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# Life cycle assessment of strawberry and asparagus production

**Client**
Peter Gerber, BAFU
Pierryves Padey, BAFU
3003 Bern

**Authors**
Thomas Kägi, Flora Conte, Tanja Laube, Gavin Roberts, Carbotech AG

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Carbotech AG
Postfach, CH-4002 Basel
www.carbotech.ch

Office Zürich
Gasometerstrasse 9, CH-8005 Zürich
T +41 61 206 95 25

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**Contractor**
Carbotech AG, Zurich

**Author**
Thomas Kägi, Flora Conte, Tanja Laube, Gavin Roberts

**Project Management / Contact**
Thomas Kägi
+41 44 444 20 17
t.kaegi@carbotech.ch

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Andy Eigenmann, myclimate

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# 1 Introduction

There are only a few inventory data for fruit and vegetables in the Federal Office for the Environment (FOEN) database. To raise the awareness of the population about the importance of their choices in the consumption of vegetables and fruit it is necessary to expand the information in this area to include other crops. It was therefore decided to generate the inventory data for strawberries and asparagus.

The project aims to generate new data and update the life cycle inventories (LCI) and the life cycle assessment for the following currently practiced production, transport and packaging scenarios:

| Key inventories | Transportation |
|---|---|
| Strawberries, conventional, heated greenhouse/CH | lorry |
| Strawberries, conventional, unheated plastic tunnel/CH | lorry |
| Strawberries, organic, unheated plastic tunnel/CH | lorry |
| Strawberries, conventional, unheated multi tunnel/ES | lorry |
| Asparagus, conventional/CH | lorry |
| Asparagus, conventional/PE | air freight, sea freight |
| Asparagus, conventional/MX | air freight |

# 2 Methodology and procedure

Today, there is a broad consensus that LCA is the most comprehensive and meaningful method to assess the environmental impacts of products and systems. Therefore, this method is used to determine the environmental impacts of the products mentioned.

## 2.1 General description of LCA

Life cycle assessment (LCA) is a method for recording and assessing the effects of human activities on the environment and deriving optimisation potential from them. Due to the complexity of nature and the global economic system, it is not sufficient to consider only individual problematic substances or local impacts. The following requirements for the method result from the demand for a comprehensive assessment:

- Consideration of the various environmental impacts as comprehensively as possible
- Consideration of the entire life cycle
- Quantification of the environmental impact
- Evaluation of the different impacts as a basis for decisions
- Scientifically supported to achieve a high level of reliability and acceptance

Life cycle assessment is the method that best meets these requirements today. The results of the life cycle assessment can be used:

- as decision-making support when facing different options
- to account for the relevant impacts
- to determine the main influencing factors
- in strategic planning to identify optimisation potentials
- for the assessment of measures
- as a basis for eco-design
- for the derivation of recommendations for action

## 2.2 Procedure of LCA

After the problem and the systems to be investigated have been defined, the flows of goods, materials and energy as well as the resource requirements are recorded. Subsequently, the effects on the environment are determined with the help of selected indicators that describe these effects. With the aim of expressing the results with a key figure and thus enabling, or at least facilitating, evaluation, an assessment of the various environmental impacts can be made by weighting them accordingly.

According to ISO 14040/44 (ISO, 2006; ISO/TC, 2006), a life cycle assessment comprises the following steps:
- Defining the objectives and system boundaries (framework conditions)
- Recording the relevant material and energy flows as well as the resource requirements (life cycle inventory)
- Determine the impact on the environment (impact assessment)
- Interpretation of the environmental impacts based on the objectives (interpretation)
- Developing measures (optimisation)

As Figure 1 shows, this is not a linear process, but an interactive process of cognition and optimisation.

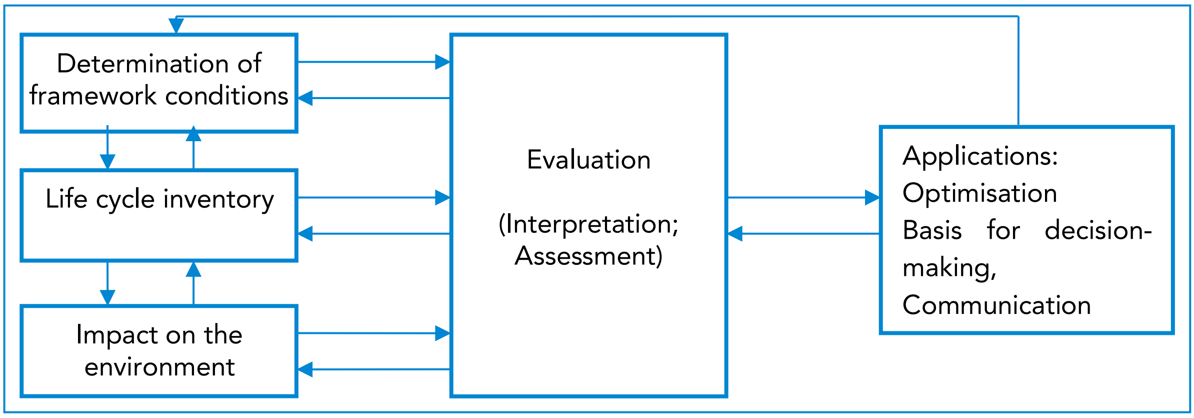


**Figure 1: Steps of a life cycle assessment according to ISO 14040/44**

The present study follows the ISO 14040 standard; in individual points, such as the use of overall aggregating methods, the present study goes beyond the standard.

## 2.3 Objectives and framework conditions

The definition of the systems to be examined and compared depends on the objective or question. This results in different framework conditions and system boundaries. The system boundaries define which processes and upstream processes are taken into account. For example, the time frame of the data used and the environmental impacts to be investigated are defined.

### 2.3.1 Objective

The life cycle assessment is intended to answer the question of which strawberry or asparagus cultivation is preferable from an ecological point of view. Furthermore, an important goal is to provide life cycle inventories for strawberry and asparagus production. In particular, the following goals should be considered:

- Analysis and comparison of the environmental impact of strawberry cultivation on soil in Switzerland and Andalusia, Spain.
- Analysis and comparison of the environmental impact of asparagus cultivated in Switzerland, Peru and Mexico.

### 2.3.2 Functional unit

If a product is compared with alternatives, these must provide the same benefit or fulfil the same function. The measure to which the comparison refers to is called the functional unit.

In this study, for the analysis and comparison of the strawberry variants, the following functional unit was defined:

- 1kg of fresh strawberry, delivered to a generic store in Switzerland.
- 1kg of fresh asparagus, delivered to a generic store in Switzerland.

### 2.3.3 Application and target group of the study

The study is primarily aimed at the client and the interested public.

### 2.3.4 External Review

An external review of the study was conducted by Andy Eigenmann, myclimate. The review report is integrated in the appendix of the report. The review states that the present study complies with the international standards for life cycle assessments (ISO 14040 and 14044) and the methodological guidelines of the ecoinvent v2 methodological framework (Frischknecht et al., 2007, S. 2). This includes especially:

- Completeness of the documentation. All investigated datasets should be described in the report, and all necessary meta information and flow data should be available for each dataset.
- Consistency with the quality guidelines. It is checked whether the unit processes have been modelled according to the ecoinvent quality guidelines. The quality guidelines cover for example the estimation of transport distances or the calculation of energy demands in the inventory (see chapter 2.4.2).
- Plausibility check of the life cycle inventory data. Selected input and output flows are controlled for plausibility.
- Completeness of inputs and outputs. The completeness of flows is based on the environmental and technical knowledge of the reviewing person. Reviewers are not necessarily technical experts of the processes reviewed. If necessary, they were supported by the person responsible for the report.
- Mathematical correctness of calculations. Selected inputs and outputs are controlled in view of mathematical correctness, e.g. the transport service inputs, the waste heat or $CO_2$ emissions.

### 2.3.5 System boundary

This LCA looks at the ecological impacts 'from cradle to grave', i.e. from the extraction of the raw materials through the individual steps of the strawberry and asparagus cultivation up to and including disposal of the packaging. In accordance with the life cycle assessment approach, all environmentally relevant processes within the system boundary are recorded and evaluated as far as possible.

The system boundary of the present study thus essentially comprises the following material and energy flows of the subsequent processes and services that are considered relevant (see Figure 2):

- Provision of auxiliary materials and production of strawberries and asparagus
- Transport of raw materials and auxiliary materials, strawberries and asparagus
- Waste along the production chains and from provisioning auxiliary materials and energy
- Provision of energy heat and electricity, energy sources such as oil, natural gas, coal, etc. for the processes involved.

Not considered in this study:

- Packaging of fertilisers and pesticides (not relevant)
- Losses during processing and transportation (not relevant)
- Storage

For all these processes, the impacts due to emissions into soil, air and water as well as the resource requirements (e.g. energy resources or land use) are taken into account.

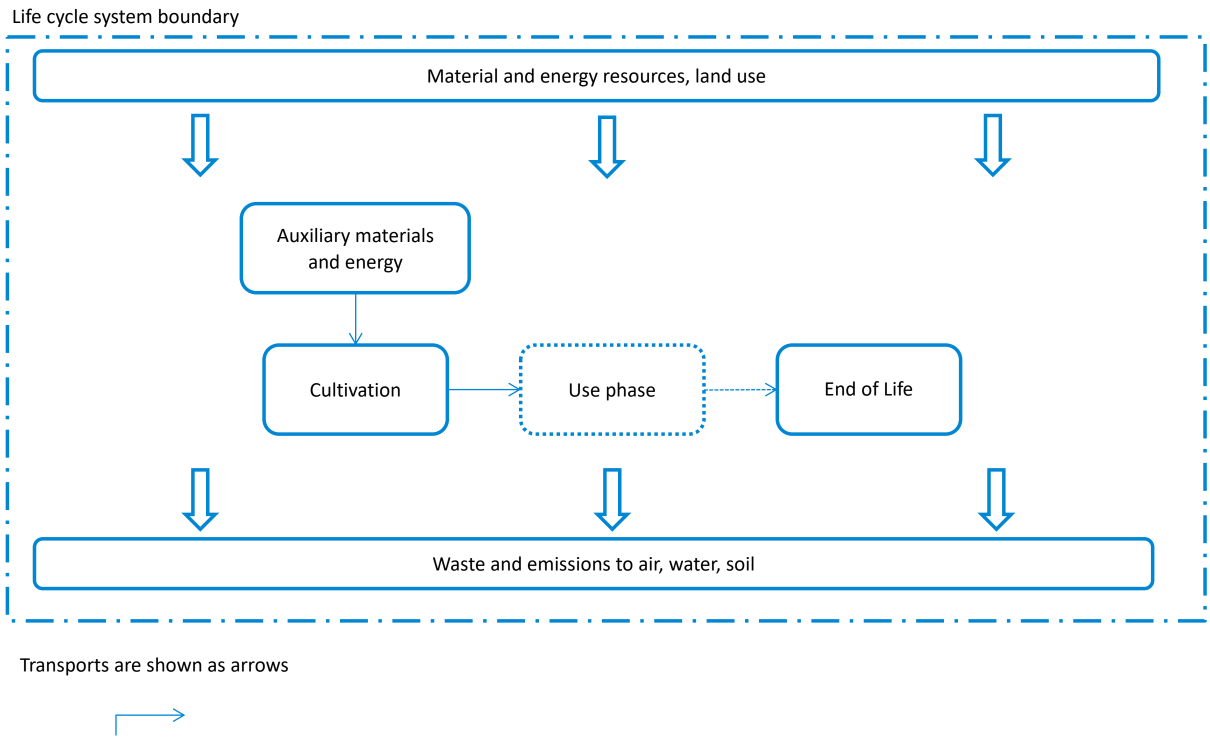


**Figure 2: Schematic representation of the processes**

Unlike strawberries, asparagus is a perennial crop. Therefore, the data for asparagus cultivation are average values of a multi-year cultivation period: For Switzerland it is the average value of eight years, for Mexico and Peru that of four years.

## 2.4 Life Cycle Inventories

The report contains information on strawberry and asparagus production. In order to address the complete cultivation system some auxiliary inventories with regard to infrastructure, auxiliary materials and further processing had to be created.

The following inventories were created for the LCI of strawberries and asparagus:

**Auxiliary materials and processing**

- Strawberry seedling, (organic) for planting, in unheated greenhouse/RER
- Asparagus seedling, for planting, open field/GLO
- Installation for drip irrigation/CH
- Diesel, burned in agricultural machine/CH

**Strawberry cultivation**

- Strawberries, conventional, heated greenhouse/CH
- Strawberries, conventional, unheated plastic tunnel/CH
- Strawberries, organic, unheated plastic tunnel/CH
- Strawberries, conventional, unheated multi tunnel/ES

**Asparagus cultivation**

- Asparagus, conventional/CH
- Asparagus, conventional/PE
- Asparagus, conventional/MX

### 2.4.1 Auxiliary Inventories

#### 2.4.1.1 Strawberry seedling, (organic) for planting, unheated greenhouse/RER

Data for strawberry seedling production were derived from Stoessel et al. (2012) and complemented with approximated fertiliser and pesticide data from tomato seedling production (Kägi et al., 2021). For organic production, no chemical fertiliser and pesticides were used. Direct field emissions were assumed to be similar.

**Table 1: Inputs for strawberry seedling production**

| | Unit | Strawberry seedling production | Strawberry seedling production, organic | Used inventory |
|---|---|---|---|---|
| N-fertiliser | kg N / p | 3.3e-4 | 0 | Average mineral fertiliser, as N, at regional storehouse/RER U |
| P-fertiliser | kg P2O5 / p | 4.2e-4 | 0 | Average mineral fertiliser, as P2O5, at regional storehouse/RER U |
| K-fertiliser | kg K2O / p | 1.6e-3 | 0 | Average mineral fertiliser, as K2O, at regional storehouse/RER U |
| Organic fertiliser | kg N / p | 0 | 3.3e-4 | Manure cattle |
| Pesticides | kg / p | 2.9e-8<br>1.2e-6 | 0 | Pesticide unspecified<br>Copper oxide |
| Installation drip irrigation | m3 / p | 5.1e-4 | 5.1e-4 | Installation for drip irrigation |
| Electricity | kWh/p | 1.2e-4 | 1.2e-4 | Electricity, low voltage, ENTSO |
| Peat | kg/p | 3e-4 | 3e-4 | Peat, at mine |
| Plastic tunnel | kg/p | 7.7e-7 | 7.7e-7 | Plastic tunnel/ES |

#### 2.4.1.2 Asparagus seedling, for planting/RER

Data for asparagus seedling production were taken from Vazquez-Rowe et al., (2015).

**Table 2: Material inputs for asparagus seedling production**

| | Unit | Asparagus, seedling production, 250'000 seedling per ha | Used inventory |
|---|---|---|---|
| Ammonium nitrate | kg N / ha | 87 | Ammonium nitrate, as N, at regional storehouse |
| Phosphoric acid | kg / ha | 110 | Phosphoric acid, fertiliser grade, 70% in H2O, at plant |
| Potassium sulphate | kg K2O / ha | 58 | Potassium sulphate, as K2O, at regional storehouse |
| Magnesium sulphate | kg Mg / ha | 2 | Magnesium sulphate, at plant |
| Calcium nitrate | kg N / ha | 2 | Calcium nitrate, as N, at regional storehouse |
| Potassium nitrate | kg N / ha | 30 | Potassium nitrate, as N, at regional storehouse |
| Pesticides | kg / ha | 0.84 | Pesticide unspecified |
| Water | $m^3$ / ha | 3'357 | Water, unspecified natural origin |
| Electricity for irrigation | kWh / ha | 1'600 | Electricity, low voltage |

#### 2.4.1.3 Irrigation, drip

So far, there is no module for drip irrigation in the UVEK database. Therefore, we created a drip irrigation inventory for Swiss conditions. Amounts and materials for this inventory were derived from the Handbook on pressurized irrigation techniques (Phocaides, 2007).

#### 2.4.1.4 Diesel, burned in agricultural machine

This inventory is based on transport, tractor and trailer from the UVEK database but the functional unit was converted from tkm to the corresponding demand of diesel in kg.

### 2.4.2 Cultivation inputs and yields

#### 2.4.2.1 Yields

Yields for strawberry cultivation in Switzerland were provided by the Swiss Fruit Association (Schweizer Obstverband, 13. April 2022). Yield for strawberry cultivation in Spain was taken from the LCA on environmental footprint of cultivating strawberry in Spain (Romero-Gámez & Suárez-Rey, 2020).

Yield for asparagus cultivation in Switzerland was modelled according to the factsheet for asparagus cultivation of Strickhof (2016) is an average value for a cultivation period of eight years (year 1 and 2: 0 t / ha, year 3 and 8: 4.5 t / ha, year 4 and 7: 4.75 t / ha, year 5 and 6: 5 t / ha). Yield for asparagus from Peru was taken from Vazquez-Rowe et al., (2015) and is an average value for a cultivation period of four years. For Mexico, the yield is based on a newspaper report and represents the average yield of different regions (Godina Gonzalez, 2018).

**Table 3: Yields for strawberry cultivation**

| | Unit | Strawberries, conventional, heated greenhouse/CH | Strawberries, conventional, unheated plastic tunnel/CH | Strawberries, organic, unheated plastic tunnel/CH | Strawberries, conventional, unheated multi tunnel/ES |
|---|---|---|---|---|---|
| Source | | (Schweizer Obstverband, 2022) | (Schweizer Obstverband, 2022) | (Schweizer Obstverband, 2022) | (Romero-Gámez & Suárez-Rey, 2020) |
| Yield | t / (ha*a) | 52 | 14 | 12 | 55 |

**Table 4: Yields for asparagus cultivation**

| | Unit | Asparagus, conventional/CH | Asparagus, conventional/PE | Asparagus, conventional/MX |
|---|---|---|---|---|
| Source | | (Strickhof, 2016) | (Vazquez-Rowe et al., 2015) | (Godina Gonzalez, 2018) |
| Yield | t / (ha*a) | 3.6 | 6.9 | 6.2 |

#### 2.4.2.2 Material inputs

**Strawberries**
The material input on strawberry cultivation includes data on materials needed to install the tunnels and auxiliary systems, fertilisers, pesticides and water for irrigation.

As for Switzerland, data for auxiliary materials for strawberry cultivation in plastic tunnel were taken from Valiante et al. (2019), for cultivation in greenhouse conditions they were adopted from the inventory of tomatoes in heated greenhouse. The amount of water input was modelled within the project 'World Food LCA database (WFLDB)' and is representative for strawberry production in Switzerland under heated greenhouse conditions and non-heated greenhouse conditions, respectively. Data for fertiliser inputs in conventional strawberry cultivation refer to the standards for fertilisation of Agroscope (Carlen & Ançay, 2017). Pesticide inputs were derived from the Greenpeace study on pesticides in Swiss strawberries (Schenkel et al., 2016). Since no data on fertiliser usage was available for organic strawberry production in Switzerland, inputs were taken from various interviews with strawberry producers (anonymous, April 2022). Natural products for the treatment of pests and diseases in organic farming are not considered in this study.

For strawberry cultivation in Spain input data for fertiliser, water and auxiliary materials (pipes, pumps, mulch) were taken from Romero-Gámez & Suárez-Rey (2020). Pesticide inputs were calculated on the basis of the laboratory findings of the Chemical and Veterinary Investigation Office Stuttgart (Dr. Benkenstein, 2021).

**Asparagus**
Data for asparagus cultivation in Switzerland were derived from Soode et al. (2015) and are average values of a cultivation period of eight years. This does not include the data for fertilising, these are taken from Neuweiler and Krauss (2017) and Feller (2019).

All data for Peru were derived from Vazquez-Rowe et al. (2015) and are average values of a cultivation period of four years. For Mexico, the same data was used and the country-specific data was adjusted.

The data on pesticides for asparagus cultivation in Switzerland and Mexico were calculated on the basis of the laboratory findings of the Chemical and Veterinary Investigation Office Stuttgart (Dr. Benkenstein, 2021). For all countries, source for the amount of seedlings is the Swiss Vegetable Producers Association (2022).

**Table 5: Material inputs for strawberry cultivation**

| | Unit | Strawberries, conventional, heated greenhouse/ CH | Strawberries, conventional, unheated plastic tunnel/CH | Strawberries, organic, unheated plastic tunnel/CH | Strawberries, conventional, unheated multi tunnel/ES | Used inventory |
|---|---|---|---|---|---|---|
| N-fertiliser | kg N / ha | 220 | 100 | 0 | 275 | Average mineral fertiliser, as N, at regional storehouse/RER U |
| P-fertiliser | kg P2O5 / ha | 104 | 34 | 0 | 247 | Average mineral fertiliser, as P2O5, at regional storehouse/RER U |
| K-fertiliser | kg K2O / ha | 247 | 121 | 0 | 375 | Average mineral fertiliser, as K2O, at regional storehouse/RER U |
| Magnesia | kg / ha | 50 | 20 | 0 | 0 | Magnesia, at plant |
| Organic fertiliser | kg N / ha | 0 | 0 | 150 | 0 | Manure cattle |
| Pesticides | kg / ha | 1.59 | 1.59 | 0 | 5.95 | Pesticide unspecified |
| Water, tap water | m3 / ha | 822 | 493 | 493 | 6'447 | Tap water, unspecified natural origin |
| Water, desalinated water | m3 / ha | 0 | 0 | 0 | 1'321 | Tap water, desalinated sea water/ES U |
| Plastic equipment | kg / ha | 100 | 508 | 508 | 526 | Polypropylene/Polyethylene, granulate + extrusion |
| Steel equipment | kg / ha | 0.1 | 0 | 0 | 1.5 | Steel, low alloyed + section bar rolling |
| Strawberry seedlings | p | 45'000 | 45'000 | 45'000 | 45'000 | Strawberry seedling, unheated greenhouse, at production site |

**Table 6: Material inputs for asparagus cultivation**

| | Unit | Asparagus, conventional/CH | Asparagus, conventional/PE | Asparagus, conventional/MX | Used inventory |
|---|---|---|---|---|---|
| N-fertiliser | kg N / ha | 108 | 0 | 0 | Average N fertiliser |
| P-fertiliser | kg P2O5 / ha | 36 | 0 | 0 | Average P fertiliser |
| K-fertiliser | kg K2O / ha | 126 | 0 | 0 | Average K fertiliser |
| Ammonium nitrate | kg N / ha | 0 | 63.8 | 81.5 | Ammonium nitrate, as N, at regional storehouse |
| Phosphoric acid | kg / ha | 0 | 242.3 | 241.5 | Phosphoric acid, fertiliser grade, 70% in H2O, at plant |
| Potassium sulphate | kg K2O / ha | 0 | 149.7 | 117.0 | Potassium sulphate, as K2O, at regional storehouse |
| Magnesium sulphate | kg Mg / ha | 26 | 27.5 | 27.6 | Magnesium sulphate, at plant |

| | | | | | |
|---|---|---|---|---|---|
| Calcium nitrate | kg N / ha | 0 | 8.3 | 9.2 | Calcium nitrate, as N, at regional storehouse |
| Boric acid | kg / ha | 0 | 5.9 | 8.5 | Boric acid, anhydrous, powder, at plant |
| Urea e ammonium nitrate | kg N / ha | 0 | 90.0 | 62.8 | Urea ammonium nitrate, as N, at regional storehouse |
| Potassium nitrate | kg N / ha | 0 | 22.2 | 36.7 | Potassium nitrate, as N, at regional storehouse |
| Organic fertiliser | kg / ha | 0 | 39.5<br>49 | 68.0<br>34.1 | Poultry manure as proxy for guano (PE/MX)<br>Vinasse as proxy for liquid fertiliser |
| Pesticides | kg / ha | 5.8 | 9.9 | 6.1 | Pesticide unspecified |
| Water | $m^3$ / ha | 19 | 10'107 | 10'107 | Water, unspecified natural origin |
| Plastic equipment | kg / ha | 53 | 0 | 0 | Polyethylene granulate + extrusion (foil) |
| Asparagus seedlings | P / (ha * a) | 2875 | 5'750 | 5'750 | Asparagus seedling, open field, at production site |

#### 2.4.2.3 Energy and machinery use

**Strawberries**

Heat demand for heated greenhouse in Switzerland was reported by Energie-Agentur der Wirtschaft (2022) and corresponds to the average value of two Swiss plants from the years 2017 to 2020. Typically, greenhouses are heated from March to May. Electricity use for heating system was estimated as 1 % of heat demand based on data for heating systems, further electricity use was estimated based on the inventory of tomatoes in heated greenhouse.

Electricity use for all processes in multi tunnel cultivation in Spain and machinery use were derived from Romero-Gámez & Suárez-Rey (2020) and applied for Switzerland. Energy and diesel consumption for multi tunnel cultivation in Spain was taken from Romero-Gámez & Suárez-Rey (2020), for Switzerland from Valiante et al. (2019.

**Asparagus**

Energy data for asparagus cultivation were derived from Soode et al. (2015) for Switzerland, from Vazquez-Rowe et al. (2015) for Peru and for Mexico. Except for machinery use, these data refer to Romero-Gámez & Suárez-Rey (2020).

**Table 7: Energy and machinery use for strawberry cultivation**

| | Unit | Strawberries, conventional, heated greenhouse/ CH | Strawberries, conventional, unheated plastic tunnel/CH | Strawberries, organic, unheated plastic tunnel/CH | Strawberries, conventional, unheated multi tunnel/ES | Used inventory |
|---|---|---|---|---|---|---|
| Heat for heating | kWh / ha | 320'000 | 0 | 0 | 0 | Heat, natural gas or heat from waste |
| Electricity, for heating unit | kWh / ha | 3'200 | 0 | 0 | 0 | Electricity, low voltage |
| Electricity for irrigation and machinery | kWh / ha | 189 | 114 | 114 | 1'789 | Electricity, low voltage |
| Diesel | kg / ha | 0 | 44.5 | 44.5 | 42.3 | Diesel, burned in agricultural machine |

**Table 8: Energy and machinery use for asparagus cultivation**

| | Unit | Asparagus, conventional/CH | Asparagus, conventional/PE | Asparagus, conventional/MX | Used inventory |
|---|---|---|---|---|---|
| Electricity for irrigation and machinery | kWh / ha | 869 | 3'665 | 3'417 | Electricity, low voltage |
| Diesel | kg / ha | 445 | 66.3 | 63.9 | Diesel, burned in agricultural machine |

### 2.4.3 Direct field emissions

**Strawberries**
For Spain, the fertiliser emissions were taken from Romero-Gámez & Suárez-Rey (2020). All other direct field emissions were calculated according to the methodology described in Nemecek and Schnetzer (2011). Nitrate leaching was calculated according to the SQCB-model.

**Asparagus**
All direct field emissions were calculated according to the methodology described in Nemecek and Schnetzer (2011). Nitrate leaching was calculated according to the SQCB-model. The quantities are valid for the whole period (total).

#### 2.4.3.1 Emissions to air

**Table 9: Emissions to air for strawberry cultivation**

| | Unit | Strawberries, conventional, heated greenhouse/CH | Strawberries, conventional, unheated plastic tunnel/CH | Strawberries, organic, unheated plastic tunnel/CH | Strawberries, conventional, unheated multi tunnel/ES |
|---|---|---|---|---|---|
| $NH_3$ in air | kg $NH_3$ / ha*a | 1.15E+01 | 5.23E+00 | 43.7E+01 | 1.02E+01 |
| $N_2O$ in air | kg $N_2O$ / ha*a | 3.80E+00 | 1.96E+00 | 1.27E+00 | 2.75E+00 |
| $NO_X$ in air | kg $NO_X$ / ha*a | 8.00E-01 | 4.10E-01 | 2.66E-01 | 7.15E+00 |
| Water to air | kg $H_2O$ / ha*a | 7.42E+05 | 4.45E+05 | 4.45+05 | 6.56E+06 |

**Table 10: Emissions to air for asparagus cultivation**

| | Unit | Asparagus, conventional/CH | Asparagus, conventional/PE | Asparagus, conventional/MX |
|---|---|---|---|---|
| $CO_2$ in air | kg $CO_2$ / ha*a | 0 | 6.06E+01 | 4.23 E+01 |
| $NH_3$ in air | kg $NH_3$ / ha*a | 5.65E+00 | 1.23E+01 | 1.11E+01 |
| $N_2O$ in air | kg $N_2O$ / ha*a | 2.00E+00 | 3.31E+00 | 3.49E+00 |
| $NO_X$ in air | kg $NO_X$ / ha*a | 4.20E-01 | 7.00E-01 | 7.30E-01 |
| Water to air | m3 / ha*a | 1.13E+01 | 4.69E+03 | 4.68E+03 |

#### 2.4.3.2 Emissions to soil

**Table 11: Emissions to soil for strawberry cultivation**

| | Unit | Strawberries, conventional, heated greenhouse/CH | Strawberries, conventional, unheated plastic tunnel/CH | Strawberries, organic, unheated plastic tunnel/CH | Strawberries, conventional, unheated multi tunnel/ES |
|---|---|---|---|---|---|
| Cd | kg / ha | 0 | 0 | 0 | 1.90E-02 |
| Cu | kg / ha | 3.36E-03 | 3.80E-05 | 0 | 0 |
| Azoxystrobin | kg / ha | 2.00E-02 | 2.00E-02 | 0 | 6.00E-02 |
| Benzamide | kg / ha | 0 | 0 | 0 | 1.10E-01 |
| Bifenazat | kg / ha | 0 | 0 | 0 | 2.00E-02 |
| Bupirimate | kg / ha | 4.00E-02 | 4.00E-02 | 0 | 0 |
| Chlorate | kg / ha | 0 | 0 | 0 | 5.25E+00 |
| Chlorpyrifos-methyl | kg / ha | 0 | 0 | 0 | 1.00E-02 |

| | | | | | |
|---|---|---|---|---|---|
| Cyprodinil | kg / ha | 2.30E-01 | 2.30E-01 | 0 | 7.00E-02 |
| Difenoconazole | kg / ha | 4.00E-02 | 4.00E-02 | 0 | 0 |
| Dimethomorph | kg / ha | 0 | 0 | 0 | 4.00E-02 |
| Etoxazole | kg / ha | 1.00E-02 | 1.00E-02 | 0 | 1.00E-02 |
| Fenhexamid | kg / ha | 5.30E-01 | 5.30E-01 | 0 | 0 |
| Fludioxonil | kg / ha | 1.00E-01 | 1.00E-01 | 0 | 5.00E-02 |
| Fluopyram | kg / ha | 8.00E-02 | 8.00E-02 | 0 | 1.20E-01 |
| Fosetyl | kg / ha | 0 | 0 | 0 | 1.00E-01 |
| Indoxacarb | kg / ha | 0 | 0 | 0 | 1.00E-02 |
| Isopropyl hyradzincarboxylate | kg / ha | 0 | 0 | 0 | 2.00E-02 |
| Kresoxim-methyl | kg / ha | 9.00E-02 | 9.00E-02 | 0 | 0 |
| Myclobutanil | kg / ha | 2.00E-02 | 2.00E-02 | 0 | 2.00E-02 |
| Penconazole | kg / ha | 0 | 0 | 0 | 1.00E-02 |
| Pendimethalin | kg / ha | 0 | 0 | 0 | 1.00E-02 |
| Phenmedipham | kg / ha | 1.20E-01 | 1.20E-01 | 0 | 0 |
| Quinoxyfen | kg / ha | 1.00E-02 | 1.00E-02 | 0 | 0 |
| Sodium chlorate | kg / ha | | | 0 | 5.25E+00 |
| Spinosad | kg / ha | 0 | 0 | 0 | 2.00E-02 |
| Thiacloprid | kg / ha | 1.30E-01 | 1.30E-01 | 0 | 0 |
| Trifloxystrobin | kg / ha | 1.60E-01 | 1.60E-01 | 0 | 1.60E-01 |

**Table 12: Emissions to soil for asparagus cultivation**

| | Unit | Asparagus, conventional/CH | Asparagus, conventional/PE | Asparagus, conventional/MX |
|---|---|---|---|---|
| Cd to soil | kg / ha | 2.00E-03 | 0 | 1.90E-03 |
| Cu to soil | kg / ha | 0 | 0 | 0 |
| Zn to soil | kg / ha | 0 | 0 | 0 |
| Pb to soil | kg / ha | 0 | 0 | 0 |
| Ni to soil | kg / ha | 7.40E-04 | 3.10E-03 | 4.70E-03 |
| Cr to soil | kg / ha | 0 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| Hg to soil | kg / ha | 0 | 6.60E-06 | 8.30E-06 |
| Azoxystrobin | kg / ha | 1.00E-02 | 0 | 0 |
| Boscalid | kg / ha | 4.00E-02 | 0 | 5.00E-02 |
| Chlorate | kg / ha | 5.58E+00 | 0 | 5.17E+00 |
| Chlorpyrifos | kg / ha | 0 | 8.20E+00 | 0 |
| Cyprodinil | kg / ha | 2.00E-02 | 0 | 0 |
| Dimethomorph | kg / ha | 1.25E-03 | | |
| Flonicamid | kg / ha | 0 | 0 | 1.00E-02 |
| Fludioxonil | kg / ha | 1.00E-02 | 0 | 2.50E-02 |
| Fosetyl | kg / ha | 6.00E-02 | 0 | 0 |
| Imidacloprid, Olefin | kg / ha | 0 | 0 | 2.50E-02 |
| Metalaxyl | kg / ha | 0 | 0 | 2.50E-02 |
| Methomyl | kg / ha | 0 | 1.50E+00 | 0 |
| Metribuzin | kg / ha | 5.20E-01 | 0 | 0 |
| Myclobutanil | kg / ha | 1.25E-03 | | |
| Sulfur | kg / ha | 0 | 5.00E-02 | 0 |
| Pendimethalin | kg / ha | 5.00E-03 | | |
| Quinoxifen | kg / ha | 1.25E-03 | | |
| Thiacloprid | kg / ha | 2.50E-03 | | |
| Trifloxystrobin | kg / ha | 3.75E-03 | | |
| Tebuconazole | kg / ha | 0 | 1.75E-01 | 0 |
| Glyphosate | kg / ha | 0 | 0 | 8.30E-01 |

#### 2.4.3.3 Emissions to water

**Table 13: Emissions to water for strawberry cultivation**

| | Unit | Strawberries, conventional, heated greenhouse/CH | Strawberries, conventional, unheated plastic tunnel/CH | Strawberries, organic, unheated plastic tunnel/CH | Strawberries, conventional, unheated multi tunnel/ES |
|---|---|---|---|---|---|
| Nitrate in ground water | kg $NO_3$ / ha | 1.29E+02 | 7.50E+01 | 2.10E+02 | 8.09E+01 |
| Phosphorus in ground water | kg P / ha | 7.00E-02 | 7.00E-02 | 7.00E-02 | 7.00E-02 |

| | | | | | |
|---|---|---|---|---|---|
| Phosphorus in surface water | kg P / ha | 7.80E-01 | 7.50E-01 | 8.20E-01 | 8.40E-01 |
| Cd to water | kg / ha | 4.5E-05 | 3.8E-05 | 2.9E-05 | 4.8E-05 |
| Cu to water | kg / ha | 3.2E-03 | 2.9E-03 | 3.6E-03 | 3.4E-03 |
| Zn to water | kg / ha | 1.6E-02 | 9.4E-03 | 2.9E-02 | 2.1E-02 |
| Pb to water | kg / ha | 1.2E-04 | 6.1E-05 | 3.1E-04 | 1.9E-04 |
| Ni to water | kg / ha | 7.8E-06 | 4.7E-06 | 1.2E-05 | 9.7E-06 |
| Cr to water | kg / ha | 1.9E-02 | 1.7E-02 | 1.8E-02 | 2.0E-02 |
| Hg to water | kg / ha | 0 | 0.0E+00 | 1.3E-06 | 0 |
| Water to water | $m^3$ / ha | 3.32E+01 | 3.54E+01 | 3.72E+01 | 1.16E+03 |

**Table 14: Emissions to water for asparagus cultivation**

| | Unit | Asparagus, conventional/CH | Asparagus, conventional/PE | Asparagus, conventional/MX |
|---|---|---|---|---|
| Nitrate in ground water | kg $NO_3$ / ha | 1.15E+02 | 1.63E+02 | 1.75E+02 |
| Phosphorus in ground water | kg P / ha | 7.00E-02 | 7.00E-02 | 7.00E-02 |
| Phosphorus in surface water | kg P / ha | 7.50E-01 | 7.40E-01 | 7.50E-01 |
| Water to water | $m^3$ / ha | 4.39E+00 | 5.41E+03 | 1.01E+04 |
| Cd to water | kg / ha | 3.8E-05 | 3.9E-06 | 3.8E-05 |
| Cu to water | kg / ha | 2.9E-03 | 2.7E-03 | 2.7E-03 |
| Zn to water | kg / ha | 9.8E-03 | 1.2E-02 | 1.4E-02 |
| Pb to water | kg / ha | 6.4E-05 | 9.3E-05 | 9.4E-05 |
| Ni to water | kg / ha | 4.9E-06 | 8.3E-06 | 8.8E-06 |
| Cr to water | kg / ha | 1.7E-02 | 1.0E-02 | 1.6E-02 |
| Hg to water | kg / ha | 0 | 1.6E-07 | 1.9E-07 |

### 2.4.4 Land use

Land use is already included in the greenhouse and tunnel infrastructure with regard to the strawberry cultivation. It corresponds to a little more than 10’000 $m^2$ per ha and year.

With regard to asparagus, duration of one cropping cycle of asparagus is 12 months therefore 10’000 $m^2$ per ha and year is used.

### 2.4.5 Summary of life cycle inventory data

The life cycle inventories for the newly modelled and updated processes are provided as unit process raw data in the EcoSpold v1 format (unit process in SimaPro). The electronic data includes the full EcoSpold v1 documentation.
For each investigated process, two types of tables (X-Process and X-Exchange) are provided. For better readability of the whole report, these data are listed in the Annex.

### 2.4.6 Further data used for LCIA

Apart from the newly created life cycle inventories, the following data were used and connected to the respective background data:

**Transportation**

- 150 km by lorry 32-40t for Swiss strawberries and Swiss asparagus from farm to regional centre in Switzerland and 100 km by lorry 16-32t for distribution to store.
- 2'000 km by lorry 32-40t for strawberries from Andalusia to regional centre in Switzerland and 100 km by lorry 16-32t for distribution to store.
- 260 km by lorry 32-40t for asparagus from Peru from plant to port or airport in Callao, 10'673 km air freight to Switzerland (option: 15'277 km sea freight to Rotterdam and 700 km by lorry 32-40t to regional centre in Switzerland) and 150 km by lorry 16-32t for transport to storage and distribution to store.
- 260 km by lorry 32-40t for asparagus from Mexico from plant to airport, 9'516 km air freight to Switzerland, and 150 km by lorry 16-32t for transport to storage and distribution to store.

**Packaging**

We assumed the following packaging materials:
- Strawberries: boxes on 91.85 g cardboard and 24.6 g PE foil / kg of product
- Swiss asparagus: boxes on 114.8 g cardboard and 25.667 g PE foil / kg of product
- Imported asparagus: boxes on 225 g polypropylene and 29.7 g PE foil / 5 kg of product

### 2.4.7 Data quality

The data quality of the relevant data is generally good. Yields, material inputs, field work and direct field emissions were updated for this study. Other inputs and outputs which have not been updated during this study are usually of very low relevance for the calculated environmental impacts.

## 2.5 Impact analysis

In this step, the life cycle inventory is assessed with regard to the impact on the environment. The calculation of the impact analysis includes the following two sub-steps:
- Classification (classification of substances from the life cycle inventory with regard to their effects)
- Characterisation (calculation of the effects on the environment):
  In this process, the individual substances are weighted against each other according to their damage potential with respect to a lead substance. This results in the damage potentials with regard to a specific environmental impact. In the case of the global warming potential, $CO_2$ is used as the lead substance and contributions from other greenhouse gases such as methane and nitrous oxide are converted into $CO_2$ equivalents.

On midpoint level (impact categories) only the Global Warming Potential is presented in this study (see Annex).

## 2.6 Assessment of environmental impacts

The result of the impact assessment is a compilation of various indicators, each of which describes one aspect of the environmental impact. In order to obtain a well-founded basis for decision-making, the various impacts can be weighted and summarised in a key figure. The weighting of different environmental impacts is a process in which values are incorporated and which is therefore supported as widely as possible to ensure a high level of acceptance.

In the context of this study, the aggregated ecopoints of the ecological scarcity method 2021 (Frischknecht et al., 2021) was used. The results are expressed in eco-points ('Umweltbelastungspunkte' – UBP). The assessment using the ecological scarcity method was developed with the cooperation of the Federal Office for the Environment and is well established in Switzerland. This method was chosen because it takes into account the environmental situation as well as the environmental goals of Switzerland for the assessment (see Figure 3) and is thus broadly supported in terms of values. With regard to the use of the overall aggregating methods, the present study deviates from ISO standard 14040. Since the assessment of the various environmental impacts depends on value standards, these overall aggregating methods are partly rejected. It should be noted that also the selection of specific environmental impacts is subjective. If only a part of the impacts is considered, e.g. only the carbon footprint, this is virtually the same as weighting the other impacts with zero. The consideration of the individual impact categories can certainly be helpful, e.g. to determine the causes of specific impacts and to work out possible optimisation potentials. However, individual environmental aspects must not be excluded as a basis for decision-making or for considering the overall environmental impacts. For this, overall aggregating assessment methods are not only helpful but also necessary (Kägi et al., 2016) in order to ensure the validity of the results. As a second approach, the EF v3.0 method (European Commission. Joint Research Centre., 2019) was used. The EF v3.0 provides 16 different impact categories and a normalisation and weighting scheme to derive the total environmental footprint (single score).

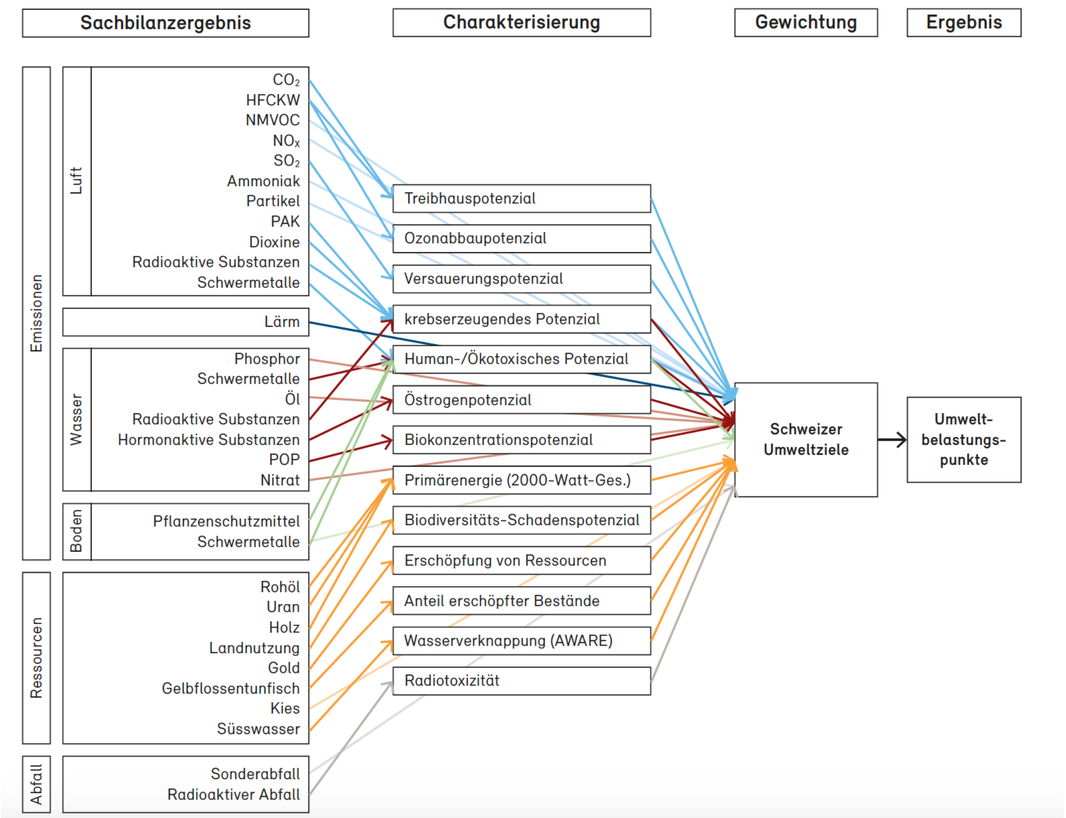


**Figure 3: Basic scheme of the ecological scarcity method (graphic from Frischknecht u. a., 2021)**

## 2.7 Uncertainty

For each of the used data inputs in all the inventories, data uncertainty was considered by using the pedigree matrix provided in Simapro. The pedigree matrix translates qualitative aspects with regard to completeness, temporal correlation, geographic correlation as well as further technological correlation into a quantitative uncertainty value. Based on this data uncertainty, a monte carlo analysis is performed in order to address the overall uncertainty of the results.

# 3 Life Cycle Impact Assessment

Only the environmental footprint according to the ecological scarcity method 2021 is shown and discussed. The carbon footprint (see annex 1) ) shows similar results, the environmental footprint according to the EF v3.0 method (see annex 2) shows some differences.

## 3.1 Results and discussion for strawberries, delivered to store

Figure 4 shows the environmental footprint of the different strawberry variants.

**Comparison of variants**

Heated greenhouse strawberries from Switzerland have by far the highest environmental impact due to the fossil energy demand for heating, even though the yield is much higher than in unheated plastic tunnels (52 t / ha compared to 14 t / ha in conventional and 12 t / ha in organic cultivation).

The results for the strawberries cultivated in unheated plastic tunnel are in a similar range. Conventional strawberries in unheated plastic tunnels in Andalusia, Spain have a much higher yield per ha (55 t / ha compared to 14 t / ha and 12t / ha) than unheated conventional or organic Strawberries in Switzerland and show lower impact contribution with regard to fertilisers, pesticides or other cultivation processes. However, the impact from transportation is much higher for the Spanish strawberries. The greenhouse infrastructure contributes similarly even though the yield is much higher in Spain because the Spanish unheated greenhouse infrastructure is much more intensive than the Swiss ones.

**Process contribution**

Considering heated greenhouse cultivation based on natural gas, the highest shares come from the combustion of natural gas and the infrastructure of the greenhouse itself. All other processes are of low relevance.

For strawberries cultivated in unheated plastic tunnel, infrastructure is the main contributor to the environmental impact. With the Swiss variants, infrastructure is followed by fertilizing, further cultivation processes and packaging who show equal shares (about 20%). All other processes – such as pesticides, water scarcity and transportation – play a minor role. In the case of strawberries from Spain, after infrastructure transport and packaging cause the highest impact and are of more relevance than the remaining processes.

Considering the cultivation in Andalusia, Spain, it becomes obvious that water scarcity is not as relevant anymore even for water-intensive crops in regions with high water scarcity compared to former LCA studies that used the ecological scarcity 2013 method. In this respect, the new method is very different from the 2013 method.

Pesticides contribute little to the environmental footprint in this evaluation, although a great deal of pesticides are used in conventional strawberry cultivation.

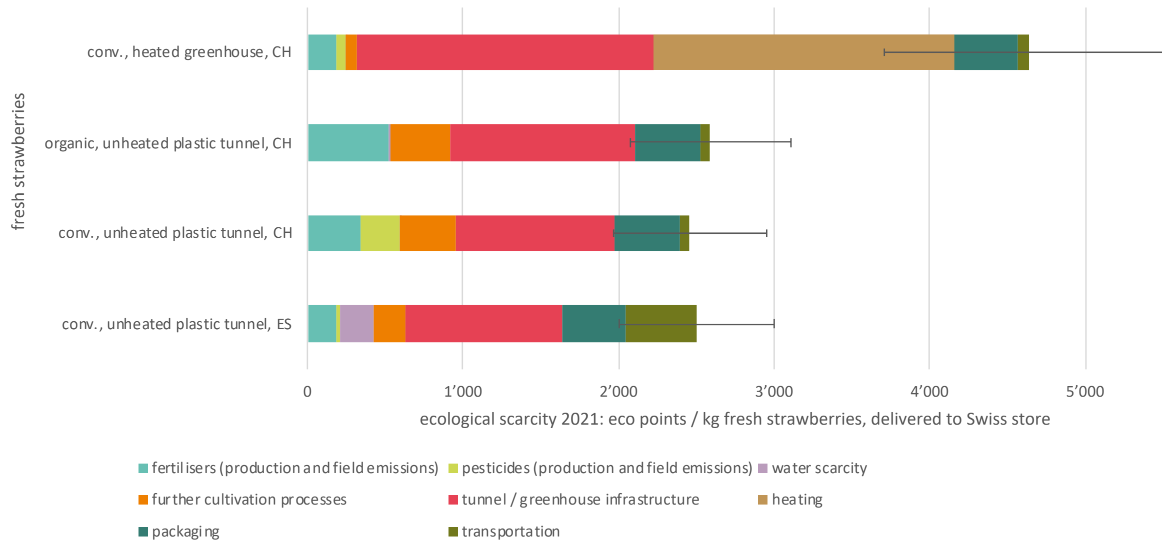


**Figure 4: Process contributions to the environmental impact for strawberries, distributed to generic Swiss store**

**Relevant impact categories**

With all variants, global warming is the most relevant impact category. Especially for the heated systems due to $CO_2$-emissions from natural gas and the unheated system in Spain due to higher demand of auxiliary materials and the desalination of sea water.

Other air emissions and water pollutants also show relevance. So does land use with the Swiss variants due to lower yields.

The water resources are of some relevance in Spain, where water scarcity is high. It should be noted that the average water scarcity factor for Spain was used, as there is only one water flow for Spain. The fact is that most strawberries come from Almeria, where water scarcity is even much higher. However, an inspection of the ecological scarcity methodology shows that the maximum water scarcity factor would be 25 % higher than that for Spain. I.e. even if the maximum water scarcity was calculated in the ecological scarcity method, the conclusions would not be different.

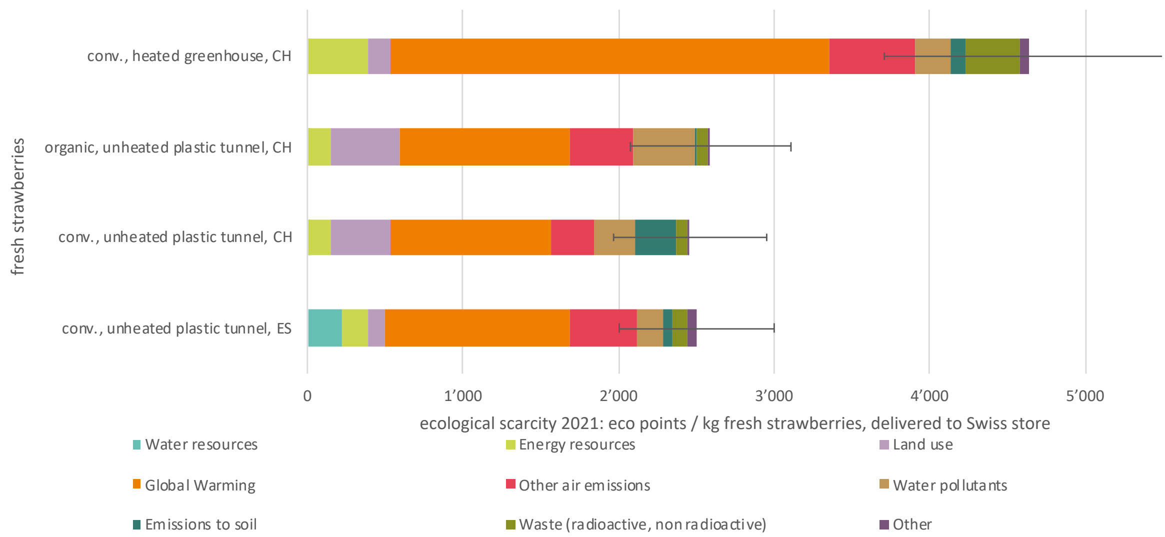


**Figure 5: Environmental impact for strawberries, distributed to generic Swiss store**

## 3.2 Results and discussion for asparagus, delivered to store

Figure 6 shows the environmental footprint of the different asparagus variants.

**Comparison of variants**

The lowest environmental footprint is shown by asparagus from Swiss production. It is significantly lower than with all other variants. This is mainly due to the short transport distance and the mode of transport. Transport makes the big difference between asparagus from Switzerland and asparagus from Mexico.

Asparagus from Peru show a worse outcome than asparagus from Mexico because of the pesticides. The use of Chlorpyrifos makes the difference. If it weren't for the Chlorpyrifos, the result of asparagus from Peru by sea would be similar to Mexican asparagus.

The highest environmental footprint is shown by asparagus from Peru which are imported by air freight.

**Process contribution**

With asparagus from Peru, pesticides contribute most to the environmental footprint due to the very high environmental toxicity and the risk to human health of Chlorpyrifos. If only this one pesticide were replaced, the outcome would be different. The fact that precisely this pesticide is frequently used in Peru has been confirmed not only by the data from studies but also by laboratory findings.

Considering transport from overseas, once again the high environmental impact of flights is confirmed. With asparagus from Mexico, air freight is responsible for approximately 80% of the impacts, with asparagus from Peru it's because of the high share of pesticides 'only' a little over 40%. All other processes play a secondary role.

With regard to asparagus from Switzerland, the footprint is dominated by the further cultivation processes which cause half of the total impacts, followed by the impacts of fertilization.

Packaging is with all variants comparatively less relevant, but is slightly more influential for asparagus from Switzerland than for asparagus from overseas.

Water scarcity only shows a certain relevance with asparagus from Mexico. It should be noted that the average water scarcity factor for Peru and Mexico was used, as there is only one water flow each for Peru and Mexico. The fact is that especially in Peru, asparagus is mainly grown in arid areas, where water scarcity is much higher. An inspection of the ecological scarcity methodology shows that the maximum water scarcity factor would be 4 times higher than that for Peru. I.e. even if the maximum water scarcity was calculated in the ecological scarcity method, the conclusions would not be different. However, water scarcity would then be similarly relevant as the fertilisers.

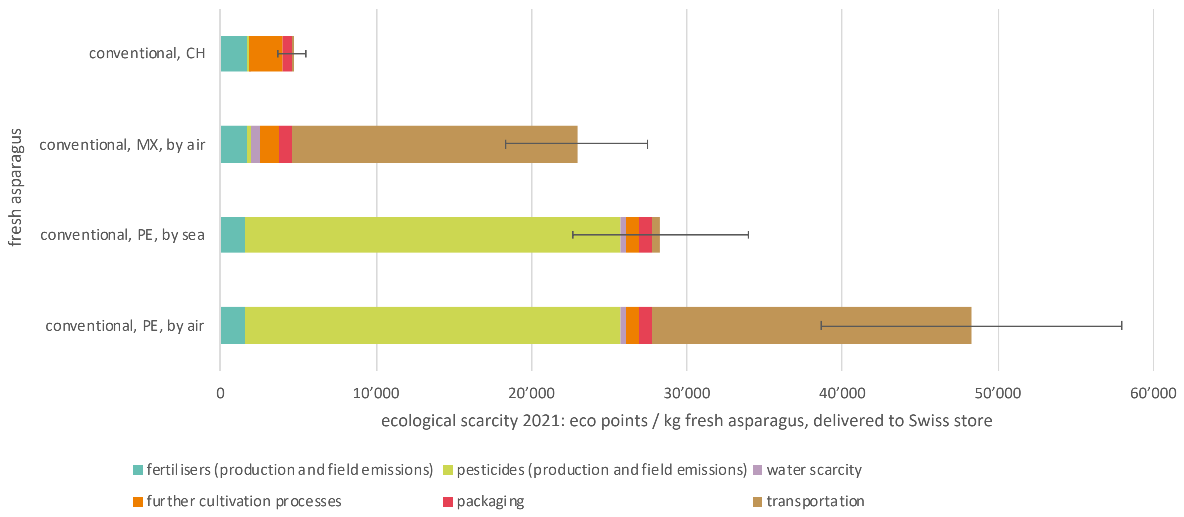


**Figure 6: Process contributions to the environmental impact for asparagus, distributed to generic Swiss store**

**Relevant impact categories**

Considering asparagus from Peru, the most relevant impact category is emissions to soil (pesticides). As for the variant imported by air freight, global warming is a major impact category too.

Regarding asparagus produced in Switzerland, global warming (mainly stemming from diesel burnt in agricultural machinery) the is the most dominant impact category followed by water pollutants (nitrate leaching) and other air emissions.

Due to the emissions from air freight, global warming is the undisputed leading impact category with asparagus from Mexico. All other impact categories show very little relevance.

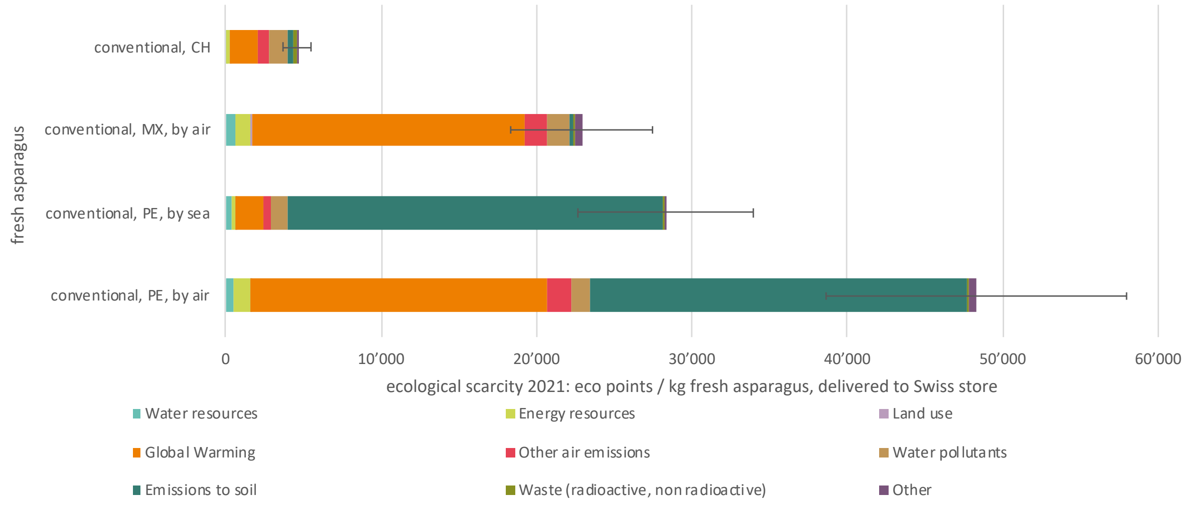


**Figure 7: Environmental impact for asparagus, distributed to generic Swiss store**

**Evaluations according to other methods**

For strawberries, the carbon footprint according to IPCC 2021 (see annex 1) correlates with the ecological footprint based on the ecological scarcity method. For asparagus, Peruvian asparagus transported by ship has a similar carbon footprint as Swiss asparagus, as pesticide emissions are not taken into account.

The environmental footprint according to the EF v3.0 methods (see annex 2) does not correlate well with the environmental footprint based on the ecological scarcity method. For strawberry production the difference between heated and unheated strawberry production is less clear due to higher importance of water scarcity (ES production) and acidification and eutrophication (organic CH) in the EF method compared to the ecological scarcity method. For asparagus production, the Peruvian asparagus transported by ship shows a lower impact than Mexican asparagus imported by air because of lower importance of the pesticide emissions.

# 4 Conclusion

Due to the high efficiency, strawberries from Spain have a similar environmental impact as those from unheated production in Switzerland. Fruits cultivated in heated greenhouse using fossil heating energy have by far the highest environmental impact. For strawberries from tunnel production, cultivation is more impact-relevant than transport and packaging.

Regarding asparagus, the LCA confirms the results of other studies: fresh, seasonal and domestic vegetables are the best choice. In the case of asparagus from overseas, from an environmental point of view those imported by ship are to be preferred to those imported by airplane. With import by air freight, impacts of transportation dominate the ecological footprint.

In the case of pesticides, it is evident that the type of pesticide used plays a major role. Many substances that are banned in Europe are applied in other countries as the regulations are less strict. But even within Europe banned active substances are detected time and again. The use of pesticides is non-transparent with all conventional cultivations. Consumers who want to be on the safe side, choose organic options.

So from an environmental point of view, local production should be promoted for several reasons, e.g. the reduction of emissions due to short transportation routes and the better regulation of pesticides use, especially compared to overseas countries. The use of renewable energy should also play a role in future cultivation.

With regard to the used impact method ecological scarcity 2021 the most obvious difference to the former method is the very low relevance of water scarcity.

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# A1 Global warming potential

The global warming potential correlates with the environmental footprint based on the ecological scarcity method for strawberries. For asparagus, Peruvian asparagus transported by ship shows a similar carbon footprint as Swiss asparagus because pesticide emissions are not accounted for.

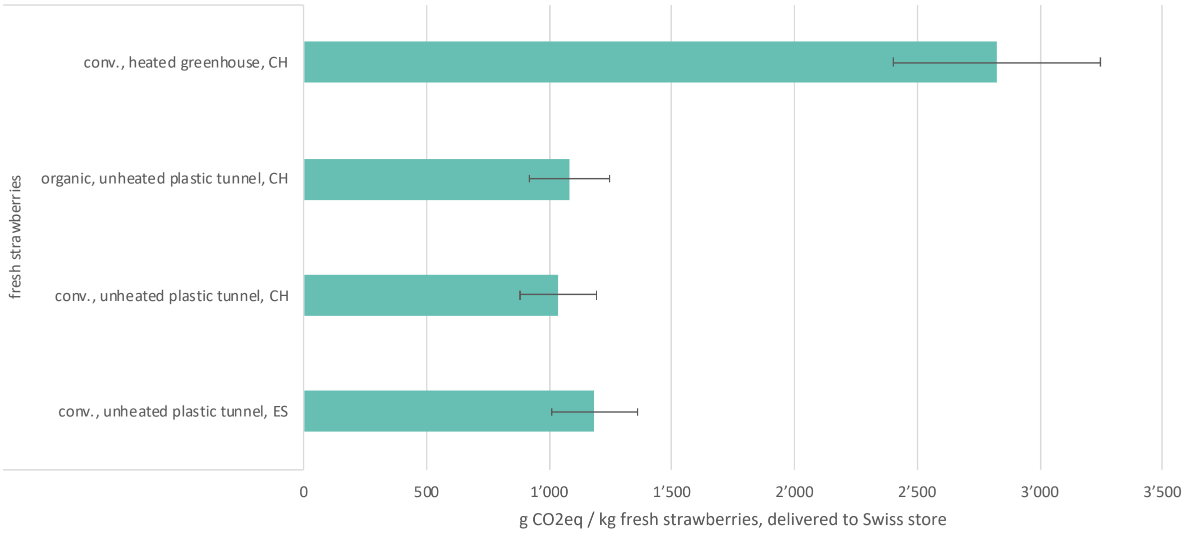


**Figure 8: Carbon footprint for strawberries, delivered to Swiss store**

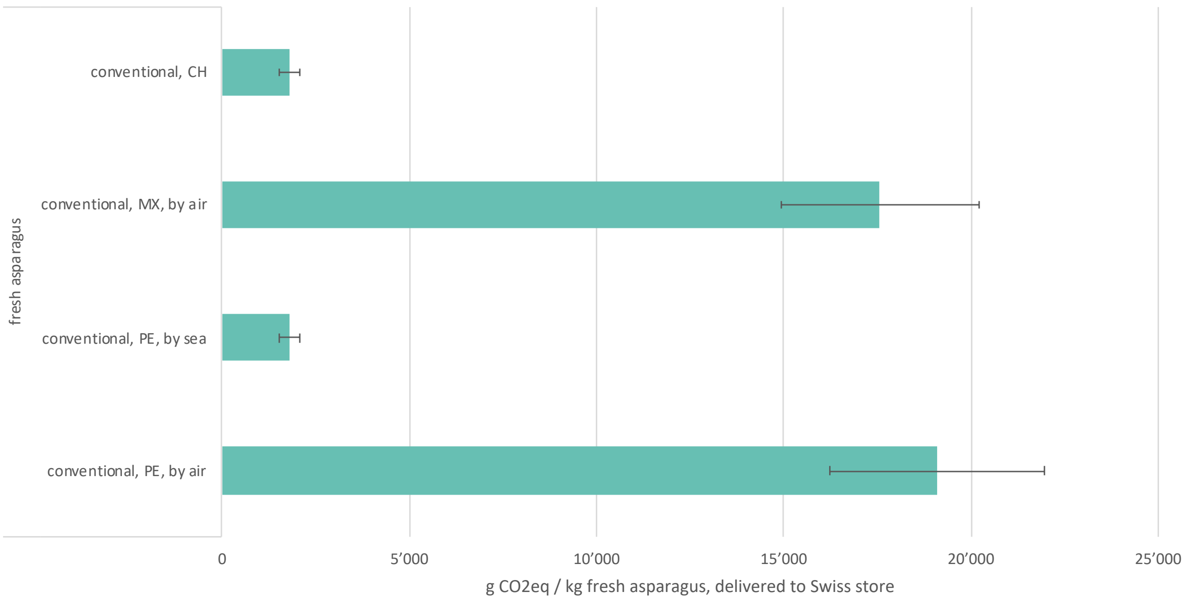


**Figure 9: Carbon footprint for asparagus, delivered to Swiss store**

# A2 EF v3.0 method

The environmental footprint according to the EF v3.0 methods does not correlate well with the environmental footprint based on the ecological scarcity method.
For strawberry production the difference between heated and unheated strawberry production is less clear due to higher importance of water scarcity (ES production) and acidification and eutrophication (organic CH) in the EF method compared to the ecological scarcity method.
For asparagus production, the Peruvian asparagus transported by ship shows a lower impact than Mexican asparagus imported by air because of lower importance of the pesticide emissions.

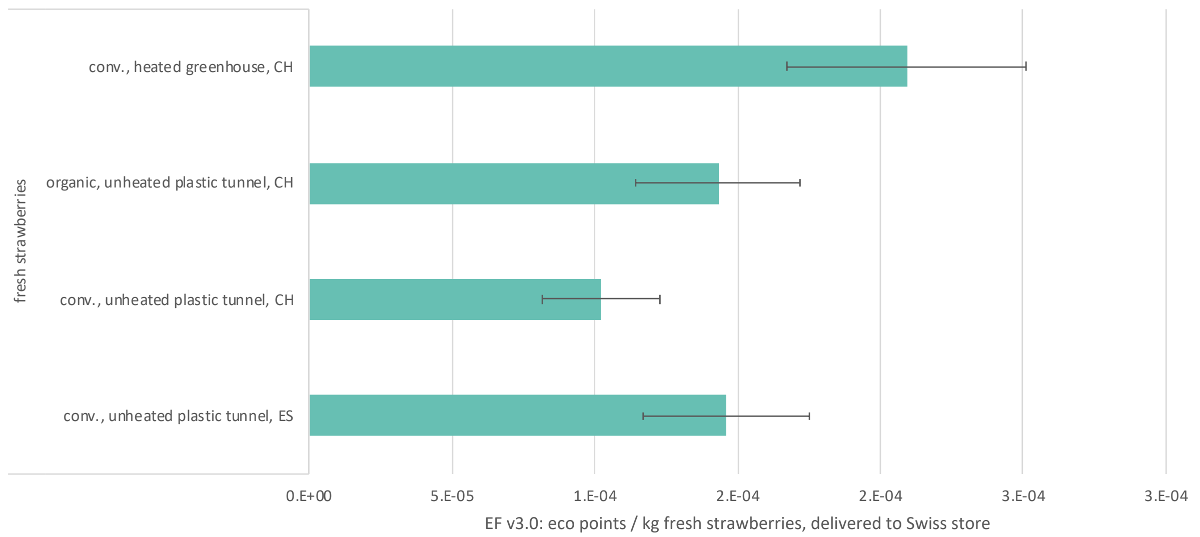


**Figure 10: Environmental footprint according to EF v3.0 for strawberries, delivered to Swiss store**

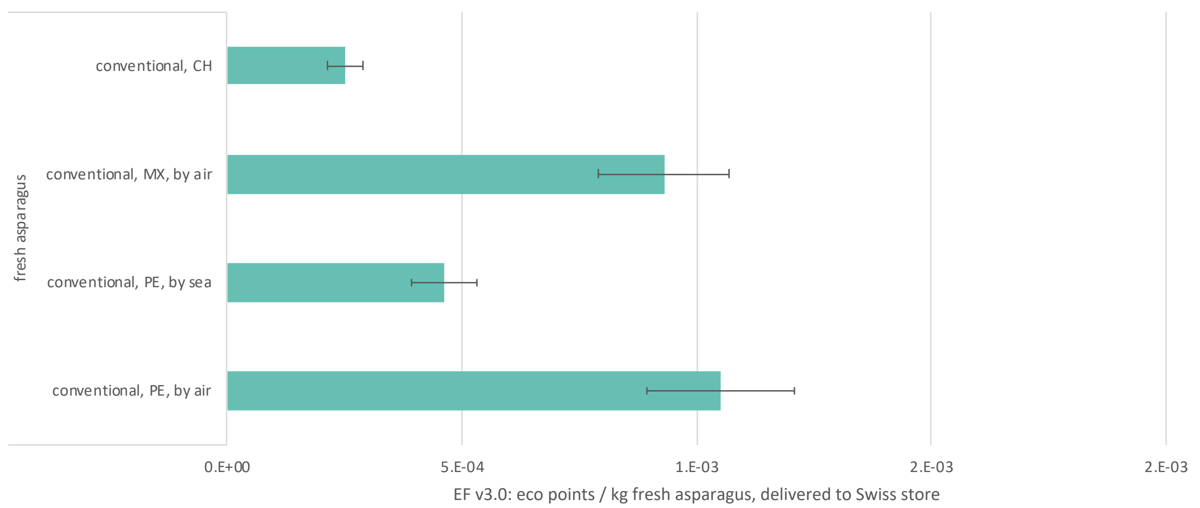


**Figure 11: Environmental footprint according to EF v3.0 for asparagus, delivered to Swiss store**

# A3 Table with results

**Table 15: Results for strawberries calculated with ecological scarcity 2021**

| eco points / kg strawberries, delivered Swiss store | Strawberries, conventional, heated greenhouse/CH | Strawberries, conventional, unheated plastic tunnel/CH | Strawberries, organic, unheated plastic tunnel/CH | Strawberries, conventional, unheated multi tunnel/ES |
|---|---|---|---|---|
| Fertilisers (production and field emissions) | 180 | 337 | 527 | 181 |
| Pesticides (production and field emissions) | 70 | 251 | 0 | 30 |
| Water scarcity | 0 | 1 | 1 | 216 |
| Further cultivation processes | 63 | 365 | 385 | 201 |
| Tunnel / greenhouse infrastructure | 1'913 | 1'025 | 1'196 | 1'007 |
| Heating | 1'931 | 0 | 0 | 0 |
| Packaging | 414 | 414 | 414 | 414 |
| Transportation | 66 | 66 | 66 | 456 |
| Total | 4'636 | 2'460 | 2'589 | 2'505 |

**Table 16: Results for asparagus calculated with ecological scarcity 2021**

| eco points / kg asparagus, delivered Swiss store | Asparagus, conventional/CH | Asparagus, conventional/PE, by air | Asparagus, conventional/PE, by sea | Asparagus, conventional/MX, by air |
|---|---|---|---|---|
| Fertilisers (production and field emissions) | 1'739 | 1'526 | 1'526 | 1'703 |
| Pesticides (production and field emissions) | 136 | 24'162 | 24'162 | 206 |
| Water scarcity | 0 | 435 | 435 | 583 |
| Further cultivation processes | 2'153 | 766 | 766 | 1'194 |
| Packaging | 525 | 893 | 893 | 893 |
| Transportation | 66 | 20'538 | 515 | 18'323 |
| Total | 4'618 | 48'320 | 28'297 | 22'902 |

**Table 17: Carbon footprint of strawberries**

| g CO2eq / kg strawberries, delivered Swiss store | Strawberries, conventional, heated greenhouse/CH | Strawberries, conventional, unheated plastic tunnel/CH | Strawberries, organic, unheated plastic tunnel/CH | Strawberries, conventional, unheated multi tunnel/ES |
|---|---|---|---|---|
| Total | 2'825 | 1'039 | 1'083 | 1'185 |

**Table 18: Carbon footprint of asparagus**

| g CO2eq / kg asparagus, delivered Swiss store | Asparagus, conventional/CH | Asparagus, conventional/PE, by air | Asparagus, conventional/PE, by sea | Asparagus, conventional/MX, by air |
|---|---|---|---|---|
| Total | 1'785 | 19'096 | 1'788 | 17'560 |

**Table 19: Results for strawberries calculated with EF v3.0**

| Eco points / kg strawberries, delivered Swiss store | Strawberries, conventional, heated greenhouse/CH | Strawberries, conventional, unheated plastic tunnel/CH | Strawberries, organic, unheated plastic tunnel/CH | Strawberries, conventional, unheated multi tunnel/ES |
|---|---|---|---|---|
| Total | 2.09E-04 | 1.02E-04 | 1.43E-04 | 1.46E-04 |
| Climate change | 7.51E-05 | 2.77E-05 | 3.46E-05 | 2.57E-05 |
| Ozone depletion | 3.19E-07 | 2.80E-08 | 2.86E-08 | 4.60E-08 |
| Ionising radiation | 1.27E-06 | 5.02E-07 | 5.80E-07 | 6.32E-07 |
| Photochemical ozone formation | 4.85E-06 | 2.74E-06 | 3.30E-06 | 2.98E-06 |
| Particulate Matter | 1.28E-05 | 8.10E-06 | 2.05E-05 | 7.37E-06 |
| Human toxicity, non-cancer | 2.78E-06 | 1.54E-06 | 1.70E-06 | 2.29E-06 |
| Human toxicity, cancer | 2.67E-06 | 1.03E-06 | 1.40E-06 | 1.35E-06 |
| Acidification terrestrial and freshwater | 9.43E-06 | 5.05E-06 | 1.67E-05 | 4.82E-06 |
| Eutrophication, freshwater | 1.50E-06 | 1.18E-06 | 1.78E-06 | 7.70E-07 |
| Eutrophication, marine | 2.94E-06 | 2.98E-06 | 5.32E-06 | 1.67E-06 |
| Eutrophication, terrestrial | 4.75E-06 | 2.80E-06 | 1.24E-05 | 2.28E-06 |
| Ecotoxicity, freshwater | 2.06E-05 | 2.35E-05 | 1.45E-05 | 1.25E-05 |
| Land use | 2.80E-06 | 2.67E-06 | 2.63E-06 | 2.63E-06 |
| Water use | 1.83E-06 | 1.43E-06 | 1.45E-06 | 5.64E-05 |
| Resource use, fossils | 5.21E-05 | 1.87E-05 | 2.36E-05 | 1.81E-05 |
| Resource use, minerals and metals | 1.36E-05 | 2.20E-06 | 2.76E-06 | 6.31E-06 |

**Table 20: Results for asparagus calculated with EF v3.0**

| Eco points / kg strawberries, delivered Swiss store | Asparagus, conventional/CH | Asparagus, conventional/PE, by air | Asparagus, conventional/PE, by sea | Asparagus, conventional/MX, by air |
|---|---|---|---|---|
| Total | 2.50E-04 | 1.05E-03 | 4.62E-04 | 9.30E-04 |
| Climate change | 4.75E-05 | 3.69E-04 | 4.79E-05 | 3.43E-04 |
| Ozone depletion | 1.08E-07 | 2.27E-07 | 1.09E-07 | 1.92E-07 |
| Ionising radiation | 1.70E-06 | 1.36E-06 | 7.01E-07 | 1.32E-06 |
| Photochemical ozone formation | 9.76E-06 | 3.87E-05 | 6.50E-06 | 3.58E-05 |
| Particulate Matter | 1.60E-05 | 2.24E-05 | 1.55E-05 | 2.55E-05 |
| Human toxicity, non-cancer | 4.02E-06 | 4.81E-06 | 3.11E-06 | 3.62E-06 |
| Human toxicity, cancer | 1.58E-06 | 1.53E-06 | 7.30E-07 | 1.76E-06 |
| Acidification terrestrial and freshwater | 1.61E-05 | 5.04E-05 | 1.69E-05 | 5.12E-05 |
| Eutrophication, freshwater | 5.29E-06 | 3.66E-06 | 3.18E-06 | 3.97E-06 |
| Eutrophication, marine | 1.62E-05 | 2.70E-05 | 1.17E-05 | 2.71E-05 |
| Eutrophication, terrestrial | 1.17E-05 | 3.27E-05 | 1.01E-05 | 3.06E-05 |
| Ecotoxicity, freshwater | 4.37E-05 | 1.95E-04 | 1.59E-04 | 6.05E-05 |
| Land use | 3.56E-05 | 2.50E-05 | 2.44E-05 | 1.07E-05 |
| Water use | 3.42E-06 | 1.20E-04 | 1.29E-04 | 1.83E-04 |
| Resource use, fossils | 3.26E-05 | 1.54E-04 | 2.88E-05 | 1.46E-04 |
| Resource use, minerals and metals | 4.92E-06 | 4.99E-06 | 4.32E-06 | 5.21E-06 |

# A4 Metadata and unit process raw data

The life cycle inventories for the newly modelled and updated processes are provided as unit process raw data in the EcoSpold v1 format (unit process in SimaPro). The electronic data includes the full EcoSpold v1 documentation.
For each investigated process, two types of tables (X-Process and X-Exchange) are provided. For better readability of the whole report, these data are listed here in the Annex.

## A4.1 Auxiliary inventories

| | | |
|---|---|---|
| ReferenceFunction | Name | strawberry seedling, for planting, in unheated greenhouse |
| Geography | Location | RER |
| ReferenceFunction | InfrastructureProcess | 0 |
| ReferenceFunction | Unit | p |
| | IncludedProcesses | The inventory includes the processes applied in this phase, that is the processes of irrigating, fertilisation, pest and pathogen control, harvesting; the greenhouse and the machines and shed or surface used to park them; all inputs as seeds, fertilizers (mineral and organic), active substances, water for irrigation, fuels end energy as well as the transport to the farm. |
| | Amount | 1 |
| | LocalName | Erdbeersetzling, zum Einpflanzen, in unbeheiztem Gewächshaus |
| | Synonyms | |
| | GeneralComment | This inventory refers to 1 strawberry seedling. |
| | InfrastructureIncluded | 1 |
| | Category | agricultural means of production |
| | SubCategory | seed |
| | LocalCategory | Landwirtschaftliche Produktionsmittel |
| | LocalSubCategory | Saatgut |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2017 |
| | EndDate | 2020 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | The inventory is modelled for Europe |
| Technology | Text | |
| Representativeness | Percent | |
| | ProductionVolume | |
| | SamplingProcedure | The data is based on literature and expert judgements. |
| | Extrapolations | none |
| | UncertaintyAdjustments | none |

**Figure 1: Metadata of strawberry seedling, for planting, in unheated greenhouse/RER**

| | Name | Location | Infrastructure Process | Unit | strawberry seedling, for planting, in unheated greenhouse | Uncertainty Type | Standard Deviation 95% | General Comment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | RER | | | |
| | Infrastructure Process | | | | 0 | | | |
| | Unit | | | | p | | | |
| product | strawberry seedling, for planting, in unheated greenhouse | RER | 0 | p | 1.0 | 0 | | |
| resource, in water | Water, river | - | - | m3 | 5.10E-04 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); ; |
| resource, biotic | Peat | - | - | kg | 3.00E-04 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); ; |
| technosphere | plastic tunnel | ES | 1 | m2a | 7.69E-07 | 1.00E+00 | 3.38E+00 | (4,4,4,2,4,5,BU:3); ; |
| | installation for drip irrigation | CH | 0 | m3 | 5.10E-04 | 1.00E+00 | 3.38E+00 | (4,4,4,2,4,5,BU:3); ; |
| | electricity, low voltage, production ENTSO, at grid | ENTSO | 0 | kWh | 1.22E-04 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); ; |
| | average mineral fertiliser, as P2O5, at regional storehouse | RER | 0 | kg | 4.19E-04 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); ; |
| | average mineral fertiliser, as N, at regional storehouse | RER | 0 | kg | 3.28E-04 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); ; |
| | average mineral fertiliser, as K2O, at regional storehouse | RER | 0 | kg | 1.63E-03 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); ; |
| | pesticide unspecified, at regional storehouse | RER | 0 | kg | 2.88E-08 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); ; |
| | copper oxide, at plant | RER | 0 | kg | 1.15E-06 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); ; |
| emission air, low population density | Water | - | - | kg | 0.04.59E-7 | 1.00E+00 | 1.94E+00 | (4,4,4,2,4,5,BU:1.5); ; |
| | Ammonia | - | - | kg | 1.27E-05 | 1.00E+00 | 1.74E+00 | (4,4,4,2,4,5,BU:1.2); ; |
| | Dinitrogen monoxide | - | - | kg | 9.72E-06 | 1.00E+00 | 1.94E+00 | (4,4,4,2,4,5,BU:1.5); ; |
| | Nitrogen oxides | - | - | kg | 1.53E-05 | 1.00E+00 | 1.94E+00 | (4,4,4,2,4,5,BU:1.5); ; |
| emission water, river | Water | - | - | kg | 4.59E-07 | 1.00E+00 | 1.94E+00 | (4,4,4,2,4,5,BU:1.5); ; |
| emission water, ground- | Water | - | - | kg | 1.02E-05 | 1.00E+00 | 1.94E+00 | (4,4,4,2,4,5,BU:1.5); ; |
| emission soil, agricultural | Cadmium | - | - | kg | 2.88E-08 | 1.00E+00 | 1.70E+00 | (4,4,4,2,4,5,BU:1.1); ; |
| | Copper | - | - | kg | 1.15E-06 | 1.00E+00 | 1.70E+00 | (4,4,4,2,4,5,BU:1.1); ; |

**Figure 2: Unit process raw data of strawberry seedling, for planting, in unheated greenhouse/RER**

| | | |
|---|---|---|
| ReferenceFunction | Name | strawberry seedling, organic, for planting, in unheated greenhouse |
| Geography | Location | RER |
| ReferenceFunction | InfrastructureProcess | 0 |
| ReferenceFunction | Unit | p |
| | IncludedProcesses | The inventory includes the processes applied in this phase, that is the processes of irrigating, fertilisation, pest and pathogen control, harvesting; the greenhouse and the machines and shed or surface used to park them; all inputs as seeds, fertilizers (mineral and organic), active substances, water for irrigation, fuels end energy as well as the transport to the farm. |
| | Amount | 1 |
| | LocalName | Erdbeersetzling, Bio, zum Einpflanzen, in unbeheiztem Gewächshaus |
| | Synonyms | |
| | GeneralComment | This inventory refers to 1 strawberry seedling. |
| | InfrastructureIncluded | 1 |
| | Category | agricultural means of production |
| | SubCategory | seed |
| | LocalCategory | Landwirtschaftliche Produktionsmittel |
| | LocalSubCategory | Saatgut |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2017 |
| | EndDate | 2020 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | The inventory is modelled for Europe |
| Technology | Text | |
| Representativeness | Percent | |
| | ProductionVolume | |
| | SamplingProcedure | The data is based on literature and expert judgements. |
| | Extrapolations | none |
| | UncertaintyAdjustments | none |

**Figure 3: Metadata of strawberry seedling, organic, for planting, in unheated greenhouse/RER**

| | Name | Location | Infrastructure Process | Unit | strawberry seedling, organic, for planting, in unheated greenhouse | Uncertainty Type | Standard Deviation 95% | General Comment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | RER | | | |
| | Infrastructure Process | | | | 0 | | | |
| | Unit | | | | p | | | |
| product | strawberry seedling, organic, for planting, in unheated greenhouse | RER | 0 | p | 1.0 | 0 | | |
| resource, in water | Water, river | - | - | m3 | 5.10E-04 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); ; |
| resource, biotic | Peat | - | - | kg | 3.00E-04 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); ; |
| technosphere | plastic tunnel | ES | 1 | m2a | 7.69E-07 | 1.00E+00 | 3.38E+00 | (4,4,4,2,4,5,BU:3); ; |
| | installation for drip irrigation | CH | 0 | m3 | 5.10E-04 | 1.00E+00 | 3.38E+00 | (4,4,4,2,4,5,BU:3); ; |
| | electricity, low voltage, production ENTSO, at grid | ENTSO | 0 | kWh | 1.22E-04 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); ; |
| emission air, low population density | Water | - | - | kg | 0.04.59E-7 | 1.00E+00 | 1.94E+00 | (4,4,4,2,4,5,BU:1.5); ; |
| | Ammonia | - | - | kg | 1.27E-05 | 1.00E+00 | 1.74E+00 | (4,4,4,2,4,5,BU:1.2); ; |
| | Dinitrogen monoxide | - | - | kg | 9.72E-06 | 1.00E+00 | 1.94E+00 | (4,4,4,2,4,5,BU:1.5); ; |
| | Nitrogen oxides | - | - | kg | 1.53E-05 | 1.00E+00 | 1.94E+00 | (4,4,4,2,4,5,BU:1.5); ; |
| emission water, river | Water | - | - | kg | 4.59E-07 | 1.00E+00 | 1.94E+00 | (4,4,4,2,4,5,BU:1.5); ; |
| emission water, ground- | Water | - | - | kg | 1.02E-05 | 1.00E+00 | 1.94E+00 | (4,4,4,2,4,5,BU:1.5); ; |

**Figure 4: Unit process raw data of strawberry seedling, organic, for planting, in unheated greenhouse/RER**

| | | |
|---|---|---|
| ReferenceFunction | Name | asparagus seedling, open field, at production site |
| Geography | Location | GLO |
| ReferenceFunction | InfrastructureProcess | 0 |
| ReferenceFunction | Unit | p |
| | IncludedProcesses | The inventory includes the irrigating, fertilisation, pest and pathogen control; all inputs as fertilizers (mineral and organic), active substances, water for irrigation, fuels end energy as well as the transport to the farm. |
| | LocalName | Spargelsetzling, offenes Feld, ab Produktionsort |
| | Synonyms | |
| | GeneralComment | This inventory refers to 1 asparagus seedling. |
| | InfrastructureIncluded | 1 |
| | Category | agricultural means of production |
| | SubCategory | seed |
| | LocalCategory | Landwirtschaftliche Produktionsmittel |
| | LocalSubCategory | Saatgut |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2015 |
| | EndDate | 2022 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | The inventory is globally modelled. |
| Technology | Text | |
| Representativeness | Percent | |
| | ProductionVolume | |
| | SamplingProcedure | The data is based on literature and expert judgements. |
| | Extrapolations | none |
| | UncertaintyAdjustments | none |

**Figure 5: Metadata of asparagus seedling, open field, at production site/GLO**

| | Name | Location | Infrastructure Process | Unit | asparagus seedling, open field, at production site | Uncertainty Type | Standard Deviation 95% | General Comment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | GLO | | | |
| | Infrastructure Process | | | | 0 | | | |
| | Unit | | | | p | | | |
| product | asparagus seedling, open field, at production site | GLO | 0 | p | 1.0 | 0 | | |
| resource, land | Transformation, from annual crop, non-irrigated | - | - | m2 | 4.00E-02 | 1.00E+00 | 1.34E+00 | (4,1,3,2,1,5,BU:1.1); |
| | Transformation, to annual crop, non-irrigated | - | - | m2 | 4.00E-02 | 1.00E+00 | 1.34E+00 | (4,1,3,2,1,5,BU:1.1); |
| | Occupation, annual crop | - | - | m2a | 4.00E-02 | 1.00E+00 | 1.34E+00 | (4,1,3,2,1,5,BU:1.1); |
| technosphere | diesel, burned in agricultural machine | CH | 0 | kg | 8.24E-05 | 1.00E+00 | 1.24E+00 | (1,2,3,3,1,5,BU:1.05); ; |
| | poultry manure, dried, at regional storehouse | CH | 0 | kg | 1.60E-04 | 1.00E+00 | 1.24E+00 | (1,2,3,3,1,5,BU:1.05); ; |
| | ammonium nitrate, as N, at regional storehouse | RER | 0 | kg | 3.48E-04 | 1.00E+00 | 1.24E+00 | (1,2,3,3,1,5,BU:1.05); ; |
| | phosphoric acid, fertiliser grade, 70% in H2O, at plant | GLO | 0 | kg | 4.39E-04 | 1.00E+00 | 1.24E+00 | (1,2,3,3,1,5,BU:1.05); ; |
| | potassium sulphate, as K2O, at regional storehouse | RER | 0 | kg | 2.32E-04 | 1.00E+00 | 1.24E+00 | (1,2,3,3,1,5,BU:1.05); ; |
| | magnesium sulphate, at plant | RER | 0 | kg | 8.00E-06 | 1.00E+00 | 1.24E+00 | (1,2,3,3,1,5,BU:1.05); ; |
| | calcium nitrate, as N, at regional storehouse | RER | 0 | kg | 8.00E-06 | 1.00E+00 | 1.24E+00 | (1,2,3,3,1,5,BU:1.05); ; |
| | potassium nitrate, as N, at regional storehouse | RER | 0 | kg | 1.20E-04 | 1.00E+00 | 1.24E+00 | (1,2,3,3,1,5,BU:1.05); ; |
| | installation for drip irrigation | CH | 0 | m3 | 1.34E-02 | 1.00E+00 | 3.06E+00 | (1,2,3,3,1,5,BU:3); ; |
| | tap water, unspecified natural origin OECD, at user | RER | 0 | kg | 1.34E-02 | 1.00E+00 | 1.24E+00 | (1,2,3,3,1,5,BU:1.05); ; |
| | pesticide unspecified, at regional storehouse | RER | 0 | kg | 3.35E-06 | 1.00E+00 | 1.24E+00 | (1,2,3,3,1,5,BU:1.05); ; |
| | transport, freight, lorry 32-40 metric ton, EURO 4 | RER | 0 | tkm | 1.45E-03 | 1.00E+00 | 2.11E+00 | (4,2,3,3,1,5,BU:2); ; |
| | transport, freight, lorry 32-40 metric ton, EURO 4 | RER | 0 | tkm | 1.54E-02 | 1.00E+00 | 2.11E+00 | (4,2,3,3,1,5,BU:2); ; |
| | transport, aircraft, freight, long-haul | RER | 0 | tkm | 9.21E-03 | 1.00E+00 | 2.11E+00 | (4,2,3,3,1,5,BU:2); ; |
| | transport, tractor and trailer | CH | 0 | tkm | 8.52E-04 | 1.00E+00 | 2.11E+00 | (4,2,3,3,1,5,BU:2); ; |
| | transport, transoceanic freight ship | OCE | 0 | tkm | 2.54E-03 | 1.00E+00 | 2.11E+00 | (4,2,3,3,1,5,BU:2); ; |
| | electricity, low voltage, production GLO, at grid | GLO | 0 | kWh | 6.40E-03 | 1.00E+00 | 1.24E+00 | (1,2,3,3,1,5,BU:1.05); ; |
| emission air, low population density | Ammonia | - | - | kg | 1.70E-05 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); ; |
| | Nitrogen oxides | - | - | kg | 1.92E-06 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); ; |
| | Dinitrogen monoxide | - | - | kg | 9.20E-06 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); ; |
| | Water, OECD | - | - | kg | 7.26E-03 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); ; |
| emission water, ground- | Nitrate | - | - | kg | 6.16E-03 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); ; |
| | Phosphorus | - | - | kg | 2.80E-07 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); ; |
| emission water, river | Phosphorus | - | - | kg | 2.96E-06 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); ; |
| | Water | - | - | kg | 7.26E-03 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); ; |
| | Cadmium, ion | - | - | kg | 8.80E-12 | 1.00E+00 | 3.09E+00 | (4,1,1,1,1,5,BU:3); ; |
| | Copper, ion | - | - | kg | 8.80E-09 | 1.00E+00 | 3.09E+00 | (4,1,1,1,1,5,BU:3); ; |
| | Zinc, ion | - | - | kg | 3.36E-08 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); ; |
| | Lead | - | - | kg | 1.44E-10 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); ; |
| | Nickel, ion | - | - | kg | 2.80E-11 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); ; |
| | Chromium, ion | - | - | kg | 2.88E-08 | 1.00E+00 | 3.09E+00 | (4,1,1,1,1,5,BU:3); ; |
| | Mercury | - | - | kg | 3.64E-13 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); ; |
| emission soil, agricultural | Imidacloprid | - | - | kg | 3.38E-07 | 1.00E+00 | 1.32E+00 | (1,2,3,3,1,5,BU:1.2); ; |
| | Methomyl | - | - | kg | 2.16E-06 | 1.00E+00 | 1.32E+00 | (1,2,3,3,1,5,BU:1.2); ; |
| | Sulfur | - | - | kg | 7.60E-08 | 1.00E+00 | 1.58E+00 | (1,2,3,3,1,5,BU:1.5); ; |
| | Difenoconazole | - | - | kg | 4.80E-07 | 1.00E+00 | 1.32E+00 | (1,2,3,3,1,5,BU:1.2); ; |
| | Deltamethrin | - | - | kg | 3.00E-04 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); ; |
| | Mercury | - | - | kg | 1.44E-11 | 1.00E+00 | 1.32E+00 | (4,1,1,1,1,5,BU:1.1); ; |

**Figure 6: Unit process raw data of asparagus seedling, open field, at production site/GLO**

| | | |
|---|---|---|
| ReferenceFunction | Name | installation for drip irrigation |
| Geography | Location | CH |
| ReferenceFunction | InfrastructureProcess | 0 |
| ReferenceFunction | Unit | m3 |
| | IncludedProcesses | This inventory includes the water pumping, energy use, infrastructure, but not the water emissions of irrigation (shall be included in the crop production dataset). |
| | LocalName | Installation Tropfsystem Bewässerung |
| | Synonyms | |
| | GeneralComment | This dataset represents the drip irrigation in Switzerland with a 90% irrigation efficieny. The inventory includes the water pumping of ground water and surface water, as well as the infrastructure. The water supplied to the plants (1m3) and the water evaporated or infiltrated shall be included in the crop production datasets. |
| | InfrastructureIncluded | 1 |
| | Category | water supply |
| | SubCategory | production |
| | LocalCategory | Wasserversorgung |
| | LocalSubCategory | Bereitstellung |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2015 |
| | EndDate | 2020 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | The inventory is modelled for Switzerland |
| Technology | Text | |
| Representativeness | Percent | |
| | ProductionVolume | |
| | SamplingProcedure | Literature values and estimations. |
| | Extrapolations | none |
| | UncertaintyAdjustments | none |

**Figure 7: Metadata of installation for drip irrigation/CH**

| | Name | Location | Infrastructure Process | Unit | installation for drip irrigation | Uncertainty Type | Standard Deviation 95% | General Comment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | CH | | | |
| | Infrastructure Process | | | | 0 | | | |
| | Unit | | | | m3 | | | |
| product | installation for drip irrigation | CH | 0 | m3 | 1.0 | 0 | | |
| technosphere | brass, at plant | CH | 0 | kg | 6.20E-04 | 1.00E+00 | 1.42E+00 | (3,4,4,3,3,5,BU:1.05); ; |
| | cast iron, at plant | RER | 0 | kg | 1.80E-05 | 1.00E+00 | 1.42E+00 | (3,4,4,3,3,5,BU:1.05); ; |
| | extrusion, plastic pipes | RER | 0 | kg | 1.07E-02 | 1.00E+00 | 1.42E+00 | (3,4,4,3,3,5,BU:1.05); ; |
| | injection moulding | RER | 0 | kg | 9.90E-03 | 1.00E+00 | 1.42E+00 | (3,4,4,3,3,5,BU:1.05); ; |
| | steel product manufacturing, average metal working | RER | 0 | kg | 1.09E-03 | 1.00E+00 | 1.42E+00 | (3,4,4,3,3,5,BU:1.05); ; |
| | injection moulding | RER | 0 | kg | 9.90E-03 | 1.00E+00 | 1.42E+00 | (3,4,4,3,3,5,BU:1.05); ; |
| | nylon 66, at plant | RER | 0 | kg | 3.10E-06 | 1.00E+00 | 1.42E+00 | (3,4,4,3,3,5,BU:1.05); ; |
| | polyethylene, HDPE, granulate, at plant | RER | 0 | kg | 2.60E-03 | 1.00E+00 | 1.42E+00 | (3,4,4,3,3,5,BU:1.05); ; |
| | polyethylene, LDPE, granulate, at plant | RER | 0 | kg | 8.10E-03 | 1.00E+00 | 1.42E+00 | (3,4,4,3,3,5,BU:1.05); ; |
| | polypropylene, granulate, at plant | RER | 0 | kg | 9.90E-03 | 1.00E+00 | 1.42E+00 | (3,4,4,3,3,5,BU:1.05); ; |
| | steel, low-alloyed, at plant | RER | 0 | kg | 4.50E-04 | 1.00E+00 | 1.42E+00 | (3,4,4,3,3,5,BU:1.05); ; |
| | diesel, burned in building machine, average | CH | 0 | MJ | 3.94E-05 | 1.00E+00 | 2.20E+00 | (3,5,4,3,3,5,BU:2); ; |
| | disposal, inert material, 0% water, to sanitary landfill | CH | 0 | kg | 3.10E-06 | 1.00E+00 | 1.52E+00 | (4,5,4,5,3,5,BU:1.05); ; |
| | disposal, polyethylene, 0.4% water, to municipal incineration | CH | 0 | kg | 1.07E-02 | 1.00E+00 | 1.52E+00 | (4,5,4,5,3,5,BU:1.05); ; |
| | disposal, polypropylene, 15.9% water, to municipal incineration | CH | 0 | kg | 9.90E-03 | 1.00E+00 | 1.52E+00 | (4,5,4,5,3,5,BU:1.05); ; |
| | disposal, building, bulk iron (excluding reinforcement), to sorting plant | CH | 0 | kg | 1.09E-03 | 1.00E+00 | 1.52E+00 | (4,5,4,5,3,5,BU:1.05); ; |

**Figure 8: Unit process raw data of installation for drip irrigation/CH**

| | | |
|---|---|---|
| ReferenceFunction | Name | diesel, burned in agricultural machine |
| Geography | Location | CH |
| ReferenceFunction | InfrastructureProcess | 0 |
| ReferenceFunction | Unit | kg |
| | IncludedProcesses | The inventory includes the diesel demand and the combustions emissions as well as the agricultural machinery |
| | LocalName | Diesel, verbrannt in landwirtschaftlichen Maschinen |
| | Synonyms | |
| | GeneralComment | This dataset represents the diesel demand in agricultural machinery and is valid for 1kg diesel, burned in agricultural machinery |
| | InfrastructureIncluded | 1 |
| | Category | agricultural production |
| | SubCategory | fuels |
| | LocalCategory | Landwirtschaftliche Produktion |
| | LocalSubCategory | Brenn- und Treibstoffe |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2014 |
| | EndDate | 2022 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | The inventory is modelled for Europe |
| Technology | Text | |
| Representativeness | Percent | |
| | ProductionVolume | |
| | SamplingProcedure | The data is based on literature and expert judgements. |
| | Extrapolations | none |
| | UncertaintyAdjustments | none |

**Figure 9: Metadata of diesel, burned in agricultural machine/CH**

| | Name | Location | Infrastructure Process | Unit | diesel, burned in agricultural machine | Uncertainty Type | Standard Deviation 95% | General Comment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | CH | | | |
| | Infrastructure Process | | | | 0 | | | |
| | Unit | | | | kg | | | |
| product | diesel, burned in agricultural machine | CH | 0 | kg | 1.0 | 0 | | |
| technosphere | tractor, production | CH | 1 | kg | 8.37E-02 | 1.00E+00 | 3.06E+00 | (1,2,3,2,1,5,BU:3); ; |
| | trailer, production | CH | 1 | kg | 5.55E-01 | 1.00E+00 | 3.06E+00 | (1,2,3,2,1,5,BU:3); ; |
| | diesel, at regional storage | CH | 0 | kg | 1.00E+00 | 1.00E+00 | 1.30E+00 | (1,2,4,2,1,5,BU:1.05); ; |
| | shed | CH | 1 | m2 | 1.86E-03 | 1.00E+00 | 3.09E+00 | (1,2,4,2,1,5,BU:3); ; |
| emission air, low population density | NMVOC, non-methane volatile organic compounds, unspecified origin | - | - | kg | 2.14E-03 | 1.00E+00 | 1.63E+00 | (4,1,3,2,1,5,BU:1.5); |
| | Nitrogen oxides | - | - | kg | 3.90E-02 | 1.00E+00 | 1.63E+00 | (4,1,3,2,1,5,BU:1.5); |
| | Carbon monoxide, fossil | - | - | kg | 5.87E-03 | 1.00E+00 | 5.06E+00 | (2,2,2,1,1,5,BU:5); |
| | Carbon dioxide, fossil | - | - | kg | 3.12E+00 | 1.00E+00 | 1.22E+00 | (2,2,2,1,1,5,BU:1.05); |
| | Sulfur dioxide | - | - | kg | 1.01E-03 | 1.00E+00 | 1.22E+00 | (2,2,2,1,1,5,BU:1.05); |
| | Methane, fossil | - | - | kg | 1.29E-04 | 1.00E+00 | 1.57E+00 | (2,2,2,1,1,5,BU:1.5); |
| | Benzene | - | - | kg | 7.29E-06 | 1.00E+00 | 3.05E+00 | (2,2,2,1,1,5,BU:3); |
| | Particulates, < 2.5 um | - | - | kg | 4.91E-03 | 1.00E+00 | 3.05E+00 | (2,2,2,1,1,5,BU:3); |
| | Cadmium | - | - | kg | 1.00E-08 | 1.00E+00 | 5.06E+00 | (2,2,2,1,1,5,BU:5); |
| | Chromium | - | - | kg | 5.00E-08 | 1.00E+00 | 5.06E+00 | (2,2,2,1,1,5,BU:5); |
| | Copper | - | - | kg | 1.70E-06 | 1.00E+00 | 5.06E+00 | (2,2,2,1,1,5,BU:5); |
| | Dinitrogen monoxide | - | - | kg | 1.20E-04 | 1.00E+00 | 1.57E+00 | (2,2,2,1,1,5,BU:1.5); |
| | Nickel | - | - | kg | 7.00E-08 | 1.00E+00 | 5.06E+00 | (2,2,2,1,1,5,BU:5); |
| | Zinc | - | - | kg | 1.00E-06 | 1.00E+00 | 5.06E+00 | (2,2,2,1,1,5,BU:5); |
| | Benzo(a)pyrene | - | - | kg | 3.00E-08 | 1.00E+00 | 3.05E+00 | (2,2,2,1,1,5,BU:3); |
| | PAH, polycyclic aromatic hydrocarbons | - | - | kg | 3.28E-06 | 1.00E+00 | 3.05E+00 | (2,2,2,1,1,5,BU:3); |
| | Heat, waste | - | - | MJ | 4.54E+01 | 1.00E+00 | 1.22E+00 | (2,2,2,1,1,5,BU:1.05); |
| | Ammonia | - | - | kg | 2.00E-05 | 1.00E+00 | 1.30E+00 | (2,2,2,1,1,5,BU:1.2); |
| | Selenium | - | - | kg | 1.00E-08 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); |
| emission soil, agricultural | Zinc | - | - | kg | 4.82E-04 | 1.00E+00 | 1.32E+00 | (4,1,1,1,1,5,BU:1.1); |
| | Lead | - | - | kg | 7.87E-07 | 1.00E+00 | 1.32E+00 | (4,1,1,1,1,5,BU:1.1); |
| | Cadmium | - | - | kg | 1.79E-07 | 1.00E+00 | 1.32E+00 | (4,1,1,1,1,5,BU:1.1); |

**Figure 10: Unit process raw data of diesel, burned in agricultural machine/CH**

## A4.2 Cultivation

| | | |
|---|---|---|
| ReferenceFunction | Name | strawberries, conventional, heated greenhouse |
| Geography | Location | CH |
| ReferenceFunction | InfrastructureProcess | 0 |
| ReferenceFunction | Unit | kg |
| | IncludedProcesses | The inventory includes irrigating, fertilisation, pest and pathogen control, heating, harvesting; the greenhouse and the machines and shed or surface used to park them; all inputs as young plants (seedlings), fertilizers (mineral and organic), growing media, active substances, water for irrigation, fuels end energy as well as transports to the farm and the direct field emissions. |
| | LocalName | Erdbeeren, konventionell, beheiztes Gewächshaus |
| | Synonyms | |
| | GeneralComment | The inventory refers to the production of 1 kg of conventional strawberries in a heated greenhouse in Switzerland. |
| | InfrastructureIncluded | 1 |
| | Category | agricultural production |
| | SubCategory | plant production |
| | LocalCategory | Landwirtschaftliche Produktion |
| | LocalSubCategory | Pflanzenbau |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2016 |
| | EndDate | 2022 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | The inventory is modelled for Switzerland |
| Technology | Text | |
| Representativeness | Percent | |
| | ProductionVolume | |
| | SamplingProcedure | Literature and data from producer |
| | Extrapolations | none |
| | UncertaintyAdjustments | none |

**Figure 11: Metadata of strawberries, conventional, heated greenhouse/CH**

| | Name | Location | Infrastructure Process | Unit | strawberries, conventional, heated greenhouse | Uncertainty Type | Standard Deviation 95% | General Comment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | CH | | | |
| | Infrastructure Process | | | | 0 | | | |
| | Unit | | | | kg | | | |
| product | strawberries, conventional, heated greenhouse | CH | 0 | kg | 1.0 | 0 | | |
| resource, biotic | Energy, gross calorific value, in biomass | - | - | MJ | 1.83E-01 | 1.00E+00 | 1.22E+00 | (2,1,1,1,1,5,BU:1.05); |
| resource, in air | Carbon dioxide, in air | - | - | kg | 1.94E+00 | 1.00E+00 | 1.22E+00 | (2,1,1,1,1,5,BU:1.05); |
| technosphere | average mineral fertiliser, as N, at regional storehouse | RER | 0 | kg | 4.23E-03 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| | magnesium sulphate, at plant | RER | 0 | kg | 9.62E-04 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| | average mineral fertiliser, as P2O5, at regional storehouse | RER | 0 | kg | 2.00E-03 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| | average mineral fertiliser, as K2O, at regional storehouse | RER | 0 | kg | 4.75E-03 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| | strawberry seedling, for planting, in unheated greenhouse | RER | 0 | p | 8.65E-01 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| | tap water, unspecified natural origin CH, at user | CH | 0 | kg | 1.58E-02 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| | polypropylene, granulate, at plant | RER | 0 | kg | 1.92E-03 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| | extrusion, plastic film | RER | 0 | kg | 1.92E-03 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| | greenhouse, glass walls and roof, metal tubes | CH | 1 | m2a | 1.92E-01 | 1.00E+00 | 3.05E+00 | (2,3,1,1,1,5,BU:3); |
| | pesticide unspecified, at regional storehouse | RER | 0 | kg | 3.06E-05 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| | transport, freight, lorry, fleet average | CH | 0 | tkm | 4.17E-03 | 1.00E+00 | 2.05E+00 | (2,3,1,1,1,5,BU:2); |
| | heat, natural gas, at boiler modulating >100kW | RER | 0 | MJ | 2.22E+01 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| | electricity, low voltage, at grid | CH | 0 | kWh | 6.15E-02 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| | electricity, low voltage, at grid | CH | 0 | kWh | 3.64E-03 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| | disposal, polyethylene, 0.4% water, to municipal incineration | CH | 0 | kg | 1.92E-03 | 1.00E+00 | 1.22E+00 | (2,3,1,1,1,5,BU:1.05); |
| emission air, low population density | Dinitrogen monoxide | - | - | kg | 7.31E-05 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| | Ammonia | - | - | kg | 2.21E-04 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Carbon dioxide, fossil | - | - | kg | 0.00E+00 | 1.00E+00 | 1.30E+00 | (4,1,1,1,1,5,BU:1.05); |
| | Nitrogen oxides | - | - | kg | 1.54E-05 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission air, unspecified | Water, CH | - | - | kg | 1.43E+01 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, unspecified | Water, CH | - | - | m3 | 6.38E-04 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, ground- | Nitrate | - | - | kg | 2.48E-03 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| | Phosphorus | - | - | kg | 1.35E-06 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, river | Phosphorus | - | - | kg | 1.44E-05 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| | Cadmium, ion | - | - | kg | 8.65E-10 | 1.00E+00 | 3.09E+00 | (4,1,1,1,1,5,BU:3); |
| | Copper, ion | - | - | kg | 6.15E-08 | 1.00E+00 | 3.09E+00 | (4,1,1,1,1,5,BU:3); |
| | Zinc, ion | - | - | kg | 3.08E-07 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); |
| | Lead | - | - | kg | 2.31E-09 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); |
| | Nickel, ion | - | - | kg | 1.50E-10 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); |
| | Chromium, ion | - | - | kg | 3.65E-07 | 1.00E+00 | 3.09E+00 | (4,1,1,1,1,5,BU:3); |
| emission soil, agricultural | Azoxystrobin | - | - | kg | 3.85E-07 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Bupirimate | - | - | kg | 7.69E-07 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Cyprodinil | - | - | kg | 4.42E-06 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Difenoconazole | - | - | kg | 7.69E-07 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Etoxazole | - | - | kg | 1.92E-07 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | N-(2,3-dichloro-4-hydroxyphenyl)-1-methylcyclohexane-1-carboxamide | - | - | kg | 1.02E-05 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Fludioxonil | - | - | kg | 1.92E-06 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Zoxamide | - | - | kg | 1.54E-06 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Kresoxim-methyl | - | - | kg | 1.73E-06 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Myclobutanil | - | - | kg | 3.85E-07 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Phenmedipham | - | - | kg | 2.31E-06 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Quinoxyfen | - | - | kg | 1.92E-07 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Thiacloprid | - | - | kg | 2.50E-06 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Trifloxystrobin | - | - | kg | 3.08E-06 | 1.00E+00 | 1.37E+00 | (4,1,1,1,1,5,BU:1.2); |
| | Cadmium | - | - | kg | 6.46E-08 | 1.00E+00 | 1.32E+00 | (4,1,1,1,1,5,BU:1.1); |
| emission economic-issue, unspecified | Water, embodied in product, CH | - | - | kg | 9.00E-01 | 1.00E+00 | 1.30E+00 | (4,1,1,1,1,5,BU:1.05); |

**Figure 12: Unit process raw data of strawberries, conventional, heated greenhouse/CH**

| | | |
|---|---|---|
| ReferenceFunction | Name | strawberries, conventional, unheated plastic tunnel |
| Geography | Location | CH |
| ReferenceFunction | InfrastructureProcess | 0 |
| ReferenceFunction | Unit | kg |
| | IncludedProcesses | The inventory includes irrigating, fertilisation, pest and pathogen control, harvesting; the tunnel and the machines and shed or surface used to park them; all inputs as young plants (seedlings), fertilizers (mineral and organic), growing media, active substances, water for irrigation, fuels end energy as well as all transports to the farm and the direct field emissions. |
| | LocalName | Erdbeeren, konventionell, unbeheizter Folientunnel |
| | Synonyms | |
| | GeneralComment | The inventory refers to the production of 1 kg of conventional strawberries in a unheated double layer tunnel in Switzerland. |
| | InfrastructureIncluded | 1 |
| | Category | agricultural production |
| | SubCategory | plant production |
| | LocalCategory | Landwirtschaftliche Produktion |
| | LocalSubCategory | Pflanzenbau |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2016 |
| | EndDate | 2022 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | The inventory is modelled for Switzerland |
| Technology | Text | |
| Representativeness | Percent | |
| | ProductionVolume | |
| | SamplingProcedure | Based on literature and producer interviews |
| | Extrapolations | none |
| | UncertaintyAdjustments | none |

**Figure 13: Metadata of strawberries, conventional, unheated plastic tunnel/CH**

| | Name | Location | Infrastructure Process | Unit | strawberries, conventional, unheated plastic tunnel | Uncertainty Type | Standard Deviation 95% | General Comment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | CH | | | |
| | Infrastructure Process | | | | 0 | | | |
| | Unit | | | | kg | | | |
| product | strawberries, conventional, unheated plastic tunnel | CH | 0 | kg | 1.0 | 0 | | |
| resource, biotic | Energy, gross calorific value, in biomass | - | - | MJ | 1.83E-01 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| resource, in air | Carbon dioxide, in air | - | - | kg | 1.94E+00 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| technosphere | average mineral fertiliser, as N, at regional storehouse | RER | 0 | kg | 7.14E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,1,1,5,BU:1.05); |
| | average mineral fertiliser, as K2O, at regional storehouse | RER | 0 | kg | 8.64E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,1,1,5,BU:1.05); |
| | average mineral fertiliser, as P2O5, at regional storehouse | RER | 0 | kg | 2.43E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,1,1,5,BU:1.05); |
| | magnesium sulphate, at plant | RER | 0 | kg | 1.43E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,1,1,5,BU:1.05); |
| | pesticide unspecified, at regional storehouse | CH | 0 | kg | 1.14E-04 | 1.00E+00 | 1.24E+00 | (2,1,3,1,1,5,BU:1.05); |
| | tap water, unspecified natural origin CH, at user | CH | 0 | kg | 3.52E+01 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| | plastic tunnel | CH | 1 | m2a | 7.14E-01 | 1.00E+00 | 3.06E+00 | (3,3,1,1,1,5,BU:3); |
| | strawberry seedling, for planting, in unheated greenhouse | RER | 0 | p | 3.21E+00 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); |
| | polyethylene, HDPE, granulate, at plant | RER | 0 | kg | 1.29E-03 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | polyethylene, LDPE, granulate, at plant | RER | 0 | kg | 3.50E-02 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | extrusion, plastic pipes | RER | 0 | kg | 1.29E-03 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | extrusion, plastic film | RER | 0 | kg | 3.50E-02 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | diesel, burned in agricultural machine | CH | 0 | kg | 3.18E-03 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | transport, freight, lorry, fleet average | CH | 0 | tkm | 1.66E-02 | 1.00E+00 | 2.05E+00 | (2,1,1,3,1,5,BU:2); |
| | electricity, low voltage, production CH, at grid | CH | 0 | kWh | 8.14E-03 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | disposal, polyethylene, 0.4% water, to municipal incineration | CH | 0 | kg | 1.81E+01 | 1.00E+00 | 1.30E+00 | (4,1,1,1,1,5,BU:1.05); |
| emission air, low population density | Dinitrogen monoxide | - | - | kg | 1.40E-04 | 1.00E+00 | 1.57E+00 | (2,2,2,1,1,5,BU:1.5); |
| | Ammonia | - | - | kg | 3.74E-04 | 1.00E+00 | 1.30E+00 | (2,2,2,1,1,5,BU:1.2); |
| | Nitrogen oxides | - | - | kg | 2.93E-05 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission air, unspecified | Water, CH | - | - | kg | 3.18E+01 | 1.00E+00 | 1.63E+00 | (4,1,3,2,1,5,BU:1.5); |
| emission water, ground- | Nitrate | - | - | kg | 5.36E-03 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| | Phosphorus | - | - | kg | 5.00E-06 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, river | Phosphorus | - | - | kg | 3.57E-05 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| | Water, CH | - | - | m3 | 4.93E+02 | 1.00E+00 | 1.63E+00 | (4,1,3,2,1,5,BU:1.5); |
| | Zinc, ion | - | - | kg | 7.14E-07 | 1.00E+00 | 5.12E+00 | (4,1,3,2,1,5,BU:5); |
| | Chromium, ion | - | - | kg | 1.43E-06 | 1.00E+00 | 3.10E+00 | (4,1,3,2,1,5,BU:3); |
| emission soil, agricultural | Azoxystrobin | - | - | kg | 1.43E-06 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | Bupirimate | - | - | kg | 2.86E-06 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | Cyprodinil | - | - | kg | 1.64E-05 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | Difenoconazole | - | - | kg | 2.86E-06 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | Etoxazole | - | - | kg | 7.14E-07 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | N-(2,3-dichloro-4-hydroxyphenyl)-1-methylcyclohexane-1-carboxamide | - | - | kg | 3.79E-05 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | Fludioxonil | - | - | kg | 7.14E-06 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | Zoxamide | - | - | kg | 7.14E-06 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | Kresoxim-methyl | - | - | kg | 6.43E-06 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | Myclobutanil | - | - | kg | 1.43E-06 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | Phenmedipham | - | - | kg | 8.57E-06 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | Quinoxyfen | - | - | kg | 7.14E-07 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | Thiacloprid | - | - | kg | 9.29E-06 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| | Trifloxystrobin | - | - | kg | 1.14E-05 | 1.00E+00 | 1.32E+00 | (2,1,3,1,1,5,BU:1.2); |
| emission economic-issue, unspecified | Water, embodied in product, CH | - | - | kg | 9.00E-01 | 1.00E+00 | 1.30E+00 | (4,1,1,1,1,5,BU:1.05); |

**Figure 14: Unit process raw data of strawberries, conventional, unheated plastic tunnel/CH**

| | | |
|---|---|---|
| ReferenceFunction | Name | strawberries, organic, unheated plastic tunnel |
| Geography | Location | CH |
| ReferenceFunction | InfrastructureProcess | 0 |
| ReferenceFunction | Unit | kg |
| | IncludedProcesses | The inventory includes irrigating, fertilisation, pest and pathogen control, harvesting; the tunnel and the machines and shed or surface used to park them; all inputs as young plants (seedlings), fertilizers (mineral and organic), growing media, active substances, water for irrigation, fuels end energy as well as transports to the farm and the direct field emissions. |
| | LocalName | Erdbeeren Bio, unbeheizter Folientunnel |
| | Synonyms | |
| | GeneralComment | The inventory refers to the production of 1 kg of organic strawberries in a unheated double layer tunnel in Switzerland. |
| | InfrastructureIncluded | 1 |
| | Category | agricultural production |
| | SubCategory | plant production |
| | LocalCategory | Landwirtschaftliche Produktion |
| | LocalSubCategory | Pflanzenbau |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2017 |
| | EndDate | 2022 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | The inventory is modelled for Switzerland |
| Technology | Text | |
| Representativeness | Percent | |
| | ProductionVolume | |
| | SamplingProcedure | Based on literature and producer interviews |
| | Extrapolations | none |
| | UncertaintyAdjustments | none |

**Figure 15: Metadata of strawberries, organic, unheated plastic tunnel/CH**

| | Name | Location | Infrastructure Process | Unit | strawberries, organic, unheated plastic tunnel | Uncertainty Type | Standard Deviation 95% | General Comment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | CH | | | |
| | Infrastructure Process | | | | 0 | | | |
| | Unit | | | | kg | | | |
| product | strawberries, organic, unheated plastic tunnel | CH | 0 | kg | 1.0 | 0 | | |
| resource, biotic | Energy, gross calorific value, in biomass | - | - | MJ | 1.83E-01 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| resource, in air | Carbon dioxide, in air | - | - | kg | 1.94E+00 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| technosphere | tap water, unspecified natural origin CH, at user | CH | 0 | kg | 4.11E+01 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| | plastic tunnel | CH | 1 | m2a | 8.33E-01 | 1.00E+00 | 3.06E+00 | (3,3,1,1,1,5,BU:3); |
| | strawberry seedling, organic, for planting, in unheated greenhouse | RER | 0 | p | 3.75E+00 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); |
| | polyethylene, HDPE, granulate, at plant | RER | 0 | kg | 1.50E-03 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | polyethylene, LDPE, granulate, at plant | RER | 0 | kg | 4.08E-02 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | extrusion, plastic pipes | RER | 0 | kg | 1.50E-03 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | extrusion, plastic film | RER | 0 | kg | 4.08E-02 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | diesel, burned in agricultural machine | CH | 0 | kg | 3.71E-03 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | transport, freight, lorry, fleet average | CH | 0 | tkm | 1.27E-02 | 1.00E+00 | 2.05E+00 | (2,1,1,3,1,5,BU:2); |
| | electricity, low voltage, production CH, at grid | CH | 0 | kWh | 9.51E-03 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | disposal, polyethylene, 0.4% water, to municipal incineration | CH | 0 | kg | 1.81E+01 | 1.00E+00 | 1.30E+00 | (4,1,1,1,1,5,BU:1.05); |
| emission air, low population density | Dinitrogen monoxide | - | - | kg | 8.41E-05 | 1.00E+00 | 1.57E+00 | (2,2,2,1,1,5,BU:1.5); |
| | Ammonia | - | - | kg | 3.64E-03 | 1.00E+00 | 1.30E+00 | (2,2,2,1,1,5,BU:1.2); |
| | Nitrogen oxides | - | - | kg | 1.77E-05 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission air, unspecified | Water, CH | - | - | kg | 3.71E+01 | 1.00E+00 | 1.63E+00 | (4,1,3,2,1,5,BU:1.5); |
| emission water, ground- | Nitrate | - | - | kg | 1.01E-02 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| | Phosphorus | - | - | kg | 5.83E-06 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, river | Phosphorus | - | - | kg | 6.83E-05 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| | Water, CH | - | - | m3 | 3.10E-03 | 1.00E+00 | 1.63E+00 | (4,1,3,2,1,5,BU:1.5); |
| | Cadmium, ion | - | - | kg | 2.42E-09 | 1.00E+00 | 3.10E+00 | (4,1,3,2,1,5,BU:3); |
| | Copper, ion | - | - | kg | 3.00E-07 | 1.00E+00 | 3.10E+00 | (4,1,3,2,1,5,BU:3); |
| | Zinc, ion | - | - | kg | 2.42E-06 | 1.00E+00 | 5.12E+00 | (4,1,3,2,1,5,BU:5); |
| | Lead | - | - | kg | 2.58E-08 | 1.00E+00 | 5.12E+00 | (4,1,3,2,1,5,BU:5); |
| | Nickel, ion | - | - | kg | 1.00E-09 | 1.00E+00 | 5.12E+00 | (4,1,3,2,1,5,BU:5); |
| | Chromium, ion | - | - | kg | 1.50E-06 | 1.00E+00 | 3.10E+00 | (4,1,3,2,1,5,BU:3); |
| | Mercury | - | - | kg | 1.08E-10 | 1.00E+00 | 5.12E+00 | (4,1,3,2,1,5,BU:5); |
| emission economic-issue, unspecified | Water, embodied in product, CH | - | - | kg | 9.00E-01 | 1.00E+00 | 1.30E+00 | (4,1,1,1,1,5,BU:1.05); |

**Figure 16: Unit process raw data of strawberries, organic, unheated plastic tunnel/CH**

| | | |
|---|---|---|
| ReferenceFunction | Name | strawberries, conventional, unheated plastic tunnel |
| Geography | Location | ES |
| ReferenceFunction | InfrastructureProcess | 0 |
| ReferenceFunction | Unit | kg |
| | IncludedProcesses | The inventory includes irrigating, fertilisation, pest and pathogen control, harvesting; the tunnel and the machines and shed or surface used to park them; all inputs as young plants (seedlings), fertilizers (mineral and organic), growing media, active substances, water for irrigation, fuels end energy as well as all transports to farm and the direct field emissions. |
| | LocalName | Erdbeeren, konventionell, unbeheizter Folientunnel |
| | Synonyms | |
| | GeneralComment | The inventory refers to the production of 1 kg of conventional strawberries in a unheated double layer tunnel in Spain. |
| | InfrastructureIncluded | 1 |
| | Category | agricultural production |
| | SubCategory | plant production |
| | LocalCategory | Landwirtschaftliche Produktion |
| | LocalSubCategory | Pflanzenbau |
| | Formula | |
| | StatisticalClassification | |
| | CASNumber | |
| TimePeriod | StartDate | 2020 |
| | EndDate | 2022 |
| | DataValidForEntirePeriod | 1 |
| | OtherPeriodText | |
| Geography | Text | The inventory is modelled for Spain. |
| Technology | Text | |
| Representativeness | Percent | |
| | ProductionVolume | |
| | SamplingProcedure | Based on literature and producer interviews |
| | Extrapolations | none |
| | UncertaintyAdjustments | none |

**Figure 17: Metadata of strawberries, conventional, unheated plastic tunnel/ES**

| | Name | Location | Infrastructure Process | Unit | strawberries, conventional, unheated plastic tunnel | Uncertainty Type | Standard Deviation 95% | General Comment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | ES | | | |
| | Infrastructure Process | | | | 0 | | | |
| | Unit | | | | kg | | | |
| product | strawberries, conventional, unheated plastic tunnel | ES | 0 | kg | 1.0 | 0 | | |
| resource, biotic | Energy, gross calorific value, in biomass | - | - | MJ | 1.83E-01 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| resource, in air | Carbon dioxide, in air | - | - | kg | 1.94E+00 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| resource, in water | Water, unspecified natural origin, ES | - | - | m3 | 1.17E-01 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| technosphere | average mineral fertiliser, as N, at regional storehouse | RER | 0 | kg | 5.00E-03 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | average mineral fertiliser, as K2O, at regional storehouse | RER | 0 | kg | 6.82E-03 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | average mineral fertiliser, as P2O5, at regional storehouse | RER | 0 | kg | 4.49E-03 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | pesticide unspecified, at regional storehouse | RER | 0 | kg | 1.08E-04 | 1.00E+00 | 1.22E+00 | (2,1,1,1,1,5,BU:1.05); |
| | tap water, desalinated sea water, at user | ES | 0 | kg | 2.40E-02 | 1.00E+00 | 1.22E+00 | (2,1,1,1,1,5,BU:1.05); |
| | plastic tunnel | ES | 1 | m2a | 1.82E-01 | 1.00E+00 | 3.06E+00 | (3,3,1,1,1,5,BU:3); |
| | strawberry seedling, for planting, in unheated greenhouse | RER | 0 | p | 8.18E-01 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); |
| | polyethylene, HDPE, granulate, at plant | RER | 0 | kg | 2.29E-03 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | polyethylene, LDPE, granulate, at plant | RER | 0 | kg | 7.27E-03 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | steel, low-alloyed, at plant | RER | 0 | kg | 2.79E-05 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | extrusion, plastic pipes | RER | 0 | kg | 1.90E-03 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | extrusion, plastic film | RER | 0 | kg | 7.27E-03 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | blow moulding | RER | 0 | kg | 3.94E-04 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | section bar rolling, steel | RER | 0 | kg | 2.78E-05 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | diesel, burned in agricultural machine | CH | 0 | kg | 7.69E-04 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | electricity, low voltage, at grid | ES | 0 | kWh | 3.25E-02 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | transport, freight, lorry, fleet average | RER | 0 | tkm | 7.80E-03 | 1.00E+00 | 2.05E+00 | (2,1,1,3,1,5,BU:2); |
| | disposal, steel, 0% water, to municipal incineration | CH | 0 | kg | 2.79E-05 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| | disposal, polyethylene, 0.4% water, to municipal incineration | CH | 0 | kg | 1.26E+02 | 1.00E+00 | 1.21E+00 | (1,1,1,1,1,5,BU:1.05); |
| emission air, low population density | Dinitrogen monoxide | - | - | kg | 5.00E-05 | 1.00E+00 | 1.57E+00 | (2,2,2,1,1,5,BU:1.5); |
| | Ammonia | - | - | kg | 1.85E-04 | 1.00E+00 | 1.30E+00 | (2,2,2,1,1,5,BU:1.2); |
| | Carbon dioxide, fossil | - | - | kg | 0.00E+00 | 1.00E+00 | 1.22E+00 | (2,2,2,1,1,5,BU:1.05); |
| | Nitrogen oxides | - | - | kg | 1.30E-04 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission air, unspecified | Water, ES | - | - | kg | 1.19E+02 | 1.00E+00 | 1.63E+00 | (4,1,3,2,1,5,BU:1.5); |
| emission water, ground- | Nitrate | - | - | kg | 1.47E-03 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, unspecified | Water, ES | - | - | m3 | 7.72E+03 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, ground- | Phosphorus | - | - | kg | 1.27E-06 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, river | Phosphorus | - | - | kg | 9.09E-06 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission soil, agricultural | Cadmium | - | - | kg | 1.82E-07 | 1.00E+00 | 1.32E+00 | (4,1,1,1,1,5,BU:1.1); |
| | Azoxystrobin | - | - | kg | 1.09E-06 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Chlorpyrifos methyl | - | - | kg | 1.82E-07 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Cyprodinil | - | - | kg | 1.27E-06 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Dimethomorph | - | - | kg | 7.27E-07 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Etoxazole | - | - | kg | 1.82E-07 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Maleic hydrazide | - | - | kg | 3.64E-07 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Fosetyl-aluminium | - | - | kg | 1.82E-06 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Fludioxonil | - | - | kg | 9.09E-07 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Zoxamide | - | - | kg | 2.00E-06 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Indoxacarb | - | - | kg | 1.82E-07 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Myclobutanil | - | - | kg | 3.64E-07 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Penconazole | - | - | kg | 1.82E-07 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Pendimethalin | - | - | kg | 1.82E-07 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Spinosad | - | - | kg | 3.64E-07 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| | Trifloxystrobin | - | - | kg | 3.09E-06 | 1.00E+00 | 1.30E+00 | (2,1,1,1,1,5,BU:1.2); |
| emission economic-issue, unspecified | Water, embodied in product, ES | - | - | kg | 9.00E-01 | 1.00E+00 | 1.30E+00 | (4,1,1,1,1,5,BU:1.05); |

**Figure 18: Unit process raw data of strawberries, conventional, unheated plastic tunnel/ES**

| | |
|---|---|
| Name | asparagus, conventional |
| Location | CH |
| InfrastructureProcess | 0 |
| Unit | kg |
| IncludedProcesses | The inventory includes irrigating, fertilisation, pest and pathogen control, harvesting; mulching and the machines and shed or surface used to park them; all inputs as young plants (seedlings), fertilizers (mineral and organic), growing media, active substances, water for irrigation, fuels end energy as well as the transport to the farm and the direct field emissions. |
| LocalName | Spargeln, konventionell |
| Synonyms | |
| GeneralComment | The inventory refers to the average production of 1 kg of conventional asparagus in Switzerland. |
| InfrastructureIncluded | 1 |
| Category | agricultural production |
| SubCategory | plant production |
| LocalCategory | Landwirtschaftliche Produktion |
| LocalSubCategory | Pflanzenbau |
| Formula | |
| StatisticalClassification | |
| CASNumber | |
| StartDate | 2014 |
| EndDate | 2022 |
| DataValidForEntirePeriod | 1 |
| OtherPeriodText | |
| Text | The inventory is modelled for Switzerland |
| Text | |
| Percent | |
| ProductionVolume | |
| SamplingProcedure | Based on literature and producer interviews |
| Extrapolations | none |
| UncertaintyAdjustments | none |

**Figure 19: Metadata of asparagus, conventional/CH**

| | Name | Location | Infrastructure Process | Unit | asparagus, conventional | Uncertainty Type | Standard Deviation 95% | General Comment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | CH | | | |
| | Infrastructure Process | | | | 0 | | | |
| | Unit | | | | kg | | | |
| product | asparagus, conventional | CH | 0 | kg | 1.0 | 0 | | |
| resource, biotic | Energy, gross calorific value, in biomass | - | - | MJ | 1.67E+00 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| resource, in air | Carbon dioxide, in air | - | - | kg | 0.00E+00 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| resource, land | Occupation, annual crop | - | - | m2a | 2.81E+00 | 1.00E+00 | 1.34E+00 | (4,1,3,2,1,5,BU:1.1); |
| | Transformation, from annual crop, non-irrigated | - | - | m2 | 2.81E+00 | 1.00E+00 | 1.34E+00 | (4,1,3,2,1,5,BU:1.1); |
| | Transformation, to annual crop, non-irrigated | - | - | m2 | 2.81E+00 | 1.00E+00 | 1.34E+00 | (4,1,3,2,1,5,BU:1.1); |
| resource, biotic | Peat | - | - | kg | 1.47E-01 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| technosphere | average mineral fertiliser, as N, at regional storehouse | RER | 0 | kg | 3.03E-02 | 1.00E+00 | 1.22E+00 | (2,1,2,1,1,5,BU:1.05); |
| | average mineral fertiliser, as K2O, at regional storehouse | RER | 0 | kg | 3.54E-02 | 1.00E+00 | 1.22E+00 | (2,1,2,1,1,5,BU:1.05); |
| | average mineral fertiliser, as P2O5, at regional storehouse | RER | 0 | kg | 1.01E-02 | 1.00E+00 | 1.22E+00 | (2,1,2,1,1,5,BU:1.05); |
| | magnesium sulphate, at plant | RER | 0 | kg | 7.30E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | pesticide unspecified, at regional storehouse | CH | 0 | kg | 1.63E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | installation for drip irrigation | CH | 0 | m3 | 5.34E-03 | 1.00E+00 | 3.10E+00 | (4,1,3,2,1,5,BU:3); |
| | tap water, unspecified natural origin CH, at user | CH | 0 | kg | 5.34E+00 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| | asparagus seedling, open field, at production site | GLO | 0 | p | 8.08E-01 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); |
| | polyethylene, LDPE, granulate, at plant | RER | 0 | kg | 1.49E-02 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | extrusion, plastic film | RER | 0 | kg | 1.49E-02 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | electricity, low voltage, production CH, at grid | CH | 0 | kWh | 2.44E-01 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | transport, freight, lorry, fleet average | CH | 0 | tkm | 2.99E-02 | 1.00E+00 | 2.05E+00 | (2,1,1,3,1,5,BU:2); |
| | disposal, polyethylene, 0.4% water, to municipal incineration | CH | 0 | kg | 1.49E-02 | 1.00E+00 | 1.30E+00 | (4,1,1,1,1,5,BU:1.05); |
| emission air, unspecified | Water, CH | - | - | kg | 3.16E+00 | 1.00E+00 | 1.63E+00 | (4,1,3,2,1,5,BU:1.5); |
| emission air, low population density | Dinitrogen monoxide | - | - | kg | 5.62E-04 | 1.00E+00 | 1.57E+00 | (2,2,2,1,1,5,BU:1.5); |
| | Ammonia | - | - | kg | 1.59E-03 | 1.00E+00 | 1.30E+00 | (2,2,2,1,1,5,BU:1.2); |
| | Nitrogen oxides | - | - | kg | 1.18E-04 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, ground- | Nitrate | - | - | kg | 3.23E-02 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| | Phosphorus | - | - | kg | 1.97E-05 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, river | Phosphorus | - | - | kg | 2.11E-04 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| | Water, CH | - | - | m3 | 1.25E-03 | 1.00E+00 | 1.63E+00 | (4,1,3,2,1,5,BU:1.5); |
| | Cadmium, ion | - | - | kg | 1.07E-08 | 1.00E+00 | 3.10E+00 | (4,1,3,2,1,5,BU:3); |
| | Copper, ion | - | - | kg | 8.15E-07 | 1.00E+00 | 3.10E+00 | (4,1,3,2,1,5,BU:3); |
| | Zinc, ion | - | - | kg | 2.75E-06 | 1.00E+00 | 5.12E+00 | (4,1,3,2,1,5,BU:5); |
| | Lead | - | - | kg | 1.80E-08 | 1.00E+00 | 5.12E+00 | (4,1,3,2,1,5,BU:5); |
| | Nickel, ion | - | - | kg | 1.38E-09 | 1.00E+00 | 5.12E+00 | (4,1,3,2,1,5,BU:5); |
| | Chromium VI | - | - | kg | 4.78E-06 | 1.00E+00 | 3.10E+00 | (4,1,3,2,1,5,BU:3); |
| emission soil, agricultural | Cadmium | - | - | kg | 5.62E-07 | 1.00E+00 | 1.26E+00 | (2,1,3,1,1,5,BU:1.1); |
| | Nickel | - | - | kg | 2.08E-07 | 1.00E+00 | 1.26E+00 | (2,1,3,1,1,5,BU:1.1); |
| | Azoxystrobin | - | - | kg | 2.81E-06 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Boscalid | - | - | kg | 1.12E-05 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Sodium | - | - | kg | 1.57E-03 | 1.00E+00 | 1.57E+00 | (2,1,2,3,1,5,BU:1.5); |
| | Cyprodinil | - | - | kg | 5.62E-06 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Dimethomorph | - | - | kg | 3.51E-07 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Fludioxonil | - | - | kg | 2.81E-06 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Fosetyl-aluminium | - | - | kg | 1.69E-05 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Metribuzin | - | - | kg | 1.83E-05 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Myclobutanil | - | - | kg | 3.51E-07 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Pendimethalin | - | - | kg | 1.40E-06 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Quinoxyfen | - | - | kg | 3.51E-07 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Thiacloprid | - | - | kg | 7.02E-07 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Trifloxystrobin | - | - | kg | 1.05E-06 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| emission economic-issue, unspecified | Water, embodied in product, CH | - | - | kg | 9.30E-01 | 1.00E+00 | 1.30E+00 | (4,1,1,1,1,5,BU:1.05); |

**Figure 20: Unit process raw data of asparagus, conventional/CH**

| | |
|---|---|
| Name | asparagus, conventional |
| Location | PE |
| InfrastructureProcess | 0 |
| Unit | kg |
| IncludedProcesses | The inventory includes irrigating, fertilisation, pest and pathogen control, harvesting, mulching and the machines and shed or surface used to park them; all inputs as young plants (seedlings), fertilizers (mineral and organic), growing media, active substances, water for irrigation, fuels end energy as well as the transport to the farm and the direct emissions on the field. |
| LocalName | Spargeln, konventionell |
| Synonyms | |
| GeneralComment | The inventory refers to the average production of 1 kg of conventional asparagus in Peru |
| InfrastructureIncluded | 1 |
| Category | agricultural production |
| SubCategory | plant production |
| LocalCategory | Landwirtschaftliche Produktion |
| LocalSubCategory | Pflanzenbau |
| Formula | |
| StatisticalClassification | |
| CASNumber | |
| StartDate | 2015 |
| EndDate | 2022 |
| DataValidForEntirePeriod | 1 |
| OtherPeriodText | |
| Text | The inventory is modelled for Peru. |
| Text | |
| Percent | |
| ProductionVolume | |
| SamplingProcedure | Based on literature and producer interviews |
| Extrapolations | none |
| UncertaintyAdjustments | none |

**Figure 21: Metadata of asparagus, conventional/PE**

| | Name | Location | Infrastructure Process | Unit | asparagus, conventional | Uncertainty Type | Standard Deviation 95% | General Comment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | PE | | | |
| | Infrastructure Process | | | | 0 | | | |
| | Unit | | | | kg | | | |
| product | asparagus, conventional | PE | 0 | kg | 1.0 | 0 | | |
| resource, biotic | Energy, gross calorific value, in biomass | - | - | MJ | 1.48E+00 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| resource, in air | Carbon dioxide, in air | - | - | kg | 1.39E-01 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| resource, land | Occupation, annual crop | - | - | m2a | 1.45E+00 | 1.00E+00 | 1.34E+00 | (4,1,3,2,1,5,BU:1.1); |
| | Transformation, from annual crop, non-irrigated | - | - | m2 | 1.45E+00 | 1.00E+00 | 1.34E+00 | (4,1,3,2,1,5,BU:1.1); |
| | Transformation, to annual crop, non-irrigated | - | - | m2 | 1.45E+00 | 1.00E+00 | 1.34E+00 | (4,1,3,2,1,5,BU:1.1); |
| resource, in water | Water, unspecified natural origin, PE | - | - | m3 | 1.46E+00 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| technosphere | diesel, burned in agricultural machine | CH | 0 | kg | 9.61E-03 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | poultry manure, dried, at regional storehouse | CH | 0 | kg | 5.72E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,1,1,5,BU:1.05); |
| | vinasse, at fermentation plant | CH | 0 | kg | 7.10E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,1,1,5,BU:1.05); |
| | ammonium nitrate, as N, at regional storehouse | RER | 0 | kg | 9.25E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | phosphoric acid, fertiliser grade, 70% in H2O, at plant | GLO | 0 | kg | 3.51E-02 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | potassium sulphate, as K2O, at regional storehouse | RER | 0 | kg | 2.17E-02 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | magnesium sulphate, at plant | RER | 0 | kg | 3.99E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | calcium nitrate, as N, at regional storehouse | RER | 0 | kg | 1.20E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | boric acid, anhydrous, powder, at plant | RER | 0 | kg | 8.55E-04 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | urea ammonium nitrate, as N, at regional storehouse | RER | 0 | kg | 1.30E-02 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | potassium nitrate, as N, at regional storehouse | RER | 0 | kg | 3.22E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | pesticide unspecified, at regional storehouse | CH | 0 | kg | 1.44E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,1,1,5,BU:1.05); |
| | installation for drip irrigation | CH | 0 | m3 | 1.46E+00 | 1.00E+00 | 3.10E+00 | (4,1,3,2,1,5,BU:3); |
| | asparagus seedling, open field, at production site | GLO | 0 | p | 8.33E-01 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); |
| | electricity, low voltage, production PE, at grid | PE | 0 | kWh | 5.31E-01 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | transport, freight, lorry, fleet average | RER | 0 | tkm | 2.91E-02 | 1.00E+00 | 2.05E+00 | (2,1,1,3,1,5,BU:2); |
| emission air, unspecified | Water, PE | - | - | kg | 6.79E+02 | 1.00E+00 | 1.63E+00 | (4,1,3,2,1,5,BU:1.5); |
| emission air, low population density | Dinitrogen monoxide | - | - | kg | 4.80E-04 | 1.00E+00 | 1.57E+00 | (2,2,2,1,1,5,BU:1.5); |
| | Ammonia | - | - | kg | 1.78E-03 | 1.00E+00 | 1.30E+00 | (2,2,2,1,1,5,BU:1.2); |
| | Carbon dioxide, fossil | - | - | kg | 8.78E-03 | 1.00E+00 | 1.22E+00 | (2,2,2,1,1,5,BU:1.05); |
| | Nitrogen oxides | - | - | kg | 1.01E-04 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, ground- | Nitrate | - | - | kg | 2.36E-02 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| | Phosphorus | - | - | kg | 1.01E-05 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, unspecified | Water, PE | - | - | m3 | 7.85E-01 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| | Cadmium, ion | - | - | kg | 5.65E-10 | 1.00E+00 | 3.09E+00 | (4,1,1,1,1,5,BU:3); |
| | Copper, ion | - | - | kg | 3.91E-07 | 1.00E+00 | 3.09E+00 | (4,1,1,1,1,5,BU:3); |
| | Zinc, ion | - | - | kg | 1.74E-06 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); |
| | Lead | - | - | kg | 1.35E-08 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); |
| | Nickel, ion | - | - | kg | 1.20E-09 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); |
| | Chromium, ion | - | - | kg | 1.45E-06 | 1.00E+00 | 3.09E+00 | (4,1,1,1,1,5,BU:3); |
| | Mercury | - | - | kg | 2.32E-11 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); |
| | Phosphorus | - | - | kg | 1.07E-04 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission soil, agricultural | Nickel | - | - | kg | 4.49E-07 | 1.00E+00 | 1.26E+00 | (2,1,3,1,1,5,BU:1.1); |
| | Mercury | - | - | kg | 9.57E-10 | 1.00E+00 | 1.26E+00 | (2,1,3,1,1,5,BU:1.1); |
| | Chlorpyrifos | - | - | kg | 1.19E-03 | 1.00E+00 | 1.30E+00 | (2,1,2,1,1,5,BU:1.2); |
| | Methomyl | - | - | kg | 2.17E-04 | 1.00E+00 | 1.30E+00 | (2,1,2,1,1,5,BU:1.2); |
| | Sulfur | - | - | kg | 7.25E-06 | 1.00E+00 | 1.57E+00 | (2,1,2,2,1,5,BU:1.5); |
| | Tebuconazole | - | - | kg | 2.54E-05 | 1.00E+00 | 1.30E+00 | (2,1,2,1,1,5,BU:1.2); |
| emission economic-issue, unspecified | Water, embodied in product, PE | - | - | kg | 9.30E-01 | 1.00E+00 | 1.30E+00 | (4,1,1,1,1,5,BU:1.05); |

**Figure 22: Unit process raw data of asparagus, conventional/PE**

| | |
|---|---|
| Name | asparagus, conventional |
| Location | MX |
| InfrastructureProcess | 0 |
| Unit | kg |
| IncludedProcesses | The inventory includes irrigating, fertilisation, pest and pathogen control, harvesting; mulching and the machines and shed or surface used to park them; all inputs as young plants (seedlings), fertilizers (mineral and organic), growing media, active substances, water for irrigation, fuels end energy as well as the transport to the farm and the direct field emissions. |
| Amount | 1 |
| LocalName | Spargeln, konventionell |
| Synonyms | |
| GeneralComment | The inventory refers to the average production of 1 kg of conventional asparagus in Mexico. |
| InfrastructureIncluded | 1 |
| Category | agricultural production |
| SubCategory | plant production |
| LocalCategory | Landwirtschaftliche Produktion |
| LocalSubCategory | Pflanzenbau |
| Formula | |
| StatisticalClassification | |
| CASNumber | |
| StartDate | 2015 |
| EndDate | 2022 |
| DataValidForEntirePeriod | 1 |
| OtherPeriodText | |
| Text | The inventory is modelled for Mexico. |
| Text | |
| Percent | |
| ProductionVolume | |
| SamplingProcedure | Based on literature and producer interviews |
| Extrapolations | none |
| UncertaintyAdjustments | none |

**Figure 23: Metadata of asparagus, conventional/MX**

| | Name | Location | Infrastructure Process | Unit | asparagus, conventional | Uncertainty Type | Standard Deviation 95% | General Comment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | MX | | | |
| | Infrastructure Process | | | | 0 | | | |
| | Unit | | | | kg | | | |
| product | asparagus, conventional | MX | 0 | kg | 1.0 | 0 | | |
| resource, biotic | Energy, gross calorific value, in biomass | - | - | MJ | 1.67E+00 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| resource, in air | Carbon dioxide, in air | - | - | kg | 1.39E-01 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| resource, land | Occupation, annual crop | - | - | m2a | 1.61E+00 | 1.00E+00 | 1.34E+00 | (4,1,3,2,1,5,BU:1.1); |
| resource, in water | Water, unspecified natural origin, MX | - | - | m3 | 1.63E+00 | 1.00E+00 | 1.32E+00 | (4,1,3,2,1,5,BU:1.05); |
| resource, land | Transformation, from annual crop, non-irrigated | - | - | m2 | 1.61E+00 | 1.00E+00 | 1.34E+00 | (4,1,3,2,1,5,BU:1.1); |
| | Transformation, to annual crop, non-irrigated | - | - | m2 | 1.61E+00 | 1.00E+00 | 1.34E+00 | (4,1,3,2,1,5,BU:1.1); |
| technosphere | diesel, burned in agricultural machine | CH | 0 | kg | 1.03E-02 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | poultry manure, dried, at regional storehouse | CH | 0 | kg | 1.10E-02 | 1.00E+00 | 1.22E+00 | (2,1,2,1,1,5,BU:1.05); |
| | vinasse, at fermentation plant | CH | 0 | kg | 5.50E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,1,1,5,BU:1.05); |
| | ammonium nitrate, as N, at regional storehouse | RER | 0 | kg | 81.5/6200 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | phosphoric acid, fertiliser grade, 70% in H2O, at plant | GLO | 0 | kg | 3.90E-02 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | potassium sulphate, as K2O, at regional storehouse | RER | 0 | kg | 1.89E-02 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | magnesium sulphate, at plant | RER | 0 | kg | 4.45E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | calcium nitrate, as N, at regional storehouse | RER | 0 | kg | 1.48E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | boric acid, anhydrous, powder, at plant | RER | 0 | kg | 1.38E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | urea ammonium nitrate, as N, at regional storehouse | RER | 0 | kg | 1.01E-02 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | potassium nitrate, as N, at regional storehouse | RER | 0 | kg | 5.92E-03 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | pesticide unspecified, at regional storehouse | CH | 0 | kg | 9.92E-04 | 1.00E+00 | 1.22E+00 | (2,1,2,3,1,5,BU:1.05); |
| | installation for drip irrigation | CH | 0 | m3 | 1.63E+00 | 1.00E+00 | 3.10E+00 | (4,1,3,2,1,5,BU:3); |
| | asparagus seedling, open field, at production site | GLO | 0 | p | 9.27E-01 | 1.00E+00 | 1.69E+00 | (4,4,4,2,4,5,BU:1.05); |
| | electricity, low voltage, production MX, at grid | MX | 0 | kWh | 5.51E-01 | 1.00E+00 | 1.22E+00 | (2,1,1,3,1,5,BU:1.05); |
| | transport, freight, lorry, fleet average | RER | 0 | tkm | 7.17E-02 | 1.00E+00 | 2.05E+00 | (2,1,1,3,1,5,BU:2); |
| emission air, unspecified | Water, MX | - | - | kg | 7.56E+02 | 1.00E+00 | 1.63E+00 | (4,1,3,2,1,5,BU:1.5); |
| emission air, low population density | Dinitrogen monoxide | - | - | kg | 5.63E-04 | 1.00E+00 | 1.57E+00 | (2,2,2,1,1,5,BU:1.5); |
| | Ammonia | - | - | kg | 1.79E-03 | 1.00E+00 | 1.30E+00 | (2,2,2,1,1,5,BU:1.2); |
| | Carbon dioxide, fossil | - | - | kg | 6.82E-03 | 1.00E+00 | 1.22E+00 | (2,2,2,1,1,5,BU:1.05); |
| | Nitrogen oxides | - | - | kg | 1.18E-04 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, ground- | Nitrate | - | - | kg | 2.82E-02 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| | Phosphorus | - | - | kg | 1.13E-05 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, unspecified | Water, MX | - | - | m3 | 8.72E-01 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission water, river | Cadmium, ion | - | - | kg | 6.13E-09 | 1.00E+00 | 3.09E+00 | (4,1,1,1,1,5,BU:3); |
| | Copper, ion | - | - | kg | 4.35E-07 | 1.00E+00 | 3.09E+00 | (4,1,1,1,1,5,BU:3); |
| | Zinc, ion | - | - | kg | 2.26E-06 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); |
| | Lead | - | - | kg | 1.52E-08 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); |
| | Nickel, ion | - | - | kg | 1.42E-09 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); |
| | Chromium, ion | - | - | kg | 2.58E-06 | 1.00E+00 | 3.09E+00 | (4,1,1,1,1,5,BU:3); |
| | Mercury | - | - | kg | 3.06E-11 | 1.00E+00 | 5.10E+00 | (4,1,1,1,1,5,BU:5); |
| | Phosphorus | - | - | kg | 1.21E-04 | 1.00E+00 | 1.62E+00 | (4,1,1,1,1,5,BU:1.5); |
| emission soil, agricultural | Cadmium | - | - | kg | 3.06E-07 | 1.00E+00 | 1.26E+00 | (2,1,3,1,1,5,BU:1.1); |
| | Nickel | - | - | kg | 7.58E-07 | 1.00E+00 | 1.26E+00 | (2,1,3,1,1,5,BU:1.1); |
| | Mercury | - | - | kg | 1.34E-09 | 1.00E+00 | 1.26E+00 | (2,1,3,1,1,5,BU:1.1); |
| | Boscalid | - | - | kg | 8.06E-06 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Flonicamid | - | - | kg | 1.61E-06 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Fludioxonil | - | - | kg | 4.03E-06 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Imidacloprid | - | - | kg | 4.03E-06 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Metalaxyl-M | - | - | kg | 4.03E-06 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| | Glyphosate | - | - | kg | 1.33E-04 | 1.00E+00 | 1.30E+00 | (2,1,2,3,1,5,BU:1.2); |
| emission economic-issue, unspecified | Water, embodied in product, MX | - | - | kg | 9.30E-01 | 1.00E+00 | 1.30E+00 | (4,1,1,1,1,5,BU:1.05); |

**Figure 24: Unit process raw data of asparagus, conventional/MX**

# A5 Review report

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## External review

# LCA of strawberry and asparagus production

## Bundesamt für Umwelt BAFU

Zürich, 26.08.2022

**Content:** External Review of the "Life cycle assessment of strawberry and asparagus production", carried out by Carbotech AG and commissioned by the Bundesamt für Umwelt BAFU

**Date:** 26.08.2022

**Reviewer:** Andy Eigenmann
Project Manager Consulting and Solutions
+41 (0)44 500 43 50
andy.eigenmann@myclimate.org

**Client:** Bundesamt für Umwelt BAFU
Mr. Pierryves Padey
Papiermühlestrasse 172
3003 Bern

**Foundation myclimate**
Pfingstweidstrasse 10
8005 Zürich, Switzerland
T +41 44 500 43 50
info@myclimate.org
www.myclimate.org

# Content

# 1 Background

The Bundesamt für Umwelt BAFU has commissioned Carbotech AG to generate the inventory data and life cycle assessment calculations of strawberries and asparagus. So far, the existing inventories of tomatoes and beans were often used as examples from the agricultural and food sector. Now, these are to be expanded by other products in the field of vegetables and fruits, to further raise the awareness of customer decisions and their impact on the environment.

# 2 Reviewed content

The validation is based on the following data, provided by Thomas Kägi of Carbotech AG:

- Final version of the report “Life cycle assessment of strawberry and asparagus production” from the 14th August 2022.
- All main and auxiliary inventories newly created and used for the study.

# 3 Guidelines

The validation of the study at hand is guided by the reference provided in ecoinvent report No.1 “Overview and Methodology”[1], especially the review principles listed in chapter 9.4:

**Completeness of the documentation.** All investigated datasets should be described in the report, and all necessary meta information and flow data should be available for each dataset.

**Consistency with the quality guidelines.** It is checked whether the unit processes have been modelled according to the ecoinvent quality guidelines. The quality guidelines cover for example the estimation of transport or the calculation of energy demands in the inventory

**Plausibility check of the life cycle inventory data.** Selected input and output flows are controlled for plausibility.

**Completeness of inputs and outputs.** The completeness of flows is based on the environmental and technical knowledge of the reviewing person. Reviewers are not necessarily technical experts of the processes reviewed. If necessary they were supported by the person responsible for the report.

**Mathematical correctness of calculations.** Selected inputs and outputs are controlled in view of mathematical correctness, e.g. the transport service inputs, the waste heat or $CO_2$ emissions.

Furthermore, it was also verified that the study complies with the international standards for life cycle assessments (ISO 14040 and 14044).

[1] Frischknecht, R., & Jungbluth, N. (2007). Overview and Methodology. Data v2.0. ecoinvent report no. 1. Dübendorf: Swiss Centre for Life Cycle Inventories.

# 4 Review

## 4.1 Completeness of the documentation

The present study report is very detailed and well documented. The background of the study, as well as the goal and scope are clearly described. A summary of all considered variants of strawberries and asparagus is already provided at the beginning, which simplifies the overview.

The functional unit used, and the system boundaries of the study are described in an understandable way.

All inventories newly created for the study are listed and described. The description itself is very detailed and lists all the data used and their sources in detail. In addition, other data sources that were used for plausibility checks are listed and the differences to the data used in the study are explained. On the one hand, this provides a very good overview, and on the other hand, it allows the background data of the study to be put into context. Furthermore, the assumptions made by Carbotech to fill data gaps in the inventories are also well documented.

The results of the study are all listed and presented in graphical form, which makes it easy to compare the different product variants. The discussion is going into detail regarding the results, analyzing the different life phases and putting them into context.

**Summary**

In general, the documentation has a very high level of detail. It is comprehensible, transparent and covers all areas of the study. It therefore meets the criterion of completeness.

## 4.2 Consistency with the quality guidelines

The quality guidelines include the validation of underlying scope and modelling principles, the documentation of elementary flows, dealing with multi-output and allocation rules, and uncertainty considerations.

The underlying scope was appropriately chosen for this study. The geographical focus lies on the one hand on a cultivation in Switzerland, and on the other hand on various other traditional growing countries, which allows a good comparison. In the case of the basic data used, attention was paid to using the most up-to-date sources available. When modelling data gaps and uncertainties, comparative values were used if available, or an approach was taken based on real situations or well founded assumptions.

All elementary flows that were newly modelled are noted in the study report. The division into the different categories and subcategories was also carried out correctly. If changes were made to elementary flows in existing inventories, this is also documented in the report and is therefore traceable.

Multi-output processes are not present in this study and no allocations had to be made.

As in most cases only one source was available for the data for newly compiled inventories, which contained only single or average values, no detailed uncertainty calculation could be carried out. Therefore, an uncertainty assessment was carried out using the Pedigree matrix, which is in accordance with the quality guideline.

**Summary**

The study was conducted in accordance with the four areas of the ecoinvent quality guideline, and thus meets these criteria.

## 4.3 Plausibility check of the life cycle inventory data

On the one hand, the plausibility of the data was checked in a joint meeting with the authors. The data used were checked, while additional detailed information was provided by the authors. A first verification of the inventories and results could already be done.

On the other hand, an in-depth review of the data sets was carried out after this meeting, in combination with the report. Thereby, the inputs and outputs were checked on a sample basis and compared with other sources.

**Summary**

No inconsistencies or serious deviations were identified during the review. The available data are plausible and well founded. The criterion of plausibility is therefore met.

## 4.4 Completeness of inputs and outputs

The inputs and outputs of the present study have a high degree of completeness. Especially the highly relevant areas, such as pesticide use in non-European countries, have been included in detail. Inputs and outputs in the cultivation phase are generally extensively covered, which is very relevant due to the importance of this phase.

The flows in the other life phases are also well modelled. The use of materials in infrastructure and packaging, their disposal and the various transport processes were fully covered.

**Summary**

All relevant inputs and outputs were recorded in full and included in this study. The validation criterion of completeness of inputs and outputs is therefore fulfilled.

## 4.5 Mathematical correctness of calculations

During the plausibility check on site together with the authors, an initial review of the calculations was also carried out. This was followed by a second, more detailed examination of the underlying values and formulas. During this, all calculations could be verified, with no errors present and the modelling set up being correct.

**Summary**

The mathematical basis of the present study is correct, and the criterion is therefore fulfilled.

# 5 Conclusion from the reviewer

The present study fully complies with all criteria of the ecoinvent guideline, as well as the ISO standards 14040/44. It has a high level of detail, especially in the very relevant phase of cultivation. Moreover, it was carefully carried out and well documented.

During the review, the reviewer was provided with all necessary data and documents, and all questions and uncertainties were immediately considered and discussed.

The reviewer therefore expects that the inventories created can be included in the database.

Zürich, 26.08.2022

Andy Eigenmann