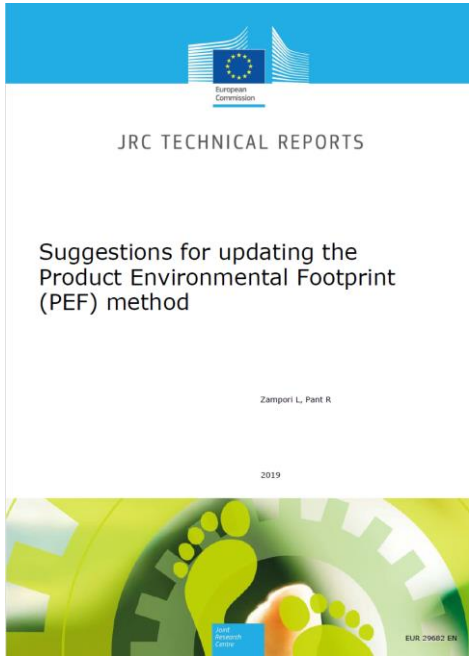
Guide to “Product Environmental Footprint of compound feed with grass protein concentrate”

Product Environmental Footprint (PEF): Developed by the Joint Research Center of the European Commission to transparently assess the environmental impacts of products and services throughout their life cycle, decrease the environmental impacts, and strengthen the European markets for green products. The overarching purpose of PEF information is to enable to reduce the environmental impacts through the whole supply chain activities (from extraction of raw materials, through production and use and to final waste management).

Product Environmental Footprint Category Rules (PEFCR): Product category-specific, life cycle-based rules that complement general methodological guidance for PEF studies by providing further specifications at the level of a specific product category. PEFCRs help to shift the focus of the PEF study toward 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 method.

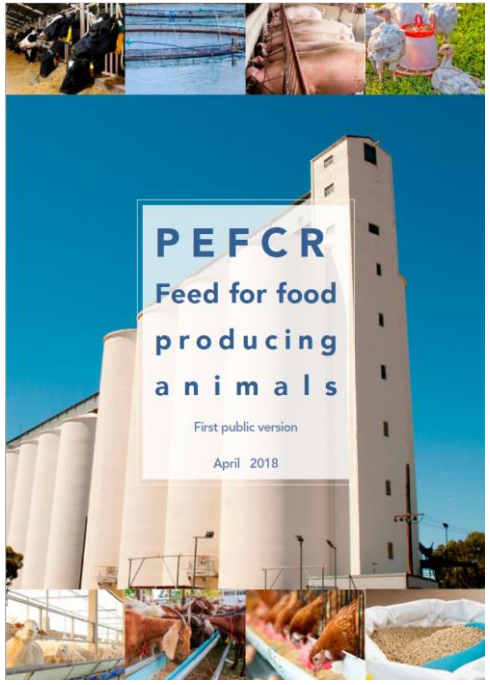


The rules provided in the PEF method enable to conduct PEF studies that are more reproducible, comparable and verifiable, compared to existing alternative approaches.

https://eplca.jrc.ec.europa.eu/permalink/PEF_method.pdf

Grass protein concentrate (GPC): This guide briefly describes the PEF and the steps in the PEF calculation. Grass protein concentrate (GPC) is used as an example to summarize how a PEF study can be implemented. GPC is a feed-grade protein with 90% dry weight and 47% crude protein, extracted from clover-grass, and can partly or fully replace soybean meal in compound feeds. It can be produced locally in Denmark and decrease the import of soybean and soybean meal from abroad and increase Denmark’s self-sufficiency in feed protein.

Comparability is only possible if the results are based on the same Product Environmental Footprint Category Rules (PEFCR).



https://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR_Feed_Feb%202020.pdf

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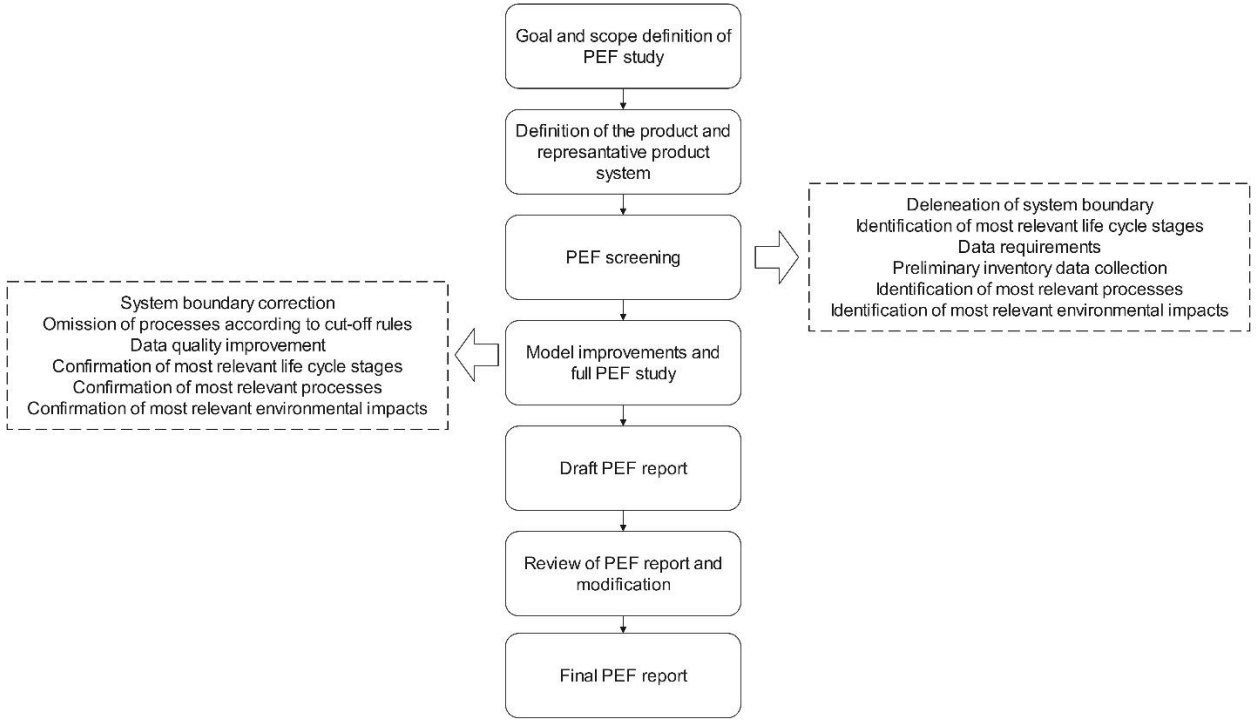
How to do PEF for compound feed with Grass Protein Concentrate?

PEFCR requirement: The first step is to carefully read and follow the instructions detailed in the latest draft of PEFCR Feed for food-producing animals. Find the latest draft on the European Commission website at https://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm



Overview of step-to-step guide on how to implement a PEF study

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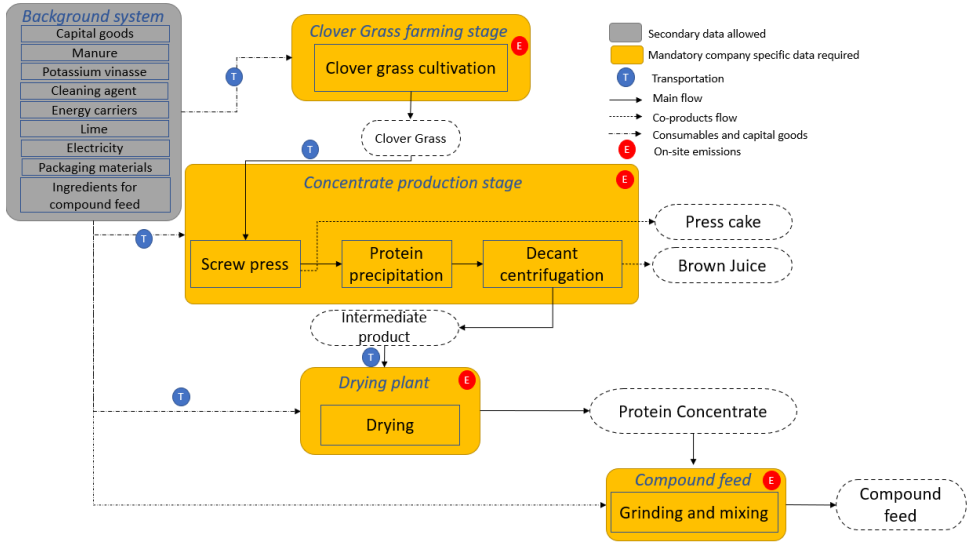
Scope of the PEF

Functional Unit (FU): The functional unit needs to be clearly defined. FU defines the qualitative and quantitative aspects of the function(s) and/or service(s) provided by the product being evaluated. The functional unit definition answers the questions "what?", "how much?", "how well?", and "for how long?"

Reference flow: A reference flow needs to be defined to which the inputs and outputs flow to be scaled. Life cycle inventory and life cycle impact assessment results are then shown per reference flow. Reference flow can be one tonne of grass protein concentrate.

System boundary: The system boundary defines which parts of the product life cycle and which associated life cycle stages and processes belong to the analyzed system (i.e., are required for carrying out its function as defined by the functional unit), except for those processes excluded based on the cut-off rule.
The system boundary shall be defined following a general supply-chain logic, including all stages from raw material acquisition and pre-processing, production of the main product, product distribution and storage, use stage and end of life treatment of the product (if appropriate).



System boundary for the assessment of compound feed production with organic protein concentrate, including indication of the processes for which company-specific data are mandatory

Life Cycle Inventory

An inventory of all material, energy and waste inputs and outputs and emissions into air, water and soil for the product supply chain shall be compiled as a basis for modelling the PEF. This is called the life cycle inventory.

Life cycle stage	Short description of the processes included
Organic grass cultivation	Organic grass used for GPC is cultivated in Ausumgaard farm and surrounding farms. The cultivation of organic grass requires the input of manure and biogas slurry as well as energy carriers, water, auxiliary materials and may involve land transformation. The full life cycle of the production of these products, including transport and depreciation of capital goods is in the scope of this PEF study.
Inbound transportation	The delivery of harvested grass to the biorefinery plant is part of the life cycle of GPC.
Production of GPC	GPC production is the core of this PEF study where the delivered grass is processed to the final product and leaves two important co-products namely press cake and brown juice.
Outbound transportation	The transportation of intermediate protein concentrate to the drying facility as well as transportation of co-products are included in the scope of this study.
Production of compound feed	The process includes grinding/milling and mixing of several feed ingredients for the production of final compound feed ready to sell into the market.
Processing of coproducts	The processing of the coproducts may belong to the scope of this PEF study. This depends on the adapted allocation approach which is described in details in its relevant section.

There are two types of inventory data:

1. Company-specific data (also called activity data): it refers to directly measured or collected data representative of activities at a specific facility or set of facilities.
2. Secondary dataset: refers to data not from specific process within the supply-chain of the company performing the PEF study. 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.

Data Need Matrix (DNM): DNM shall be used to evaluate all processes required to model the product in scope on their data requirements. It indicates for which processes company-specific data or secondary data shall or may be used, depending on the level of influence the company has on the process.

		Data requirements
Situation 1: process run by the company	Option 1	Provide company-specific data (both activity data and direct emissions) and create a company-specific dataset.
Situation 2: process not run by the company but with access to company-specific information	Option 1	Provide company-specific data and create a company-specific dataset.
	Option 2	Use a secondary dataset that is Environmental Footprint (EF)-compliant and apply company-specific activity data for transport (distance), and substitute the sub-processes used for electricity mix and transport with supply-chain-specific EF-compliant datasets.
Situation 3: process not run by the company and without access to company-specific information	Option 1	Use an EF-compliant secondary data set in aggregated form.

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Feed milling operation

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:

1. The list of feed ingredients
2. The nutritional analysis of the feed ingredients (hereafter referred to as nutritional analysis data)
3. Energy consumption in feed mill operations
4. Outbound transport to livestock farm

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

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 (% of gross energy)
- Fossil carbon content

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Data Accuracy

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 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. Also, if specific data are collected all use of energy and auxiliary materials of the feed mill shall be divided over the specific products. 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.

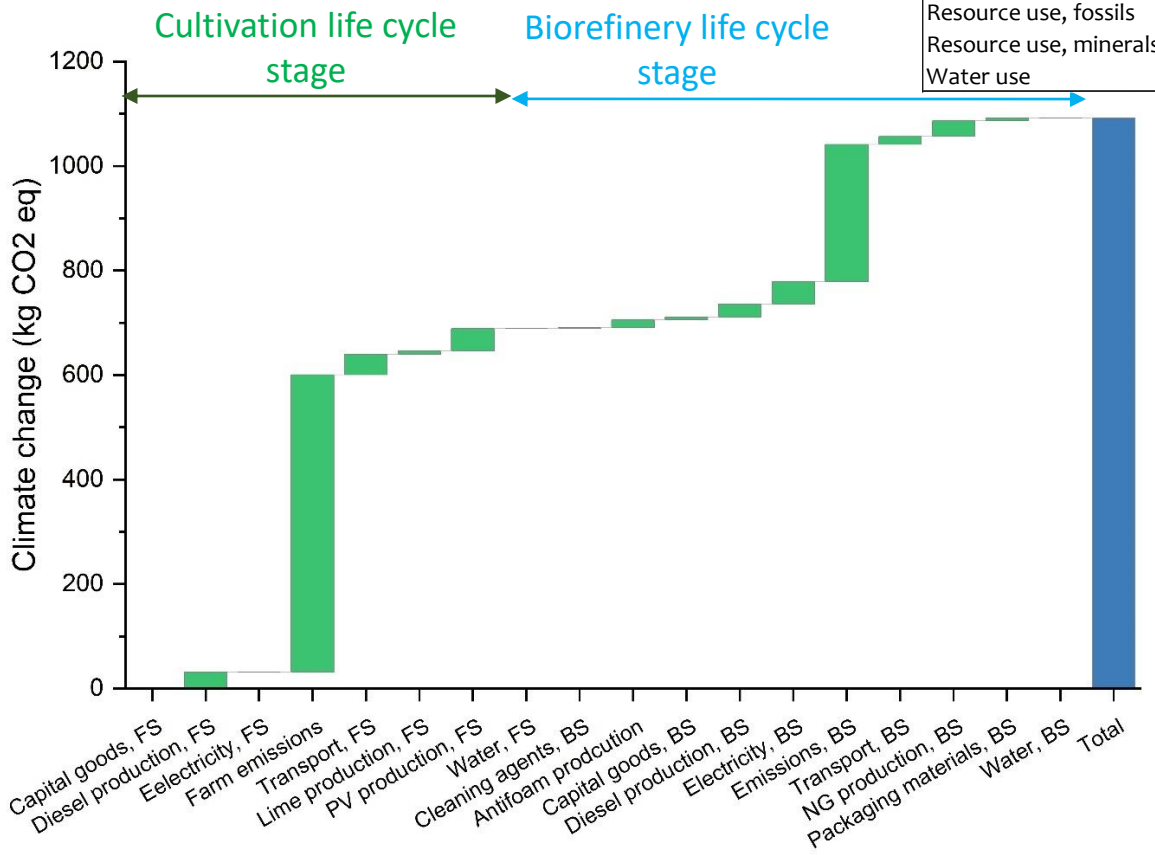
Outbound Transport

Primary data shall be collected for outbound transport as indicated in the hierarchy.

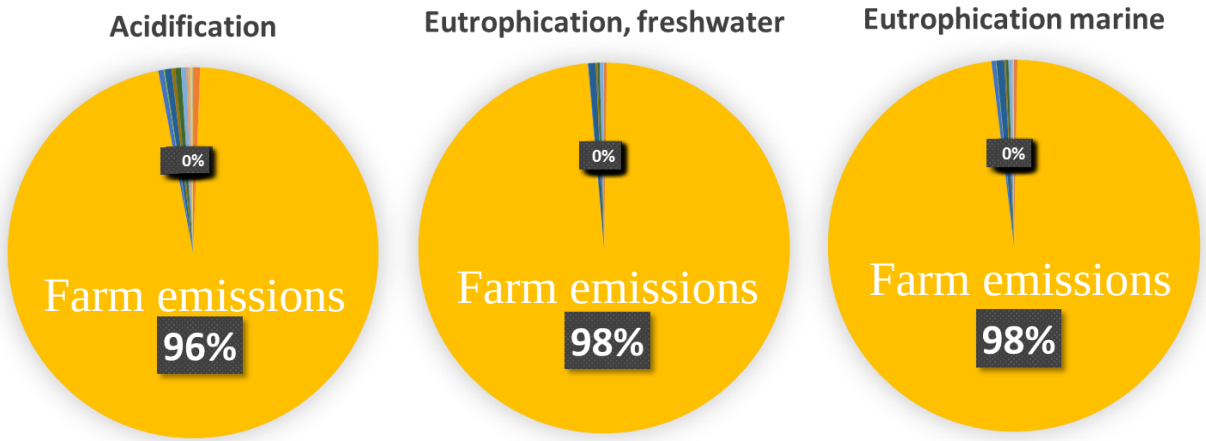
- Fuel consumption for farm-specific delivery and transport means
- Farm specific delivery distance and transport mean
- Average fuel consumption per tonne delivered, for the feed type under study and transport
- means (the average is specific to the feed under study, but the farm specific delivery distance is not available).
- 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).

PEF Grass Protein Concentrate:
A Climate change impact of 1091.5 kg CO_2,eq/tonne (GPC with 90% dry weight and 47% crude protein). Clover-grass cultivation contributed to 63% of climate change impact (689.1 kg CO_2,eq/tonne). Emissions from the application of manure and lime were the most dominant contributors to the climate change impact. Specifically, 33% of the overall impacts originate from greenhouse gases from manure and slurry application. On average 62% of the environmental impacts originated from the cultivation stage. Emissions from the application of manure and lime were the most dominant contributors to damage to the ecosystem.

Impact category	Reference unit	GPC, Ec	Soy, GLO	Soy, EU+28	Soymeal, GLO	Soymeal, EU+28
Acidification	mol H+ eq	32.01	11.36	19.46	7.11	9.11
Climate change	kg CO2 eq	1091.47	4505.64	1545.75	2795.70	3064.29
Climate change-Biogenic	kg CO2 eq	3.20	47.43	53.90	31.54	44.10
Climate change-Fossil	kg CO2 eq	1084.56	1283.24	1452.73	879.84	1068.96
Climate change-Land use and land use change	kg CO2 eq	3.71	3174.97	39.12	1884.31	1951.23
Ecotoxicity, freshwater	CTUe	413.42	28845.52	29065.05	17832.12	17256.89
Eutrophication marine	kg N eq	16.84	10.90	17.23	6.64	7.20
Eutrophication, freshwater	kg P eq	0.47	0.49	0.39	0.30	0.39
Eutrophication, terrestrial	mol N eq	56.84	42.90	79.29	26.54	32.74
Human toxicity, cancer	CTUh	4.04E-06	8.03E-05	8.87E-05	4.92E-05	5.73E-05
Human toxicity, non-cancer	CTUh	9.71E-05	2.93E-03	3.97E-03	1.77E-03	2.11E-03
Ionising radiation, human health	kBq U-235 eq	14.48	108.86	144.31	73.98	97.25
Land use	Pt	9652.47	593597.21	531849.66	357000.04	334722.89
Ozone depletion	kg CFC11 eq	1.11E-03	1.64E-05	1.82E-05	1.09E-05	1.49E-05
Particulate Matter	disease inc.	3.41E-05	1.13E-04	1.58E-04	7.02E-05	8.21E-05
Photochemical ozone formation - human health	kg NMVOC eq	0.93	3.97	4.13	2.93	4.38
Resource use, fossils	MJ	9357.65	14038.67	15291.77	9800.43	12526.51
Resource use, minerals and metals	kg Sb eq	3.68E-04	6.66E-03	7.48E-03	4.41E-03	6.10E-03
Water use	m3 depriv.	39.38	2854.01	6373.68	1725.97	1248.49

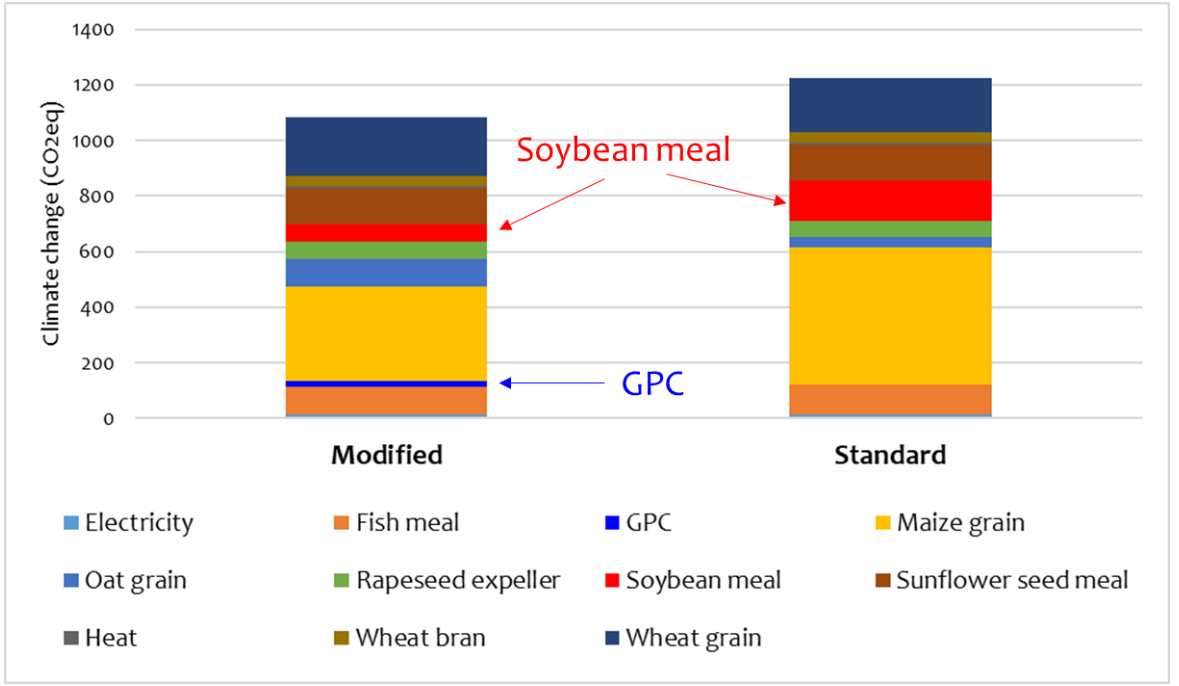


Environmental impact of organic grass protein compared with soybean and soybean meal:
GPC can substitute soybean and soybean meal, depending on its intended application. The crude protein content of GPC, soybean, and soybean meal was considered, based on which they were compared in terms of environmental footprint (EF). Having compared the EF of GPC with soybean and soybean meal (on a global and EU+28 average), GPC production found to be promising and environmentally friendly in most impact categories such as climate change, ecotoxicity, human toxicity, land use, and resources.



Compound Feed Formulation:
Two compound feed formulations for egg-laying hens are considered; Standard compound feed and compound feed with GPC. GPC contributes to 2% of the modified compound feed substituting part of the soybean meal in the standard feed.

Standard compound feed	Percentage (%)	Unit	Compound feed with GPC	Percentage (%)	Unit
Corn	34.10%		Corn	23.24%	
Wheat	20.00%		Wheat	22.00%	
Sunflowercakes	10.00%		Sunflowercakes	10.00%	
rapeseed cakes	5.90%		rapeseed cakes	5.90%	
Wheat bran	5.90%		Wheat bran	6.00%	
Fishmeal	5.40%		Fishmeal	5.00%	
Oats	5.00%		Oats	15.00%	
Soycakes	4.70%		Soycakes	2.00%	
Grass Protein Concentrate	Na		Grass Protein Concentrate	2.01%	
chalk	7.38%		chalk	7.30%	
Vitamins/minerals etc.	1.62%		Vitamins/minerals etc.	1.55%	
Electricity	0.088	kWh/kg compound feed	Electricity	0.088	kWh/kg compound feed
Heat	0.037	kWh/kg compound feed	Heat	0.037	kWh/kg compound feed



Impact category	Reference unit	Standard compound feed	Compound feed with GPC	Difference
Acidification	mol H+ eq	11.86	12.03	1.39%
Climate change	kg CO2 eq	1222.32	1084.77	-12.68%
Climate change-Biogenic	kg CO2 eq	32.87	28.53	-15.19%
Climate change-Fossil	kg CO2 eq	1019.46	949.89	-7.32%
Climate change-Land use and land use change	kg CO2 eq	169.99	106.35	-59.84%
Ecotoxicity, freshwater	CTUe	29606.75	25552.58	-15.87%
Eutrophication marine	kg N eq	9.64	9.71	0.78%
Eutrophication, freshwater	kg P eq	0.20	0.20	0.26%
Eutrophication, terrestrial	mol N eq	47.77	47.62	-0.30%
Human toxicity, cancer	CTUh	3.92E-05	3.71E-05	-5.63%
Human toxicity, non-cancer	CTUh	1.32E-03	1.36E-03	3.04%
Ionising radiation, human health	kBq U-235 eq	71.97	63.29	-13.71%
Land use	Pt	231103.89	232284.99	0.51%
Ozone depletion	kg CFC11 eq	1.10E-05	3.19E-05	65.44%
Particulate Matter	disease inc.	1.15E-04	1.07E-04	-7.47%
Photochemical ozone formation - human health	kg NMVOC eq	3.35	3.02	-10.86%
Resource use, fossils	MJ	11000.51	9992.34	-10.09%
Resource use, minerals and metals	kg Sb eq	4.65E-03	4.05E-03	-14.88%
Water use	m3 depriv.	5419.83	6300.18	13.97%

PEF compound feed:
In 12 out of 19 impact categories, including climate change, compound feed with GPC had lower environmental footprint. The Climate change impact of compound feed with GPC was 12.7% lower than standard feed. Other feed ingredients, including maize grain, wheat grain, and sunflower seed meal are the main contributors to the environmental footprint of compound feed with GPC.

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Contact information
For further information or help, you can contact us at SDU LCE at bekh@igt.sdu.dk and morb@igt.sdu.dk or at ICOEL at eikf@icoel.dk