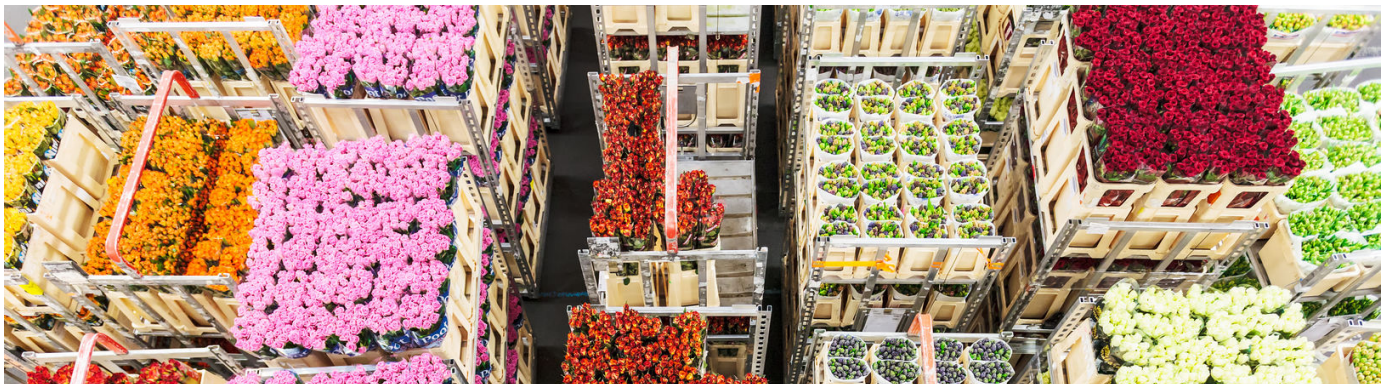

# Life cycle analysis of floricultural products

## Memorandum on an analysis of existing environmental-footprint methodologies

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## Introduction

This memorandum has been prepared in support of the Product Environmental Footprint Category Rules for potted plants and cut flowers (FloriPEFCR) that is being developed during the Environmental Footprint Transition Phase of the EU (2019-2022). The development of the methodology strictly follows the most recent guidance for developing Product Environmental Category Rules (PEFCR Guidance) published by the European Commission (Zampori and Pant, 2019). The development of the FloriPEFCR is done by the Technical Secretariat (TS): Royal FloraHolland, Fresh Produce Centre, Union Fleurs, Floriculture Sustainable Initiative, MPS Group, Florverde, Wageningen Economic Research, Blonk Consultants, PRé Sustainability and Natuur&Milieu.

The primary objective of the FloriPEFCR is to define a consistent and specific set of rules to calculate the environmental footprint of two main products from the sector of floriculture, namely Cut flowers and Potted plants. Reliable insight into the environmental footprint of horticultural product provides great opportunities to reduce your environmental impact. Harmonised rules for environmental assessments provide more comparable outcomes and allow for the development of unified and harmonised tools, labels and consumer communication. It can also help in tackling false claims, and help to showcase the efforts of the sector to improve its environmental impact. One of the elements in the FloriPEFCR development is the analysis of existing PEFCRs and PCRs for the proposed product group/sector. This memorandum examines the existing methodologies for the horticultural sector which can be used to build on, expand or improve via FloriPEFCR. This memorandum is part of the information package under the 1st Public Consultation for the First Draft FloriPEFCR (September 2021).

## Background

In the past 10 years, several initiatives have focused on the development of environmental footprint methodologies and assessments of environmental footprints of horticultural products.

In 2009 Blonk Consultants published an exploratory study for methodological choices (Blonk et al., 2009) and Wageningen Economic Research launched the $CO_2$ footprint tool (Hiller and Danse, 2009), both commissioned by the Dutch Horticultural Product Board (Productschap Tuinbouw). On

the basis of these initiatives, the Product Board developed the horticultural supplement of the British carbon footprint protocol PAS2050 in 2012 (BSI, 2012). A few years ago the foundation Benefits of Nature started developing a new calculation tool for the assessment of environmental footprints of horticultural products and has clearly set the direction towards the use of multiple environmental indicators. With the development of FloriPEFCR, all these initiatives are connected for the floriculture sector.

The comparison was made along the main elements of a PEFCR document, building on the template as suggested in Zampori and Pant (2019), which includes goal and scope (goals, functional unit, product representation, system boundaries, impact indicators), inventory (data quality requirements, end-of-life modelling, handling multifunctionality), interpretation of results, reporting and review. Each of these components is treated in the subsequent chapters in this document.

There are three methodological documents that are specific for environmental footprints of horticultural products:

- PAS2050-1 Horticultural supplement (BSI, 2012)
- Horticulture carbon footprint methodology (Blonk et al., 2009)
- Benefits of Nature (Benefits of Nature, 2017)

No other existing PEFCRs/PCRs were identified. This review of methodologies was made prior to development of the recently published Hortifootprint Category Rules (Helmes et al., 2020). The choice to exclude HortiFootprint from the comparison is simply because FloriPEFCR builds on the HortiFootprint and does not add to the comparison.

These three methodologies have been extensively used and are specific for environmental footprints of horticultural products. They were studied and embedded where applicable in the 1st Draft FloriPEFCR. This memorandum documents the comparison of these methodologies.

## Compliance to standards

The three methodologies that are specific for environmental footprints of horticultural products also refer or claim compliance to other existing documents (see Table 1). These documents can be ISO standards, other standards/specifications, guidance documents and other methodological documents. The three existing horticultural methodologies are not necessarily compliant to ISO, while the FloriPEFCR guarantees compliance with the ISO standards.

***Table 1*** *Compliance to standards in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | The FloriPEFCR is compliant with the PEFCR Guidance which guarantees compliance with the ISO standards. References are made to the ENVIFOOD protocol, LEAP and the ILCD handbook. |
| PAS2050-1 | The PAS2050-1 is compliant with the PAS2050 (2012) – which 'builds on' the ISO14040/44. |
| Horticulture CF method | Follows ISO14040/44 and PAS2050 (2008) – discusses various options. |
| Benefits of Nature | References to: PEFCR Guide version 6.3, PAS2050-1, ENVIFOOD protocol, Horticulture $CO_2$-footprint methodology (Blonk et al., 2009), ILCD Handbook. |

## Goal and Scope

This section compares the methodologies for various core components of the goal and scope of the methodologies.

**Goal**

The goal describes the purposes of the assessments performed using the different methodologies. Each methodology formulates different goals, though the goals of Benefits of Nature and PAS2050-1 appear to be similar. None of the three horticultural methodologies have the specific goal of external communication (Table 2).

***Table 2*** *Goals as defined in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | To enable to reduce the environmental impacts of goods and services taking into account supply chain activities. The PEF method enables to conduct PEF studies that are reproducible, comparable and verifiable. |
| PAS2050-1 | Provide a common basis for GHG emission quantification that will inform and enable meaningful GHG emission reduction programmes' |
| Horticulture CF method | Provide information to enable balanced decisions on methodological choices |
| Benefits of Nature | To compare the environmental performance with other producers.<br>To provide a methodology to monitor the environmental performance of the grower. |

**Functional unit**

The functional unit is the quantified performance of a product system for use as a reference unit (ISO14044:2006). In the PEFCR Guidance it is explained as 4 characteristics and a specific product code:

- The function(s)/service(s) provided: 'what'
- The extent of the function or service: 'how much'
- The expected level of quality: 'how well'
- The duration/life time of the product: 'how long'
- The NACE code(s).

Methodologies have different definitions or guidance, as summarised in Table 3.

***Table 3*** *Functional unit in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | One stem of cut flowers and one potted plant for potted plants |
| PAS2050-1 | No general rules, only guidance: (summarised)<br>• Be precise in the definition of physical properties<br>• Be aware of the units usually applied in relation to product types, cut flowers from different regions, the logical reference unit will be stems (with a certain quality). It is not meaningful to use a weight unit<br>• Be complete in the inclusion of auxiliary products such as pots, labels, substrates packaging, etc. |
| Horticulture CF method | 1,000 kg for flowers and plants |
| Benefits of Nature | For flowers and plants 1 € of product |

**Representative product specification**

The product description defines a group of specific products which have a comparable functionality and possibly comparable production systems. For example a tomato can be any variety of tomato, but always has the functionality of providing nutrition with more or less the same nutritional values.

In that sense they could be comparable. However, a grower of tomatoes produced in a heated greenhouse wants to compare the environmental performance with tomatoes from other growers produced in heated greenhouses. A consumer, retailer, NGO or policy maker on the other hand may want to compare tomatoes from open field in Spain with tomatoes from Dutch greenhouses. So, the different product description must be aligned with the goals. Table 4 compares the definitions of a representative product among methodologies. While PAS2050-1 is the most specific for horticultural products, it only described production systems and thus not the entire life-cycle.

***Table 4*** *Representative product in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | Representative products to be determined in the PECFR (see PEFCR Guidance)<br>Two representative products are defined: (1) potted plants, which is a mix of three crops two types of pot soil. (2) cut flowers which is a mix of four crops from several regions |
| PAS2050-1 | A distinction is made based on the type of production techniques and transport mode:<br>• Heated, air transport<br>• Heated, not air<br>• Unheated/protected, air transport<br>• Unheated/protected, not air transport<br>• Field, processed<br>• Field, unprocessed<br>• Field, unprocessed, air transport? |
| Horticulture CF method | As in PAS2050-1 |
| Benefits of Nature | Distinction is made based on production technique:<br>• Heated<br>• Unheated/protected<br>• Field |

**System boundaries**

The system boundaries are a set of criteria specifying which unit processes are part of a product system. A unit process is the smallest element considered in the life cycle inventory analysis for which input and output data are quantified. There is a main distinction between cradle-to-gate and cradle-to-grave, where the first excludes the consumer phase and possibly also retail, transport and processing and where the latter includes the whole life cycle including end-of-life treatment.

***Table 5*** *System boundaries in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | Cradle-to-grave |
| PAS2050-1 | • Cradle-to-grower gate + disposal<br>• Excluding goods/ maintenance climate control, tractors, irrigation, buildings<br>1% cut-off allowed |
| Horticulture CF method | • Cradle-to-grower gate + disposal<br>Discusses the relevance of capital goods |
| Benefits of Nature | Cradle to grower gate + disposal |

All methodologies except FloriPEFCR define incomplete life cycles (see Table 5). The incomplete life cycles may work for comparing the environmental performance of products from specific production systems (e.g. heated greenhouses) within specific regions (e.g. the Netherlands), but does not work for instance when products come from different production systems, are transported between different regions and are packed differently throughout the life cycle.

**Selection of impact indicators**

Impact indicators represent environmental issues to which life cycle inventory analysis results are to be assigned. Table 6 lists impact indicators for the four methodologies. Each indicator has a specific unit, such as climate change (kg $CO_2$ equivalents), land use ($m^2$.year crop eq.), and fine particulate matter formation (kg PM2.5 eq.). To assess the score of a product for each indicator, scientific methods have been developed which provide the characterisation factors, i.e. factors derived from a characterisation model which are applied to convert amounts of certain emissions, resource extractions and land uses to the units of the indicators. For example, 1 kg of $N_2O$ emission is equivalent to 298 kg $CO_2$ emission; so the climate change-specific characterisation factor for $N_2O$ emissions is 298 kg $CO_2$eq per kg of $N_2O$. These factors are regularly updated, based on the newest scientific insights. This causes incomparability with results based on outdated factors or based on factors from a different scientific method.

***Table 6*** *Impact indicators in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | GWP100* IPCC2013 including carbon feedback: 34 CH4 biogenic 36.75 CH4 fossil 298 N2O<br>Impact indicators:<br>• Climate change<br>• Ozone depletion<br>• Human toxicity (cancer/non-cancer)<br>• Particulate matters<br>• Ionising radiation, human health<br>• Photochemical Ozone formation, human health<br>• Acidification<br>• Eutrophication (terrestrial, freshwater, marine)<br>• Ecotoxicity (freshwater)<br>• Land use<br>• Water use<br>• Resource use (minerals and metals and fossils) |
| PAS2050-1 | GWP100 IPCC2006 including carbon feedback: 22.25 $CH_4$ biogenic, 25 $CH_4$ fossil, 298 $N_2O$<br>Impact indicators:<br>• Climate change |
| Horticulture CF method | As in PAS2050-1 |
| Benefits of Nature | Impact indicators:<br>• Climate change<br>• Human toxicity (freshwater aquatic, marine aquatic, freshwater sediment, marine sediment terrestrial)<br>• Abiotic resource depletion<br>• Photochemical oxidant formation<br>• Acidification<br>• Eutrophication<br>• Ozone layer depletion<br>Weighting done by monetisation of the impact indicators |

* GWP- Global warming potential – Capacity of a greenhouse gas to influence radiative forcing, expressed in terms of a reference substance (for example, $CO_2$-equivalent units) and specified time horizon (e.g. GWP 20, GWP 100, GWP 500, for 20, 100, and 500 years respectively). It relates to the capacity to influence changes in the global average surface-air temperature and subsequent change in various climate parameters and their effects, such as storm frequency and intensity, rainfall intensity and frequency of flooding, etc.

FloriPEFCR is most up-to-date, reflecting a state-of-the-art and thus more complete methodology. According to PEFCR Guidance, the representative product studies must include all 16 environmental footprint impact indicators as specified in Zampori and Pant (2019). The hot spot analyses in these studies is used to determine the 80% most relevant environmental indicators. The most relevant indicators are the minimum set to be incorporated in PEF studies complying to the FloriPEFCR. PEFCRs are allowed to add additional requirements in terms of indicators and additional information.

**Data quality requirements**

Data quality is the characteristics of data that relate to their ability to satisfy stated requirements. This is an important factor: the data must be of similar quality to make fair comparisons and for any purpose the data should have a certain quality standard. Table 7 lists the overall data requirements as specified in different methodologies.

***Table 7*** *Overall data quality requirements in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | Extensive rules in the PEFCR Guidance in terms of data quality via the data needs matrix |
| PAS2050-1 | Following PAS2050: Preference for more time, geography and technology specific, more accurate and precise data<br>Documentation of completeness, consistency, reproducibility and data sources |
| Horticulture CF method | Description of specific sources of international and specific data for the Netherlands. No data quality requirements described. |
| Benefits of Nature | Contains a mapping table of all kinds of possible inputs for growing horticultural products and secondary data processes, including adapted datasets. |

Primary and secondary data are distinguished. Primary data refers to data from specific processes within the supply-chain of the company applying the study. Primary data are site-specific, company-specific (if multiple sites for the 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. Secondary data refers to data not from specific processes within the supply-chain of the company. FloriPEFCR is the only methodology which requires a certain level of primary data to be included, listing mandatory company-specific processes.

Table 8a-8d list guidance for life cycle inventory (LCI) and Table 9 lists sources for secondary data.

***Table 8a*** *LCI guidance: annual variation in weather influences and other external factors*

| Methodology | Description |
|---|---|
| FloriPEFCR | For cultivation 3-year average data should be used (annual and perennial) |
| PAS2050-1 | For cultivation 3-year average data should be used (annual and perennial) |
| Horticulture CF method | Not mentioned |
| Benefits of Nature | Each year separately |

***Table 8b*** *LCI guidance: product representativeness*

| Methodology | Description |
|---|---|
| FloriPEFCR | PEFCR Guidance offers guidance on sampling of data to come to a representative set. FloriPEFCR requires specific data to come from company specific sources |
| PAS2050-1 | Representative sample is allowed for groups of growers |
| Horticulture CF method | Not mentioned |
| Benefits of Nature | Not mentioned |

***Table 8c*** *LCI guidance: pesticides emissions*

| Methodology | Description |
|---|---|
| FloriPEFCR | Pesticides emissions: default 80% soil; 10% air; 10% water<br>Use PestLCI for more specific results |
| PAS2050-1 | Not in scope |
| Horticulture CF method | Not in scope |
| Benefits of Nature | Pesticides emissions to water and air are quantified per substance applied |

***Table 8d*** *LCI guidance: GHG emissions*

| Methodology | Description |
|---|---|
| FloriPEFCR | • Modelling GHG emissions: follow IPCC2013<br>• Guidance for greenhouses<br>• For LULUC, use Blonk tool<br>• No soil carbon change from soil management<br>• Guidance for allocation in case of CHP<br>• Emissions from peat as substrate are specified<br>• Guidance on use of $CO_2$ from third parties for fertilisation |
| PAS2050-1 | • Modelling GHG emissions: follow IPCC (2006)<br>• For LULUC, use Blonk tool<br>• No soil carbon change from soil management<br>• CHP $CH_4$ leakage: 1230 mg C/$m^3$ natural gas (2.3% of fuel input) |
| Horticulture CF method | • Modelling GHG emissions: follow IPCC2006<br>• First concept on LULUC for Blonk tool<br>Emissions from peat as substrate are specified |
| Benefits of Nature | • Modelling GHG emissions: follow IPCC (2006)<br>• For LULUC, use Blonk tool<br>• Emissions from peat as in Blonk et al. (2009)<br>• CHP $CH_4$ leakage: 535 mg C/$m^3$ natural gas (1% of fuel input) |

***Table 9*** *Secondary data requirements in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | Specific secondary database has been developed and this EF database is mandatory to use in PEF studies |
| PAS2050-1 | No requirements formulated |
| Horticulture CF method | ELCD and EcoInvent mentioned<br>Various references to reports as data sources |
| Benefits of Nature | Specific list of datasets from secondary databases specified<br>Main database is EcoInvent 3.2 cut-off |

FloriPEFCR specifies most extensive rules in terms of data quality requirements and use of foreground data in the context of representativeness. A dedicated database for secondary processes has been developed for PEF which is mandatory to use. FloriPEFCR also offers the most detailed guidance for modelling emissions for the floricultural sector.

**End-of-life modelling**

End-of-life (EoL) modelling is relevant when used materials are recycled into materials for use in another life cycle or recycled materials are used as input of the studied product's life cycle. It needs to be determined how much of the benefits and burdens of the recycling process is allocated to the studied product and to the other product's life cycle.

***Table 10*** *End-of-life in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | Circular formula for material, energy, disposal |
| PAS2050-1 | See PAS2050, depending on the situation |
| Horticulture CF method | Not specified |
| Benefits of Nature | Not specified |

Table 10 describes how EoL is addressed in the methodologies. While the PAS2050-1 allows the expert to interpret the situation and select the rule that seems most suitable, the FloriPEFCR on the other hand has developed a formula that is applicable to all situations. This makes it easier and more consistent, but it may not give logical results. On the other hand, the formula can be manipulated by adapting the parameters. It is expected that the end-of-life modelling is not the most relevant methodological issue for floriculture.

**Handling multifunctionality**

Multifunctionality occurs in unit processes where more than one product is produced or multiple services are provided. An example is a greenhouse with a combined heat and power system where several types of flowers are produced and excess electricity is sold to the grid. Tables 10a,b specify how multifunctionality aspects are addressed in different methodologies. FloriPEFCR covers allocation rules for a broad set of topics which are relevant to floricultural sector and contributes to further advancement of previously published methodology. Detailed elaboration on handling multifunctionality of combined heat and power systems used during cultivation is documented in a separate memorandum (Ponsioen et al., 2020).

***Table 10a*** *Multifunctionality aspects of combined heat and power in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | Energy allocation |
| PAS2050-1 | Avoided country grid mix |
| Horticulture CF method | Analysis:<br>• avoided coal fired<br>• avoided natural gas<br>• avoided country mix<br>• energy allocation<br>• economic |
| Benefits of Nature | Energy allocation |

***Table 10b*** *Other multifunctionality aspects in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | Mainly economic allocation<br>Also allocation rules for other topics like use of green manure, organic fertilisers, use of peat soils, $CO_2$ fertilisation, transport and storage |
| PAS2050-1 | • Economic<br>• Crop fertiliser needs<br>• Similar functionality: mass (e.g. apples)<br>• $CO_2$ fertilisation: 0.5 kg $CO_2$/kg $CO_2$ |
| Horticulture CF method | Not specified |
| Benefits of Nature | • Economic (also in case of $CO_2$ fertilisation and coco-peat)<br>• In case of pot-plants in greenhouses, allocation based on number of pots<br>• In case of 2 or more crops in 1 greenhouse, $m^2$. week occupation |

## Interpretation

Interpretation is related to hotspot analyses, calculating benchmarks, sensitivity analyses, and drawing conclusions in a comparative assertion (comparing the environmental footprint of a product from two different product systems).

***Table 11*** *Guidance on interpretation of results in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | Formalised instructions for hotspot analysis<br>Formalised instructions for data quality assessments based on the hotspot analysis |
| PAS2050-1 | Not specified |
| Horticulture CF method | Not specified |
| Benefits of Nature | Expert judgement on data quality and allocation procedures<br>Hotspot analysis is recommended |

Table 11 lists the requirements regarding the interpretation. The FloriPEFCR has formalised rules on how to assess data quality and hotspot analysis, while Benefits of Nature leaves this to the expert. The instructions of the FloriPEFCR are labour intensive, but prevents biased interpretation. On the other hand, experienced experts can do this more efficiently when they do not have to follow these procedures and when a review is done, the reviewer can check this.

## Reporting and review

A methodology may contain rules on which elements need to be reported, the type and format of the report and specific requirements for reporting inventory, impact assessment results and interpretation. To ensure conformity with a methodology a review may be required. There may be requirements for the qualification of the reviewer, the reviewer may be independent or internal, and there may be other rules to which the review needs to qualify. The rules may also depend on the goal of the study. Only FloriPEFCR specifies templates for the reporting and specifically addressed a review procedure.

***Table 12*** *Guidance on reporting and review in the methodology*

| Methodology | Description |
|---|---|
| FloriPEFCR | Reporting template as defined in the PEFCR Guide:<br>• Summary<br>• Goal<br>• Scope<br>• Inventory<br>• Impact results<br>• Interpretation<br>• Annex<br>• Confidential report<br>Specific requirements on reporting inventory, impact assessment and interpretation are specified in the PEFCR Guidance.<br><br>Review is required conform ISO standards:<br>• for external or internal communication: shall be critically reviewed by independent and qualified external reviewer (or review team).<br>• comparative assertion: shall be critically reviewed by an independent panel of 3 qualified external reviewers.<br>Requirements for qualification are specified. |
| PAS2050-1 | Not specified |
| Horticulture CF method | Not specified |
| Benefits of Nature | Not specified |

## Final conclusions

The goal of the FloriPEFCR is to provide a harmonised methodology after which consistent PEF studies can be performed for the European floricultural sector, producing unambiguous results that can be compared. With the overview of existing methods applicable to footprint analysis in horticulture, it can be concluded that FloriPEFCR outperforms them regarding the standardisation of rules. This in turn brings in the complexity of the newly developed method, which is the counterpart of the achieved harmonisation and is common to all PEFCRs. No other relevant PEFCRs were detected during the preparation of this overview and thus no conflicts have been observed with the draft of FloriPEFCR.

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