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GLOSSARY AND ACRONYMS

KEPIs	Key Environmental Performance Indicators
LCA	Life Cycle Assessment
LCIA	Life cycle Impact Assessment
N/A	Not Applicable
SENSE	Harmonised Environmental Sustainability in the European food and drink chain
SME	Small and Medium Enterprises

1 EXECUTIVE SUMMARY

This deliverable contains the data (indicators) that is to be collected from each production step in the supply chain. The following production steps have been defined:

- Company profile (not a production step, but data must be collected)
- Plant production (food and feed)
- Fisheries
- Aquaculture
- Livestock
- Food and feed processing
- Transports

Measurable Key Environmental Performance Indicators (KEPIs) with a food chain approach for different products groups is also suggested, based on work in WP1 and WP2. It shall be noted that those KEPIs do not have an LCA perspective as they mostly reflect data on resources consumption in the value chain, no modelling of emissions is done as in an LCA. The KEPIs shall not be used directly to compare products or producers, but they may help the SMEs in the food chain to understand the differences in results for the LCIA indicators that also will be the result from the SENSE tool.

2 Environmental performance indicators for the food chain

2.1 Overview

Deliverable 2.2 of the SENSE project contains the data that is to be collected from each production step in the supply chain. Measureable Key Environmental Performance Indicators (KEPIs) with a food chain approach for different products groups is also suggested, based on work in WP1 and WP2.

In WP 1 the key environmental impacts and challenges for the three food supply chains meat/dairy, orange juice and aquaculture, have been identified based on literature reviews of LCA studies (Landquist et al., 2013). Based on the research the following key environmental impact categories have been identified: climate change, eutrophication, acidification, human toxicity, ecotoxicity, land use, abiotic resource depletion and water depletion. For each impact category an LCIA method, regionalized when appropriate, has been selected to be used in the further work in the SENSE project (Aronsson et al., 2013, Esturo et al., 2013).

In task 2.1 three Life Cycle Assessment (LCA) case studies were performed and priority information that should be asked from an SME was identified for each of the three selected food supply chains (Jungbluth et al., 2013a, Jungbluth et al., 2013b, Yngvadottir et al., 2013). Task 2.1 also identified KEPIs as 'simple to measure indicators' that can be used in the SENSE tool to calculate an indicator for the environmental impacts from each production step in the value chain.

In task 2.3 the standardized system to collect data is developed, as well as a guide on how the input data shall be collected or calculated. Remaining categories will also be defined.

The SENSE tool will create a simplified LCA from the information that are collected from the SMEs in the food chain. The result from the simplified LCA will be presented as LCIA indicators. Also, for each production step of the food chain, KEPIs will be calculated. The KEPIs must be simple and linked to key environmental challenges, build on accessible production data in the supply chain production steps and should also be easy to understand to be able to use them to communicate environmental performance through the supply chain.

It is important that indicators are measurable and based on data that is currently collected or can be collected with little monetary input. Feenstra et al., 2005 defined the following essential parameters for an indicator:

- **Measurable:** The indicator data must be quantifiable.
- **Available:** The data must be available to the public.
- **Cost-effective:** It must be possible to access the data with little monetary input.
- **Stable, reliable, credible:** The data must be from a reliable and credible source, collected in a rigorous and consistent way and replicable from one time period to the next.
- **Understandable and usable:** The indicator must be easily understandable by potential interpreters so that they feel confident on how to use it.

To be useful indicators should be quantitative, relevant and understandable (Cederberg 2004). Similar conclusions were made by Van der Werf and Petit (2002) for on-farm level indicators. In this study it was recommended that indicators are based on environmental effects of practices rather than indicators based on practices as the link with the objective is direct and the choice of means to perform or change the practice is up to the producer.

The KEPIs developed in the SENSE project are based on the three LCA case studies from task 2.1.

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2.2 Indicators for the different production steps in the food chain

Based on the previous research in the SENSE project the indicators that are to be collected from the SMEs have been identified. They have been grouped according to the different production steps in the supply chain and are presented in a table for each production step. The following production steps have been defined:

- Company profile (not a production step, but data must be collected)
- Plant production (food and feed)
- Fisheries
- Aquaculture
- Livestock
- Food and feed processing
- Transports

In the following chapters the input data that is to be asked for in each production step is given together with the unit in which it is to be collected. For some of the data input categories have been defined already in this deliverable, and the remaining will be defined in task 2.3. In the tables in the following chapters this has been marked with *Preliminary, to be defined* together with some examples of what to report for the indicator. The categories are needed to streamline the input of data and the calculation of the simplified LCAs in the SENSE tool.

For all processing steps as well as for the company level the share of products and by-products of total turnover is collected. This data is needed to distribute the environmental impact between the products and by-products. The SENSE project group has chosen economic allocation as a standard as it is a method that is widely used, and it gives an allocation of the environmental burden that most often are relative fair. Various allocation methods can be favourable for various products and by-products, and some food associations have agreed upon a specific allocation method. The SENSE tool will only create simplified LCAs, and it would make it too complicated to use different allocation methods for various food processing steps.

2.2.1 Company profile

The data in Table 1 shall be collected from all enterprises involved in the supply chain.

Table 1. Indicators for companies in the supply chain, *Company profile*

Indicators	Unit	Categories
Area of buildings	m ²	N/A
Share of investigated products of total turnover	%	N/A

2.2.2 Plant production – food and feed

The products from **Plant production** in agriculture are either used directly as food, e.g. orange juice, or as feed to animals (e.g. cows or fishes) to produce food, e.g. meat, milk or fish. The feed for cows and fish most often consists of more than one crop or constituent. The feed can be grown on the farm or purchased.

For each crop used as food or feed the data for **Plant production** in Table 2 is to be collected. If the detailed data is not known, e.g. if the feed is purchased general data LCI data from Ecoinvent must be available in the tool, see the production step **Aquaculture** chapter 2.2.4 and **Livestock** chapter 2.2.5.

The unit is per cultivated hectare of the crop if nothing else is stated.

Table 2. Indicators for **Plant production**

Indicators	Unit	Categories
Land use	ha	Arable; Grazing; Permanent crop; Forest
Plant products and by-products	type	<i>Preliminary, to be defined:</i> Barley; Maize; Hey; Silage; Oranges; Straw etc.
Yield of plant product and by-products	kg/ha	N/A
Share of product and by-products profit of the total crop profit	%	N/A
Nitrogen-fertiliser use	kg-N/ha	<i>Preliminary, to be defined:</i> Nitrate; Ammonium; Urea
Phosphorous-fertiliser use	kg-P ₂ O ₅ or kg-P/ha	N/A
Manure and slurry application	kg/ha	<i>To be defined</i>
Pesticide and active substance	kg/ha	<i>To be defined</i>
Energy use	MJ/ha (or other units e.g. l, kWh)	Diesel; Petrol; Electricity by country; Natural gas
Fresh water use	m ³ /ha	By country

2.2.3 Fisheries

The data for **Fisheries** is listed in Table 3 and is to be collected per year if nothing else is stated.

One of the case studies in the SENSE is aquaculture where fishmeal and other products originating from fisheries are used as feed the aquaculture. Fish feed is produced from oily fish (pelagic species like herring, capelin, mackerel, and menhaden and species like bluewithing etc.). Some of these are also used for human consumption. Additionally, products used for feed are by-products from demersal species that are directly used as food. Therefore data for **Fisheries** must be collected to assess the impact of the catching which is mainly fuel use depending on type of fishing method and species. The fish feed most often consists of more than one fish species. For each fish species used as feed the following table must be completed.

The production step **Fisheries** end at the harbour when the fish or fish products are landed.

Table 3. Indicators for **Fisheries**

Indicator	Unit	Categories
Products sold	kg	<i>Preliminary, to be defined.</i> Species; Whole fish; Head on gutted
Share of product and by-products profit of the total company profit	%	N/A
Energy use	MJ (or other units e.g. l, kWh)	Diesel, Heavy fuel oil, Natural gas, Biogas; Electricity; Steam

2.2.4 Aquaculture

The data for **Aquaculture** is listed in Table 4 and is to be collected per year if nothing else is stated.

For the **Aquaculture** production step the use of feed is an important environmental indicator. Therefore it is important to get a good idea of the feed consumption and the constituents of the feed, which can be from both agriculture and fisheries.

For the use of feed the first choice could be to enter if feed is purchased or produced at the farm and next production step is to enter the constituents and other detailed information.

If detailed data on the cultivation of the different components of the feed is not available, general LCI data from Ecoinvent must be available in the tool, for crop ingredients e.g. soy meal and fish ingredients (fish meal and fish oil from different species).

Table 4. Indicators for **Aquaculture**

Indicator	Unit	Categories
Products sold	kg	<i>Preliminary, to be defined.</i> Species; Whole fish; Head on gutted; Fillets; Trimmings; Bones; Head etc.
Animal weight	kg live weight	<i>To be defined.</i> Species
Share of product and by-products profit of the total company profit	%	N/A
Use of feed, total	kg	N/A
Feed: Composition	%	<i>Preliminary, to be defined.</i> Capelin meal; Herring meal; Capelin oil; Wheat; Rape seed meal; Maize wheat gluten; Soybean meal; Soybean oil; Vitamin; Minerals; Colour; Purchased feed, composition unknown
Energy use	MJ (or other units e.g. l, kWh)	Diesel; Heavy fuel oil; Natural gas; Biogas; Electricity; Steam
Fresh water use	m ³	By country
Wastewater	m ³	N/A
Wastewater (quality)	mg/l	P; N; TSS; BOD; COD
Packaging material	Kg	<i>Preliminary, to be defined.</i> Paper; Plastic; Metal; Glass etc

2.2.5 Livestock

The data for **Livestock** is presented in table (Table 5) and is to be collected per year if nothing else is stated.

Another case study in the SENSE project is the supply chain for beef and dairy products. In this supply chain the emissions of methane from the ruminants are very important for climate change. Therefore detailed data on the herd size as well as the weight and number of dairy cows, calves etc. in the herd is needed as this data is used to calculate the methane emissions.

The feed can either be cultivated at the farm or purchased. If it is cultivated at the farm, the production step **Plant production** shall be used for the different crops. If detailed data on the cultivation of the different components of the feed is not available, e.g. if it is purchased as a mix, general LCI data from Ecoinvent must be available in the tool, e.g. for soy meal and fish meal.

The share of products and by-products refer to the animal sold for slaughtering and other animals sold to other farms.

The milking is included in the **Livestock** production step.

Table 5. Indicators for **Livestock**

Indicator	Unit	Categories
Type of animal	Category	Dairy cows; Bull; Suckler cow; Calf; Heifer; Non-dairy cattle; Market swine; Breeding swine; Swine; Buffalo; Sheep; Goats; Camels; Horses, mules and asses; Poultry
Herd size	Number/category	Drop down menu 'Type of animal'
Animal weight per category (drop down menu from Type of animal)	kg live weight/ category	Drop down menu 'Type of animal'
Products sold	kg or l	<i>Preliminary, to be defined.</i> <i>Raw milk, animal to slaughter, egg, wool etc</i>
Share of product and by-products profit of the total company profit	%	N/A
Use of feed, total	kg	N/A
Feed composition (to be selected from input to the production step Plant production It should also be possible to add other purchased feed)	%	<i>Preliminary, to be defined.</i> Drop-down menu from Plant production plus additional choices for purchased feed: Barley, Wheat; Rape seed meal; Maize wheat gluten; Soybean meal; Soybean oil; Vitamin; Minerals; Colour; Purchased feed, composition unknown
Energy use	MJ (or other units e.g. l, kWh)	Diesel, Heavy fuel oil, Natural gas, Biogas; Electricity; Steam; Cooling energy; Compressed air
Fresh water use	m ³	By country

2.2.6 Food and feed processing

The data for **Food and feed processing** (Table 6) is to be collected per year if nothing else is stated.

In the **Food and feed processing** step processes are included where various raw materials are processed and packed, e.g. the slaughterhouse where the cow is slaughtered and the beef is produced, the dairy where the milk products are produced, and the juice processing plant where the orange juice is pressed and packed. Also feed processing is included, e.g. to produce fish meal and fish oil. The amount and type of packaging material should also be collected.

Table 6. Indicators for **Food and feed processing** companies

Indicator	Unit	Categories
Food product and by-products sold	kg or l	<i>To be defined</i>
Share of product and by-products profit of the total company profit	%	N/A
Incoming product (raw materials)	kg or l	Drop down menu from previous life cycle production steps, see chapter 2.2.7.
Energy use	MJ (or other units e.g. l, kWh)	Electricity; Steam; Cooling energy; Compressed air
Fresh water use	m ³	By country
Packaging material	kg	<i>Preliminary, to be defined.</i> Paper, Card board, Plastic, Metal, Glass etc.
Wastewater	m ³	<i>Preliminary, to be defined:</i> High load, Low load
Waste and Waste handling as drop down menu for each chosen waste	kg	<i>Preliminary, to be defined.</i> <i>Waste: Plastics, Paper, Cardboard, Glass, metals, Organic waste, Classified waste etc.</i> <i>Waste handling: Reuse, Recycling, Incineration without energy reuse, Incineration with energy use, Landfill, Composting etc.</i>

2.2.7 Transportation

Transports occur between the other production steps in the food chain. In the SENSE tool this production step is relevant for the incoming transport of raw material to the food and feed production step and also for the transport of the final product to wholesaler/retailer.

The data for **Transportation** (Table 7) is to be collected per year if nothing else is stated.

Table 7. Environmental performance indicators for **Transportation**

Indicators	Unit	Categories
Transportation carrier	Category	<i>Preliminary, to be defined.</i> Boat transoceanic; Boat smaller; Lorry >16t; Lorry 3.5-16t; Rail; Aircraft
Temperature	Category	Ambient, Chilled, Frozen
Transported amount	kg/trip	N/A
Transportation distance	km/trip one way	N/A

3 Key Environmental Performance Indicators (KEPIs)

From the data collected in the value chain simplified LCAs and KEPIs will be calculated in the SENSE tool. The idea with the KEPIs is that they shall reflect the main environmental impacts from each production step of the value chain presented in an easy understandable way. As an example a KEPI could be “Consumption of energy per kg product produced” or “kg of fertiliser per hectare”. It shall be noted that those KEPIs do not have an LCA perspective as they mostly reflect data on resources consumption in the value chain, no modelling of emissions is done as in an LCA. The KEPIs shall not be used directly to compare products or producers, but they may help the SMEs in the food chain to understand the differences in results for the LCIA indicators that also will be the result from the SENSE tool.

In task 2.1 KEPIs were identified based on the experience and LCA results from the three food and drink chains. Some identified KEPIs were the same for all the studied chains, others were different. None of the KEPIs cover all environmental impact from the food chains, but together they give an idea about it. The development and use of KEPI's are a promising approach to facilitate the application of LCA in complex supply chains with many small actors.

In Table 8 the KEPIs that have been selected for the three investigated supply chains in the SENSE project are presented. They are selected based on their relevance for the environmental impact, on data availability and on the ease of measurement. In the table the KEPIs are presented for each production step. Each KEPI has a name and a unit. The list of KEPIs is displayed below the production steps. The impact categories that were selected in WP1 are listed vertically. For each KEPIs it is marked when there is an important contribution to an impact category, the cell is coloured in red. The red cell is either filled with a cross or with the main pollutant emitted by the KEPI, e.g. carbon dioxide, heavy metals, ammonia, phosphate, etc.

In the reports of the LCA case studies in task 2.1 a description of why the different KEPIs are important can be found (Jungbluth et al. 2013a, Jungbluth et al. 2013b, Yngvadottir et al. 2013).

It should be noted that most of the KEPIs are relevant for many more food products, not only the studied one. E.g. the KEPIs for Plant production and for Food and feed processing is the same for many food chains. There are also some indicators that are specific for some production step, e.g. Aquaculture and Livestock.

Table 8. Key Performance indicators for the different production steps in the value chain

Impact category	Plant production							Fishes	Aquaculture					Livestock - ruminants					Food and feed processing				Special			Main pollutants			
	kg N/hectare kg N/kg crop	kg-P2O5/hectare kg-P2O5/kg crop	kg N/hectare kg N/kg crop	kg/hectare kg/kg crop	l/hectare l/kg crop	ha/kg crop	ha/kg crop		m3/hectare m3/kg crop	MI/kg product ¹	kg/kg	MI/kg product ¹	kWh/l product ¹	kg waste/kg product ¹	m3/kg product ¹	kg/kg product ¹	kg raw milk/dairy cow	kg feed/kg live weight	m2/kg product ¹	kWh/kg raw milk	m3/kg raw milk	MI/kg product	kWh/l product	m3/kg product	type/kg product		kg waste/kg product	kg raw milk/kg product	kg live weight/kg meat
Key Environmental Performance Indicator (KEPI)	N-fertiliser use	P2O5-fertiliser use	Manure and slurry application	Pesticide and active substance content	Diesel use incl. machineries	Arable land use	Grazing land use	Water use	Energy use	Feed Efficiency (FCR ¹ : Feed used/Fish produced)	Energy use	Electricity use	Organic waste to sea	Water use	Packaging material	Raw milk production	Feed efficiency	Buildings	Electricity use milking	Water use milking	Energy use	Electricity use	Water use	Packaging material	Waste	Raw milk input	Meat production	Yield	
All impact categories									x						x	x									x	x	x	x	
Climate change	N2O		N2O		CO2				CO2		CO2	CO2			CO2	CH4			CO2		CO2	CO2		CO2					CO2, CH4, N2O
Human toxicity		HM			HM														HM										Heavy metals (HM)
Acidification	NH3		NH3		NOx											NH3													NOx, NH3
Eutrophication, terrestrial	NOx		NH3		NOx																								NO3, NH3
Eutrophication, freshwater		PO4		PPP	PO4	PO4	PO4																						PO4
Eutrophication, marine	NO3		NO3		NOx								x																NO3 (Nitrate), NOx
Ecotoxicity, freshwater		HM		PPP	HM																							Heavy metals (HM) Plant Protection Products	
Land use						x	x																					Land use (m2a and type)	
Abiotic resource depletion	x	x		x	x				x		x	x			x				x	x		x	x		x			Fossil resources	
Water depletion					x									x								x							Water use

¹ Feed Conversion Rate

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REFERENCES

- Aronsson, A., Landquist, B., Pardo, G., Esturo, A., Ramos, S., Jungbluth, N., Flury, K. and Stucki, M. 2013. Environmental assessment methodology and sustainability indicators for products and supply chains. SENSE - Harmonised Environmental Sustainability in the European food and drink chain, Seventh Framework Programme: Project no. 288974. Funded by EC. Deliverable D 1.3 SIK, Gothenburg.
- Cederberg, C. 2004. Environmental indicators- a handbook for the dairy industry, The Swedish Dairy Association, Report no:7034-P. In Swedish: Miljöindikatorer – en handbok för Mejeriindustrin. Rapport nr 7034-P. Svensk Mjök.
- Esturo, A., Ramos, S., Aronsson, A., Landquist, B., Jungbluth, N., Flury, K. and Stucki, M. 2013. Report on regional variations that affect environmental impacts. SENSE - Harmonised Environmental Sustainability in the European food and drink chain, Seventh Framework Programme: Project no. 288974. Funded by EC. Deliverable D 1.2 AZTI, Bilbao.
- Feenstra, G., Jaramillo, C., McGrath, S., Noel Grunell, A. and Mamen, K. 2005. Proposed Indicators for Sustainable Food Systems. Ecotrust and affiliates, Funded by the Roots of Change Fund, http://www.vividpicture.net/documents/16_Proposed_Indicators.pdf, accessed 2012-10-15
- Jungbluth, N., Doublet, G., Stucki, M. and Schori, S. 2013a. Life cycle assessment of Romanian beef and dairy products. SENSE – Harmonised Environmental Sustainability in the European food and drink chain. Seventh Framework Programme: Project no. 288974. Funded by EC. Deliverable D2.1 ESU-services Ltd, Zürich.
- Jungbluth, N., Doublet, G., Stucki, M., Schori, S. Life cycle assessment of orange juice. 2013b. SENSE – Harmonised Environmental Sustainability in the European food and drink chain. Seventh Framework Programme: Project no. 288974. Funded by EC. Deliverable D2.1, ESU-services Ltd, Zürich.
- Landquist, B., Aronsson, A., Esturo, A., Ramos, S., Pardo, G., Ólafsdóttir, G., Viera, G., Larsen, E., Nielsen, T., Ingólfssdóttir, G. M. and Yngvadóttir, E. 2013. Key environmental challenges for food groups and regions representing the variation within the EU. SENSE - Harmonised Environmental Sustainability in the European food and drink chain, Seventh Framework Programme: Project no. 288974. Funded by EC. Deliverable D 1.1. SIK, Gothenburg.
- Van Der Werf, H.M.G. and Petit, J. 2002. Evaluation of the environmental impact of agriculture at the farm level: a comparison and analysis of 12 indicator-based methods. *Agriculture, Ecosystems and Environment*, 93,131-145
- Yngvadóttir, E., Ingólfssdóttir, G., Olafsdóttir, G. Life cycle assessment of aquaculture salmon. 2013. SENSE – Harmonised Environmental Sustainability in the European food and drink chain. Seventh Framework Programme: Project no. 288974. Funded by EC. Deliverable D2.1, ESU-services Ltd, Zürich.

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