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Life cycle assessment of tomatoes and green beans production

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Life cycle assessment of tomatoes and green beans production

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1 Introduction

Within the framework of the sustainable development strategy, the FOEN has the mandate to provide qualitatively good and transparent basic data and assessment methods for life cycle assessments. In order to explain how the environmental impact of products is calculated in life cycle assessments and in particular with the ecological scarcity method (ecopoint-method[1]), the FOEN uses two examples from the agricultural and food sector: tomatoes and beans. These examples clearly show the influence of the different types of production and transport as well as the different forms of packaging. The data and results of the examples are based on two older studies from Carbotech AG (Study by Carbotech AG from 2005 on the environmental impact of tomato production; Carbotech AG study from 2011 on the environmental impact of bean production).

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

Key inventories	**Variants**	**Transportation**
tomato, tunnel, unheated CH	-	lorry
tomato, heated greenhouse, early harvest, CH	natural gas and waste heat for heating	lorry
tomato, heated greenhouse, late harvest, CH		lorry
tomato, organic, tunnel, unheated CH	-	lorry
tomato, greenhouse, unheated, Almeria ES	incl. desalinated water	lorry
green beans, Kenya		air freight
green beans, CH	fresh, frozen, dried, canned	lorry
green beans, organic, CH		lorry

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:

[1] In German: Methode der ökologischen Knappheit (UBP-Methode)

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

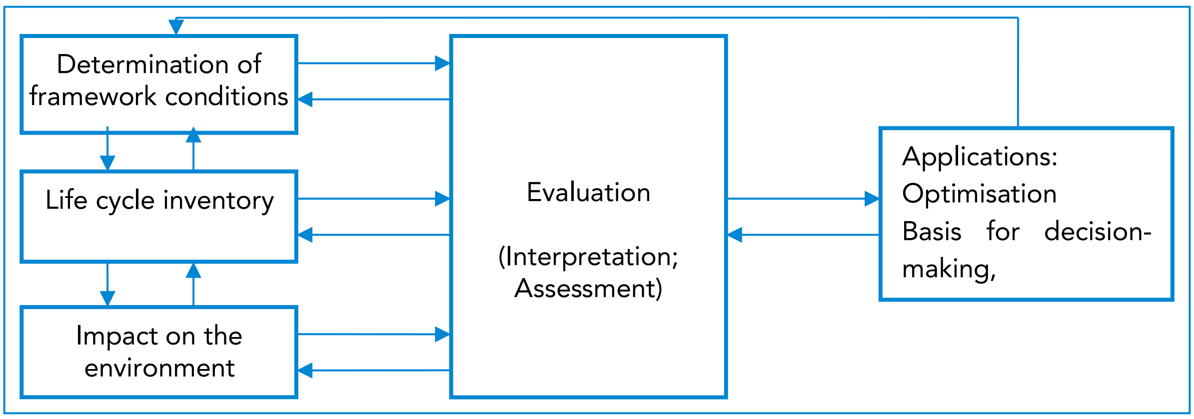

Figure 1: Steps of a life cycle assessment according to ISO 14040/44

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 tomato cultivation or green bean variant is preferable from an ecological point of view. Furthermore, an important goal is to provide life cycle inventories for tomato and green beans production. In particular, the following goals should be considered:

- Analysis and comparison of the environmental impact of tomato cultivation in Switzerland and Almeria, Spain.
- Analysis and comparison of the environmental impact of ready-to-eat green beans cultivated and processed in Switzerland or Kenya

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 tomato variants, the following functional unit was defined:
1kg of fresh tomato, delivered to a generic store in Switzerland.

For the analysis and comparison of the green beans variants, the following functional unit was defined:
1kg of green beans, ready-to-eat in Swiss household.

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 (R. Frischknecht u. a., 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 chapters 4 to 7).
- 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 tomato and green beans 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.

In the case of green beans, the further processing and the use phase (cooking by the consumers) was taken into account.

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 and 3):

- Provision of auxiliary materials and production of tomatoes and green beans
- Transport of raw materials and auxiliary materials, tomatoes and green beans
- 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:

- Transportation from store to consumer
- Losses during transportation or in the case of green beans during cooking at home

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.

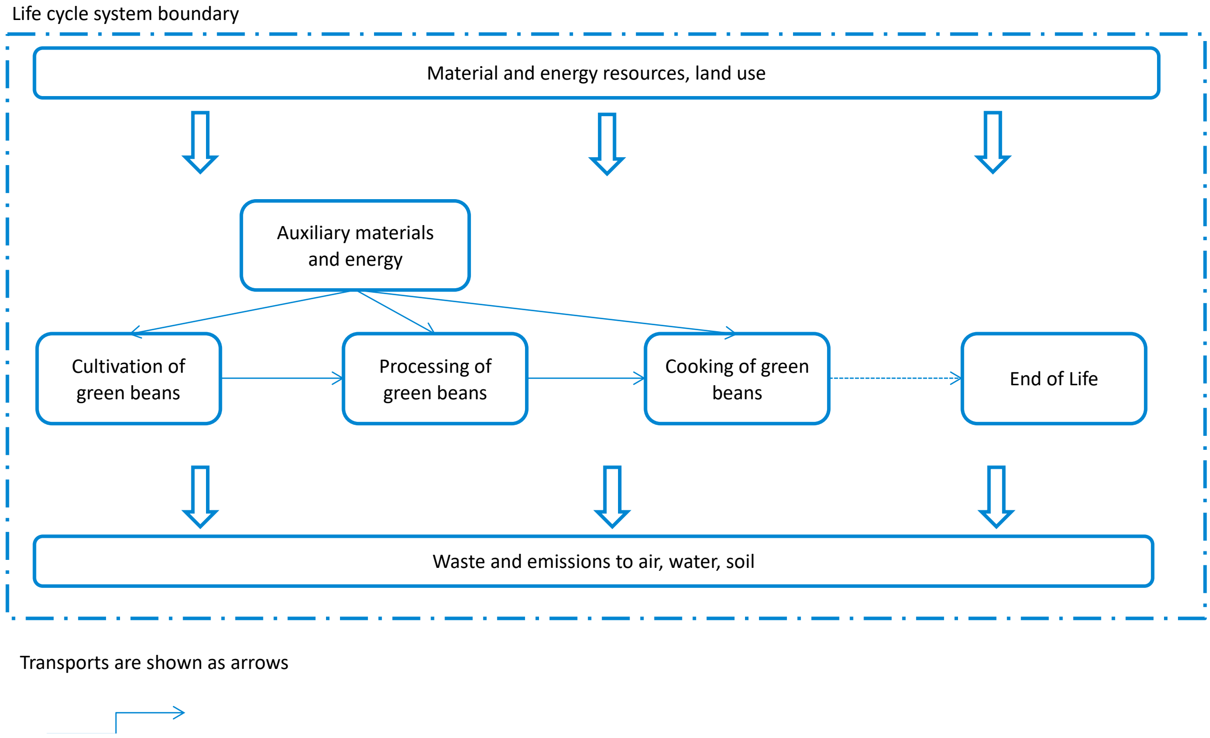

Figure 2: Schematic representation of the processes considered for green beans

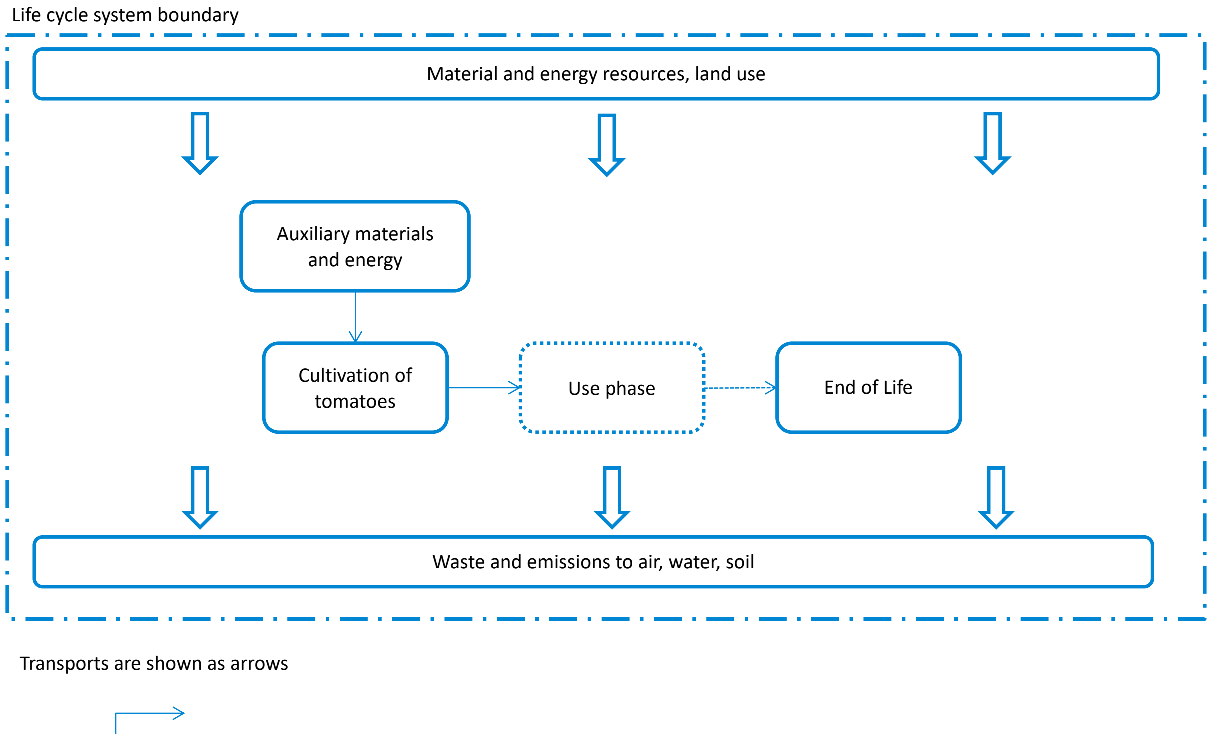

Figure 3: Schematic representation of the processes considered for tomato

2.4 Life Cycle Inventories

The report contains information on tomatoes and green beans 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:

Infrastructure

- Greenhouse, glass walls and roof, metal tubes/CH
- Plastic tunnel/CH
- Plastic tunnel/ES

Auxiliary materials and processing

- Average mineral fertiliser, as K_2O, at regional storehouse/RER
- Average mineral fertiliser, as N, at regional storehouse/RER
- Average mineral fertiliser, as P_2O_5, at regional storehouse/RER
- Irrigation, sprinkler/CH
- Tap water, desalinated sea water/ES
- Tomato seedling
- Canning of food/CH
- Drying, by vacuum rotary, per 1kg water/CH
- Deep-freezing of food/CH

Tomato cultivation

- Tomato, organic, unheated plastic tunnel/CH
- Tomato, hors-sol, heated greenhouse, early harvest/CH
- Tomato, hors-sol, heated greenhouse, late harvest/CH
- Tomato, conventional, unheated plastic tunnel/ES

Green beans cultivation

- Green beans, IP, at farm/CH
- Green beans, organic, at farm/CH
- Green beans, conventional, at farm/KE

2.4.1 Infrastructure

There are various greenhouses and tunnel systems. In this study, we focused on a modern glass greenhouse that is commonly used in Switzerland. For Spain, we looked at the Almeria tunnel type, which is a combination of steel beams and plastic film.

2.4.1.1 Greenhouse, glass walls and roof, production

It was not possible to obtain greenhouse manufacturer data directly. Information from the literature varies considerably with regard to material requirements (see table 1). Due to the high level of detail in the data collection, the greenhouse with glass walls and roof as reported in the Agribalyse 3.0 database (Koch & Salou 2015) was used. For the detailed greenhouse composition see Annex A1.

Table 1: Key data for greenhouse, glass walls and roof

Inputs	Unit			
Source		(Koch & Salou, 2015), considered	(Torres Pineda u. a., 2020), not considered	(Theurl u. a., 2014), not considered
Lifespan	Years	30	50	30
Steel	t/(ha*a)	5.1	0.9	5.5
Concrete	m3/(ha*a)	3.7	1.46	11
Glass	t/(ha*a)	4.8	1.3	6.7
Plastics	t/(ha*a)	0.04	0.01	0.6

2.4.1.2 Plastic tunnel, production

It was not possible to obtain plastic tunnel manufacturer data directly. The production in Spain is characterized by multi-tunnel houses employing a solid steel construction, concrete blocks, and plastic cover. We used data from Pérez Neira et al. (2018) who reported data for the typical multi-tunnel system used in Spain. Typical plastic tunnels in Switzerland have a light steel construction and two plastic layers. We used data from Theurl et al. (2014) who reported data for the typical unheated tunnel system used in Austria which is comparable to the Swiss case. However, the tunnel system in the study by Theurl et al. (2014) only has one plastic layer. Therefore, we doubled the value for plastics input in order to reflect the two plastic layers commonly used in Switzerland. For the detailed greenhouse composition see Annex A1.

Table 2: Key data for plastic tunnels

Inputs	Unit	Plastic tunnel CH	Multi-Tunnel ES		
Source		(Theurl u. a., 2014), considered	(Pérez Neira u. a., 2018), considered	(Theurl u. a., 2014), not considered	(Torrellas u. a., 2012), not considered
Type of tunnel		half-round tunnel with two plastic layers	solid steel construction, concrete blocks, and plastic cover	solid steel construction, concrete blocks, and plastic cover	solid steel construction, concrete blocks, and plastic cover
Lifespan	a	20 for steel, 7 for most plastics	20 for steel and concrete, 3 for most plastics	unclear	15 for steel and concrete, 3 for most plastics
Steel	t/(ha*a)	0.78	4.1	4.6	5.1
Plastics	t/(ha*a)	0.82 (2 * 0.41 due to double layer)	2.9	2.6	2.8
Concrete	t/(ha*a)		14.3	6.4	9.7

2.4.2 Auxiliary Inventories

2.4.2.1 Average fertilisers

Especially in the case of N and P fertilisers, the types of fertiliser can vary depending on the producer. In order to be able to better depict the average fertiliser composition, average N, P and K fertiliser inventories were compiled on the basis of Agribalyse 3.0 databbase (Koch & Salou 2015).

Table 3: Composition of average N-fertiliser (per kg, according to Koch & Salou, 2015)

Substance	Urea	Ammonium Sulphate	Diammonium Phosphate	Ammonium nitrate phosphate	Monoammonium phosphate
Input (kg per kg N-Fertiliser)	0.236	0.058	0.025	0.645	0.009

Table 4: Composition of average P_2O_5-fertiliser (per kg, according to Koch & Salou, 2015)

Substance	Triple Superphosphate	Single Superphosphate	Diammonium Phosphate	Ammonium nitrate phosphate
Input (kg per kg P_2O_5-Fertiliser)	0.411	0.044	0.261	0.285

Table 5: Composition of average K_2O-fertiliser (per kg, according to Koch & Salou, 2015)

Substance	Potassium Chloride	Potassium Sulphate
Input (kg per kg K_2O -Fertiliser)	0.884	0.117

2.4.2.2 Irrigation

So far, there is no irrigation module in the UVEK database. Therefore, we created an irrigation inventory for Swiss conditions (mainly sprinkler). Data for this inventory was mainly based on a FAO example of a hose-move sprinkler irrigation design (FAO, 2007) and own assumptions.

2.4.2.3 Tap water, desalinated

In Spain, especially in Almeria, where most of the tomatoes are cultivated, desalinated water is used to some extent in order to reduce the pressure on the scarce ground water. For the desalination process we used data from Wright & Colling (1989), and adapted it to the Spanish region. The electricity demand of the desalination plant near Almeria is about 4 kWh per m3 of desalinated water (AcuaMed, unknown)

2.4.2.4 Further processing of food

Canning of food

For canning food we used data for blanching (1.38 MJ/kg) and for sterilizing (1.17 MJ/kg) from Zimmermann et al. (2017).

Deep-freezing of food

Blanching (1.38 MJ/kg) and shock-freezing (1.62 MJ/kg) was derived from Zimmermann et al. (2017). Data for storage at freezing temperature were derived from a confidential study (0.92 MJ/kg). A storage time of about 6 months was assumed. Storage at home in a freezer was estimated with 2 month storage time in an average freezer with a yearly energy demand of 1.2 kWh / L (0.72 MJ/kg).

Drying of food

Drying of green beans was assumed to be done in medium sized dryers operated by electricity. For energy consumption we used data from a typical dryer from Bucher AG (Bucher, 2021). The electricity demand is about 0.9 kWh / L water evaporated.

2.4.3 Cultivation inputs and yields

2.4.3.1 Yields

Yields for tomato cultivation in Switzerland were taken from interviews with tomato producers in Switzerland for heated greenhouse production and unheated production in tunnel systems (Tomatenanbau, 2021).
Yields for tomato cultivation in Almeria, Spain, were taken from literature sources. The range of reported yields in Almeria varies from 90 t per ha and year Pérez Neira u. a. (2018) to 140 t per ha and year (Valera u. a., 2017). In this study we used an average yield of 130 t per ha and year as reported in Theurl u. a. (2014).

Yields for green beans cultivation in Switzerland were taken from Zimmermann et al. (2017) for conventional green beans and from FiBL for organic cultivation. Yields for green beans from Kenya were reported in Basset-Mens et al. (2019).

Table 6: Yields for tomato cultivation

	Unit	Tomato, heated greenhouse, CH	Tomato, foil tunnel, unheated, CH	Tomato, organic, foil tunnel, unheated, CH	Tomato, multi-tunnel, unheated, ES
Source		(Tomatenanbau, 2021)	(Tomatenanbau, 2021)	(Tomatenanbau, 2021)	(Theurl u. a., 2014)
Yield	t/(ha*a)	310	200	160	130

Table 7: Yields for green beans cultivation

	Unit	Green beans, CH	Green beans, organic	Green beans, Kenya
Source		Zimmermann et al. 2017	FiBL 1997	Basset-Mens et al. 2019
Yield in kg/ha*a)		9 286	6 500	9 926

2.4.3.2 Material inputs

Tomato

Data for tomato cultivation in heated greenhouse in CH and in unheated foil tunnels were taken from various interviews with tomato producers (Tomatenanbau, 2021).
Data for organic tomato cultivation in Switzerland were taken from Theurl et al. (2014). Since no data on fertiliser usage was available for conventional tomato production in Switzerland, double the amount of fertiliser used in the hors sol production was used and adjusted according to the yield.
Data for tomato cultivation in Almeria, Spain was used from Theurl et al. (2014) for yield and fertiliser inputs. Pesticide inputs were derived from Garcia Martinez (2019). All other inputs are based on Perez-Neira et al. (2018).
Water use per kg of yield was approximated by using Agribalyse 3.0 data for closed and open systems (Koch & Salou, 2015)

Green beans

Data for green beans cultivation were derived from Zimmermann et al. (2017) for IP and from FiBL (1997) for organic cultivation and from Basset-Mens (2019) for the cultivation in Kenya.

Table 8: Material inputs for tomato cultivation

	Unit	Tomato, heated greenhouse, CH	Tomato, foil tunnel, unheated, CH	Tomato, organic, foil tunnel, unheated, CH	Tomato, multi-tunnel, unheated, ES	Used inventory
N-fertiliser	kg N / ha	465	599	0	750	Average N fertiliser, at regional storehouse
P-fertiliser	kg P2O5 / ha	231	298	0	339	Average P2O5 fertiliser, at regional storehouse
K-fertiliser	kg K2O / ha	982	1 270	0	1 410	Average K2O fertiliser, at regional storehouse
Magnesia	kg / ha	173	111	0	0	Magnesia, at plant
Organic fertiliser	kg / ha	0	0	6 860	0	Vinasse, at plant
Green manure	ha	0	0	1	0	Green manure, organic, until April
Pesticides	kg / ha	0.55 12	0.55 12	0	4.15	pesticide unspecified Rape oil as a proxy for oil based products,
Rock wool	kg / ha	0	0	0	146	Rock wool, at plant
Coconut husk	kg / ha	200	0	0	0	Coconut husk, at plant
Water, river/groundwater	m3 / ha	5 770	5 280	4 220	2 010	Water, well or river
Water, desalinated water	m3 / ha	0	0	0	411	Tap water, desalinated
Plastic equipment	kg / ha	520	590	590	172	Polypropylene granulate + extrusion
Steel equipment	kg / ha	844	844	844	369	Steel, low alloyed + section bar rolling

Table 9: Material inputs for green beans cultivation

	Unit	Green beans, CH	Green beans, organic, CH	Green beans, Kenya	Used inventory
N-fertiliser	kg N / ha	0	0	29	Average N fertiliser, at regional storehouse
P-fertiliser	kg P2O5 / ha	10	0	54	Average P2O5 fertiliser
K-fertiliser	kg K2O / ha	30	0	0	Average K2O fertiliser
Organic fertiliser based on waste biomass	kg / ha			15 000	Burden free in production
Green manure	Amount in ha	1	1	0	Green manure, until April
Pesticides	kg / ha	0.442 0.196	0	0	benzo[thia]diazole-compounds, at regional storehouse Diphenylether-compounds, at regional storehouse/
Water	m^3 / ha	300	300	4 000	Water, from nature

2.4.3.3 Energy and machinery use

Tomato

Heat demand for heated greenhouse in Switzerland were simulated by Energie-Agentur der Wirtschaft (2021) for late and early harvest. For early harvest, planting occurs in mid-January, the cultivation period lasts until mid-October. During this time the temperature is 18°C during the day and 16°C at night. For the remaining period it is 5°C during the day and 3°C at night (frost-free). For late harvest, planting occurs in the beginning of March, the cultivation period lasts until mid-October. The temperature values during and after the cultivation period are the same as for the early harvest scenario. Electricity use for heating system was estimated as 1 % of heat demand based on data for heatin systems .

Electricity use for irrigation (ground water pump systems) in Almeria as well as general diesel demand was derived from Perez-Neira et al. (2019). Further electricity use was estimated based on (Kägi u. a., 2021).

Table 10: Energy and machinery use for tomato cultivation

	Unit	Tomato, heated greenhouse, early / late, CH	Tomato, foil tunnel, unheated, CH	Tomato, organic, foil tunnel, unheated, CH	Tomato, multi-tunnel, unheated, ES	Used inventory
Heat for heating	MWh / ha	2 083 / 1 524	0	0	0	Heat, natural gas or heat from waste
Electricity, for heating unit	kWh/ha	20 830 / 15 240	0	0	0	Electricity, low voltage
Electricity for irrigation	kWh/ha	577	528	422	2 210	Electricity, low voltage
Diesel for machinery	MJ/ha				10 200	Diesel, burned in diesel-electric generation set
Ploughing	Amount		1	1		Tillage, ploughing
Harrowing	Amount		1	1		Tillage, harrowing, by spring tine harrow

Table 11: Energy and machinery use for green beans cultivation

	Unit	Green Beans CH	Bohnen Bio	Bohnen Kenya	Used inventory
Currrying	Amount of application	1	1	0	Tillage, currying, by weeder
Harrowing	Amount of application	2	2	0	Tillage, harrowing, by spring tine harrow
Ploughing	Amount of application	1	1	0	Tillage, ploughing
Application of fertiliser	Amount of application	1	1	0	Fertilising, by broadcaster
Sowing	Amount of application	1	1	0	Sowing
Application of pesticides	Amount of application	1		0	Application of plant protection products
Harvesting	Amount of application	1	1	0	Combine harvesting
Irrigation	m^3	300			Irrigation, sprinkler
Diesel for machinery*	MJ			17 600	Diesel, burned in diesel-electric generating set

2.4.4 Direct field emissions

The direct field emissions were calculated according to the methodology described in Nemecek and Schnetzer (2011). Nitrate leaching was calculated according to the SQCB-model.

2.4.4.1 Emissions to air

Table 12: Emissions to air for tomato cultivation

	Unit	Tomato, heated greenhouse, CH	Tomato, foil tunnel, unheated, CH	Tomato, organic, foil tunnel, unheated, CH	Tomato, multi-tunnel, unheated, ES
NH_3 in air	kg NH_3 / ha	16.22	20.9	88.8	26.2
CO_2 in air (from urea)	kg CO_2 / ha	86.15	0	0	0
N_2O in air	kg N_2O / ha	3.78	5.13	0.93	6.02
NO_x in air	kg NO_x / ha	0.79	1.08	0.195	1.26
Water to air	m^3 H_2O / ha	5 430	3 696	2 960	2 149

Table 13: Emissions to air for green bean cultivation

	Unit	Green beans, CH	Green beans, organic, CH	Green beans, Kenya
NH_3 in air	kg NH_3 / ha	0	0	7.4
N_2O in air	kg N_2O / ha	0.87	0.91	3.6
NO_x in air	kg NO_x / ha	0.18	0.19	0.76
Water to air	m^3 H_2O / ha	210	210	2 800

2.4.4.2 Emissions to soil

Table 14: Emissions to soil for tomato cultivation

	Unit	Tomato, heated greenhouse, CH	Tomato, foil tunnel, unheated, CH	Tomato, organic, foil tunnel, unheated, CH	Tomato, multi-tunnel, unheated, ES
Cd to soil	kg / ha	0	0	0	0
Cu to soil	kg / ha	0	0	0	0
Zn to soil	kg / ha	0	0	0	0
Pb to soil	kg / ha	0	0	0	0
Ni to soil	kg / ha	0	0	0	0
Cr to soil	kg / ha	0	0	0	0
Hg to soil	kg / ha	0	0	0	0
Tebuconazole	kg / ha	0.3	0.3	0	0
Trifloxystrobin	kg / ha	0.15	0.15	0	0
Azadirachtin	kg / ha	0.06	0.06	0	0
Oils, biogenic	kg / ha	12	12	0	0
Spinosad	kg / ha	0.04	0.04	0	0
Mancozeb	kg / ha	0	0	0	1.29
Triadimenol	kg / ha	0	0	0	0.41
Kresoxim-metyl	kg / ha	0	0	0	0.05
Sulfur	kg / ha	0	0	0	0.75
Imidacloprid	kg / ha	0	0	0	0.15
Iprodione	kg / ha	0	0	0	0.25
Cymoxanil	kg / ha	0	0	0	0.66

Table 15: Emissions to soil for green bean cultivation

	Unit	Green beans, CH	Green beans, organic, CH	Green beans, Kenya
Cd to soil	kg / ha	4.417E-05	0	2.6E-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	0	0	0
Cr to soil	kg / ha	0	0	0
Hg to soil	kg / ha	0	0	0
Bentazone	kg / ha	0.442	0	0
Fluazifop-P-butyl	kg / ha	0.196	0	0

2.4.4.3 Emissions to water

Table 16: Emissions to water for tomato cultivation

	Unit	Tomato, heated greenhouse, CH	Tomato, foil tunnel, unheated, CH	Tomato, organic, foil tunnel, unheated, CH	Tomato, multi-tunnel, unheated, ES
Nitrate in ground water	kg NO_3 / ha	0	315	302	0
Phosphorus in ground water	kg P / ha	0	0.07	0.07	0
Phosphorus in surface water	kg P / ha	0	0.87	0.74	0
Cd to water	kg / ha	0	4.7E-05	3.2E-5	4.1E-05
Cu to water	kg / ha	0	3.3E-03	3.6E-3	1.2E-03
Zn to water	kg / ha	0	2.4E-02	2.9E-2	6.6E-03
Pb to water	kg / ha	0	2.9E-04	5.6E-4	1.9E-01
Ni to water	kg / ha	0	1.1E-05	1.3E-5	3.1E-06
Cr to water	kg / ha	0	2.0E-02	2.0E-2	1.6E-02
Hg to water	kg / ha	0	0	1.2E-6	1.2E-06
Water to water	m^3 / ha	51.5	1 394	1 120	42.4

Table 17: Emissions to water for green bean cultivation

	Unit	Green beans, CH	Green beans, organic, CH	Green beans, Kenya
Nitrate in ground water	kg NO_3 / ha	113	131	107
Phosphorus in ground water	kg P / ha	0.74	0.74	0.74
Phosphorus in surface water	kg P / ha	0.07	0.07	0.07
Cd to water	kg / ha	2.4E-05	0	4.4E-05
Cu to water	kg / ha	1.7E-03	0	3.6E-03
Zn to water	kg / ha	2.2E-03	0	2.9E-02
Pb to water	kg / ha	1.4E-05	0	5.6E-04
Ni to water	kg / ha	9.4E-07	0	1.4E-05
Cr to water	kg / ha	1.1E-02	0	2.0E-02
Hg to water	kg / ha	0	0	1.2E-06
Water to water	m^3 / ha	81.5	83.8	1 191

2.4.5 Land use

Land use is already included in the greenhouse infrastructure with regard to the tomato cultivation. It corresponds to a little more than 10 000 m^2 per ha and year. Beans grow in the field for about half a year, therefore 5 000 m^2/ha and year are used. The land use of the intercrop (green manure) is included in the corresponding inventory of green manure.

2.4.6 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.

2.4.7 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

- 1800 km by lorry >32t for tomato from Almeria to regional centre in Switzerland and 100 km by lorry 16-32t for distribution to store.
- 150 km by lorry >32t for CH tomato and CH green beans from farm to regional centre in Switzerland and 100 km by lorry 16-32t for distribution to store.
- 6000 km air freight from Kenya to Switerland, 200 km by lorry >32 t in Kenya and Switzerland to regional centre and LKW 100 km by lorry 16-32t for distribution to store.

Cooking of green beans
We assumed a 2 kW cooking plate with the following cooking times:

- Fresh green beans: 10 min full power and 10 min cooking with half power
- Frozen green beans: 10 min full power and 10 min cooking with half power
- Dried green beans: 10 min full power and 25 min cooking with half power + 2 weeks of deep-freeze storage at home (0.2 kWh)
- Canned green beans: 6 min with half power

Packaging
We assumed the following packaging materials for green beans

- Fresh green beans: plastic bag based on 20 g PE foil / kg of product
- Frozen green beans: plastic bag based on 20 g PE foil / kg of product
- Dried green beans: plastic bag based on 20 g PE foil / kg of product
- Canned green beans: 100 g tincan / kg of product

2.4.8 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 (Rolf Frischknecht u. a., 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 4) 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).

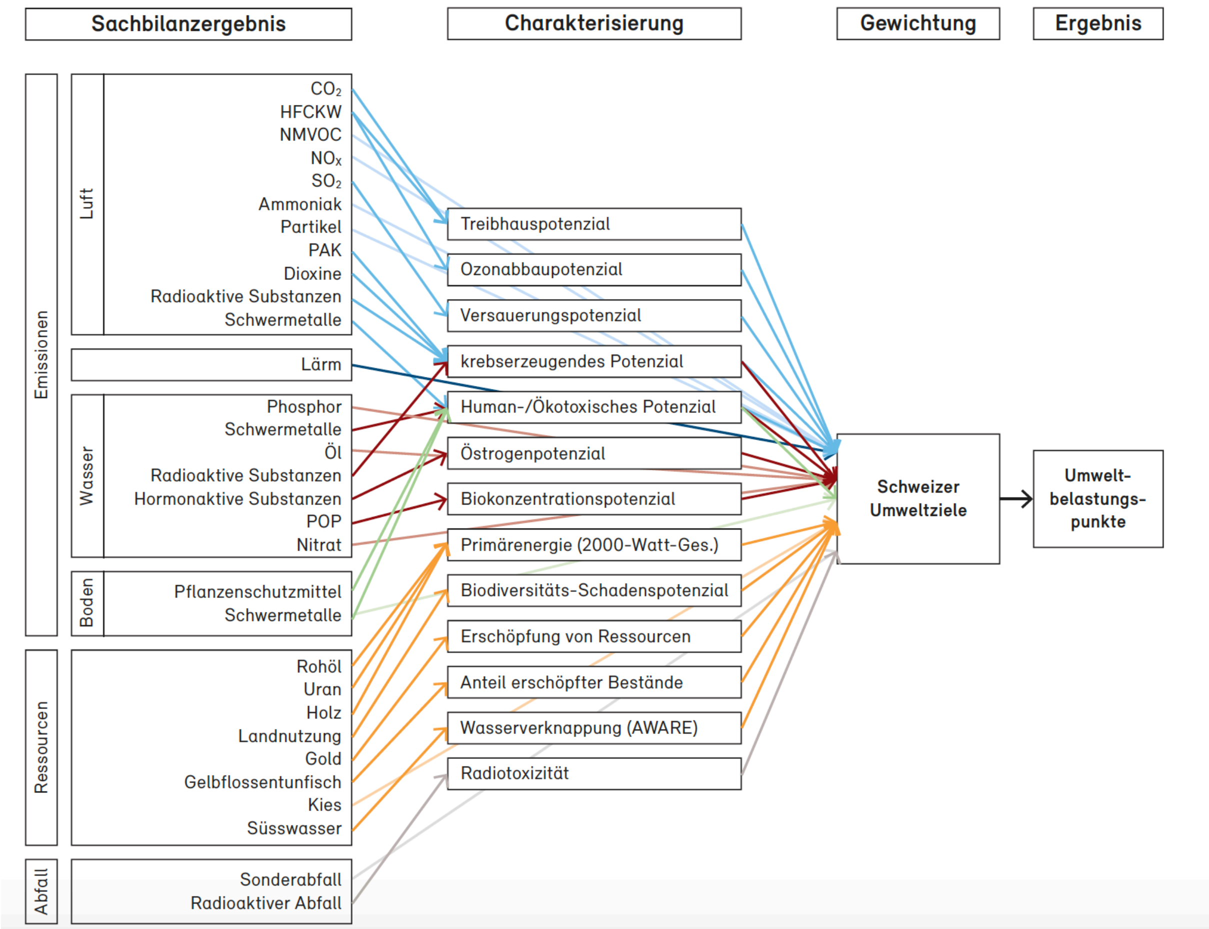

Figure 4: Basic scheme of the ecological scarcity method (graphic from Frischknecht u. a., 2021)

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 unvertainty 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) as well as the environmental footprint according to the EF v3.0 method (see Annex 2) show similar results and draw the same conclusions.

3.1 Results and discussion for tomato, delivered to store

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

Comparison of variants

The lowest environmental footprint is shown by tomatoes in unheated foil tunnels in Switzerland, organic or conventional.

They are followed by tomatoes in a heated greenhouse in Switzerland, if the heat source is based on waste heat. Even though the yields in the heated greenhouse are much higher than in unheated foil tunnels (310 t / ha compared to 160 t / ha to 200 t /ha) and the fertiliser efficiency is higher, the impacts are higher in the greenhouse heated by waste heat due to the greenhouse infrastructure itself.

Unheated greenhouse tomatoes from Almeria have a higher environmental impact than Swiss tomato in unheated foil tunnels or heated greenhouse based on waste heat. The reason is mainly the transportation (1 800 km by lorry) combined with a rather low yield of 130 t / ha and a massive greenhouse infrastructure.

Swiss tomato cultivated in greenhouse heated with natural gas show by far the highest environmental impact due to the fossil energy demand for heating.

Process contribution

Considering heated greenhouse cultivation based on natural gas, the highest share comes from the combustion of natural gas, followed by the infrastructure of the greenhouse itself. All other cultivation processes are of low relevance.

Considering the tomato cultivation in Almeria, transportation and greenhouse infrastructure is most important. Regarding the cultivation itself, it is mainly dominated by fertiliser emissions followed by pesticide applications. Even though water scarcity is very high in Almeria, it becomes obvious that water scarcity is hardly 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.

In Swiss unheated tunnel cultivation fertiliser emissions contribute most to the environmental footprint, followed by the tunnel infrastructure, further cultivation processes and transportation.

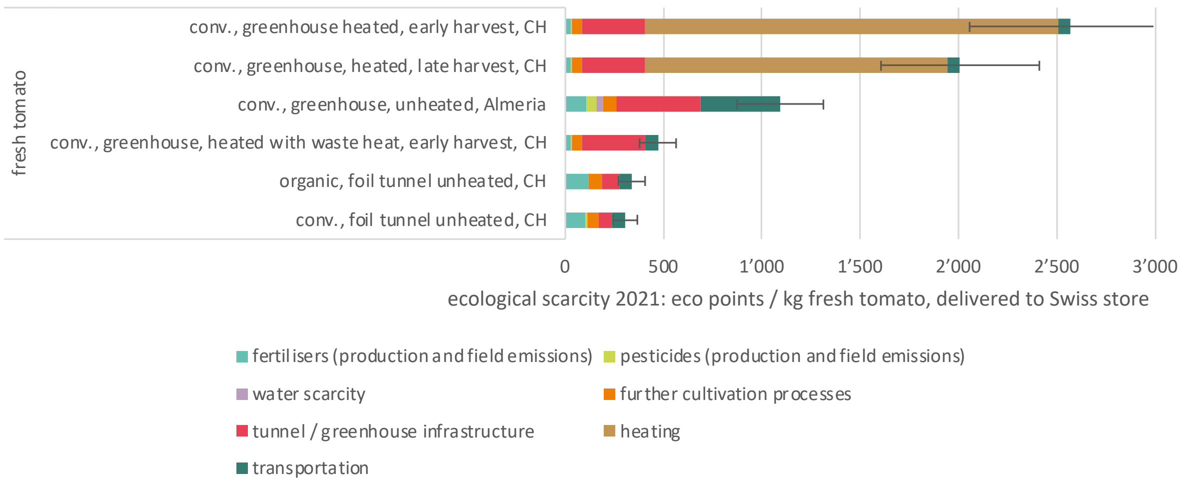

Figure 5: Process contributions to the environmental impact for tomato, distributed to generic Swiss store

Relevant impact categories

Considering tomato production in heated greenhouses the most relevant impact categories are global warming (especially for heated systems due to CO_2-emissions from natural gas combustion) and energy resources.

In unheated production (or heated with waste heat) global warming tends to be the most relevant impact category, but others such as other air emissions, water pollutants and land use show some relevance, too. Emissions to soil (mainly pesticides) show some minor relevance only in tomato produce in Almeria. Also, the water resources are only of minor relevance in Almeria, even though the water scarcity is very high there.

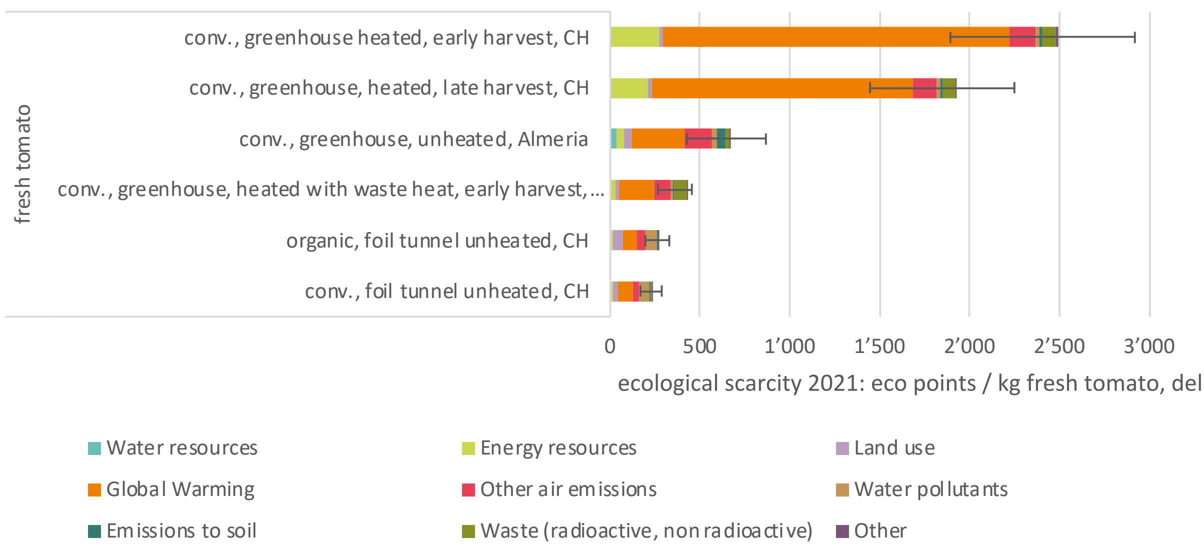

Figure 6: Environmental impact for tomato, distributed to generic Swiss store

3.2 Results and discussion for green beans, ready for consumption

Figure 6 shows the environmental footprint of the different green bean variants.

Comparison of variants
The lowest environmental footprint is shown by fresh green beans from Swiss production. The somewhat higher footprint of the organic green beans is not significant.

Processed green beans show a higher environmental footprint than fresh green beans. Within the processed variants, dried green beans show a slightly lower footprint than canned or frozen green beans.

The highest environmental footprint is shown by fresh green beans from Kenya, which are imported by air freight.

Process contribution
Considering Swiss green beans, cultivation contributes most to the environmental footprint, followed by the processing and cooking steps. Packaging is only relevant in the case of canned green beans.

With regard to green beans from Kenya, the footprint is dominated by air freight.

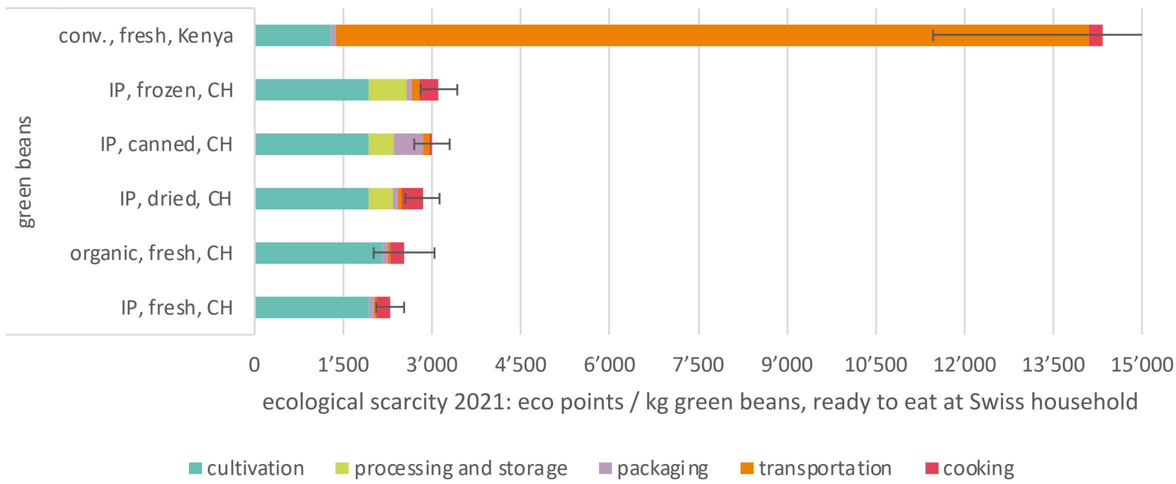

Figure 7: Process contributions to the environmental impact for green beans, ready-to-eat at Swiss household

Relevant impact categories
Considering green beans produced in Switzerland the most relevant impact categories are water pollutants (nitrate leaching), global warming and land use. Other impacts such as waste (radioactive and non-radioactive), other air emissions, emissions to soil (mainly pesticides and heavy metals) and resource use are of lower relevance.
Regarding green beans from Kenya global warming is the most dominant impact category followed by other air emissions (both due to emissions from air freight). All other impact categories show similar relevance as for Swiss production.

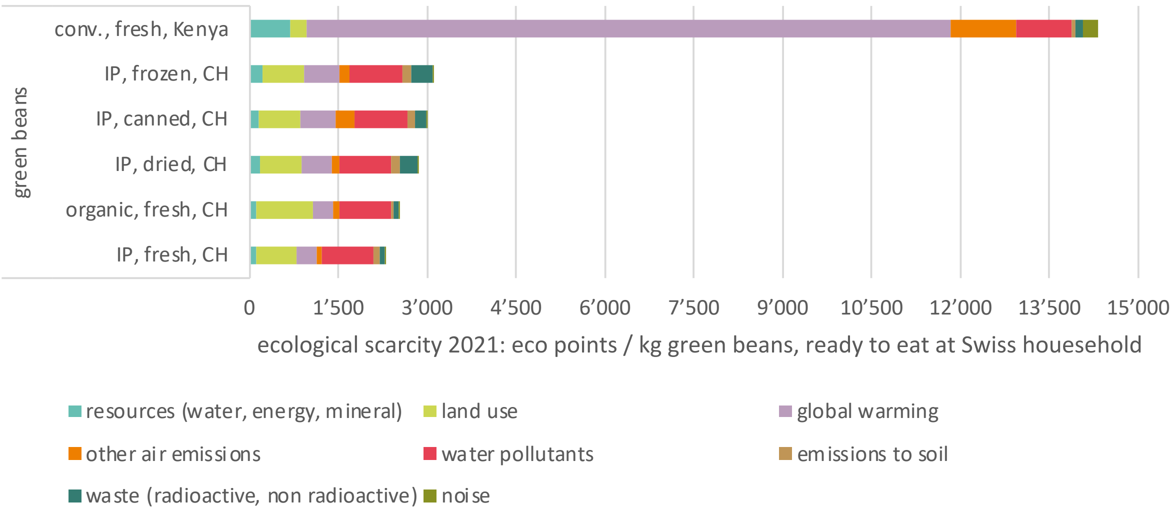

Figure 8: Environmental impact for green beans, ready-to-eat at Swiss household

4 Conclusion

The updated LCA again shows a similar picture to the earlier studies. Fresh, seasonal and domestic tomatoes or beans are preferable to other variants, but only if not grown in greenhouses using fossil heating energy.

For both tomatoes and green beans, the cultivation process has by far the most relevant environmental impact compared to transport, packaging and processing (except if transported by air freight).

Within tomato cultivation the differences of cultivation impacts are much larger than for green beans, with heating demand and greenhouse structures having the biggest impact, followed by fertiliser production and emissions.

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.

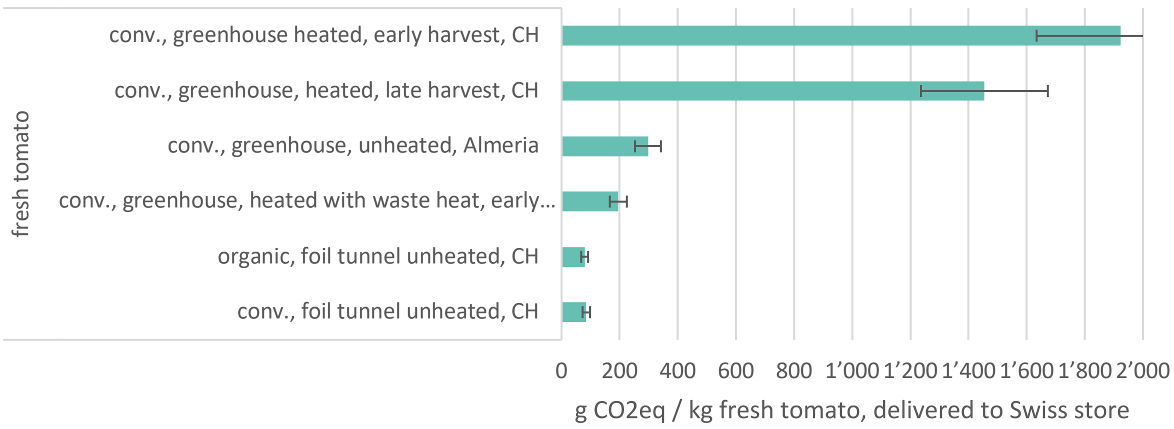

Figure 9: carbon footprint for tomato, delivered to Swiss store

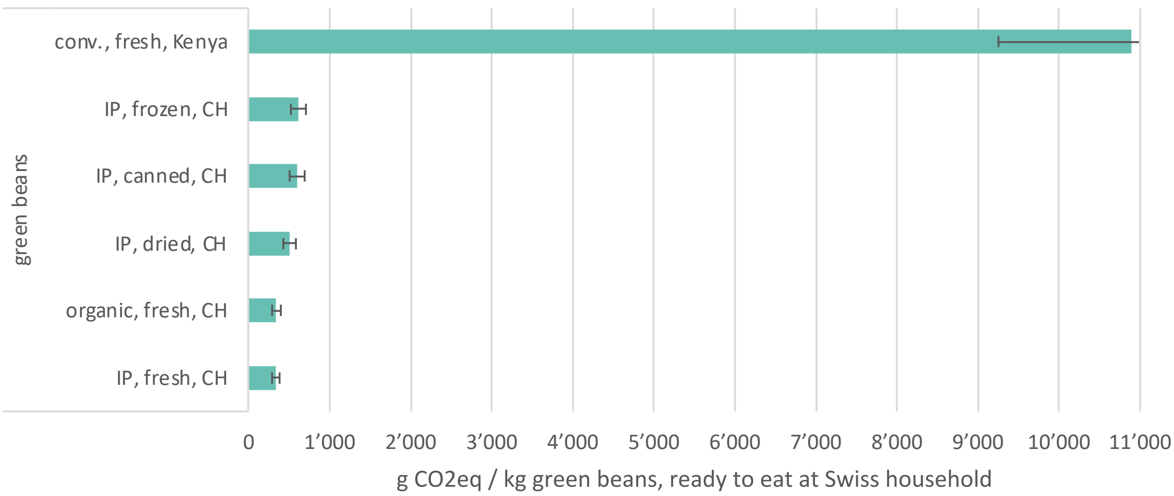

Figure 10: carbon footprint for green beans, ready-to-eat at Swiss household

A2 EF v3.0 method

The environmental footprint according to the EF v3.0 methods correlates with the environmental footprint based on the ecological scarcity method.

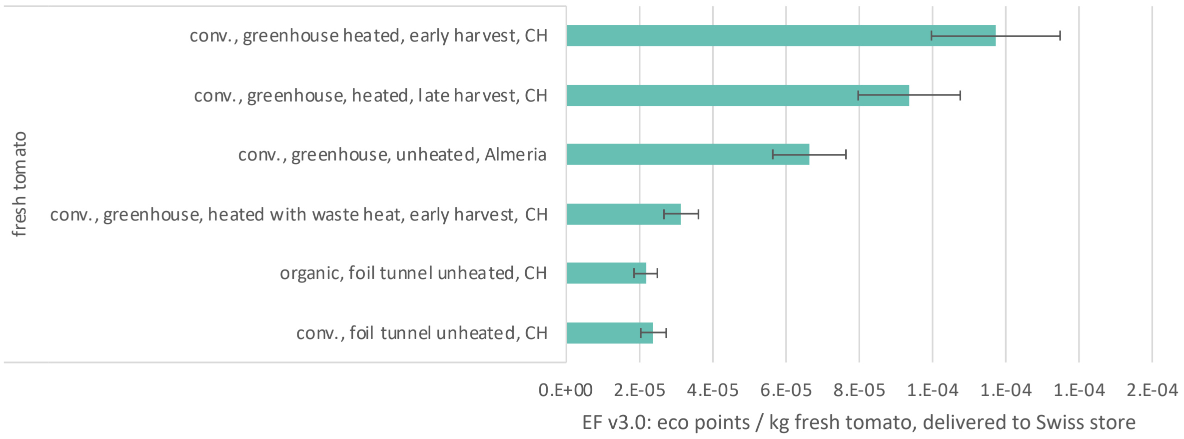

Figure 11: environmental footprint according to EF v3.0 for tomato, delivered to Swiss store

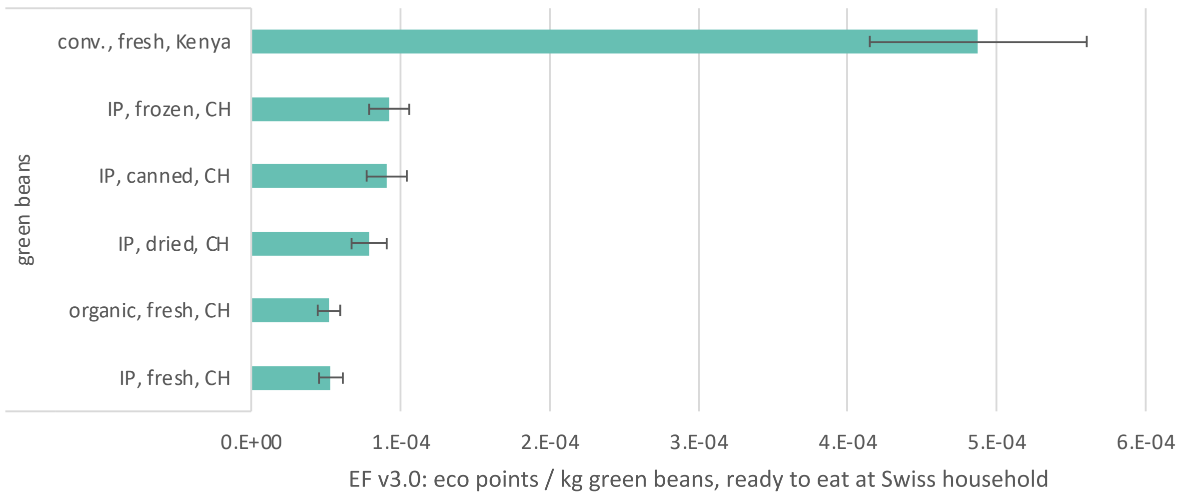

Figure 12: environmental footprint according to EF v3.0 for green beans, ready-to-eat at Swiss household

A3 Table with results

Table 18: Results for green beans calculated with ecological scarcity 2021

eco points / kg green beans, ready to eat at Swiss household	IP, fresh, CH	organic, fresh, CH	IP, dried, CH	IP, canned, CH	IP, frozen, CH	conv., fresh, Kenya
cultivation	1922	2159	1922	1922	1922	1286
processing and storage	0	0	423	432	651	0
packaging	82	82	82	500	82	82
transportation	50	50	55	99	119	12719
cooking	238	238	356	48	333	238
Total	2292	2528	2839	3002	3108	14325

Table 19: Results for tomato calculated with ecological scarcity 2021

	fresh tomato					
eco points / kg tomato, delivered to swiss store	conv., foil tunnel unheated, CH	organic, foil tunnel unheated, CH	conv., greenhouse, heated with waste heat, early harvest, CH	conv., greenhouse, unheated, Almeria	conv., greenhouse, heated, late harvest, CH	conv., greenhouse heated, early harvest, CH
fertilisers (production and field emissions)	103	117	31	110	31	31
pesticides (production and field emissions)	9	0	6	48	6	6
water scarcity	0	0	0	36	0	0
further cultivation processes	56	68	51	67	51	51
tunnel / greenhouse infrastructure	72	90	320	426	320	320
heating	0	0	0	0	1536	2099
transportation	64	64	64	407	64	64
total	304	339	472	1096	2008	2571

Table 20: Carbon footprint of green beans

g CO2eq / kg green beans, ready to eat at Swiss household	IP, fresh, CH	organic, fresh, CH	IP, dried, CH	IP, canned, CH	IP, frozen, CH	conv., fresh, Kenya
Total	334	340	510	595	613	334

Table 21: Carbon footprint of tomato

	fresh tomato					
g CO2eq / kg tomato, delivered to swiss store	conv., foil tunnel unheated, CH	organic, foil tunnel unheated, CH	conv., greenhouse, heated with waste heat, early harvest, CH	conv., greenhouse, unheated, Almeria	conv., greenhouse, heated, late harvest, CH	conv., greenhouse heated, early harvest, CH
total	85	79	195	297	1’455	1’922

Table 22: Results for green beans calculated with EF v3.0

Eco points / kg green beans, ready to eat at Swiss household	IP, fresh, CH	organic, fresh, CH	IP, dried, CH	IP, canned, CH	IP, frozen, CH	conv., fresh, Kenya
Total	5.30E-05	5.16E-05	7.85E-05	9.06E-05	9.23E-05	4.88E-04
Climate change	9.09E-06	9.23E-06	1.37E-05	1.59E-05	1.65E-05	2.04E-04
Ozone depletion	1.90E-08	1.63E-08	4.13E-08	4.12E-08	5.15E-08	1.73E-07
Ionising radiation	1.10E-06	1.10E-06	3.46E-06	2.20E-06	4.29E-06	1.42E-06
Photochemical ozone formation	1.54E-06	1.71E-06	1.97E-06	2.36E-06	2.30E-06	3.08E-05
Particulate Matter	1.84E-06	1.19E-06	2.20E-06	3.82E-06	2.78E-06	1.13E-05
Human toxicity, non-cancer	2.86E-07	3.45E-07	4.92E-07	1.80E-06	6.34E-07	2.02E-06
Human toxicity, cancer	2.69E-07	1.13E-07	3.49E-07	1.66E-06	4.04E-07	1.02E-06
Acidification terrestrial and freshwater	2.54E-06	2.05E-06	3.88E-06	4.08E-06	4.57E-06	3.49E-05
Eutrophication, freshwater	2.41E-06	3.27E-06	3.05E-06	3.00E-06	3.36E-06	2.11E-06
Eutrophication, marine	1.00E-05	1.01E-05	1.02E-05	1.03E-05	1.03E-05	1.67E-05
Eutrophication, terrestrial	1.51E-06	1.15E-06	1.77E-06	2.01E-06	1.97E-06	2.16E-05
Ecotoxicity, freshwater	4.05E-06	1.18E-06	5.37E-06	7.70E-06	6.16E-06	1.90E-05
Land use	6.48E-06	8.34E-06	6.50E-06	6.53E-06	6.52E-06	3.31E-06
Water use	2.48E-06	2.50E-06	5.13E-06	5.30E-06	6.54E-06	4.79E-05
Resource use, fossils	8.38E-06	8.40E-06	1.83E-05	1.46E-05	2.24E-05	9.02E-05
Resource use, minerals and metals	1.01E-06	9.46E-07	2.17E-06	9.19E-06	3.54E-06	1.15E-06

Table 23: Results for tomato calculated with EF v3.0

	fresh tomato					
g CO2eq / kg tomato, delivered to swiss store	conv., foil tunnel unheated, CH	organic, foil tunnel unheated, CH	conv., greenhouse, heated with waste heat, early harvest, CH	conv., greenhouse, unheated, Almeria	conv., greenhouse, heated, late harvest, CH	conv., greenhouse heated, early harvest, CH
Total	2.38E-05	2.18E-05	3.14E-05	6.65E-05	9.37E-05	1.17E-04
Climate change	3.15E-06	3.00E-06	6.09E-06	1.36E-05	3.93E-05	5.17E-05
Ozone depletion	6.08E-09	4.19E-09	1.32E-08	2.98E-08	2.22E-07	2.99E-07
Ionising radiation	7.76E-08	6.94E-08	3.46E-07	2.24E-07	3.75E-07	4.48E-07
Photochemical ozone formation	4.75E-07	3.79E-07	7.79E-07	2.26E-06	2.01E-06	2.47E-06
Particulate Matter	1.37E-06	2.49E-06	2.06E-06	4.98E-06	2.46E-06	2.61E-06
Human toxicity, non-cancer	2.45E-07	2.34E-07	5.14E-07	1.08E-06	6.08E-07	6.47E-07
Human toxicity, cancer	1.60E-07	1.76E-07	4.55E-07	6.34E-07	5.52E-07	5.90E-07
Acidification terrestrial and freshwater	9.33E-07	2.29E-06	1.62E-06	3.24E-06	2.58E-06	2.96E-06
Eutrophication, freshwater	9.22E-08	1.12E-07	2.46E-07	3.47E-07	2.82E-07	3.12E-07
Eutrophication, marine	7.26E-07	9.56E-07	3.10E-07	8.14E-07	6.92E-07	8.36E-07
Eutrophication, terrestrial	5.72E-07	1.76E-06	7.84E-07	1.81E-06	1.36E-06	1.58E-06
Ecotoxicity, freshwater	1.23E-05	6.81E-06	9.20E-06	1.26E-05	9.57E-06	9.74E-06
Land use	3.23E-08	3.80E-08	6.40E-08	1.04E-07	8.86E-08	9.79E-08
Water use	1.05E-06	1.01E-06	1.90E-06	1.18E-05	2.19E-06	2.37E-06
Resource use, fossils	2.25E-06	2.10E-06	4.55E-06	9.69E-06	2.89E-05	3.81E-05
Resource use, minerals and metals	4.39E-07	3.46E-07	2.45E-06	3.29E-06	2.48E-06	2.52E-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 Infrastructure

ReferenceFunction	401	Name	greenhouse, glass walls and roof, metal tubes
Geography	662	Location	CH
ReferenceFunction	493	InfrastructureProcess	1
ReferenceFunction	403	Unit	m2a
DataSetInformation	201	Type	1
	202	Version	1.0
	203	energyValues	0
	205	LanguageCode	en
	206	LocalLanguageCode	de
DataEntryBy	302	Person	107
	304	QualityNetwork	1
ReferenceFunction	400	DataSetRelatesToProduct	1
	402	IncludedProcesses	This inventory includes the production of the greenhouse as well as the permanent technical infrastructure, that is greenhouse (bearing structure and covering materials), heating and cooling systems, fertirrigation, CO2 injection, stocking facilities and working equipement as far as it is installed permanently (i.e. chariots on rails etc.) working equipement as far as it is installed permanently (i.e. chariots on rails etc).
	404	Amount	1
	490	LocalName	Gewächshaus, Glaswände und -dach, Metallrohre
	491	Synonyms	
	492	GeneralComment	The inventory refers to the production of a greenhouse with glass walls with a lifespan of 20 years
	494	InfrastructureIncluded	1
	495	Category	agricultural means of production
	496	SubCategory	buildings
	497	LocalCategory	Landwirtschaftliche Produktionsmittel
	498	LocalSubCategory	Gebäude
	499	Formula	
	501	StatisticalClassification	
	502	CASNumber	
TimePeriod	601	StartDate	2015
	602	EndDate	2020
	603	DataValidForEntirePeriod	1
	611	OtherPeriodText	
Geography	663	Text	The inventory is modelled for Switzerland
Technology	692	Text	
Representativeness	722	Percent	
	724	ProductionVolume	
	725	SamplingProcedure	Literature and manufacturer information.
	726	Extrapolations	none
	727	UncertaintyAdjustments	none

Figure 1: Metadata of greenhouse with glass walls production

	Name	Location	Infrastructure Process	Unit	greenhouse, glass walls and roof, metal tubes	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				CH			
	Infrastructure Process				1			
	Unit				m2a			
product	greenhouse, glass walls and roof, metal tubes	CH	1	m2a	1.0	0		
resource, land	Occupation, heterogeneous, agricultural	-	-	m2a	1.20E+00	1.00E+00	1.26E+00	(2,2,3,2,1,5,BU:1.1); ;
	Transformation, to heterogeneous, agricultural	-	-	m2	1.20E+00	1.00E+00	1.32E+00	(2,2,3,2,1,5,BU:1.2); ;
	Transformation, from annual crop	-	-	m2	5.33E-02	1.00E+00	1.32E+00	(2,2,3,2,1,5,BU:1.2); ;
	Transformation, from forest	-	-	m2	8.15E-03	1.00E+00	2.06E+00	(2,2,3,2,1,5,BU:2); ;
	Transformation, from heterogeneous, agricultural	-	-	m2	1.07E+00	1.00E+00	1.32E+00	(2,2,3,2,1,5,BU:1.2); ;
	Transformation, from pasture, man made, extensive	-	-	m2a	1.81E-03	1.00E+00	1.26E+00	(2,2,3,2,1,5,BU:1.1); ;
	Transformation, from pasture, man made, intensive	-	-	m2a	3.68E-02	1.00E+00	1.26E+00	(2,2,3,2,1,5,BU:1.1); ;
	Transformation, from permanent crop, fruit	-	-	m2	8.07E-03	1.00E+00	1.32E+00	(2,2,3,2,1,5,BU:1.2); ;
	Transformation, from urban, discontinuously built	-	-	m2	2.52E-02	1.00E+00	2.06E+00	(2,2,3,2,1,5,BU:2); ;
	Occupation, construction site	-	-	m2a	4.00E-02	1.00E+00	1.58E+00	(2,2,3,2,1,5,BU:1.5); ;
technosphere	steel, low-alloyed, at plant	RER	0	kg	1.77E-01	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	section bar rolling, steel	RER	0	kg	1.77E-01	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	zinc coating, coils	RER	0	m2	1.84E-02	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	steel, low-alloyed, at plant	RER	0	kg	1.17E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	section bar rolling, steel	RER	0	kg	1.17E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	zinc coating, coils	RER	0	m2	1.21E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	steel, converter, chromium steel 18/8, at plant	RER	0	kg	4.00E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	section bar rolling, steel	RER	0	kg	4.00E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	zinc coating, coils	RER	0	m2	4.00E-05	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	aluminium alloy, AlMg3, at plant	RER	0	kg	2.28E-01	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	section bar extrusion, aluminium	RER	0	kg	2.28E-01	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	flat glass, uncoated, at plant	RER	0	kg	4.80E-01	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	concrete, sole plate and foundation, at plant	CH	0	m3	3.69E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	steel, low-alloyed, at plant	RER	0	kg	6.67E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	copper, at regional storage	RER	0	kg	1.01E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	polyvinylchloride, suspension polymerised, at plant	RER	0	kg	1.79E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	wire drawing, copper	RER	0	kg	2.80E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	electronics for control units	RER	0	kg	3.00E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	steel, low-alloyed, at plant	RER	0	kg	1.00E-05	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	electricity, medium voltage, at grid	CH	0	kWh	5.97E-02	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	diesel, burned in building machine, average	CH	0	MJ	2.52E-01	1.00E+00	2.06E+00	(2,2,3,2,1,5,BU:2); ;
	diesel, burned in building machine, average	CH	0	MJ	1.98E-01	1.00E+00	2.06E+00	(2,2,3,2,1,5,BU:2); ;
	polyethylene, HDPE, granulate, at plant	RER	0	kg	3.41E-02	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	extrusion, plastic pipes	RER	0	kg	3.41E-02	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	polyethylene, HDPE, granulate, at plant	RER	0	kg	2.23E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	injection moulding	RER	0	kg	2.23E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	polyethylene, HDPE, granulate, at plant	RER	0	kg	2.25E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	blow moulding	RER	0	kg	2.25E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	steel, low-alloyed, at plant	RER	0	kg	8.80E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	oil boiler 100kW	CH	1	unit	1.86E-06	1.00E+00	3.06E+00	(2,2,3,2,1,5,BU:3); ;
	cogen unit 200kWe diesel SCR, components for electricity only	RER	1	unit	6.20E-10	1.00E+00	3.06E+00	(2,2,3,2,1,5,BU:3); ;
	gas motor 206kW	RER	1	unit	6.20E-10	1.00E+00	3.06E+00	(2,2,3,2,1,5,BU:3); ;
	steel, low-alloyed, at plant	RER	0	kg	1.48E-02	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	steel, low-alloyed, at plant	RER	0	kg	3.20E-01	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	drawing of pipes, steel	RER	0	kg	3.20E-01	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	steel, low-alloyed, at plant	RER	0	kg	2.64E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	steel, low-alloyed, at plant	RER	0	kg	1.00E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	steel, converter, chromium steel 18/8, at plant	RER	0	kg	2.24E-02	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	sheet rolling, steel	RER	0	kg	2.24E-02	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	polyethylene, HDPE, granulate, at plant	RER	0	kg	3.67E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	blow moulding	RER	0	kg	3.67E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	steel, converter, chromium steel 18/8, at plant	RER	0	kg	1.00E-02	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	sheet rolling, steel	RER	0	kg	1.00E-02	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	polyethylene, LLDPE, granulate, at plant	RER	0	kg	5.70E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	extrusion, plastic film	RER	0	kg	5.70E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	polyethylene, HDPE, granulate, at plant	RER	0	kg	8.00E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	extrusion, plastic pipes	RER	0	kg	8.00E-03	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	polyvinylchloride, suspension polymerised, at plant	RER	0	kg	8.00E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	extrusion, plastic pipes	RER	0	kg	8.00E-04	1.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	polyethylene, LLDPE, granulate, at plant	RER	0	kg	4.76E-02	2.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	extrusion, plastic film	RER	0	kg	4.76E-02	3.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	polystyrene, expandable, at plant	RER	0	kg	4.90E-03	4.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	foaming, expanding	RER	0	kg	4.90E-03	5.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	agricultural machinery, general, production	CH	1	kg	3.00E-04	6.00E+00	3.06E+00	(2,2,3,2,1,5,BU:3); ;
	synthetic rubber, at plant	RER	0	kg	3.00E-04	7.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	extrusion, plastic pipes	RER	0	kg	3.00E-04	8.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	polyethylene, HDPE, granulate, at plant	RER	0	kg	5.50E-04	9.00E+00	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	blow moulding	RER	0	kg	5.50E-04	1.00E+01	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	agricultural machinery, general, production	CH	1	kg	3.00E-04	1.10E+01	3.06E+00	(2,2,3,2,1,5,BU:3); ;
	concrete block, at plant	DE	0	kg	1.07E-01	1.20E+01	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	concrete, sole plate and foundation, at plant	CH	0	m3	6.00E-05	1.30E+01	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	steel, low-alloyed, at plant	RER	0	kg	3.12E-03	1.40E+01	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	sheet rolling, steel	RER	0	kg	3.12E-03	1.50E+01	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	zinc coating, coils	RER	0	m2	4.00E-08	1.60E+01	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	transport, freight, lorry 16-32 metric ton, EURO 5	RER	0	tkm	1.94E-01	1.70E+01	2.06E+00	(2,2,3,2,1,5,BU:2); ;
	transport, freight, lorry 7.5-16 metric ton, EURO 5	RER	0	tkm	7.89E-04	1.80E+01	2.06E+00	(2,2,3,2,1,5,BU:2); ;
	transport, freight, lorry 16-32 metric ton, EURO 5	RER	0	tkm	8.11E-03	1.90E+01	2.06E+00	(2,2,3,2,1,5,BU:2); ;
	transport, freight, lorry 7.5-16 metric ton, EURO 5	RER	0	tkm	1.76E-04	2.00E+01	2.06E+00	(2,2,3,2,1,5,BU:2); ;
	transport, freight, lorry 7.5-16 metric ton, EURO 5	RER	0	tkm	1.05E-03	2.10E+01	2.06E+00	(2,2,3,2,1,5,BU:2); ;
	transport, freight, lorry 7.5-16 metric ton, EURO 5	RER	0	tkm	2.90E-05	2.20E+01	2.06E+00	(2,2,3,2,1,5,BU:2); ;
	transport, freight, lorry 7.5-16 metric ton, EURO 5	RER	0	tkm	2.03E-06	2.30E+01	2.06E+00	(2,2,3,2,1,5,BU:2); ;
	transport, freight, lorry 7.5-16 metric ton, EURO 5	RER	0	tkm	2.59E-02	2.40E+01	2.06E+00	(2,2,3,2,1,5,BU:2); ;
	disposal, steel, 0% water, to inert material landfill	CH	0	kg	4.58E-02	2.50E+01	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	electronics scrap, for precious metal recovery, at preparation plant	GLO	0	kg	3.28E-03	2.50E+01	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	disposal, municipal solid waste, 22.9% water, to municipal incineration	CH	0	kg	4.58E-01	2.50E+01	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	disposal, steel, 0% water, to inert material landfill	CH	0	kg	6.06E-01	2.50E+01	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;
	disposal, aluminium, 0% water, to sanitary landfill	CH	0	kg	5.70E-02	2.50E+01	1.24E+00	(2,2,3,2,1,5,BU:1.05); ;

Figure 2: Unit process raw data of greenhouse with glass walls production production

ReferenceFunction	401	Name	plastic tunnel
Geography	662	Location	CH
ReferenceFunction	493	InfrastructureProcess	1
ReferenceFunction	403	Unit	m2a
DataSetInformation	201	Type	1
	202	Version	1.0
	203	energyValues	0
	205	LanguageCode	en
	206	LocalLanguageCode	de
DataEntryBy	302	Person	107
	304	QualityNetwork	1
ReferenceFunction	400	DataSetRelatesToProduct	1
	402	IncludedProcesses	The inventory includes the productuon and dismantling of a double layer plastic tunnel made of a structure of steel, covered with plastic sheet. The plastic cover must be replaced every 4 to 7 years. The tunnel lifetime is typically 25 years. The greenhouse also includes a fertigation system made of a network of polyethylene pipes.
	490	LocalName	Plastiktunnel
	491	Synonyms	
	492	GeneralComment	This dataset represents the production and dismantling of 1 m2a of plastic tunnel (unheated) used for agricultural production.
	494	InfrastructureIncluded	1
	495	Category	agricultural means of production
	496	SubCategory	buildings
	497	LocalCategory	Landwirtschaftliche Produktionsmittel
	498	LocalSubCategory	Gebäude
	499	Formula	
	501	StatisticalClassification	
	502	CASNumber	
TimePeriod	601	StartDate	2014
	602	EndDate	2020
	603	DataValidForEntirePeriod	1
	611	OtherPeriodText	
Geography	663	Text	The inventory is modelled for Switzerland
Technology	692	Text	
Representativeness	722	Percent	
	724	ProductionVolume	
	725	SamplingProcedure	Literature
	726	Extrapolations	This dataset has been extrapolated from the year 2014 to the year of the calculation (2021). The uncertainty has been adjusted accordingly.

Figure 3: Metadata of plastic tunnel production CH

	Name	Location	Infrastructure Process	Unit	plastic tunnel	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				CH			
	Infrastructure Process				1			
	Unit				m2a			
product	plastic tunnel	CH	1	m2a	1.0	0		
technosphere	extrusion, plastic film	RER	0	kg	8.32E-02	1.00E+00	1.25E+00	(2,3,3,3,1,5,BU:1.05); ;
	polyethylene, HDPE, granulate, at plant	RER	0	kg	1.22E-02	1.00E+00	1.25E+00	(2,3,3,3,1,5,BU:1.05); ;
	polyvinylchloride, at regional storage	RER	0	kg	2.27E-02	1.00E+00	1.25E+00	(2,3,3,3,1,5,BU:1.05); ;
	polyethylene, LDPE, granulate, at plant	RER	0	kg	3.49E-02	1.00E+00	1.25E+00	(2,3,3,3,1,5,BU:1.05); ;
	polypropylene, granulate, at plant	RER	0	kg	1.14E-02	1.00E+00	1.25E+00	(2,3,3,3,1,5,BU:1.05); ;
	section bar rolling, steel	RER	0	kg	7.81E-02	1.00E+00	1.25E+00	(2,3,3,3,1,5,BU:1.05); ;
	steel, low-alloyed, at plant	RER	0	kg	7.81E-02	1.00E+00	1.25E+00	(2,3,3,3,1,5,BU:1.05); ;
	disposal, polyethylene, 0.4% water, to municipal incineration	CH	0	kg	4.71E-02	1.00E+00	1.25E+00	(2,3,3,3,1,5,BU:1.05); ;
	disposal, plastics, mixture, 15.3% water, to municipal incineration	CH	0	kg	1.14E-02	1.00E+00	1.25E+00	(2,3,3,3,1,5,BU:1.05); ;
	disposal, polyvinylfluoride, 0.2% water, to municipal incineration	CH	0	kg	2.27E-02	1.00E+00	1.25E+00	(2,3,3,3,1,5,BU:1.05); ;

Figure 4: Unit process raw data of plastic tunnel production CH

ReferenceFunction	Name	plastic tunnel
Geography	Location	ES
ReferenceFunction	InfrastructureProcess	1
ReferenceFunction	Unit	m2a
DataSetInformation	Type	1
	Version	1.0
	energyValues	0
	LanguageCode	en
	LocalLanguageCode	de
DataEntryBy	Person	107
	QualityNetwork	1
ReferenceFunction	DataSetRelatesToProduct	1
	IncludedProcesses	The inventory includes the plastic tunnel production and dismantling. The tunnel is made of a structure of galvanized steel, covered with a EVA (ethylene vinyl acetate) copolymer sheet. The plastic cover must be replaced every 3 to 4 years. The tunnel lifetime is typically 25 years. The greenhouse also includes a fertigation system made of a network of polyethylene pipes. Other auxiliary facilities are also considered.
	Amount	1
	LocalName	Plastiktunnel
	Synonyms	
	GeneralComment	This dataset represents the production and dismantling of 1 m2a of plastic tunnel type Almeria used for agricultural production.
	InfrastructureIncluded	1
	Category	agricultural means of production
	SubCategory	buildings
	LocalCategory	Landwirtschaftliche Produktionsmittel
	LocalSubCategory	Gebäude
	Formula	
	StatisticalClassification	
	CASNumber	
TimePeriod	StartDate	2014
	EndDate	2020
	DataValidForEntirePeriod	1
	OtherPeriodText	
Geography	Text	The inventory is modelled for Spain
Technology	Text	
Representativeness	Percent	
	ProductionVolume	
	SamplingProcedure	Literature
	Extrapolations	This dataset has been extrapolated from the year 2014 to the year of the calculation (2021). The uncertainty has been adjusted accordingly.
	UncertaintyAdjustments	none

Figure 5: Metadata of plastic tunnel production ES

	Name	Location	Infrastructure Process	Unit	plastic tunnel	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				ES			
	Infrastructure Process				1			
	Unit				m2a			
product	plastic tunnel	ES	1	m2a	1.0	0		
technosphere	concrete, normal, at plant	CH	0	m3	6.20E-04	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	polyethylene, HDPE, granulate, at plant	RER	0	kg	5.05E-02	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	polypropylene, granulate, at plant	RER	0	kg	4.80E-02	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	polyvinylchloride, at regional storage	RER	0	kg	2.79E-02	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	polyethylene, LDPE, granulate, at plant	RER	0	kg	1.44E-01	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	extrusion, plastic film	RER	0	kg	1.76E-01	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	injection moulding	RER	0	kg	9.85E-02	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	steel, low-alloyed, at plant	RER	0	kg	4.10E-01	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	sheet rolling, steel	RER	0	kg	4.16E-01	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	wire drawing, copper	RER	0	kg	5.70E-03	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	zinc, primary, at regional storage	RER	0	kg	2.33E-02	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	tractor, production	CH	0	kg	2.15E-02	1.00E+00	3.05E+00	(2,3,3,3,1,5,BU:1.05); ;
	disposal, polyethylene, 0.4% water, to municipal incineration	CH	0	kg	1.94E-01	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	disposal, polypropylene, 15.9% water, to municipal incineration	CH	0	kg	4.80E-02	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;
	disposal, polyvinylchloride, 0.2% water, to municipal incineration	CH	0	kg	2.79E-02	1.00E+00	1.22E+00	(2,3,3,3,1,5,BU:1.05); ;

Figure 6: Unit process raw data of plastic tunnel production ES

A4.2 Auxiliary inventories

ReferenceFunction	Name	average mineral fertiliser, as K2O, at regional storehouse
Geography	Location	RER
ReferenceFunction	InfrastructureProcess	0
ReferenceFunction	Unit	kg
DataSetInformation	Type	1
	Version	1.0
	energyValues	0
	LanguageCode	en
	LocalLanguageCode	de
DataEntryBy	Person	107
	QualityNetwork	1
ReferenceFunction	DataSetRelatesToProduct	1
	IncludedProcesses	The inventory includes an average mixture of various K2O fertilisers.
	Amount	1
	LocalName	Durchschnittlicher Mineraldünger, als K2O, ab Regionallager
	Synonyms	
	GeneralComment	The inventory refers to the production of 1 kg K2O fertiliser
	InfrastructureIncluded	1
	Category	agricultural means of production
	SubCategory	mineral fertiliser
	LocalCategory	Landwirtschaftliche Produktionsmittel
	LocalSubCategory	Mineraldünger
	Formula	
	StatisticalClassification	
	CASNumber	
TimePeriod	StartDate	2017
	EndDate	2020
	DataValidForEntirePeriod	1
	OtherPeriodText	
Geography	Text	RER
Technology	Text	
Representativeness	Percent	
	ProductionVolume	
	SamplingProcedure	The data is based on literature and statistical data as well as expert judgements.
	Extrapolations	none
	UncertaintyAdjustments	none

Figure 7: Metadata of K2O fertiliser production

	Name	Location	Infrastructure Process	Unit	average mineral fertiliser, as K2O, at regional storehouse	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				RER			
	Infrastructure Process				0			
	Unit				kg			
product	average mineral fertiliser, as K2O, at regional storehouse	RER	0	kg	1.0	0		
technosphere	potassium chloride, as K2O, at regional storehouse	RER	0	kg	8.84E-01	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;
	potassium sulphate, as K2O, at regional storehouse	RER	0	kg	1.17E-01	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;

Figure 8: Unit process raw data of K2O fertiliser production

ReferenceFunction	Name	average mineral fertiliser, as N, at regional storehouse
Geography	Location	RER
ReferenceFunction	InfrastructureProcess	0
ReferenceFunction	Unit	kg
	IncludedProcesses	The inventory includes an average mixture of N fertilisers.
	LocalName	Durchschnittlicher Mineraldünger, als N, ab Regionallager
	Synonyms	
	GeneralComment	The inventory refers to the production of 1 kg N fertiliser
	InfrastructureIncluded	1
	Category	agricultural means of production
	SubCategory	mineral fertiliser
	LocalCategory	Landwirtschaftliche Produktionsmittel
	LocalSubCategory	Mineraldünger
	Formula	
	StatisticalClassification	
	CASNumber	
TimePeriod	StartDate	2017
	EndDate	2020
	DataValidForEntirePeriod	1
	OtherPeriodText	
Geography	Text	RER
Technology	Text	
Representativeness	Percent	
	ProductionVolume	
	SamplingProcedure	The data is based on literature and statistical data as well as expert judgements.
	Extrapolations	none
	UncertaintyAdjustments	none

Figure 9: Metadata of N fertiliser production

	Name	Location	Infrastructure Process	Unit	average mineral fertiliser, as N, at regional storehouse	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				RER			
	Infrastructure Process				0			
	Unit				kg			
product	average mineral fertiliser, as N, at regional storehouse	RER	0	kg	1.0	0		
technosphere	urea, as N, at regional storehouse	RER	0	kg	2.36E-01	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;
	ammonium sulphate, as N, at regional storehouse	RER	0	kg	5.80E-02	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;
	diammonium phosphate, as N, at regional storehouse	RER	0	kg	2.50E-02	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;
	ammonium nitrate phosphate, as N, at regional storehouse	RER	0	kg	6.45E-01	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;
	monoammonium phosphate, as N, at regional storehouse	RER	0	kg	9.00E-03	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;

Figure 10: Unit process raw data of N fertiliser production

ReferenceFunction	401	Name	average mineral fertiliser, as P2O5, at regional storehouse
Geography	662	Location	RER
ReferenceFunction	493	InfrastructureProcess	0
ReferenceFunction	403	Unit	kg
	402	IncludedProcesses	The inventory includes n average mixture of P2O5 fertilizers
	490	LocalName	Durchschnittlicher Mineraldünger, als P2O5, ab Regionallager
	491	Synonyms	
	492	GeneralComment	The inventory refers to the production of 1 kg P2O5 fertiliser
	494	InfrastructureIncluded	1
	495	Category	agricultural means of production
	496	SubCategory	mineral fertiliser
	497	LocalCategory	Landwirtschaftliche Produktionsmittel
	498	LocalSubCategory	Mineraldünger
	499	Formula	
	501	StatisticalClassification	
	502	CASNumber	
TimePeriod	601	StartDate	2017
	602	EndDate	2020
	603	DataValidForEntirePeriod	1
	611	OtherPeriodText	
Geography	663	Text	RER
Technology	692	Text	
Representativeness	722	Percent	
	724	ProductionVolume	
	725	SamplingProcedure	The data is based on literature and statistical data as well as expert judgements.
	726	Extrapolations	none
	727	UncertaintyAdjustments	none

Figure 11: Metadata of P2O5 fertiliser production

	Name	Location	Infrastructure Process	Unit	average mineral fertiliser, as P2O5, at regional storehouse	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				RER			
	Infrastructure Process				0			
	Unit				kg			
product	average mineral fertiliser, as P2O5, at regional storehouse	RER	0	kg	1.0	0		
technosphere	triple superphosphate, as P2O5, at regional storehouse	RER	0	kg	4.11E-01	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;
	single superphosphate, as P2O5, at regional storehouse	RER	0	kg	4.40E-02	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;
	diammonium phosphate, as P2O5, at regional storehouse	RER	0	kg	2.61E-01	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;
	ammonium nitrate phosphate, as P2O5, at regional storehouse	RER	0	kg	2.85E-01	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;
	ammonium nitrate phosphate, as P2O5, at regional storehouse	RER	0	kg	1.48E-01	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;
	ammonium nitrate phosphate, as P2O5, at regional storehouse	RER	0	kg	7.40E-02	1.00E+00	1.30E+00	(4,1,2,2,1,5,BU:1.05); ;

Figure 12: Unit process raw data of P2O5 fertiliser production

ReferenceFunction	Name	irrigation, sprinkler
Geography	Location	CH
ReferenceFunction	InfrastructureProcess	0
ReferenceFunction	Unit	m3
DataSetInformation	Type	1
	Version	1.0
	energyValues	0
	LanguageCode	en
	LocalLanguageCode	de
DataEntryBy	Person	107
	QualityNetwork	1
ReferenceFunction	DataSetRelatesToProduct	1
	IncludedProcesses	This dataset starts with pumping water from wells and water bodies. This dataset ends with delivering water to the plant and includes the water pumping, energy use, infrastructure, but not the water emissions of irrigation (shall be included in the crop production dataset).
	Amount	1
	LocalName	Bewässerung, Sprinkler
	Synonyms	
	GeneralComment	This dataset represents the sprinkler irrigation in Switzerland with a 75% 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 13: Metadata of irrigation by sprinkler

	Name	Location	Infrastructure Process	Unit	irrigation, sprinkler	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				CH			
	Infrastructure Process				0			
	Unit				m3			
product	irrigation, sprinkler	CH	0	m3	1.0	0		
resource, in water	Water, river, CH	-	-	m3	7.80E-01	1.00E+00	1.26E+00	(3,1,3,1,1,5,BU:1.05); ;
	Water, well, CH	-	-	m3	2.20E-01	1.00E+00	1.26E+00	(3,1,3,1,1,5,BU:1.05); ;
technosphere	brass, at plant	CH	0	kg	2.60E-05	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	bronze, at plant	CH	0	kg	2.29E-05	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	cast iron, at plant	RER	0	kg	2.20E-06	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	extrusion, plastic pipes	RER	0	kg	8.60E-04	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	injection moulding	RER	0	kg	7.59E-04	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	metal working machine operation, average process heat	RER	0	kg	1.58E-04	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	nylon 6, at plant	RER	0	kg	3.80E-07	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	polyethylene, HDPE, granulate, at plant	RER	0	kg	4.90E-04	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	polyethylene, LDPE, granulate, at plant	RER	0	kg	3.70E-04	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	polypropylene, granulate, at plant	RER	0	kg	5.90E-05	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	polyvinylchloride, at regional storage	RER	0	kg	7.00E-04	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	steel, low-alloyed, at plant	RER	0	kg	1.30E-04	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	diesel, burned in diesel-electric generating set	GLO	0	MJ	3.48E-01	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	electricity, low voltage, at grid	CH	0	kWh	6.10E-01	1.00E+00	1.42E+00	(3,4,4,3,3,5,BU:1.05); ;
	diesel, burned in building machine, average	CH	0	MJ	9.59E-06	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	3.80E-07	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	8.60E-04	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	5.90E-05	1.00E+00	1.52E+00	(4,5,4,5,3,5,BU:1.05); ;
	disposal, polyvinylchloride, 0.2% water, to municipal incineration	CH	0	kg	7.00E-04	1.00E+00	1.52E+00	(4,5,4,5,3,5,BU:1.05); ;

Figure 14: Unit process raw data of irrigation by sprinkler

ReferenceFunction	Name	tap water, desalinated sea water, at user
Geography	Location	ES
ReferenceFunction	InfrastructureProcess	0
ReferenceFunction	Unit	kg
DataSetInformation	Type	1
	Version	1.0
	energyValues	0
	LanguageCode	en
	LocalLanguageCode	de
DataEntryBy	Person	107
	QualityNetwork	1
ReferenceFunction	DataSetRelatesToProduct	1
	IncludedProcesses	This dataset includes all processes involved fo the desalination of sea water by reverse osmosis.
	Amount	1
	LocalName	Trinkwasser, Meerwasserentzsalzung, ab Hausanschluss
	Synonyms	
	GeneralComment	This dataset is a copy ot the respective ecoinvent v3 process.
	InfrastructureIncluded	1
	Category	water supply
	SubCategory	production
	LocalCategory	Wasserversorgung
	LocalSubCategory	Bereitstellung
	Formula	
	StatisticalClassification	
	CASNumber	
TimePeriod	StartDate	2005
	EndDate	2020
	DataValidForEntirePeriod	1
	OtherPeriodText	
Geography	Text	The inventory is modelled for Spain
Technology	Text	
Representativeness	Percent	
	ProductionVolume	
	SamplingProcedure	Literature
	Extrapolations	none
	UncertaintyAdjustments	none

Figure 15: Metadata of desalinated tap water

	Name	Location	Infrastructure Process	Unit	tap water, desalinated sea water, at user	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				ES			
	Infrastructure Process				0			
	Unit				kg			
product	tap water, desalinated sea water, at user	ES	0	kg	1.0	0		
resource, in water	Water, salt, ocean	-	-	m3	2.50E-03	1.00E+00	1.24E+00	(1,1,3,1,1,5,BU:1.05); ;
technosphere	carbon dioxide liquid, at plant	RER	0	kg	5.83E-06	1.00E+00	1.28E+00	(3,4,3,1,1,5,BU:1.05); ;
	carbon dioxide liquid, at plant	RER	0	kg	2.77E-05	1.00E+00	1.28E+00	(3,4,3,1,1,5,BU:1.05); ;
	chlorine, liquid, production mix, at plant	RER	0	kg	2.00E-07	1.00E+00	1.36E+00	(3,4,3,1,3,5,BU:1.05); ;
	chlorine, liquid, production mix, at plant	RER	0	kg	1.00E-06	1.00E+00	1.36E+00	(3,4,3,1,3,5,BU:1.05); ;
	chemicals organic, at plant	GLO	0	kg	9.37E-07	1.00E+00	1.36E+00	(3,4,3,1,3,5,BU:1.05); ;
	EDTA, ethylenediaminetetraacetic acid, at plant	RER	0	kg	2.34E-09	1.00E+00	2.56E+00	(5,5,5,5,5,5,BU:1.05); ;
	epoxy resin, liquid, at plant	RER	0	kg	4.75E-09	1.00E+00	1.24E+00	(1,1,3,1,1,5,BU:1.05); ;
	epoxy resin, liquid, at plant	RER	0	kg	2.26E-08	1.00E+00	1.24E+00	(1,1,3,1,1,5,BU:1.05); ;
	glass fibre, at plant	RER	0	kg	3.50E-07	1.00E+00	1.24E+00	(1,1,3,1,1,5,BU:1.05); ;
	iron (III) chloride, 40% in H2O, at plant	CH	0	kg	5.20E-13	1.00E+00	1.41E+00	(3,4,4,1,3,5,BU:1.05); ;
	lime, hydrated, packed, at plant	CH	0	kg	3.66E-07	1.00E+00	1.28E+00	(3,4,3,1,1,5,BU:1.05); ;
	lime, hydrated, packed, at plant	CH	0	kg	4.31E-05	1.00E+00	1.28E+00	(3,4,3,1,1,5,BU:1.05); ;
	chemicals organic, at plant	GLO	0	kg	3.00E-08	1.00E+00	1.36E+00	(3,4,3,1,3,5,BU:1.05); ;
	polycarboxylates, 40% active substance, at plant	RER	0	kg	1.01E-06	1.00E+00	2.56E+00	(5,5,5,5,5,5,BU:1.05); ;
	polycarboxylates, 40% active substance, at plant	RER	0	kg	2.05E-06	1.00E+00	2.56E+00	(5,5,5,5,5,5,BU:1.05); ;
	chemicals organic, at plant	GLO	0	kg	7.39E-08	1.00E+00	1.36E+00	(3,4,3,1,3,5,BU:1.05); ;
	sodium hydroxide, 50% in H2O, production mix, at plant	RER	0	kg	2.73E-05	1.00E+00	1.36E+00	(3,4,3,1,3,5,BU:1.05); ;
	sodium hypochlorite, 15% in H2O, at plant	RER	0	kg	6.54E-07	1.00E+00	1.36E+00	(3,4,3,1,3,5,BU:1.05); ;
	sodium hypochlorite, 15% in H2O, at plant	RER	0	kg	3.11E-06	1.00E+00	1.36E+00	(3,4,3,1,3,5,BU:1.05); ;
	sodium sulphate from sulfuric acid digestion of spodumene	GLO	0	kg	5.50E-06	1.00E+00	1.24E+00	(1,1,3,1,1,5,BU:1.05); ;
	sodium sulphate from sulfuric acid digestion of spodumene	GLO	0	kg	3.16E-05	1.00E+00	1.24E+00	(1,1,3,1,1,5,BU:1.05); ;
	tap water, at user	CH	0	kg	5.60E-05	1.00E+00	1.24E+00	(1,1,3,1,1,5,BU:1.05); ;
	water works	CH	1	unit	5.35E-13	1.00E+00	3.06E+00	(1,1,3,1,1,5,BU:3); ;
	electricity, low voltage, at grid	ES	0	kWh	3.72E-03	1.00E+00	1.24E+00	(1,1,3,1,1,5,BU:1.05); ;
emission air, low population density	Carbon dioxide, biogenic	-	-	kg	3.25E-05	1.00E+00	1.60E+00	(5,4,3,1,1,5,BU:1.05); ;
emission water, ocean	Boron	-	-	kg	1.04E-05	1.00E+00	5.09E+00	(3,4,3,1,1,5,BU:5); ;
	Calcium, ion	-	-	kg	1.01E-03	1.00E+00	3.08E+00	(3,4,3,1,1,5,BU:3); ;
	Carbonate	-	-	kg	2.70E-06	1.00E+00	3.08E+00	(3,4,3,1,1,5,BU:3); ;
	Chloride	-	-	kg	4.81E-02	1.00E+00	3.08E+00	(3,4,3,1,1,5,BU:3); ;
	Fluoride	-	-	kg	2.50E-06	1.00E+00	1.61E+00	(3,4,3,1,1,5,BU:1.5); ;
	Hydrogen carbonate	-	-	kg	3.26E-04	1.00E+00	3.08E+00	(3,4,3,1,1,5,BU:3); ;
	Magnesium	-	-	kg	3.23E-03	1.00E+00	5.09E+00	(3,4,3,1,1,5,BU:5); ;
	Potassium, ion	-	-	kg	9.62E-04	1.00E+00	5.09E+00	(3,4,3,1,1,5,BU:5); ;
	Sodium, ion	-	-	kg	2.67E-02	1.00E+00	5.09E+00	(3,4,3,1,1,5,BU:5); ;
	Strontium	-	-	kg	3.25E-05	1.00E+00	5.09E+00	(3,4,3,1,1,5,BU:5); ;
	Sulfate	-	-	kg	6.81E-03	1.00E+00	1.61E+00	(3,4,3,1,1,5,BU:1.5); ;
emission water, unspecified	Water, GLO	-	-	m3	1.50E-03	1.00E+00	1.61E+00	(3,4,3,1,1,5,BU:1.5); ;
technosphere	disposal, municipal solid waste, 22.9% water, to municipal incineration	CH	0	kg	1.43E-08	1.00E+00	2.56E+00	(5,5,5,5,5,5,BU:1.05); ;
	disposal, municipal solid waste, 22.9% water, to municipal incineration	CH	0	kg	3.61E-09	1.00E+00	2.56E+00	(5,5,5,5,5,5,BU:1.05); ;
	disposal, municipal solid waste, 22.9% water, to municipal incineration	CH	0	kg	5.16E-09	1.00E+00	2.56E+00	(5,5,5,5,5,5,BU:1.05); ;
	disposal, municipal solid waste, 22.9% water, to municipal incineration	CH	0	kg	8.42E-07	1.00E+00	2.56E+00	(5,5,5,5,5,5,BU:1.05); ;
	disposal, municipal solid waste, 22.9% water, to municipal incineration	CH	0	kg	1.01E-05	1.00E+00	2.56E+00	(5,5,5,5,5,5,BU:1.05); ;
	disposal, glass, 0% water, to municipal incineration	CH	0	kg	3.18E-09	1.00E+00	2.56E+00	(5,5,5,5,5,5,BU:1.05); ;
	disposal, glass, 0% water, to municipal incineration	CH	0	kg	3.74E-07	1.00E+00	2.56E+00	(5,5,5,5,5,5,BU:1.05); ;

Figure 16: Unit process raw data of desalinated tap water

ReferenceFunction	Name	Tomato, seedling, conventional, soilless production, at production site
Geography	Location	RER
ReferenceFunction	InfrastructureProcess	0
ReferenceFunction	Unit	p
	IncludedProcesses	The inventory includes : (1) the processes applied in this phase, that is the processes of irrigating, fertilisation, pest and pathogen control, harvesting; (2) the greenhouse and the machines and shed or surface used to park them; (3) all inputs as young plants (nursery), fertilizers (mineral and organic), active substances, water for irrigation, fuels end energy as well as the transport to the farm; The temporal border of the inventory is 'sowing of the seedling to its harvest' (73 days).
	LocalName	Tomatensetzling, konventionell, hors-sol, ab Produktionsort
	Synonyms	
	GeneralComment	This inventory refers to 1 tomato seedling. About 15000 seedlings are needed per ha
	InfrastructureIncluded	1
	Category	agricultural means of production
	SubCategory	seed
	LocalCategory	Landwirtschaftliche Produktionsmittel
	LocalSubCategory	Saatgut
	Formula	
	StatisticalClassification	
	CASNumber	
TimePeriod	StartDate	2015
	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 17: Metadata of tomato seedling production

	Name	Location	Infrastructure Process	Unit	Tomato, seedling, conventional, soilless production, at production site	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				RER			
	Infrastructure Process				0			
	Unit				p			
product	Tomato, seedling, conventional, soilless production, at production site	RER	0	p	1.0	0		
resource, in water	Water, river	-	-	m3	3.00E-03	1.00E+00	1.69E+00	(4,4,4,2,4,5,BU:1.05); ;
technosphere	nitric acid, 50% in H2O, at plant	RER	0	kg	3.65E-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	2.27E-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	1.50E-04	1.00E+00	1.69E+00	(4,4,4,2,4,5,BU:1.05); ;
	magnesium sulphate, at plant	RER	0	kg	1.04E-03	1.00E+00	1.69E+00	(4,4,4,2,4,5,BU:1.05); ;
	potassium nitrate, as K2O, at regional storehouse	RER	0	kg	1.48E-03	1.00E+00	1.69E+00	(4,4,4,2,4,5,BU:1.05); ;
	calcium nitrate, as N, at regional storehouse	RER	0	kg	2.87E-04	1.00E+00	1.69E+00	(4,4,4,2,4,5,BU:1.05); ;
	chemicals inorganic, at plant	GLO	0	kg	5.00E-08	1.00E+00	1.69E+00	(4,4,4,2,4,5,BU:1.05); ;
	monoammonium phosphate, as P2O5, at regional storehouse	RER	0	kg	1.92E-04	1.00E+00	1.69E+00	(4,4,4,2,4,5,BU:1.05); ;
	monoammonium phosphate, as N, at regional storehouse	RER	0	kg	4.07E-05	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); ;
	rock wool, at plant	CH	0	kg	4.71E-02	1.00E+00	1.69E+00	(4,4,4,2,4,5,BU:1.05); ;
	electricity mix	NL	0	kWh	5.00E-01	1.00E+00	1.69E+00	(4,4,4,2,4,5,BU:1.05); ;
	polystyrene, general purpose, GPPS, at plant	RER	0	kg	4.14E-03	1.00E+00	1.69E+00	(4,4,4,2,4,5,BU:1.05); ;
	natural gas, burned in industrial furnace >100kW	RER	0	MJ	1.44E+01	1.00E+00	1.69E+00	(4,4,4,2,4,5,BU:1.05); ;
	tomatoes conventional, hors-sol, at greenhouse	ES	0	kg	3.07E-03	1.00E+00	1.69E+00	(4,4,4,2,4,5,BU:1.05); ;
	transport, freight, lorry 32-40 metric ton, EURO 4	RER	0	tkm	1.54E-02	1.00E+00	2.38E+00	(4,4,4,2,4,5,BU:2); ;
	transport, aircraft, freight, intercontinental	RER	0	tkm	9.21E-03	1.00E+00	2.38E+00	(4,4,4,2,4,5,BU:2); ;
	transport, tractor and trailer	CH	0	tkm	8.52E-04	1.00E+00	2.38E+00	(4,4,4,2,4,5,BU:2); ;
	transport, transoceanic freight ship	OCE	0	tkm	2.54E-03	1.00E+00	2.38E+00	(4,4,4,2,4,5,BU:2); ;
	transport, freight, lorry 32-40 metric ton, EURO 4	RER	0	tkm	1.45E-03	1.00E+00	2.38E+00	(4,4,4,2,4,5,BU:2); ;
	greenhouse, glass walls and roof, metal tubes	CH	1	m2a	6.66E-03	1.00E+00	3.38E+00	(4,4,4,2,4,5,BU:3); ;
emission air, low population density	Ammonia	-	-	kg	1.27E-05	1.00E+00	1.74E+00	(4,4,4,2,4,5,BU:1.2); ;
	Dinitrogen monoxide	-	-	kg	2.77E-07	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); ;
	Dinitrogen monoxide	-	-	kg	9.44E-06	1.00E+00	1.94E+00	(4,4,4,2,4,5,BU:1.5); ;
emission water, river	Zinc, ion	-	-	kg	5.68E-08	1.00E+00	5.43E+00	(4,4,4,2,4,5,BU:5); ;
	Chromium, ion	-	-	kg	3.93E-08	1.00E+00	3.38E+00	(4,4,4,2,4,5,BU:3); ;
	Mercury	-	-	kg	7.17E-11	1.00E+00	5.43E+00	(4,4,4,2,4,5,BU:5); ;
	Cadmium, ion	-	-	kg	3.12E-09	1.00E+00	3.38E+00	(4,4,4,2,4,5,BU:3); ;
	Copper, ion	-	-	kg	8.01E-09	1.00E+00	3.38E+00	(4,4,4,2,4,5,BU:3); ;
	Nickel, ion	-	-	kg	7.36E-09	1.00E+00	5.43E+00	(4,4,4,2,4,5,BU:5); ;
	Lead	-	-	kg	1.06E-09	1.00E+00	5.43E+00	(4,4,4,2,4,5,BU:5); ;
emission soil, agricultural	Abamectin	-	-	kg	2.88E-08	1.00E+00	1.74E+00	(4,4,4,2,4,5,BU:1.2); ;
	Copper	-	-	kg	1.15E-06	1.00E+00	1.70E+00	(4,4,4,2,4,5,BU:1.1); ;

Figure 18: Unit process raw data of tomato seedling production

ReferenceFunction	401	Name	Canning of legumes
Geography	662	Location	CH
ReferenceFunction	493	InfrastructureProcess	0
ReferenceFunction	403	Unit	kg
DataSetInformation	201	Type	1
	202	Version	1.0
	203	energyValues	0
	205	LanguageCode	en
	206	LocalLanguageCode	de
DataEntryBy	302	Person	107
	304	QualityNetwork	1
ReferenceFunction	400	DataSetRelatesToProduct	1
	402	IncludedProcesses	The inveontory includes all processes from washing, blanching to filling, but without the tincan itself.
	490	LocalName	
	491	Synonyms	
	492	GeneralComment	The inventory applies to the processing of 1kg of legumes.
	494	InfrastructureIncluded	1
	495	Category	food industry
	496	SubCategory	processing
	497	LocalCategory	Lebensmittel
	498	LocalSubCategory	Verarbeitung
	499	Formula	
	501	StatisticalClassification	
	502	CASNumber	
TimePeriod	601	StartDate	2014
	602	EndDate	2020
	603	DataValidForEntirePeriod	1
	611	OtherPeriodText	
Geography	663	Text	The inventory is modelled for Switzerland
Technology	692	Text	
Representativeness	722	Percent	
	724	ProductionVolume	
	725	SamplingProcedure	
	726	Extrapolations	none
	727	UncertaintyAdjustments	none

Figure 19: Metadata of canning of food

	Name	Location	Infrastructure Process	Unit	Canning of legumes	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				CH			
	Infrastructure Process				0			
	Unit				kg			
product	Canning of legumes	CH	0	kg	1.0	0		
technosphere	electricity, low voltage, at grid	CH	0	kWh	7.08E-01	1.00E+00	1.25E+00	(2,3,3,2,1,5,BU:1.05); ;
	chemical plant, organics	RER	1	unit	1.00E-10	1.00E+00	3.06E+00	(2,3,3,2,1,5,BU:3); ;
	tap water, at user	CH	0	kg	1.20E+00	1.00E+00	1.25E+00	(2,3,3,2,1,5,BU:1.05); ;

Figure 20: Unit process raw data of canning of food

ReferenceFunction	401	Name	Drying of food, 1 kg water
Geography	662	Location	CH
ReferenceFunction	493	InfrastructureProcess	0
ReferenceFunction	403	Unit	kg
DataSetInformation	201	Type	1
	202	Version	1.0
	203	energyValues	0
	205	LanguageCode	en
	206	LocalLanguageCode	de
DataEntryBy	302	Person	107
	304	QualityNetwork	1
ReferenceFunction	400	DataSetRelatesToProduct	1
	402	IncludedProcesses	The inventory includes the energy needed to evaporate 1 kg of water
	404	Amount	1
	490	LocalName	
	491	Synonyms	
	492	GeneralComment	The inventory refers to an average drying machine with a yield of 30 to 40 kg of dried products per day.
	494	InfrastructureIncluded	1
	495	Category	food industry
	496	SubCategory	processing
	497	LocalCategory	Lebensmittel
	498	LocalSubCategory	Verarbeitung
	499	Formula	
	501	StatisticalClassification	
	502	CASNumber	
TimePeriod	601	StartDate	2020
	602	EndDate	2020
	603	DataValidForEntirePeriod	1
	611	OtherPeriodText	
Geography	663	Text	The inventory is modelled for Switzerland
Technology	692	Text	
Representativeness	722	Percent	
	724	ProductionVolume	
	725	SamplingProcedure	data ist based on data sheets from producer of drying machines
	726	Extrapolations	none
	727	UncertaintyAdjustments	none

Figure 21: Metadata of drying of food

	Name	Location	Infrastructure Process	Unit	Drying of food, 1 kg water	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				CH			
	Infrastructure Process				0			
	Unit				kg			
product	Drying of food, 1 kg water	CH	0	kg	1.0	0		
technosphere	electricity, low voltage, at grid	CH	0	kWh	8.80E-01	1.00E+00	2.07E+00	(3,3,1,1,5,5,BU:1.05); ;
	steel, low-alloyed, at plant	RER	0	kg	2.04E-03	1.00E+00	2.07E+00	(3,3,1,1,5,5,BU:1.05); ;
emission water, unspecified	Water, CH	-	-	m3	1.00E+00	1.00E+00	2.29E+00	(3,3,1,1,5,5,BU:1.5); ;

Figure 22: Unit process raw data of drying of food

ReferenceFunction	Name	Freezing of beans
Geography	Location	CH
ReferenceFunction	InfrastructureProcess	0
ReferenceFunction	Unit	kg
	IncludedProcesses	The inventory includes all prozesses of the shock freezing an storage of 1kg of food.
	LocalName	
	Synonyms	
	GeneralComment	Inventory refers to the shock freezing an storage of 1kg of food.
	InfrastructureIncluded	1
	Category	food industry
	SubCategory	processing
	LocalCategory	Lebensmittel
	LocalSubCategory	Verarbeitung
	Formula	
	StatisticalClassification	
	CASNumber	
TimePeriod	StartDate	2016
	EndDate	2020
	DataValidForEntirePeriod	1
	OtherPeriodText	
Geography	Text	The inventory is modelled for Switzerland
Technology	Text	
Representativeness	Percent	
	ProductionVolume	
	SamplingProcedure	based on confidential data from a company
	Extrapolations	none
	UncertaintyAdjustments	none

Figure 23: Metadata of freezing and storing of food

	Name	Location	Infrastructure Process	Unit	Freezing of beans	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				CH			
	Infrastructure Process				0			
	Unit				kg			
product	Freezing of beans	CH	0	kg	1.0	0		
technosphere	electricity, low voltage, at grid	CH	0	kWh	1.09E+00	1.00E+00	1.24E+00	(2,4,2,1,1,5,BU:1.05); ;
	chemical plant, organics	RER	1	unit	1.00E-10	1.00E+00	3.06E+00	(2,4,2,1,1,5,BU:3); ;
emission air, low population density	Ethane, pentafluoro-, HFC-125	-	-	kg	1.32E-06	1.00E+00	1.58E+00	(2,4,2,1,1,5,BU:1.5); ;

Figure 24: Unit process raw data of freezing and storing of food

A4.3 Cultivation

ReferenceFunction	Name	green beans conventional, at farm
Geography	Location	KE
ReferenceFunction	InfrastructureProcess	0
ReferenceFunction	Unit	kg
	IncludedProcesses	The inventory includes the processes of soil cultivation, sowing, weed control, fertilisation, pest and pathogen control and harvest. Inputs of fertilisers, pesticides and seed as well as their transports to the regional processing center (10km) are considered. The direct emissions on the field are also included.
	LocalName	Bohnen konventionell, ab Hof
	Synonyms	
	GeneralComment	The inventory refers to the production of green beans in Kenya.
	InfrastructureIncluded	1
	Category	agricultural production
	SubCategory	plant production
	LocalCategory	Landwirtschaftliche Produktion
	LocalSubCategory	Pflanzenbau
	Formula	
	StatisticalClassification	
	CASNumber	
TimePeriod	StartDate	2014
	EndDate	2020
	DataValidForEntirePeriod	1
	OtherPeriodText	
Geography	Text	The inventory is modelled for Switzerland
Technology	Text	
Representativeness	Percent	
	ProductionVolume	
	SamplingProcedure	Literature
	Extrapolations	none
	UncertaintyAdjustments	none

Figure 25: Metadata of green beans production in Kenya

	Name	Location	Infrastructure Process	Unit	green beans conventional, at farm	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				KE			
	Infrastructure Process				0			
	Unit				kg			
product	green beans conventional, at farm	KE	0	kg	1.0	0		
resource, biotic	Energy, gross calorific value, in biomass	-	-	MJ	0.00E+00	1.00E+00	1.30E+00	(4,1,1,1,1,5,BU:1.05); ;
resource, in air	Carbon dioxide, in air	-	-	kg	0.00E+00	1.00E+00	1.30E+00	(4,1,1,1,1,5,BU:1.05); ;
resource, land	Occupation, annual crop, non-irrigated	-	-	m2a	0.00E+00	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1); ;
	Transformation, from annual crop, non-irrigated	-	-	m2	0.00E+00	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1); ;
	Transformation, to annual crop, non-irrigated	-	-	m2	0.00E+00	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1); ;
resource, in water	Water, unspecified natural origin, KE	-	-	m3	0.00E+00	2.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
technosphere	compost, at plant	CH	0	kg	0.00E+00	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	average mineral fertiliser, as N, at regional storehouse	RER	0	kg	0.00E+00	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	pea seed IP, at regional storehouse	CH	0	kg	0.00E+00	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	0.00E+00	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	0.00E+00	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	transport, freight, lorry 16-32 metric ton, fleet average	CH	0	tkm	0.00E+00	1.00E+00	2.05E+00	(2,1,2,1,1,5,BU:2); ;
	diesel, burned in diesel-electric generating set	GLO	0	MJ	0.00E+00	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
emission air, low population density	Nitrogen oxides	-	-	kg	0.00E+00	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5); ;
	Dinitrogen monoxide	-	-	kg	0.00E+00	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5); ;
	Ammonia	-	-	kg	0.00E+00	1.00E+00	1.37E+00	(4,1,1,1,1,5,BU:1.2); ;
emission air, unspecified	Water, KE	-	-	kg	0.00E+00	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5); ;
emission water, ground-	Nitrate	-	-	kg	0.00E+00	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5); ;
	Phosphorus	-	-	kg	0.00E+00	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5); ;
emission water, river	Phosphorus	-	-	kg	0.00E+00	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5); ;
	Cadmium, ion	-	-	kg	0.00E+00	1.00E+00	3.32E+00	(4,1,1,1,4,5,BU:3); ;
	Chromium, ion	-	-	kg	0.00E+00	1.00E+00	3.32E+00	(4,1,1,1,4,5,BU:3); ;
	Copper, ion	-	-	kg	0.00E+00	1.00E+00	3.32E+00	(4,1,1,1,4,5,BU:3); ;
	Lead	-	-	kg	0.00E+00	1.00E+00	5.36E+00	(4,1,1,1,4,5,BU:5); ;
	Nickel, ion	-	-	kg	0.00E+00	1.00E+00	5.36E+00	(4,1,1,1,4,5,BU:5); ;
	Zinc, ion	-	-	kg	0.00E+00	1.00E+00	5.36E+00	(4,1,1,1,4,5,BU:5); ;
	Mercury	-	-	kg	0.00E+00	2.00E+00	5.36E+00	(4,1,1,1,4,5,BU:5); ;
emission water, unspecified	Water, river, KE	-	-	m3	0.00E+00	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5); ;
emission soil, agricultural	Cadmium	-	-	kg	0.00E+00	1.00E+00	1.63E+00	(4,1,1,1,4,5,BU:1.1); ;
	Copper	-	-	kg	0.00E+00	1.00E+00	1.63E+00	(4,1,1,1,4,5,BU:1.1); ;
	Zinc	-	-	kg	0.00E+00	1.00E+00	1.63E+00	(4,1,1,1,4,5,BU:1.1); ;
	Lead	-	-	kg	0.00E+00	1.00E+00	1.63E+00	(4,1,1,1,4,5,BU:1.1); ;
	Nickel	-	-	kg	0.00E+00	1.00E+00	1.63E+00	(4,1,1,1,4,5,BU:1.1); ;
	Chromium	-	-	kg	0.00E+00	1.00E+00	1.63E+00	(4,1,1,1,4,5,BU:1.1); ;
	Mercury	-	-	kg	0.00E+00	1.00E+00	1.63E+00	(4,1,1,1,4,5,BU:1.1); ;
emission economic-issue, unspecified	Water, embodied in product, KE	-	-	kg	0.00E+00	1.00E+00	1.62E+00	(4,1,1,1,4,5,BU:1.05); ;

Figure 26: Unit process raw data of green beans production in Kenya

ReferenceFunction	Name	green beans IP, at farm
Geography	Location	CH
ReferenceFunction	InfrastructureProcess	0
ReferenceFunction	Unit	kg
	IncludedProcesses	The inventory includes the processes of soil cultivation, sowing, weed control, fertilisation, pest and pathogen control and harvest. Machine infrastructure and a shed for machine sheltering is included. Inputs of fertilisers, pesticides and seed as well as their transports to the regional processing center are considered. The direct emissions on the field are also included.
	LocalName	Bohnen IP, ab Hof
	Synonyms	
	GeneralComment	The inventory refers to the production of green beans in Switzerland, based on Swiss integrated production
	InfrastructureIncluded	1
	Category	agricultural production
	SubCategory	plant production
	LocalCategory	Landwirtschaftliche Produktion
	LocalSubCategory	Pflanzenbau
	Formula	
	StatisticalClassification	
	CASNumber	
TimePeriod	StartDate	2017
	EndDate	2020
	DataValidForEntirePeriod	1
	OtherPeriodText	
Geography	Text	The inventory is modelled for Switzerland
Technology	Text	
Representativeness	Percent	
	ProductionVolume	
	SamplingProcedure	Data were compiled from literature
	Extrapolations	field work and pesticide application were etrapolated from fava beans production

Figure 27: Metadata of IP green beans production in Switzerland

	Name	Location	Infrastructure Process	Unit	green beans IP, at farm	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				CH			
	Infrastructure Process				0			
	Unit				kg			
product	green beans IP, at farm	CH	0	kg	1.0	0		
resource, biotic	Energy, gross calorific value, in biomass	-	-	MJ	1.54E+01	1.00E+00	1.30E+00	(4,1,1,1,1,5,BU:1.05); ;
resource, in air	Carbon dioxide, in air	-	-	kg	1.21E+00	1.00E+00	1.30E+00	(4,1,1,1,1,5,BU:1.05); ;
resource, land	Occupation, annual crop, non-irrigated	-	-	m2a	5.38E-01	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1); ;
	Transformation, from annual crop, non-irrigated	-	-	m2	1.08E+00	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1); ;
	Transformation, to annual crop, non-irrigated	-	-	m2	1.08E+00	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1); ;
technosphere	tillage, currying, by weeder	CH	0	ha	1.08E-04	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	tillage, harrowing, by spring tine harrow	CH	0	ha	2.15E-04	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	tillage, ploughing	CH	0	ha	1.08E-04	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	fertilising, by broadcaster	CH	0	ha	1.08E-04	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	combine harvesting	CH	0	ha	1.08E-04	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	application of plant protection products, by field sprayer	CH	0	ha	1.08E-04	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	sowing	CH	0	ha	1.08E-04	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	transport, tractor and trailer	CH	0	tkm	1.04E-02	1.00E+00	2.05E+00	(2,1,2,1,1,5,BU:2); ;
	pea seed IP, at regional storehouse	CH	0	kg	4.85E-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	1.08E-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	3.23E-03	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	benzo[thia]diazole-compounds, at regional storehouse	RER	0	kg	4.76E-05	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	diphenylether-compounds, at regional storehouse	RER	0	kg	2.11E-05	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	transport, freight, light commercial vehicle	CH	0	tkm	4.31E-04	1.00E+00	2.05E+00	(2,1,2,1,1,5,BU:2); ;
	transport, freight, lorry 16-32 metric ton, fleet average	CH	0	tkm	4.31E-04	1.00E+00	2.05E+00	(2,1,2,1,1,5,BU:2); ;
	green manure IP, until April	CH	0	ha	1.08E-04	1.00E+00	1.22E+00	(2,1,2,1,1,5,BU:1.05); ;
	irrigation, sprinkler	CH	0	m3	3.23E-02	1.00E+00	3.05E+00	(2,1,2,1,1,5,BU:3); ;
emission air, low population density	Nitrogen oxides	-	-	kg	1.96E-05	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5); ;
	Dinitrogen monoxide	-	-	kg	9.34E-05	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5); ;
emission air, unspecified	Water, CH	-	-	kg	2.26E+01	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5); ;
emission water, ground-	Nitrate	-	-	kg	1.22E-02	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5); ;
	Phosphorus	-	-	kg	7.99E-05	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5); ;
emission water, river	Phosphorus	-	-	kg	7.54E-06	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5); ;
	Cadmium, ion	-	-	kg	2.54E-09	1.00E+00	3.32E+00	(4,1,1,1,4,5,BU:3); ;
	Chromium, ion	-	-	kg	1.21E-06	1.00E+00	3.32E+00	(4,1,1,1,4,5,BU:3); ;
	Copper, ion	-	-	kg	1.78E-07	1.00E+00	3.32E+00	(4,1,1,1,4,5,BU:3); ;
	Lead	-	-	kg	1.45E-09	1.00E+00	5.36E+00	(4,1,1,1,4,5,BU:5); ;
	Nickel, ion	-	-	kg	1.01E-10	1.00E+00	5.36E+00	(4,1,1,1,4,5,BU:5); ;
	Zinc, ion	-	-	kg	2.38E-07	1.00E+00	5.36E+00	(4,1,1,1,4,5,BU:5); ;
emission water, unspecified	Water, CH	-	-	m3	8.78E-03	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5); ;
emission soil, agricultural	Cadmium	-	-	kg	4.76E-09	1.00E+00	1.63E+00	(4,1,1,1,4,5,BU:1.1); ;
	Bentazone	-	-	kg	4.76E-05	1.00E+00	1.67E+00	(4,1,1,1,4,5,BU:1.2); ;
	Fluazifop-P-butyl	-	-	kg	2.11E-05	1.00E+00	1.67E+00	(4,1,1,1,4,5,BU:1.2); ;
emission economic-issue, unspecified	Water, embodied in product, CH	-	-	kg	9.10E-01	1.00E+00	1.62E+00	(4,1,1,1,4,5,BU:1.05); ;

Figure 28: Unit process raw data of IP green beans production in Switzerland

ReferenceFunction	Name	green beans organic, at farm
Geography	Location	CH
ReferenceFunction	InfrastructureProcess	0
ReferenceFunction	Unit	kg
	IncludedProcesses	The inventory includes the processes of soil cultivation, sowing, weed control, fertilisation, pest and pathogen control and harvest. Machine infrastructure and a shed for machine sheltering is included. Inputs of fertilisers and seed as well as their transports to the regional processing center (10km) are considered. The direct emissions on the field are also included.
	LocalName	Bohnen bio, ab Hof
	Synonyms	
	GeneralComment	The inventory refers to the organic production of 1 kg of green beans in Switzerland
	InfrastructureIncluded	1
	Category	agricultural production
	SubCategory	plant production
	LocalCategory	Landwirtschaftliche Produktion
	LocalSubCategory	Pflanzenbau
	Formula	
	StatisticalClassification	
	CASNumber	
TimePeriod	StartDate	2017
	EndDate	2020
	DataValidForEntirePeriod	1
	OtherPeriodText	
Geography	Text	The inventory is modelled for Switzerland
Technology	Text	
Representativeness	Percent	
	ProductionVolume	
	SamplingProcedure	Literature
	Extrapolations	Data for fiel work activities were exrapolated from fava beans
	UncertaintyAdjustments	none

Figure 29: Metadata of organic green beans production in Switzerland

	Name	Location	Infrastructure Process	Unit	green beans organic, at farm	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				CH			
	Infrastructure Process				0			
	Unit				kg			
product	green beans organic, at farm	CH	0	kg	1.0	0		
resource, land	Occupation, annual crop, non-irrigated	-	-	m2a	7.69E-01	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1);
	Transformation, from annual crop, non-irrigated	-	-	m2	1.54E+00	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1);
	Transformation, to annual crop, non-irrigated	-	-	m2	1.54E+00	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1);
resource, biotic	Energy, gross calorific value, in biomass	-	-	MJ	1.52E+01	1.00E+00	1.30E+00	(4,1,1,1,1,5,BU:1.05);
resource, in air	Carbon dioxide, in air	-	-	kg	1.20E+00	1.00E+00	1.30E+00	(4,1,1,1,1,5,BU:1.05);
technosphere	tillage, currying, by weeder	CH	0	ha	1.54E-04	1.00E+00	1.32E+00	(4,1,3,1,1,5,BU:1.05);
	tillage, harrowing, by spring tine harrow	CH	0	ha	3.08E-04	1.00E+00	1.32E+00	(4,1,3,1,1,5,BU:1.05);
	tillage, ploughing	CH	0	ha	1.54E-04	1.00E+00	1.32E+00	(4,1,3,1,1,5,BU:1.05);
	combine harvesting	CH	0	ha	1.54E-04	1.00E+00	1.32E+00	(4,1,3,1,1,5,BU:1.05);
	sowing	CH	0	ha	1.54E-04	1.00E+00	1.32E+00	(4,1,3,1,1,5,BU:1.05);
	hoeing	CH	0	ha	1.54E-04	1.00E+00	1.32E+00	(4,1,3,1,1,5,BU:1.05);
	transport, tractor and trailer	CH	0	tkm	1.04E-02	1.00E+00	2.11E+00	(4,1,3,1,1,5,BU:2);
	pea seed organic, at regional storehouse	CH	0	kg	6.92E-03	1.00E+00	1.32E+00	(4,1,3,1,1,5,BU:1.05);
	green manure organic, until April	CH	0	ha	1.54E-04	1.00E+00	1.32E+00	(4,1,3,1,1,5,BU:1.05);
	irrigation, sprinkler	CH	0	m3	4.62E-02	1.00E+00	3.32E+00	(4,1,1,1,4,5,BU:3);
emission air, low population density	Nitrogen oxides	-	-	kg	2.95E-05	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5);
	Dinitrogen monoxide	-	-	kg	1.41E-04	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5);
emission air, unspecified	Water, CH	-	-	kg	3.23E-05	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5);
emission water, ground-	Phosphorus	-	-	kg	1.08E-05	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5);
	Nitrate	-	-	kg	2.02E-02	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5);
emission water, river	Phosphorus	-	-	kg	1.13E-04	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5);
	Cadmium, ion	-	-	kg	0.00E+00	1.00E+00	3.32E+00	(4,1,1,1,4,5,BU:3);
emission water, unspecified	Water, CH	-	-	m3	1.29E-02	1.00E+00	1.88E+00	(4,1,1,1,4,5,BU:1.5);

Figure 30: Unit process raw data of organic green beans production in Switzerland

ReferenceFunction	401	Name	tomatoes conventional, hors-sol, at greenhouse
Geography	662	Location	ES
ReferenceFunction	493	InfrastructureProcess	0
ReferenceFunction	403	Unit	kg
	402	IncludedProcesses	The inventory includes : (1) irrigating, fertilisation, pest and pathogen control, heating, harvesting; (2) the greenhouse and the machines and shed or surface used to park them; (3) all inputs as young plants (nursery), fertilizers (mineral and organic), growing media, active substances, water for irrigation, fuels end energy as well as the transport to the farm; The temporal border of the inventory is one year of continuous production.
	490	LocalName	Tomaten konventionell, hors-sol, ab Gewächshaus
	491	Synonyms	
	492	GeneralComment	The inventory refers to the hors-sol production of 1 kg of tomato in Almeria in an unheated greenhouse
	494	InfrastructureIncluded	1
	495	Category	agricultural production
	496	SubCategory	plant production
	497	LocalCategory	Landwirtschaftliche Produktion
	498	LocalSubCategory	Pflanzenbau
	499	Formula	
	501	StatisticalClassification	
	502	CASNumber	
TimePeriod	601	StartDate	2017
	602	EndDate	2020
	603	DataValidForEntirePeriod	1
	611	OtherPeriodText	
Geography	663	Text	The inventory is modelled for Spain
Technology	692	Text	
Representativeness	722	Percent	
	724	ProductionVolume	
	725	SamplingProcedure	Literature
	726	Extrapolations	none
	727	UncertaintyAdjustments	none

Figure 31: Metadata of tomato production in unheated greenhouse in Almeria

	Name	Location	Infrastructure Process	Unit	tomatoes conventional, hors-sol, at greenhouse	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				ES			
	Infrastructure Process				0			
	Unit				kg			
product	tomatoes conventional, hors-sol, at greenhouse	ES	0	kg	1.0	0		
resource, biotic	Energy, gross calorific value, in biomass	-	-	MJ	7.60E-01	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
resource, in air	Carbon dioxide, in air	-	-	kg	7.70E-02	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
resource, in water	Water, unspecified natural origin, EG	-	-	m3	1.55E-02	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
technosphere	average mineral fertiliser, as N, at regional storehouse	RER	0	kg	5.77E-03	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	2.61E-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	1.08E-02	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	pesticide unspecified, at regional storehouse	RER	0	kg	3.19E-05	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	rock wool, at plant	CH	0	kg	1.12E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	Tomato, seedling, conventional, soilless production, at production site	RER	0	p	1.15E-01	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	polyethylene, HDPE, granulate, at plant	RER	0	kg	1.12E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	extrusion, plastic film	RER	0	kg	1.15E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	polyvinylchloride, at regional storage	RER	0	kg	1.85E-04	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	injection moulding	RER	0	kg	2.02E-04	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	steel, low-alloyed, at plant	RER	0	kg	2.84E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	section bar rolling, steel	RER	0	kg	2.84E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	plastic tunnel	ES	1	m2a	7.69E-02	1.00E+00	3.05E+00	(2,3,1,1,1,5,BU:3);
	tap water, desalinated sea water, at user	ES	0	kg	3.16E+00	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	polypropylene, granulate, at plant	RER	0	kg	1.62E-05	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	electricity, low voltage, at grid	ES	0	kWh	1.70E-02	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	diesel, burned in diesel-electric generating set	GLO	0	MJ	7.85E-02	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	1.12E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	disposal, polypropylene, 15.9% water, to municipal incineration	CH	0	kg	1.62E-05	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	disposal, polyvinylchloride, 0.2% water, to municipal incineration	CH	0	kg	1.85E-04	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
emission air, low population density	Dinitrogen monoxide	-	-	kg	4.63E-05	1.00E+00	1.57E+00	(2,3,1,1,1,5,BU:1.5);
	Ammonia	-	-	kg	2.02E-04	1.00E+00	1.31E+00	(2,3,1,1,1,5,BU:1.2);
	Nitrogen oxides	-	-	kg	9.69E-06	1.00E+00	1.57E+00	(2,3,1,1,1,5,BU:1.5);
emission air, unspecified	Water, ES	-	-	kg	1.66E+01	1.00E+00	1.57E+00	(2,3,1,1,1,5,BU:1.5);
emission water, unspecified	Water, ES	-	-	m3	3.26E+00	1.00E+00	1.57E+00	(2,3,1,1,1,5,BU:1.5);
emission soil, agricultural	Mancozeb	-	-	kg	9.88E-06	1.00E+00	1.31E+00	(2,3,1,1,1,5,BU:1.2);
	Triadimenol	-	-	kg	3.12E-06	1.00E+00	1.31E+00	(2,3,1,1,1,5,BU:1.2);
	Kresoxim-methyl	-	-	kg	3.85E-07	1.00E+00	1.31E+00	(2,3,1,1,1,5,BU:1.2);
	Sulfur	-	-	kg	5.77E-06	1.00E+00	1.57E+00	(2,3,1,1,1,5,BU:1.5);
	Imidacloprid	-	-	kg	1.15E-06	1.00E+00	1.31E+00	(2,3,1,1,1,5,BU:1.2);
	Iprodion	-	-	kg	1.92E-06	1.00E+00	1.31E+00	(2,3,1,1,1,5,BU:1.2);
	Cymoxanil	-	-	kg	5.08E-06	1.00E+00	1.31E+00	(2,3,1,1,1,5,BU:1.2);
emission economic-issue, unspecified	Water, embodied in product, CH	-	-	kg	9.51E-01	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);

Figure 32: Unit process raw data of tomato production in unheated greenhouse in Almeria

ReferenceFunction	Name	tomatoes late conventional, hors-sol heated, at greenhouse
Geography	Location	CH
ReferenceFunction	InfrastructureProcess	0
ReferenceFunction	Unit	kg
DataSetInformation	Type	1
	Version	1.0
	energyValues	0
	LanguageCode	en
	LocalLanguageCode	de
DataEntryBy	Person	107
	QualityNetwork	1
ReferenceFunction	DataSetRelatesToProduct	1
	IncludedProcesses	The inventory includes : (1) irrigating, fertilisation, pest and pathogen control, heating, harvesting; (2) the greenhouse ; (3) all inputs as young plants (nursery), fertilizers (mineral and organic), growing media, active substances, water for irrigation, fuels end energy as well as the transport to the farm; (4) the direct emissions of the fuel combustion and the direct emissions in the greenhouse. The temporal border of the inventory is one year of continuous production.
	Amount	1
	LocalName	Tomaten spät konventionell, hors-sol beheizt, ab Gewächshaus
	Synonyms	
	GeneralComment	The inventory refers to the production of 1kg of fresh tomato in a heated greenhouse in Switzerland
	InfrastructureIncluded	1
	Category	agricultural production
	SubCategory	plant production
	LocalCategory	Landwirtschaftliche Produktion
	LocalSubCategory	Pflanzenbau
	Formula	
	StatisticalClassification	
	CASNumber	
TimePeriod	StartDate	2017
	EndDate	2020
	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 33: Metadata of tomato production in heated greenhouse in Switzerland, late harvest

	Name	Location	Infrastructure Process	Unit	tomatoes late conventional, hors-sol heated, at greenhouse	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				CH			
	Infrastructure Process				0			
	Unit				kg			
product	tomatoes late conventional, hors-sol heated, at greenhouse	CH	0	kg	1.0	0		
resource, biotic	Energy, gross calorific value, in biomass	-	-	MJ	7.60E-01	1.00E+00	1.22E+00	(2,1,1,1,1,5,BU:1.05);
resource, in air	Carbon dioxide, in air	-	-	kg	7.70E-02	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	1.50E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	magnesium sulphate, at plant	RER	0	kg	5.57E-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	7.44E-04	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	3.16E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	Tomato, seedling, conventional, soilless production, at production site	RER	0	p	4.83E-06	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	1.86E+01	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	polypropylene, granulate, at plant	RER	0	kg	1.57E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	extrusion, plastic film	RER	0	kg	1.62E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	polypropylene, granulate, at plant	RER	0	kg	3.35E-01	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	injection moulding	RER	0	kg	3.35E-01	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	polypropylene, granulate, at plant	RER	0	kg	1.34E+00	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	injection moulding	RER	0	kg	1.35E+00	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	steel, low-alloyed, at plant	RER	0	kg	2.72E+00	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	section bar rolling, steel	RER	0	kg	2.72E+00	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	polypropylene, granulate, at plant	RER	0	kg	3.22E-04	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	extrusion, plastic film	RER	0	kg	3.32E-04	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	3.22E-02	1.00E+00	3.05E+00	(2,3,1,1,1,5,BU:3);
	pesticide unspecified, at regional storehouse	RER	0	kg	1.78E-06	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	rape oil, at oil mill	CH	0	kg	3.87E-05	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	chemicals organic, at plant	GLO	0	kg	1.61E-05	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	heat, natural gas, at boiler modulating >100kW	RER	0	MJ	4.91E+00	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	electricity, low voltage, at grid	CH	0	kWh	4.90E-02	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	electricity, low voltage, at grid	CH	0	kWh	1.86E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
emission air, low population density	Dinitrogen monoxide	-	-	kg	1.22E-05	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
	Ammonia	-	-	kg	5.22E-05	1.00E+00	1.37E+00	(4,1,1,1,1,5,BU:1.2);
	Carbon dioxide, fossil	-	-	kg	2.78E-04	1.00E+00	1.30E+00	(4,1,1,1,1,5,BU:1.05);
	Nitrogen oxides	-	-	kg	2.56E-06	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
emission air, unspecified	Water, CH	-	-	kg	1.75E+01	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
emission water, unspecified	Water, CH	-	-	m3	1.66E-04	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
emission soil, agricultural	Tebuconazole	-	-	kg	9.66E-07	1.00E+00	1.37E+00	(4,1,1,1,1,5,BU:1.2);
	Trifloxystrobin	-	-	kg	4.83E-07	1.00E+00	1.37E+00	(4,1,1,1,1,5,BU:1.2);
	Azadirachtin	-	-	kg	1.93E-07	1.00E+00	1.37E+00	(4,1,1,1,1,5,BU:1.2);
	Oils, biogenic	-	-	kg	3.87E-05	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
	Spinosad	-	-	kg	1.42E-07	1.00E+00	1.37E+00	(4,1,1,1,1,5,BU:1.2);
emission economic-issue, unspecified	Water, embodied in product, CH	-	-	kg	9.50E-01	1.00E+00	1.30E+00	(4,1,1,1,1,5,BU:1.05);

Figure 34: Unit process raw data of tomato production in heated greenhouse in Switzerland, late harvest

ReferenceFunction	Name	tomatoes early conventional, hors-sol heated, at greenhouse
Geography	Location	CH
ReferenceFunction	InfrastructureProcess	0
ReferenceFunction	Unit	kg
	IncludedProcesses	The inventory includes : (1) irrigating, fertilisation, pest and pathogen control, heating, harvesting; (2) the greenhouse ; (3) all inputs as young plants (nursery), fertilizers (mineral and organic), growing media, active substances, water for irrigation, fuels end energy as well as the transport to the farm; (4) the direct emissions of the fuel combustion and the direct emissions in the greenhouse. The temporal border of the inventory is one year of continuous production.
	LocalName	Tomaten früh konventionell, hors-sol beheizt, ab Gewächshaus
	Synonyms	
	GeneralComment	The inventory refers to the production of 1kg of fresh tomato in a greenhouse in Switzerland
	InfrastructureIncluded	1
	Category	agricultural production
	SubCategory	plant production
	LocalCategory	Landwirtschaftliche Produktion
	LocalSubCategory	Pflanzenbau
	Formula	
	StatisticalClassification	
	CASNumber	
TimePeriod	StartDate	2017
	EndDate	2020
	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 35: Metadata of tomato production in heated greenhouse in Switzerland, early harvest

	Name	Location	Infrastructure Process	Unit	tomatoes early conventional, hors-sol heated, at greenhouse	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				CH			
	Infrastructure Process				0			
	Unit				kg			
product	tomatoes early conventional, hors-sol heated, at greenhouse	CH	0	kg	1.0	0		
resource, biotic	Energy, gross calorific value, in biomass	-	-	MJ	7.60E-01	1.00E+00	1.22E+00	(2,1,1,1,1,5,BU:1.05);
resource, in air	Carbon dioxide, in air	-	-	kg	7.70E-02	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	1.50E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	magnesium sulphate, at plant	RER	0	kg	5.57E-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	7.44E-04	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	3.16E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	Tomato, seedling, conventional, soilless production, at production site	RER	0	p	4.83E-06	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	1.86E+01	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	polypropylene, granulate, at plant	RER	0	kg	1.57E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	extrusion, plastic film	RER	0	kg	1.62E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	polypropylene, granulate, at plant	RER	0	kg	3.35E-01	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	injection moulding	RER	0	kg	3.35E-01	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	polypropylene, granulate, at plant	RER	0	kg	1.34E+00	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	injection moulding	RER	0	kg	1.35E+00	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	steel, low-alloyed, at plant	RER	0	kg	2.72E+00	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	section bar rolling, steel	RER	0	kg	2.72E+00	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	polypropylene, granulate, at plant	RER	0	kg	3.22E-04	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	extrusion, plastic film	RER	0	kg	3.32E-04	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	3.22E-02	1.00E+00	3.05E+00	(2,3,1,1,1,5,BU:3);
	pesticide unspecified, at regional storehouse	RER	0	kg	1.78E-06	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	rape oil, at oil mill	CH	0	kg	3.87E-05	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	chemicals organic, at plant	GLO	0	kg	1.61E-05	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	heat, natural gas, at boiler modulating >100kW	RER	0	MJ	6.71E+00	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	electricity, low voltage, at grid	CH	0	kWh	6.70E-02	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
	electricity, low voltage, at grid	CH	0	kWh	1.86E-03	1.00E+00	1.22E+00	(2,3,1,1,1,5,BU:1.05);
emission air, low population density	Dinitrogen monoxide	-	-	kg	1.22E-05	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
	Ammonia	-	-	kg	5.22E-05	1.00E+00	1.37E+00	(4,1,1,1,1,5,BU:1.2);
	Carbon dioxide, fossil	-	-	kg	2.78E-04	1.00E+00	1.30E+00	(4,1,1,1,1,5,BU:1.05);
	Nitrogen oxides	-	-	kg	2.56E-06	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
emission air, unspecified	Water, CH	-	-	kg	1.75E+01	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
emission water, unspecified	Water, CH	-	-	m3	1.66E-04	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
emission soil, agricultural	Tebuconazole	-	-	kg	9.66E-07	1.00E+00	1.37E+00	(4,1,1,1,1,5,BU:1.2);
	Trifloxystrobin	-	-	kg	4.83E-07	1.00E+00	1.37E+00	(4,1,1,1,1,5,BU:1.2);
	Azadirachtin	-	-	kg	1.93E-07	1.00E+00	1.37E+00	(4,1,1,1,1,5,BU:1.2);
	Oils, biogenic	-	-	kg	3.87E-05	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
	Spinosad	-	-	kg	1.42E-07	1.00E+00	1.37E+00	(4,1,1,1,1,5,BU:1.2);
emission economic-issue, unspecified	Water, embodied in product, CH	-	-	kg	9.50E-01	1.00E+00	1.30E+00	(4,1,1,1,1,5,BU:1.05);

Figure 36: Unit process raw data of tomato production in heated greenhouse in Switzerland, early harvest

ReferenceFunction	Name	tomatoes organic, tunnel, at farm
Geography	Location	CH
ReferenceFunction	InfrastructureProcess	0
ReferenceFunction	Unit	kg
DataSetInformation	Type	1
	Version	1.0
	energyValues	0
	LanguageCode	en
	LocalLanguageCode	de
DataEntryBy	Person	107
	QualityNetwork	1
ReferenceFunction	DataSetRelatesToProduct	1
	IncludedProcesses	The inventory includes : (1) irrigating, fertilisation, pest and pathogen control, heating, harvesting; (2) the greenhouse and the machines and shed or surface used to park them; (3) all inputs as young plants (nursery), fertilizers (mineral and organic), growing media, active substances, water for irrigation, fuels end energy as well as the transport to the farm; (4) the direct emissions of the fuel combustion, and the direct emissions in the greenhouse. The temporal border of the inventory is one year of continuous production.
	Amount	1
	LocalName	Tomaten Bio, Folientunnel, ab Hof
	Synonyms	
	GeneralComment	The inventory refers to the production of 1 kg organic fresh tomato in a double layer tunnel
	InfrastructureIncluded	1
	Category	agricultural production
	SubCategory	plant production
	LocalCategory	Landwirtschaftliche Produktion
	LocalSubCategory	Pflanzenbau
	Formula	
	StatisticalClassification	
	CASNumber	
TimePeriod	StartDate	2017
	EndDate	2020
	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 37: Metadata of organic tomato production in unheated greenhouse in Switzerland

	Name	Location	Infrastructure Process	Unit	tomatoes organic, tunnel, at farm	Uncertainty Type	Standard Deviation 95%	General Comment
	Location				CH			
	Infrastructure Process				0			
	Unit				kg			
product	tomatoes organic, tunnel, at farm	CH	0	kg	1.0	0		
resource, biotic	Energy, gross calorific value, in biomass	-	-	MJ	7.63E-02	1.00E+00	1.22E+00	(2,1,1,1,1,5,BU:1.05);
resource, in air	Carbon dioxide, in air	-	-	kg	0.00E+00	1.00E+00	1.22E+00	(2,1,1,1,1,5,BU:1.05);
technosphere	vinasse, at fermentation plant	CH	0	kg	4.29E-05	1.00E+00	1.24E+00	(3,3,1,1,1,5,BU:1.05);
	tillage, ploughing	CH	0	ha	6.25E-06	1.00E+00	1.24E+00	(3,3,1,1,1,5,BU:1.05);
	tillage, harrowing, by spring tine harrow	CH	0	ha	6.25E-06	1.00E+00	1.24E+00	(3,3,1,1,1,5,BU:1.05);
	green manure organic, until April	CH	0	ha	6.25E-06	1.00E+00	1.24E+00	(3,3,1,1,1,5,BU:1.05);
	tap water, unspecified natural origin CH, at user	CH	0	kg	2.64E+00	1.00E+00	1.24E+00	(3,3,1,1,1,5,BU:1.05);
	plastic tunnel	CH	1	m2a	6.25E-02	1.00E+00	3.06E+00	(3,3,1,1,1,5,BU:3);
	Tomato, seedling, conventional, soilless production, at production site	RER	0	p	2.40E+05	1.00E+00	1.24E+00	(3,3,1,1,1,5,BU:1.05);
	polypropylene, granulate, at plant	RER	0	kg	6.25E-02	1.00E+00	1.24E+00	(3,3,1,1,1,5,BU:1.05);
	extrusion, plastic film	RER	0	kg	6.40E-02	1.00E+00	1.24E+00	(3,3,1,1,1,5,BU:1.05);
	polypropylene, granulate, at plant	RER	0	kg	6.25E-02	1.00E+00	1.24E+00	(3,3,1,1,1,5,BU:1.05);
	injection moulding	RER	0	kg	6.29E-02	1.00E+00	1.24E+00	(3,3,1,1,1,5,BU:1.05);
	steel, low-alloyed, at plant	RER	0	kg	6.25E-02	1.00E+00	1.24E+00	(3,3,1,1,1,5,BU:1.05);
	electricity, low voltage, production CH, at grid	CH	0	kWh	2.64E-03	1.00E+00	1.24E+00	(3,3,1,1,1,5,BU:1.05);
emission air, low population density	Dinitrogen monoxide	-	-	kg	5.81E-06	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
	Ammonia	-	-	kg	5.55E-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	1.22E-06	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
emission air, unspecified	Water, CH	-	-	kg	1.85E+01	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
emission water, ground-	Phosphate	-	-	kg	4.38E-07	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
emission water, unspecified	Water, CH	-	-	m3	7.00E-03	1.00E+00	1.62E+00	(4,1,1,1,1,5,BU:1.5);
emission soil, agricultural	Cadmium	-	-	kg	6.68E-08	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1);
	Copper	-	-	kg	1.89E-06	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1);
	Zinc	-	-	kg	8.46E-06	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1);
	Lead	-	-	kg	2.40E-06	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1);
	Chromium	-	-	kg	1.07E-06	1.00E+00	1.32E+00	(4,1,1,1,1,5,BU:1.1);
	Mercury	-	-	kg	5.88E-09	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	9.50E-01	1.00E+00	1.30E+00	(4,1,1,1,1,5,BU:1.05);

Figure 38: Unit process raw data of organic tomato production in unheated greenhouse in Switzerland

External review

LCA of tomatoes and beans production

Bundesamt für Umwelt BAFU

Zürich, 9.12.2021

Content: External Review of the “Life cycle assessment of tomatoes and beans production”, carried out by Carbotech AG and commissioned by the Bundesamt für Umwelt BAFU

Date: 9.12.2021

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1 Background

The Bundesamt für Umwelt BAFU has commissioned Carbotech AG to update the inventory data and life cycle assessment calculations of tomatoes and beans. These two food products are often used as examples to communicate the methodological processes of LCA. As the data basis of the studies is already older, the BAFU considered it urgent to carry out an update.

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 tomatoes and beans production" from the 1st December 2021.
- Life cycle inventories "Inventare Tomaten" and "Inventare Bohnen", including the inventories 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 tomatoes and beans 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. It was also clearly explained that the use phase (preparation by the end customer) is also considered for the beans.

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 goes into detail about 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 analysis focuses on the one hand on the countries where tomatoes and beans are grown, and on the other hand on the Swiss market as the place of sale, which reflects the present situation well. 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 always used, or an approach was taken based on real situations (e.g. in the preparation of the beans).

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 author. The data used were checked, while additional detailed information was provided by the author. 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 fertilizers and pesticides, as well as the closely connected direct field emissions, 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.

But the flows are also well modelled in the other phases. The use of materials in infrastructure and packaging, their disposal and the various transport processes were fully covered. In case of the beans, the utilization phase and the relevant energy flows were also properly assessed.

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 author, 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, 09.12.2021

Andy Eigenmann