Comparative Product Carbon Footprint study between a conventional range of malnutrition treatments and a Reduced Carbon Footprint range

Study report

Version V1.1

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Public version

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Executive summary

This report presents the results of a comparative product carbon footprint study between Nutriset's conventional range of products intended to combat malnutrition and a Reduced Carbon Footprint range with two levels of reduction: the **Reduced Carbon Footprint – Peanut Formula** option (RCF-PF) and the **Reduced Carbon Footprint – Soy Peanut Formula** option (RCF-SPF). This approach is part of Nutriset's climate roadmap, aimed at contributing to carbon neutrality by 2050, in line with the Paris Agreement.

The study was carried out in accordance with **ISO 14067**, **ISO 14040/44** and the **GHG Protocol**, with verification by AFNOR Certification. It covers life-cycle stages from raw material production to factory gate after manufacturing ("cradle-to-gate"), and also includes transport of finished products to the storage site. The functional unit selected is one carton of finished product manufactured at the Malaunay site.

The products studied are **Plumpy'Nut®** (PNUT), a treatment for severe acute malnutrition; **Plumpy'Sup™** (PSUP), a treatment for moderate acute malnutrition; **Plumpy'Doz™** (PDOZ) and **Enov'Nutributter®+** (ENB+), lipid-based nutrient supplements in medium and small quantities respectively. Each product was modelled in its conventional version and in its reduced-carbon-footprint versions, incorporating ingredients from lower-carbon supply chains for the RCF-PF option, and formulas containing soy in addition to decarbonised sourcing for the RCF-SPF option. The reduced-carbon-footprint range also includes a green electricity contract for production and the use of biofuel for transporting finished products to storage.

The carbon footprint reductions for the reduced-carbon-footprint range and its variants, compared with their conventional references, are as follows:

	PNUT	PNUT RCF-PF	PNUT RCF-SPF	PSUP	PSUP RCF-PF	PSUP RCF-SPF	PDOZ	PDOZ RCF-PF	PDOZ RCF-SPF	ENB+	ENB+ RCF-PF
GHG emissions for one carton of finished product (kgCO2e)	65.6	54.0	47.7	65.8	50.2	42.8	66.2	50.6	43.2	63.7	59.1
Reduction in GHG emissions vs. conventional product		-18%	-27%		-24%	-35%		-24%	-35%		-7%

These reductions mainly come from raw material sourcing and formulation, which represent **88% to 94%** of the total footprint depending on the product and the option considered. The other items (production, packaging, transport) have a marginal impact, although optimisations have been integrated, such as a green electricity contract and the use of HVO biofuel for transporting finished products between the production site and the storage site.

The study relies on assumptions for certain stages, particularly energy consumption for manufacturing the RCF range, and on generic databases for ingredients, which introduces uncertainties. The main recommendations following the analysis are to secure and expand low-carbon agricultural supply chains; optimise product formulation by reducing the share of carbon-intensive ingredients; strengthen data quality; and extend the scope to other environmental impacts (ecosystem quality, biodiversity, plastic pollution). Product Carbon Footprint should not be the only component in a decision-making process.

The study nevertheless demonstrates that reducing the carbon footprint of nutrition products is possible without compromising nutritional quality, by acting primarily on raw material sourcing and product formulation. This represents a key step in Nutriset's climate strategy and, more broadly, a lever for meeting donor and humanitarian actors' expectations regarding decarbonisation.

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Version history

Version	Date	Status	Author(s)	Verifier(s)	Affected sections	Changes made
V1.0	20 March 2026	Verified	Marianne Pochon	Stéphane Petitot (AFNOR Certification)	All	First version of the report for validation/verification by AFNOR Certification according to ISO 14067:2018, ISO 14026:2018 and the GHG Protocol Product Life Cycle Accounting and Reporting Standard
V1.1	27 May 2026	Verified	Marianne Pochon	Stéphane Petitot (AFNOR Certification)	1.2; 4.2; 4.3; 5.2; 5.3; 6.3	Added PCR Food and beverage products (main PCR) (1.0.1) 2025:03 as a reference standard; quantified uncertainty for activity data and emission factors; integrated uncertainty calculations; added footprint results by emission category and life-cycle stage; added sensitivity analysis based on uncertainty and electricity emission factor variation.

List of abbreviations

ACT: Assessing low-Carbon Transition
ADEME: French Agency for Ecological Transition
CH4: methane
CO2e: carbon dioxide equivalent
DQR: Data Quality Rating
EPD: Environmental Product Declaration
FU: Functional Unit
GHG: greenhouse gases
HVO: Hydrotreated Vegetable Oil
IPCC: Intergovernmental Panel on Climate Change
LCA: Life Cycle Assessment
LUC: Land Use Change
LNS-MQ/SQ: Lipid-based Nutrient Supplement – Medium/Small Quantity
MAM: Moderate Acute Malnutrition
N2O: nitrous oxide
NGOs: non-governmental organisations
PCF: Product Carbon Footprint
PCR: Product Category Rules
PE: Polyethylene
PET: Polyethylene Terephthalate
R&D: Research & Development
RCF: Reduced Carbon Footprint
RCF-PF: Reduced Carbon Footprint – Peanut Formula
RCF-SPF: Reduced Carbon Footprint – Soy Peanut Formula
RSPO SG: Roundtable on Sustainable Palm Oil – Segregated
RUTF: Ready-to-Use Therapeutic Food
RUSF: Ready-to-Use Supplementary Food
SAM: Severe Acute Malnutrition
SDGs: Sustainable Development Goals
UN: United Nations
UNICEF: United Nations International Children's Emergency Fund
WFP: World Food Programme
WHO: World Health Organization

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1. General aspects

1.1. Study context

Nutriset is a family-owned company located near Rouen in Normandy, specialised in the development, production and distribution of nutrition solutions for vulnerable populations. Since its creation in 1986, the company's mandate has been "to fight malnutrition". Climate disruption is now, along with armed conflicts and economic crises, one of the main causes of malnutrition and food insecurity worldwide. Fighting malnutrition therefore also requires action against climate disruption. To respond more effectively to its mandate, the company's Executive Management committed in 2022 to contributing to carbon neutrality as defined under the Paris Agreement in 2015.

In 2022, Nutriset carried out a Bilan Carbone® for its 2021 activity and, in 2023, a Life Cycle Assessment of its flagship product, Plumpy'Nut®, a Ready-to-Use Therapeutic Food (RUTF). The diagnosis showed that 95% of the company's environmental impacts stem from the agricultural raw materials it purchases. The company's nutrition solutions and the ingredients used in them were therefore identified as Nutriset's primary decarbonisation lever.

In 2023, the company engaged in ADEME's ACT step-by-step approach to define decarbonisation targets and a greenhouse gas reduction plan by 2030. Designing and developing lower-carbon nutrition solutions was integrated into the decarbonisation roadmap as a priority project.

After one year of internal work in collaboration with suppliers, in 2025 Nutriset succeeded in developing a new **Reduced Carbon Footprint (RCF)** range with two levels of reduction for each product: **Peanut Formula (RCF-PF)** and **Soy and Peanut Formula (RCF-SPF)**. Each option reduces GHG emissions compared with the conventional product range while maintaining compliance with nutritional requirements set by WHO and FAO, as specified in the Codex Alimentarius.

The purpose of this study is therefore to compare the GHG emissions of the products in the reduced-carbon-footprint range with those of the conventional range, for the commercialisation of this offer and communication of the resulting reductions.

1.2. Standards and guidelines

This study is based on the principles, requirements and guidelines defined in existing international standards on Life Cycle Assessment (**ISO 14040:2006** and **ISO 14044:2006**) and complies with specific requirements for quantifying a product carbon footprint.

The study was carried out in compliance with **ISO 14067:2018**, the **GHG Protocol Product Life Cycle Accounting and Reporting Standard: 2011**, **NF EN ISO 14026:2018**, and **PCR Food and beverage products** (main PCR) (version 1.0.1) 2025:03.

As a comparative study, it was conducted in accordance with the methodological requirements and comparability principles set out in **Annex B of ISO 14067**: identical functional unit, consistent system boundaries, harmonised allocation methods, equivalent data quality, transparent documentation of assumptions, uncertainties and limitations, and critical analysis of results including sensitivity assessment.

The **PCR 2025:03 Food and beverage products** [6] was retained as a sectoral reference applicable to this study because the assessed products are nutrition solutions intended for human consumption and fall within the agri-food sector. It is considered relevant for structuring key methodological aspects of an ISO 14067 Product Carbon Footprint. Certain PCR requirements were adapted due to the study objective and scope: the functional unit is a carton but can be converted into kg of product; the study is cradle-to-gate rather than cradle-to-grave due to variability in distribution and end-of-life; and other environmental indicators were not modelled because ISO 14067 focuses specifically on climate change impact.

1.3. Validation/verification by a third-party body

To ensure the robustness, transparency and credibility of the results, independent verification of the methodology and product carbon footprint calculations was requested from a qualified third-party body, AFNOR Certification. This verification ensures that the study complies with the requirements of the above standards and supports external communication and commercialisation of the Reduced Carbon Footprint range.

1.4. Limitations

- Single-criterion scope limited to GHG emissions expressed in CO2e; other environmental impact categories are not covered.
- Social, economic and ethical dimensions are excluded.
- Some life-cycle stages rely on simplifying assumptions, which may introduce uncertainty.
- Results depend strongly on the quality and representativeness of primary and secondary data.
- The choice of system boundaries influences results and is transparently justified.
- Allocation methods can affect comparability and are documented.
- The results are based solely on Nutriset assumptions and industrial practices and may not be used by third parties for comparisons outside the study scope.

2. Study objectives

2.1. Reasons for carrying out the study

This study is part of a project to design, develop and commercialise nutrition solutions to combat malnutrition with identical nutritional specifications but a reduced carbon footprint compared with existing solutions. It operationalises the key decarbonisation levers identified in Nutriset's roadmap: raw material sourcing choices and product formulation.

The objectives are to assess the carbon footprint of the four products in the conventional reference range (using 2024 activity data), the four products in the RCF-PF range, the three products in the RCF-SPF range, and to compare the seven products in the reduced-carbon-footprint range with their conventional equivalents.

2.2. Intended applications

Third-party verification of the calculations and methodology aims to ensure scientific robustness, support commercialisation of the reduced-carbon-footprint products, and enable transparent communication on associated GHG reductions in accordance with ISO 14026. It also supports awareness among internal and external stakeholders regarding climate change, product impacts and Nutriset's decarbonisation roadmap.

2.3. Intended audience

- Nutriset internal teams, including R&D, production, quality, purchasing, logistics, climate strategy and impact measurement teams.
- Raw material and packaging suppliers.
- Industrial producers and partners, particularly PlumpyField® network members.
- Customers and distributors.
- The humanitarian ecosystem, including NGOs, UN agencies and international institutions.
- Public authorities and regulatory bodies.
- Donors and investors integrating environmental objectives into their funding policies.

2.4. Communication

Verified environmental claims to be communicated after this study are listed below. They will be systematically accompanied by complementary statements specifying scope, time frame, geography and calculation methodology.

<u>Reduced Carbon Footprint – Peanut Formula</u>

"One carton of Plumpy'Nut® Reduced Carbon Footprint – Peanut Formula emits 18% less GHG than one carton of conventional Plumpy'Nut®, at identical weight and nutritional specifications."
"One carton of Plumpy'Sup™ RCF-PF emits 24% less GHG than one carton of conventional Plumpy'Sup™."
"One carton of Plumpy'Doz™ RCF-PF emits 24% less GHG than one carton of conventional Plumpy'Doz™."
"One carton of Enov'Nutributter®+ RCF-PF emits 7% less GHG than one carton of conventional Enov'Nutributter®+."

<u>Reduced Carbon Footprint – Soy and Peanut Formula</u>

"One carton of Plumpy'Nut® RCF-SPF emits 27% less GHG than one carton of conventional Plumpy'Nut®."
"One carton of Plumpy'Sup™ RCF-SPF emits 35% less GHG than one carton of conventional Plumpy'Sup™."
"One carton of Plumpy'Doz™ RCF-SPF emits 35% less GHG than one carton of conventional Plumpy'Doz™."

Complementary statements

Reference-product emissions are calculated for 2024 according to the GHG Protocol market-based method. Impact is measured for one carton manufactured at Malaunay, France. The scope is cradle-to-gate, including sourcing, manufacturing and transport to the first storage site; storage, shipment to final consumption location and packaging end-of-life are excluded. The reduction is assessed on the basis of a Product Carbon Footprint compliant with ISO 14067:2018 and the GHG Protocol Product Standard:2011, including uncertainty analysis. Food and Beverage PCRs were also applied as a sectoral reference. Claims are valid for two years from the date of issuance of the validation/verification statement. Full methodological information is available in the public version of this report.

For ENB+ RCF-PF, a prudent complementary statement is added because of the level of uncertainty: *With a 7% reduction in its carbon footprint, ENB+ RCF-PF represents a first milestone in Nutriset's eco-design approach and confirms improvement areas, especially ingredient sourcing, while laying the foundations for future developments.*

Claims remain valid only if there is no change to product formulation, industrial processes, manufacturing sites, packaging, logistics route or fuel, and emission factors, or if these are updated and documented. If a parameter changes, claims must be reassessed and a new product carbon footprint calculation must be performed before external communication.

Communication materials include the public report, institutional and technical brochures, social media content, targeted email campaigns, events and direct presentations. A dedicated reduced-carbon-footprint logo has been created for packaging and commercial communication.

3. Scope of the study

3.1. Study objects

The products studied are described below.

Table 1 : Products description [1]

Product	Type	Target audience	Main function	Format / use	Quantity defined for one treatment or one beneficiary
Plumpy'Nut®	Ready-to-use therapeutic food (RUTF)	Children ≥ 6 months with severe acute malnutrition	Home treatment without hospitalisation	92 g sachet; 150–185 kcal/kg/day for 4–8 weeks	13.53 kg
Plumpy'Sup™	Ready-to-use supplementary food (RUSF)	Children ≥ 6 months with moderate acute malnutrition	Nutritional supplement for weight gain	100 g sachet; 75 kcal/kg/day for 2 months	9 kg
Plumpy'Doz™	Lipid-based nutrient supplement (LNS-MQ)	Children 6–36 months	Prevention of malnutrition during at-risk periods	50 g sachet; 1 sachet/day	9 kg
Enov'Nutributter®+	Lipid-based nutrient supplement (LNS-SQ)	Children 6–24 months	Prevention of post-breastfeeding nutritional deficiencies	20 g sachet; 1 sachet/day	7.3 kg

The reference range consists of the four products currently manufactured and marketed by Nutriset using standard raw material purchasing, formulation and manufacturing practices. The last available detailed activity year for modelling the conventional range is 2024.

The reduced-carbon-footprint range includes two lower-carbon variants for each product, except Enov'Nutributter®+, which has only one RCF-PF variant. The main differences relate to ingredient sourcing for RCF-PF and both sourcing and formulation for RCF-SPF. Product typology, target audience, main function, format and use remain unchanged from the reference range. Nutritional specifications remain compliant with the Codex Alimentarius.

Table 2 : Products designation

Conventional range	Code	Reduced carbon footprint range	Peanut Formula	Soy Peanut Formula
Plumpy'Nut®	PNUT	PNUT RCF	PNUT RCF-PF	PNUT RCF-SPF
Plumpy'Sup™	PSUP	PSUP RCF	PSUP RCF-PF	PSUP RCF-SPF
Plumpy'Doz™	PDOZ	PDOZ RCF	PDOZ RCF-PF	PDOZ RCF-SPF
Enov'Nutributter®+	ENB+	ENB+ RCF	ENB+ RCF-PF	ENB+ RCF-SPF

3.2. Functional unit and reference flows

For each product, the functional unit is: "One carton of finished products manufactured at Nutriset's Malaunay site, France."

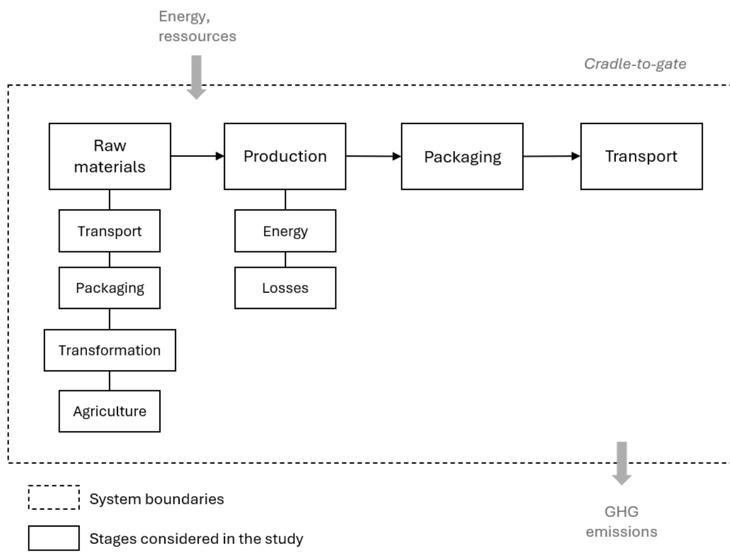
Table 3 : Reference flow for each product of the study

Conventional product	Reduced carbon footprint products	Net weight per carton	Reference flow
PNUT	PNUT RCF-PF; PNUT RCF-SPF	13.8 kg	One carton manufactured by Nutriset in Malaunay
PSUP	PSUP RCF-PF; PSUP RCF-SPF	15.0 kg	One carton manufactured by Nutriset in Malaunay
PDOZ	PDOZ RCF-PF; PDOZ RCF-SPF	15.0 kg	One carton manufactured by Nutriset in Malaunay
ENB+	ENB+ RCF-PF	12.0 kg	One carton manufactured by Nutriset in Malaunay

3.3. System boundaries and description of the product system

The study is cradle-to-gate and includes all life-cycle stages from raw material production to the factory gate of the finished product. Transport of finished products to the storage site before shipment is also included. Storage, shipment to final consumption location and end-of-life are excluded because markets and destinations vary considerably, Nutriset does not decide shipping routes or modes, and no end-of-life information is available after consumption.

Figure 1 : Scope of the study

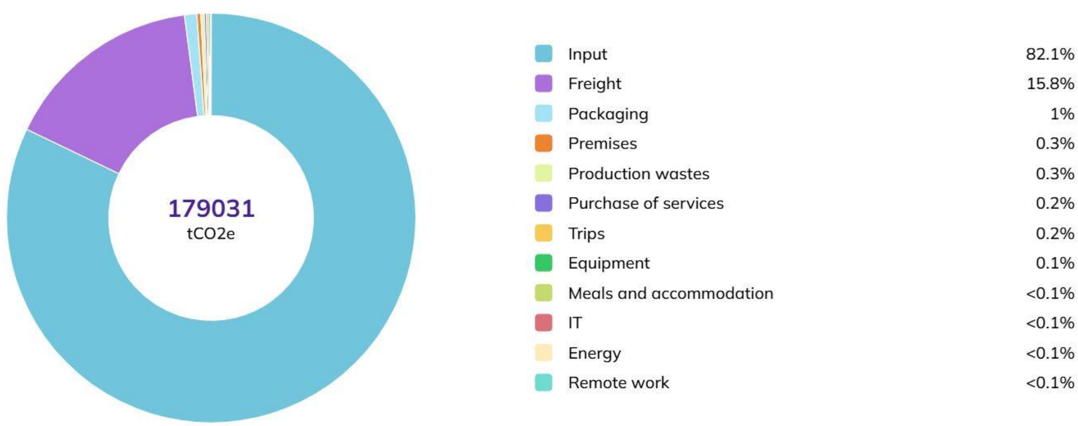


- Raw materials: agricultural production, processing, transport and packaging where applicable, defined consistently with emission factors.
- Production: processing operations at Malaunay and soy flour extrusion at Maromme for RCF-SPF products, including energy-related emissions and production losses.

- Packaging: primary multilayer plastic sachets and secondary packaging (plastic bag, carton, glue, cardboard interlayer, pallet and macro-perforated stretch film). Packaging production impacts are included; packaging transport is excluded as negligible.
- Transport: transport of finished products to the storage site in Le Havre, 80 km from Malaunay.

Excluded elements include capital goods, service purchases, water consumption and treatment, employee and visitor travel, packaging transport to Nutriset and post-production waste treatment. Nutriset France's 2024 Bilan Carbone® shows that each of these items represents less than 0.3% of company GHG emissions within the scope considered.

Figure 2 : Nutriset France Carbon footprint results for 2024 activity



3.4. Cut-off criteria

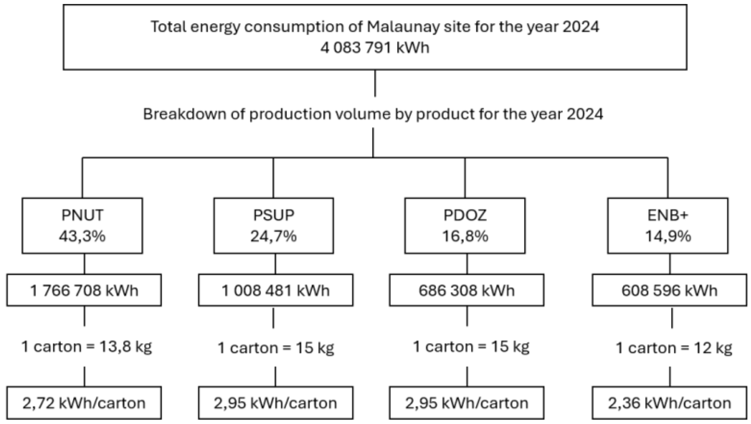
Flows were included when they represented more than 1% of total mass or more than 1% of total CO2e impact associated with the functional unit. All flows excluded based on these thresholds represent less than 5% of total impact, in accordance with ISO 14067 requirements.

3.5. Allocation rules

All calculations were based on physical flows (mass, energy), without co-product allocation since no co-products are present in the systems studied. Formula composition and packaging quantities are based on primary data. Energy flows are allocated according to production volumes at Malaunay and the quantity of extruded soy flour at Maromme.

The same logic was applied to the soy flour extrusion process at the Maromme site—an ingredient used exclusively in the "Reduced Carbon Footprint – Soy & Peanut" formulas. The Maromme site's total energy consumption for 2024 (comprising both electricity and gas) was divided by the total quantity of extruded soy flour produced that year. This yields an energy consumption figure in kWh per kilogram of finished product for each energy source. This factor is then applied to the inclusion rate of the extruded soy flour in the various products containing it, calculated on the basis of the functional unit.

Figure 3 : Allocation of energy consumption for manufacturing each product at Malaunay



4. Life-cycle inventory

4.1. Data collection

Quantification of GHG emissions is based on the collection of activity data covering the life-cycle stages of the products and the selection of emission factors used for the calculations. Activity data come directly from Nutriset or its industrial partners, including ingredient and packaging quantities, energy consumption at production sites, logistics route to the storage location and technical product characteristics. Data are representative of 2024 practices for the conventional range and 2026 forecast data for the RCF range.

Emission factors come from recognised databases such as Ecoinvent 3.11, Base Empreinte® v23.8, Agribalyse® 3.2 and CarbonCloud, and from specific supplier data for the RCF ingredients.

Table 4 : Activity data description

Range	Products	Life-cycle stage	Data nature	Source	Geographical scope	Period	Technology
Conventional	PNUT, PSUP, PDOZ, ENB+	Raw materials	Primary	Nutriset Purchasing	Site	2024	Conventional
		Formulas	Primary	Nutriset R&D	Site	2024	Conventional
		Production	Primary	Nutriset Technical Dept.	Site	2024	Standard
		Packaging	Primary	Nutriset Packaging	Site	2024	Standard
		Transport	Primary	Nutriset Logistics	Site	2024	Standard
Reduced Carbon Footprint	RCF-PF and RCF-SPF variants	Raw materials	Primary	Nutriset Purchasing	Site	2026	Lower-carbon agriculture and/or processing
		Formulas	Primary	Nutriset R&D	Site	2026	Lower-carbon SPF formulas, except ENB+
		Production	Secondary	Assumption based on 2024 data	Site	2026	Renewable electricity with Guarantees of Origin
		Packaging	Primary	Nutriset Packaging	Site	2026	Standard
		Transport	Primary	Customer Service	Site	2026	HVO biofuel shuttle

4.2. Activity data

Raw materials

Ingredients in the conventional and reduced-carbon-footprint ranges comply with the same quality and nutritional specifications. The differentiating factor is the supply chain. Some suppliers provide ingredients with a reduced carbon footprint compared with the same conventional ingredient, either through lower-emission agricultural practices or lower-carbon energy processes during transformation.

Formulas

Product formulations and ingredient quantities are confidential. The formulas ensure nutritional equivalence between conventional products and their RCF variants.

Production

Energy consumption in 2024 by industrial site was used as the reference for manufacturing emissions. Energy was allocated proportionally to production volumes due to the absence of direct metering by production line. For comparability, energy consumption for the RCF products is assumed to be identical to that of the corresponding conventional products.

Production losses

Production loss rates were included because they represent significant material flows above 1% of product mass. 2024 loss data were provided by management control. Forecast loss rates for RCF products are assumed to be identical to conventional equivalents.

Extrusion

For PNUT RCF-SPF, PSUP RCF-SPF and PDOZ RCF-SPF, soy flour extrusion is an additional step performed at Maromme. 2024 Maromme energy consumption was used to estimate energy per kg of extruded flour and applied to the quantities incorporated in the formulas. A theoretical extrusion loss rate was used because 2024 extrusion was still in implementation phase.

Packaging

Packaging quantities are based on incorporation rates provided by the packaging engineer. These rates are identical between conventional products and their RCF equivalents.

Transport

The distance from Malaunay to the Le Havre storage site is 80 km. Activity data are expressed in tonne.kilometres and are identical for conventional and RCF products.

Data quality of activity data (DQR)

In this report, the quality of activity data (Data Quality Rating - DQR) was assessed according to four criteria defined in the Product Environmental Footprint Category Rules Guidance (PEFCR) [2] method which are the level of technological, temporal, geographic representativeness, and the precision of the data.

Table 5 : Activity data quality rating scale

Criterion	1 – Very good	2 – Good	3 – Medium	4 – Poor	5 – Very poor
TeR (technological)	Highly representative of actual process	Representative with minor variations	Representative but older or generic technology	Partly non-representative	Non-representative
GeR (geographical)	Local/single-site data	Country	Region	Continent	Remote proxy/out of context
TiR (temporal)	≤2 years between data and study publication	2–3 years	3–5 years or forecast	5–10 years	>10 years or unknown
P (precision/uncertainty)	Measured; very low uncertainty (<5%)	Calculated; low uncertainty (5–15%)	Estimated/literature; medium uncertainty (15–30%)	High uncertainty (30–50%)	Very high uncertainty (>50%)

The overall quality score of a data item is obtained by averaging the four criteria. Uncertainty is then defined based on the DQR:

- DQR ≤1: uncertainty ≤5%;
- 1 < DQR ≤ 2: uncertainty 5–20%;
- 2 ≤ DQR ≤ 3: uncertainty 20–30%;
- 3 ≤ DQR < 4: uncertainty 30–50%;
- 4 ≤ DQR ≤ 5: uncertainty >50%.

Table 6 : Assessment of the quality and uncertainty of activity data for each product range

Phase	Donnée d'activité ou flux élémentaire	Unit	DQR AD Ref 2024	Uncertainty AD Ref 2024	DQR AD RCF-PF 2026	Uncertainty AD RCF-PF	DQR AD RCF-SPF 2026	Uncertainty AD RCF-SPF
Formula	Ingredient 1	kg	1	5%	1	5%	1	5%
	Ingredient 2	kg	1	5%	1	5%	1	5%
	Ingredient 3	kg	1	5%	1	5%	1	5%
	Ingredient 4	kg	1	5%	1	5%	1	5%
	Ingredient 5	kg	1	5%	1	5%	1	5%
	Ingredient 6	kg	1	5%	1	5%	1	5%
	Ingredient 7	kg	1	5%	1	5%	1	5%
	Ingredient 8	kg	1	5%	1	5%	1	5%
	Ingredient 9	kg	1	5%	1	5%	1	5%
	Ingredient 10	kg	1	5%	1	5%	1	5%
	Ingredient 11	kg	1	5%	1	5%	1	5%
	Ingredient 12	kg					1	5%
	Ingredient 13	kg	1	5%	1	5%	1	5%
Production	Extrusion - gas Maromme 2024	kWh					2	20%
	Extrusion - elec Maromme 2024	kWh					2	20%
	Losses extrusion	kg					2	20%
	Production - elec Malaunay 2024	kWh	1,3	10%	2	20%	2	20%
	Losses in production	kg	1,3	10%	2	20%	2	20%
Packaging	Sachet	kg	1	5%	1	5%	1	5%
	Carton	kg	1	5%	1	5%	1	5%
	Layers	kg	1	5%	1	5%	1	5%
	Palette	kg	1	5%	1	5%	1	5%
	Plastic bag	kg	1	5%	1	5%	1	5%
	Macroperforated stretch film	kg	1	5%	1	5%	1	5%
	Glue	kg	1	5%	1	5%	1	5%
Transport	Shuttle	tkm	1	5%	1	5%	1	5%

Activity data quality is globally very good for both ranges, with primary data for formulas, ingredients and packaging and good-quality estimated data for production.

4.3. Emission factors

The Product Carbon Footprint uses greenhouse gases defined in the IPCC Sixth Assessment Report (AR6) [4]. 100-year Global Warming Potentials were used to convert emissions into CO2e.

Table 7 : Main GHGs considered in the study (AR6, IPCC 2023)

Gas	100-year GWP (AR6)
CO2 (carbon dioxide)	1
CH4 (methane)	29.8
N2O (nitrous oxide)	273
HFC-32	771
SF6	26 900

For conventional products, emission factors from recognised databases were used. Agribalyse® 3.2 [7] was the main source for agricultural raw materials; CarbonCloud was used for certain commodities when factors were unavailable in Agribalyse® ; Base Empreinte® v23.8 and Ecoinvent 3.11 were used for energy, packaging and transport. Supermarket and retail phases were subtracted from Agribalyse® factors to align with the study scope; for oils, packaging impacts were also subtracted where bulk tank transport applies.

For RCF ingredients, specific emission factors communicated by suppliers were used. These ingredients come from dedicated traceable supply chains or improved agricultural and transformation practices aimed at reducing GHG emissions compared with conventional methods.

Data quality of emission factors (DQR)

A DQR assessment was also performed for emission factors to ensure transparency and robustness. Where uncertainty values were available in databases, they were reported; otherwise, uncertainty was derived from DQR. Supplier-specific factors were rated using a supplier questionnaire when DQR or uncertainty was not provided directly.

Table 8 : Emission factors quality rating scale

Criterion	1 – Very good	2 – Good	3 – Medium	4 – Poor	5 – Very poor
TeR (technological)	Identical technology to actual process	Identical with minor variations	Representative but older/generic	Similar but non-representative	Different technology
GeR (geographical)	Local/single-site data	Country	Region	Continent	Remote proxy/out of context
TiR (temporal)	Study published during EF validity	≤2 years after EF validity	≤4 years after EF validity	≤6 years after EF validity	>6 years after EF validity
P (precision/uncertainty)	Very precise; uncertainty <5%	Precise; uncertainty <10%	Medium uncertainty 15–30%	High uncertainty 30–50%	Very high or unknown >50%

Breakdown of GHG emissions

The split between fossil, biogenic and land-use-change emissions was performed because it is relevant for agri-food products whose emissions mainly come from agricultural production. Agribalyse® values were used where available; otherwise, analogies based on item origin were used.

5. Impact calculations

5.1. Impact results

The carbon footprint results were obtained by multiplying activity data for each product by the corresponding emission factors. Calculations were performed in Microsoft Excel. Results by life-cycle stage are presented below.

Table 9 : GHG emissions results for each product

Stage/Product	PNUT	PNUT RCF-PF	PNUT RCF-SPF	PSUP	PSUP RCF-PF	PSUP RCF-SPF	PDOZ	PDOZ RCF-PF	PDOZ RCF-SPF	ENB+	ENB+ RCF-PF
Formula	61.6	50.5	43.3	61.6	46.7	38.4	61.6	46.7	38.4	56.1	52.0
Production	2.0	1.6	2.5	2.2	1.6	2.4	2.2	1.6	2.4	4.7	4.3
Packaging	1.9	1.9	1.9	2.0	2.0	2.0	2.3	2.3	2.3	2.8	2.8
Transport	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Total	65.6	54.0	47.7	65.8	50.2	42.8	66.2	50.6	43.2	63.7	59.1
Reduction vs reference		-18%	-27%		-24%	-35%		-24%	-35%		-7%

Figure 4 : Comparison of GHG emissions between PNUT and reduced-carbon-footprint variants

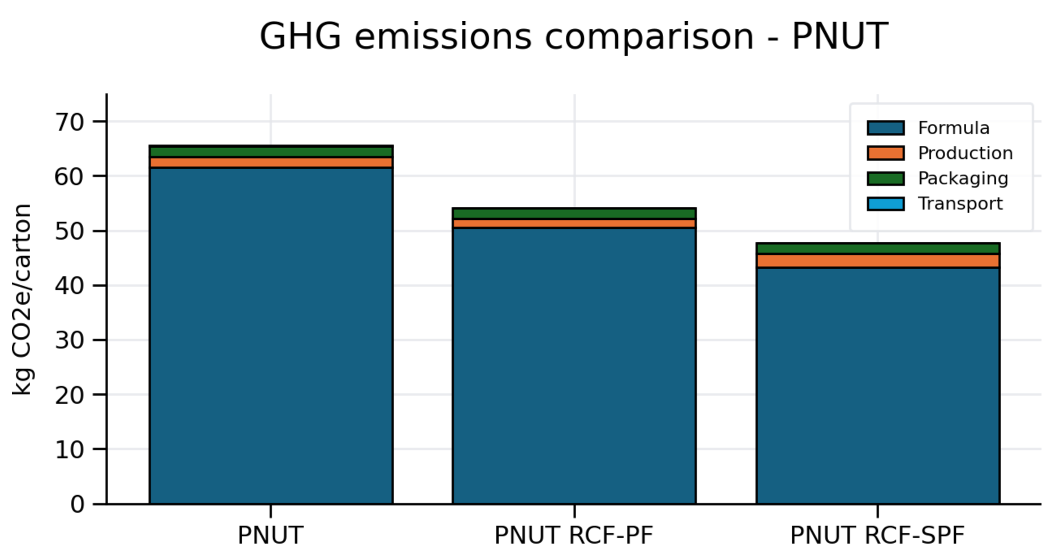


Figure 5 : Comparison of GHG emissions between PSUP and reduced-carbon-footprint variants

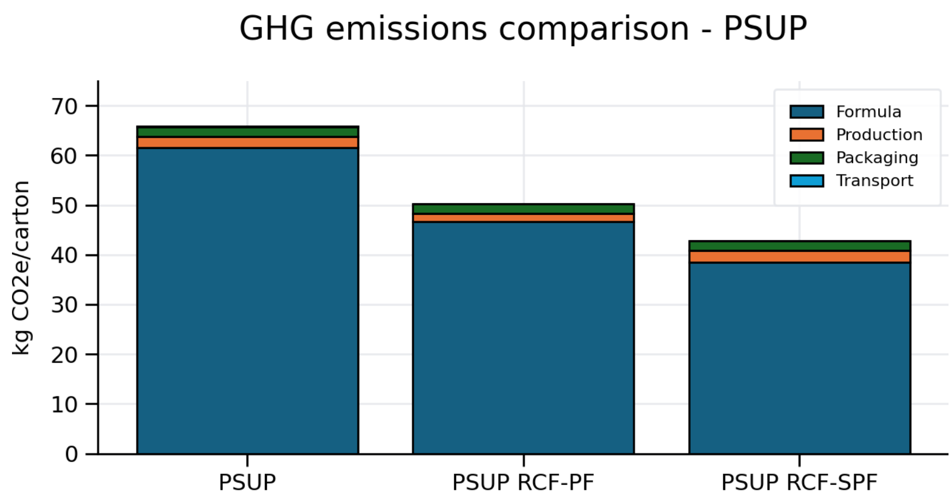


Figure 6 : Comparison of GHG emissions between PDOZ and reduced-carbon-footprint variants

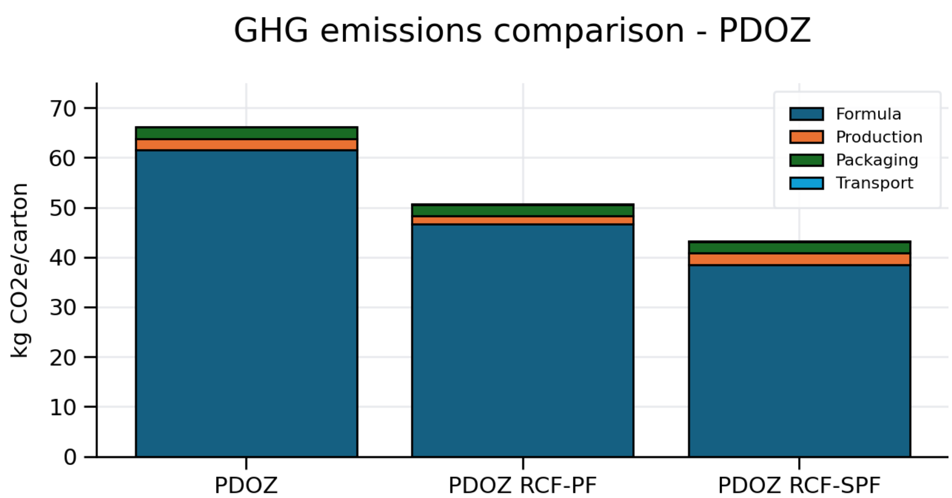
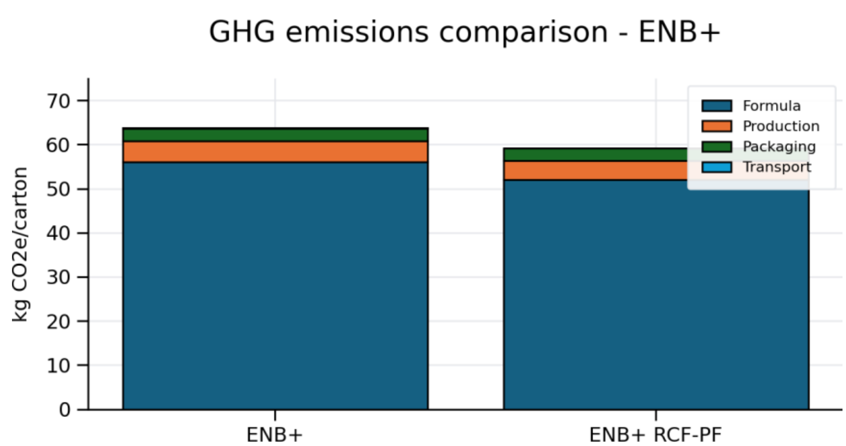


Figure 7 : Comparison of GHG emissions between ENB+ and reduced-carbon-footprint variant



5.2. Data quality

Data Quality Rating

The DQR of an elementary flow is obtained by multiplying the DQR of the activity data by the DQR of the corresponding emission factor. The final product DQR is the sum of the DQRs of each elementary flow, weighted by its contribution to the product's total carbon footprint.

Table 10 : Data Quality Rating for each product

PNUT 2024	PNUT RCF-PF	PNUT RCF-SPF	PSUP 2024	PSUP RCF-PF	PSUP RCF-SPF	PDOZ 2024	PDOZ RCF-PF	PDOZ RCF-SPF	ENB+ 2024	ENB+ RCF-PF
2.1	2.0	1.9	2.2	2.1	1.9	2.2	2.1	1.9	1.8	1.7

RCF-PF and RCF-SPF products show better data quality, mainly due to the use of supplier-specific emission factors, which are more representative than generic database factors. Results are considered globally satisfactory since no product exceeds a DQR of 2.2; the objective for future studies is DQR ≤2 for all products.

Uncertainties

Uncertainties were calculated for each emission line using a normal distribution. The emission line uncertainty combines activity data and emission factor uncertainties. Overall uncertainty for a life-cycle stage or the finished product is calculated by weighting each emission line uncertainty by its emissions. This produces a 95% confidence interval. A sensitivity index was also calculated to identify which emission lines contribute most to total variance.

Table 11 : Uncertainty results for each product

Stage	PNUT	PNUT RCF-PF	PNUT RCF-SPF	PSUP	PSUP RCF-PF	PSUP RCF-SPF	PDOZ	PDOZ RCF-PF	PDOZ RCF-SPF	ENB+	ENB+ RCF-PF
Formula	12%	13%	6%	14%	15%	8%	14%	15%	8%	10%	8%
Production	14%	22%	15%	14%	22%	15%	14%	22%	15%	14%	22%
Packaging	14%	14%	14%	14%	14%	14%	15%	15%	15%	16%	16%
Transport	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%
Overall uncertainty	**12%**	**13%**	**5%**	**13%**	**14%**	**8%**	**13%**	**14%**	**8%**	**9%**	**7%**

5.3. Emissions breakdown

GHG emissions were split between biogenic emissions, fossil emissions and emissions related to land-use change (LUC). The breakdown is mainly based on available information in LCA databases, especially Agribalyse® [5], and by analogy where supplier-specific factors did not include this split.

Table 12 : Breakdown of biogenic, fossil, and CAS-related GHG emissions for each stage of the life cycle of each product (kgCO2e/carton)

	PNUT	PNUT RCF-PF	PNUT RCF-SPF	PSUP	PSUP RCF-PF	PSUP RCF-SPF	PDOZ	PDOZ RCF-PF	PDOZ RCF-SPF	ENB+	ENB+ RCF-PF
Formula	18,8	18,5	18,5	16,5	15,2	14,2	16,5	15,2	14,2	17,4	17,4
Production	0,6	0,6	0,5	0,5	0,5	0,5	0,6	0,5	0,5	1,4	1,4
Packaging	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
Transport	0	0	0	0	0	0	0	0	0	0	0
Biogenic emissions *(relative share %)*	**19,6** *(30%)*	**19,3** *(35%)*	**19,2** *(40%)*	**17,2** *(26%)*	**15,9** *(32%)*	**14,9** *(35%)*	**17,2** *(26%)*	**15,9** *(31%)*	**14,9** *(35%)*	**19** *(30%)*	**19** *(32%)*
Formula	25,6	22,0	18,9	25,9	21,6	18,2	25,9	21,6	18,2	27,5	24,8
Production	0,9	0,7	1,7	1,0	0,7	1,6	1,0	0,7	1,6	2,2	2,1
Packaging	1,4	1,4	1,4	1,5	1,5	1,5	1,8	1,8	1,8	2,2	2,1
Transport	0,1	0	0	0,1	0	0	0,1	0	0	0,1	0
Fossil emissions *(relative share %)*	**28** *(42%)*	**24,2** *(45%)*	**22** *(46%)*	**28,4** *(43%)*	**23,9** *(48%)*	**21,3** *(50%)*	**28,8** *(43%)*	**24,2** *(48%)*	**21,6** *(50%)*	**32** *(50%)*	**29** *(49%)*
Formula	17,4	10	6,0	19,3	10,0	6,1	19,3	10,0	6,1	11,6	10,1
Production	0,5	0,3	0,2	0,6	0,2	0,3	0,6	0,3	0,3	1,0	0,8
Packaging	0,1	0,2	0,2	0,2	0,2	0,2	0,3	0,2	0,3	0,1	0,2
Transport	0	0	0	0	0	0	0	0	0	0	0
Land use change emissions *(relative share %)*	**18** *(28%)*	**10,5** *(20%)*	**6,5** *(14%)*	**20,2** *(31%)*	**10,4** *(20%)*	**6,6** *(15%)*	**20,2** *(31%)*	**10,5** *(21%)*	**6,7** *(15%)*	**12,7** *(20%)*	**11,1** *(19%)*
Total emissions totales kgCO2e/carton	**65,6**	**54,0**	**47,7**	**65,8**	**50,2**	**42,8**	**66,2**	**50,6**	**43,2**	**63,7**	**59,1**

The breakdown shows that formulation is the main contributor for all products and emission categories. In particular, fossil-based emissions and those linked to land-use change are primarily driven by ingredients, confirming the decisive role of raw material sourcing in the products' carbon footprint. The reductions in RCF-PF and RCF-SPF versions mainly result from significant decreases in land-use-change emissions and reductions in fossil emissions associated with raw materials. Biogenic emissions remain broadly stable in absolute terms, increasing only as a relative share of the total footprint. Production, packaging and transport contribute weakly and vary little between scenarios.

6. Interpretation

6.1. Main emission sources

- PNUT RCF-PF: 18% reduction in GHG emissions compared with conventional PNUT
- PNUT RCF-SPF: 27% reduction compared with conventional PNUT
- PSUP RCF-PF: 24% reduction compared with conventional PSUP
- PSUP RCF-SPF: 35% reduction compared with conventional PSUP
- PDOZ RCF-PF: 24% reduction compared with conventional PDOZ
- PDOZ RCF-SPF: 35% reduction compared with conventional PDOZ
- ENB+ RCF-PF: 7% reduction compared with conventional ENB+

These reductions are mainly explained by the Formula stage, i.e. ingredient origin and incorporation rates. **Product formulation represents 88% to 94% of total emissions** depending on the reference. Dairy derivatives are the largest contributor, followed by peanuts and palm oil. RCF reductions are linked to specific low-carbon ingredient supply chains, supplier-specific emission factors and soy-containing formulas for RCF-SPF variants.

Production represents **3% to 7%** of total emissions. Reductions are partly explained by the green electricity contract from 1 January 2026 under the GHG Protocol market-based method. For RCF-SPF products, soy flour extrusion adds a small production impact, causing a slight increase in the production stage compared with conventional references. **Packaging** emissions are identical between conventional and RCF products and represent **3% to 5%**. Transport is nearly negligible within the study scope; reductions reflect the use of HVO biofuel instead of conventional diesel for the shuttle to storage.

6.2. Product-by-product synthesis

- Plumpy'Nut® RCF-PF: 18% carbon footprint reduction, mainly due to sourcing specific ingredients from decarbonised supply chains.
- Plumpy'Nut® RCF-SPF: 27% reduction, mainly driven by formulation (-26%) through soy integration and low-carbon ingredients.
- Plumpy'Sup™ RCF-PF and Plumpy'Doz™ RCF-PF: both show a 24% reduction, mostly due to low-carbon ingredient sourcing.
- Plumpy'Sup™ RCF-SPF and Plumpy'Doz™ RCF-SPF: both show a 35% total reduction; formulation is the main lever, while extrusion slightly increases production emissions.
- Enov'Nutributter®+ RCF-PF: 7% reduction, driven by specific ingredient factors, and supported by production and transport improvements.

6.3. Completeness, consistency and sensitivity analysis

Completeness

The study satisfies ISO 14067 completeness requirements. All significant material, energy and GHG flows associated with the product life cycle have been included from raw material extraction to transport to the storage site. Excluded items are capital goods, employee and visitor travel, water consumption, packaging transport to Nutriset and storage of finished products. The analysis is considered complete and representative, with no significant omission likely to undermine result robustness.

Consistency

Methodological consistency is ensured through an identical functional unit, identical system boundaries, harmonised calculation methods, common assumptions for production steps, and no differentiated allocation rule. Thus, observed footprint differences can be robustly attributed to formulation and sourcing choices in the RCF range rather than methodological differences.

Sensitivity

Sensitivity analysis identifies the main uncertainty sources influencing the product carbon footprints. Upstream ingredient data, especially peanuts and certain dairy derivatives, dominate uncertainty. The top three uncertainty contributors were varied simultaneously to calculate lower and upper bounds for each footprint.

Table 13 : Variation of impact values based on the uncertainty of the three main contributors for each product (kgCO2e/carton).

Value	PNUT	PNUT RCF-PF	PNUT RCF-SPF	PSUP	PSUP RCF-PF	PSUP RCF-SPF	PDOZ	PDOZ RCF-PF	PDOZ RCF-SPF	ENB+	ENB+ RCF-PF
Lower bound top 3 contributors	54.5	44.5	43.6	53.4	40.5	37.7	53.7	40.9	38.1	55.6	52.9
Central impact calculation	**65.6**	**54.0**	**47.7**	**65.8**	**50.2**	**42.8**	**66.2**	**50.6**	**43.2**	**63.7**	**59.1**
Upper bound top 3 contributors	76.6	63.6	51.8	78.3	60.0	47.9	78.7	60.4	48.2	71.9	65.4

The central values of RCF-PF and RCF-SPF formulations remain systematically lower than the 2024 formulations. The sensitivity analysis confirms that conclusions regarding improved carbon performance are globally robust with respect to the main uncertainty sources identified. Improvement efforts should therefore focus on the parameters contributing most to global uncertainty, especially major ingredients in the formula.

Variation in the electricity emission factor

A sensitivity analysis assessed the influence of the GHG Protocol market-based versus location-based approaches for electricity-related emissions. The market-based approach uses supplier emission factors, while the location-based approach uses the average French electricity mix from Base Empreinte®.

Table 14 : Influence of the electricity emission factor on impact calculations

Approach	PNUT	PNUT RCF-PF	PNUT RCF-SPF	PSUP	PSUP RCF-PF	PSUP RCF-SPF	PDOZ	PDOZ RCF-PF	PDOZ RCF-SPF	ENB+	ENB+ RCF-PF
Market-based	65.6	54.0	47.7	65.8	50.2	42.8	66.2	50.6	43.2	63.7	59.1
Location-based *variation (%)*	65.6 *0.1%*	54.2 *0.2%*	48.0 *0.6%*	65.9 *0.1%*	50.4 *0.3%*	43.1 *0.7%*	66.3 *0.1%*	50.7 *0.3%*	43.5 *0.7%*	63.8 *0.1%*	59.2 *0.2%*

Switching from market-based to location-based accounting results in very limited variations, from 0.1% to 0.7% depending on the reference. This is explained by the marginal contribution of electricity to total emissions, confirming the robustness of the study conclusions regardless of electricity accounting approach.

6.4. Conclusions, limitations and recommendations

Conclusions

The analysis shows that product **formulation** and **ingredient sourcing** are the main emission-reduction levers, representing approximately 90% of the total footprint of the products studied. Observed reductions in the RCF ranges mainly result from ingredients from specific supply chains and low-carbon agricultural practices. Efforts should focus on securing and expanding low-carbon raw material supply chains while continuing secondary optimisations on other life-cycle stages.

Limitations

- The cradle-to-gate scope excludes transport to consumption locations, consumption and end-of-life. Previous LCA work on Plumpy'Nut® suggests these stages represent a minor share of climate-change emissions (<5%), but they may be important for other environmental impacts such as plastic pollution.
- Some simplifying assumptions are used, notably for extrusion and manufacturing energy consumption.
- Ingredient emission factors come from generic databases when specific data are unavailable, which can introduce variability.
- Uncertainty modelling provides an order of magnitude and an indicator of data quality but has limits.
- Energy allocation by production volume is used due to the absence of direct line-level measurements.
- Other environmental impacts, such as biodiversity, human health, ecosystems and resource scarcity, are not assessed. Product Carbon Footprint should not be the sole component of decision-making.

Recommendations

Sourcing

- Secure and expand low-carbon supply chains for key raw materials, especially dairy, while strengthening traceability and supplier contracting.
- Integrate environmental criteria into purchasing specifications to secure sustainable agricultural practices and reduce ingredient-production emissions.

Formulation

- Collaborate with institutions to review malnutrition-treatment specifications in order to integrate more plant-based proteins, which are less carbon-intensive than animal proteins.

Production

- Improve industrial energy efficiency through technological investments and low-carbon energy.
- Monitor energy consumption by production line to improve data quality and identify reduction opportunities.

Transport

- Continue favouring decarbonised transport modes.
- Implement logistics emissions monitoring to guide strategic decisions.

Packaging

- Although contribution is low, reduce material use, improve recyclability, and explore circular solutions such as reuse. Packaging use and end-of-life are outside the study scope, but they contribute to global plastic pollution and affect health and biodiversity.

Data quality and monitoring

- Strengthen inventory data quality through systematic supplier collection, including DQR and uncertainty.
- Monitor regular updates of emission factors to ensure alignment with scientific standards.
- Document and archive assumptions and sources to ensure traceability and facilitate third-party verification.

Governance and communication

- Embed Product Carbon Footprint work in a responsible global vision aligned with Nutriset's humanitarian mission and public-good objectives.

- Use transparent and responsible communication based on verified data and international standards.
- Participate in sector initiatives and contribute to common standards for reducing the carbon footprint of humanitarian products.

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