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SENSE tool deployment

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Executive Summary

The aim of the SENSE project was to develop a web based tool aimed at facilitating a harmonized sustainability assessment for the life cycle of products for SMEs in the food sector. The SENSE tool is designed with a user-friendly data entry and harmonized life cycle assessment (LCA) methodologies to calculate environmental impacts. The assessment when using the SENSE tool is simplified for SMEs by applying selected input data defined as Key Environmental Performance Indicators (KEPIs). The selected KEPIs contributed up to 90-95% of the environmental impacts as assessed by LCA in the three food chains studied in the project, meat and dairy, fruit juice and aquaculture. Moreover, the SENSE tool has been validated in case studies by comparing with a commercial software and showed less than 10% variation when using the same methodologies and datasets for the eleven impact categories: climate change, human toxicity [cancer effects; non-cancer effects], acidification, eutrophication [terrestrial; freshwater; marine], ecotoxicity [freshwater], land use, abiotic resource depletion and water depletion (Olafsdottir et al., 2014).

Objective - Assessment of the deployment of the SENSE tool
The objective of the work described in this report was to assess the deployment of the SENSE tool in pilot trials in SMEs in selected food sectors; beef and dairy, fruit juice and salmonid aquaculture supply chains. This was the last phase of the validation of the SENSE tool to obtain information on issues related to i) willingness of companies to invest in time and resources to compile data; ii) assess if data entry was successful as performed by the companies; iii) validate the results of the SENSE tool´s calculations and; iv) to explore the views of the SMEs on the usability of the SENSE tool for their company.

Methods – Involvement of external companies, checking data and views on the SENSE tool
Procedures were established to involve external companies in the testing. A link to the web based SENSE tool was provided to SME‘s and they were given guidelines and support during the testing. The users have to create their company´s profile in the tool, define products and create a process diagram of their supply chain. The companies entered annual data as the input according to the selected Key Environmental Performance Indicators (KEPIs) e.g. use of energy, water, resources, fertilizers, pesticides and output emissions like waste and wastewater. The tool´s calculations take into account economic allocation of products. Results are presented as an overview of the products´ environmental profile EID (Environmental Identification Document) and additionally the users can extract the results on the environmental impacts for each process step in an excel file for further analysis or documentation. Moreover, questions on social impacts have been implemented in the tool to obtain an assessment of the companies´ performance and to enhance the awareness of the contribution of social responsibility in the overall sustainable development of the food sector.

The report includes an assessment of the input data entered by SMEs and validation of results from the SENSE tool calculations. A set of testing criteria were established and the assessment was performed by SENSE partners including experts on LCA. After testing of the SENSE tool, the users gave feedback on the perceived usability, benefits and limitation of the tool by answering an on-line survey questionnaire. Furthermore, stakeholders in the aquaculture sector were invited to

give feedback during an open workshop to establish a consensus on the applicability of the SENSE tool for the respective sector.

Results of the pilot studies on the assessment of the deployment of the SENSE tool

Willingness to perform testing

In all the food chains it was a challenge to convince companies to perform testing of the SENSE tool. The main reason for the reluctance to participate was lack of time.

Furthermore, factors influencing the willingness of companies were:

- Lack of human resources in companies to perform the testing of the tool
- Data collection was perceived as a difficult and time consuming task
- Obtaining data from suppliers was considered problematic
- Data collection for the SENSE tool was seen as a burden on top of current efforts to compile required data for authorities
- Some companies are well aware of the environmental impacts of their production and have own systems in place. They did not see an added benefit of using the SENSE tool
- Companies have different views on confidentiality and transparency of data and reluctance to perform testing was partly explained by fear of data being misused
- Some companies were more interested in assessing their own performance rather than the life cycle of a product
- Lack of knowledge on LCA based assessment and the relevance of other environmental impact categories than climate change (carbon footprint)

Seventy five companies were invited to test the SENSE tool during the pilot implementation and final number of participants was 22, thereof eight in the meat and dairy sector, five fruit juice companies and nine companies from the aquatic food sector.

- The meat sector was in general not willing to participate, but dairy companies performed the testing of the SENSE tool. However, difficulties in obtaining data from the farmers was persistent
- The main difficulty to involve fruit juice companies was explained by the lack of time due to seasonal harvesting and perhaps lack of motivation since they are already burdened with documentation to fulfil requirements of sectorial standards
- Aquaculture companies in Iceland were in general willing to test the tool since annual data was already compiled for Green book-keeping and data on most of the KEPIs is publicly available.
- Several stakeholders identified benefit of using the SENSE tool for carbon footprint calculations as required by voluntary standards e.g. the Aquaculture Stewardship Council standard

In conclusion the companies noted that it would save time and be beneficial to synchronize the data requirements of the authorities and the sector specific documentation with the voluntary marketing standards and consequently, also for the SENSE tool.

Results of checking data entry in the tool - Limitations and suggested improvements

The results of checking data input in the SENSE tool showed that some aspects of data entry were not sufficient as performed by the SMEs´ users and needed to be better explained to ensure harmonized assessment. Expert assistance was needed to fill in data correctly for example:

- to ensure that data is connected between life cycle stages
- to explain how to define „product“
- the concept of economic allocation[1] and necessary input data was not fully understood by SME's and allocation factors were not entered correctly according to economics, therefore allocation process needs to be better explained
- to ensure that all KEPI data is entered, since data gaps if KEPIs are not all entered can bias the results
- data collection from upstream suppliers (e.g. feed) and downstream (e.g. processing) was a sometimes a challenge and in some cases the assessment only included one process step

Further improvements of the SENSE tool were suggested:

- to ensure proper understanding translations are needed. English language is an obstacle for SME's. Not all contents and manuals of the tool are fully translated to all languages
- to take into account regionalized impacts, background datasets in the tool need to be added i.e. some additional average datasets (slurry, manure, concentrated feed, more pesticides and fertilizers) should be available for agriculture
- datasets with average composition of feed for aquaculture need to be updated and added to reflect the composition of the feed used by the users of the tool
- additional datasets are needed for wastewater for different aquaculture systems and regions

Although a detailed manual is available for the users, it was considered necessary to improve the guidelines and add specific relevant guidance directly at the point of entry in the SENSE tool using the „info“ button already implemented in the tool. This should be considered in the next version of the tool.

Additionally, since the tool is designed in a general way to allow different products to be analyzed, mandatory fields are not defined and users can proceed with calculations without entering all data. Therefore, there is a risk that the impacts will be underestimated. Consequently, it was concluded that data checking by experts would be essential in the future application of the SENSE tool to prevent data gaps.

Results of SENSE tool calculations - comparison with SimaPro and literature data

The results of SENSE tool calculations for the products assessed from the SMEs were checked by exploring if the range of values obtained were within the range of earlier SENSE tool case studies that had been validated in the SENSE project. Additionally, literature values for similar products (e.g. raw and pasteurized milk, orange juice, salmon and arctic charr) were used for comparison. The methodology or impact characterization factors applied in some of the studies reported in the literature vary and therefore only the climate change impact was assessed. Overall the results of the SENSE tool calculations of climate change for the products of the external companies fulfilled the testing criteria and did not vary by more than a factor of two compared to literature values. Results of two cases were validated by performing calculations by the SimaPro software using the same methodologies and datasets as the SENSE tool. The testing criteria was set at <10% and

[1] Allocation is the partition of the environmental impact between different products produced together (e.g. wheat and straw; cheese and whey; milk and meat). Economic allocation splits the impact according to the percentage of total turnover of the different products.

the observed variation was < 5%. However, some error in the calculation of the transport phase was observed when analyzing parallel multiproduct transport phases. This has now been corrected in the current version of the SENSE tool (January 2015).

Further studies are needed to have more data on environmental impacts using common methods and harmonized assessment for benchmarking food products

- Further LCA case studies of food products are needed based on the harmonized recommended methodologies as have been implemented in the SENSE tool to obtain average data for benchmarking.

Results of the on-line survey – Perceived benefits on the SENSE tool and future recommendations

The results from the survey questionnaire included feedback from the companies regarding the need for environmental assessment and included questions on the need for assessment on social impacts as part of the SENSE tool´s sustainability reporting features. Degree of agreement with statements on the benefits of the SENSE tool gave an insight to the perceived benefit of using the SENSE-tool.

Sustainability awareness in SMEs - Environmental and social aspects/ sharing of data

- Two thirds of the companies responding to the survey agreed on foreseen enhanced demand from their customers on information of environmental impacts as well as social impacts
- The results of the SENSE tool were considered a benefit for the companies to communicate both environmental impacts and social impacts as part of B2B communication or sustainability reporting, however 3rd party verification was emphasized
- The testing of the SENSE tool motivated “life cycle thinking” and understanding of sustainability performance in the companies
- SMEs are currently not familiar with LCA concepts and they only know about carbon footprint
- The tool may be useful for companies for self-assessment and to identify hotspots in their processes. Also to explore the effects of improvements for example change in feed composition
- A potential benefit identified was to use the results for marketing, but it was considered important that the SENSE tool had some kind of certification so companies could use it in marketing
- Benchmarking would be considered as a very interesting option, but only possible if enough verified data was available
- 3rd party verification is strongly recommended if results are used in B2B communication or for benchmarking

Assessment of user friendliness when entering data and views on the usefulness of the SENSE tool results for the SMEs.

The outcome of the on-line survey supports the finding of the internal expert assessment when checking the data. The views of the external users regarding user-friendliness and functionality of the tool when inserting data into the SENSE tool revealed that the users lacked understanding of

some of the SENSE tool features. The majority of them considered that training on the SENSE tool concepts and support on data entry was considered a benefit for the companies

- SME´s welcomed the opportunity to obtain training in using the SENSE tool in particular personal help and visits on site.

Recommendations

1) The SENSE tool is currently a prototype that can be adapted to different food products. The tool needs to be updated with more user friendly guidance and should also be updated with average datasets to ensure the relevance of the outcome for the respective food products in different regions.
2) The guidance of experts is recommended to facilitate the assessment for the companies and ensure standardization of data entry.
3) Considering the complexity of the life cycle thinking and the challenges the user faced when entering their data - even though the data entry was based on simple KEPIs and described in detail in the guidelines - the integration of an expert check of the data is recommended for the SENSE-tool. All results downloaded – especially the EID (Environmental Information Document) - without a review could have the sign „Draft“ or „Not validated“. After the validation this would change to „validated by …“, so that it is not possible to publicly present results that are based on incomplete or incorrect data.
4) The SENSE tool can provide a harmonized assessment according to EC recommendations (EC, 2013), on the condition that there is compliance with the SENSE tool guidelines for data entry. While the SENSE tool makes clear positions on the confidentiality of the data as user first start to enter the system, future issues on data management are still highlighted.
5) The SENSE tool can be a simple way for SMEs to provide data as part of the requirements for a sustainable product certification.
6) The SENSE tool is recommended for use in pilot studies on food as a screening tool to assess products environmental footprint i.e. the PEF pilots of the European Commission to establish Product Environmental Footprint Category Rules (PEFCR)[2] that use a common template irrespective of the product, and will contribute to the goal of the Single European Market for Green Products[3]
7) Furthermore, the tool can be recommended for self-assessment in companies and training to enhance life cycle thinking and sustainability awareness.

[2] http://ec.europa.eu/environment/eussd/smgp/pdf/Guidance_products.pdf

[3] http://ec.europa.eu/environment/eussd/smgp/

PREFACE

This report is part of the SENSE project (www.senseproject.eu) covering the assessment of the deployment of the developed SENSE-tool in SMEs in food supply chains (Task 4.3). The reporting includes the Phase 3 validation during pilot implementation of the SENSE tool in external companies in the fruit juice, meat and dairy and salmonid aquaculture food sectors. Initial phases of the validation included functionality testing and verification by comparing the SENSE tool calculations with commercial software (Phase 1 and 2). The suitability of the selected key environmental performance indicators applied as input data for the SENSE tool, was assessed earlier (Olafsdóttir et al., 2014) by comparing with full scale LCA studies performed for the different food products (Doublet et al., 2013a,b; Ingolfsdóttir et al., 2013)

Following SENSE partners contributed to the validation and the assessment of the deployment of the SENSE tool during the Phase 3 testing of the SENSE tool in SMEs in the food sector:

Guðrún Ólafsdóttir at UoI-ASCS[4] was the leader of the pilot implementation of the SENSE tool and the editor of this report. She was responsible for contacting companies in the aquaculture food supply chain, checking and verifying data and responsible for the on-line survey as well as organising the WP4 workshop in collaboration with the UoI team, Sigurður Bogason and Ragnhildur Eva Guðmundsdóttir.

Erling Larsen from DTU-Aqua[5] was involved in contacting aquaculture companies in DK.

Eva Yngvadóttir Alexandra Kjeld and Gyda M Ingólfsdóttir at EFLA[6] participated in checking data in the aquaculture chain and supported data verification and software update.

Alistair Lane from EAS[7] assisted in identifying aquaculture companies for testing and organisation of the aquaculture workshop and was the main editor of the summary from the workshop.

Bianca Pop from TriTecc[8], Andrei Victor Prodan from Provac, and Birgit Landquist at SIK[9] contacted and interviewed companies in the meat and dairy sector and Enrico Frabetti from Clitravi[10] and Adina Ghebri from CALION were involved in identifying companies

Regula Keller, Niels Jungbluth and Alex König at ESU-services[11] were responsible for contacting companies, validation and checking data input in the meat and dairy and chains and conducted interviews with SME.

Aintzane Esturo and Susanne Koswig from SGF[12] and Saioa Ramos at AZTI[13] were responsible for contacting companies in the fruit juice supply chain and checking data.

Berta Alvarez from Biozoon[14] and Saioa Ramos collaborated in developing the on-line questionnaire in collaboration with the SENSE partners.

Lohitzune Larrinaga and Unai Albinarrrate at Ingenet[15] were responsible for updating the software and implementing changes during the iterative validation process.

[4] http://www.ascs.is/
[5] http://www.aqua.dtu.dk/
[6] http://www.efla-engineers.com/
[7] http://www.easonline.org/
[8] www.tritecc.ro
[9] http://www.sik.se/ from 1 January 2015 www.sp.se/foodbioscience
[10] http://www.clitravi.eu/
[11] http://www.esu-services.ch
[12] http://www.sgf.org/
[13] http://www.azti.es/
[14] http://biozoon.de/en/
[15] http://www.ingenet.es/

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GLOSSARY AND ACRONYMS

SENSE	Harmonised Environmental Sustainability in the European food and drink chain
LCA	Life Cycle Assessment
LCIA	The life cycle impact assessment
KEPIS	Key environmental performance indicators
SCP/SIP	The European Commission´s Sustainable Consumption and Production Industrial Policy
FAO	Food and Agricultural Organisation
SAFA	Sustainability Assessment of Food and Agriculture
PEF	Product Environmental Footprint
PEFCRs	Product Environmental Footprint Category Rules
GFSI	Global Food Safety Initiative
EID	Environmental Identification Document
KEPI	Key environmental performance indicator
GHG	Greenhouse Gas

1 Introduction

1.1 The SENSE tool development

Responsibility in sustainability and environmental issues is gradually being implemented in food supply chains. This trend is evidenced by the various standards and certification programs available worldwide for food manufacturing companies. The standards are covering good manufacturing practices and different aspects like quality, organic and regional production, animal welfare, human health, environmental issues and social responsibility. Retailers and manufacturers are seeking to develop their own supply chain systems that embed sustainability. Such efforts may be signaled directly to consumers via labels but can also be communicated through non-label provisions of information, such as annual corporate responsibility and sustainability reports.
Information on environmental impacts and social aspects are often provided as labels on food products. However, data to substantiate these labels is often not transparent and more analysis is needed on the relationships within the food chain over the construction and transmission of signals over food integrity; for example, the role of retailers in relation to producers in this process (Barling and Simpson, 2012).
Methods to assess sustainability performance are often not accessible for SMEs. Moreover, data gathering for environmental assessment is often regarded a burden and companies therefore are not willing to undertake such an assessment. However, when given opportunities to implement life cycle tools, there appears to be potential incentives in SMEs to use Life Cycle Assessment (LCA) results to create an image for the product and the organization, to use in marketing, and for product development (Witczak, 2014).

The SENSE project has developed a web-based system which provides a simplified assessment of environmental impacts of food products and addresses also selected social impacts of companies.
The tool compiles through the standardized data collection system the key environmental performance indicators (KEPIs) (e.g. energy and resource use, water consumption, waste and wastewater generation, land occupation, fertilizer use, etc.) and performs an environmental impact assessment for the different life cycle steps of the product The SENSE-tool development is aimed at facilitating self-assessment of sustainability in SMEs and includes besides a simplified environmental assessment some aspects of social impacts. Some results on the SENSE tool concepts and functionalities have been presented in conferences (Ramos *et al*., 2014a,b; Doublet et al., 2014; Aronsson et al., 2014; Olafsdóttir et al., 2014a; Yngvadottir et al., 2014).

The life cycle impact assessment (LCIA) methods that are applied in the SENSE tool were defined in the SENSE project (Aronsson *et al.,* 2013, Ramos *et al*., 2014)) and comply with those recommended by the ILCD handbook (European Commission, 2011) and the ENVIFOOD protocol (Food SCP RT, 2013), except for water use. The methodology chosen is aligned to the later EU recommendation on the use of common methods to communicate the life cycle environmental performance (European Commission, 2013). Results from the initial validation of the SENSE tool showed that the tool calculates environmental impacts which are comparable to results when using commercial software that applies the same methodologies and datasets. It is important to note that the SENSE tool is a simplified tool, and the assessment is not an alternative for complete LCA studies (Olafsdóttir *et al.,* 2014). Moreover, it is important to acknowledge that the LCA methodology does not cover assessment of some challenges in primary production of food systems like animal welfare, biodiversity changes caused by escapes and use of medication, land use change and indirect land use change (LUC; ILUC), carbon sequestration, soil erosion, impacts of harvesting methods etc. (Aronsson *et al.,* 2014).

1.2 Positioning of the SENSE tool among standards and sustainability initiatives

One of the aims of the pilot testing of the SENSE tool in SMEs is to explore the view of the users on the need and potential exploitation of the SENSE tool beyond the project. It is foreseen that the tool can be used by SMEs for self-assessment but also as a complimentary analysis tool for existing standards and initiatives by providing an easy to use data gathering system and means to apply life cycle approach for reporting environmental impacts.
Various international initiatives are working on harmonization and standardization of sustainability assessment for the food sector. The European Commission´s Sustainable Consumption and Production Industrial Policy (SCP/SIP) Action Plan and FoodDrinks Europe have motivated the ENVIFOOD protocols to facilitate harmonization. The key principle of the ENVIFOOD protocols on environmental information in the food and drinks chain states that "Environmental information communicated along the food chain, including to consumers, shall be scientifically reliable and consistent, understandable and not misleading, so as to support informed choices" (Food SCP RT, 2013). Moreover, the Food and Agricultural Organization (FAO) have published guidelines SAFA (Sustainability Assessment of Food and Agriculture) to facilitate self-assessment of enterprises (FAO, 2013). The need for a common language regarding sustainability assessment is emphasised and the need to motivate environmental, social and economic data acquisition of key indicators to understand the overall impact of the production. The SAFA guidelines build on existing sustainability tools with the goal of integrating and relating current systems through a common framework. SAFA does not assess products or processes – but enterprises and a reference can be made to "consistency with the SAFA procedures and principles" provided that the assessment is made fully transparent in all its choices and customization (e.g. with regards to boundaries, data sources, indicator selection, rating, etc.) (FAO, 2013).

Although environmental assessment with a focus on carbon foot printing has been recommended by various initiatives, the importance to take into consideration all environmental impacts of products in a balanced way in place of sole focus on greenhouse gas emissions has been emphasized (EC JRC, 2011). The life cycle assessment according to ISO 14044, is the recommended methodological approach to provide holistic information based on a complete LCA (i.e. global warming potential, eutrophication, acidification, ecotoxicity etc. (JRC, 2010). The SENSE tool has the advantage to include the relevant methodologies recommended for a balanced assessment.

1.3 Data acquisition and assessment of sustainability performance

There is a need for concerted policy development to ensure the availability of high-quality life cycle data at the sectorial level as a basis for robust product and corporate environmental footprinting. The Product Environmental Footprint (PEF) initiative and pilots are currently in focus in the European Commission and addressing the challenges involved in the mission to create a "Single Market for Green Products" (Lane et al., 2014). An important part of the work for all pilots is to establish the Product Environmental Footprint Category Rules (PEFCRs) that provide specific guidance for calculating and reporting a product's life cycle environmental impacts. A special guidance document[16] has been prepared by the Commission to help the pilots through this process.
The SENSE tool could be a potential tool to motivate self-assessment of companies, in particular for the food types studied in the SENSE project (meat and dairy, fruit juice and aquaculture

[16] http://ec.europa.eu/environment/eussd/smgp/pdf/Guidance_products.pdf

salmonid products). It can also be applicable for other food types since the tool is modular and can be adapted to different food supply chains, since challenges are common in food supply systems. “Given the development work that has already been done on the SENSE tool, it would be logical for this to be taken up for the PEF pilot” (Lane et al., 2014).
An initial “Blueprint of the SENSE project Policy and Governance Implementation Roadmap” has been established (Barling et al., 2014). The document sets out the key policies and governance steps needed to support the wider dissemination and deployment of the SENSE tool among SMEs in the European food and drink sector, as a contribution to the furtherance of the EU's Sustainable Development agenda.

The web based SENSE tool is well suited to implement the EC recommendation on the use of common methods to measure and communicate the life cycle environmental performance of products and organizations (European Commission, 2013). Based on the initial validation of the SENSE tool it can be recommended to companies for benchmarking their products' environmental performance in a balanced way for the following impact categories; climate change, human toxicity [cancer effects; non-cancer effects], acidification, eutrophication [terrestrial; freshwater; marine], ecotoxicity [freshwater], land use, abiotic resource depletion and water depletion (Olafsdottir *et al*., 2014).

1.4 Objective of the assessment of SENSE tool´s deployment in SMEs

The SENSE pilot studies reported herein will further give information on issues related to willingness of companies to invest in time and resources to compile data and perform self-assessment of their performance.

The pilot implementation of the SENSE tool was the PHASE 3 validation of the SENSE tool conducted in companies outside of the SENSE consortium. Some companies from the SENSE-consortium also participated to enlarge the amount of companies that give feedback.

The objective was to assess the deployment of the SENSE tool in pilot trials in SMEs in selected food sectors; meat and dairy, fruit juice and salmonid aquaculture supply chains.

Main steps of the Phase 3 validation of the SENSE tool:

- Selected companies were invited to test the tool and a password issued to access the tool. The user guidelines “SENSE Tool for Dummies” were available for testers and support was given from SENSE partners and follow up procedures applied to ensure data input (Annex II)
- Functionality testing of the web based SENSE tool by SMEs in food supply chains.
- Verification of correct data input as well as assessing the outcome of the SENSE-tool and EID performed by experts. The responses to questions on the social impacts in the SENSE tool were checked and the results assessed by comparing to a grading scheme. (section 3.1).
- Analysis of views on the benefits and usability of the tool were explored by interviews and an on-line survey in companies approached for testing in the meat and dairy sectors, fruit juice and aquaculture sectors (section 3.2).
- The aim of including questions on social aspects in the tool was to raise awareness of the companies on how they could improve their social performance (see questions on social aspects Annex III). The view of the companies on the usefulness of including data on social aspects is covered by the relevant questions in the on-line survey (section 3.2).
- A workshop was organized (AQUA workshop, Reykjavík September 29th 2014), with the aim to discuss and present the results of the pilot validation and obtain feedback on the functionality of developed SENSE-tool and EID, based on the food SME´s stakeholders’ experience of the pilot implementation. A consensus on the validity of the tools for application in the food & drinks sector was established (section 3.3).

2 Methods

2.1 Involvement of companies in the testing of the SENSE tool

Criteria to identify companies for testing the SENSE tool (Table 1) and procedures on how to approach the companies and inviting them to test the tool were established ("Procedures for involvement of companies in testing the SENSE tool" see Annex II).

Table 1 Selection criteria established in the project before inviting potential companies to test the tool

	Criteria / Justification
Activity of companies	Select SMEs and respective supply chains of aquaculture, meat/dairy and fruit juice that are similar to the ones analyzed earlier in the SENSE LCA case studies (Olafsdottir et al., 2014) (see Figure 1)
Aquaculture	Salmonid species: Salmon, Rainbow trout and Arctic charr are included - Feed and rearing conditions (net-pen / land based) should be comparable with the earlier LCA case studies. Seabass and seabream in Europe were considered but not included.
Fruit juice	Orange juice production, but different fruits and juice production (e.g. apples) may be of interest (same challenges). In addition to European companies, one company in South America was considered.
Meat / dairy	Meat from cattle /beef was selected. Dairy production can be selected as a separate supply chain
Size of companies	SMEs are defined as follows: Less than 250 persons employed; annual turnover of up to EUR 50 million, or a balance sheet total of no more than EUR 43 million (Commission Recommendation of 6 May 2003).
Other companies, were considered to test the SENSE tool	The SENSE tool is designed to be modular and flexible so it could be used for other food products. It was considered of interest to have feedback on the usability of the SENSE tool for other food systems and large companies producing similar food products. The supply chain of the company may include SMEs and the SENSE tool could then be used to collect data from those suppliers.
Boundaries of the supply chain	The selected main company should be a part of a defined supply chain. Boundaries of the supply chain should ideally be from "cradle to gate" of the processing company. Depending on the availability of the data, some only considered a single process, i.e. livestock husbandry or fruit juice pressing. The companies were expected to send an inquiry to the relevant suppliers in the supply chain to get data.
	Steps in the supply chain: Cultivation of food and feed, Feed production, Livestock /Aquaculture, Food processing, Transport to Wholesaler. Retail to consumers is not considered in the SENSE tool
Schemes or standards adhered to	Information on uptake of standards is relevant to assess the status and trends in the companies (e.g. HACCP and GMP; ISO 9001, ISO 14001, ISO 22000, GlobalGAP, BRC, IFS, SQF, PGI, Organic, Freedom food, Friends of the Sea, MSC, ASC etc.)

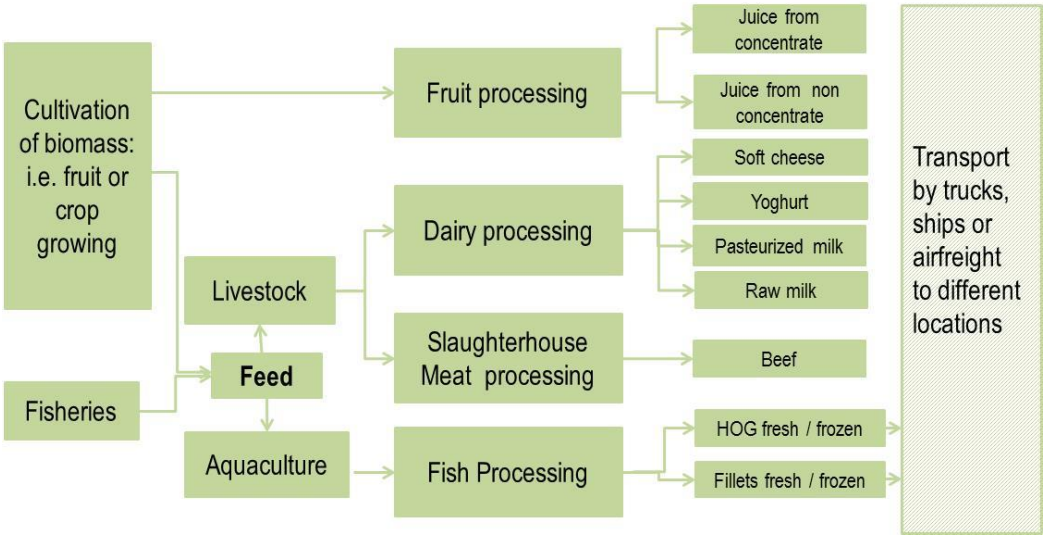


Figure 1 Overview of supply chains and products in the pilot testing of the SENSE tool

The implementation of the SENSE-tool followed protocols that had been established in the project for the functionality testing and validation of the SENSE tool (Olafsdóttir et al., 2014). The SMEs received help from the SENSE partners for the data entry. The help was provided as on-site assistance, teleconference meetings, where the screen was shared while the data was entered, or by giving guidance via telephone or e-mail.

The SENSE tool is a prototype and software errors or suggestions for improvements were communicated to the software developers during the testing period by using a Google drive on-line document. Thus a continued iterative development of the SENSE tool was performed during this Phase 3 of the pilot implementation.

2.2 Internal validation – Checking data

The assessment of the deployment was performed in two ways: firstly, internally by the SENSE partners who checked the data and assessed the calculations, and secondly externally with an on-line survey to assess the view of external companies who were invited to test the tool (Annex I).

When checking data, the evaluators had access to the SENSE tool accounts for the relevant SMEs. Companies were contacted to achieve further information or they were assisted to finalize the data input if needed.

2.2.1 Validation objective

The objective of the assessment of the data input and the calculated output of the SENSE tool was to:

- Check the data input executed by third parties
- Assess the functionality and suitability of the software for SMEs in the chosen sectors
- Evaluate the output by comparing the results to values in other studies and literature
- Verify calculations by using commercial software in selected cases.

2.2.2 Testing criteria

Table 2 Testing criteria applied by the SENSE team who assessed the reliability of data entered by external companies and verified the reliability of the SENSE tool´s calculations

	Data checking	Assessment criteria	Fulfilment of criteria
A	Data entry	Is data missing that is crucial for the calculation of the environmental impact? Are numbers entered in the correct way? Are values reasonable?	The criterion is fulfilled if all data is correctly entered and calculation of the environmental impact is completely possible
B	Connecting data from different processes	Is the connection between the supplier and the producer correct so that the whole life-cycle is included in the calculation?	The criterion is fulfilled if the last process in the chain includes all data from previous steps and the data entered give correct calculation of the impacts.
C	Data entry and availability of datasets	Are relevant datasets available in the tool? Are the datasets selected appropriate? Are the necessary inputs on allocation interpreted correctly and is data entered fitting to the unit and the information asked?	When appropriate datasets were selected and correct units selected, the criterion is fulfilled.
D	Saving data	Is the data entered, saved in the correct way so that it was not lost?	The criterion is fulfilled, if all data were available for the verifier.
E	Exporting data	Is the data entered in the tool the same as the data exported in the excel-file?	If the data in both places are exactly the same, the criterion is fulfilled.
F	Calculations and results	The results were assessed within the data obtained and generally compared to selected literature data of environmental impact as reviewed by Landquist et al.,(2013) Since data is entered from different systems, including different processes with different completeness in each step the ability to make direct comparison is limited.	The criterion is fulfilled if the results obtained for the impact category “climate change” do not vary more than a factor of 2 within the average of comparable products obtained from literature (i.e. raw milk, pasteurized milk, cheese, fruit juice and salmonid products) If the deviation was higher, a reasonable explanation was given
G	Exporting results	The results of the EID, the results shown in the tool and the results in the exported excel file were compared	If the results are exactly the same, the criterion is fulfilled
H	Comparing results from the tool with LCA software	A dataset from a dairy chain and an aquaculture chain was entered into SimaPro Software to conduct a final comparison of the results and making sure all calculations were done correctly. A detailed comparison of LCA results with SENSE-results has been conducted and is described in D4.1. (Olafsdóttir et al., 2014)	If the differences for the impact category “climate change” are less than ten percent using the same data, the criterion is fulfilled.

2.3 External validation – On-line Survey

The objective was to assess the usability of the results and the information obtained from the SENSE-tool (KEPIs and calculated output) for the SME´s and assess if the tool was fulfilling requirements based on current need for the environmental and social aspect of sustainability assessment in companies.

An on-line questionnaire survey was developed using open ended questions, multiple choice and Likert scale (Annex I). The survey was administered via Google drive survey form. A link was provided to companies to obtain their feedback on the following:

- Sustainability awareness in food SMEs
- The perceived user friendliness and functionality of the tool
- Evaluation of the effectiveness of the SENSE-tool to meet the specified objectives outlined in requirements or standards used by the SMEs
- Explore the uptake of different standards (sector specific food production & technology standards (i.e. organic production), food quality and safety standards and voluntary environmental and social standards and certification schemes including industrial and market driven initiatives i.e. eco-labels, social and ethical awareness.)
- Comparison of results from SENSE tool analysis with requirements for information in current schemes imposed by certain retailers on their supplier networks

When testing was completed by the companies, the SENSE partners who were responsible for contacting each company sent the link to the on-line survey or alternatively filled in the word version of the survey questionnaire by interviewing the companies. The survey was also sent to companies that were not willing to participate to gain more insight to the need of SMEs. The on-line survey questionnaire is available in Annex I.

2.4 Workshop

A workshop on environmental assessment of aquaculture was held in Reykjavík on September 29th 2014. The event was organized by the University of Iceland and EFLA Engineers in collaboration with EAS (European Aquaculture Society)[17]. The objective was to bring together the salmonids production companies that have tested the SENSE tool and Aquaculture producer organizations in several countries (e.g. Iceland, Norway, Denmark, UK) to assess the usefulness and potential of the tool and its place within the monitoring of sustainability in the professional sector. More than 30 participants joined the workshop: individual producers, association representatives and other industry partners.

Figure 2. SENSE partners during a “stormy and rainy” visit to an aquaculture farm hosted by Náttúra in Þorlákshöfn, Iceland. From left: Alistair Lane (EAS), Guðrún Ólafsdóttir (ASCS-UoI), Ingólfur Arnason (Náttúra), Sigurður Bogason (ASCS-UoI), and on the right Birgit Landquist and Anna Woodhouse from SIK in Sweden.

[17] http://www.senseproject.eu/node/305

3 Results

3.1 Participation of SMEs in the SENSE tool testing

In the meat and dairy industry 31 companies received invitation to test the SENSE tool, and in total eight companies performed testing. In the meat and dairy chain, there are four processes involved for the production of milk: agricultural step (feed production), livestock step (milk and meat production), processing (pasteurization etc. at the dairy) and additionally transport in between the steps. Five Romanian companies from which two are project partners that also provided data for the full LCA (Doublet *et al*., 2013a), one Spanish company and one Swiss dairy and one Swiss farm.

In the fruit juice sector, 20 companies were contacted, and the SENSE tool was tested in five companies: two Spanish companies, one Brazilian, one Turkish company and one German company. In the fruit juice sector, the main processes included are fruit production and processing (including bottling and packaging), and transports in between the steps. The two companies involved in the partnership of the project made a complete analysis from “cradle to gate” taking into account fruit production and the juice pressing, bottling, packaging and transportation. The other three companies made a “gate-to-gate” approach, taking into account just the inventory data of their own processing plant, and did not include the fruit production. In order to cover the lack of data for the primary production, comparison for the testing criteria, was done just for the processing stages.

In the aquaculture supply chain, 24 companies were invited to test the tool and eight companies in Iceland performed the testing, thereof one was a project partner who also provided data for a full LCA (Ingólfsdóttir *et al*., 2013). A fish processing company also tested the SENSE tool for their supply chain including the fisheries, processing and transport to market. Average data on aquaculture farming was obtained from Norway (Högnes, 2014). The main steps in the aquaculture chain are juvenile production, aquaculture on-growing, processing, transport between steps and to market. The data for the processing was sometimes included in the overall data for the aquaculture farm if the processing facilities were on-site.

Various challenges and obstacles were encountered when contacting companies and convincing them to test the tool with their own data. Therefore, the aim to obtain statistically representative results for benchmarking was not reached. Initially the aim was to assess up to 27 different supply chain systems (nine of each subsector), but in total 22 companies tested the tool (Table 3).

Table 3 Demographics – An overview of the number of companies participating in the SENSE tool pilot testing, the boundaries of the life cycle data inventory and the countries of companies testing the tool

Food Sector	# invited/ # tested	# companies that entered data / data boundaries		Countries (# of SMEs) (location where testing of the SENSE tool was performed)	Feedback #on-line survey / #interviews
		“gate to gate”	“cradle to gate”		
Meat & Dairy	31 / 8	5	3	RO (5), ES (1), CH (2)	0 / 2 (meat) 7 / 4 (dairy)
Fruit juice	20 / 5	3	2	ES (2), BR (1), DE (1), TR (1)	5 / 0
Aquaculture	24 / 10	4	5 + 1*	IS (9), NO (1) *	5 / 0
Total	**75 / 22**	**22 + 1***			**23**

* average data from Norway

Note that not all companies that performed the testing completed the on-line survey. Since the on-line survey was also applied in interviews with companies that were interested in the SENSE tool concept, but not willing to participate the overall feedback was from 23 companies (Table 3).

3.2 Willingness of companies to perform testing

In the meat and dairy chain, only one quarter of the companies contacted were willing to test the SENSE tool. Some of the companies in Sweden, Romania and Switzerland that were reluctant to test the tool agreed to be interviewed by SENSE partners. In this way a valuable feedback was obtained and this was reported in the on-line survey form by the interviewees.

In the fruit juice sector, five out of twenty companies tested the SENSE tool (Table 2). This was explained mainly by the lack of time and personnel available for testing the tool, which was a common obstacle for all the food producing SMEs. The fruit sector is seasonal, and the period of the year when the testing was expected coincided with their bulk of activity. So, even though the companies are aware of the environmental issues, they could not invest time in testing a tool. Moreover, it is important to highlight that the juice sector is highly regulated and audited, so most of SMEs are overwhelmed with data filling required in audits and certifications which are compulsory to satisfy customers.

The companies in the aquaculture sector in Iceland were more willing to test the SENSE tool and data was obtained from eight companies. The fact that green bookkeeping is mandatory for aquaculture companies and the data is publicly available in Iceland facilitated the data gathering in companies. The data on the KEPIs needed for the SENSE tool had been prepared for the authorities.

Aquaculture companies in Norway were invited by e-mail but either they did not respond or declined the invitation. However, data on average Norwegian aquaculture production was obtained from SINTEF (Högnes, 2014) and this was valuable to compare with the Icelandic companies. Moreover data on average Norwegian feed in 2010 and 2012 was obtained and used as input data for the SENSE tool to explore the impact of the feed composition. Aquaculture companies in Denmark were also invited to test the tool, but were not able to complete the testing in due time. They however, expressed an interest to follow up and participate in further testing of the SENSE tool.

The feedback from the SMEs including those that were not willing to participate in the testing is summarized here. It gives an insight on the main drivers that impede the participation of SMEs in using the SENSE tool and can be used to further adapt the service to the needs of the future users.

One main feedback mentioned by most of the SMEs is the availability of time: SMEs typically do not have a person responsible only for environmental issues, so it is difficult to find time for such additional tasks. It was perceived that the data collection, especially upstream in the value chain, would consume much time and that too much data was asked for.

A difficulty that affects mainly the meat and dairy chain is the involvement of many SMEs for the production chain and that there are at least three steps involved (livestock/farming, milk/meat production and processing (dairy or slaughterhouse)). Additionally a feed processing step could also be part of the value chain. Usually many farms (in one case almost 100) are involved as suppliers to one production place and the SME dairies and slaughterhouses felt they were unable to contact all their suppliers to collect this kind of data.

Some SMEs already used some sort of environmental monitoring system and therefore did not see the advantage to use an additional tool. It was pointed out booth in the aquaculture companies as well as on agriculture farms that the data entry should be synchronized with data compilation

already fulfilled for the government. This would make the data entry much easier for the companies. It should be noted that although larger SME dairy companies in Sweden maintain green bookkeeping records consisting of most of the KEPIs needed as input for the SENSE tool, they were still not more willing to participate in the testing of the tool than smaller companies.

Some of the SME´s had a general negative attitude towards too detailed data collection. They already have to collect a multitude of other data for different governmental bodies and are not willing to collect more data, e g the data that was asked for to perform LCA on all suppliers of milk. They also felt that it was not possible to ask the suppliers to enter data into the tool, it felt as an administrative burden that could be part of e.g. future price negotiations. Although the aim of the SENSE system is to simplify the data gathering and use the annual data for the selected KEPIs, it may still be time consuming to retrieve data from the current information systems in companies and from farmers. Some, also feared that their data would be misused despite the confidentiality of the data entered. Others did not have all the data available and therefore did not want to participate. In a few cases it was pointed out that it was not a good idea to publish environmental assessment results as they feared that the results will show a great impact, especially from primary production, and they were afraid of the reactions on this.

Generally the processors of food products were more interested in the assessment of their environmental impact than the producers (farmers). The processors were interested in the comparison of their facility and not in the comparison of their true impact including all life-cycle steps.

3.3 Results of the internal validation of the SENSE tool testing by SMEs

In this chapter the results of the internal validation of the SENSE tool is described. In most cases support was given to the SMEs by the project partners to fill in data. If errors were found in the data entered, this was revised during the evaluation of the results. The review and validation of data entered by the testing companies, was based on assessment criteria as described in detail in part 2.2. The usability and performance of the tool was evaluated by checking if all necessary data had been filled in a correct way in the tool and consequently allowing calculations of results. Only the result of the climate change impact were compared to literature data since new methodologies are applied for the other impacts e.g. eutrophication, acidification, and toxicity.
The results of the testing and the fulfillment of the criteria are described here, arranged in the same order.

3.3.1 Testing criteria A: Data entry

In many cases, data was not connected correctly to the environmental impact because the products produced and/or the incoming products were not defined correctly. For example, when only data on the processing step was entered, the analysis was not considering the life-cycle aspect as foreseen in the tool. Since most dairies have more than one supplier of milk, it is not possible to cover all suppliers for a dairy. A small mistake in data entry, i.e. when data refers to another unit than shown, can have a huge influence on the results.

This criterion was only fulfilled with the support of the SENSE partners to the SMEs.

For future development of the tool, the following key recommendations for data entry can be made:

- Provide a clear warning message if any data that is entered in the tool is not linked to environmental information, because the product (e.g. incoming products, feed, or pesticide) is not defined well enough. Better guidance should be provided how to include environmental impacts for this input.
- Provide better guidance in the tool as how to define the products.
- Better guide the user through all crucial steps, i.e. with a "continue-button" within the tool, so that the user smoothly arrives from data entry to the final results.

At the moment there is the risk that data is not entered completely and thus results do not show the environmental impacts of a product over the full life cycle. **The conclusion for this point is that an external reviewer or a certifier is needed in order to ensure the correct input of data**.

3.3.2 Testing criteria B: Connecting data from different processes

There are two links that are important to calculate the overall impact of a product in the tool: The link of different steps in the processing line to form a life cycle and the link between data from the supplier and from the one receiving the (pre-) product.

The connections of the different process steps were understood by most users, even though some problems came up during the testing. A difficulty in splitting the data into two steps is that some data is only available as a sum, which is a general difficulty when assessing environmental effects. Then, an expert guess for the shares used for each of the products is needed.

The correct linkage between the datasets from the supplier to the data of the following processor caused difficulties in some cases since users did not enter the same year and product name or if the product was not identified as product to be used in the next step.

Without the support of the project partners, this criterion was only partly fulfilled.

Future recommendations:

Users need support from experts to fill in data.

- It is important to give clear guidelines to ensure that data is connected between life cycle stages

3.3.3 Testing criteria C: Data entry and availability of datasets

3.3.3.1 Meat and dairy

Table 4 Checking input data (Key Environmental Performance Indicators) for meat and dairy in the SENSE tool

KEPI / Rules for input data	Unit for SENSE tool data input	Comments / Fulfillment of criteria
Plant production		
N-fertilizer use	kg N/ha and year	For fertilizers and slurry, most users needed support to choose the right dataset and enter the data correctly.
P_2O_5-fertiliser use	kg/ha and year	
Manure and slurry application	kg/ha and year	
Pesticide and active ingredient (AI) content	e.g. kg AI/ha and year	Most farmers know the brand name of a pesticide. The names of the active ingredients are a challenge for them. Brand

KEPI / Rules for input data	Unit for SENSE tool data input	Comments / Fulfillment of criteria
		names[18] have to be translated by calculating the active ingredient, which was not understood by all users.
Diesel use incl. machineries	energy unit (kwh, L of diesel, m^3 of natural gas, etc.)/ha/year	Diesel can be used for other products not available in the tool, so that the part of it used for milk/beef production has to be guessed.
Land use	ha/year	Difficulties for allocation, no difficulties for data entry.
Water use	Freshwater use: l or m^3/ha/year	No difficulties.
Plant production	kg/ha used to convert the data from impact per year to impact per kg	The amount of feed produced in the agricultural step is given as an average of the production per total area of agricultural area. This number was not well understood by the users.
Livestock - ruminants		
Livestock	number of animals /year	It was unclear which cows should be counted for the tool.
Raw milk production	kg/year	No difficulties.
Electricity use milking	energy unit (kwh, L of diesel, m^3 of natural gas, etc.) / year	No difficulties.
Water use milking	m^3/year	No difficulties.
Food and feed processing		
Energy use Electricity use	energy unit (kwh, L of diesel, m^3 of natural gas, etc.) / year	No difficulties.
Water use	m^3/year	No difficulties.
Packaging material	kg/year	No difficulties.
Waste	kg/year	No difficulties.
Dairy		
Raw milk input	Kg /year; share in turnover (%)	For a farm that sells a part of the produced feed and uses a part for their own livestock it is difficult to choose which values shall be entered into the tool. Since usually only data for the whole farm is available, all data is entered for one year and the whole farm. The environmental impact is then allocated to the different products based on their percentage of total turnover (economical allocation). Many users just entered the mass share of products instead of the economic shares of products. In the SENSE-tool for Dummies, this is explained, but this information does not reach the users.
Slaughtering		
Meat production	Kg /year; share in turnover (%)	

3.3.3.2 Fruit juice

For the fruit juice companies which have their own orange trees, it was fairly easy to fill in the required data, mostly because the selected companies were new companies with available data. The most “tricky” inputs were: the definition of incoming products and the percentage of the share of turnover, which most of the companies do not understand.

Table 5 Checking KEPI data for fruit juice in the SENSE tool

KEPI / Rules for input data	Unit for SENSE tool data input	Comments /Fulfillment of criteria
Plant production		
Definition of incoming products		Defining the percentage of the share of turnover was challenging for companies

[18] In Switzerland a helpful list of pesticides brand names and active ingredients is available here: http://www.blw.admin.ch/psm/produkte/index.html?lang=de

KEPI / Rules for input data	Unit for SENSE tool data input	Comments /Fulfillment of criteria
N-fertiliser use	kg N/ha/year	No difficulties
P_2O_5-fertiliser use	kg P/ha/year	They had problems to enter the right number, because the farmers in some European countries calculate with P, but for the tool they have to provide P_2O_5. Both options should be available for entering data in the tool P_2O_5 or P.
Manure and slurry application	kg/ha/year	No difficulties
Pesticide and active ingredient content	e.g. kg AI/ha/year	Some pesticides are missing in the list and average pesticides were used.
Diesel use incl. machineries	energy unit (kwh, L of diesel, m^3 of natural gas, etc.)/ha/year	No difficulties
Land use	ha/year	No difficulties
Water use	Freshwater use: l or m^3/ha/year	No difficulties
Food and feed processing		
Energy use	energy unit (kwh, L of diesel, m3 of natural gas, etc.) / year	No difficulties
Electricity use	energy unit (kwh, L of diesel, m^3 of natural gas, etc.)/year	No difficulties
Water use	m3/year	No difficulties
Packaging material	kg/year	No difficulties
Waste	kg/year	No difficulties
Juice processing		
Yield	kg/year; share in turnover (%)	The percentage of the share in turnover was not well understood by most of the companies

3.3.3.3 Aquaculture

Data from green bookkeeping facilitated the data collection in aquaculture companies. In the case when the aquaculture companies did not have ownership of the processing facilities, the data from the processing step was not readily available. Data from suppliers was sometimes difficult to obtain and some of the cases included only the aquaculture step but not the whole life cycle of the products. However, since data on feed is facilitated by selecting background datasets representative for various feed composition and ingredients, the main impacts are accounted for in the SENSE tool calculations.

Table 6 Checking input data (Key Environmental Performance Indicators) for aquaculture products in the SENSE tool

KEPI / Rules for input data	Unit for SENSE tool data input	Comments / Fulfillment of criteria
Aquaculture		
Allocation	Kg /year; share in turnover (%) NA	SENSE approach is to use economic allocation for the harmonized methodology. However, in the case of aquaculture products, the companies could see the benefit to apply mass allocation which would give more favourable results for the environmental impacts of the final products. It was argued that since the share of annual turnover is not introduced in the SENSE tool, the user could choose which allocation method to apply. Thus harmonization was not achieved.

KEPI / Rules for input data	Unit for SENSE tool data input	Comments / Fulfillment of criteria
Feed Efficiency (FCR: Feed used/Fish produced)	NA	For aquaculture companies that are new and starting the operation, the amount of biomass is low and the use of feed is high. For farms with a longer history of growing, a more balanced input /output is achieved and the annual feed conversion rate (FCR) is more realistic. In general it is more reliable to assess the impacts over as average of 2-3 years to take into account the life cycle of salmonid species (1-2,5) years.
Feed use	Kg/year	Datasets for typical “Icelandic feed” and “Norwegian feed” have been added to the tool based on data of fisheries from SINTEF (Högnes, 2013) since no appropriate datasets on marine ingredients were available in the ecoinvent database. Additionally marine and crop ingredients have been added to the tool as a drop down list so users can select their own composition. Processing of feed and transport of raw materials to feed producer is then not included, only production of the raw materials.
Fish produced	Kg/year	The user selects one of the product he has defined in the tool.
Energy /fuel use	L of diesel/year, m^3 natural gas/ year, Kwh/year	The user can choose between different form of energy (diesel, electricity, heavy fuel oil and natural gas). When selecting electricity regional datasets are used to calculate the environmental effects.
Fresh water use	m^3/year	This KEPI represents fresh water use (tap water). It is common that land based aquaculture companies use brackish water. In that case they should estimate the amount of fresh water used and enter that number into the tool. As the availability of water differs greatly between countries and regions, regional characterization factors are used to calculate the environmental effects.
Packaging	Kg/year	The user can choose between different packaging material as a drop down list.
Output		
Waste water	m^3/year or L/year	If the user is a land based aquaculture company he needs to enter the amount of waste water and select the organic load of the wastewater depending on the nature of the process. e.g. *wastewater high organic load* represents emission of 0,00015 kg P-eq per m^3 and 0,0045 kg N-eq/m^3 (CH: treatment, potato starch production effluent, to waste water treatment, class 2) or *wastewater low organic load* represents emission of 6,6E-05 kg P-eq per m^3 and 0,00023 kg N-eq/m^3 (CH: treatment, sewage, unpolluted, to wastewater treatment, class 3). For marine aquaculture systems an average N discharge to the marine environment due to feces and uneaten feed per kg of fish is being taken into account as a default (41 kg N eq/ 1 ton fish) (Heldbo et al., 2013).
Food processing		
Energy use	(kwh, L diesel, m^3 of natural gas)/ year	No difficulties
Water use	m^3/year	No difficulties
Packaging material	Kg/year	No difficulties
Waste	Kg/year	No difficulties
Fisheries		
Energy use	L of diesel / year	The main KEPIs connected to the fisheries is the use of diesel.

The criterion for data entry for all supply chains to achieve full harmonization was only fulfilled with the support provided by the SENSE partners to the SMEs.

- The SENSE tool has been designed to obtain a harmonized assessment, but this ambitious goal can only be achieved if users are committed to follow the guidelines for the standardized data entry. Main reasons are the allocation factors that were not entered according to economics by the users. If different allocation procedures are used by different users the final results are not harmonized and not comparable.
- Another reason is that not all KEPI data were entered and therefore there is a risk of underestimating impacts. Since the tool is designed in a general way to allow different products to be analyzed, it is difficult to define mandatory fields.
- **The guidance of experts is needed to achieve full standardization of data entries.**

For further development of the data input in the SENSE tool, the following improvements are suggested:

- Better information on the allocation process available right at the point of data entry and also clear explanations in the guidelines SENSE tool for Dummies
- Better guidance on the entry of the feed components right at the point of data entry
- Some information should be entered with more steps to avoid that complicated calculations have to be conducted by the user (fertilizers, feed, maybe pesticides)
- The availability of datasets in the SENSE tool is limited and improvements were suggested e.g. some additional datasets (slurry, manure, concentrated feed, more pesticides and fertilizers) should be available for agriculture. Average datasets for feed in aquaculture also need to be updated to reflect the composition of feed applied by the users.
- Additional datasets for wastewater for different aquaculture systems should be implemented. This applies to land based aquaculture where regional conditions and different treatment of the waste water needs to be taken into account. There are two cases identified: Icelandic conditions (primary treatment only) and average European conditions (primary, secondary and tertiary treatment).
- An additional unit of the fertilizer should be added, so that both references (P_20_5 and P) can be used.

3.3.4 Testing criteria D: Saving data

Many of the users complained about lost data when they were working on data entry. This occurred because the button to save data had to be pressed in addition to entering the data and this was often overlooked. Data from the previous step was therefore often lost when the next step was done without saving the page or the input line. When all the data had been entered correctly and saved the verifier could analyze the data. **This criterion was fulfilled**

Recommendations for further development of the tool

- it is suggested to simplify the saving process, i.e. by automatically saving the page whenever information is entered into the tool and notifying if not saved before continuing.

3.3.5 Testing criteria E: Exporting data

This test was performed for several datasets. It was verified that all data in the Excel-sheet was the same as shown in the SENSE-tool. The possibility to extract data from the tool as and Excel file gives the users possibilities to analyze further both the input data and the results. **This criterion was fulfilled**

3.3.6 Testing criteria F: Calculations and results

The results of the calculated environmental impacts in the pilot studies for products in the different food chains were assessed and an overview obtained as tabulated below for all the food sectors.

Direct comparison cannot be justified because the production systems within the same sectors are different. However, the overview gives an idea of the range of values that can be expected for similar products and will be used here to justify or discuss the differences in environmental impacts observed between different production systems. Furthermore, recommendations can be established and guidance on how to establish reference values for benchmarking as an option in the future exploitation of the SENSE tool. Direct use of the values obtained cannot at this point be used for benchmarking because of the limited data for the different production system within each food sector. When assessing if the values obtained by SENSE tool calculation were within the range of literature values, only the climate change impact was assessed, since methodology for some of the other impacts varies in the literature.

3.3.6.1 Dairy products

Table 7 Raw Milk: Examples of results on environmental impacts of two pilot studies for raw milk, and from data of a full LCA study on Romanian beef and dairy products calculated with SimaPro (Inventory data stemming from Doublet et al. 2013a). The results are shown for 1 kg of raw milk

Impact category	Unit/kg	Examples of values in SENSE Pilot for raw milk		LCA case study Doublet et al. 2013a, raw milk	Results with updated LCIA methods, data from LCA case study Doublet et al 2013, raw milk
Climate change	kg CO2 eq	1.03E+00	1.03E+00	1.06E+00	1.06E+00
Human toxicity, cancer effects	CTUh	7.64E-09	1.94E-08	2.21E-08	5.66E-08
Human toxicity, non-cancer effects	CTUh	3.26E-07	5.73E-07	6.59E-07	7.78E-07
Acidification	molc H+ eq	6.88E-03	1.39E-02	1.62E-02	1.61E-02
Eutrophication, terrestrial	molc N eq	3.27E-02	6.69E-02	7.31E-02	7.30E-02
Eutrophication, freshwater	kg P eq	1.55E-05	2.84E-05	1.51E-04	2.89E-04
Eutrophication, marine	kg N eq	7.40E-03	1.35E-02	6.20E-03	6.23E-03
Ecotoxicity, freshwater	CTUe	5.01E-01	6.17E-01	6.96E-01	5.33E+00
Land use	kg C deficit	1.24E+01	4.31E+01	3.98E+01	3.98E+01
Water depletion	m3 water eq	4.91E-04	7.65E-03	1.20E-03	1.19E-03
Abiotic resource depletion	kg Sb eq	5.50E-06	8.12E-06	*2.73E-03**	1.66E-05

* - A different methodology has been used for characterization. Since the method for abiotic resource depletion was changed after the LCA in the SENSE tool, the calculations were run again with updated methods to allow comparisons of the results.

The literature values for climate change impact for raw milk vary between 0.74 and 2.8 kg CO_2/kg raw milk (Doublet et al., 2013a). The results obtained in the two pilot studies are in line with the expected results from literature.

Three additional case studies were conducted that were not complete, since the feed cultivation step was left out, even though feed was produced on farm (2 cases), or the users main inputs of agriculture were missing, so that the results could not be used for verification. Their values for climate change were 1.40, 2.47 and 2.88 kg CO_2-eq per liter raw milk and were as well in the expected range despite missing data.

The criterion is fulfilled for raw milk.

Table 8 Pasteurized milk: Examples of results on environmental impacts in one pilot study of Spanish pasteurized milk, and from data of the LCA study on Romanian beef and dairy products, both calculated with the SENSE-tool and as a full LCA with SimaPro (Inventory data stemming from Doublet et al. 2013a). The results are shown for 1 kg of pasteurized milk.

Impact category	Unit/kg	SENSE Pilot for pasteurized milk (ES)	SENSE tool case study Doublet et al. 2013a, pasteurized milk (RO)	LCA case study Doublet et al. 2013a, pasteurized milk (RO)	Results with updated LCIA methods, data from LCA case study Doublet et al 2013, pasteurized milk
Climate change	kg CO2 eq	1.61E+00	2.47E+00	1.93E+00	1.77E+00
Human toxicity, cancer effects	CTUh	1.06E-08	3.60E-08	3.65E-08	1.05E-07
Human toxicity, non-cancer effects	CTUh	2.35E-07	9.82E-07	9.42E-07	1.17E-06
Acidification	molc H+ eq	9.32E-03	9.14E-03	2.32E-02	2.28E-02
Eutrophication, terrestrial	molc N eq	3.88E-02	3.42E-02	1.01E-01	1.01E-01
Eutrophication, freshwater	kg P eq	1.34E-05	7.32E-05	2.38E-04	6.27E-04
Eutrophication, marine	kg N eq	1.59E-03	3.67E-03	8.57E-03	8.63E-03
Ecotoxicity, freshwater	CTUe	6.24E-01	1.10E+00	1.14E+00	1.04E+01
Land use	kg C deficit	1.08E+01	5.29E+01	5.35E+01	5.34E+01
Water depletion	m3 water eq	5.74E-03	2.45E-03	2.21E-03	2.06E-03
Abiotic resource depletion	kg Sb eq	6.13E-06	3.07E-05	*7.81E-03**	2.81E-05

* - A different methodology has been used for characterisation. Since the method for abiotic resource depletion was changed after the LCA in the SENSE tool, the calculations were run again with updated methods to allow comparisons of the results.

The results obtained in the pilot study for the impact category climate change are in the range of the literature data that were compiled by Doublet et al. (2013a) and Landquist et al. (2013). The literature value for pasteurized milk range between 0.67 and 1.93 kg CO_2-eq per kg milk, whereas the pilot study conducted reached a value of 1.61.

The criterion is fulfilled for pasteurized milk. The results do not deviate more than by a factor of two compared to literature data.

A dairy produces different outputs, e.g. pasteurized milk, yoghurt and cheese, to which the environmental impact of the raw milk has to be allocated to. Therefore the results are very sensitive to the allocation process. For the LCA study and some of the literature data, the IDF allocation approach (also named physico-chemical allocation) was used; in the SENSE-tool the economic allocation is foreseen. The users of the pilot study used allocation based on weight because the allocation procedure was not well understood as explained before. For a detailed analysis of differences between the LCA and the SENSE tool case study, please refer to Olafsdóttir et al., (2014). The results do not deviate more than by a factor of two compared to literature data.

The data for soft cheese was allocated between different dairy products, whereas for the production of Swiss cheese, by-products like whey have not been taken into account and all environmental impact was allocated to cheese. The results are therefore difficult to compare between different studies as by-products are treated differently. Depending on the type of cheese (soft cheese, hard cheese), the amount of liters of milk needed per kilogram of cheese produced varies, affecting the results. Moreover production systems of cheese vary between companies and need to be considered and explained when comparison is made.

Table 9 Cheese: Examples of results on environmental impacts in one pilot study of Swiss hard cheese, and with data from an LCA study on Romanian beef and dairy products (Inventory data stemming from Doublet et al. 2013a), both calculated with the SENSE-tool and as a full LCA with SimaPro. The results are shown for 1 kg of cheese.

Impact category	Unit/kg	Pilot for semi-hard cheese (CH)	SENSE tool case study (Olafsdottir et al., 2014) soft cheese (RO)	LCA case study for cheese Doublet et al. 2013a, soft cheese (RO)	Results with updated LCIA methods, data from LCA case study Doublet et al 2013, semi-hard cheese
Climate change	kg CO2 eq	4.61E+01	1.01E+01	7.76E+0	7.92E+00
Human toxicity, cancer effects	CTUh	2.27E-07	1.44E-07	1.62E-07	4.74E-07
Human toxicity, non-cancer effects	CTUh	7.45E-06	4.10E-06	4.45E-06	5.29E-06
Acidification	molc H+ eq	7.63E-02	3.72E-02	1.03E-01	1.04E-01
Eutrophication, terrestrial	molc N eq	3.03E-01	1.42E-01	4.56E-01	4.59E-01
Eutrophication, freshwater	kg P eq	4.86E-04	2.99E-04	1.06E-03	2.76E-03
Eutrophication, marine	kg N eq	1.03E-01	1.52E-02	3.88E-02	3.94E-02
Ecotoxicity, freshwater	CTUe	4.20E+01	4.46E+00	4.96E+00	4.60E+01
Land use	kg C deficit	5.45E+02	2.19E+02	2.44E+02	2.44E+02
Water depletion	m3 water eq	8.08E-03	8.90E-03	1.04E-02	1.04E-02
Abiotic resource depletion	kg Sb eq	8.79E-05	1.27E-04	*2.55E-02**	1.27E-04

* - A different methodology has been used for characterization. Since the method for abiotic resource depletion was changed after the LCA in the SENSE tool, the calculations were run again with updated methods to allow comparisons of the results.

3.3.6.1.1 Limitations of the results of dairy products to be used in benchmarking

Milk products are very variable concerning their properties, i.e. fat content of milk or production process of cheese. This complicates the comparison of products when looking at results from other case studies. For example the allocation between cheese and milk products of a dairy influence the results per kg of milk and respectively per kg of cheese and thus has an influence on the benchmarking. Depending on the chosen allocation, results of the different dairy products (e.g. milk, cheese) can be quite different. Additionally, experience showed that the economic allocation was not well understood by the users.

3.3.6.2 Fruit juice *products*

Results from three external companies were explored using the data they introduced in the SENSE tool for the production systems. The other two orange juice companies did not upload complete datasets for the production, only for the social aspects. As was expected huge differences are observed in most of the selected impact categories when comparing with the values obtained in a complete LCA study (Doublet et al., 2013b), mainly due to different processing systems (Table 10).

Table 10 Examples of results on environmental impacts in pilot studies of fruit juice and results from LCA case study on orange juice (Doublet et al. 2013b). The results are shown for the processing of 1 l of orange juice without taking into account the orange growing

Impact category	Unit/kg	C1	C2	C3	SENSE tool case study	Doublet et al. 2013b
Climate change	kg CO_2 eq	9,37E+00	7,41E-01	9,58E-02	4,06E-01	4,84E-01
Human toxicity, cancer effects	CTUh	2,50E-07	1,32E-08	3,61E-08	4,05E-09	5,00E-09
Human toxicity, non-cancer effects	CTUh	1,41E-05	1,33E-07	3,63E-07	1,89E-08	3,44E-08
Acidification	molc H+ eq	7,86E-02	2,22E-03	2,77E-03	1,49E-03	1,81E-03
Eutrophication, terrestrial	molc N eq	3,19E-01	3,84E-03	2,54E-03	2,63E-03	3,74E-03
Eutrophication, freshwater	kg P eq	3,49E-04	1,11E-04	3,31E-04	1,51E-05	2,13E-05
Eutrophication, marine	kg N eq	2,88E-02	3,32E-04	1,99E-04	2,59E-04	4,47E-04
Ecotoxicity, freshwater	CTUe	1,09E+01	3,13E-01	8,65E-01	2,12E-01	3,94E-01
Land use	kg C deficit	5,42E+01	4,82E-01	6,21E-02	2,05E-01	2,45E-01
Water depletion	m3 water eq	7,71E-02	3,67E-03	1,77E-04	9,07E-03	1,05E-02
Abiotic resource depletion		5,21E-04	1,56E-05	4,44E-05	3,26E-06	

- Company C1 uses a large amount of diesel in their production. This usage is responsible for up to 60% of the environmental effects in all impact categories. This could be an explanation of the deviation in the results compared to the value received by Doublet et al. (2013b). It is not clear if there was an error in entering this data because the results seem unusual high. Further checking of the data input would be recommended.
- Company C2 sells their juice in bulk instead of bottling it in PET bottles. They take into account the amount of metal used for the sold bulks, which has considerable impact. Regarding the water depletion which vary -185% from the LCA case study by Doublet et al. (2013b), this company does not use water for diluting concentrate juice and therefore consumes less water.
- Company C3 does not use a lot of energy, so it results in about 5 times (405%) lower carbon footprint. Regarding organic pollution, it is also true that this company utilizes all kinds of by-products and organic wastes (oils, pellets, waste water treatment, etc) so the impact here

should be much lower. Finally, the water depletion potential impact is lower because the company is located in a country with high water availability.

The values obtained for two of the fruit juice companies C2 (0.74 kg CO_2 e/l) and C3 (0.10 kg CO_2 e/l) were within the range of reported literature values for orange juice in different studies (0.4 to 1.1 kg CO_2-eq per liter) as reviewed by Doublet et al. (2013b)

3.3.6.2.1 Limitations of the results of fruit juice products to be used in benchmarking:

Juice products are very variable concerning their production methods. Some products are produced from concentrate juice, others are processed "not from concentrate", and there are huge differences in the by-products treatment between companies. So, even if the results obtained for the three companies are, more or less in the same range and within range of literature values as reviewed by Landquist *et al.,* (2013), this value cannot be recommended for benchmarking companies because there is not enough data (a minimum of data from 9 companies was recommended). Additionally, the interpretation could be misleading if production systems are not considered. For example, it might be observed that a given company was using too much water when compared to another company producing the same product and therefore reducing the water use could be suggested. However, the difference in water use may be because the juice is produced from concentrate and therefore more water use would be logical in the production. In general when making suggestions for improvements based on benchmarking of products the knowledge about the characteristics of the production processes is vital and boundaries of the analyzed systems need to be comparable i.e. for the juice production it needs to be stated if the bottling process is included or not in the assessment.

3.3.6.3 Aquaculture products

The different aquaculture production systems have different environmental impacts depending on the species that are farmed, as well as the system type, size, the feed conversion ratio and technique or marine environment used for production. In the SENSE pilot studies one company producing Atlantic salmon in marine based system and five companies producing Arctic charr in land based systems in Iceland tested the tool and additionally one aquaculture company producing Arctic trout. Average data on aquaculture net pen farming systems in Norway was obtained from SINTEF (Högnes, 2014).
Table 11 shows an overview of results from selected companies representing land based and marine based systems and results from the Norwegian average data for net pen marine system.
Companies A, B and C are all producing arctic charr in land based system, but the systems vary, mainly regarding the availability of fresh water and use of energy. Company D is a marine based conventional net pen salmon farm. Some of the data obtained from the companies included only the aquaculture on-growing, whereas other included the whole life cycle including hatchery of juveniles, on-growing aquaculture, processing and transport to market by trucks in Iceland and transoceanic or airfreight shipping to markets in Europe.

Table 11 Examples of environmental impacts in pilot studies of salmonid aquaculture products, results using Norwegian average date and from LCA case study on salmon aquaculture (Ingolfsdottir et al. 2013). The results are shown for 1 kg of fresh salmonid (HOG) System boundaries are aquaculture farm and processing and two cases for company D where transport to markets are included. (NA = not available)

Impact category	Unit/kg	Examples from SENSE tool Pilots							Ingolfsdottir et al. (2013)
		Land based systems – Arctic Charr			Marine based systems – Salmon				
		Company A	Company B	Company C	Norwegian Average data* "Norwegian feed"	Company D No transport "Icelandic feed"	Company D SHIP IS-UK** "Icelandic feed"	Company D AIR IS-DK*** "Icelandic feed"	Company D LCA case study
Climate change	kg CO_2 eq	**3,59E+00**	**3,21E+00**	**5,07E+00**	**2,37E+00**	**2,38E+00**	**2,80E+00**	**6,15E+00**	**2,70E+00**
Human toxicity, cancer effects	CTUh	1,48E-07	5,44E-08	1,03E-07	3,76E-08	4,07E-08	4,93E-08	5,55E-08	5,50E-08
Human toxicity, non-cancer effects	CTUh	1,74E-06	2,20E-06	3,29E-06	1,65E-06	1,72E-06	1,79E-06	1,85E-06	1,90E-07
Acidification	molc H+ eq	3,67E-02	4,63E-02	7,07E-02	3,29E-02	3,45E-02	3,77E-02	5,45E-02	1,40E-02
Eutrophication, terrestrial	molc N eq	7,24E-02	8,83E-02	1,31E-01	6,15E-02	6,72E-02	7,60E-02	1,38E-01	7,50E-02
Eutrophication, freshwater	kg P eq	1,80E-04	1,36E-04	3,63E-04	8,63E-05	9,68E-05	1,10E-04	1,18E-04	2,30E-04
Eutrophication, marine	kg N eq	NA	NA	NA	7,58E-02	1,27E-02	3,07E-01	3,13E-01	1,60E-01
Ecotoxicity, freshwater	CTUe	6,11E+00	6,38E+00	1,01E+01	5,81E+00	4,76E+00	5,09E+00	5,45E+00	8,40E+00
Land use	kg C deficit	1,63E+02	2,34E+02	3,32E+02	1,98E+02	1,74E+02	1,79E+02	1,88E+02	NA
Water depletion	m^3 water eq	5,79E-03	1,67E-03	2,64E-03	1,12E-03	1,11E-03	1,52E-03	2,15E-03	1,70E-05
Abiotic resource depletion	kg Sb eq	9,71E-05	3,28E-05	8,40E-05	2,15E-05	2,67E-05	3,53E-05	3,72E-05	NA

* Resource use for average Norwegian aquaculture (smolt production and processing not included, except packaging has been included) (Högnes, 2014, personal communication);estimated distance **IS-UK:1750km; ***IS-DK:2200km.

The result of the SENSE tool calculations for climate change impact for conventional net pen systems for salmon in the Icelandic Company D and Norwegian average data were similar, around 2,4 CO_2e/kg HOG. The results are slightly lower than earlier reported by Ytrestöyl *et al.* for the 2010 feed (2.6 kg CO_2 e/kg). The land based flow through systems A, B and C had higher impacts ranging from (3.20 - 5.1 kg CO_2 e/kg). These values are within the range of reported values for land based system i.e. 2.8 kg CO_2 e/kg for land based flow through system for salmon and 5.4 kg CO_2 e/kg for arctic charr in a flow through system (Ayer and Tyedmers, 2009).

According to LCA studies reviewed earlier in the SENSE project (Olafsdóttir et al., 2013), the main factor that influences the higher climate change impacts in land based systems is because more energy is required for recirculation or pumping of water in land based systems (Aubin et al., 2009; Ayer and Tyedmers, 2009).

Influence of energy use: In Iceland some of the land based aquaculture companies are drilling for water and this has a considerable climate change impact as seen in particular for company C (5.1 kg CO_2 e/kg). The results for company C indicated higher environmental impacts on their product than in the other companies for all impact categories. This can be explained by very high energy use. Moreover, the production is recently established and therefore it has low biomass and higher FCR than the other companies and this influences the results. The length of a life cycle of salmonid species is around 2 years and therefore annual data can be misleading since the biomass is not yet balanced. A few of the companies testing the tool had a small operation or recently started their production of arctic charr and were still producing low amount or about 100 tons per year.

The total operational period of the facility is an important factor in the assessment. It takes a few years for an aquaculture operation to establish a balanced state and new farms have higher impacts due to low biomass. Therefore, data to assess the environmental impacts should be based on an average of a few years.

Company B with free flowing water and low energy use had the lowest climate change impact of the arctic charr land based systems (3.21 kg CO_2 e/kg). The climate change impact for arctic charr HOG produced by company A was 3.59 kg CO_2 e/kg (Table 11). Company A is a well-established on-growing land based farm with facilities including indoor and outdoor tanks and an overall production of arctic charr of more than 2000 tons per year. Literature values for recirculation system for arctic charr are very high or 28.2 kg CO_2 e/kg and 5.4 kg CO_2 e/kg in a flow through system for arctic charr, whereas in the same study the value for land based flow through system for salmon was 2.8 kg CO_2 e/kg (Ayer and Tyedmers, 2009).

Influence of transport: The impact of different transport modes is shown for Company D in Table 11 to compare transoceanic (2.80 CO_2e/kg) and airfreight (6.15 CO_2e/kg) shipping from Iceland to Europe. Several LCA studies on aquaculture and seafood products have included the impact of processing and transport where the large impacts of airfreight have been emphasized (Ellingsen et al., 2009; Ziegler et al., 2012; Ingolfsdóttir et al., 2010). In a study by Winther *et al*. (2009) the feed production accounted for 75% (2.72 CO_2eq /kg fish) of the total GWP (3.60 CO_2eq /kg fish) of all process steps of salmon produced in Norway and transported by truck to Paris.

The main interest of the aquaculture companies when testing the SENSE tool was related to the climate change impact and how to make improvements to influence this, besides considering the transport mode e.g:

- to explore how the composition of the feed can influence the results.
- to ensure that regional factors regarding water use and wastewater were considered to benchmark their products against other products on the market

Influence of feed: Feed is most often the main contributor to environmental impacts in aquaculture systems and it was considered important to facilitate the data entry to create relevant aquaculture feed datasets

Following datasets have been added in the SENSE tool (see composition in Table 12).

Icelandic feed dataset: The marine ingredients in the Icelandic feed are based on composition of the marine feed ingredients in the average Icelandic salmon aquaculture diet in 2013 (May – August) provided from an Icelandic feed producer. The composition of crop ingredients was also based on feed from the same producer.

Norwegian feed dataset: The composition of the Norwegian feed is based on composition of the average Norwegian salmon aquaculture diet in 2010 (Hognes et al., 2011; Ytrestöyl et al., 2012)
In the SENSE pilot studies the Icelandic companies all selected the Icelandic feed dataset, but for the Norwegian average data the Norwegian feed dataset was selected. Some of the aquaculture companies were interested in creating their own feed composition in the SENSE tool by selecting the crop and marine ingredients available.

Feed composition changes between years depending on supply of marine ingredients and development and trends in feed composition. Regional differences in the carbon footprint of Atlantic salmon have been reported ranging from 1.78 kg CO_2 eq/kg (whole weight) for Norwegian-produced salmon to 3.27 CO_2 eq/kg (whole weight), for fish produced in the United Kingdom (Pelletier *et al*., 2009). This difference was mainly explained by difference in feed ingredients and higher use of marine by products for salmon produced in the United Kingdom. According to Norwegian studies on different feed composition the CO_2 footprint for farmed salmon in Norway was 2.6 kg CO_2 e/kg edible product in 2010 based on the average Norwegian feed composition 2010 (Ytrestöyl *et al.,* 2011).

Table 12 Feed composition of Norwegian feed and Icelandic feed datasets in the SENSE tool and composition of Norwegian average feed in 2012

Ingredient	% of total mass "Icelandic feed dataset"	% of total mass "Norwegian feed dataset" average feed 2010	% of total mass in Norwegian average feed 2012
Marine meal	24,1%	24,8%	19,2%
Marine oil	17,2%	16,6%	11,2%
Rape seed oil	10,2%	12,5%	19,0%
Soy Protein Concentrate (SPC)		19,6%	24,7%
Pea Protein Concentrate (PPC)		4,5%	2,1%
Wheat gluten	1,8%	6,4%	5,4%
Wheat grain	15,3%	8,5%	9,0%
Sunflower meal		4,9%	6,2%
Vitamins, minerals and micro	NA	2,2%	3,2%
Maize	16,5%		
Soy	3,4%		
Rape seed meal	10,0%		

Average feed composition in Norway 2012 has much lower amount of marine ingredients (30.4%) compared to the composition from 2010 (41.4%) (Table 12). It was therefore of interest to check firstly, if results were comparable when using the "Norwegian feed" dataset in the SENSE tool and comparing with results when adding ingredients one by one from available datasets in the SENSE

tool according to feed composition 2010. Secondly, it was of interest to explore the changes in results when applying the 2012 feed composition. The results obtained differed considerably between the "Norwegian feed" dataset in the tool (2.37 kg CO_2 e/kg) and were much lower when the ingredients were selected one by one in the tool based on the 2010 and 2012 feed composition or 1.80 kg CO_2 e/kg and 1.36 kg CO_2 e/kg, respectively (Table 13). This is because when selecting the marine ingredients the production of the feed is not included and therefore e.g. energy use and transport for the feed is not taken into account. It needs to be clear in the tool that if only ingredients are selected the processing of the feed is not included only the sourcing of raw materials (crop and fish ingredients). Conversion factors to feed need to be included in the background data. It would be an improvement to have average fish meal and fish oil as optional ingredients for feed in the SENSE tool where the conversion to feed would be included.

Table 13 Results of three different feed composition using Norwegian average data and comparing when using dataset "Norwegian feed" and feed composition based on selecting ingredients in SENSE tool according to average 2010 and 2012 feed data

		Norwegian Average data for aquaculture net pen systems		
Impact category	Unit/kg	"Norwegian feed" average 2010 dataset	Feed composition based on average 2010 data*	Feed composition based on average 2012 data*
Climate change	kg CO_2 eq	2,37E+00	1,80E+00	1,36E+00
Human toxicity, cancer effects	CTUh	3,76E-08	1,94E-08	1,46E-08
Human toxicity, non-cancer effects	CTUh	1,65E-06	1,80E-07	1,57E-07
Acidification	molc H+ eq	3,29E-02	2,62E-02	1,55E-02
Eutrophication, terrestrial	molc N eq	6,15E-02	1,74E-02	-1,19E-03
Eutrophication, freshwater	kg P eq	8,63E-05	3,84E-05	1,63E-05
Eutrophication, marine	kg N eq	7,58E-02	6,22E-02	5,73E-02
Ecotoxicity, freshwater	CTUe	5,81E+00	1,16E+00	9,74E-01
Land use	kg C deficit	1,98E+02	3,36E+01	2,44E+01
Water depletion	m^3 water eq	1,12E-03	7,23E-04	5,56E-04
Abiotic resource depletion	kg Sb eq	2,15E-05	1,30E-05	1,06E-05

*conversion to feed at mill is not taken into account for the marine ingredients

Influence of water use: Because fresh water in Iceland is abundant the land based systems often use a large amount of water. The water depletion impact has been regionalized in the SENSE tool. When comparing land based systems to marine systems there is more than a factor of 5 difference between the systems (Company A and B compared to Company D) (Table 11). In some cases companies are drilling for water which is a mixture of seawater and underground freshwater. The use of this brackish water as fresh water is misleading when assessing water depletion potential since the water used is only partially fresh water. In that case the amount of fresh water could be estimated for example based on the salinity of the brackish water. However, it can be argued that the fresh water part of the brackish water is not available anyway as fresh water and therefore should not be considered at all to account for the fresh water use. Therefore, it is important to create guidelines regarding seawater use in aquaculture to prevent that this is not confused with fresh water use.

Influence of wastewater: The amount of wastewater can be very high in flow through systems if assumed to be same amount as water use, but this is dependent on the type of system and if

recirculation is applied. In Iceland the waste water from land based aquaculture generally flows through sediment ponds and then straight to sea without any further treatment in a wastewater treatment plant. Iceland is a sparsely populated country and there are strong sea currents around the island, and therefore there are no wastewater treatment plants around the country, only in the capital region (and only primary treatment there, no biological treatment). Instead of treating the wastewater from the aquaculture in a municipal wastewater treatment plant, the operation permit requires primary treatment to be carried out by the aquaculture company itself. But in Europe, wastewater receives at least secondary (biological) treatment and usually tertiary (further) treatment as well. This treatment is taken into account in the dataset provided in the SENSE tool for wastewater.

It was therefore decided not to include the wastewater in the pilot studies for land based aquaculture companies A, B and C, since this would have been misleading. When wastewater was included and accounted for as the same volume as the total water use and selecting the low organic matter dataset this caused extremely high climate change impact, where half of the overall impacts were caused by the wastewater treatment for companies A and B.

Considering regionalized impacts in aquaculture, further improvements for the SENSE tool are suggested:

- To include datasets with default values for wastewater, that are reasonable for Icelandic conditions or to consider how to implement regionalized factors for waste water. This would also apply when considering energy demanding waste water treatment in countries like Norway where most energy is hydropower.

3.3.6.3.1 Limitations of the results of aquaculture products to be used in benchmarking:

Production systems in aquaculture vary and this needs to be considered in benchmarking. The lack of sufficient amount of data for the different production systems is the main limitation when considering benchmarking based on the results from the aquaculture companies obtained during the pilot testing. When comparing impacts of the different systems to the LCA case study (Ingolfsdóttir et al., 2013) the land based systems A and B and the Norwegian case study based on average data did not vary by more than a factor of 2 for the impact categories climate change, eutrophication (terrestrial and freshwater) and freshwater ecotoxicity. Higher variation was for acidification and human toxicity non cancer effect ranging from 2,5 – 12 fold variation. The water depletion impact was more than 300 fold higher, which can be justified because of high water use in the case of the flow through land based systems. Another issue to consider when performing benchmarking is the lack of appropriate datasets to assess the environmental impact of the wastewater for the Icelandic land based systems.

3.3.7 Testing criteria G: Exporting results

The extraction of results from the tool to excel and the EID was checked. Errors were found during the testing and the tool was corrected. After the changing of the tool, no additional thorough checking of the result was carried out. The results if comparing the values of "all processes" are the same as the results of the EID. All exports are the same as the data shown in the tool. Some improvements of the EID form were suggested to improve the legibility for the users. A minor correction in the display of the result was undertaken. For further analysis of results and checking data in the SENSE tool the feature of exporting data to excel is very useful and necessary when validating results.

This criterion was fulfilled

3.3.8 Testing criteria H: Comparing results from the tool with LCA software

The data of one Spanish dairy was calculated in SimaPro in two different ways in order to compare both results with the SENSE-tool result. On the one hand using mainly own background datasets from the ecoinvent database, and on the other hand using the same datasets as used in the SENSE-tool. Comparing the results with different datasets helped to identify differences and gaps in some datasets used in the SENSE-tool. Differences and errors in the calculation of the results by the SENSE-tool were revealed by comparing the result with the same background datasets. The results of climate change for the product “yoghurt” were compared, also examining the results of each step of the life cycle and of all single inputs (e.g. water use).

The comparison with own datasets showed that the final result of the product “yoghurt” of the SENSE-tool was 6% higher than calculated with SimaPro. When the single inputs were evaluated in more detail, a significant deviation was found for the application of mineral fertilizers and for the transports. The difference in the fertilizer was due to the use of an average dataset compared to specific datasets in the SENSE-tool. The error in the transport was due to a miscalculation that only occurred if one part of the products were transported on a different, parallel route. A small difference was revealed in the effect of electricity and water use due to the use of updated datasets (see explanation in D4.1 Olafsdóttir et al., 2014).

When the same datasets were used for the dairy, the overall SENSE-tool result was only 0.4% higher than the results by calculation with the same data and datasets in SimaPro. When the three steps agriculture, livestock and processing were analyzed, the deviation for each of the processes were less than 5%. Looking at single inputs, the only big deviation still remaining was in the transports due to the reason mentioned above.

In the aquaculture, the results were calculated for one case study using the same datasets. Looking at single inputs, there was only a deviation above 10% in the electricity due to the use of updated datasets and a huge deviation in the transport. All other single inputs differed less than 3%. When the summarized results of the two aquaculture and the processing steps were analyzed, there was only a very small deviation (<2%), whereas the result of the final transport step varied significantly. The final result of the aquaculture chain was much higher with the SENSE tool. It was observed that the tool did not take into account the transported mass entered in the transport stage, but calculated with the total mass as given in the next process. This led to considerable deviation especially if only a part of products is transported over a certain distance and thus the transport calculation is split in different delivery routes. The current version of the tool has now been updated.

After the correction of the transport calculation in the SENSE-tool, the results for the lorry transports correspond to the SimaPro results with a minimal deviation of less than 3%. Nevertheless this criterion is still not fulfilled for the aircraft freight transport, as analyzed in the aquaculture results, with a deviation of 22%.

3.3.9 General suggestions for the future development of the tool

Considering the complexity of the life cycle thinking and the challenges the user faced when entering their data - even though the data entry was based on simple KEPis and described in detail in the help file - **the integration of an expert check of the data is recommended for the SENSE-tool**. All results downloaded – especially the EID (Environmental Information Document) - without a review could have the sign „**Draft“** or **„Not validated“**. After the validation this would

change to „validated by …“, so that it is not possible to publicly present results that are based on incomplete or incorrect data.

An additional feature is also suggested that helps the users to define the correct processes and the correct final products. An idea is to develop main questions which lead through a decision tree. In the end they receive a suggestion on how they could model their processes.
The tool could be improved by adding average data sets, e.g. for common feed used for cattle, so that each SME don't need to collect data from upstream the value chain. For the aquaculture some of those improvements have already been implemented in the SENSE tool for aquaculture feed (Norwegian average feed 2010 and Icelandic average feed). Additionally, datasets for fishmeal and fish oil as ingredients in feed including the conversion to feed have been suggested to allow the users to create their own combination of feed. The same applies for crop ingredients including conversion of crop ingredients to feed. This would be of benefit for companies who are interested to explore the effects of changing feed ingredients
It is not suggested to add average data for important life cycle steps, e.g. general data for milk production, since this has the main influence on the result and would weaken the LCA-aspect of the tool.
Future recommendations on availability of datasets in the SENSE tool: The SENSE tool is developed as an easy to use tool where feed was defined as KEPI but not the individual ingredients. Although companies may be interested to compile their own list of ingredients for the feed, it is a lot of effort and perhaps beyond the scope of an easy to use tool like the SENSE tool.

- Therefore, for future use of the SENSE tool, ideally more complete datasets should be available in the tool with average feed composition used by the companies. This is also valid for livestock. However, it may be a huge task to collect a wide variety of different commercial feed and update such dedicated datasets in an easy to use and general tool.

Future recommendations for benchmarking

The initial SENSE tool concept included the idea of directly calculating the benchmark with the data entered in the tool. This development has not been achieved within the SENSE project due to lack of significate number of data for the comparison between different companies.
A clear prerequisite for benchmarking would be the definition of standard products and processes. At the moment the users are free to define the product and the functional unit as they like and thus a software cannot recognize to which type of standard data the product or process could be benchmarked. As such a feature is not implemented in the tool a benchmarking was not possible.
If a benchmarking option would be implemented in the SENSE tool, clear goals of benchmarking and criteria need to be established. It has to be decided what is compared (producers or products; same production systems vs. same product produced with different production systems), what is the exact aim of the option (provide an order or magnitude of the environmental impacts; suggest improvements to the user; calculate statistical correct average data). Depending on the aim, the benchmarking option has to be implemented quite differently.

3.3.10 Assessment of social impacts

The SENSE tool has implemented questions to assess the social impacts of companies[19]. The questions are focused on adherence to labour standards and national laws, and communication of the companies´ policy regarding labour standards, as well as workers´ rights to join trade unions, their employment conditions, wages and working hours. Additionally, questions are included on the status of occupational health and safety training, training related to employees wellbeing and the actions of the companies to address issues regarding the influence of the company on the local communities both concerning remedies and additional costs as well as offering opportunities to local people (See Annex III).
The SENSE tool calculates a score for the company's performance, with results on a scale from 0-100 (Olafsdóttir et al., 2014). The company score of social impacts could be presented on the EID form along with the information on the products´ environmental performance to give a more holistic sustainability assessment.
Fourteen of the companies testing the SENSE tool used this opportunity to perform self-assessment by answering the questions on the social impacts (Table 14). It was expected that companies who already had some type of certification on quality or environmental management would obtain higher score since they might already be addressing social aspects in their company policy and would be more motivated to answer the questions. In fact the companies that received the highest scores were considering or had obtained certification approved by ISEAL i.e. Aquaculture Stewardship Council (ASC) or Forest Stewardship Council (FSC).

Other standards mentioned by the respondents were for example retailer standards and Productos Lacteos Sostenibles (PLS) certification. It was also noted that the fruit juice producers were very collaborative and motivated in answering the questions on the social impacts in the tool. It should be considered that this self-assessment was part of the pilot testing and the results are presented here to give an example on how the system can be used, but it is not intended to assess the actual performance of the different sectors because the data is limited.

[19] Questions on social impacts and the scoring scheme were developed by SENSE partner Rosalind Sharpe, City University.

Table 14 Self-assessment of social impacts performed by the participating companies in the pilot trials of the SENSE tool (n=14)

#	Food sector	Size	Country	Total score	Assessment of the social impact scores
1	Fish	10 - 50	IS	86	*Scoring range 85-100* Best practice: SME has a named senior representative with responsibility for labour standards within the company, and has a good management systems for labour standards and working conditions in place at least as far as first-tier suppliers, and demonstrates evidence of actions taken to address external impacts of production within local communities, and makes public statements of commitment (e.g. on website/labelling).
2	Fish	10 - 50	IS	86	
3	Fish	50 - 250	IS	78	*Scoring range 61-84* Good practice: SME has a named senior representative with responsibility for labour standards within the company, and has policies on labour standards and working conditions in place, and has a formal management system on-site and its policies are communicated at least as far as first tier suppliers, and it demonstrates evidence of actions taken to address external impacts of their production within local communities
4	Dairy	50 - 250	ES	77	
4	Dairy		SE	65	
6	Fruit	50 - 250	TR	51	*Scoring range 51-60* Basic Management: SME has a named senior representative with responsibility for labour standards within the company, and has adopted policies to manage labour standards and working conditions on-site, and demonstrates evidence of actions taken to address external impacts of their production within local communities
7	Fruit	10 - 50	BR	46	*Scoring range 1-50* Awareness only: SME demonstrates awareness of core labour standards and/or sector code or guidelines and of the external impacts of their activities in local communities, but management of employment practices and actions taken is limited.
8	Fruit		IT	28	
9	Dairy	< 10	RO	20	
10	Meat		RO	14	
11	Dairy	< 10	CH	10	
12	Fish	10 - 50	IS	10	
13	Fish	< 10	IS	10	
14	Dairy		CH	0	*No score: 0* No evidence: SME provides no evidence

3.4 Results of the external validation - SENSE on-line survey

Feedback was obtained after testing was completed in the pilot trials in companies in the selected food sectors; meat and dairy, fruit juice and salmonid aquaculture supply chains. The views on the functionality and usefulness of the tool were explored by interviews and an on-line survey. Aspects like willingness to share data, the need for certification, the usefulness of benchmarking, and sustainability awareness were included.

3.4.1 Demographics

Background information was collected on the size of the companies and the food sector. One third of the companies were micro size (<10 employee) and another third part was consisting of companies of 10-50 employees. One large enterprise participated in the testing of the tool and filled in the survey. The largest number of responses came from companies in the dairy sector (48%) from Sweden, Romania and Switzerland and equal number of participants (22%) from fruit juice (Spain, Brasil, Germany) and aquaculture companies (Iceland). Companies from the meat sector were from Romania.

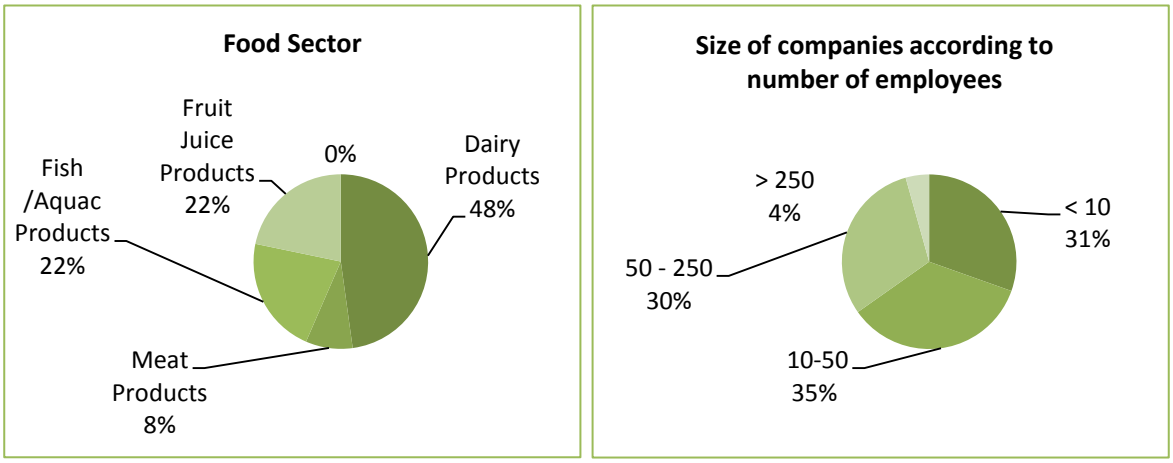


Figure 3 Demographics of companies providing input to the SENSE on-line survey (n= 23; five companies were interviewed and their feedback is included in the overall sample)

3.4.2 Data analysis and limitations

The results are based on a total number of 23 companies. Thereof, five companies who did not perform testing of the SENSE tool, but were interviewed and the survey filled in by SENSE contact persons. Since this is a small sample, a descriptive analysis was performed based on frequency figures to illustrate the semi-quantitative results and furthermore qualitative information from the interviews are included to support the findings. The results are therefore only indicative of key trends among the companies who participated in the meat and dairy, fruit juice and aquaculture supply chains.

3.4.3 Sustainability awareness in SMEs

The aim was to gather views about how well the SENSE-tool and EID met the requirements regarding environmental and social objectives of stakeholders in food supply chains. The questions explored SMEs' current practice regarding adherence to standards on quality or environmental management, food quality and safety, sustainability and schemes imposed by e.g. retailers on their supplier networks. Q1-10

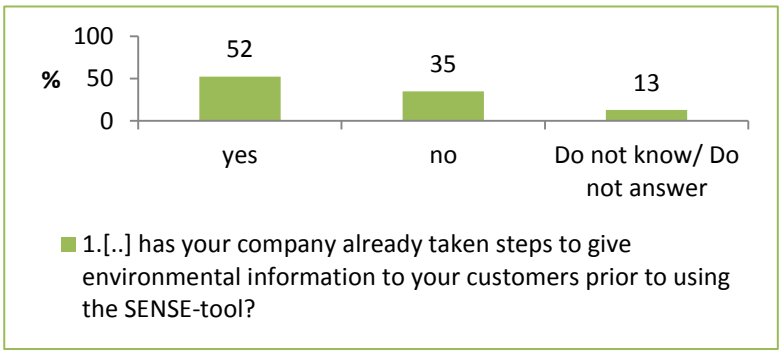


Figure 4 Sustainability awareness in SMEs – Communication of environmental information (n=23); Q1

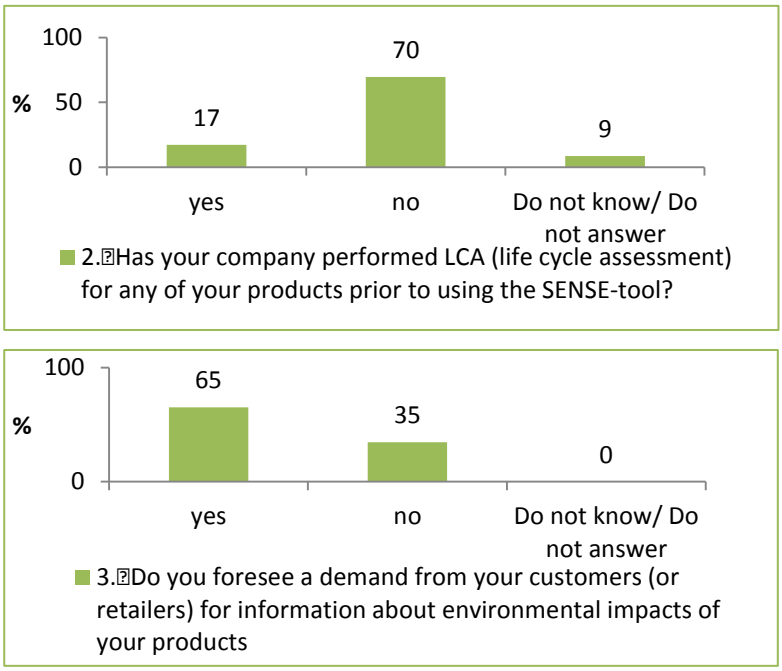


Figure 5 Sustainability awareness in SMEs – LCA and need for environmental information (n=23); Q2-3

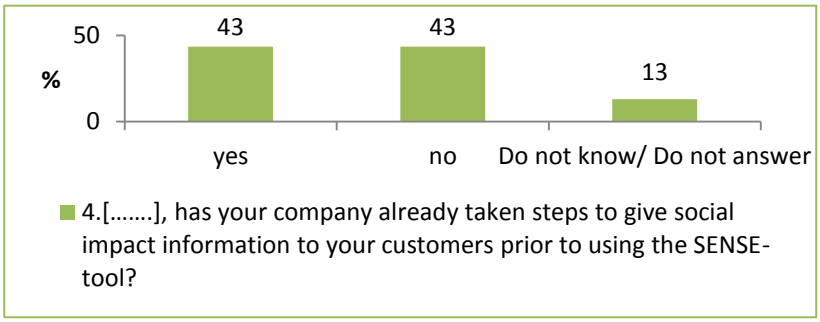
When respondents were asked about their history of communicating environmental information about their products prior to using the SENSE tool, more than half of the companies had done so.

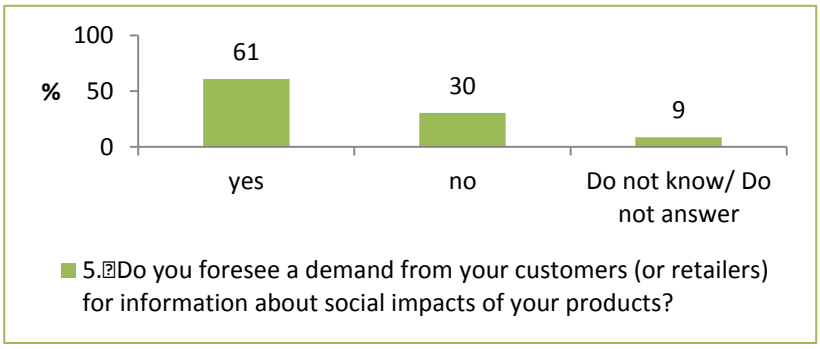
Only 17% of the companies had already performed LCA (life cycle assessment for their products. But two thirds of the companies stated "yes" regarding foreseen demand from their customers about information on environmental demand for their products.

When asked for more details about how companies communicated the environmental impacts of their products the following statements give insights to the current practices of communication in companies:

„[…] through various channels, e.g communication on webpages, on packaging of the products, to visitors at the farm. We communicate about our agricultural production, our cattle, our production, our ideas about sustainability, our objectives and achievements and our challenges within the area". Dairy company (SE)

„[..] our environmental policy, targets and improvements are communicated on our webpage and in our annual report. Waste handling and energy consumption are examples. We have our own program with environmental requirements that the suppliers of milk must fulfil and we also communicate about this voluntary commitment. We don't see that there is very much interest from the customers about environmental information. E.g., yearly we have 1-2 questions about this on Facebook. We are the dairy in Sweden with the highest percentage of organic products. Dairy company (SE)





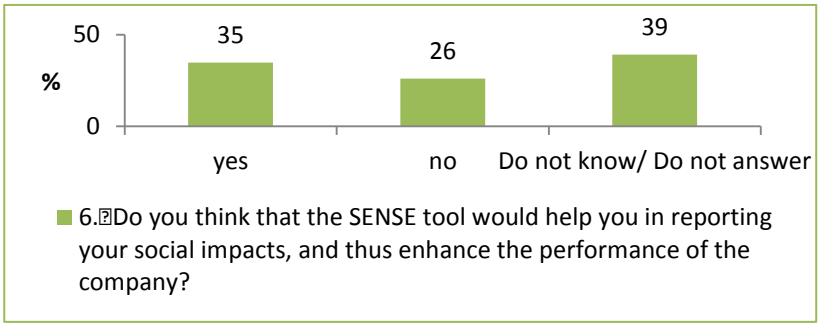


Figure 6 Sustainability awareness in SMEs – Social impact information (n=23); Q4-6,

Respondents were asked about their history of communicating sustainability (or social) information about their product, prior to using the SENSE tool.

There was not a clear trend regarding practices of communicating social information in companies, since equal share of them responded either „yes“ or „no“ (Q4).

However, a clear positive tendency as perceived by 61% of the respondents was observed regarding foreseen demand for social information from their clients (retailers) (Q5).

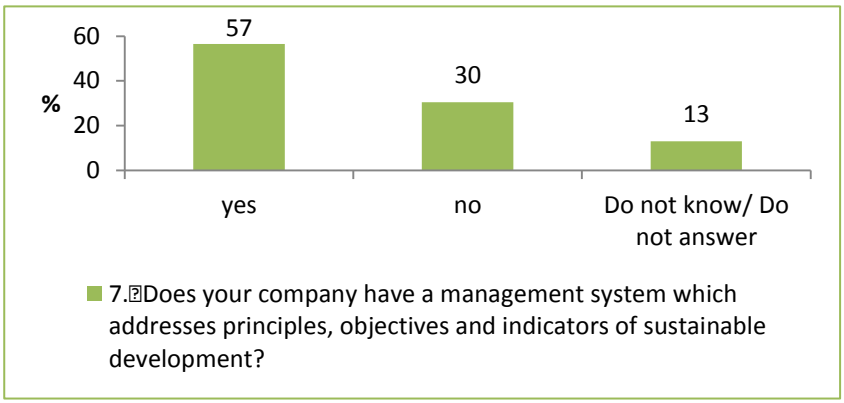
Despite the perceived need for social information from their clients in the future, the companies were unsure if the SENSE tool would help them to report their social performance and thus enhance the performance of the company. However one third of them agreed.(Q6).

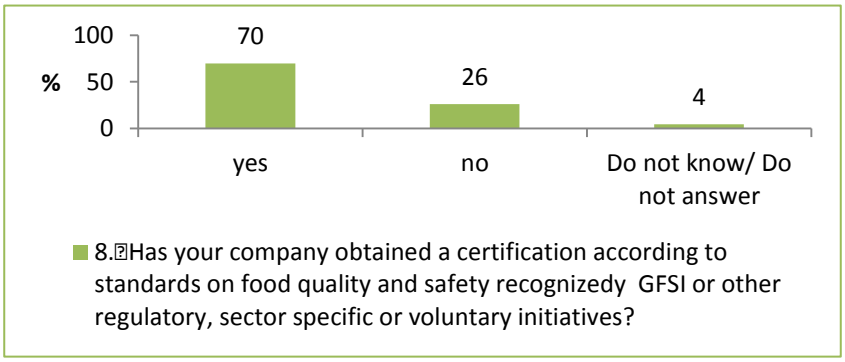
The following statements are examples of views on social aspects:

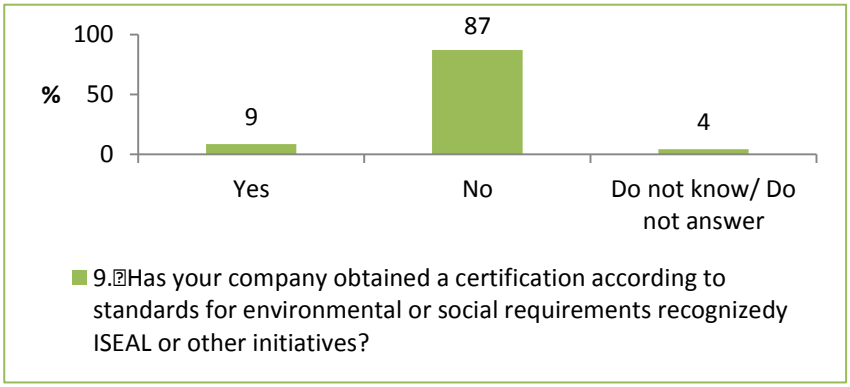
“We have a collective agreement with all our employees, which regulate salaries, vacations, health and safety for workers etc. In Sweden the minimum salaries are not specified in law, they are in the agreement between the employers and the employees”. [Dairy company, SE]

“We are a small dairy with local suppliers and customers. If we were not a socially responsible company we would get bad reputation that would have an impact on our sales immediately. Our profile is that we are a social responsible company in our region. We have about 80 employees, but totally our milk chain creates more than 400 jobs in our region. We work closely with schools and offer lectures. We also work with local sports associations, and have athletic and football schools in the summer”. Dairy company (SE)

„We have recognized limited needs for social information of our products only information about our effects on the environment“. [Aquaculture company,IS]







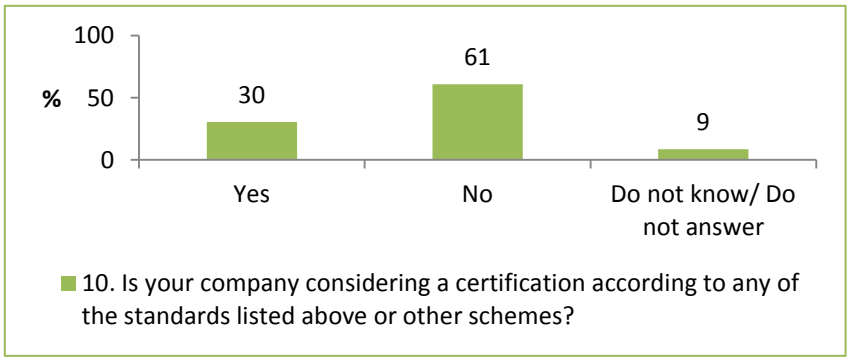


Figure 7 Sustainability awareness in SMEs – Uptake of standards (n=23); Q7-10

More than half of the companies stated that they had incorporated principles of sustainable development in their management system but about one third of them did not address this (Q7).

Seventy percent of the companies had some kind of certification addressing food quality and safety. HACCP was most often mentioned by the participants of the survey, since it is required for food in many food sectors (Q8).

Some of the companies mentioned that they had certification according to voluntary schemes that are recognized by the Global Food Safety Initiative (GFSI)[20] or other voluntary initiatives. The most common were ISO standards for quality management (ISO9001), environmental management (ISO14001) and food safety and quality management (ISO22000, FSSC2200) (Q8, Figure 8).

Other standards mentioned for good manufacturing practices including quality and safety were GAA and AquaGap mentioned in aquaculture companies and IP Sigill for meat and dairy products. Specific retailer standards were mentioned in fruit juice companies such as BRC and IFS and Whole Foods Market standard in aquaculture companies. Organic standards (KRAV) and quality lables (QM Fromarte) were mentioned in dairy companies. For fruit

[20] http://www.mygfsi.com/

companies the SGF standard was mentioned (Figure 8).

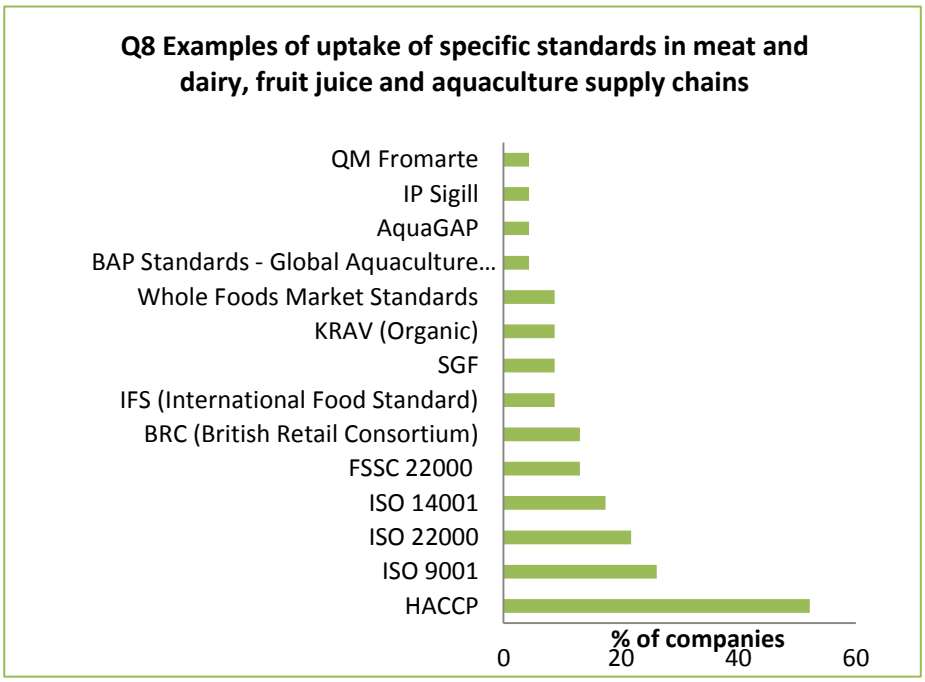


Figure 8 Sustainability awareness – Uptake of standards on management, food quality and safety, organic production and quality lables N= 21; Q8

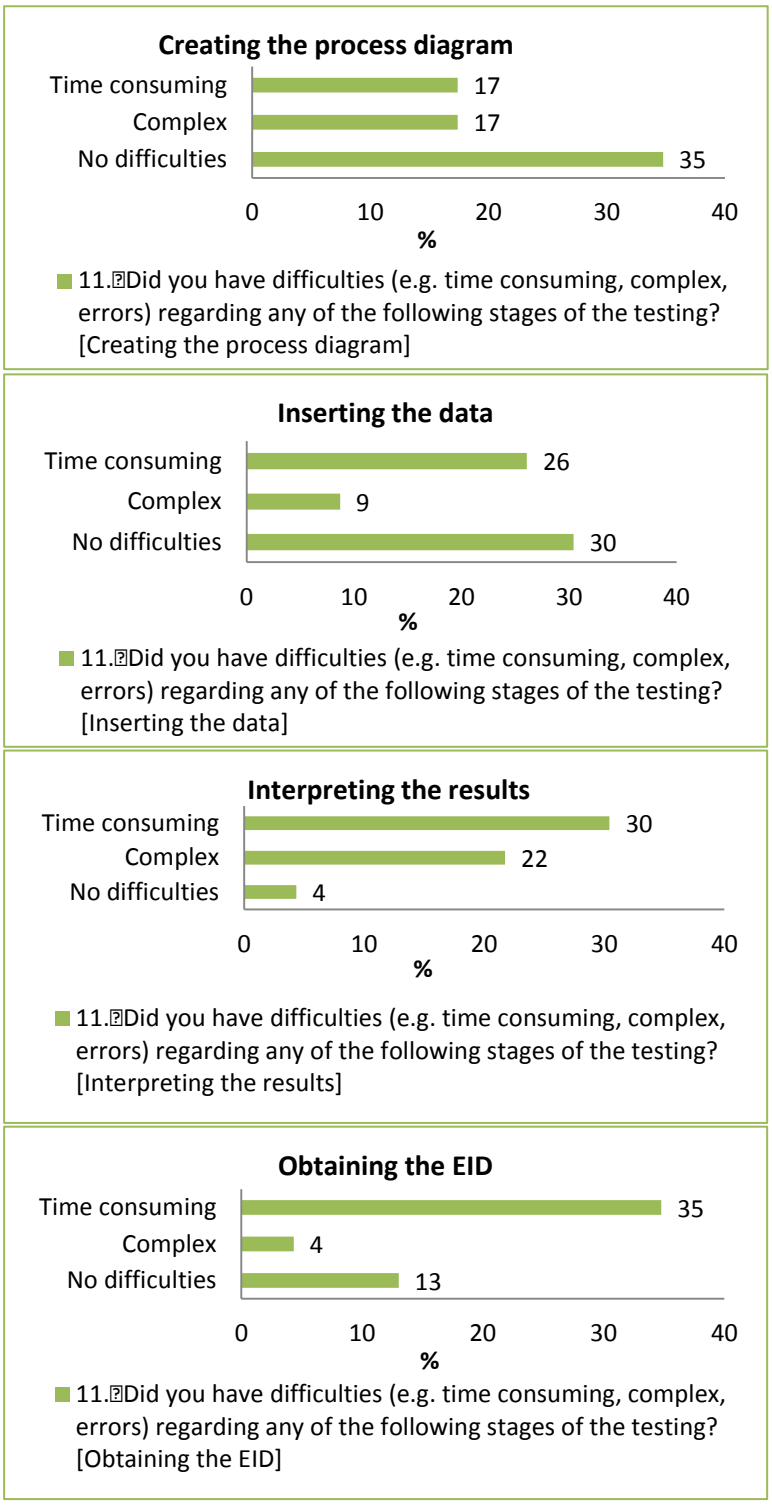
Only nine percent of the companies answering the survey had a certification for social or environmental standards recognized by ISEAL or other initiatives (Q9). However, almost one third of the companies were considering sustainability standards (Figure 7). There appears to be increasing interest in sustainability standards. The motivation for certification appears to be because of push from their customers e.g. as stated by one company "*we would only consider such standards if a large customer would explicitly ask for any of these*". Sustainability standards that food companies had or were considering were FSC (Forest Stewardship Council), ASC for aquaculture (Aquaculture Stewardship Council) and Marine Stewardship Council (MSC) standard in fish processing which all are identified by ISEAL Alliance[21] (Figure 9). Other sustainability standards mentioned were Productos Lacteos Sostenibles (PLS) for dairy products[22], Empresa Socialmente Responsable (ESR)[23] a standard for social responsibility and a certification for regional products "natürli" controlled by OIC (Organisme intercantonal de certification)[24]. One company mentioned energy management according to ISO 50001.

Figure 9 Sustainability awareness – Examples of standards and certification on sustainability in companies in the dairy, aquaculture and fish processing supply chains (environmental, social) Q10

[21] http://www.isealalliance.org/
[22] http://www.magrama.gob.es/es/megustalaleche/productos-lacteos-sostenibles/
[23] http://www.empresasocialmenteresponsable.com/
[24] http://oic-izs.ch/de

3.4.4 SENSE tool - Data input and perceived user friendliness

The aim is to evaluate the user-friendliness and functionality of the tool when inserting data into the SENSE tool. Q 11-14 (only answered by those companies that tested the tool)



When asked about specific functionalities of the SENSE tool, about one third stated they had no difficulties to create the process diagram and inserting data, while approximately one third of them stated they considered this time consuming and complex

Regarding interpretation of the results from the SENSE tool half of the companies testing the tool experienced this as time consuming and complex and only 4% stated that they had no difficulties

When asked about if companies had difficulties to obtain the EID document, about one third of the respondents stated that it was time consuming.

Figure 10 SENSE tool data input and perceived user friendliness: complexity, difficulties, time; (n=23); Q11

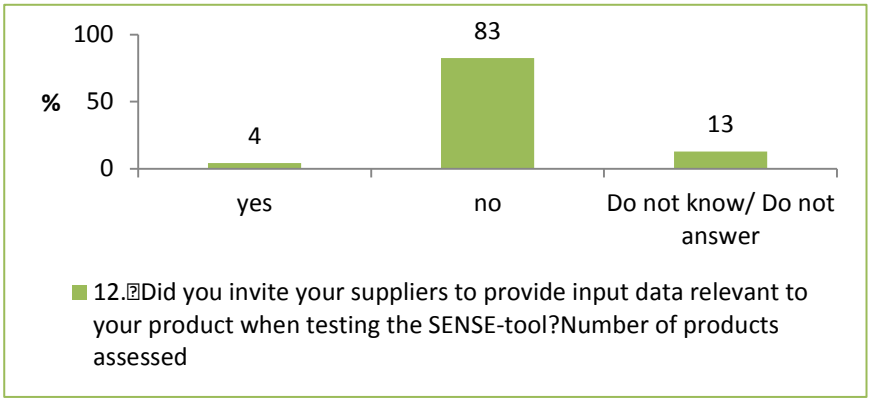


Figure 11 SENSE tool - Data input – invitation to suppliers (n=23); Q12

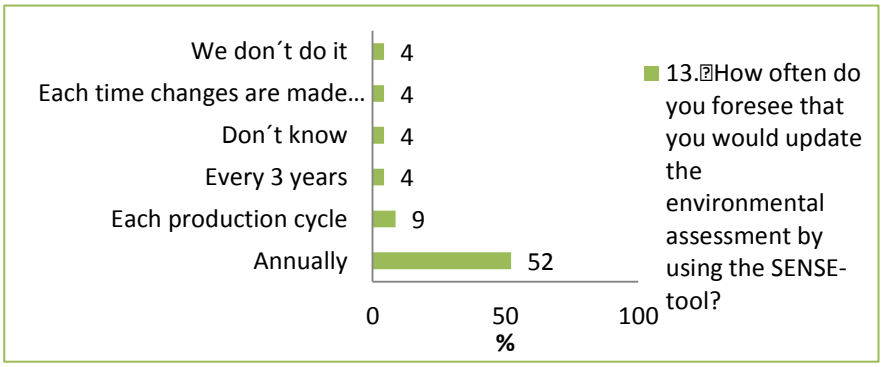


Figure 12 SENSE tool – update of the environmental assessment (n=23); Q13

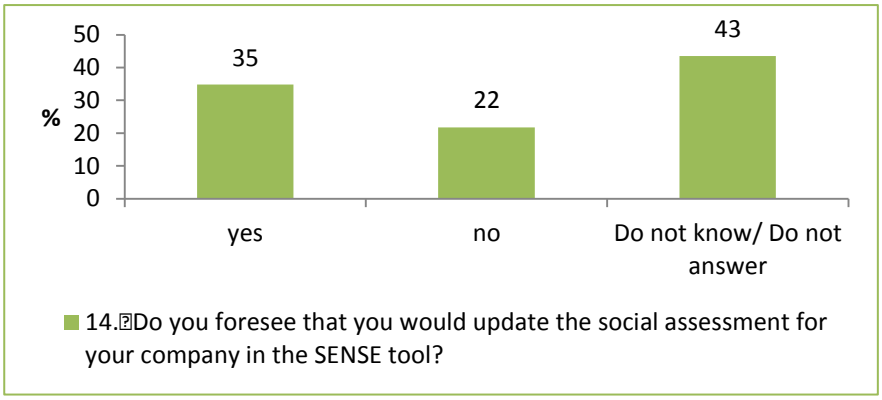


Figure 13 SENSE tool – update of the social assessment (n=23); Q14

The majority of the companies (83%) responding to the survey did not invite their suppliers to test the tool and therefore data was sometimes only from one step in the supply chain.

A dairy company stated in the interview that according to their experience most of the suppliers reacted in an enervated way if they were asked to give data. The farmers already give data to the authorities and therefore their first reaction to give even more data would be rather negative.

In some case companies had no difficulties to obtain data for example if they had ownership of the chain and were their own suppliers for the input needed.

More than half of the respondent stated that they would update the environmental assessment annually (Figure 12). However, only one third of the companies foresaw that they would update the social assessment (Figure 13). The main reasons why they did not foresee to update it, was because they did not expect any important changes in the future. They already considered social aspects, “since it enhances the good reputation of the company “. Accordingly, many of their clients had already their own platform for evaluation of social responsibility. The assessment of the social impacts would only be useful if the SENSE tool gained some international recognition and validation. One company stated that an assessment of social impacts was not needed, since they already considered social aspects and would take measures independent of questionnaires and assessments.

3.4.5 SENSE tool – Results

The objective of the following questions is to assess the usefulness of the results for the SMEs. Further, the aim is to explore the understanding of terms used for sustainability assessments and identify whether there are needs for training Q15-19

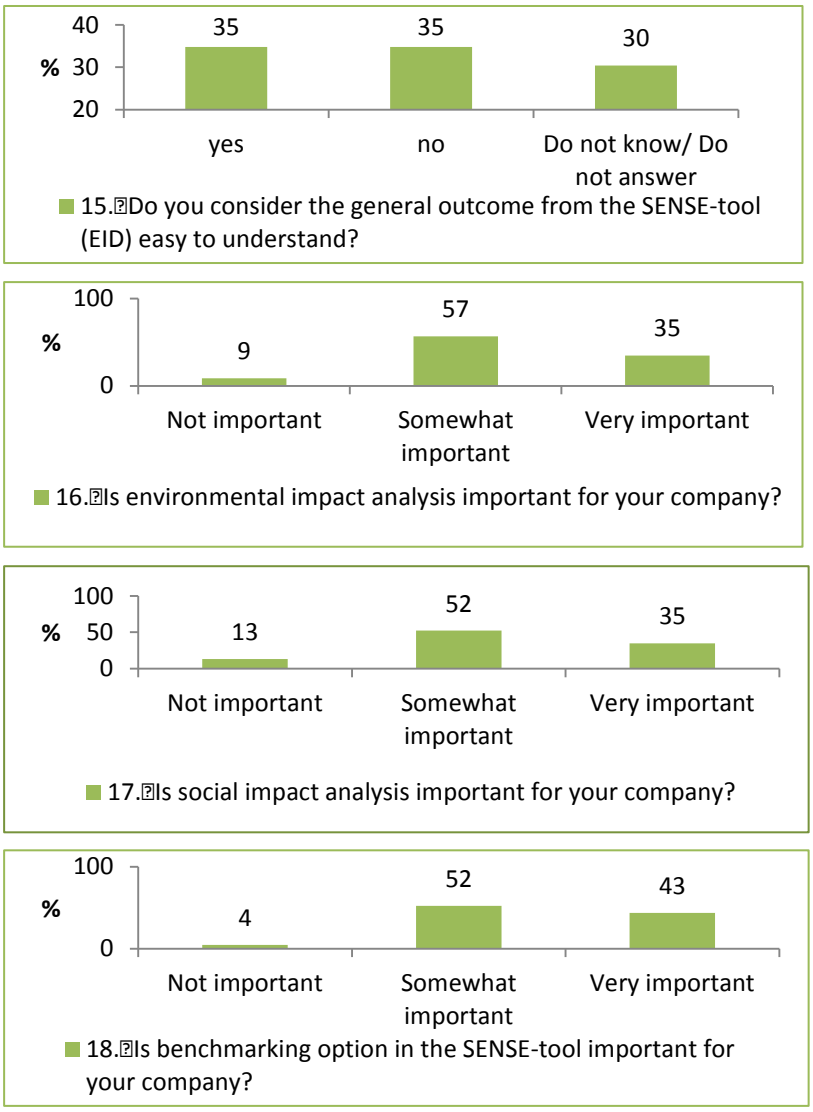


Figure 14 SENSE tool - Results –Importance of SENSE tool results (EID, environmental-, social impacts) and benchmarking for companies (n=23); Q15-18

When asked about the importance of the SENSE tool´s results, the views on the general outcome (EID) were mixed regarding how easy it was to understand it.

Some of the companies stated that they had limited knowledge about the whole environmental sustainability concept and welcomed the opportunity to obtain some training from SENSE.

In interviews it was pointed out that simplified explanations would be helpful regarding the interpretation of the charts. Moreover, the EID document had too small text (font size) and the figures were confusing with a lot of bars and colours, but lacking explanation.

Since they were not familiar with typical reference values for the impact categories, this should be added.

A reference value would also be helpful to compare the outcome of the EID with other producers. Thus it would be clear if an improvement was needed or whether their performance was good.

The views regarding the importance of environmental and social impact analysis and benchmarking for the companies was similar (Q16-18). One third of the respondents considered all options very important and more than half of them considered this to be somewhat important and only a few stated “not important”.

Many of the companies in the meat and dairy chain are well aware of their environmental challenges and are working towards improvements. One company stated for example that in their daily practices they considered that cleaning agents were not wasted thoughtlessly, and they were considering improvements in energy efficiency like use of solar cells etc. A dairy company stated:

> *"[….] it is important to not only compare one aspect, but to see the whole picture [……]. Although we use a lot of energy, the aspect that we pay a good milk price and create many jobs; should also be considered". [Dairy company, CH]*

Some companies were negative towards the SENSE tool when the question was raised about effective use of the tool in the future and stated:

> *"there is no demand of the data we can obtain through SENSE by any of our customers [….] there is no benefit for us to invest time (money) for SENSE".[Fruit juice company, DE)*

The following statements highlight the view of the meat and dairy companies:

> *"We think it is a problem to show that the main environmental impact happens at the dairy farm. We are a cooperative company that is owned by the dairy farmers." [Dairy company, SE]*

> *"I rather want to make my own decisions and do not like to make improvements because of enforcement by the law [….] I would prefer to obtain information and implement sensible improvements rather than law enforcement." [Dairy company, CH]*

Benchmarking using the SENSE tool was considered interesting for many of the companies. However, one of the dairies mentioned that they could already do this with "Fromarte", the Swiss umbrella organization for cheese specialists. Another company interviewed expressed concerns with benchmarking;

> *"It is not possible to compare with others, as no company or farm is exactly as ours. I think there is a risk with benchmarking – if you get results that show that you are better compared to other maybe you stop improving and are satisfied with what you achieve. In our company we always want to be better than last year in everything*." *[Dairy company, SE]*

> *"We would like to know where we stand in comparison with other companies, however, I do not know how data privacy can be managed to convince us all to give the information" [Dairy company, RO]*

Regarding data privacy, transparency and benchmarking, one of the aquaculture companies (IS) mentioned that harmonized data gathering would be a benefit to save time for them. For example it would be useful if some of the data collected for the aquaculture association and specific standards could be synchronized with the required Green bookkeeping of the authorities.

When asked if support was needed to use the SENSE tool (Q19), about 40% of the companies were in favour of having a training course in addition to the SENSE tool user guidelines "SENSE tool for Dummies" to ensure effective use of the SENSE tool in the future.

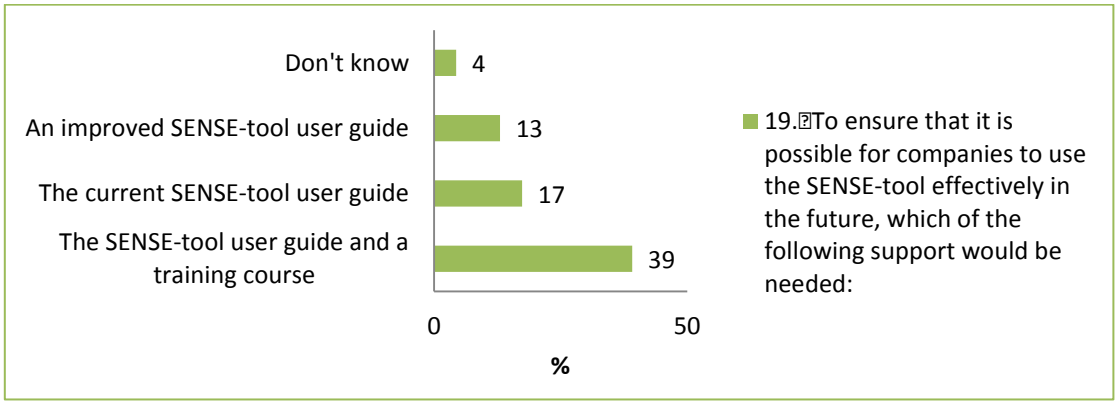


Figure 15 SENSE tool support and guidance for effective use of the tool in the future (n=23); Q19

Further support like training, support from experts and user-friendly guidelines and information within the SENSE tool was suggested and considered necessary to implement the tool

- Give explanation of the relevant concepts e.g. environmental sustainability
- Provide step by step explanation for creating the diagram and the data input. This was quite challenging for some of the companies. A clear description of the next steps to perform within the tool, so that from one step to the next there is always a "continue" available that leads through the main steps.
- The SENSE tool has the option to print out a template for the inventory as an excel file to facilitate collecting all data before entering it into the tool. Furthermore, it was suggested to give examples of filled out questionnaires.
- The SENSE tool has been translated to 8 languages and this was considered a benefit. Further translations should be motivated as needed depending on users.
- It was considered very important to have help to insert data and to obtain more explanations. Personal support e.g. expert coming to the company and offering help on site was considered most helpful. Direct support on site from an expert is very efficient, since much less time is needed if it is explained directly. Most often the lack of time is the problem."
- Information on the page itself would be really helpful and better than the SENSE-tool for dummies.

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3.4.6 Future use of the SENSE tool

The aim of the questions on the future use of the tool was to evaluate the need and usefulness of tools like the SENSE tool for SMEs. Specifically, the objective was to explore how they would communicate and use the EID and if they perceived the implementation of the SENSE tool to be economically and technically feasible Q20-21.

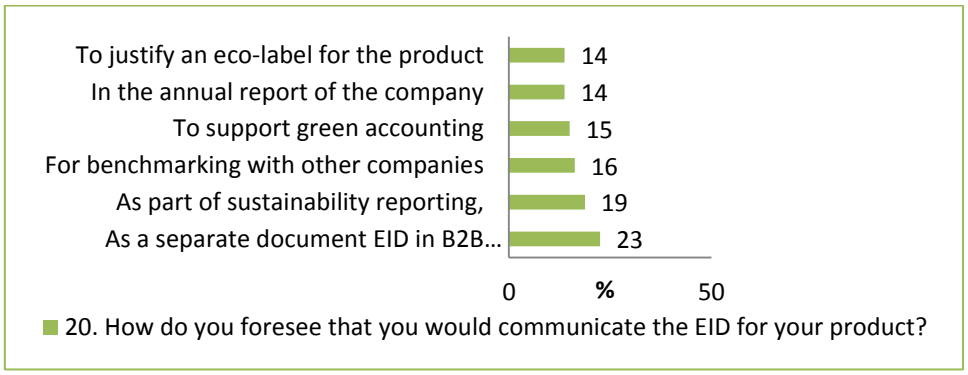
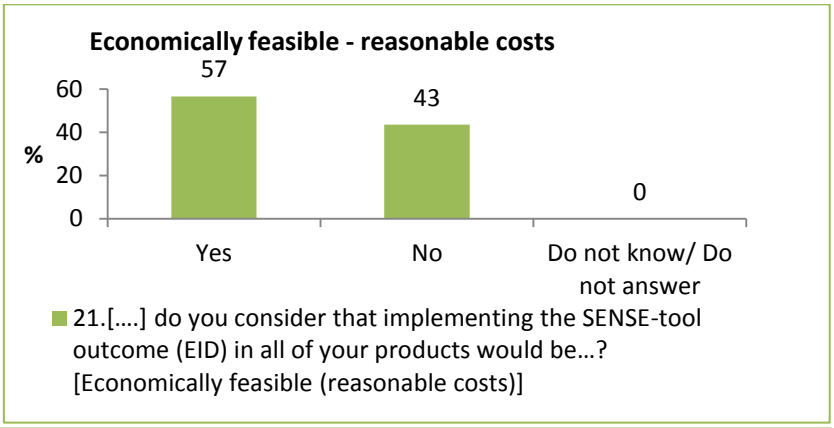


Figure 16 Future use of the SENSE tool – Communication of the EID; (n=20) prioritized 4 choices; Q20



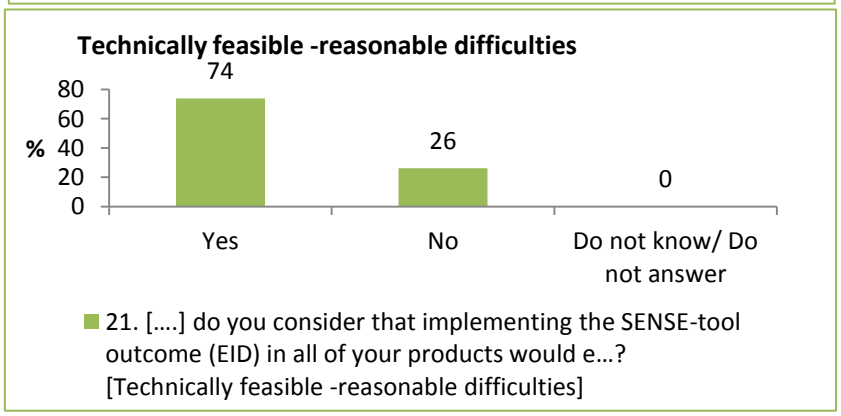


Figure 17 Future use of the SENSE tool – implementation, economically and technically feasible (N=23);Q21

The companies did not prioritize in particular any of the options given as means to communicate the EID, although the option to use it for B2B communication was most frequently selected and secondly to use in sustainability reporting (Q20). With regard to the resources to be committed 74% of the respondents considered that it would be technically feasible to implement the SENSE tool and the EID for all their products, while 57% of them agreed that it would be economically feasible for their company (Q21).

3.4.7 Sharing of data and certification

To ensure the exploitation of the SENSE–tool beyond the project, the aim of the following questions was to identify additional issues that need to be considered to maintain the SENSE-tool as a service to SMEs. The objective was to explore views on data sharing and transparency in the supply chain. Further, the aim was to explore expectations regarding certification and trust in the SENSE tool outcome (EID). Q22-25

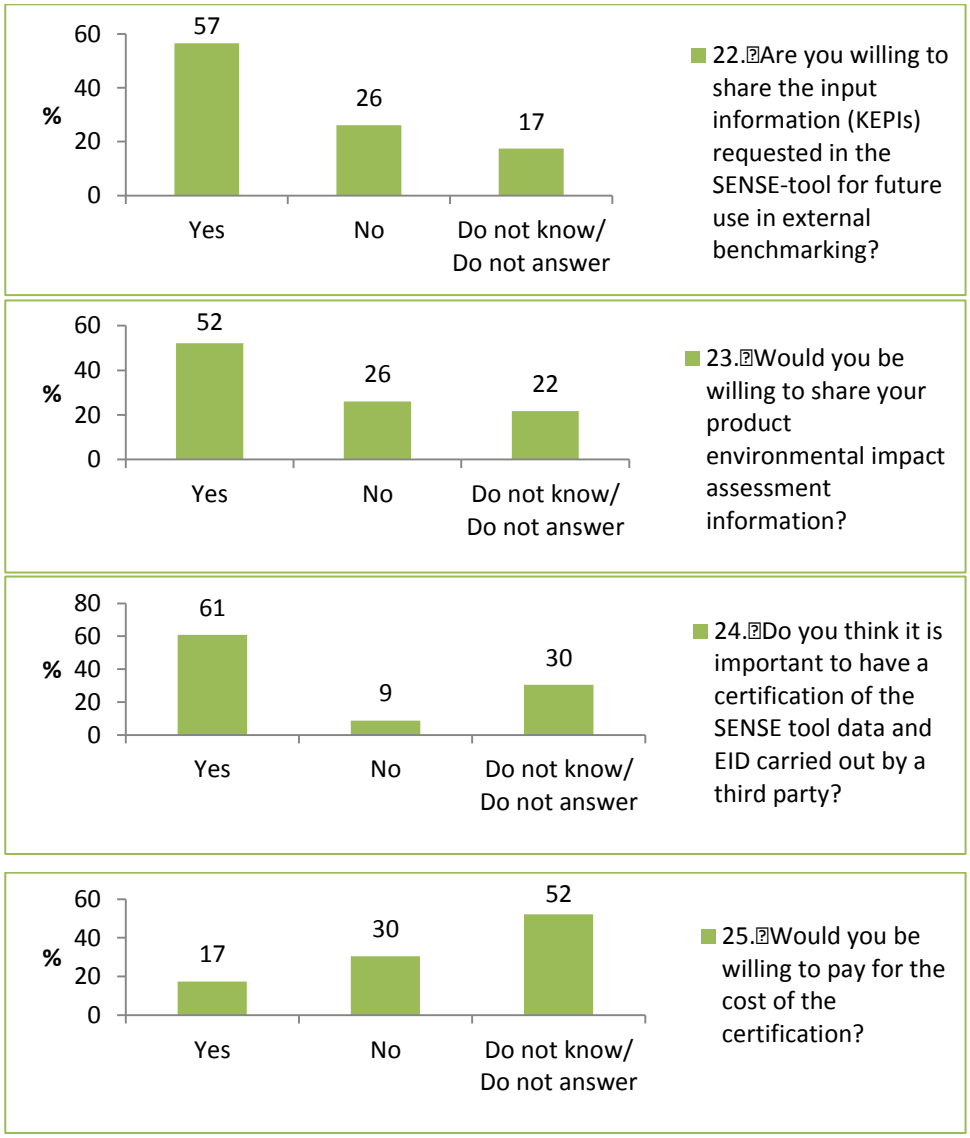
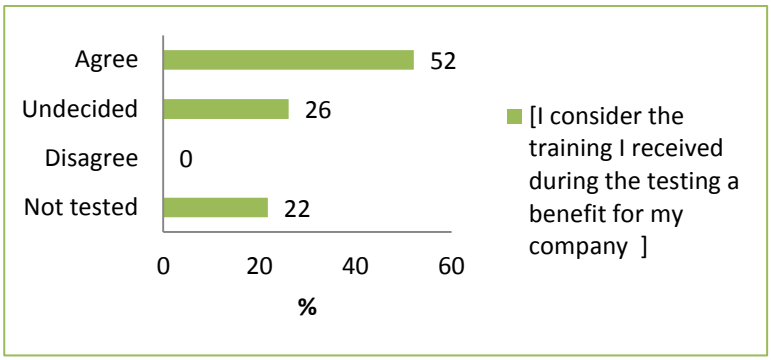


Figure 18 Sharing of data on KEPIS and environmental impacts and views on third party certification (n=23) Q22-25

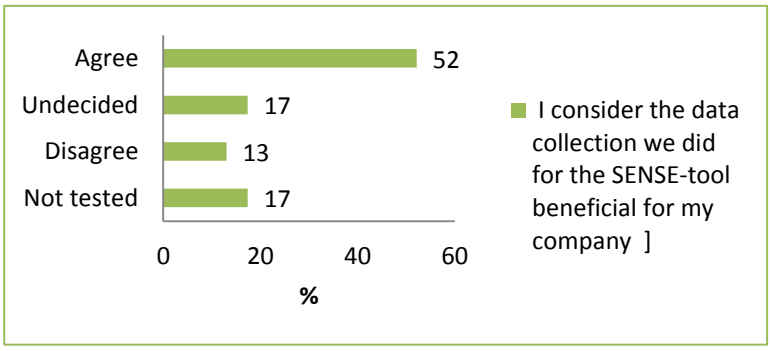
More than half of the respondents (57%) agreed that they were willing to share information on the KEPIs and the environmental impact assessment (52%) whereas one quarter of them responded “no”. Around two thirds of the respondents were in favor of certification by a third party, but only 17% were willing to cover the cost and half of them were unsure (Do not know).

3.4.8 Statements on the benefits of the SENSE tool

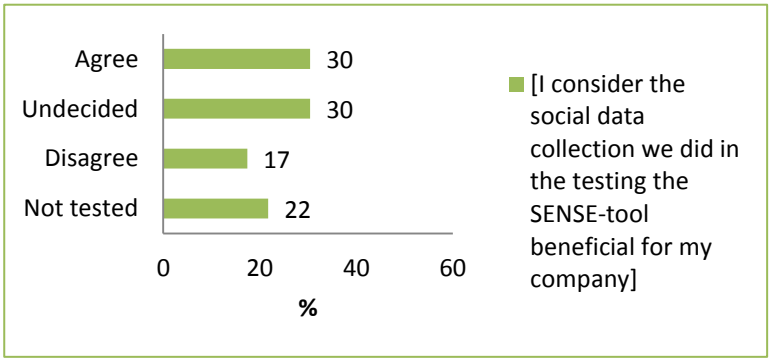
The aim of the following fifteen statements is to evaluate the perceived benefit of using the SENSE-tool. Q26



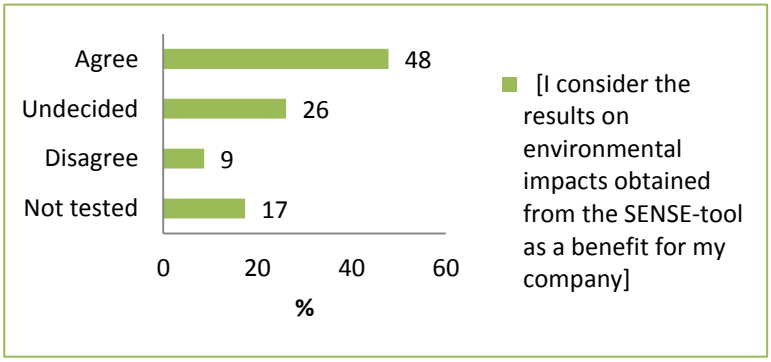
More than half of the companies agreed that the training received during the SENSE tool testing was a benefit for the company and no one disagreed.



About half of the respondents (52%) agreed that the data collection in general was beneficial.

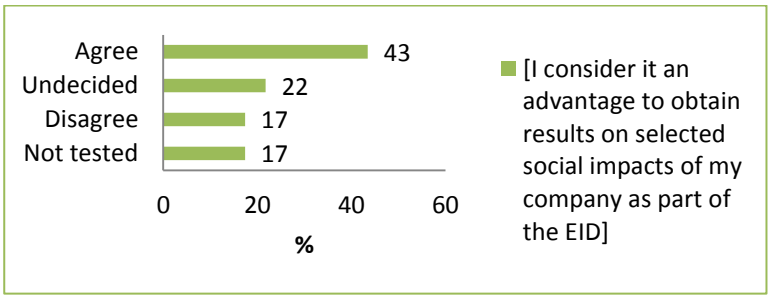


However, the perceived benefit of the social data collection was agreed on by fewer companies or 30% of the respondents and 47 % were undecided or disagreed.

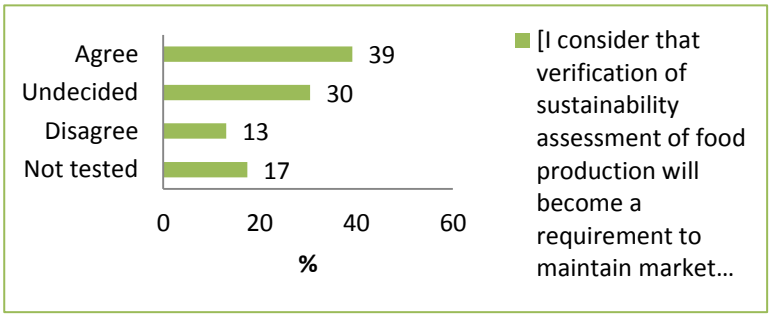


When considering the benefit of obtaining results of environmental impacts almost half of the companies agreed on the benefit and 35% were undecided or disagreed.

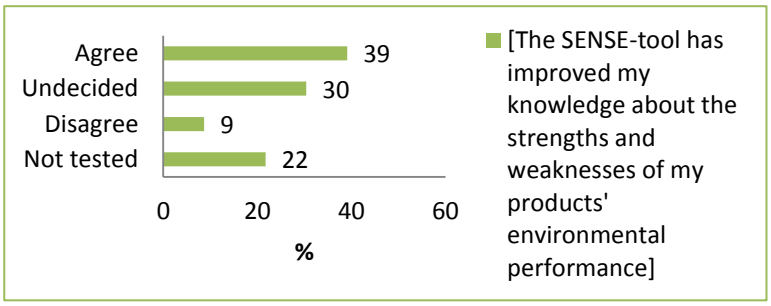
Figure 19 Statements on the benefits of the SENSE tool (n=23); Q26



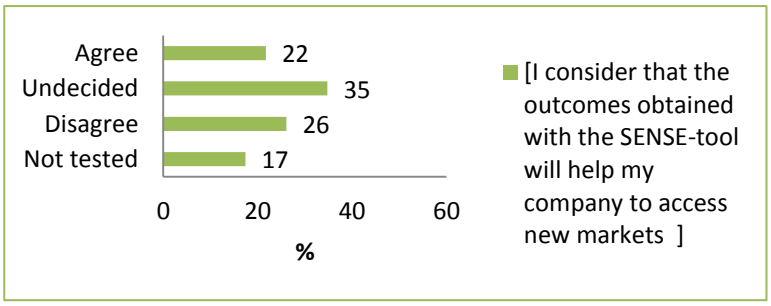
The option to include results of social impacts for the company as part of the EID was considered a benefit by almost half of the respondent (43%).

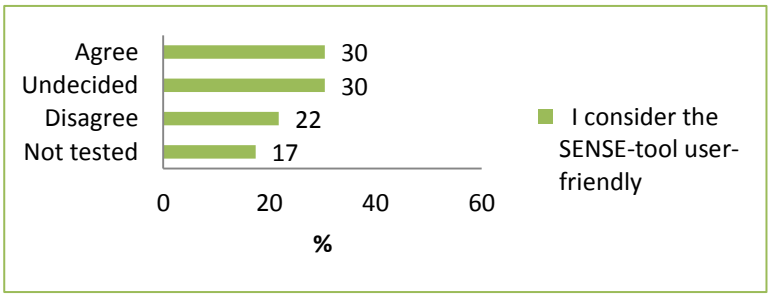


The statement on the need for sustainability assessment as a requirement to maintain market position was consequently agreed on by 39% of companies.



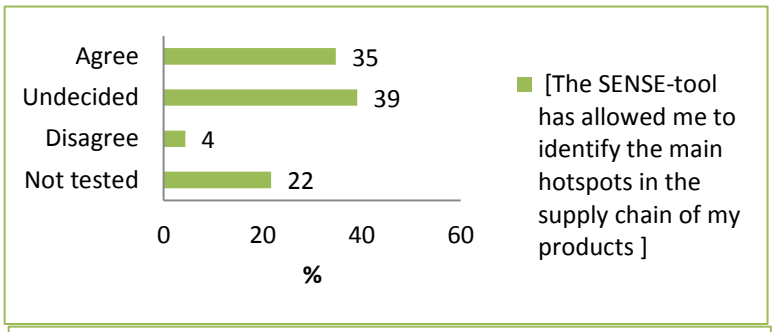
When asked if their experience with the SENSE-tool had improved their knowledge of the company´s environmental performance, almost 40% agreed. However, only 22% agreed that the outcomes obtained with the SENSE tool would help to access new markets.



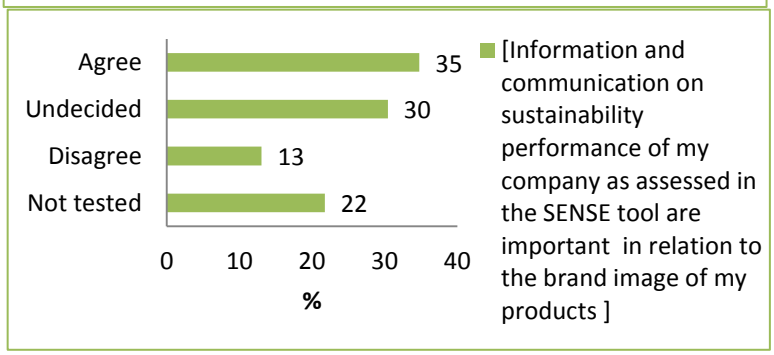


The views regarding user-friendliness of the SENSE tool were mixed. Almost one third of the companies agreed and same ratio (30%) of respondents were undecided, while 22% of those who tested the tool disagreed.

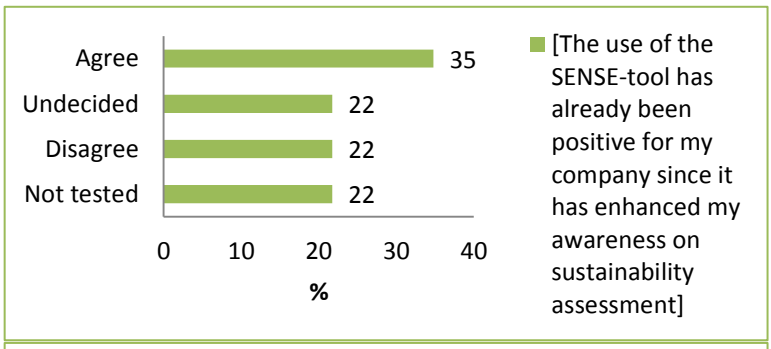
Figure 20 Statements on the benefits of the SENSE tool (n=23); Q26



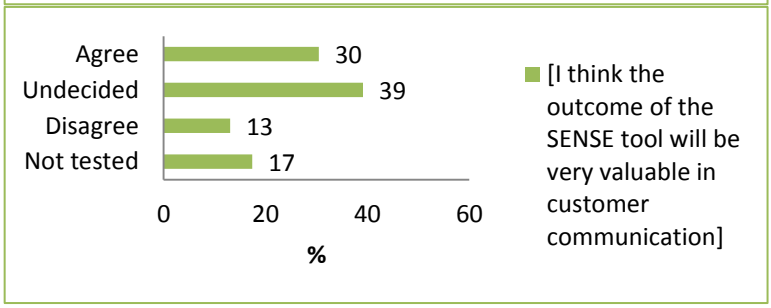
Approximately one third of the companies agreed that the SENSE tool had allowed them to identify hotspots in their supply chain.



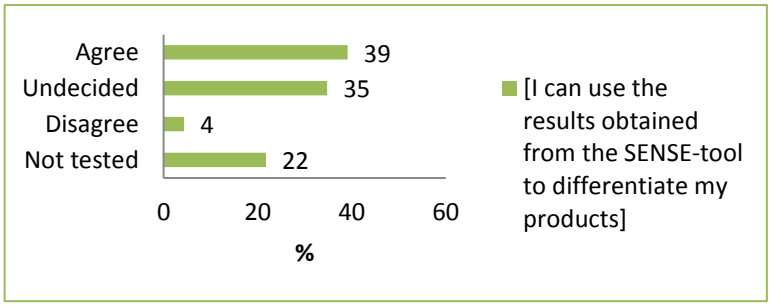
Similar ratio of respondents agreed (35%) that information on their sustainability performance as assessed by the SENSE tool would be important for the brand image of their products.



Although 35% agreed that the use of the SENSE tool had enhanced their sustainability awareness, 44% were undecided or disagreed.

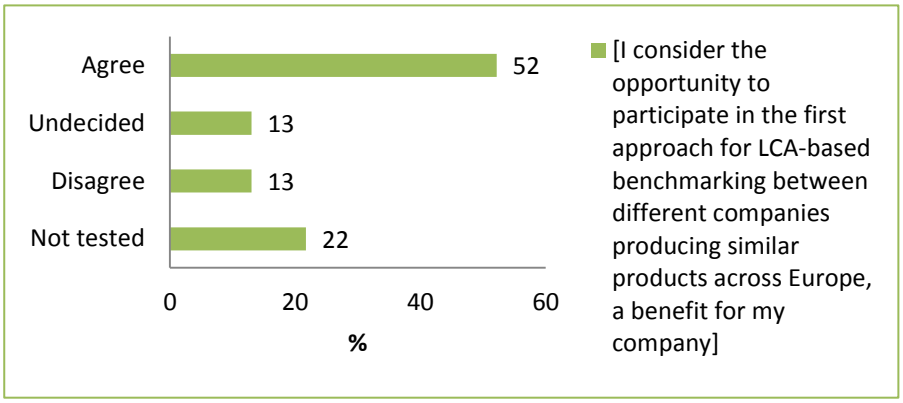


Regarding the role of the SENSE tool in customer communication, one third agreed and another one third were undecided that it would be valuable.



Similar ratio of respondents also either agreed or were undecided (39% and 35%, respectively) that the SENSE tool could be used to differentiate their products.

Figure 21 Statements on the benefits of the SENSE tool (n=23); Q26



More than half of the companies agreed that the opportunity to take part in a LCA based benchmarking was a benefit for their company.

Figure 22 Statements on the benefits of the SENSE tool (n=23); Q26

3.4.9 Conclusions

Overall it can be stated based on the results of the on-line survey that more than half of the respondents agreed on the foreseen enhanced need for environmental and social assessment to communicate products´ environmental impacts and social impacts of companies as part of their sustainability performance profile.

Although the companies had limited understanding of LCA and they were not familiar with the concepts and the environmental impact categories other than climate change they still were interested in receiving training and more than half of them considered the training obtained when testing the SENSE tool a benefit for their company. The opportunity to establish a LCA based benchmark of their products was perceived as a benefit by half of the respondents.

3.5 Results Aquaculture workshop

The aim of the workshop was to bring together the salmonids production companies that have tested the SENSE tool and Aquaculture Producer Organizations in key several countries (Scotland, Norway and Iceland) to assess the usefulness and potential of the tool and its place within the monitoring of sustainability in the professional sector.

Minutes of the discussion on the uptake of the SENSE tool.

Alistair Lane (EAS) and Sigurdur Bogason (UoI) co-chaired the workshop and discussions on the SENSE tool industry potential uptake. Several key issues facing the aquaculture industry raised opening questions for discussions, relating to the positioning of the SENSE tool within the proliferation of labels and certification and the recommendations that SENSE might give to the European Commission and potentially Member State policy makers.

SENSE and certification

In Scotland, there is growing awareness of the need to demonstrate the environmental footprint of a product. However, one of the main challenges with the SENSE tool is that there are currently no specific methodologies (apart from full Life Cycle Analysis) for SMEs in the sector to compare it with, although it is likely that in future, the SENSE tool will not be the only analysis tool available for SMEs.

The key drivers affecting the uptake of the SENSE tool will be either legislative or from the value chain (retailers), so SMEs will only do this when they are obliged to. Furthermore, SMEs are reluctant to have another certification (and accompanying set of auditors) and hence the Certification Scheme that SENSE is proposing could not be another stand-alone scheme, but more logically positioned as a measurement tool that is part of the needs of an existing certification.

Consumers are already overwhelmed and confused by the plethora of labels. Replying to a question on whether SMEs were ready to reply to consumers that insist on buying only 'the most sustainable product', it is likely that retailers of Scottish salmon would not demand that at present, although if one of the leading companies were to get a full sustainability standard, then of course the others would follow suit.

The SENSE tool has been designed so as to provide a simple solution to complex issues (compared to SIMAPRO or other LCA software) and this is a positive point, given that SMEs would need to have a tool that remained simple to use, but gave reliable data and comparison within the overall environmental certification 'system'. For example, within the Aquaculture Stewardship Council[25] (ASC) standard that is being implemented by the leaders of the salmon sector, the SENSE tool may certainly be used to measure the greenhouse gas emission and base line data for an SME can be obtained rapidly. It was noted that the first company to gain ASC certification in Norway was in fact an SME from the Northern part of the country.

[25] http://www.asc-aqua.org/

Another issue raised was one of data management issue regarding the tool. Recent European studies have shown awareness of companies in confidentiality of data. The SENSE tool ensures that data provided is kept confidential. Furthermore, it seems that mentalities towards data management are changing and the example of the EU Market Observatory for Fisheries and Aquaculture products[26] (EUMOFA) shows the advantages of sharing data on market and financial issues that can help a company to create market intelligence and hence potentially increase its competitiveness.

The communication of environmental credentials in the vale chain was a major issue discussed. Many retailers rapidly adopted the Marine Stewardship Council[27] (MSC) standard for sustainable fisheries, and, for example, ALDI and LIDL in Germany are only selling MSC certified fish. It is likely that these and other) retailers will also demand ASC certification from aquaculture producers.

But what happens when the majority of aquaculture companies obtain the standard? This is highly likely in the salmon sector, where the companies that constitute the Global Salmon Initiative[28] (GSI) – and who represent 70% of the global production of Atlantic salmon – have all committed to ASC certification. It was also noted that IKEA have also committed to having all of their salmon ASC certified by 2015.

On this issue, it is likely that the ASC standard would become more demanding and most probably on environmental standards. One comment of this was that there may be a more reaching ASC and potentially an “ASC-lite”. If this were to be the case, then full LCA light be required in higher standard ASC and the SENSE tool in an ASC-lite. Another comment was the unlikeliness of only one certification scheme fully dominating the market, given that all the current sustainability schemes are private, and that market competitiveness between them would diminish market domination.

This is currently exemplified by the certification for organic aquaculture products, where many labels are present, all slightly different in their requirements, and many chosen by aquaculture producers depending on the target market for their products and the recognition of that label by consumers in that target market. Although there is a movement towards a single EU organic standard, it is not sure at present if the sustainability standards will follow suit.

It was commented that labels are an ‘insurance policy’ for retailers that are in a highly competitive market and need to distinguish themselves from their competitors. Brands are also very important here, as are retailers’ own-brands.

The Global Sustainable Seafood Initiative[29] (GSSI) was created in 2013 to provide a benchmark for sustainability labels and aims to create consensus measures that should allow easier recognition and comparability of credible seafood certification programs. It was commented that 20 years ago, this was also the case for HACCP (hazard analysis and critical control points) as a preventive approach to food safety and is now a ‘given’ or baseline procedure. It maybe that just as

[26] http://ec.europa.eu/fisheries/market-observatory/

[27] http://www.msc.org/

[28] http://www.globalsalmoninitiative.org/

[29] http://www.ourgssi.org/

consumers consider that the food they buy is safe, they might also in the future consider that food products are sustainable, when the majority of products in a specific market sector are certified as such.

SENSE recommendations

The European Commission has set up several non-food and food pilots, to establish Product Environmental Footprint Category Rules (PEFCR) that use a common template irrespective of the product, and will contribute to the goal of the Single European Market for Green Products[30]. Two related pilots have been approved – one on salmon and one on feeds for animal production. SENSE partners are already in contact with the technical secretariats of the fish pilot, to see how the SENSE tool could fit into the PEFCR that they are developing. This would be the first recommendation to the Commission.

A second recommendation on general sustainability communication would be for the Commission to incorporate SENSE material (i.e. the films that have been produced) as part of the current INSEPERABLE[31] campaign.

Furthermore, sustainability criteria can of course be used to market local products, and a Fisheries Local Action Group[32] (FLAG) could also be a vehicle for further developing the SENSE tool or using it as part of a local initiative.

Other SENSE issues

Aquaculture companies (and the sector in general) are looking at comparisons with other food production sectors (beef, poultry, pork etc.) to show the advantages of the aquaculture activity in terms of footprint or resource use. It is, however, difficult to get comparative data from the beef sector, and it may be due to that sector's concerns that data provision will show them in a negative light. The real reasons are unknown, but it was also commented that if all food sectors need to demonstrate environmental sustainability as a certification, then the meat and dairy sector will be obliged to do the same. SENSE has the advantage of having developed the tool for the three sectors (beef and dairy, juice and salmon) and the SENSE partners were asked if they had data from the beef sector, so as to be able to make a comparison of the sectors involved.

The partners were also asked if they had demonstrated the tool to retailers, or at least included retailers in the development of it. Until now, retailers contacted by SENSE have unfortunately shown little interest and this might be due to the fact the tool had not been sufficiently developed when they were approached. As SENSE draws to an end, it would be time now to re-open this dialogue.

In summary:

- The SENSE tool can be a simple way for SMEs to provide data as part of the requirements for a sustainable product certification.

[30] http://ec.europa.eu/environment/eussd/smgp/

[31] http://ec.europa.eu/fisheries/inseparable/en

[32] https://webgate.ec.europa.eu/fpfis/cms/farnet/

- While the Aquaculture Stewardship Council certification is being positioned as the preferred scheme for many leading producers in the salmon sector, it is likely that other standards will continue to be used by producers depending on the retail channel and the targeted market.
- There is a growing awareness by companies that they need to demonstrate their environmental footprint (and other sustainability credentials), but until retail pressure or legislation forces them to do it, many will not do it proactively.
- While the SENSE tool makes clear positions on the confidentiality of the data as users first start to enter the system, future issues on data management are still highlighted.
- The European Commission will be recommended to:
    - Consider how the SENSE tool would fit within the relevant Product Environmental Footprint Pilots for the food sector that it covers.
    - Consider incorporating visual or other material from SENSE to its fisheries promotional campaign 'Inseperable'
    - Look at the creation of Fisheries Local Action Groups for aquaculture species as a tool to create local initiatives and further develop the tool.
- SENSE tool data might be used to provide a comparison of the environmental credentials for the three sectors, and this would be useful for the salmon sector.
- During the last phase of the project, SENSE should approach the major retailers to have their impression of the usefulness and possible uptake of the tool in the value chain.

Figure 23 The SENSE project´s partners attending a progress meeting in Reykjavík in connection with the SENSE AQUA workshop.

4 Conclusions

The pilot implementation in SMEs was the last phase of the validation procedure of the SENSE tool prototype. Throughout the iterative validation phases and testing of the tool further improvements have been implemented in the tool and the software has been updated. The pilot studies included more diversity in food production systems and supply chains than in the earlier case studies performed within the project. This provided opportunities to make the tool more flexible and also revealed limitations that had not been foreseen for example when multiproduct transport processes were included in the supply chains. Suggestions for various functionality improvements of the tool and improved guidelines were communicated to the tool developers to implement. Furthermore, recommendations for future improvements were established based on lessons learned in the pilot studies. Therefore, this last phase of the validation of the tool has been very useful to enhance the performance of the developed SENSE tool.

Various challenges and obstacles were encountered when contacting companies and convincing them to test the tool with their own data. Therefore, the aim to obtain statistically representative results for benchmarking was not reached. Initially the aim was to assess up to 27 different supply chain systems (nine of each subsector). Overall 75 companies were invited but only one third of them were willing to test the tool and in total 22 companies performed the testing by entering own data, including the food SMEs from the SENSE consortium.

One main reason that impeded the participation of the contacted SMEs was the lack of time. The SMEs typically do not have a person responsible only for environmental issues. It was perceived that the data collection, especially upstream in the value chain where a multitude of suppliers can be part of the system, would consume much time and that too much data was asked for. Moreover, the SMEs have to collect already a lot of data to comply with the laws of their countries. This was another reason why they were not enthusiastic to collect more data without seeing a direct economic benefit for them.

The fact that green bookkeeping is mandatory for aquaculture companies and the data is publicly available in Iceland facilitated the data gathering in this specific case. The data on the KEPIs needed for the SENSE tool are already collected for the authorities. It was pointed out both in the aquaculture companies as well as on agriculture farms that the data entry should be synchronized with data compilation already fulfilled for the government. This would make the data entry much easier for the companies and save time.

It should be noted that although large dairy companies in Sweden maintain green bookkeeping records consisting of most of the KEPIs needed as input for the SENSE tool, they were still not more willing to participate in the testing of the tool than smaller companies. Several reasons were mentioned such as data confidentiality and fear of misuse of data and some companies did not see any benefit of using the information that the SENSE tool would provide.

In all three food chains, many SMEs are taking actions to improve their environmental performance. Most of the companies in the meat and dairy chain are well aware of their environmental challenges and are working towards improvements. Many stated that they already have an own system to monitor their environmental burden or their carbon footprint and did not see the advantage of using yet another system.

For further development of the data input and datasets in the SENSE tool, the following considerations and improvements are suggested:

- Better information on the allocation process available right at the point of data entry and also clear explanations in the guidelines SENSE tool for Dummies

- Better guidance in the entry of the feed produced right at the point of data entry
- Some information should be entered with more steps to avoid that complicated calculations have to be conducted by the user (Fertilizers, feed, maybe pesticides)
- Some additional datasets (slurry, manure, concentrated feed, more pesticides and fertlizers) should be available for agriculture
- Datasets with average composition of feed for aquaculture need to be updated and added to reflect the composition of the feed used by the users of the tool
- Additional datasets for wastewater for different aquaculture systems should be considered. This applies to land based aquaculture where regional conditions and different treatment of the waste water needs to be taken into account. There are two cases identified: Icelandic conditions (primary treatment only) and average European conditions (primary, secondary and tertiary treatment).
- Additional units for different KEPIs should be introduced in the tool (e.g. for fertilizers P_20_5 and P)
- Even though the tool is prepared for a standardized data introduction, companies in many cases did not understand some of the LCA concepts used in the system (such as allocation), and therefore some data was not entered correctly.
- Not all input KEPI data were entered due to the fact that the companies do not have all data regarding their product, and thus some relevant data for the impact characterization is missing.

The ambitious goal of harmonized environmental impact assessment using the SENSE tool in SMEs can only be reached if standardized data entry is fulfilled. This was not fully achieved in the SENSE pilot studies without support provided to the SMEs. Main reasons are the allocation factors[33] that were not fully understood and not always entered according to economics by the users. If different allocation procedures are used by different users the final results are not harmonized and not comparable.

Another reason is that not all KEPI data were entered and thus data gaps can lead to biased results. Since the tool is designed in a general way to allow different products to be analyzed, it is difficult to define mandatory fields and standardize all data input.

The guidance of experts is needed to achieve full standardization of data entries: Considering the complexity of the life cycle thinking and the challenges the user faced when entering their data - even though the data entry was described in detail in the SENSE tool guidelines - the integration of an expert check of the data is recommended for the SENSE-tool. All results downloaded – especially the EID (Environmental Information Document) - without a validation could have the sign „Draft“ or „Not validated”, so that it is not possible to publicly present results that are based on incomplete or incorrect data. It is very challenging to design an easy to use software that can represent the complexity of the real world in an adequate way.

Results and calculations with the SENSE tool were within range of literature values:

Results on calculation of climate change impact with the SENSE tool for raw and pasteurized milk and farmed arctic charr and salmon were within the range of the testing criteria and did not differ more than factor of two from earlier LCA cased studies in the project for similar products (Doublet et al., 2013a,b; Ingolfsdottir et al., 2013) and reported literature values as reviewed by Landquist et al. (2013a). For fruit juice the range of values were also in agreement with the earlier studies apart

[33] Allocation is the partition of the environmental impact between different products produced together (e.g. wheat and straw; cheese and whey; milk and meat). Economic allocation splits the impact according to the percentage of total turnover of the different products.

from results from one company where high values could not be sufficiently explained and further checking of the data input would be recommended.

The comparison of SENSE tool results with commercial software (SimaPro) showed that results of climate change for the two products tested i.e. dairy product “yoghurt” and aquaculture product (HOG Arctic charr) differed <10% and thus fulfilling the testing criteria. However, large deviations were found for the transport phase which needed further attention of the software developers to check for errors in the formulas used and has now been updated in the SENSE tool.

The feedback from the online questionnaire was filled out by 23 companies of which 5 shared their view without testing the tool. Overall the answers on the feedback questionnaire showed that 30-50% of the people filling out the questionnaire agreed that the SENSE tool would be a benefit for their company. However, it should be noted that 40-60% of the respondents were undecided or disagreed about the benefits. The highest rate of agreement (52%) was regarding the benefit of the training for the company received during the SENSE tool testing and no one disagreed. It is of interest that the same ratio of respondents agreed on the benefit to participate in LCA based benchmarking although the majority of the companies had not performed LCA for the products prior to using the SENSE tool.

The views regarding user-friendliness of the SENSE tool were mixed. Almost one third of the companies agreed and same ratio of respondents were undecided, while 22% of those who tested the tool disagreed

Suggestions to enhance the successful deployment of the SENSE tool included: training, support from experts, user-friendly guidelines and information within the SENSE tool which was considered necessary to implement the tool

- Give explanation of the relevant concepts e.g. environmental sustainability
- Provide step by step explanation for creating the diagram and the data input, so that the user is guided through all main steps.
- The SENSE tool has been translated to 8 languages and this was considered a benefit. Further translations especially the guidelines should be motivated as needed depending on users.
- It turned out to be very important to have personal contact and help to insert data and give explanations. Personal support e.g. expert coming to the company and offering help on site was considered most helpful and is very efficient, since much less time is needed if the tool is explained directly. Information within the tool itself would be really helpful and better than the external SENSE-tool for dummies document.

Perceived benefits and future use of the SENSE tool

About half of the respondents agreed that the data collection on the KEPIs in general was beneficial. However, the perceived benefit of the social data collection was agreed on by fewer companies or about one third of the respondents and about half of them were undecided or disagreed. When considering the benefit of obtaining results of environmental impacts almost half of the companies agreed on the benefit and some agreed that the SENSE-tool had improved their knowledge of the company´s environmental performance. Approximately one third of the companies agreed that the SENSE tool had allowed them to identify hotspots in their supply chain. The statement on the need for sustainability assessment as a requirement to maintain market position was agreed on by almost half of the companies and the respondents agreed that information on their sustainability performance as assessed by the SENSE tool would be important for the brand image of their products. However, less than a quarter of them agreed that the outcome obtained with the SENSE tool would help to access new markets. Regarding the role of

the SENSE tool in customer communication, one third agreed and another one third were undecided that it would be valuable. Similar ratio of respondents also either agreed or they were undecided that the SENSE tool could be used to differentiate their products. Around two thirds of the respondents were in favor of certification of the SENSE tool by a third party
Overall it can be stated based stakeholders responses in the on-line survey that there is a foreseen enhanced need for environmental and social impact assessments to communicate environmental footprints of food products and social impacts of companies as part of companies´ sustainability performance profile.

Although the companies had limited understanding of LCA and they were not familiar with the concepts and the environmental impact categories other than climate change they still were interested in receiving training. More than half of them considered the training obtained when testing the SENSE tool a benefit for their company. The opportunity to establish a LCA based benchmark of their products was perceived as a benefit by half of the respondents.

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SENSE tool deployment

Annex I

Questionnaire – on-line survey

SENSE On-Line Survey

SENSE-tool deployment

The SENSE project (FP7-KBBE-GA:288974) has developed an innovative software tool, the SENSE tool, which gives SMEs in the food and drinks chains an opportunity to calculate the environmental impacts of their food products.

Thank you for taking the time to test the SENSE tool. The SENSE project team would appreciate if you could in addition give your feedback on your experience of the testing by filling out this questionnaire.

Confidentiality statement:

You have been invited to participate in this survey because your feedback is a vital part in the deployment process of the SENSE tool

The procedure involves filling an online survey that will take approximately 30 minutes. We will do our best to keep your information confidential. All data is stored in a password protected electronic format.

The outcome of the survey questions will be used to assess the outcome of the testing of the SENSE tool in SMEs. The results will be used only within the SENSE project to assess the deployment of the SENSE tool and give the tool developers guidance on further developments needed. Furthermore, scientific papers based on the overall outcome will be published. To help protect your confidentiality we will not disseminate information that will personally identify you or your company.

The questionnaire includes questions on:

- Sustainability awareness in SMEs
- SENSE tool - Data input
- SENSE tool - Results
- Future use of the SENSE tool
- Sharing of data and certification
- Statements on the benefits of the SENSE tool

Demographics

Company name _____

Country:

Sector

Size of company

Sustainability awareness in SMEs

The aim is to gather views about how well the SENSE-tool and EID meet the requirements and environmental and social objectives of stakeholders in food supply chains. The following questions explore SMEs' current practice regarding adherence to standards on food quality and safety or environmental management, sustainability and schemes imposed by e.g. retailers on their supplier networks.

1. With regard to your history of communicating environmental information about your products, has your company already taken steps to give **environmental information** to your customers prior to using the SENSE-tool?

   ☐ Yes ☐ No ☐ Don´t know /Don´t answer

   If yes, please explain what kind of environmental information?

   _____

   _____

   _____

2. Has your company performed LCA (life cycle assessment) for any of your products prior to using the SENSE-tool?

   ☐ Yes ☐ No ☐ Don´t know /Don´t answer

   If yes, please explain why the assessment was performed?

   _____

   _____

   _____

3. Do you foresee a demand from your customers (or retailers) for information about **environmental impacts** of your products

   ☐ Yes ☐ No ☐ Don´t know /Don´t answer

4. With regard to your history of communicating sustainability (or social) information about your products, has your company already taken steps to give **social impact information** to your customers prior to using the SENSE-tool?

   ☐ Yes ☐ No ☐ Don´t know /Don´t answer

   If yes, please explain what kind of social impact information?

   _____

   _____

   _____

5. Do you foresee a demand from your customers (or retailers) for information about **social impacts** of your products

   ☐ Yes ☐ No ☐ Don´t know /Don´t answer

6. Do you think that the SENSE tool would help you in reporting your **social impacts**, and thus enhance the performance of the company?

   ☐ Yes ☐ No ☐ Don´t know /Don´t answer

7. Does your company have a management system which addresses principles, objectives and indicators of sustainable development?

   ☐ Yes ☐ No ☐ Don´t know /Don´t answer

8. Has your company obtained a certification according to standards on food quality and safety recognized by the Global Food Safety Initiative (GFSI) (http://www.mygfsi.com) or other regulatory, sector specific or voluntary initiatives?:

   ☐ Yes ☐ No ☐ Don´t know /Don´t answer

   If yes, please mark all that apply

   ☐ HACCP,
   ☐ ISO 9001
   ☐ ISO 22000
   ☐ ISO 14001,
   ☐ IFS (International Food Standard)
   ☐ FSSC 22000 (Food Safety System Certification 22000),
   ☐ KRAV (Organic),
   ☐ IP Sigill
   ☐ GlobalGAP,
   ☐ BRC, (British Retail Consortium)
   ☐ GAA, BAP Standards - Global Aquaculture Alliance

   ☐ GRMS, *Global Red Meat Standard*
   ☐ CanadaGAP,
   ☐ SQF (Safe Quality Foods)
   ☐ Other. Please give details

   _____

9. Has your company obtained a certification according to standards for environmental or social requirements recognized by ISEAL (http://www.isealalliance.org/) or other initiatives?

   ☐ Yes ☐ No ☐ Don´t know /Don´t answer

If yes, please mark all that apply

- ☐ Sustainable Agriculture Standard (SAN),
- ☐ Marine Stewardship Council (MSC),
- ☐ Aquaculture Stewardship Council (ASC),
- ☐ Fairtrade,
- ☐ Linking Environment and Farming (LEAF),
- ☐ Social Accountability Accreditation Services (SAAS),
- ☐ Alliance for Water Stewardship,
- ☐ Forest Stewardship Council (FSC)
- ☐ Friend of the Sea
- ☐ Other. Please give details

_____

10. Is your company considering a certification according to any of the standards listed above or other schemes?

☐ Yes ☐ No ☐ Don´t know /Don´t answer

If yes, please give details:

_____

_____

_____

SENSE tool - Data input (FUNCTIONALITY testing of the SENSE tool)

The aim is to evaluate the user-friendliness and functionality of the tool when inserting data into the SENSE tool.

11. Did you have **difficulties (e.g. time consuming, complex, errors)** regarding any of the following stages of the testing? Please mark all that apply:

	No Difficulties	Time consuming	Complex	Errors
Creating your profile				
Creating the process diagram				
Inserting the data				
Interpreting the results				
Obtaining the EID				
Other				

Please give details on the difficulties:

12. Did you invite your suppliers to provide input data relevant to your product when testing the SENSE-tool?

☐ Yes ☐ No ☐ Don´t know /Don´t answer

If yes, did you have any difficulties in involving your supplier?

☐ Yes ☐ No ☐ Don´t know /Don´t answer

If yes, please detail the difficulties you experienced:

13. How often do you foresee that you would update the environmental assessment by using the SENSE-tool?

- ☐ Annually
- ☐ Each production cycle
- ☐ Every time when needed
- ☐ Every time changes are made in the production or the supply chain
- ☐ Other

14. Do you foresee that you would update the social assessment for your company in the SENSE tool?

☐ Yes ☐ No ☐ Don´t know /Don´t answer

If no, please explain why:

SENSE tool – Results (Usefulness of the SENSE Tool results)

The objective of the following questions is to assess the usefulness of the results for the SMEs. and identify whether there is a need for training

15. Do you consider the general outcome from the SENSE-tool (EID) easy to understand?

☐ Yes ☐ No ☐ Don´t know /Don´t answer

If no, please explain why?

16. Is environmental impact analysis important for your company?

☐ Very important ☐ Somewhat important ☐ Not important

If not important, please explain why

17. Is social impact analysis important for your company?

☐ Very important ☐ Somewhat important ☐ Not important

If not important, please explain why

18. Is benchmarking option in the SENSE-tool important for your company?

☐ Very important ☐ Somewhat important ☐ Not important

If not important, please explain why

19. To ensure that it is possible for companies to use the SENSE-tool effectively in the future, which of the following support would be needed:

☐ The current SENSE-tool user guide.

- ☐ An improved SENSE-tool user guide.
- ☐ The SENSE-tool user guide and a training course.
- ☐ Other

Please suggest further support that you think will be necessary to implement the SENSE tool

_____

_____

_____

Future use of the SENSE tool

The aim of the following questions is to evaluate the need for and usefulness of tools like the SENSE tool for SMEs

20. Let's say that an EID would be available for your products. How do you foresee that you would communicate it? (Please prioritize)

- ☐ As a separate document EID in B2B communication / marketing
- ☐ To support green accounting / green bookkeeping
- ☐ As evidence for Environmental Product Declaration (EPD)
- ☐ In the annual report of the company
- ☐ As part of sustainability reporting
- ☐ To justify an eco-label for the product
- ☐ For benchmarking with other companies
- ☐ Other:

_____

_____

21. With regard to the resources to be committed, do you consider that implementing the SENSE-tool outcome (EID) in all of your products would be…?

- technically feasible (reasonable difficulties) Yes ☐ No ☐
- economically feasible (reasonable costs) Yes ☐ No ☐

Sharing of data and certification

To ensure the exploitation of the SENSE–tool beyond the project, the aim of the following questions is to identify additional issues that need to be considered to maintain the SENSE-tool as a service to SMEs. The objective is to explore views on data sharing and transparency in the supply chain. Further, the aim is to explore expectations regarding certification and trust in the SENSE tool outcome (EID).

22. Are you willing to share the input information (KEPIs) requested in the SENSE-tool for future use in external benchmarking?

☐ Yes ☐ No ☐ Don´t know /Don´t answer

23. Would you be willing to share your product environmental impact assessment information?

☐ Yes ☐ No ☐ Don´t know /Don´t answer

24. Do you think it is important to have a certification of the SENSE tool data and EID carried out by a third party?

☐ Yes ☐ No ☐ Don´t know /Don´t answer

25. Would you be willing to pay for the cost of the certification?

☐ Yes ☐ No ☐ Don´t know /Don´t answer

If no, who should cover the cost?

Statements on the benefits of the SENSE tool

The aim of the following questions is to evaluate the perceived benefit of using the SENSE-tool. This view is important to support further exploitation of the SENSE-tool

26. For each of the following statements regarding the SENSE-tool, please ***mark with a cross*** to show whether you: "1 = disagree", "2 = undecided", "3 = agree"

		1	2	3
1.	I consider the SENSE-tool user-friendly.			
2	I consider the data collection we did for the SENSE-tool beneficial for my company			
3.	I consider the results on environmental impacts obtained from the SENSE-tool as a benefit for my company			
4.	The SENSE-tool has improved my knowledge about the strengths and weaknesses of my products' environmental performance			
5.	The SENSE-tool has allowed me to identify the main hotspots in the supply chain of my products			
6.	I consider the social data collection we did in the testing the SENSE-tool beneficial for my company			
7.	I consider it an advantage to obtain results on selected social impacts of my company as part of the EID			
8.	Information and communication on sustainability performance of my company as assessed in the SENSE tool are important in relation to the brand image of my products			
9.	I can use the results obtained from the SENSE-tool to differentiate my products			
10.	The use of the SENSE-tool has already been positive for my company since it has enhanced my awareness on sustainability assessment			

11.	I consider that the outcomes obtained with the SENSE-tool will help my company to access new markets			
12.	I think the outcome of the SENSE tool will be very valuable in customer communication			
13.	I consider that verification of sustainability assessment of food production will become a requirement to maintain market position			
14.	I consider the opportunity to participate in the first approach for LCA-based benchmarking between different companies producing similar products across Europe, a benefit for my company			
15.	I consider the training I received during the testing a benefit for my company			

Deliverable: D4.2

SENSE tool deployment

Annex II

Procedures for involvement of companies in testing the SENSE tool

Step by step involvement of SMEs in the SENSE tool testing:

1. List of companies was compiled by the SENSE partners

    - Meat and dairy; Contact person: Bianca Pop, others involved, ESU, SIK, BZN, AUU, CLITRAVI
    - Orange juice; Contact person: Aintzane Esturo others involved AZTI and SGF
    - Aquaculture; Contact person: Guðrún Olafsdóttir /Sigurður Bogason, others involved EFLA, DTU, EAS

2. Call the potential companies

3. Follow up by an e-mail (see example below) and attach an Invitation letter

> Dear Mr.XXXX
> I contact you in order to invite you to collaborate in the validation of an environmental evaluation tool developed within the SENSE project (www.senseproject.eu) and which has been financed by the European Union. The objective of the project is to offer the European food SMEs a tool to measure in an easy way the environmental impact of the products. The tool is based in the Life Cycle principles and provides indicators such as the carbon footprint, the water footprint or the eutrophication potential. xx is one of the participants in the project and we have preselected (the target company), together with other European companies, due to your high compromise with the environment, to test the SENSE tool.
> The advantages of participating in the validation of the tool are:
> • Opportunity to have a free environmental assessment based on LCA
> • Identification of the improvement opportunities in the environmental aspects in your processes
> • Collect the required information for the LCA inventory
> • To get a report on the environmental impact associated to your products
> • Collaborate in a pioneer European project which aims to promote sustainability in the food sector in Europe
>
> From your side it is required:
> • To collect the data asked in the attached document (attached excel)
> • To introduce the data in the SENSE tool
> • Estimated time 4 hours.
>
> Should you have any doubt on the data to collect or the introduction of the data in the SENSE tool, you can contact Ms. Saioa Ramos (sramos@azti.es) who will guide you.
> I remain awaiting your answer.
> Kind regards,

    - Brief Introduction of the SENSE project
    - Explain the benefits (see section in D4.1)
    - Confidentiality explained (information included in the tool)
    - Introduce the SENSE tool / Explain the key concepts (see list in D4.1)
    - Explain the data needed: List of KEPIS/ Questionnaire (see table in D4.1 for further explanation)

4. When companies had agreed to participate a list of KEPIS /Questionnaire for input data was sent as xls to help companies to prepare data along with the SENSE tool guidelines.

5. Link to the SENSE tool will be provided / Password for the SENSE tool will be issued by Ingenet / Lohitzune Llarrinaga, e-mail: llarrinaga@ingenet.es

6. SENSE-tool for Dummies provided as pdf and info in the on-line version of the tool – Also available in the tool (“help” button near the logout).

7. A training video for using the tool: https://www.youtube.com/playlist?list=PLE4V8Cu7O0dnJJO8gC18Auz92Jm3_3eew

8. Companies fill in the questionnaire and insert the data into the tool. Further help as needed was provided by SENSE contact persons and tool developers

9. Data compilation and checking:
   - The SME fills in the questionnaires in the SENSE-tool. The completed questionnaires are exported to Excel files and assessed by respective SENSE contact person
   - The environmental impacts computed by the SENSE tool are exported by the companies to Excel files and sent to the respective contact person and LCA experts for checking the input data and assess the output
   - If companies are not able to finalize the testing it is still very important to conduct an interview with them and fill in the survey (word document) or alternatively the on-line survey

10. On-line survey to give feedback to the developers of the tool and assess the deployment of the tool a link to the questionnaire survey to fill in after testing: https://docs.google.com/forms/d/1J3p28hPPTEJAkXT0mvglDGR20XTy547QVWx2D_7F2I8/viewform?usp=send_form

Deliverable: D4.2

SENSE tool deployment

Annex III

Questions on social aspects in the SENSE tool

Prepared in the SENSE project by Rosalind Sharpe, City University UK

SENSE Social impacts questions in the SENSE tool

English

1. Does your company have a named senior manager/board member /company equivalent with responsibility for labour standards within the company?

To be eligible to answer YES, you need to provide the name and job title

Please tick all of the statements below that apply:

No

Yes

- ✓ Responsibilities cover on-site operations only
- ✓ Responsibilities extend to first-tier suppliers
- ✓ Responsibilities extend beyond first-tier suppliers

2. Are you aware of a set of standards or guidelines for your INDUSTRY sector that stipulates minimum standards on labour rights and employment conditions that covers AT LEAST core ILO labour standards?

To be eligible to answer YES, please tick below the categories this policy/guidelines covers:

- ✓ Freedom of association and collective bargaining
- ✓ Forced or bonded labour
- ✓ Child labour
- ✓ No discrimination
- ✓ Written conditions of employment
- ✓ A decent living wage
- ✓ Maximum hours of work
- ✓ Healthy and safe working conditions

3. Do you communicate your policy on labour standards to the public?

Please tick all of the statements below that apply to where you make these public commitments:

- ✓ Company web-site
- ✓ Product labelling
- ✓ Annual reporting

4. Are your staff in this category of work able to freely join independent trade unions or another form of representation?

If you have other forms of representation in place, please explain what these are

Does your trade union recognition/other worker representation agreement cover (please tick all that apply):

- ✓ Disciplinary and grievance procedures
- ✓ Pay bargaining

5. Do all staff in this category of work receive written information about their employment conditions and wages they will receive ?

To be eligible to answer YES, please attach a copy of a contract for this category of worker.

- ✓ Browse
- ✓ Add
- ✓ Is not selected file

6. Do the number of hours this category of worker is employed for in an average week comply with national laws?

Please tick all of the statements below that apply:

- ✓ Management systems in place to ensure these workers do not regularly work in excess of 48 hours per week
- ✓ Responsible senior manager/company equivalent regularly reviews this with workers
- ✓ Policy is communicated to at least first-tier suppliers

7. Do your hourly pay rates meet the national legal minimum standards for this category of worker?

- ✓ Pay rates exceed legal minimum standards
- ✓ Regular pay reviews with workers
- ✓ Policy is communicated to at least first-tier suppliers

8a. Do you offer occupational health and safety training ? (for example, on handling chemicals/pesticides or other hazardous substances)

- ✓ Senior manager/ company equivalent has responsibility to monitor and ensure that regular health and safety training takes place
- ✓ Systems in place to communicate training policy to first-tier suppliers
- ✓ Systems in place to communicate training policy beyond first-tier suppliers

8b. Do you offer health and safety training related to employee well-being? (for example, managing levels of tobacco and alcohol consumption, encouraging good nutrition and regular exercise).

- ✓ Senior manager/company equivalent has responsibility to monitor and ensure that regular health and safety training takes place
- ✓ Systems in place to communicate training policy to first-tier suppliers
- ✓ Systems in place to communicate training policy beyond first-tier suppliers

9a. Do you take positive action to address external costs in local communities affected by your production processes and activities?

- ✓ Employ local people and build local skills
- ✓ Notify local businesses when tendering opportunities arise and encourage them to apply
- ✓ Provide support for local training initiatives
- ✓ Take active measures to improve the health of employees and their communities e.g. through education/training programmes/local sports' initiatives etc.