3 (manure)	*Air*	*kg NH_3= kg N*FracGASF= 1*0.2* (17/14)= 0.24 kg NH_3/ kg N manure applied*
NO_3^- (synthetic fertiliser and manure)	*Water*	*kg NO_3^-= kg N*FracLEACH = 1*0.3*(62/14) = 1.33 kg NO_3^-/ kg N applied*
P based fertilisers	*Water*	*0.05 kg P/ kg P applied*

10.2.6 Heavy metal emissions

Heavy metal emissions from field inputs shall be modelled as emission to soil and/or leaching or erosion to water. The inventory to water shall specify the oxidation state of the metal (e.g., Cr+3, Cr+6). As crops assimilate part of the heavy metal emissions during their cultivation clarification is needed on how to model crops that act as a sink. The following modelling approach shall be used:

- *The final fate (emission compartment) of the heavy metal elementary flows is considered within the system boundary: the inventory does account for the final emissions (release) of the heavy metals in the environment and therefore shall also account for the uptake of heavy metals by the crop. For example, heavy metals in agricultural crops cultivated for feed will mainly end up in the animal digestion and used as manure back on the field where the metals are released in the environment and their impacts are captured by the impact assessment methods. Therefore the inventory of the agricultural stage shall account for the uptake of heavy metals by the crop[36]. A limited amount ends up in the animal (= sink), which should be neglected for simplification.*

10.2.7 Rice cultivation

Methane emissions from rice cultivation shall be included on basis of IPCC 2006 calculation rules.

10.2.8 Peat soils

Drained peat soils shall include carbon dioxide emissions on the basis of a model that relates the drainage levels to annual carbon oxidation.

10.2.9 Other activities

The following activities shall be included :

- *Input of seed material (kg/ha)*

[36] There is no dataset with negative values for toxicity-related emissions in the secondary datasets listed in this PEFCR. When primary data are used for cultivation, the operator shall include manure application in the crop modelling to avoid negative values for toxicity-related emissions.

- *Input of peat to soil (kg/ha + C/N ratio)*
- *Input of lime (kg $CaCO_3$/ha, type)*
- *Machine use (hours, type) (to be included if there is high level of mechanisation)*
- *Input N from crop residues that stay on the field or are burned (kg residue + N content/ha)*
- *Crop yield (kg/ha)*
- *Drying and storage of products*
- *Field operations through total fuel consumption or through inputs of sub-farm units (specific machinery, transport to and from field, energy for irrigation, etc).*

10.3 Manufacturing

The data mentioned in **Error! Reference source not found.** shall be collected (repeated below). The d ata shall be recorded according to the format in the table. In the fourth column, the method of measurement should be explained. This includes the sources of information and any conversion of information and related assumptions.

Table 10.2.9-1: Collection of activity data at the feed mill

Activity data	Unit per tonne of feed out	Quantity	Source and method of measurement (if relevant)
Electricity use	kWh		
Gas use	MJ LHV		
Heat use	MJ LHV		
Other energy inputs	MJ LHV (specify type)		
Water	m^3 (specify type)		
Packaging (only in case of feed sold in small units e.g. 25 kg bags of calf feed)	Kg (specify type)		

Data can be derived on different levels of accurateness which needs to be determined in relation to the scope of the study.

If the feed operation is not part of assessing differences in a comparison between alternatives or changes in time the minimum level of accurateness shall be ***average feed mill data*** determined for 1 year of normal operation. (Normal operation is data corrected for calamities).

If comparisons are made (between alternatives or in time) that include changes in the feed mill operation (e.g. pelleting or not, temperature, pressure etc.) ***specific feed mill*** (e.g. processing line or sub-processing line) processing data shall be collected. This can either be done on the basis of measurements or an analysis where use of energy and auxiliary materials is derived on technical

specifications of equipment. Also if specific data are collected all use of energy and auxiliary materials of the feed mill shall be divided over the specific products (see sections 9.8 and 9.9).

Thus, any estimate of specific energy and auxiliary materials use for a feed product shall be done on the basis of allocating the use of the complete factory to sub-processes

Completeness of data

Data on electricity use, fuel use, heat use and shall always be recorded and collected on the basis of annual usage data based on consolidated information from feed mill's bookkeeping.

The collected activity data shall be connected with the secondary data for energy (see the accompanying excel file).

10.4 Distribution stage

The transport from factory to final client shall be modelled within this life cycle stage. The final client is defined as the livestock or fish farm.

Feed is usually delivered to livestock farm by truck while it is delivered by boat to fish farms. The delivery of feed to the farm is a mandatory company specific data (see section 9.1.4)

The format below shall be used for data collection

Table 10.2.9-1: Data collection for feed transport to farm if fuel use can be collected

Activity data	Unit	Quantity	Technology (EURO-class 1, 2, 3, 4,5, 6)	Source and method of measurement
Fuel use (type 1)	unit/tonne delivered feed (specify unit)			
Fuel use (type 2)	unit/tonne delivered feed (specify unit)			
Fuel use (type 3)	unit/tonne delivered feed (specify unit)			
Fuel use (type 4)	unit/tonne delivered feed (specify unit)			

The next step is to fill in Table 10.2.9-1 with the parameterized transport datasets as available in the EC datasets on transport, see the accompanying excel file.

The parametrized transport model will then calculate the emissions and fuel use assuming an average fuel use per kilometer. Since you have collected your own fuel use data per tonne delivered you shall correct the calculated fuel use and emissions of the parameterized process with your measured fuel use by the following formula:

Emissions & fuel use transport = (Calculated emissions & fuel use)* actual fuel use/calculated fuel use

The results shall be connected to the datasets for the production of mineral diesel and biodiesel from http://lcdn.thinkstep.com/Node/processSearch.xhtml

If no fuel use data is available, the hierarchy defined section 9.1.4 shall be followed.

11) PEF results

11.1 Representative product[37]

As mentioned in section 3.2, the representative product is a virtual compound feed product and consists of the average composition of feed ingredients consumed by the EU compound feed industry in the time period 2009-2013. The characterised, normalised and weighted results for the representative product are described in the tables below.

Table 10.2.9-1 ***: Characterised results for the representative product (virtual compound feed based on average consumption of feed ingredients by the EU compound feed industry)***

Impact category	Unit of measure	Value
Climate change total	kg $CO_{2\,eq}$	1304
of which Climate change - biogenic		35
of which Climate change – land use and land transformation		516
Ozone depletion	kg CFC-11 $_{eq}$	9.70E-07
Particulate matter	disease incidence	9.68E-05
Ionising radiation, human health	kBq U^{235} $_{eq}$	46
Photochemical ozone formation, human health	kg NMVOC $_{eq}$	3
Acidification	mol H+ $_{eq}$	12
Eutrophication, terrestrial	mol N $_{eq}$	51
Eutrophication, freshwater	kg P $_{eq}$	2.25E-01
Eutrophication, marine	kg N $_{eq}$	9

[37] Since feed is an intermediate product, no benchmark shall be considered

Impact category	Unit of measure	Value
Land use	Dimensionless (pt)	274510
Water use	m^3 world $_{eq}$	2174
Resource use, minerals and metals	kg Sb $_{eq}$	2.74E-04
Resource use, fossils	MJ	7316

Table 10.2.9-2 ***:Normalised results for results for the representative product (virtual compound feed based on average consumption of feed ingredients by the EU compound feed industry)***

Impact category	Value
Climate change	0.17
Climate change – fossil	n/a
Climate change – biogenic	n/a
Climate change - land use and transform.	n/a
Ozone depletion	4.2E-05
Ionising radiation, human health	0.011
Photochemical ozone formation, human health	0.068
Particulate matter	0.15
Acidification terrestrial and freshwater	0.21
Eutrophication, freshwater	0.088
Eutrophication, marine	0.33
Eutrophication, terrestrial	0.29
Land use	0.21
Water use	0.19
Resource use, fossils	0.11
Resource use, mineral and metals	0.0047

Table 10.2.9-3: ***Weighted results for results for the representative product (virtual compound feed based on average consumption of feed ingredients by the EU compound feed industry)***

Impact Category	***Value***
Climate change	3.7
Climate change - biogenic	0.19
Climate change – land use and land transformation	1.5
Ozone depletion	2.8E-04

Particulate matter	1.5
Ionising radiation, human health	5.9E-02
Photochemical ozone formation, human health	0.35
Acidification	1.4
Eutrophication terrestrial	1.1
Eutrophication freshwater	0.26
Eutrophication marine	1.0
Land use	1.7
Water use	1.7
Resource use, mineral and metals	3.8E-02
Resource use, fossils	1.0

11.2 PEF profile

The applicant shall calculate the PEF profile of its product in compliance with all requirements included in this PEFCR. The following information shall be included in the PEF report:

- *full life cycle inventory;*
- *characterised results in absolute values, for all impact categories (including toxicity; as a table);*
- *normalised and weighted result in absolute values, for all impact categories (including toxicity; as a table);*
- *the aggregated single score in absolute values*

Together with the PEF report, the applicant shall develop an aggregated EF-compliant dataset of its product in scope. This dataset shall be made available on the EF node (http://eplca.jrc.ec.europa.eu/EF-node). The disaggregated version may stay confidential.

11.3 Additional technical information

The following additional technical information

- Nutritional analysis data, as defined in section 9.1.2
- *The biogenic carbon content at factory gate (physical content) shall be reported. If derived from native forest, it shall report that the corresponding carbon emissions shall be modelled with the elementary flow '(land use change)'.*

11.4 Additional environmental information

11.4.1 Nitrous oxide (N_2O) emissions for climate change

The emissions from nitrous oxide (N2O) contributing to the impact on climate change shall be reported separately as additional environmental information.

11.4.2 Biodiversity

The TS feed recognizes the importance of quantifying the impact on biodiversity that the feed lifecycle may have. This is already partially captured by the impact categories listed in section 7.5, in particular with the impact assessment method which is recommended for land use and which is proposed by the United Nations Environment Programme (UNEP) as a proxy for the impact on biodiversity associated with land use. In the screening study, the possibility to assess impact on biodiversity was tested using ReCiPe (see screening report for more information). This was further tested in the supporting studies The indicator translates the following mid- point impacts to a pressure indicator on biodiversity on the basis of an underlying model (Goedkoop et al., 2009), into species lost for a period of time (species.year).

- Climate change Ecosystems
- Terrestrial acidification
- Freshwater eutrophication
- Terrestrial ecotoxicity
- Freshwater ecotoxicity
- Marine ecotoxicity
- Agricultural land occupation
- Urban land occupation
- Natural land transformation

Although the indicator can be improved the results seem to in line with the scientific knowledge on the major threats on biodiversity as being defined by the UNEP in the global biodiversity outlook (Secretariat of the Convention on Biological Diversity, 2010). ReCiPe is readily available in the main LCA software, is it therefore a cost-effective solution to address specifically biodiversity in PEF studies. Therefore, impacts on biodiversity shall be reported in PEF profiles as additional information, by applying this methodology.

One of the challenges when assessing the impacts on biodiversity of animal products, is to capture both on-farm and off-farm impacts. The off-farm impacts are mainly associated with the feed purchased by the farmer. The objective of this PEFCR is to provide recommendations addressing off-farm impacts perspective, hence the choice of ReCiPe which is an LCA-based approach.

This approach should be ideally complemented by recommendations relative to on-farm impacts on biodiversity, which would fall under the responsibility of the PEFCRs for animal products.

12) Verification

The verification of an EF study/report carried out in compliance with this PEFCR shall be done according to all the general requirements included in Section 8 of the PEFCR Guidance version 6.3 and the requirements listed below.

The verifier(s) shall verify that the EF study is conducted in compliance with this PEFCR.
These requirements will remain valid until an EF verification scheme is adopted at European level or alternative verification approaches applicable to EF studies/report are included in existing or new policies.

The verifier(s) shall validate the accuracy and reliability of the quantitative information used in the calculation of the study. As this can be highly resource intensive, the following requirements shall be followed:

- *the verifier shall check if the correct version of all impact assessment methods was used. For each of the most relevant impact categories, at least 50% of the characterisation factors (for each of the most relevant EF impact categories) shall be verified, while all normalisation and weighting factors of all ICs shall be verified. In particular, the verifier shall check that the characterisation factors correspond to those included in the EF impact assessment method the study declares compliance with[38];*
- *all the newly created datasets shall be checked on their EF compliancy (for the meaning of EF compliant datasets refer to Annex H of the Guidance). All their underlying data (elementary flows, activity data and sub processes) shall be validated;*
- *the aggregated EF-compliant dataset of the product in scope (meaning, the EF study) is available on the EF node (http://eplca.jrc.ec.europa.eu/EF-node).*
- *for at least 70% of the most relevant processes in situation 2 option 2 of the DNM, 70% of the underlying data shall be validated. The 70% data shall including all energy and transport sub processes for those in situation 2 option 2;*
- *for at least 60% of the most relevant processes in situation 3 of the DNM, 60% of the underlying data shall be validated;*
- *for at least 50% of the other processes in situation 1, 2 and 3 of the DNM, 50% of the underlying data shall be validated.*

In particular, it shall be verified for the selected processes if the DQR of the process satisfies the minimum DQR as specified in the DNM.

The selection of the processes to be verified for each situation shall be done ordering them from the most contributing to the less contributing one and selecting those contributing up to the identified percentage starting from the most contributing ones. In case of non-integer numbers, the rounding shall be made always considering the next upper integer.

These data checks shall include, but should not be limited to, the activity data used, the selection of secondary sub-processes, the selection of the direct elementary flows and the CFF parameters. For example, if there are 5 processes and each one of them includes 5 activity data, 5 secondary datasets and 10 CFF parameters, then the verifier(s) has to check at least 4 out of 5 processes (70%) and, for

[38] Available at: http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml

each process, (s)he shall check at least 4 activity data (70% of the total amount of activity data), 4 secondary datasets (70% of the total amount of secondary datasets), and 7 CFF parameters (70% of the total amount of CFF parameters), i.e. the 70% of each of data that could be possible subject of check.

The verification of the EF report shall be carried out by randomly checking enough information to provide reasonable assurance that the EF report fulfils all the conditions listed in section 8 of the PEFCR Guidance.

Particular attention shall be paid to the following aspects:

a) Is the list of feed ingredients representative for the feed under study, and does it accurately reflect the time related variability?
b) Is the list of feed ingredients consistent with the nutritional analysis data?
c) Is the list of feed ingredients correctly connected to the available secondary data?
d) If proxies have been used, are these determined in accordance to the procedures described in this PEFCR, and has the data quality been modified accordingly?

When this PEFCR is used to assess the environmental footprint of a high number of products, each PEF profile shall not be considered as an individual PEF study and a sampling procedure shall be used to apply the verification requirements, following common audit practices.

13) References

European Commission. (2013). 2013/179/EU: Commission Recommendation of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations. *Official Journal of the European Union*.

European Commission. (2016). *Guidance for the implementation of the EU Product Environmental Footprint (PEF) during the Environmental Footprint (EF) pilot phase - draft version 5.2*.

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Goedkoop, M., Heijungs, R., Huijbregts, M., Schryver, A. De, Struijs, J., & Zelm, R. Van. (2009). *ReCiPe 2008 A life cycle assessment method which comprises harmonised category indicators at the midpoint and the endpoint level. Report 1 Characterisation.* Den Haag.

JRC, & European Commission. (2015). Baseline Approaches for the Cross-Cutting Issues of the Cattle Related Product Environmental Footprint Pilots in the Context of the Pilot Phase.

Secretariat of the Convention on Biological Diversity. (2010). Global diversity Outlook 3.

Technical Secretariat for the Feed Pilot. (2015). *PEF screening report in the context of the EU Product Environmental Footprint Category Rules (PEFCR) Pilots - Feed for food producing animals*.

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14) Annex 1 - List of EF normalisation and weighting factors

Global normalisation factors are applied within the EF. The normalisation factors as the global impact per person are used in the EF calculations.

Impact category	Unit	Normalisation factor	Normalisation factor per person	Impact assessment robustness	Inventory coverage completeness	Inventory robustness	Comment
Climate change	kg $CO_{2\ eq}$	5.35E+13	7.76E+03	I	II	I	
Ozone depletion	kg CFC-11 $_{eq}$	1.61E+08	2.34E-02	I	III	II	
Human toxicity, cancer	CTUh	2.66E+05	3.85E-05	II/III	III	III	
Human toxicity, non-cancer	CTUh	3.27E+06	4.75E-04	II/III	III	III	
Particulate matter	disease incidence	4.39E+06	6.37E-04	I	I/II	I /II	NF calculation takes into account the emission height both in the emission inventory and in the impact assessment.
Ionising radiation, human health	kBq $U^{235}{}_{eq}$	2.91E+13	4.22E+03	II	II	III	
Photochemical ozone formation, human health	kg NMVOC $_{eq}$	2.80E+11	4.06E+01	II	III	I/II	
Acidification	mol H+ $_{eq}$	3.83E+11	5.55E+01	II	II	I/II	
Eutrophication, terrestrial	mol N $_{eq}$	1.22E+12	1.77E+02	II	II	I/II	

Eutrophication, freshwater	kg P_{eq}	1.76E+10	2.55E+00	II	II	III	
Eutrophication, marine	kg N_{eq}	1.95E+11	2.83E+01	II	II	II/III	
Land use	pt	9.20E+15	1.33E+06	III	II	I I	The NF is built by means of regionalised CFs.
Ecotoxicity, freshwater	CTUe	8.15E+13	1.18E+04	II/III	III	III	
Water use	m^3 world $_{eq}$	7.91E+13	1.15E+04	III	I	II	The NF is built by means of regionalised CFs.
Resource use, fossils	MJ	4.50E+14	6.53E+04	III	I	II	
Resource use, minerals and metals	kg Sb_{eq}	3.99E+08	5.79E-02	III			

Weighting factors for Environmental Footprint

	Aggregated weighting set	Robustness factors	Calculation	**Final weighting factors**
	(50:50)	(scale 1-0.1)		
WITHOUT TOX CATEGORIES	A	B	C=A*B	C scaled to 100
Climate change	15.75	0.87	13.65	**22.19**
Ozone depletion	6.92	0.6	4.15	**6.75**
Particulate matter	6.77	0.87	5.87	**9.54**
Ionizing radiation, human health	7.07	0.47	3.3	**5.37**
Photochemical ozone formation, human health	5.88	0.53	3.14	**5.1**
Acidification	6.13	0.67	4.08	**6.64**
Eutrophication, terrestrial	3.61	0.67	2.4	**3.91**
Eutrophication, freshwater	3.88	0.47	1.81	**2.95**
Eutrophication, marine	3.59	0.53	1.92	**3.12**
Land use	11.1	0.47	5.18	**8.42**
Water use	11.89	0.47	5.55	**9.03**
Resource use, minerals and metals	8.28	0.6	4.97	**8.08**
Resource use, fossils	9.14	0.6	5.48	**8.92**

15) Annex 2 - check-list for the PEF study

Each PEF study shall include this annex, completed with all the requested information.

ITEM	***Included in the study (Y/N)***	***Section***	***Page***
[This column shall list all the items that shall be included in PEF studies. One item per row shall be listed. This column shall be completed by the TS]	[The PEF study shall indicate if the item is included or not in the study]	[The PEF study shall indicate in which section of the study the item is included]	[The PEF study shall indicate in which page of the study the item is included]
Purpose of the study (1, 2 or 3 as defined in introduction)			
Summary			
General information about the product			
General information about the company			
Diagram with system boundary and indication of the situation according to DNM			
List and description of processes included in the system boundaries			

ITEM	***Included in the study (Y/N)***	***Section***	***Page***
List of co-products, by-products and waste			
List of activity data used			
List of secondary datasets used			
Data gaps			
Assumption			
Scope of the study			
DQR calculation of each dataset used for the most relevant processes and the new ones created.			
DQR (of each criteria and total) of the study			

16) Annex 3 - Critical review report

Only the majors comments have been reported here. The editorial comments have not been reported here.

First round of review :

File version : PEFCR Feed - 16 December v2.2 for remodelling and review.pdf

Reviewer	Line	Page	Section	Comment	Type of comment	Suggestion	Follow up
Sebastien Humbert	1	1		Nice and well-structured document. I concentrated on feedbacks associated with "things" to improve/modify/justify/clarify: Here, below, only major feedbacks are provided; In the word document, additional minor editing feedbacks are provided.	Ge.	n/a	Ok
Cecile Schneider	1	1		I will join Theun in complementing the TS for the great work but I would of course like to see some more ambitious requirements on the sourcing side, especially on encouraging traceability of the supply chain (which is the first step towards sustainability as we all know). As I refer to the Trase project from the Stockholm Environment Institute and the Global Canopy Programme working on traceability of sources of soy to the sub-national level, I am hereby sharing the link for your information: https://www.sei-international.org/trase	Ge.		Ok
Theun Vellinga	1	1		In general, the PEFCR is good to read and in most cases very clear and will be a helpful guidance for users. I wish to express my compliments to the TS. But, as a reviewer, the search is for the things that could be improved. So, please find my comments in this Excel file. First I have read the PEF Guide and later compared the PEFCR for feed with the Guide. Most of the comments are minor, but I have some major comments: (1) the role of N2O emissions is not clear. It is important in crop production, but is not in the definition of climate change. This is in line with the PEF Guide, but it is	Ge./Te.	Please address my comments	Ok

				not correct and confusing. In addition, there is a mistake in the PEF Guide (see my comment about the PEF Guide in this Excel file) (2) the feed quality is very limited in information. Is this really enough? In LEAP, we made a better list. Why not referring to that list? (3) chapter 7.4 can be improved, I think. I have no concrete recommendations, but am willing to assist in a discussion about better guidance on the reporting. (4) it is a bit strange that very detailed information is given about transport, while processing that are in control of the feed mill industry cannot produce default values (see also comments of the supporting studies). I think that more supporting data can be provided.			
Cecile Schneider	1	1		On the ReCiPe methodology for biodiversity, I was wondering whether it would be possible to include a reference to the new methodology "IMPACT World+" which will be published this year and will be even more comprehensive than ReCiPe (although it's still in development)?	Te.		Ok (not possible to a method under development)
Sebastien Humbert	1	1		The PEFCR gives lots of useful data for transportation but basically nothing else for other quantitative info. It feels a bit that the document says "collect primary data to do your PEF" and misses a bit providing more default data for cases where primary data are not available. TO BE DISCUSSED	Te.	Add more quantitative info such as default data throughout the document. TO BE DISCUSSED	Ok (was adressed throughout the document)
Theun Vellinga	206	8	1	Isn't this a theoretical option? Everyone will compare.	Te	in fact you could remove this one	Ok (no change ; importance to have proportionate requirements)
Sebastien Humbert	294	10	1.1.4	"This PEFCR is therefore valid for all compound feed products from feed mills sold in the EU, including the associated supply chains inside and outside the EU. " Unclear if this PEFCR also covers the imported feed.	Te.	Clarify	Ok (clarification made)
Sebastien Humbert	368	13	4.1	"The different declared units or reference flows should not be compared": this is unclear? What do you mean with "different"?	Te.	Clarify	Ok (clarification made)

Theun Vellinga	378	13	4.2	Benchmarking is not allowed. But you speak about comparison at line 206-210. What is the difference?	Te	Make clear what the difference is between comparison and benchmark. An option is to elaborate this in chapter 6 and refer to that chapter in section 4.3	Ok (clarification made)
Cecile Schneider	403	14	4.3	Add "soybean cake" as it's a significant example	Te	Add "soybean cake" in examples of single feed materials product	Ok (modification done)
Theun Vellinga	405	14	4.3	Feed materials from food and beverage of produced at animal farms. Are grains and maize silage from arable out of scope?	Te	These groups are not consistent, make consistent group. Include all other feed materials that are essential, but do not go through the feed mill.	Ok (no modification)
Cecile Schneider	426	15	4.4	PEFCR should also be used as a threshold with a time-bound target in the future, not just comparisons (by 2020 the environmental footprint must be reduced by half for example)	Ge	Add: 4) Definition of a time-bound target for reducing the environmental impact of animal feed products	Ok (no modification)
Cecile Schneider	437	15	4.5	It is important to keep in mind the environmental impact of cultivation as well.	Ge	Add: Beyond the actual land to be cultivated,	Ok (modification done)
Theun Vellinga	438	15	4.4	This implies a too narrow definition at line 405. See earlier comments	Te		Ok (no modification)
Theun Vellinga	463	18	4.4	This is a very large lc stage!	Te	shouldn't you make a breakdown?	Ok (no modification) (no modification)
Theun Vellinga	475	18	4.4, table	LC shall be extended with manure application	Te	In fact that is already in the LC of stage 1a, what is extra?	Ok (modification done)
Sebastien Humbert	483	20	4.6, Table 4-1	AWARE is not classified as low robustness anymore	Te.	Modify the classification of AWARE to "Medium robustness"	Ok (no modification)
Theun Vellinga	487	21	4.6	It is according PEF Guidance, but it is strange to keep N2O out here.	Te	Feed production is part of the scope and shall be included, so N2O should be mentioned here, I think.	Ok (added N2O as additional information)
Sebastien Humbert	494	21	4.6	"This is further explained in section 4.8." Really? Not really	Te.	Clarify / complete section 4.8 on that topic	Ok

							(modification done)
Sebastien Humbert	497	21	4.6	"However the PEF studies on food producing animals may only use a part for their external communication.": Which indicators and Depending on what?	Te.	Clarify	Ok (modification done)
Cecile Schneider	529	22	4.7	You need to explain that ReCiPe can also be used outside of Europe	Te	While ReCiPe is mainly being used in Europe, it can also be used in other regions of the world, including regions with different ecosystems (it might be less precise, but still useful).	Ok (no modification)
Theun Vellinga	578	24	5.1	N application is one of the most relevant flows, but N2O is not in your climate change impacts. This is not correct and confusing.	Te	Changes in chapter 4 to make clear where N2O is incorporated.	Ok (added N2O as additional information)
Sebastien Humbert	578	24	5, Table 5-1	"Most relevant life cycle stage" actually this list is not the same as the list in section 4.5: Align	Te.	Align list of life cycle stages throughout the document	Ok (modification done)
Cecile Schneider	582	24	5.1	Processes are currently not in the control of food manufacturers but manufacturers can make efforts towrads full traceability, ie asking their suppliers to provide information about source	Ge	Add "in the current supply chains arrangements in which full traceability is not yet ensured. While feed manufacturers should work towrads full traceability, for now only secondary data can be sued for these processes."	Ok (no modification)
Cecile Schneider	599	25	5.1	The modeling of feed ingredients production is also important for a later stage when we probably will reach full traceability of the soy supply chains (see Trase initiative of the Stockholm Environment Institute which is aiming at this goal)	Ge	Add: "and for future scenarios in which feed manufacturers could have full traceability about feed ingredient production"	Ok (no modification)
Theun Vellinga	616	25	5.2	Reference is made to the Data needs matrix, but this DNM has not been made for agricultural modelling.	Te	Make clear to what DNM is referred to. I assume, this is section 2.15 of the PEF Guide	Ok (modification done)
Theun Vellinga	664	28	5.3.2	This is a very concise list. I think it is not enough. Many studies need ME or Ne values, also digestibility of protein, Adf, NDF etc. is required.	Te	Make a more complete list? E.g. look at LEAP.	Ok (no modification. Not possible to go as far as LEAP in the list of nutritional data for reasons of confidentiality

							and intellectual property. Nevertheless, all the information required for LCA modelling of feed use at the livestock farm are included in the mandatory nutritional data required in the PEFCR
Sebastien Humbert	689	28	5.3.3, Table 5-4	Precise if the Water is "consumed" or "withdrawn"	Te.	Precise if the Water is "consumed" or "withdrawn"	Ok (modification done)
Sebastien Humbert	711	30	5.3.3, Table 5-4	What do you mean with "no PEF"? Clarify (in a footnote below the table?)	Te.	What do you mean with "no PEF"? Clarify (in a footnote below the table?)	Ok (modification done)
Sebastien Humbert	746	31	5.3.4	Unclear how the adaptation to the actual fuel use would influence parameters/impacts not connected to fuel consumption (such as truck maintenance, etc.)? Clarify	Te.	Clarify	Ok (no modification)
Theun Vellinga	754	31	5.3.4	Is only fuel consumption used in emission calculations? No construction and maintenance?	Te		Ok (no modification)
Theun Vellinga	772	32	5.3.4	Isn't the DQr value too high? I thought 1.6 was the max. See PEF Guidance page 89.	Te	Adjust example	Ok (no modification
Sebastien Humbert	780	33	5.3.5	Complete the sentence with "and mean of transport"?	Te.	Complete the sentence with "and mean of transport"?	Ok (modification done)
Sebastien Humbert	783	33	5.3.5, Table 5-9	Clarify if this table can be used by default when no data on transport are available	Te.	Clarify if this table can be used by default when no data on transport are available	Ok (modification done)
Theun Vellinga	796	34	5.3.5	See my earlier comments about line 772.	Te	Adjust example	Ok (modification done)
Cecile Schneider	873	36	5.3.6.2	Trase initiative (mentioned above) is aiming at going beyond country of origin for soy supply chain	Ge	Country of production and if available state/district	Ok (modification done)
Sebastien Humbert	919	39	5.4.1, Figure 5-1	What if the country of origin is unknown and it is not known if outside or within EU?	Te.	Add this case (additional "n" arrow below the second box of the second column)	Ok (modification done)

Sebastien Humbert	945	41	5.5	"in the respective" what?	Te.	Complete	Ok (modification done)
Sebastien Humbert	990	42	5.9	Which alternatives? Precise	Te.	Which alternatives? Precise	Ok (modification done)
Sebastien Humbert	996	42	5.9	Which alternatives? Precise	Te.	Which alternatives? Precise	Ok (modification done)
Theun Vellinga	1050	44	7.1	The reason for chapter 7.1 is not clear to me. It is in fact repeating the content of an earlier table. There is no instruction in this section.	Ge	Come with instructions here: the user shall define robustness according... And is robustness of PEF results only defined by the impact category, or also by the quality of the calculations and data?	Ok (modification done)
Theun Vellinga	1085	45	7.4	This section is "thin". It must be possible to do more with this. Is it mandatory to mention limitations and recommendations?	Ge	Think about improvement of this section. Should conclusions AND limitations AND recommendations always be mentioned? Are there experiences from the supporting studies? And I think that the results of 7.1 and 7.2 should come back here and must be used.	Ok (modification done)
Sebastien Humbert	1093	46	8	This section is about verification and in the text you speak about critical review… unclear.	Te.	Review this section (also based on new template?)	Ok (modification done)
Theun Vellinga	1101	46	8	This sentence is useful in section 7.4.	Ge		Ok (modification done)
Sebastien Humbert	1164	49	Annex 1	Add a URL link where the full screening report can be accessed (freely and openly)	Te.	Add a URL link where the full screening report can be accessed (freely and openly)	Ok(modification done)
Theun Vellinga	1217	51	Annex 2	This recommendation can be used in chapter 7	Te		Ok (modification done)
Theun Vellinga	1225	52	Annex 2	This is an important aspect, as it defines other input data (fertilizers, yields, etc) and it is sensitive for public debate (Brazilian soy) etc. Will there come a procedure to deal with this? There is nothing	Te	Develop a procedure, a escape option.	Ok (modification done)

				mentioned in the relevant section (chapter 5)			
Theun Vellinga	1242	53	Annex 3	You mention the need for primary data at the feed mill. In Annex 2, the supporting studies stressed at the lack of data at the stage. What will you do about it?	Ge	There have to be more clear and directive recommendations. This process is in direct control of the compound feed stakeholders and no detailed data are available.	Ok (modification done)
Sebastien Humbert	1243	53	Annex 3	It seems weird that for "System boundaries [Section 4.5]", the rules are less stringent for purpose 3 than for purpose 2? Clarify why?	Te.	It seems weird that for "System boundaries [Section 4.5]", the rules are less stringent for purpose 3 than for purpose 2? Clarify why?	Ok (modification done)
Theun Vellinga	1280	54	Annex 4	Interesting that this is defined in detail in the PEFCR, whereas default energy use for feed mills of other aspects are not. Looks a bit unbalanced.	Ge	Think about addition of other supporting material, such as default values for energy use at feed mills and for specific actions such as toasting.	Ok (no modification)
Sebastien Humbert	1281	55	Annex 4, Table 2	Very useful table!	Te.	n/a	Thanks !
Theun Vellinga	419 - 426	14	4.4	See my earlier comments.	Te		Ok (modification done)
Theun Vellinga	443 - 445	15	4.4	Do I understand correctly that additives and minerals are in scope, as are crops?	Te	Make more clear what is and is not in scope.	Ok (modification done)
Theun Vellinga	456 - 458	16	4.4	Average is quite vague. Average at national level or EU level or other?	Te	define average, or tell that this is done later.	Ok (modification done)

Second round of review :

File version : PEFCR Feed final draft v3.3 for review before vote 13 December final.doxcx

Reviewer	Line	Page	Section	Comment	Type of comment	Suggestion	Follow up
Theun Vellinga	1	1	General	Depreciation of capital goods in machine use in crop cultivation, is it incorporated or not?	Te.		OK (included for cultivation but not for processing due to cut-off rule)
Theun Vellinga	1	1	General	Transport emissions: is there a table with fuel use per tonkm? Is depreciation and maintenance not incorporated?	Te.		Ok (covered by the secondary data on transport).
Theun Vellinga	1	1	General	The carbon storage is not quite clear.	Te.		OK (clarified that it is not covered for the time being) Reaction of TV: I'm fine with the choice of the TS and the way it is defined in the PEF and the Guidance document. But as the Effort Sharing Regulation (ESR) explicitly opens opportunities for using carbon storage in the reduction of GHG emissions, I have the impression that the PEF Guidance and the PEF Feed both tell that it is not possible to calculate this according the rules. This might cause problems later, as currently large European dairy processors as ARLA and Friesland Campina are exploring the options to include carbon storage in the emissions calculation and in the reduction plans related to the ESR. So, my comment is more a warning that the current formulation might lead to confusion and comments.
Theun Vellinga	1	1		nitrous oxide emissions are […] treated really poor in the PEFCR.	Te.	It will be added as a recommendation in additional information. This gives the impression to me that "if you like" you can do the nitrous oxide emissions as well. I would suggest that this is mandatory, as the nitrogen emissions are very important, especially in plant production. It should be formulated a bit more prescriptive. But maybe this will happen in the text of the PEF Guidance, but your comment does not show this level of prescription.	OK (N2O included as mandatory additional information)
Sebastien Humbert	555	22	6.4	About: PEF studies carried out in compliance with this PEFCR would reasonably lead to reproducible results and the information included	Te.	Shouldn't you delete this statement since you are an intermediate product?	OK (no modification since comparisons are still possible under the limited conditions described in the chapter on limitations)

				therein may be used to make comparisons and comparative assertions under the prescribed conditions (see chapter on limitations).			
Cécile Schneider / Sebastien Humbert	659	26	7.4, Table 7.4-1	About "auxiliary materials" in "Production of feed ingredients"	Te.	And in some cases, land-use change and/or land degradation	OK (modification done)
Sebastien Humbert	671	27	Table 7.5-1	Make sure to align the structure of the table (order of IC) and naming of impact categories and units with the latest Guidance (see table in "PEFCR guidance v6.3_Main changes.docx")	Te.		OK (modification done)
Sebastien Humbert	671	27	Table 7.5-1	About « Climate change »	Te.	To avoid confusion, I suggest to add a line here with "Climate change – fossil"	OK (climate change reported as follows: climate change total, biogenic and land use change and recommend to distinguish N2O related emissions as additional information)
Sebastien Humbert	727	30	7.6.3	About « The comparison of the PEF profiles of different feeds shall therefore: • only take place when it is clear that they fulfil the same function and animal response, i.e. in the context of cradle to grave PEF study of identical animal products (e.g. one kilogramme of eggs on similar farms with two types of feed), and only be interpreted as part of the complete interpretation of the PEF profile of the animal product at stake. »	Te.	Very good point!	Thanks!
Sebastien Humbert	747	31	8.1	About the list of most relevant impact categories	Te.	Putting my cap of "LCA expert" and not simply expert in following the PEF procedure, I raise my "reserve" as to not consider freshwater and marine eutrophication as most relevant impact categories in the context of feed production. If the goal is to reduce the number of impact categories, I would first look at freshwater and marine eutrophication	OK (modification done: clarified that this is the result of the hotspot analysis but that results for all impact categories will be available for downstream partners since feed is an intermediate product. We will also mentioned that the hotspot analysis identified the production of feed ingredient as most relevant life cycle

						before respiratory inorganics and acidification.	stage, which is consistent with existing knowledge.)
Theun Vellinga	849, to 864			outbound transport. Does it mean that emissions per tonkm as used in many studies are not applicable anymore? Is it only fuel use and not the maintenance or depreciation?	Te.		Tonkm can still be used, but there are more accurate solutions higher in the hierarchy.
Sebastien Humbert	892	40	9.2	About « This means that it is not mandatory to use company specific data for water use »	Te.	Confusing. If it is a process expected to be run by the company, why wouldn't it be mandatory to use company specific data for water? This might only be a phrasing issue in the paragraph?	Ok (modification done: clarified that it is encouraged but not mandatory.)
Sebastien Humbert	897	9.2	Table 9.2-1	About « Water consumption in the feed mill »	Te.	Through this section, it is not clear if what has to be collected is water withdrawal (the amount of water that the company purchase/use) or only the water consumption (i.e. the fraction of water used that is not return in waste water, i.e. the fraction of water that is evaporated in the feed mill). To be consistent with the AWARE method, only the water actually consumed (i.e. evaporated or incorporated into the product) should be used.	OK (modification done : clarified that consumption is considered equal to withdrawal, for simplification)
Sebastien Humbert	1228	54	9.8, Table 9.8-a	About « two physical alternatives »	Te.	Which ones ?	Ok (modification done and this requirement was moved to chapter on limitations, with a should instead of a shall and the reasons for the recommendation will be explained.)
Sebastien Humbert	1437	61	9.10	About « Soil carbon storage »	Te.	Not completed	OK (modification done)
Sebastien Humbert	1441	61	9.10	About « Climate change – biofenic »	Te.	In the PEF results of the representative product, you did report climate change biogenic separately. Clarify ?	Ok (Indeed: we will report climate change total, biogenic and land use.)
Sebastien Humbert	1445	61	9.11	About « the end of life of the packaging »	Te.	Not only. It is also for the end of life of all materials used and discarded throughout the supply chain (including for example feed waste). Furthermore this formula is also to calculate the impact for the production of packaging material. Rephrase?	OK (modification done)
Theun Vellinga	1530			No depreciation and maintenance of machine use? This is conflicting with the table on line 657	Te.		OK (Capital goods are included for cultivation)

Theun Vellinga	1572			outputs, I propose that the user will produce a mass balance, showing the destination/fate of the total ingoing mass. It will improve the quality of the calculations.	Te.		OK (modification done)
Sebastien Humbert	1624	66	10.1.5	About « The PEF profile shall be calculated and reported using A equal to 1. »	Te.	TBD	Ok (modification done; since the A value applies to the product in scope (feed) and not to the packaging, the sentence was be deleted.).
Sebastien Humbert	1628	66	10.1.5, Table		Te.	What about textile based bags?	Ok (modification done; since the A value applies to the product in scope (feed) and not to the packaging, the sentence was be deleted.)
Sebastien Humbert	1726	70	10.2.6	About « Therefore the inventory of the agricultural stage shall account for the uptake of heavy metals by the crop. »	Te.	I challenge this assumption. I would take the other one. Neglecting the update of heavy metals by the crop.	OK (no change in the text but footnote added highlighting that there is no negative emissions in the datasets accompanying this PEFCR and that the operator should be careful to potential negative emissions and include default manure application in the crop modelling to avoid them)
Theun Vellinga / Sebastien Humbert	1806	73	11.1, Table 11-1-1	TV: The table is not according the reporting rules on climate change: the first line (with climate change in bold) is probably fossil emissions. This should be mentioned explicitly. SH: Bug in the first line	Te.		OK (mistake in the table)
Sebastien Humbert	1806	73	11.1, Table 11.1-1		Te.	Make sure to align the structure of the table (order of IC) and naming of impact categories and units with the latest Guidance (see table in "PEFCR guidance v6.3_Main changes.docx")	Ok (modification done)
Sebastien Humbert	1806	73	11.1, Table 11.1-1		Te.	I would be consistent in the number of significant figures in the three tables. Maybe only for climate change you can have three significant figures. For all of others, I would only have 2 significant figures.	Ok (modification done)
Sebastien Humbert	1926	81	Annex 1		Te.	Remove reference to "supporting studies"	OK (modification done)
Sebastien Humbert / Theun Vellinga	2107		Annex 5	SH: Unclear if the distances inland have to be added to the distances between lands. E.g. if soy comes from AR to NL, do you do all distances in AR + distances of ship from AR to NL? Or only the ship distance? TV: what we did in LEAP (and also in FeedPrint) is transport from e.g. Argentina	Te.		Ok (modification done)

				to NL, inland transport in AR (truck, train other), transport from AR to NL by seaship, inland transport in NL (train, inland vessel, truck). So, inland transport is always accounted for. But I have not checked the text on this, but we made a detailed description for the LEAP document, and I assumed this would be applied here as well.			

--END--

17) Annex 4 - Illustrative implementation of the Data Needs Matrix from the perspective of a feed company

By definition, the mandatory company-specific data are excluded from the implementation of the Data Needs Matrix. The mandatory company-specific data are described in section 9.1 and the four data points are

- The list of feed ingredients (Bill of Materials, BoM)
- The nutritional analysis data
- Energy consumption in feed mill operations
- Outbound transport to livestock farm

The typical processes for which the use of the Data Needs Matrix is required to determine whether primary or secondary shall be used are therefore:

- Water consumption in the feed mill
- Feed ingredients production
- Inbound transport (delivery to the feed mill)
- Packaging production (for feeds delivered in bags)

Situation 1: process run by the company applying the PEFCR

Most of these processes are actually feed mill operations and are defined as company-specific data, with the exception of water consumption in the feed mill, for which it is not mandatory to use primary data

The next step is to check whether water consumption is a most relevant process or not. Since water consumption in the feed mill is not a most relevant process, 2 options are therefore available

- Use primary data (company specific activity data for water consumption per tonne of feed combined with default data for 1m^3 of water in the country at stake)
- Use the default data provided in the PEFCR (0,13 m^3 per tonne)

Situations 2 and 3

The situations 2 and 3 cover the processes not run by the company applying the feed PEFCR. For a feed company, these processes are typically

- Feed ingredient production
- Inbound transport (to the feed mill)
- Packaging production

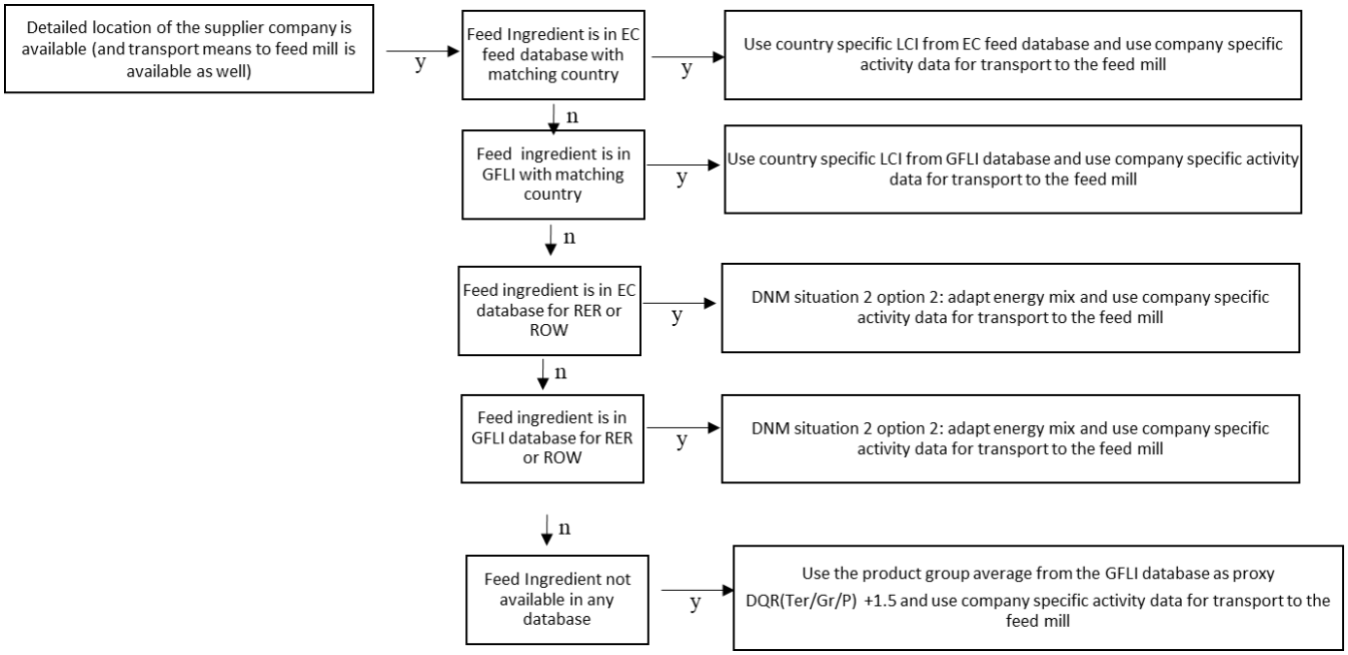
Situation 2

Situation 2 covers processes not run by the company applying the Feed PEFCR, but with access to company-specific information. The next steps are then distinguished on the basis of the type of information which is available. An example is provided below for the production of feed ingredients.

- Case #1: there is enough information available to use primary data: this corresponds to the situation, 2, option 1 of the Data Needs Matrix

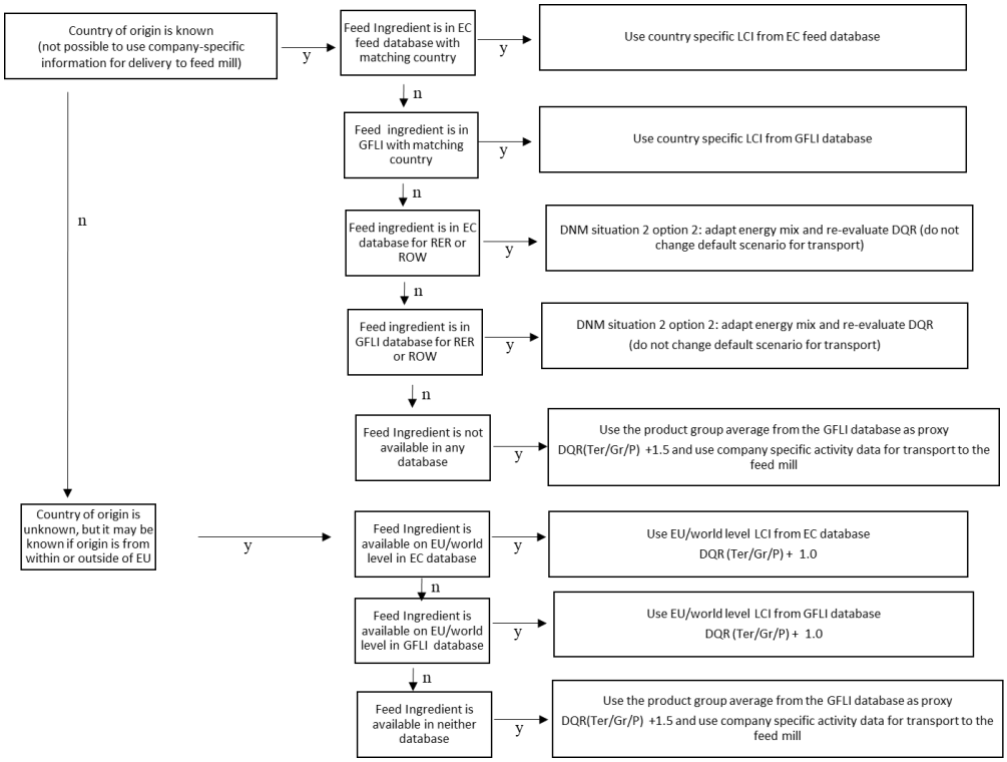
    - For an unprocessed product: cradle to gate primary data should be used according to rules for agricultural modelling
    - For a processed product
        - Primary data for cultivation may be combined with primary data for processing (primary + primary). The primary data required for processing are
            - Energy use (fuel and power)
            - Origin of feed ingredients to be processed
            - Auxiliary materials
            - Water use
            - Inbound transport (delivery to the feed mill)
        - Secondary data for cultivation may be combined with primary data for processing (secondary + primary). The primary data required for processing are the same as above. The secondary data for cultivation are selected with the decision tree in section 5.3.2.
        - The combination of primary data for cultivation and secondary data for processing (primary + secondary) is not yet available since there is no gate to gate data in the EC and GFLI databases. The GFLI will consider the opportunity to develop such type of gate-to-gate data

- Case #2: primary data is not available, but some information is however available
    - Case #2 – a: the detailed location of the supplier company is available (example: soybean meal from a crushing plant in Rotterdam). The following decision tree applies



- Case #2 – b: the only information available is
    - The country of origin of the feed ingredient or
    - Whether the feed ingredient originates from the EU or not

The following decision tree applies:



Situation 3 (continuation of the example for feed ingredients)

The situation 3 covers processes not run by the company applying the Feed PEFCR and without access to company-specific information. The next step is then to check whether the process at stake is a most relevant process or not. Feed ingredients production is a most relevant process meaning that we are in situation 3 option 1, according to which secondary data shall be used with DQR ≤3.0. The decision tree provided in section 5.3 on data gaps shall be used to determine which data to use.

18) Annex 5 – Limitations relative to the definition of the system boundaries

A comparative PEF study can be used for evaluation of alternative feed configurations. This could support decisions in changing the feed composition to improve environmental performance. In this context, a cradle to gate study may not necessarily be sufficient to capture all potential consequences, as mentioned in section 3.6 on limitations.

There are two typical situations for which a cradle to gate feed PEF study is not sufficient to support decisions in terms of modification of feed composition

- the nutritional value or composition of the feed changes in a way that affects the production performance of food producing animals, (in other words, the nutritional performance of the feed with the new composition is different)
- the chemical composition of the feed changes so that it affects the environmental performance of the farming systems where the feed is consumed (including digestion and manure management) or where the manure is applied.

19) Annex 6: Default activity data for transport (distances and mode)

The transport modes and distances can be estimated using the following procedure. It is assumed that the country of origin and the destination are known:

1. Determine if the origin is a point source or distributed:
    a. A crop is grown throughout a cultivation area (origin = 'distributed'), if only data is known for the cultivation, the collection of the crops from farm should also be estimated.
    b. Processed materials are often created at only a single location (origin = 'point')
2. Determine if in the destination country a distribution step takes place:
    a. If a product is likely to be first shipped to a warehouse and then distributed to multiple customers throughout a country, the destination type = 'distributed'
    b. If a single customer receives the entire shipment, this could be regarded as point
3. Estimate the transport distances for the distribution/distributed steps using the table below, by looking up average internal transport distances of a country (listed as for example NL – NL).
4. Estimate the transport distance from country of origin to country of use by looking up average transport distance between the applicable countries: e.g. FR – NL (first the inland transport needs to be determined in the country of origin, then the overseas transport and then again inland transport in the country of destination)
5. Include the default transport LCIs in your analysis, using the estimated transport distances and correct the DQIs where relevant.

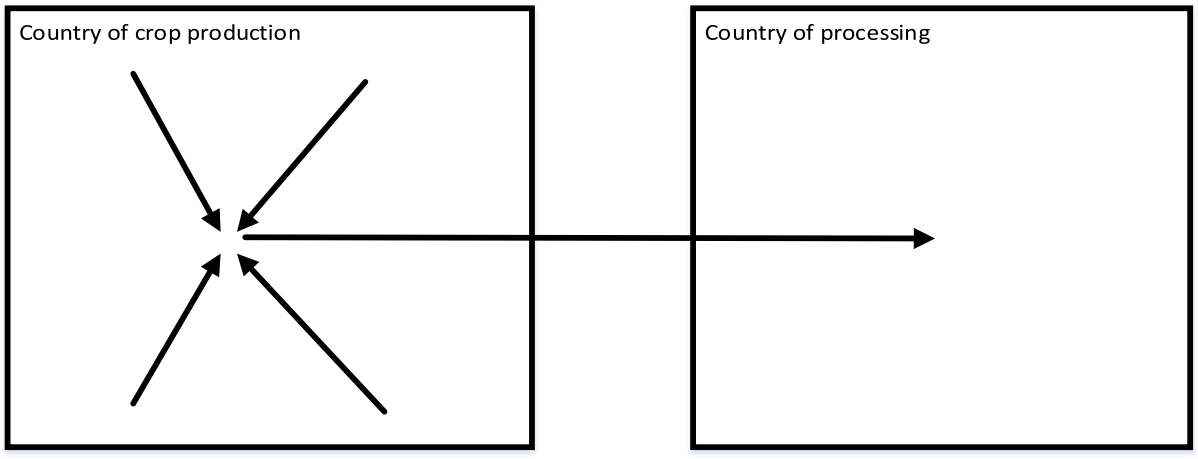


Figure 11.4.2-1: Example of transport model where there is a distributed type origin and a point source destination, this could for example apply to wheat from Ukraine delivered directly to a feed producer in France.

The transport distances were estimated on the basis of the following sources:

- Domestic distances based on transport mix from EuroStat (tkm travelled per mode for domestic transport tasks).
- Distance between EU countries based on country midpoint to midpoint, using international transport mode mix from EuroStat
- Distance between European countries and countries outside Europe based on transoceanic freight distances using http://www.searates.com/reference/portdistance/
- Various literature sources and expert judgement for data gaps for internal transport in Non-EU countries.

Table 11.4.2-1: Default transport distances (all distances are in km single trip)

Origin	Destination	Truck dist	Train dist	Barge dist	SeaShip dist
AR	AR	410	80	10	
AR	DE				12158
AR	ES				10869
AR	IT				11716
AR	NL				11738
AT	AT	41	16	0	
AT	CZ	213	166	2	0
AT	DE	256	378	55	0
AT	HU	225	206	40	0
AT	SK	277	250	28	0
AT	UA	1585			
AT	UK	665	981	142	0
AU	AU	400	100		
AU	BE				20651
AU	DE				21027
AU	DK				21430
AU	IT				16636
AU	NL				17826
BE	AU				20651
BE	BE	59	7	11	
BE	BG	677	217	222	1278
BE	BR				10102
BE	CA				6022
BE	DE	184	116	178	
BE	FR	288	128	144	
BE	HU	670	614	118	0
BE	LT	377	581	0	772
BE	NL	72	40	104	
BE	PL	633	276	12	230
BE	RO	517	341	267	853
BE	RS	1859			
BE	UA				6516
BE	UK	50	0	0	784
BG	BE	677	217	222	1278

Origin	Destination	Truck dist	Train dist	Barge dist	SeaShip dist
BG	BG	43	19	0	
BG	DE	551	176	181	1040
BG	ES	924	296	303	1745
BG	FR	676	216	222	1276
BG	GR	215	69	71	406
BG	IT	555	178	182	1048
BG	NL	677	217	222	1278
BG	PT	1041	333	341	1965
BG	RO	146	47	48	275
BR	BE				10102
BR	BR	867	477	101	
BR	DE				10100
BR	ES				9189
BR	IE				9300
BR	IT				10036
BR	NL				9684
BR	PT				8469
BR	UK				10024
CA	BE				6022
CA	CA	182	619	1019	
CA	DE				6319
CA	ES				5750
CA	IT				7730
CA	NL				6079
CA	PT				5425
CA	UK				5965
CN	CN	455	1005	136	455
CN	DE				19754
CN	NL				19113
CZ	AT	213	166	2	0
CZ	CZ	39	16	0	
CZ	DE	285	222	2	0
CZ	PL	256	200	2	0
CZ	PT	1498	1167	13	0
CZ	SK	263	237	27	0
DE	AR				12158
DE	AT	256	378	55	0
DE	AU				21027
DE	BE	184	116	178	
DE	BG	551	176	181	1040
DE	BR				10100
DE	CA				6319
DE	CN				19754
DE	CZ	285	222	2	0

Origin	Destination	Truck dist	Train dist	Barge dist	SeaShip dist
DE	DE	84	18	4	
DE	DK	186	121	182	205
DE	ES	553	360	539	607
DE	FR	471	203	249	
DE	HU	456	418	80	0
DE	NL	160	101	154	
DE	PA	1200			10100
DE	PL	412	185	6	153
DE	PT	644	419	627	707
DE	RO	400	264	207	660
DE	RS	1408			
DE	SK	491	443	50	0
DE	UA	1752			
DE	UK	321	209	312	352
DE	UR				11966
DE	US				7266
DK	AU				21430
DK	DE	186	121	182	205
DK	DK	66	1	0	
DK	FR	282	124	151	1053
DK	LT	350	539	0	716
DK	LV	138	844	0	865
DK	PT	389	62	0	2387
DK	UA				7295
DK	UK	97	5	0	1559
ES	AR				10869
ES	BG	924	296	303	1745
ES	BR				9189
ES	CA				5750
ES	DE	553	360	539	607
ES	ES	89	5	0	
ES	FR	178	78	95	662
ES	PA	1200			9189
ES	PT	122	7	0	351
ES	RO	823	543	426	1358
ES	UA				3392
ES	UK	124	6	0	1992
ES	US				8540
FR	BE	288	128	144	
FR	BG	676	216	222	1276
FR	DE	471	203	249	
FR	DK	282	124	151	1053
FR	ES	178	78	95	662
FR	FR	80	11	2	

Origin	Destination	Truck dist	Train dist	Barge dist	SeaShip dist
FR	GR	395	173	212	1474
FR	IT	228	100	122	849
FR	NL	138	61	69	498
FR	PL	309	135	165	1152
FR	PT	236	103	126	879
FR	RO	598	394	309	987
FR	UA				3232
FR	UK	199	87	107	742
GR	BG	215	69	71	406
GR	FR	395	173	212	1474
GR	GR	40	0	0	
GR	IT	45	41	0	1027
GR	RU				1607
HU	AT	225	206	40	0
HU	BE	670	614	118	0
HU	DE	456	418	80	0
HU	HU	58	7	0	
HU	IT	609	558	107	0
HU	NL	670	613	118	0
HU	PL	413	379	73	0
HU	PT	1430	1310	252	0
HU	RO	279	255	49	0
HU	SK	122	112	21	0
HU	UK	1028	941	181	0
ID	ID	400			
ID	NL				15794
IE	BR				9300
IE	IE	58	1	0	
IE	IN				13000
IE	NL	0	0	0	1163
IE	PK				10900
IE	UK	28			441
IE	US				5700
IN	IE				13000
IN	IN	168	670		
IN	NL				11655
IT	AR				11716
IT	AU				16636
IT	BG	555	178	182	1048
IT	BR				10036
IT	CA				7730
IT	FR	228	100	122	849
IT	GR	45	41	0	1027
IT	HU	609	558	107	0

Origin	Destination	Truck dist	Train dist	Barge dist	SeaShip dist
IT	IT	99	7	0	
IT	MD	200			2479
IT	MX				10729
IT	PA	1200			10036
IT	RO	484	319	251	799
IT	SK	732	661	74	0
IT	UA				2479
IT	US				10174
LT	BE	377	581	0	772
LT	DK	350	539	0	716
LT	LT	48	64	0	
LV	DK	138	844	0	865
LV	LV	58	7	0	
MD	IT	200			2479
MD	MD	100			
MD	RO	527			
MX	IT				10729
MX	MX	500			
MY	MY	104	105		
MY	NL				14975
NL	AR				11738
NL	AU				17826
NL	BE	82	19	117	
NL	BG	677	217	222	1278
NL	BR				9684
NL	CA				6079
NL	CN				19113
NL	DE	160	101	154	
NL	FR	138	61	69	498
NL	HU	670	613	118	0
NL	ID				15794
NL	IE	0	0	0	1163
NL	IN				11655
NL	MY				14975
NL	NL	56	2	19	
NL	PA	1200			9684
NL	PH				17811
NL	PK				11275
NL	PL	569	248	10	207
NL	RO	517	341	267	852
NL	SD				7439
NL	SK	727	656	73	0
NL	TH				16787
NL	UA				6423

Origin	Destination	Truck dist	Train dist	Barge dist	SeaShip dist
NL	UK	44			684
NL	UR				11628
NL	US				6365
NL	VN				16446
PA	DE	1200			10100
PA	ES	1200			9189
PA	IT	1200			10036
PA	NL	1200			9684
PA	PA	350			
PA	PT	1200			8469
PA	UK	1200			10024
PH	NL				17811
PH	PH	400			
PK	IE				10900
PK	NL				11275
PK	PK	1019			
PL	BE	633	276	12	230
PL	CZ	256	200	2	0
PL	DE	412	185	6	153
PL	FR	309	135	165	1152
PL	HU	413	379	73	0
PL	NL	569	248	10	207
PL	PL	64	29	0	
PL	RS	1302			
PL	UA	1150			
PL	UK	1036	463	15	385
PT	BG	1041	333	341	1965
PT	BR				8469
PT	CA				5425
PT	CZ	1498	1167	13	0
PT	DE	644	419	627	707
PT	DK	389	62	0	2387
PT	ES	122	7	0	351
PT	FR	236	103	126	879
PT	HU	1430	1310	252	0
PT	PA	1200			8469
PT	PT	61	9	0	
PT	RO	933	615	483	1540
PT	UA				4847
PT	UK	143	7	0	2302
PT	US				8024
RO	BE	517	341	267	853
RO	BG	146	47	48	275
RO	DE	400	264	207	660

Origin	Destination	Truck dist	Train dist	Barge dist	SeaShip dist
RO	ES	823	543	426	1358
RO	FR	598	394	309	987
RO	HU	152	100	79	251
RO	IT	484	319	251	799
RO	MD	527			
RO	NL	517	341	267	852
RO	PT	933	615	483	1540
RO	RO	56	34	11	
RO	UK	719	474	372	1186
RS	BE	1859			
RS	DE	1408			
RS	PL	1302			
RS	RS	150			
RS	UK	2632			
RU	GR				1607
RU	RU	800	500		
SD	NL				7439
SD	SD	405	179		
SE	SE	92	39	0	
SK	AT	277	250	28	0
SK	CZ	263	237	27	0
SK	DE	491	443	50	0
SK	HU	122	112	21	0
SK	IT	732	661	74	0
SK	NL	727	656	73	0
SK	SK	39	7	0	
SK	UK	1113	1005	112	0
TH	NL				16787
TH	TH	307			
UA	AT	1585			
UA	BE				6516
UA	DE	1752			
UA	DK				7295
UA	ES				3392
UA	FR				3232
UA	IT				2479
UA	NL				6423
UA	PL	1150			
UA	PT				4847
UA	UA	285			
UA	UK				6439
UK	AT	665	981	142	0
UK	BE	50	0	0	784
UK	BR				10024

Origin	Destination	Truck dist	Train dist	Barge dist	SeaShip dist
UK	CA				5965
UK	DE	321	209	312	352
UK	DK	97	5	0	1559
UK	ES	124	6	0	1992
UK	FR	199	87	107	742
UK	HU	1028	941	181	0
UK	IE	28			441
UK	NL	44			684
UK	PA	1200			10024
UK	PL	1036	463	15	385
UK	PT	143	7	0	2302
UK	RO	719	474	372	1186
UK	RS	2632			
UK	SK	1113	1005	112	0
UK	UA				6439
UK	UK	84	11	0	
UK	US				8806
UR	DE				11966
UR	NL				11628
UR	UR	350			
US	DE				7266
US	ES				8540
US	IE				5700
US	IT				10174
US	NL				6365
US	PT				8024
US	UK				8806
US	US	182	619	1019	
VN	NL				16446
VN	VN	583			

20) Annex 7: Representative product

The choices and assumptions underlying the composition and the assessment of the representative product are the following:

1. *Composition of the representative product*

The composition of the representative product has been determined using statistics for consumption of feed ingredients in Europe (Table 11.4.2-1). It is based on a five-year average (2009-2013) in order to limit the impact of variations linked to price fluctuations and availability of ingredients for the European market. The majority of the information comes from EU statistics, FEFAC and other statistics from European associations. Table 11.4.2-2 gives an overview of the sources and additional assumptions to generate the required data. The micro ingredients composition is determined through the expertise of the members of the Technical Secretariat.. Soybean protein concentrate was used as proxy ingredient for the category 'other'. This feed ingredient is used in some specific feed formulations, but was not yet present in the representative product. In addition, it is known that soybean protein concentrate has a relatively high environmental impact, thus using this ingredient provides a conservative or worst case estimate for the category others.

Table 11.4.2-1: Composition of the representative product (domestic or imported refers to the place of processing, not necessarily to cultivation).

	5 year average		
Feed ingredient	**volume**	**%**	Comment
1. total cereals	73,290	48%	
common wheat	22,578	15%	
barley	18,119	12%	
durum wheat	137	0.1%	Wheat taken as proxy
maize	22,144	15%	
rye	1,393	1%	
sorghum	344	0.2%	
oats	2,644	2%	
triticale	4,078	3%	
others cereals	1,853	1%	Group 1. average taken as proxy
2. tapioca	215	0.1%	
3. total coproducts of the food and fuel industries	22,733	15.0%	
domestic wheat bran from wet milling	1,257	0.8%	
domestic wheat feed from wet milling	390	0.3%	assumption: 70% to compound feed
wheat bran from flour milling	6,450	4.3%	assumption: no export, no import (low value product related to transportation costs)
wheat middlings from flour milling	2,150	1.4%	
domestic DDGS from wheat	1,037	0.7%	
domestic DDGS from barley	142	0.1%	
domestic DDGS from maize	946	0.6%	
domestic DDGS from rye	200	0.1%	

	5 year average		
Feed ingredient	**volume**	**%**	Comment
domestic DDGS from triticale	100	0.1%	
imported DDGS from corn	498	0.3%	
imported Corn Gluten Feed	771	0.5%	
domestic maize germ from wet milling	533	0.4%	
domestic maize gluten feed from wet milling	933	0.6%	
domestic maize gluten meal from wet milling	85	0.1%	assumption: 100% to compound feed
domestic maize bran from maize dry milling	54	0.0%	assumption: 100% to compound feed
protamylasse from potato starch production	187	0.1%	assumption: 70% to compound feed
domestic molasses from sugar beet	972	0.6%	
imported molasses	918	0.6%	
domestic dried pulp from sugar beet	1,831	1.2%	assumption: 50% to compound feed
imported dried beet pulp	398	0.3%	assumption: 60% of EU imports going to compound feed
imported citrus pulp	380	0.3%	assumption: 50% of EU import going to compound feed
former foodstuffs	2,500	1.7%	
4. vegetable oils	972	0.6%	
palm oil	364	0.24%	assumed 37.5% of vegetable oils
rapeseed oil	364	0.24%	assumed 37.5% of vegetable oils
palm oil fatty acids	121	0.08%	assumed 12.5% of vegetable oils
rapeseed soap stock	121	0.08%	assumed 12.5% of vegetable oils
5. total oilseed meals	41,752	27.6%	
groundnut meal	38	0.02%	
imported soya meal	15,911	11%	
domestic soya meal	7,986	5%	
domestic rapeseed meal	10,346	7%	
imported sunflower meal	2,207	1%	
domestic sunflower meal	2,641	2%	
domestic cotton meal	143	0.09%	
imported copra meal	16	0.01%	
imported palm kernel meal	1,950	1%	
domestic linseed meal	259	0.17%	
domestic maize meal	256	0.17%	
6. total products of animal origin	2,848	1.9%	
animal fat	550	0.36%	
imported fish meal (marine meal)	437	0.29%	
domestic fish meal (marine meal)	349	0.23%	
fish oil (marine oil)	275	0.18%	
PAPs	30	0.02%	
whey powder	905	0.60%	
milk powder	302	0.20%	
7. dried forages (alfalfa)	2,122	1.4%	

	5 year average		
Feed ingredient	**volume**	**%**	Comment
8. pulses	1,909	1.3%	
9. minerals, additives, vitamins	5,366	3.6%	
L-Lysine HCl		0.30%	
DL-Methionine		0.05%	
L-Threonine		0.10%	
L-Tryptophan		0.01%	
Calcium carbonate		1.47%	
Mono calciumphosphate		0.23%	
Sodium chloride		0.31%	
Sodium carbonate		0.01%	
Phythase		0.01%	
Trace elements premix		0.78%	consists of 0.11% metal minerals (water excluded) of which 24.4% ZnO, 48.3% ZnSO4, 27.3% CuSO4
vitamin premix		0.28%	
10. other	982	1.3%	
11. total	151,148	100%	

Table 11.4.2-2: Main assumptions and data sources used for the composition of the representative product (2009-2013).

Ingredient	Source	Main assumptions
Cereals	FEFAC internal statistics for total cereal consumption by compound feed industry. DG AGRI cereal balance sheet for cereals mix used for feed in Europe.	Same cereal mix for compound feed industry and home mixing
Tapioca	FEFAC internal statistics	100% of Tapioca is used as feed in EU
Wheat bran from EU wet milling	Derived from quantity of wheat used for starch production, source: Starch Europe Amount of bran derived from mass balance for wheat starch production process: (van Zeist et al., 2012c)	100 % to compound feed (expert judgement) Exports and imports are not considered (low-value product in relation to transport costs)
Wheat feed from EU wet milling	Quantity of wheat used for starch production, source Starch Europe Mass balance for starch production process: (van Zeist et al., 2012d)	70 % to compound feed (expert judgement)
Wheat bran from EU flour milling	Quantity of wheat processed for flour milling and mass balance ratios, source European Flour Millers	100 % to compound feed (expert judgement) Exports and imports are not considered (low-value product in relation to transport costs)

Wheat middlings from EU flour milling	Quantity of wheat processed for flour milling and mass balance ratios, source: European Flour Millers	100 % to compound feed (expert judgement) Exports and imports are not considered (low-value product in relation to transport costs)
DDGS from EU bioethanol	Quantity of cereals processed into bioethanol: DG AGRI cereal balance sheet Co-products ratios: IFPRI report October 2011	70% to compound feed (expert judgement)
Imported DDGS	Global Trade Information Services , http://www.gtis.com/	100% from corn 100% from the US (simplification, US represents 75% of imports. (Vietnam is the number 2 supplier representing less than 10% but no LCI data are available) 100% to compound feed (logistics is difficult to manage for farmers)
Imported corn gluten feed	Global Trade Information Services , http://www.gtis.com/	100% from corn 100% from the US (simplification, US represents 75% of imports) (China is the number 2 supplier representing less than 10% but no LCI data are available) 100% to compound feed (logistics is difficult to manage for farmers)

2. Average compound feed production process

Most of the compound feed consists of pellets and is being delivered at farm by bulk road transport. As a conservative approach it was assumed that 100% is pelletized.

3. Dutch data for feed milling are assumed to be representative

The Agri-footprint database was used to assess the energy consumption in feed mills. The data available in Agri-footprint refer to average feed milling in the Netherlands, which has been used as a proxy for the average EU energy consumption in feed mills. This assumption only applies to energy, consumption, since the EU average mix was assumed for production of electricity (see next section). A comparison with data from France showed that using Dutch values is a conservative approach.

4. *Electricity and fuel use at feed mill and processing of raw materials*

The average European compound feed is produced at thousands of feed mills located over 28 EU countries. In this screening study we used the average environmental impact of electricity and fuel production in EU instead of deriving specific energy production mixes on the basis of the weighted average of production taking into account national energy mixes.

5. *Assumptions regarding the transport modality mix in Europe*

Feed ingredients are bulk materials and provided preferably by the cheapest transport means. If transport over water is possible and logistically efficient this is used as much as possible. The same argument holds for transport by rail. However, we do not have specific information available on transport means used for feed in Europe, so we assumed that the average breakdown of transport means for transport of agricultural products in Europe is valid. We expect this to give an overestimation of the share of transport by truck at the cost of transport by rail and water.

6. *Assumptions regarding transport distances in Europe.*

We modelled the average transport distances in Europe related to compound feed production and delivery to the farm separately from the specific product flows. We used for the screening a simplified model where per feed material two transportation steps take place (one transport from the producer of the feed ingredient to the feed mill, and a transport step from feed mill to farm). The average EU distance per transport modality for agricultural products is assumed for the transport from ingredient producer to feed mill. For the final step from the feed mill to the farm we assumed 150 km of transport by truck. This working method is rather crude but easily repeatable, which is seen as conditional for potential updating of the benchmark. Transport further upstream from the feed ingredient producer is assumed to be included in the background datasets.

Table 11.4.2-3: Transport distance assumptions

	Crop→ processing	Processing→Feed mill Crop → Feed mill	Feedmill → farm
Truck	150 tkm	150 tkm	150 tkm
Inland water way	500 tkm	500 tkm	
Train	268 tkm	268 tkm	

21) Annex 8: Sampling procedure

In some cases, a sampling procedure is needed by the applicant of the PEFCR in order to limit the data collection only to a representative sample of plants/farms etc. Examples of cases when the sampling procedure may be needed are in case multiple production sites are involved in the production of the same SKU. E.g., in case the same raw material/input material comes from multiple sites or in case the same process is outsourced to more than one subcontractor/supplier.

There exist different procedures to derive a representative sample. For PEFCRs a stratified sample shall be used, i.e. one that ensures that sub-populations (strata) of a given population are each adequately represented within the whole sample of a research study. With this type of sampling, it is guaranteed that subjects from each sub-population are included in the final sample, whereas simple random sampling does not ensure that sub-populations are represented equally or proportionately within the sample.

Using a stratified sample will always achieve greater precision than a simple random sample, provided that the sub-populations have been chosen so that the items of the same sub-population are as similar as possible in terms of the characteristics of interest. In addition, a stratified sample guarantees better coverage of the population. The researcher has control over the sub-populations that are included in the sample, whereas simple random sampling does not guarantee that sub-populations (strata) of a given population are each adequately represented within the final sample. However, one main disadvantage of stratified sampling is that it can be difficult to identify appropriate sub-populations for a population.

The following procedure shall be applied in order to select a representative sample as a stratified sample:

1) define the population
2) define homogenous sub-populations (stratification)
3) define the sub-samples at sub-population level
4) define the sample for the population starting from the definition of sub-samples at sub-population level.

21.1.1 How to define homogenous sub-populations (stratification)

Stratification is the process of dividing members of the population into homogeneous subgroups (sub-populations) before sampling. The sub-populations should be mutually exclusive: every element in the population shall be assigned to only one sub-population.

Aspects at least to be taken into consideration in the identification of the sub-populations:

- Geographical distribution of sites
- Technologies/farming practices involved
- Production capacity of the companies/sites taken into consideration

The number of sub-populations may be identified as:

$$Nsp = g * t * c \qquad \text{[Equation 1]}$$

- Nsp: number of sub-populations
- g : number of countries in which the sites/plants/farms are located
- t : number of technologies/farming practices
- c : number of classes of capacity of companies

In case additional aspects are taken into account, the number of sub-populations is calculated using the formula just provided and multiplying the result with the numbers of classes identified for each additional aspect (e.g., those sites which have an environmental management or reporting systems in place).

Example 1

Identify the number of sub-populations for the following population:

350 farmers located in the same region in Spain, all the farmers have more or less the same annual production and are characterized by the same harvestings techniques.

In this case:

- g=1 : all the farmers are located in the same country
- t=1 : all the framers are using the same harvesting techniques
- c=1 : the capacity of the companies is almost the same (i.e. the have the same annual production)

$$Nsp = g * t * c = 1 * 1 * 1 = 1$$

Only one sub-population may be identified that coincides with the population.

Example 2

350 farmers are distributed in three different countries (100 in Spain, 200 in France and 50 in Germany). There are two different harvesting techniques that are used that differ in a relevant way (Spain: 70 technique A, 30 technique B; France: 100 technique A, 100 technique B; Germany: 50 technique A). The capacity of the farmers in term of annual production varies between 10000t and 100000t. According to expert judgement/relevant literature, it has been estimated that farmers with an annual production lower than 50000t are completely different in terms of efficiency compared to the farmers with an annual production higher than 50000t. Two classes of companies are defined based on the annual production: class 1, if production is lower than 50000 and class 2, if production if higher than 50000. (Spain: 80 class 1, 20 class 2; France: 50 class 1, 150 class 2; Germany: 50 class 1). In **Error! Reference source not found.** are included the details about the population.

Identification of the sub-population for Example 2.

Sub-population	Country		Technology		Capacity	
1	Spain	100	Technique A	70	Class 1	50
2	Spain		Technique A		Class 2	20
3	Spain		Technique B	30	Class 1	30

Sub-population	Country		Technology		Capacity	
4	Spain		Technique B		Class 2	0
5	France	200	Technique A	100	Class 1	20
6	France		Technique A		Class 2	80
7	France		Technique B	100	Class 1	30
8	France		Technique B		Class 2	70
9	Germany	50	Technique A	50	Class 1	50
10	Germany		Technique A		Class 2	0
11	Germany		Technique B	0	Class 1	0
12	Germany		Technique B		Class 2	0

In this case:

- g=3 : three countries
- t=2 : two different harvesting techniques are identified
- c=2 : two classes of production are identified

$$Nsp = g * t * c = 3 * 2 * 2 = 12$$

It is possible to identify maximum 12 sub-populations that are summarized in **Error! Reference source not found.** :

Summary of the sub-population for example 2.

Sub-population	Country	Technology	Capacity	Number of companies in the sub-population
1	Spain	Technique A	Class 1	50
2	Spain	Technique A	Class 2	20
3	Spain	Technique B	Class 1	30
4	Spain	Technique B	Class 2	0
5	France	Technique A	Class 1	20
6	France	Technique A	Class 2	80
7	France	Technique B	Class 1	30
8	France	Technique B	Class 2	70
9	Germany	Technique A	Class 1	50
10	Germany	Technique A	Class 2	0
11	Germany	Technique B	Class 1	0
12	Germany	Technique B	Class 2	0

21.1.2 How to define sub-sample size at sub-population level

Once the sub-populations have been identified, for each sub-population the size of sample shall be calculated (the sub-sample size) based on the number of sites/farms/plants involved in the sub-population

The required sub-sample size shall be calculated using the square root of the sub-population size.

$$n_{SS} = \sqrt{n_{SP}}$$

- n_{SS}: required sub-sample size
- n_{SP}: sub-population size

Example

Example – how to calculate the number of companies in each sub-sample.

Sub-population	Country	Technology	Capacity	Number of companies in the sub-population	Number of companies in the sample (sub-sample size, [n_{SS}])
1	Spain	Technique A	Class 1	50	7
2	Spain	Technique A	Class 2	20	5
3	Spain	Technique B	Class 1	30	6
4	Spain	Technique B	Class 2	0	0
5	France	Technique A	Class 1	20	5
6	France	Technique A	Class 2	80	9
7	France	Technique B	Class 1	30	6
8	France	Technique B	Class 2	70	8
9	Germany	Technique A	Class 1	50	7
10	Germany	Technique A	Class 2	0	0
11	Germany	Technique B	Class 1	0	0
12	Germany	Technique B	Class 2	0	0

21.1.3 How to define the sample for the population

The representative sample of the population corresponds to the sum of the sub-samples at sub-population level.

21.1.4 What to do in case rounding is necessary

In case rounding is necessary, the general rule used in mathematics shall be applied:

- If the number you are rounding is followed by 5, 6, 7, 8, or 9, round the number up.
- If the number you are rounding is followed by 0, 1, 2, 3, or 4, round the number down.