European Commission

JRC SCIENCE FOR POLICY REPORT

Revision of European Green Public Procurement criteria for Food and Catering Services

PRELIMINARY REPORT

(Draft) Working Document

Belmira Neto, Rocío Rodríguez Quintero, Oliver Wolf (JRC-IPTS)

Pernilla Sjögren, Peter Lee, Dan Eatherley (Oakdene Hollins)

Joint Research Centre

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ABBREVIATIONS AND ACRONYMS

AMA: Agrarmarkt Austria
AP acidification potential
AREFLH Assembly of the European Regions producing Fruit, Vegetables and Ornamental Flowers and Plants
ASC: Aquaculture Stewardship Council
BEMP: best environmental management practice
BREF: Best Available Techniques Reference (Document)
B&I: business and industry
CIP: Competitiveness and Innovation Framework Programme (the European Commission)
DG ENV: Directorate General Environment
DG SANCO: Directorate General Health and Consumer Affairs
EC: European Commission
EIRO European Foundation for the Improvement of Living and Working Conditions
EISA European Initiative for Sustainable Development in Agriculture
EP eutrophication potential
EU: European Union
EVA European Vending Association
FAO: Food and Agriculture Organization of the United Nations
FERCO European Federation of Contract Catering Organisations
FU functional unit
GAIN Global Agricultural Information Network
GAP: Global agricultural practice
GDP: gross domestic product
GHG: greenhouse gas
GMO: genetically modified organism
GPP: Green Public Procurement
GWP global warming potential
HACCP: Hazard Analysis and Critical Control Points
HVAC: heating, ventilating and air conditioning
IFS: international featured standards
INNOCAT: procurement of eco-innovative catering project
IOBC the International Organisation for Biological and Integrated Control of Noxious Animals and Plants
IP: Integrated Production
IPTS: Institute of Prospective Technological Studies
LCA: life-cycle assessment
LCC: life-cycle costing
MSC: Marine Stewardship Council
NHS: National Health Service (the UK)
OJEU Official Journal of the European Union
PAH: polycyclic aromatic hydrocarbon
PET: polyethylene terephthalate
PEU primary energy use
PP: Public Procurement
PVC: polyvinyl chloride
SMEs: small and medium sized enterprises
SPP: Sustainable Public Procurement
UNEP United Nations Environment Programme
USDA United States Department of Agriculture

TERMS AND DEFINITIONS

Assembly serve: *The food is delivered pre-processed and reheated and assembled on site. (Mostly common in fast food restaurants)*

Catering: *"the preparation, storage and where appropriate delivery of food for consumption by the consumer at the place of preparation or at a satellite unit"* (EC DG SANCO, 1993).

Centralised: *central kitchens or central food factories, that sends out completed dishes to satellites. For example school kitchens.*

Contract catering firm: "*A business engaged in providing a meals service (for example by running staff restaurant or providing school meals)*" (National Audit Office, 2006).

Conventional kitchen: *Food is prepared on site (the majority made from scratch)*

The Hospitality and Food Service sector "*can be defined as outlets that sell food and drinks for immediate consumption outside of the home*" (WRAP, 2013).

Mass caterer: "*means any establishment (including a vehicle or a fixed or mobile stall), such as restaurants, canteens, schools, hospitals and catering enterprises in which, in the course of a business, food is prepared to be ready for consumption by the final consumer*" (OJEU, 2011).

Mass catering: "*the preparation, storage and/or delivery and serving of food to a large number of people*" (EC DG SANCO, 1993).

Meal services and catering: "*Procurement of meals services means that the contracting authority procures an external supplier which wholly or partly runs the meals service*" (Swedish Competition Authority, 2015).

Ready-prepared: *Preparation on site of large batches that are then kept frozen or chilled until required. (Used in hospitals and prisons).*

Vending and coffee machines: *Machines that are available at all times with snacks, fruit, drinks and/or sandwiches etc. that are ready to eat/drink or that can be microwaved.*

Water dispensers: *A device for heating or cooling and dispensing drinking water.*

Wholesale supplier: "*A business that buys a range of different food and non-food items from producers (such as farms or food manufacturers) and importers for resale to catering contractors, kitchens within public sector organisations*" (National Audit Office, 2006).

Codes for the representation of names of countries and their subdivisions (according to ISO 3166)	
AT: Austria	**IE**: Ireland
BE: Belgium	**IT**: Italy
BG: Bulgaria	**LT**: Lithuania
CY: Cyprus	**LU**: Luxembourg
CZ: Czech Republic	**LV**: Latvia
DE: Germany	**MT**: Malta
DK: Denmark	**NL**: Netherlands
EE: Estonia	**PL**: Poland
ES: Spain	**PT**: Portugal
FI: Finland	**RO**: Romania
FR: France	**SE**: Sweden
GR: Greece	**SI**: Slovenia
HR: Croatia	**SK**: Slovakia
HU: Hungary	**UK**: United Kingdom

CO_2	carbon dioxide
CH_4	methane
K	potassium
N	Nitrogen
N_2O	nitrous oxide
NH_3	ammonia
P	phosphorus
SO_2	sulphur dioxide
tCO_2e	emissions equivalent to tonnes of CO_2

ACKNOWLEDGEMENTS

We would like to thank all the stakeholders that took the time to respond to our survey about the current EU GPP criteria for Food and Catering Services. Your comments have been made a large part of Chapter 1 (Task 1) and it has been very useful going forward with the revision. For anonymous reasons we will not state names here, but your feedback has been greatly appreciated. In addition, all the stakeholders from different organisations across Europe that have provided feedback to us during telephone interviews and via e-mail. Your input has been greatly appreciated and used as supporting evidence in Chapter 2 (Task 2). It has helped shed light on an area with little Europe wide data.

EXECUTIVE SUMMARY

The aim of this project is to revise the existing EU Green Public Procurement (GPP) criteria for Food and Catering services. This will assist in the reduction of negative impacts of the, public procurement of these services, on the environment, human health and natural resources. The project is led by the Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) with the technical support of Oakdene Hollins. The team will carry out the necessary groundwork to the revision of criteria.

The revision of EU GPP requires in-depth information about the technical and environmental performance of the service group as well as about the current procurement processes. The scientific body of evidence gathered will be cross-checked with sector experienced stakeholders, to develop consensus on how the criteria should be revised to deliver optimum environmental improvements. The revision entails four main background tasks:

Task 1: Scope and definition proposals for the product group.

Task 2: Market analysis.

Task 3: Technical and environmental analysis.

Task 4: Improvement potential

Based on Tasks 1-4, the project team will prepare the Preliminary Report which will be the basis for producing the Technical Report that will include draft criteria proposals. Both reports comprise the working documents for the 1st Ad Hoc Working Group (AHWG) meeting. The Technical Report including draft criteria proposal will be revised in the light of the output of the 1st AHWG meeting. Additionally, within Task 1 a questionnaire was developed for stakeholder feedback about scope, definitions and current EU GPP criteria.

Chapter 1 focuses on the definition for and scoping of Food and Catering Services. The scope and definitions for these services is long and understandings vary widely. Hence, it is important to gain an overview of the different scope and definitions and to narrow down the services in order to obtain a homogenous scope for an appropriate and meaningful set for the EU GPP criteria.

Chapter 2, market analysis, presents the market overview and the market structure by focusing on the contract catering market. An overview of the food and catering service supply chain is made and the analysis of the procurement of food for the considered most important aspects.

The technical and environmental analysis (Chapter 3) provides a detail analysis of the main environmental hotspots for the food product categories by reviewing a number of LCA studies. Other non-LCA aspects including ethical and health consideration are also summarised. The technical analysis focus on the current schemes and labels identified as important for the revision of the current EU GPP criteria.

The improvement potentials (Chapter 4) provide improvement options, based on the best sector practices and national cases studies which could assist the revision of the EU GPP, and reduce the sectors environmental impacts, by drawing on findings from the market and technical analysis.

1 SCOPE, DEFINITIONS AND LEGISLATION

1.1 European Directives on Public Procurement

The Public Procurement Directive 2014/24/EU (public works, supply and service contracts) sets out the legal framework for public procurement. It applies when contracting authorities seek to acquire supplies, services (e.g. catering services), or works when its value exceeds set thresholds, unless it qualifies for a specific exclusion.

The EU procurement regime is based on the Treaty principles of transparency, non-discrimination, equal treatment and proportionality. For example, to ensure transparency and equal treatment, products that fulfil the requirements under the eco-label without having the label must also be accepted.

1.2 Public Procurement Principles

Every criterion used in a Public Procurement process must comply with the following guiding principles:

- Free movement of goods and services, freedom of establishment;
- Non-discrimination and equal treatment;
- Transparency;
- Proportionality;
- Mutual recognition.

1.3 Types of EU Public Procurement Criteria

The 'subject matter' of a contract is about what good, service or work is intended to be procured. As a general rule the criteria shall apply on the subject matter of a contract.

Selection Criteria (SC): Selection criteria refer to the tenderer, *i.e.*, the company applying for the contract, and not to the product being procured. It may relate to:

- Suitability to pursue the professional activity;
- Economic and financial standing;
- Technical and professional ability;

Technical Specifications (TS): Technical specifications constitute minimum compliance requirements that must be met by all tenders. TSs must be linked to the contract's subject matter and must not concern general corporate practices but only those specific to the product being procured. Offers not complying with the technical specifications must be rejected. TSs are not scored for award purposes, they are strictly pass/fail requirements.

Contract Performance Clauses (CPC): Contract performance clauses are used to specify how a contract must be carried out. CPCs must be linked to the contract's subject matter and must not concern general corporate practices but only those specific to the product being procured. The economic operator may not be requested to prove compliance with the CPCs during the procurement procedure. CPCs are not scored for award purposes. Compliance with the CPCs should only be monitored during the execution of the contract, therefore after this has been awarded. It may be linked to penalties or bonuses under the contract in order to ensure compliance.

Award Criteria (AC): At the award stage, the contracting authority evaluates the quality of the tenders and compares costs. Contracts are awarded based on MEAT (Most Economically Advantageous Tender). MEAT includes the following elements:

- Cost (Price, TCO: total cost of ownership or LCC: life cycle cost);
- Functional performance (*e.g.*, technical merit, delivery time, *etc*.);
- Environmental performance (*e.g.*, EU GPP criteria);

Everything that is evaluated and scored for award purposes is an AC. These may refer to characteristics of goods or to the way in which services or works are performed (in this case they are similar in form to CPCs but, opposite to these, are evaluated at the award phase). ACs must be linked to the contract's subject matter and must not concern general corporate practices but only those specific to the product being procured.

1.4 Food and Catering Services: scope and definition

The European Union Green Public Procurement (EU GPP) initiative is a voluntary instrument, defined by the European Commission (EC COM 400/2008) as: "*a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured*" (Commission of the European Communities, 2008a).

Public authorities in the European Union (EU) spend around 13 % of gross domestic product (GDP) on works, goods and services, (excluding utilities) spending over €1.7 trillion (European Commission, 2015m) . By using their considerable purchasing power they can therefore make a difference, from both an environmental and a sustainability perspective, to support the market shift into a resource-efficient and low-carbon economy.

This document is intended to provide background information for the revision of the current EU GPP criteria for the product group 'Food and Catering Services' that has been in use since 2008. This product group is considered important since the impacts of food and drink area of consumption are highlighted and recognised in the original background report (European Commission, 2008a) as responsible for 20-30 % of several environmental impacts of total consumption and in the case of eutrophication for even more than 50 % (Tukker *et al*., 2006).

The EU GPP criteria comprise two key parts, the 'core' and 'comprehensive' criteria. Table 1 provides the definitions of the two parts and Table 2 provides a summary of the current criteria.

Table 1: Definitions of the core and comprehensive criteria (Source: European Commission, 2004)

Criteria	Definition
Core	Suitable for use by any contracting authority across the Member States and address the key environment impacts. They are designed to be used with minimum additional verification effort or cost increases.
Comprehensive	For those wishing to purchase the best environmental products available on the market. These may require additional verification effort or a slight increase in cost compared to the other products with the same functionality.

Table 2: A summary of the current criteria for Food and Catering Services (Source: European Commission, 2008c)

Criteria		Summary of existing criteria
Core	Food supply	Organic food and packaging
	Catering service	Organic food, menu planning, packaging, waste generation and transport
Comprehensive	Food supply	Organic food, food from integrated production, aquaculture and marine standards, animal welfare standards and packaging.
	Catering service	Organic food, food from integrated production, menu planning, paper products, aquaculture and marine standards, animal welfare standards, packaging, equipment, cleaning products, waste generation, transport, staff training and service management.

The Institute of Prospective Technological Studies (IPTS) has developed the webpage http://susproc.jrc.ec.europa.eu/Food_Catering/ from which stakeholders may retrieve information related to the revision of the EU GPP, and register their interest in participating in the revision process.

1.4.1 Scope and definitions

1.4.1.1 Scope and definitions of the current EU GPP for 'food and catering services'

The current EU GPP criteria for food and catering services were released in 2008 (European Commission, 2008a) do not include specific definitions but only a brief description of what is considered in scope. This document states that the product group refers both to the direct procurement of food by public authorities and the procurement of catering services. The procurement of food is normally included as part of the catering service. To analyse this scope two issues are further considered, namely, the life cycle stages considered in scope and the environmental impacts and additional impacts in scope.

1.4.1.2 The life cycle stages in scope

The standards document ISO 14024 sets out the life cycle stages that should be considered in criteria setting, albeit, for Type 1 eco-labelling (ISO, 2001) it refers that:

"*Lifecycle stages to be taken into account when developing the product environmental criteria should include: extraction of resources, manufacturing, distribution, use and disposal relating to relevant cross-media environmental indicators*"

Table 3 shows the stages of the supply chain considered in scope for the revision of these criteria.

Table 3: Important food supply chain stages for 'food and catering services'

Primary production	Primary production is the life-cycle stage that has the largest environmental impact compared to other stages in food supply chains. It is responsible for around 90 % of total eutrophication and 50 % of GHG emissions. [a]
Processing	The processing stage creates food waste and uses resources such as water, energy and detergents. [a]
Transport	In comparison to production and processing, the transport stage has generally a comparatively low impact, although the mode of transport (airfreight, ship, train or road) is an important factor. [a]
Packaging	Packaging generally has a low total environmental impact compared to the production and processing stages of food products. The exceptions are bottled water and milk, where packaging has a large total impact. [a]
Wholesale	This stage is not considered to be relevant for this project. Even though food products may travel through this route they will not stay for long at this stage (due to short shelf life or inventory management the food products will be shipped off to the next supply chain level as soon as possible i.e. high turnover rate). Therefore this stage has low levels of resource use and food wastage.
Food preparation	*How the food is prepared.* Equipment (energy use, water use), food waste, type of packaging used (to preserve food until it reaches the end consumer).
Food service	*Where the food is prepared*. On site, in central kitchens (cooked and chilled/frozen for use at a later time or shipped off instantly), or prepared for assembly at a later stage. A long distance to the end consumer may require transport.
Other services	*How the food is served and consumed*. The tableware, cutlery and food containers, including dishware, are usually provided by the catering services.
End user/ consumer	*Who the food is prepared for*. Children, adults, hospital patients, soldiers etc. Portion sizes and nutritional composition are different, as is how it is served (e.g. in bulk served on plates or in single pre-prepared portions).

[a] EU Ecolabel feasibility study for food and feed products (Oakdene Hollins *et al*., 2011)

Food service supply chains are extremely complex and diverse. For example, some food service operators use the traditional 'cook from scratch' model while others buy the food 'ready to serve'. Some also use a hybrid of the two. This will have a large impact on the point in the environmental life cycle where most impacts occur, such as food waste and energy use. This can change the point in the life cycle that the intervention (criteria requirements) should target.

There are six systems identified that are likely to be relevant for this report: conventional kitchen, centralised, ready-prepared, assembly serve, vending and coffee machines, and water dispensers (as defined in the beginning of this report). These food service systems will be further reviewed in the Market Analysis (Task 2 in preparation). Furthermore to the scope and definitions, the stakeholder consultation (by means of the questionnaire) provided feedback on scope, definitions and relevance of these systems. The Technical and Environmental Analysis (Task 3 to be part of The Preliminary Report) will assess their environmental impacts.

1.4.1.3 The environmental impacts and other impacts in scope

From the perspective of the potential environmental impacts that should be considered in the revised criteria, the inclusion of both 'supply' (in the form of direct procurement of food) and 'service' broadens the scope. Table 4 provides a summary of the potential environmental impacts outlined in the handbook on GPP that should be considered for a supply or service contract.

Table 4: A summary of contract types and potential environmental impacts (Source: European Commission, 2004)

Contract type	Potential environmental impacts
Supply	• The environmental impacts of materials used to make the product, and the impact of the production processes. • The use of renewable raw materials in making the product. • The energy and water consumption of the product during use. • Durability / lifespan of the product. • Opportunities for recycling / reusing the product at the end of life. • The packaging and transportation of the product.
Service	• The technical expertise and qualifications of staff to carry out the contract in an environmentally friendly way. • The products / materials used in carrying out the services. • Management procedures put in place to minimise the environmental impact of the service. • The energy and water and air consumed, and waste generated in carrying out the service.

The current criteria have a strong focus on the first bullet point in Table 4, and in particular on addressing the significant impacts from primary food production. Conversely, a '*GPP in Practice'* case study from the City of Helsinki, Finland (*Calculating the environmental impact of catering services*) found that the average carbon footprint per meal was circa 1.1 kgCO_2e. This study showed that the 'direct energy consumption' for storage and cooking of food accounted for 41 % of that amount (see Figure 1). Direct energy consumption is considered in the last bullet point in Table 4 and thus shall not be neglected. This shows that other aspects besides food production may be relevant and it is therefore important to consider all these along in this study.

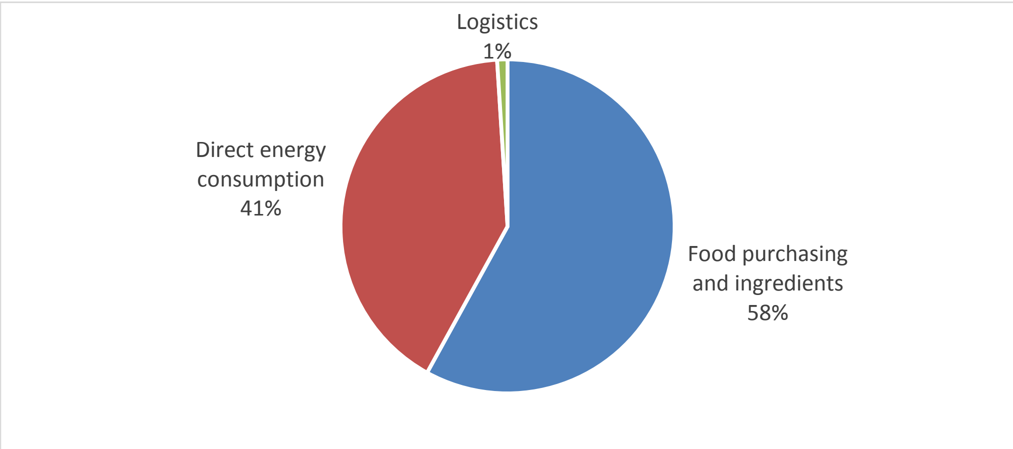

Figure 1: Share of the emissions of carbon dioxide equivalent for the three stages considered for the calculation of a carbon footprint of an average meal of a catering service in the City of Helsinki, Finland (European Commission, 2014o). The stages considered are: food purchasing, direct energy consumption and logistics.

EU GPP represents one measure introduced as part of the Sustainable Production and Consumption Action Plan (Commission of the European Communities, 2008b) together with the EU Ecolabel. Ecolabels set out the environmental requirements (criteria) which must be met by products or services in order to carry the label. The criteria are based on scientific evidence and hence are very relevant to EU GPP. A feasibility study on applying the EU Ecolabel to food, feed and drink products was undertaken in 2011 and provides an indication of the significant issues associated with food, feed and drink products (Oakdene Hollins *et al*., 2011). The study combined a literature review with a survey of both consumers and stakeholders to help identify the environmental impacts considered significant for the development of an EU Ecolabel. Table 5 provides a summary of the results. It is noted that this study had a product focus and hence did not consider the environmental impacts associated with the provision of the food service, which this report will include.

Table 5: Significant issues for food identified in the EU Ecolabel feasibility study (Oakdene Hollins *et al*., 2011)

Greenhouse gas emissions	GMOs
Use of non-renewable resources (abiotic depletion)	Fish stock depletion
Water use	Impacts on biodiversity
Eutrophication	Soil degradation and soil erosion
Food waste	Ecotoxicity
Acidification	Social issues
Animal welfare	

Additionally, many studies, including the mentioned feasibility study, highlights how social and ethical issues are considered important by consumers and other stakeholders. This is further analysed in this chapter to an insight on over the social and ethical considerations to the ongoing revision process.

1.4.2 Definitions of food and catering services

There are many different definitions available for food and catering services that differ in context and in scope. The following definitions are considered most appropriate in terms of gaining a better understanding of the scope of the criteria for this product group.

1.4.2.1 Food definitions

According to the CODEX International Food Standards (2010), food can be defined as "*any substance, whether processed, semi-processed or raw, which is intended for human consumption, and includes drinks, chewing gum and any substance which has been used in the manufacture, preparation or treatment of "food" but does not include cosmetics or tobacco or substances used only as drugs".* However, rather than defining food as a separate entity it is important to find a definition of "food for catering", in which the definitions are more focused on where the food is consumed. CODEX International Food Standards (2010) defines food for catering services as: "*those foods for use in restaurants, canteens, schools, hospitals and similar institutions where food is offered for immediate consumption"*

1.4.2.2 Catering (services) definitions

Catering services are defined differently depending on where the service is being used. Royal Institution of Chartered Surveyors (RICS, 2013) reports that: "*Catering may vary from the provision of automated vending (e.g. hot/cold drinks, hot/cold snacks, confectionery), through drinks and snack counters, cafés, deli bars, canteens and staff restaurants to a full silver-service dining room for directors and clients, and may additionally include hospitality for occasional or regular events and conferences*". EC DG SANCO (1993) has another definition: *the preparation, storage and, where* *appropriate, delivery of food for consumption by the consumer at the place of preparation or at a satellite unit".* This is more broadly defined and is aligned to CODEX International Food Standards.

1.4.2.3 Definitions of the public food service sectors

The food service sector is split into two distinct groups: the profit or commercial sector and the public sector. From an EU GPP perspective only the public sector is in scope and it is from here that definitions are sought. Other terms for the public sector that are used in literature include the *cost (non-profit) sector* and the *social sector*.

GIRA Foodservice (2010a) has defined the whole food service sector as the 'out of home market' (Table 6) and categorised 'social food service' as one part of this market. In this example, 'vending' is a separate category, even though it will occur in the other categories. Social food service is further broken down into seven subcategories (Table 7). Worth highlighting is that the 'business and Industry' subcategory includes private companies.

Table 6: Definition of food services included in the 'out-of-home market' (GIRA Foodservice, 2010a)

OUT OF HOME MARKET					
Social food service	**Commercial food service**	**Bars/pubs**	**Night life**	**Other distribution channels**	**Vending**
Business & Industry Education Healthcare Welfare Captive sector	Table service restaurants Self-service restaurants Quick service restaurants Hotels & other lodging establishments Transport and food service Concession sites	Cafés Snack- cafés Pubs Wine bars	Modern bars Discos/night clubs Bowling clubs Casinos Cabarets	Bakeries Cooking terminal Party service Daily distribution channels Take away stands Convenience stores	Hot beverages Cold beverages snacks

Table 7: Sectors and segments included in 'social food service' (GIRA Foodservice, 2010b)

SOCIAL FOOD SERVICE						
B&I	**Education**	**Health-care**	**Homes for elderly**	**Other welfare homes**	**Social leisure**	**Captive sector**
Private companies Government employment Employees' restaurants Vocational training centres Workers' homes	Central kitchens School canteens Leisure centres for children State secondary schools Private schools Student canteens at universities Other kinds of high school	State hospitals Private clinics	State homes Private homes	Homes for disabled adults Home for adults in difficulty Workers' centres Homes for disabled children Homes for children in difficulty Nursing homes & day centres for young children	Holiday camps Social tourism establish-ments Youth hostels Houses of youth and culture (MJC)	Armed forces CRS barracks Fire stations Prisons Detention centres Homes for monitored education Religious communities

Horizons (2011) has defined the public food service industry in four sectors (Table 8). Again, it is not easily isolated the public procurement information from the private in the group sector 'business and industry' (B&I).

Table 8: In depth description of the public food service sectors (Horizons, 2011)

SECTOR	DEFINITIONS	EXAMPLES
Staff Catering	Feeding employees at workplace including government locations as well as Business and Industry (B&I).	Self-Run, Contracted canteens, National Government Canteens, Local Authority Canteens/Civic Centres, Off-shore catering
Health Care	Outlets whose main focus is providing health care (including short- and long-stay care).	Hospitals, Specialised Hospitals, Day Hospitals, Care & nursing homes
Education	Outlets which are primarily concerned with educating children or adults (or both)	Nursery, Primary, Secondary schools; Further & Higher Education establishments.
Services	Outlets which provide a publicly-funded service and which are not health care or educational establishments.	Prisons, Armed forces; Police & Fire service catering, Young Offenders Institutions, Welfare services (meals on wheels, day centres)

Edwards and Overstreet (2009) provides a definition of the public sector (cost sector), shown in Table 9. Important to note is that the terms 'public' and 'social' have different meanings here (i.e. 'public service' and 'social service'). Hence the choice of wording in this report is as important as the definition of the choices. Again, the issue of private sector inclusion in the public sector is occurring in the 'other employee feeding' subsector. Industrial and non-industrial are mentioned but there is no clarification on whether this is public procurement.

Table 9: Institutions included in the cost sector (Edwards and Overstreet, 2009)

COST SECTOR						
Hospitals	**Social services**	**Education**	**Prisons**	**Public services**	**Armed forces**	**Other employee feeding**
Patients (in- and out-) Staff Visitors	Old people's homes Day care centres Meals on wheels	Universities (students and staff) Schools (day or residential)	Prisoners Staff Visitors	Police Fire Ambulance	Navy Army Air Force Marines	Industrial Non-industrial Contract vs in-house

It is clear from this review that most definitions of the public food service sector are alike one another, and all include similar categories. However, comparing the three definitions all have grey areas in terms of the distinction between private and public procurement. This means that data gathered for these categories may not be exclusive for the public sector, they may include private elements. This issue must be taken into account when conducting the Market Analysis (Task 2).

1.4.3 Food product categories

The current EU GPP includes the following food categories (European Commission, 2008a):

- fruit and vegetables
- aquaculture
- marine
- meat and dairy
- drinks and beverages

These categories were identified based primarily on the findings from the Environmental Impact of Products (EIPRO) study in 2006 (Tukker *et al.*, 2006). The EIPRO study used the United Nations COICOP[1] classification system to group products by category. Table 10 provides a summary of the classifications.

Appendix A presents the COICOP product classification outlining the products included and excluded from each food product group.

Table 10: A summary of the COICOP product categories (United Nations Statistics Division, 2015)

Division	Group	Class
01 - Food and non-alcoholic beverages	01.1 - Food	01.1.1 - Bread and cereals
		01.1.2 - Meat
		01.1.3 - Fish and seafood
		01.1.4 - Milk, cheese and eggs
		01.1.5 - Oils and fats
		01.1.6 - Fruit
		01.1.7 - Vegetables
		01.1.8 - Sugar, jam, honey, chocolate and confectionery
		01.1.9 - Food products n.e.c.[2]
	01.2 - Non-alcoholic beverages	01.2.1 - Coffee, tea and cocoa
		01.2.2 - Mineral waters, soft drinks, fruit and vegetable juices

COICOP was also used within the 2011 EU Ecolabel food, feed and drink products feasibility study. However, a few adaptations to the COICOP classifications were made to arrive at a suitable categorisation of food, feed and drink products:

- Fruit and vegetables were combined because of their similarity in terms of use and production.
- All drinks that reach the consumer in a liquid state were placed in one category.

[1] The classification of individual consumption by purpose (COICOP) is a classification used to classify both individual consumption expenditure and actual individual consumption. It is a standard classification with the framework of the United Nations System of National Accounts.

2 n.e.c: not elsewhere classified

- Tea and coffee differ significantly from other beverages as they are mostly sold as solids (powder, beans, and bags), and were given their own category.

1.4.4 Categorisation of catering services

The term *catering service* can be used in many settings, just as the terms *food service* and *hospitality* are. In the UK, *catering* includes all aspects of the *catering industry*, and recently the term *food service* has become increasingly used to describe the same thing (Edwards and Overstreet, 2009).

The European Union has established the Common Procurement Vocabulary Codes (CPV Codes) which is a standardised single classification system to be used in tendering processes available the system (SIMAP) that includes information about European Public Procurement (SIMAP, 2015). Table 11 presents the available categories for food services. These classifications include preparation of food, serving of food and customer base (such as schools).

Table 11: Catering services in CPV codes (OJEU, 2007a)

CPV Codes Restaurant and food-serving services
55310000-6 Restaurant waiter services
55311000-3 Restricted-clientele restaurant waiter services
55312000-0 Unrestricted-clientele restaurant waiter services
55320000-9 Meal-serving services
55321000-6 Meal-preparation services
55322000-3 Meal-cooking services
55330000-2 Cafeteria services
55400000-4 Beverage-serving services
55410000-7 Bar management services
55500000-5 Canteen and catering services
55510000-8 Canteen services
55511000-5 Canteen and other restricted-clientele cafeteria services
55512000-2 Canteen management services
55520000-1 Catering services
55521000-8 Catering services for private households
55521100-9 Meals-on-wheels services
55521200-0 Meal delivery service
55522000-5 Catering services for transport enterprises
55523000-2 Catering services for other enterprises or other institutions
55523100-3 School-meal services
55524000-9 School catering services
55900000-9 Retail trade services

Eurostat (2008) also has classifications of food and beverage service activities, summarised in Table 12. These are slightly different from the CPV codes but also highlight preparation of food, serving of food and identify the type of customers.

Table 12: Statistical groups for Food and Beverage Service Activities (Eurostat, 2008)

EUROSTAT - NACE Rev. 2, division I56: Food and beverage service activities
56.10 Restaurants and mobile food service activities
Restaurants
Cafeterias
Fast-food restaurants
Take-out eating places
Ice cream truck vendors
Mobile food carts
Food preparation in market stalls
Restaurant and bar activities connected to transportation, when carried out by separate units
56.21 Event catering activities
The provision of food services based on contractual arrangements with the customer, at the location specified by the customer, for a specific event.
56.29 Other food service activities
activities of food service contractors (e.g. for transportation companies)
operation of food concessions at sports and similar facilities
operation of canteens or cafeterias (e.g. for factories, offices, hospitals or schools) on a concession basis
56.30 Beverage serving activities
bars
taverns
cocktail lounges
discotheques (with beverage serving predominant)
beer parlours
coffee shops
fruit juice bars
mobile beverage vendors

The CPV codes describe different food service activities in detail in terms of how food is prepared (e.g. serving, preparing) and where it is served (e.g. restaurants, canteens). Eurostat's statistical categorisation is less detailed and differentiates food services into groups (e.g. restaurants, event catering, other catering and beverage serving). For the public sector food service the CPV codes are more useful than the Eurostat classification, since most of the food service activities would be grouped together under 'other food service activities'. In both cases, however, there is no clear distinction between public and commercial service activities.

1.4.5 Public food service sectors

The review made previously allowed to conclude that food service definitions do not clearly distinguish between the public and private food service sectors. An alternative approach to scoping the sectors to be included in the criteria is to review the public procurement spend on food and catering. In 2010, Defra estimated that the UK spends over £2 billion on food and food services. Figure 2 provides a breakdown of overall spend by sector. This shows that education (school dinners, further and higher education) and health care accounted for over 80 % of total spend. The report highlighted the fact that government department head offices account for only 1 % of public sector food procurement. While important in sending a positive message to the wider public sector, it is financially less significant and the challenges faced are different.

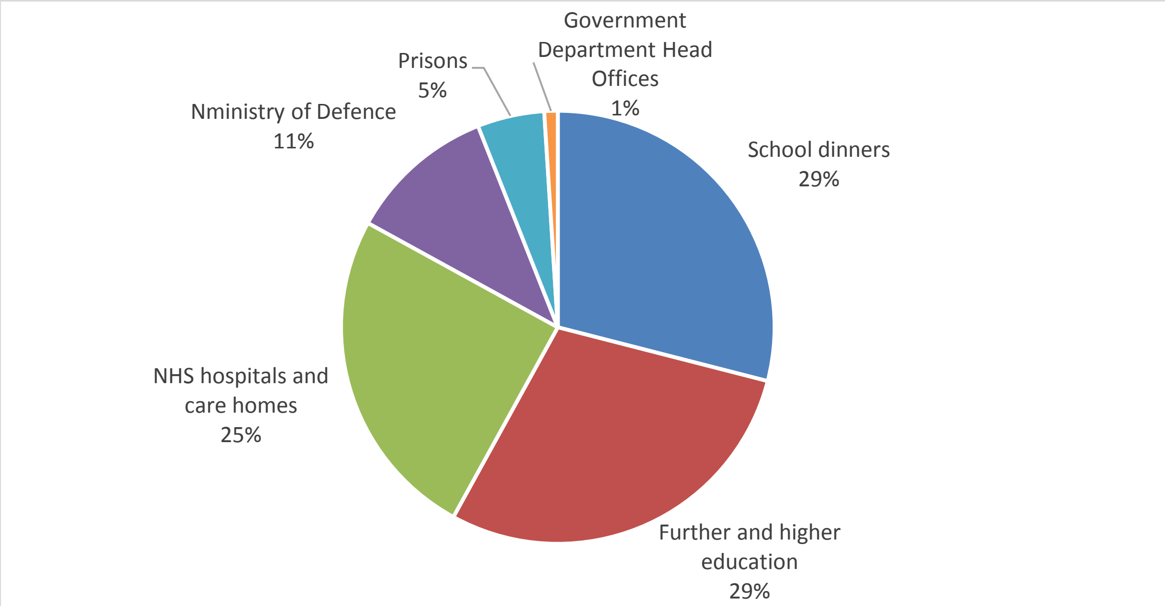

Figure 2: Public sector food procurement spend in the UK (April 2008 to March 2009) (Defra, 2010)

It is acknowledged that the UK analysis provides a snapshot of one country only, and that the spend profiles in other countries may differ significantly. However, a very initial proposal, to be later confirmed by a further public expenditure analysis at EU level (Task 2), for the public sectors to be considered in scope is the following:

- schools
- universities
- hospitals
- care homes
- armed forces
- prisons
- canteens in governmental buildings

1.5 Stakeholders feedback and analysis

A questionnaire was developed for the revision of scope, definitions and criteria of the current EU GPP for food and catering services. It was sent out to more than 300 stakeholders across Europe, including public procurers, catering service providers, food providers, industry wide body/trade associations, food labelling organisations, non-governmental organisations and others. Overall 38 responses were collected up to the fixed deadline for response.

Table 13 shows which countries in Europe the respondents were from. Table 14 shows what type of organisation they represent and which sector(s) their organisation operate in.

Table 13: Distribution of answers across EU-28

EU-28	**Number of respondents**	**EU-28**	**Number of respondents**
Austria		Lithuania	1
Belgium	5	Luxembourg	
Bulgaria		Malta	
Croatia		Netherlands	3
Cyprus		Poland	
Czech Republic		Portugal	1
Denmark	1	Romania	
Estonia		Slovakia	2
Finland	3	Slovenia	
France	2	Spain	2
Germany	3	Sweden	1
Greece		United Kingdom	8
Hungary			
Ireland	1	Subtotal	**36**
Italy	3	Switzerland	2
Latvia		**TOTAL**	**38**

Table 14: Type of organisation the respondent was from and which sector(s) the respondents operate in

Organisation type	
Food provider (only)	3
Catering service provider	4
Public procurer	9
Industry wide body/trade association	7
Food labelling organisation	
Other	15
Sector	
Schools	11
Universities	10
Hospitals	8
Care homes	9
Canteens in government buildings	9
Prisons	2
Armed forces	1
Other	20

1.5.1 Stakeholders feedback on scope

This section summarises stakeholder feedback from the survey on definitions, scope and current EU GPP criteria. The feedback will be taken into consideration going forward with the report and the development of new criteria proposals.

1.5.1.1 Food categories

The feedback on the current food categories, as well as proposals for new categories is shown in Table 15. Overall the respondents agreed with most categories, although many asked that the food categories 'eggs' and 'cereals' should be included. Three respondents asked for a much more comprehensive list of food categories; one respondent proposed using *the UK Public Health Responsibility Deal* on salt, including 76 categories.

Table 15: Feedback on current food categories

Fruit and vegetables
Most respondents (32 out of 38) agreed that this category can be kept as it is.
Aquaculture
28 respondents agreed to keep this category. However, two respondents wanted to combine Aquaculture with Marine, even though criteria specifications may be developed differently for them (due to different production methods).
Marine
31 respondents agreed to keep this category.
Meat and dairy
28 respondents agreed to keep this category as it is, whilst three respondents asked to separate meat and dairy. One respondent also proposed to create subcategories of meat (e.g. beef, pig, chicken).
Drinks and beverages
31 respondents agreed to keep this category as it is. Two respondents asked for better explanation on what this category includes and said that coffee, tea and cocoa ought to be one category and water/juice/soft drinks and beer, ought to be another.
Other food categories that were proposed
17 respondents proposed to include **eggs.** 10 respondents proposed to include **cereals.** 5 respondents proposed to include **oils and fat** (olive oils, palm oil). 3 respondents proposed to include **legumes.** 2 respondents proposed to include **bread.**

1.5.1.2 Scope definition

The scope definition, for which the stakeholders' feedback is required, will determine in a broad sense what is included in scope. In addition to this definition stakeholders also provide feedback about which public sectors ought to be included, as well as the food categories and food preparation services relevant to include.

Proposed scope definition:
"The direct procurement of food by public authorities and the procurement of catering services, either using in-house resources or facilities or out-sourced in full or in-part through contract catering firms. Food can be procured directly from producers, wholesalers or importers or can form part of the service provided by the contract catering firms."

A large part of the respondents (32 out of 38) agreed with this definition. Some comments were that the definition seems to include all relevant aspects, also from a competition perspective. Furthermore respondents liked that the definition included both outsourcing services and providing in-house services.

A small number of respondents (four in total) disagreed with this scope definition. One highlighted the need to mention catering equipment. Another asked to include ‘food manufacturers’. A third respondent agreed and suggested to include following sentence: *food can be procured directly from producers, **manufacturers**, wholesalers or importers*. A fourth respondent said that this definition will result in a complex combined supply chain where economies of scale will be lost, which will result in added costs.

1.5.1.3 Food service segments

The questionnaire asked stakeholders if the segments (schools, universities, hospitals, caring homes, canteens in government buildings, events (conferences, meetings, festivities), prisons, armed forces, should be included in scope.

Around half of the respondents agreed with these segments. No segment was proposed to be excluded, but others were proposed for inclusion. There was confusion about what was included in the term ‘caring homes’. Five respondents proposed kinder gardens and three respondents proposed nurseries to be included in scope. Others as business and industry (B&I), staff restaurants, sports facilities, child care facilities, orphanage, social services, retail, charitable food-offers, student hostels, oil platforms, remote platforms and extraction industries were also mentioned.

In conclusion the segments can be kept as they are proposed and the segments kinder gardens and nurseries suggested to be included will be further analysed for relevance in the Market Analysis (Task 2).

1.5.1.4 Catering services

The questionnaire asked stakeholders if the types of services provisions (conventional kitchen, ready-prepared, assembly-serve, centralised, vending and coffee machines, water dispensers or others) should be included in the scope.

Most respondents agreed with the catering services namely: conventional kitchen, ready-prepared, assembly-serve, centralised, vending and coffee machines and water dispensers.
Two respondents wondered why water dispensers are included. One said that (only) bottled water may be useful to include. The other respondent said that water dispensers are rather simple and may not have very much of an environmental impact compared to other categories.

In respect to the others types of service provision, respondents mentioned that others categories may content food storage equipment, cooking equipment, ware washing equipment, food waste management systems, food trolleys (let patients choose), fast food, take away, show-cooking, retail, charitable food offers.

In conclusion stakeholders agree with most of the catering services proposed and their relevance in terms of environmental impact will be looked at in the Technical and Environmental Analysis (Task 3).

1.5.2 Stakeholders feedback on food service definitions

Following section (Table 16) provides a summary of the stakeholder feedback for definitions of the food services that are proposed to be included in scope.

Table 16: Feedback on food service definitions

Catering service: *"the preparation, storage and, where appropriate, delivery of food for consumption by the consumer at the place of preparation or at a satellite unit"*
30 agreed and 4 disagreed. Comments were: - include 'clients/patients' with 'consumers', as they do not pay for the service - add 'or at the premises/venue of the client' - add the word 'safe', as in: 'delivery of food safe for consumption' - include procuring food and planning of menus/the food offer, and also include food, drinks, snacks and vending
Contract catering firm: *"A business engaged in providing a meals service (for example by running a staff restaurant or providing school meals)"*

30 agreed and 4 disagreed. Comments were:
- add drinks, snacks and vending, and the fact that some contract caterers outsource elements of their contract to other firms (e.g. vending)
- New definition: '*A business engaged in (amongst other activities or services) providing a meals service (for example by running a staff restaurant or providing school meals)*'
- New definition that includes following:
"A contract catering activity can be identified by the following features:
  - *a contractual relationship between an organisation and a contract catering provider*
  - *services are offered in the premises of the organisation*
  - *the sector has clearly defined clientele: workers, civil servants, schools and universities students, patients and inmates, etc. who have access to an canteen or internal restaurant*
  - *meals are often delivered to an end consumer at a subsidised price"*

Conventional kitchen: *"Food is prepared on site (the majority made from scratch)"*
30 agreed and 4 disagreed. Comments were: - specify what 'majority' means - replace 'majority made from scratch' with 'majority made from raw ingredients', or change the whole definition to: *Food is prepared on site (from scratch or using pre-processed ingredients/products)*, or the following: *A kitchen where all or the majority of food is prepared from scratch* - Clarify what 'on-site' means. Does it mean a school or a food factory or something else? - Also known as 'cook fresh' in the UK, and does not include kitchens designed to regenerate chilled or frozen foods only.
Ready-prepared: *"Preparation on site of large batches that are then kept frozen or chilled until required. Used in hospitals and prisons."*
28 agreed and 6 disagreed. Comments were: - it can occur in all segments - the use of this system can be different on a national level - Is the phrase 'used in hospitals and prisons' part of the definition or an example? - this definition is confusing for the UK hospital market which talks about 'in house' and 'delivered meals' to differentiate between where meals are cooked - these meals are almost always prepared in a factory, far away from where they are eaten (e.g. they need to be delivered) - Does the definition mean 'cook and chill' or 'cook and freeze'? This does not always happen on site; the food can also be cooked in a centralised kitchen or a food factory and then be delivered. - New definition: *Preparation on site of large batches that are then adequately stored frozen or chilled until required.*

Table 16: Feedback on food service definitions Cont.

Assembly serve: "The food is delivered pre-processed and reheated and assembled on site. (Mostly common in fast-food restaurants)"
27 agreed and 5 disagreed. Comments were: - remove 'mostly common in fast-food restaurants' - also common in UK hospitals; in Finish schools and kinder gardens; and applies to party and event catering - New definition: *The food is delivered pre-processed and cooked. Then the food is reheated (if necessary) and assembled on site. (Mostly common in fast-food restaurants).* - may be confusion between the definitions of assembly served, centralised and ready-prepared
Centralised: *"Central kitchens or central food factories, that sends out completed dishes to satellites. For example school kitchens."*
28 respondents agreed and 5 disagreed with this definition. - New definition: *Central kitchens or central food factories, that sends out completed dishes or pre-processed ingredients/meals to satellites. For example school kitchens*. Other comments were: - change the word 'centralised' to 'centralised production unit' - clarify what type of food preparation is included in this definition, such as 'cook and serve', 'cook and chill' (+vacuum) and 'cook and freeze' (two respondents) - What does 'completed dishes' mean? Is it prepared plates or large batches, or both? - add the word 'in-house' to differentiate these meals from ready-made delivered meals
Vending and coffee machines: *"Machines that are available at all times with snacks, fruit, drinks and/or sandwiches etc. that are ready to eat/drink or that can be microwaved."*
30 respondents agreed and 3 disagreed with this definition. Comments were: - modify the title to '*Vending and hot drinks machines*' - change the word 'microwaved' to 'reheated' since vending machines and coffee machines are used differently, this category should be divided into two, and the new criteria should be divided between the food/beverage and the energy use
Water dispensers: *"A device for heating or cooling and dispensing drinking water."*
30 respondents agreed and 4 disagreed with this definition. - New definition: *A device for dispensing cooled/heated/ambient temperature drinking water*. - Another definition: *A device for dispensing drinking water, and/or with the possibility of heating or cooling the drinking water*. Other comments were - add 'specific' or 'with the primary purpose of' after 'A device' to make it more clear (e.g. *A device with the primary purpose of heating or cooling and dispensing drinking water*) - Delete 'for heating and cooling', since some dispensers work at ambient temperatures without heating and/or cooling. There are dispensers with tap water or with bottled water, and others that heat or cool water.

Overall many stakeholders agreed with the definitions. There were also a few stakeholders that proposed to alter the definitions slightly, either by removing parts or by adding more detail. The results of this feedback are shown it the last part of this chapter: 1.9.1 Proposals for definitions and scope for food and catering services.

1.5.3 Stakeholders feedback on the current criteria

1.5.3.1 General overview of the food and catering service criteria

Overall stakeholders agreed with the current criteria and only required to alter criteria in selected parts. Some respondents asked to make certain criteria more ambitious (especially from an environmental and an ethical perspective). For instance, five respondents proposed to change all or some of the comprehensive criteria into core criteria. Two of the respondents wanted to see more specific criteria for selected food categories. Furthermore, two respondents wanted to see more scientific evidence for the actual environmental benefits of the criteria. Other respondents argued that more comprehensive criteria may result in added costs for the procurers and suppliers. If this is the case, some respondents mean, then this can lead to a lower uptake of EU GPP. This because consumers are very price sensitive in some countries in the EU.

New topics
The respondents mentioned a number of new topics that may be relevant to include in the new set of criteria. Examples are: short supply chains, collaboration in supply chains to minimise waste, monitoring and measuring food waste, food waste separation, food safety, food fraud and to create awareness on the food waste obligations. One respondent proposed that procurement of professional kitchen appliances should be a separate category. A few respondents wanted to include the alternatives of tap water, vegetarian food (reduced meat options), half-portions in the catering menus and to use Class 2 produce[3]. Furthermore, inclusion of ethical standards was also requested from some respondents. One respondent also wanted to see more on nutrition (healthy options), allergens, GMO content, and different types of health hazards in food. It is difficult to decide at this stage which of these new topics that may be relevant going forward. However, they will be kept in mind in the coming chapters.

Questions to suppliers
Have any of the criteria of the current set been difficult to comply with? Most suppliers said that it has been difficult to comply with the current criteria set (10 said yes and 3 said no), and especially the organic criterion, due to availability and cost of such products. Waste reduction and waste management was also highlighted: one reason was that it is not always possible for the caterer to influence waste management. One respondent also mentioned that animal welfare standards and IP standards had been difficult to comply with.

Can you identify any example where you have been dissuaded from taking part in the tendering process due to current criteria? The majority of suppliers said that they had not turned down a bidding for this reason (2 said yes and 7 said no). One respondent mentioned that the organic criterion had kept them from participating.

Do you think SMEs can comply with the current criteria set? Many of the supplies believed that SMEs can comply (8 said yes and 5 said no). One respondent commented that the strong competition between SMEs all over Europe make them able to compete to tenders and fulfil current criteria. Another respondent stated that, within its member base, there are SMEs working actively with the criteria. One said that large companies have dedicated persons answering bids, while SMEs do not. One respondent stated that the process and criteria are too complex for SMEs.

Questions to procurers
Have you faced problems related with the number of offers complying with criteria set (too few)? In this case there were an even split between the suppliers (5 said yes and 5 said no). One respondent mentioned that the market is not always ready for the criteria.

Do you think most SMEs can comply with the current criteria set? Also in this case the responses were even (4 said yes and 5 said no). One respondent said that SMEs can comply but that larger companies win the bids due to better deals with subcontractors. Another respondent said that the market is not always ready.

[3] Food products that are good enough to eat, but that have some sort of esthetical defect.

Has procurement using the current EU GPP criteria been more expensive compared to non-green public procurement? Even this question gave split answers *(*5 said yes and 5 said no). One respondent said that it is not possible to assess the relative cost associated with individual criteria. Another said that 'it depends' and that sustainable products will become cheaper in the future if they become more common. Finally one respondent added that in their city the procurement of food is 100 % organic, and that helps to keep the prices lower. This respondent also buys fruit and vegetables in season, and demands different varieties of apples, pears, plums etc., giving bidders extra 'points' for how many different kinds they could offer. This encouraged the large catering firms to actively enlist new SMEs to their supply chains.

Standards other than EU GPP

Some respondents said that there are local procurement guidelines in their cities/countries that they must comply with. One respondent explained that it is using the UK Government Buying Standards and Soil Association standards because they are newer and more comprehensive than EU GPP. Another respondent mentioned that there is a new Brussels label for canteens and restaurants. Overall, the reason for using another standard was because EU GPP is not comprehensive enough or not up-to-date. One respondent said that it prefers other standards that are Sustainable Public Procurement (SPP) rather than 'just' GPP.

Not using GPP at all

The majority of responses indicated that it was either because the criteria are hard to comply with (too strict) or because of economic reasons. One respondent mentioned that since the current criteria not specifies approved labels, it is harder for procurers to know what to ask for and which labels are available that complies with EU GPP. One respondent elaborated further by saying that in order for criteria to be meaningful they have to be applicable both to self-operated and out-sourced services. They also need an enforcement mechanism that will ensure compliance. If this is not built into the criteria, the result may be that they will not be adopted.

1.5.3.2 General comments on specific criteria

One part of the questionnaire asked stakeholders to provide feedback on the current criteria. This section summarises the comments obtained.

Table 17: General comments on specific criteria

Organic production (Technical specification)
- decide a set % of organic food, or a higher % - better animal welfare considerations - more information should be provided in the product sheet, for instance on what a Type 1 Ecolabel is, with a link to more detail if necessary - obstacle to implement: availability of organic products may be low (e.g. due to seasonality or because organic is not available in all segments; such as coffee, where other tailored sustainability standards are better); or - too expensive
Additional organic production (Award criteria)
- as above - a set % of organic food does not take into account regional differences of availability, nor the whole life-cycle impact of products - a race to the highest % is not helpful; a set % is better

Table 17: General comments on specific criteria (Cont.)

Integrated production (Technical specification)
- higher animal welfare standards - more ambitious in terms of % - Integrated production (IP) standards may vary in Europe and may not even exist outside Europe, which can make this criterion discriminative. - Due to a lack of set standards, bids will be difficult to compare. It may therefore be better to have this criterion as an award criterion only. [4] - Include recognised industry-owned sustainable agriculture standards (e.g. Unilever Sustainable Agriculture Code and SAI Platform Farm Sustainability Assessment) in the core criteria for IP, since this would make it easier for industry to show compliance. - To prove compliance may inflict added costs on farmers - Good with an alternative to organic, but the IP concept is not well known in all countries in Europe. Ethical (fairly traded) standards could be used instead, since these usually include minimum environmental standards. - IP is not relevant for coffee suppliers - two respondents proposed to remove this criterion
Additional Integrated Production (Award criteria)
- similar/same comments as above - organic should be promoted and chosen over IP where possible
Packaging (Award criteria)
- add a higher % of recycled content - include biodegradable content as a criterion - add new category: *Percentage of product packaging that is collected and recycled/reused by the supplier* Strongly disagree:[5] - 'single-unit packages': in certain cases single-unit packages are the best option, mainly because they protect food (food safety), minimise food waste (shelf life, portion control), and tell the consumer how to prepare the food etc.[6] - Rewrite the criterion: *'Food products shall not be supplied in single-unit packages unless this is specifically requested by the contracting authority'*. - % of renewable materials in packaging: not always the best option from a LCA perspective[7]. - More important to minimise secondary packaging than to increase recycled material content in primary packaging, as this is not fully developed yet[8].

[4] It may be risky to have it as a technical specification since it may outperform an organic bid that is just below its set percentage target but, in fact, more comprehensive than the IP bid.

[5] The stakeholders that strongly disagree include: 1 catering service provider, 1 public procurer, 1 governmental agency, 2 Industry wide body/trade associations and 2 food providers.

6 For hot beverage vending machines, LCAs state that single-portions significantly reduce use of materials (e.g. water, coffee, energy) via portion control.

7 One respondent explained that cardboard with recycled content is weaker than virgin fibre and therefore it is likely that more recycled material is needed to achieve the same standard as cardboard from virgin material.

8 For example, packaging that will be in direct contact with food is regulated for reasons of food safety, and not all recycled materials are allowed to be used.

Table 17: General comments on specific criteria (Cont.)

Aquaculture and marine products (Award criteria)
- transfer to a core criterion - animal welfare considerations, particularly in cultivation systems - There should be different criterion for marine and aquaculture fish and seafood, since they have different production methods and therefore different environmental impacts. - In addition to the labels there should be a technical specification clause that states that fish on the MCS *Fish to Avoid* list should not be purchased. - These certifications may be costly to have as a supplier of fish, which may prevent SMEs from being able to compete for bids because they cannot afford the cost of the ecolabel. - these certified fish and seafood products may not always be available for purchasing and quality (taste) may be lacking - fish is an important element of a balanced diet and it would therefore be sad to see a lower intake of it due to too strict standards
Animal welfare standards (Award criteria)
- transfer to a core criterion - make it more comprehensive and specific - some countries do not have specific national guidelines for animal welfare, an EU-wide standard would be better - have specific criteria for specific animals - concerns with this criterion: the cost of these standards must be taken into account, as consumers will not tolerate price increases - Remove criterion; as it is impossible to have a meaningful and effective control on products.
Menu planning, according to season (Technical specifications)
- remove the phrase 'whenever possible' since it is a core criterion - should only apply to fresh produce (frozen produce has a long shelf life and may have been harvested in season and then kept frozen since) - the definition 'seasonal' should be linked to the country in which it has been produced - review environmental benefit is from this criterion - product availability and price will be key drivers in adhering to this criterion - add a climate aspect to this criterion and offer vegetarian options on the menu - remove criterion; nutritional considerations could potentially lead to the need to use out-of-season produce
Paper products (Technical specification)
- should apply at both core and comprehensive level - replace '*or sustainably managed virgin fibre*' with '*from certified renewable resources*' - concern with this criterion: it should only be applied when it was reasonable and financially practical, and (if kept) it should be transferred to an Award criterion instead of a Technical specification; and - 'one by one napkins' could be promoted as an alternative - Remove criterion, as it has minimal environmental effect on catering compared to other things. - As for verification, few recycled paper products actually have ecolabels.
Equipment (Award criteria)
- Is classification A is still relevant? - Energy Star label is not relevant in the EU - include cooking equipment, ware washing equipment and food waste management equipment - The EU Energy label for professional storage cabinets is expected to come into force on 1 July 2016. It will then be mandatory and should therefore provide a basis for the requirements for this GPP. - clarify which equipment the criterion for HCFCs and HFCs target - caterers (operators) are not always in control of the equipment they use - Add note '*this only applies where the caterer is responsible for providing own equipment*'.

Table 17: General comments on specific criteria (Cont.)

Cleaning products (Award criteria)
- if the product sheet for Cleaning Products and Services is used, it should also provide a guide as to which criteria are relevant to caterers - since the R-statements will become outdated shortly due to the GHS-system, the core criteria in the above mentioned sheet should be changed to indicate the relevant Hazard Statements of the GHS-system - include animal welfare considerations (i.e. only support animal test free detergents and toiletries)
Transport (Contract performance clauses: **core criteria**)
- the current EURO-ratings in the criterion are outdated, both at core and comprehensive level - EURO-rating 5 was mentioned suitable for the core level - add: *The transport to be used in carrying out the service must meet the following criteria: (link to Core criteria from the Transport Product Sheet)* - other types of emission-saving vehicles could be mentioned - Add: vehicles with refrigerants should use an environmentally friendly refrigerant - Caterers cannot always influence what vehicles are used by others in the supply chain. Therefore only caterers that largely conduct their own transport, should be affected by this criterion. - the cost of transportation must be taken into consideration - There are also other ways to optimise transport to minimise environmental impact
Transport (Contract performance clauses: **comprehensive criteria**)
- As above - EURO-rating 6 was proposed for vehicles by some.
Waste generation (Contract performance clauses)
- re-usable items should be the first option and renewable (non-reusable) the second - re-usable glassware and cutlery etc. is only sustainable if it is washed conservatively[9] - optimal type of glassware and cutlery to be used depends on the type of business it is for[10] - if the crockery and cutlery is non-reusable, it should be made from biodegradable sources, so that it can be composted and hence crate no 'waste' - As for separate collection: it should be up to the operator to choose the best method, since it depends on what service they have, where it is and what waste collection alternatives are available in that area. Sometimes caterers have no influence over the waste collection methods.
Staff training (Contract performance clauses)
- Add more details on what should be included in the training, so that it is easy for the procurer to estimate whether the provider fulfils the requirements - that training should include more than just waste minimisation - including training on energy and water management to continuously improve the energy, water and waste minimisation performance - Why is social quality of products relevant for an environmental criterion? - Should not be too specific; leave room for companies to differ. The training should enable staff to feel confident about making suggestions based on customer feedback or leftovers, with ideas on who to report them to and how.

[9] i.e. at lower temperatures with modern equipment which uses less water

[10] For a single event non-reusable glassware and crockery may be better, whereas in a school kitchen re-usable is best. Another respondent pointed out that the reusable material sometimes needs to be plastic; for instance, in kindergartens where it is safer to use than glass and is less heavy.

Table 17: General comments on specific criteria (Cont.)

Service management (Contract performance clauses)
- Important to keep this criterion, since it is the most crucial part of catering services. - 6 months is a too ambitious target[11] - removing the phrase 'where possible' to make it clear what is required and hence make it possible to evaluate performance - a % may be useful to include as a means of measurement - New sentence: '*food used in carrying out the service is **sustainably produced'***. - clarify how the "*Evaluation of the most significant environmental aspects of the service provided*" is expected to be performed - asked to use a recognised source on how to evaluate the most significant environmental aspects, to ensure this procedure is done continuously - refer to the BREFs prepared by EU Commission

1.5.3.3 Uptake of current EU GPP criteria

Seven public procurers specified how they have used the EU GPP criteria. Table 18 show the summary of the number of responses. The green squares represent which core criterion is available and the orange squares represent which comprehensive criterion is available. Overall, it is apparent that all core criteria have been used. The organic production and transport criteria are the most used core criteria, followed by packaging and menu planning. Almost of the comprehensive criteria have also been used, but the most frequent ones are packaging and staff training, followed by aquaculture and marine, menu planning, paper products, packaging, cleaning products and transport.

Furthermore, it is visible from Table 18 that procurers of food focus mostly on organic production and packaging, followed by the aquaculture and marine criterion. Catering service procurers also focus on organic production, but also transport is equally important, followed by menu planning and staff training.

11 Proposed a change that the supplier comes up with a plan within 6 months and then gives the contractor time to live up to the plan during the time of the contract, giving the supplier sufficient time to implement the plan.

Table 18: Feedback on uptake of EU GPP

FOOD	Core	Comprehensive
Organic production	5	1
Integrated production	---	2
Additional organic	1	1
Packaging	4	4
Additional integrated	---	---
Aquaculture and marine	---	3
Animal welfare	---	2

CATERING	Core	Comprehensive
Professional capability to perform the environmental aspects of the contract	---	---
Organic production	5	2
Menu planning, according to season	4	3
Integrated production (for the % of non- organic food)	---	2
Paper products	---	3
Additional organic production	2	1
Packaging	3	3
Additional integrated production (for % of non-organic food)	---	1
Aquaculture and marine products	---	2
Animal welfare standards	---	2
Equipment	---	2
Cleaning products	---	3
Waste generation	3	2
Transport	5	3
Staff training	---	4
Service management (if Selection criteria not included)	---	---

1.6 Local, Regional and National GPP criteria for food and catering services

While in 2008 only 14 Member States had adopted national GPP action plans (Commission of the European Communities, 2008a), in November 2014 there were already 22 Member States that had some form of national action plan (European Commission, 2014a). In 2009 seven Member States had a high rate of implementation of GPP: these were the UK, Austria, the Netherlands, Germany, Sweden, Finland and Denmark (European Commission, 2015a).

Table 19 shows a list of 31 GPP initiatives reviewed in terms of the food service sectors, food products covered and catering services. This review helps identify what other GPP schemes find important to include in the scope. Figure 3, Figure 4 and Figure 5 shows the results of the review. Appendix B shows the review of sectors and food categories, in more detail.

Table 19: Summary of GPP initiatives reviewed

ID	Procurer	Procurer type	Locality	Country	Year
1	City of Lens	Local government	Lens	France	2012
2	French Government	National government	Nationwide	France	
3	Northern Ireland Executive	Regional government	Northern Ireland	UK	
4	Northern Ireland Prison Service	Central government dept	Northern Ireland	UK	
5	Education and Library Boards	Central government dept	Northern Ireland	UK	2008
6	Health & Social Care	Central government dept	Northern Ireland	UK	
7	UK Government	National government	Nationwide	UK	2014
8	City of Malmö	Local government	Malmö	Sweden	2010
9	Municipality of Rome	Local government	Rome	Italy	2013
10	East Ayrshire Council	Local government	Scotland	UK	2008
11	City of Copenhagen	Local government	Copenhagen	Denmark	2013
12	City of Vienna	Local government	Vienna	Austria	1999
13	Scottish Government	Regional government	Scotland	UK	2011
14	Malta Government	National government	Nationwide	Malta	2008
15	Badalona City Council	Local government	Badalona	Spain	2009
16	IMEB (Municipal Education Institute), Barcelona City Council	Local government	Barcelona	Spain	2013
17	City of Helsinki	Local government	Helsinki	Finland	2010
18	Federal Procurement Agency (BBG)	National government	Nationwide	Austria	2012
19	UK Government	National government	Nationwide	UK	2010
20	Kiuruvesi town	Local government	Kiuruvesi	Finland	2012
21	Municipality of Pisa		Pisa	Italy	2011
22	University catering service (unidentified)	Higher education institution	Unidentified	UK	2012
23	Various	Higher education institution	Various	Various	2014
24	Various	Various	Various	USA	2014
25	Oulun Serviisi	Municipal food catering company	Oulu	Finland	2012
26	Compass Group	Contract Caterer	Various		
27	Various	Local government	Various	UK	2009
28	Various	Local government	Various	Finland	2012
29	Food for Life Partnership (FFLP)	Charitable initiative	Nationwide	UK	2012
30	Ministry of Defence (UK)	Central government dept	Nationwide	UK	2014
31	Ireland Government	National government	Nationwide	Ireland	2012

Schools (20 of the 31 initiatives) and health & social care (11 of the 31) were the two most prominent food service sectors covered (illustrated in Figure 3). This confirms the previous analysis which placed these two sectors at the top in terms of public expenditure. In terms of food products the first three products covered in the current EU GPP criteria are also the most included ones in other GPPs; namely, meat (15), dairy (13) and wild caught seafood (11). However, the next two food categories eggs (9) and bakery (8) are not included in the current EU GPP criteria (illustrated in Figure 4).

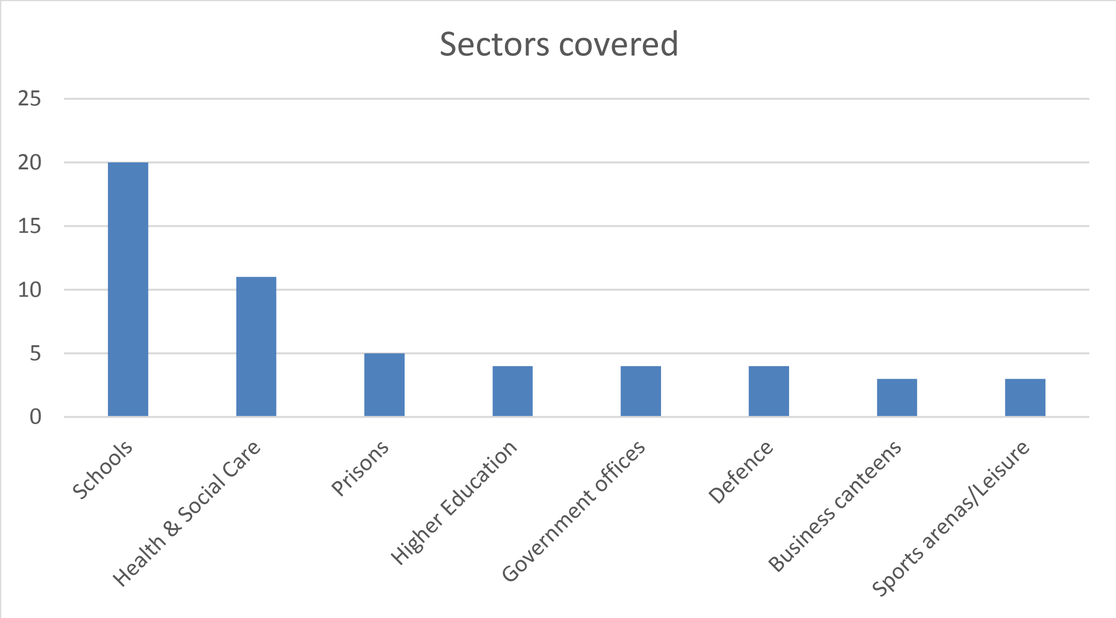

Figure 3: Aggregation of public sectors mentioned in the 31 GPPs schemes reviewed

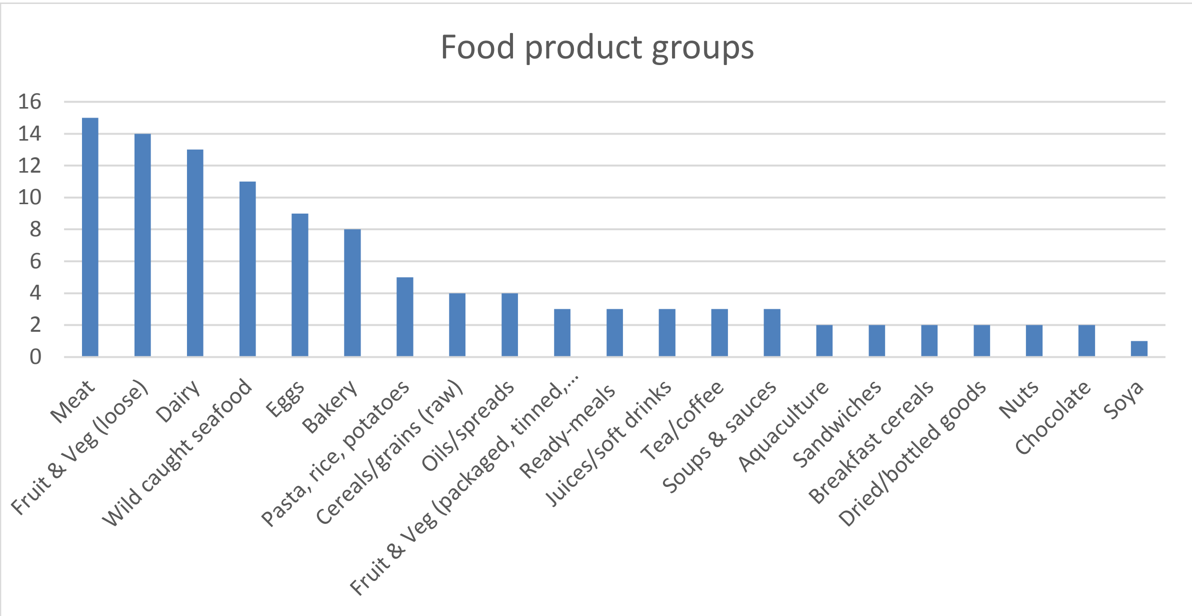

Figure 4: Aggregation of food product groups mentioned in the 31 GPPs schemes reviewed

The review of 31 GPPs also found which areas related to catering services that were mostly mentioned. 'Organic' was cited in 16 GPP schemes (out of 31) and seasonal in 15 schemes. Surprisingly integrated production, which is included in the current EU GPP criteria, was cited in only 2 cases. Ethical trading was also mentioned in 11 schemes (see Figure 5).

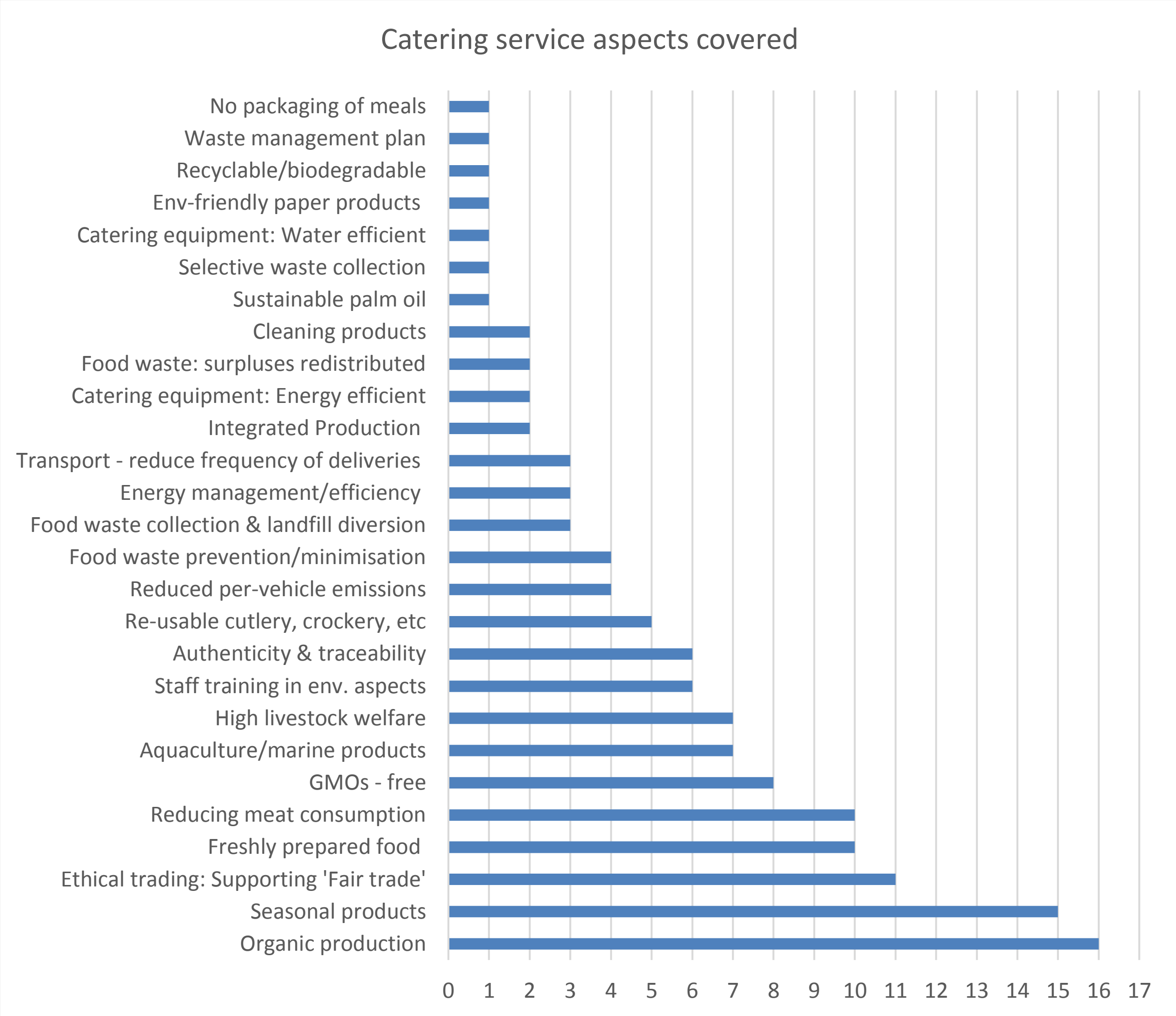

Figure 5: Criteria focused on catering services in the 31 GPPs schemes reviewed

Another review was also conducted of some of the top performing countries' national GPP schemes: namely Austria[12], Denmark[13], the Netherlands[14], Sweden[15], and the United Kingdom[16]. Also Norway[17] and UNEP (United Nations Environmental Program)[18] where reviewed. Table 20 shows the main findings from the national GPPs and SPPs. The areas highlighted in Table 20 are the most common areas that most GPPs and SPPs mentioned more or less. Some of these areas are mentioned as core while other are mentioned as comprehensive.

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[12] Nachhaltige Beschaffung (2015), *Ausschreibungen Lebensmittel (Tenders Food)*

[13] *Grønne inkøp, (2012), Indkøpsmål and Indkøpsmål for storkøkkenudstyr (procurement targets)*

[14] Dutch Ministry of Infrastructure and the Environment, (2011), *Criteria for sustainable public procurement of: Catering and Catering Equipment*

[15] Konkurrensverket (Swedish Competition Agency), (2015), *criteria-wizard*

[16] GOV.UK, 2014, *Sustainable procurement: the GBS (Governmental Buying Standard) for food and catering services*

[17] Direktoratet for Forvaltning og IKT, (2012), *Anbefalte krav og kriterier for miljøvennlige og sosialt ansvarlige anskaffelser av mat- og drikkevarer i offentlig sector, and, anskaffelser av serveringstjenster i offentlig sector, (criteria for food and catering services)*

[18] UNEP (United Nations Environment Programme), (2011*), Sustainable Procurement Guidelines – Cafeterias, Food & Kitchen Equipment product sheet*

Table 20: Main findings from 5 top performing National GPP schemes within the EU and 2 GPP schemes from outside the EU

Traceability.	Recyclable packaging.
% Organic production	Recycling procedures.
Sustainable palm oil.	Socially sourced (labour rights/helping communities).
Sustainable soy.	Minimise food waste.
Sustainable aquaculture.	Resource efficiency: energy, water, packaging.
Sustainable fisheries.	Staff training.
Seasonality.	Use reusable equipment.
Animal welfare: space (stocking densities), access to feed, water and bedding, right environment, natural behaviour, no physical interventions if possible, strict use of antibiotics, outdoor access if possible, GMO-free feed, hormone free, slaughter restrictions: maximum hours in transport, stunning before killing etc.	Have maintenance standards for equipment to maximise life.
Locally sourced.	Reduce meat consumption or animal protein.
Renewable energy.	Environmentally friendly cleaning agents.
Renewable packaging	Optimise distribution and transport by better planning.

1.7 European Legislation and Policies

1.7.1 Relevant EU Legislation for Food and Catering services

The following section summarises EU legislation and action plans (in general terms) that are relevant to this report on GPP for food and catering services, namely: biodiversity, water, waste, emissions and energy, sustainability, hygiene and food safety, and social and ethical issues.

1.7.2 Biodiversity

It is of great importance to the EU to preserve and protect biodiversity and habitats. Agricultural practices are one of the causes of biodiversity degradation The EU aims to halt the loss of biodiversity and the degradation of ecosystems in the EU by 2020.

- Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds.
- Directive 92/43/EEC on the conservation of natural habitats and wild fauna and flora
- Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions of 17 October 2008 “Addressing the challenges of deforestation and forest degradation to tackle climate change and biodiversity loss” [COM(2008) 645 final – Not published in the Official Journal].
    - The European Commission proposes to reduce gross tropical deforestation by at least 50 % by 2020 and remarks that GPP has a role to play in this.

- Commission Communication of 27 March 2001 to the Council and the European Parliament: Biodiversity Action Plan for Agriculture (Volume III) [COM(2001) 162 final - not published in the Official Journal].

1.7.3 Water

- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

- Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources

- Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture.

1.7.4 Waste

- Animal by-products regulations EC 1069 / 2009 on the management of animal by-products.

<u>Directive on Waste</u>
With a view to breaking the link between growth and waste generation, the EU has provided itself with a legal framework aimed at the whole waste cycle from generation to disposal, placing the emphasis on recovery and recycling.

- Directive 2008/98/EC (Waste Framework Directive) of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.

- Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste [See amending acts].

- Council Directive 96/59/EC of 16 September 1996 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls [See amending act(s)].

- European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste [See amending act(s)].

1.7.5 Emissions and energy

The EU is committed to reducing its GHG emissions by 20 % by 2020 in relation to 1990 levels. The EU is also committed to producing 20 % of total EU energy consumption from renewable sources. If the goal of staying under a 2 °C global temperature increase is to be met, the EU must reduce emissions within its territory by 70 % by 2050.

Emissions

- Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (Reference Document on Best Available Techniques in the Food, Drink and Milk Industries, 2006, currently under revision)

- Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their GHG emissions to meet the Community's GHG emission reduction commitments up to 2020.

- Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control.

- Directive 2000/25/EC of the European Parliament and of the Council of 22 May 2000 on action to be taken against the emission of gaseous and particulate pollutants by engines intended to power agricultural or forestry tractors and amending Council Directive 74/150/EEC.

Energy efficiency

- Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products.

- Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-using products.

Transport

- Directive 2009/33/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of clean and energy-efficient road transport vehicles.

- Regulation (EC) No 595/2009 of the European Parliament and of the Council on type-approval of motor vehicles and engines with respect to emissions from heavy duty vehicles (Euro VI) and on access to vehicle repair and maintenance information and amending Regulation (EC) No 715/2007 and Directive 2007/46/EC and repealing Directives 80/1269/EEC, 2005/55/EC and 2005/78/EC.

1.7.6 Sustainability

Integrated production

- Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products.

- Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides.

- Regulation (EC) No 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC [See amending acts].

Organic farming

- Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91

- Commission Regulation (EC) No. 889/2008 of 5 September 2008 with detailed rules on production, labelling and control

- Commission Regulation (EC) No. 1235/2008 of 8 December 2008 with detailed rules concerning import of organic products from third countries

Aquaculture and fisheries

The demand for fish in the EU is increasing and even if wild stocks recover and are caught to Maximum Sustainable Yield levels it will not be enough to meet demand. Therefore it is important for the EU to expand aquaculture, but in a sustainable way. Best practice methods should be used with consideration to the aquatic environment and to the cultivated fish and seafood. Water quality for the stocks must be high, and animal welfare and health are also important.

- Communication from the Commission to the European Parliament and the Council of 8 April 2009 - Building a sustainable future for aquaculture - A new impetus for the Strategy for the Sustainable Development of European Aquaculture [COM(2009) 162 final – Not published in the Official Journal].

- Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for Community action in the field of marine environmental policy (Marine Strategy Framework Directive).

- Council Regulation (EC) No 1342/2008 of 18 December 2008 establishing a long-term plan for cod stocks and the fisheries exploiting those stocks and repealing Regulation (EC) No 423/2004 [See amending act(s)].

- Council Regulation (EC) No 734/2008 of 15 July 2008 on the protection of vulnerable marine ecosystems in the high seas from the adverse impacts of bottom fishing gears.

- Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions of 17 October 2007 on destructive fishing practices in the high seas and the protection of vulnerable deep sea ecosystems [COM(2007) 604 final - not published in the Official Journal].

- Communication from the Commission to the Council and the European Parliament of 28 March 2007 on a policy to reduce unwanted by-catches and eliminate discards in European fisheries [COM (2007) 136 final - not published in the Official Journal].

- Communication from the Commission to the Council and the European Parliament of 5 February 2007 on improving fishing capacity and effort indicators under the common fisheries policy [COM(2007) 39 final – not published in the Official Journal].

- Communication from the Commission to the Council and the European Parliament of 29 January 2007 entitled: Review of the management of deep-sea fish stocks [COM(2007) 30 final – Not published in the Official Journal].

- Communication from the Commission to the Council and the European Parliament: Implementing sustainability in EU fisheries through maximum sustainable yield [COM(2006) 360 - not published in the Official Journal].

- Directive 2006/113/EC of the European Parliament and of the Council of 12 December 2006 on the quality required of shellfish waters [See amending act(s)].

- Council Directive 2006/44/EC of 6 September 2006 on the quality of fresh waters needing protection or improvement in order to support fish life [See Amending Act(s)].

1.7.7 Hygiene and food safety

- Commission recommendation of 19 February 2013 on a coordinated control plan with a view to establish the prevalence of fraudulent practices in the marketing of certain foods (2013/99/EU).
- Commission Regulation (EU) No 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food.

- Commission Regulation (EC) No 282/2008 of 27 March 2008 on recycled plastic materials and articles intended to come into contact with foods and amending Regulation (EC) No 2023/2006.

- Commission Directive 2007/42/EC of 29 June 2007 relating to materials and articles made of regenerated cellulose film intended to come into contact with foodstuffs.

- Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety [See amending acts].

- Regulation (EC) 852/2004 on the hygiene of foodstuffs, 29 April 2004

- Regulation (EC) 853/2004 laying down specific hygiene rules for food of animal origin, 29 April 2004

1.7.8 Social and ethics issues

Animal welfare

- Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee on the European Union strategy for the protection and welfare of animals 2012-15 [COM(2012) 6 final/2 of 15.2.2012 - not published in the Official Journal].

- Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing.

- Council Directive 2008/120/EC of 18 December 2008 laying down minimum standards for the protection of pigs.

- Council Directive 2008/119/EC of 18 December 2008 laying down minimum standards for the protection of calves.

- Council Regulation (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97.

- Council Directive 1999/74/EC of 19 July 1999 laying down minimum standards for the protection of laying hens [See amending act(s)].

- Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes [See amending act(s)].

- Council Decision 92/583/EEC of 14 December 1992 on the conclusion of the Protocol of amendment to the European Convention for the Protection of Animals kept for Farming Purposes.

- Council Decision 88/306/EEC of 16 May 1988 on the conclusion of the European Convention for the Protection of Animals for Slaughter.

- Council Decision 78/923/EEC of 19 June 1978 concerning the conclusion of the European Convention for the protection of animals kept for farming purposes.

GMO

- 2009/41/EC of the European Parliament and of the Council of 6 May 2009 on the contained use of genetically modified micro-organisms.

- Regulation (EC) No 1830/2003 of the European Parliament and of the Council of 22 September 2003 concerning the traceability and labelling of genetically modified organisms and the traceability of food and feed products produced from genetically modified organisms and amending Directive 2001/18/EC.

- Regulation (EC) No 1829/2003 of the European Parliament and of the Council of 22 September 2003 on genetically modified food and feed.

1.8 Voluntary environmental legislation, eco-labels and other schemes

1.8.1 Voluntary environmental legislation

EU Ecolabel is a voluntary environmental labelling system. It enables consumers to recognise high quality eco-friendly products. The EU Ecolabel is available for distinct product groups, e.g. cleaning products, appliances, paper products, home and garden, clothing, tourism and lubricants (European Commission, 2008b). This label is not relevant for food products but can be relevant for some areas of catering services, for example the use of cleaning products (all-purpose cleaners, detergents for dishwashers, hand washing detergents, laundry detergents), paper products (tissue paper) and appliances (dishwashers, refrigerators, washing machines etc).

- Regulation (EC) No 66/2010 of the European Parliament and of the Council of 25 November 2009 on the EU Ecolabel

Eco-management and audit system (EMAS)

The EU Eco-Management and Audit Scheme (EMAS) is a management instrument developed by the European Commission for companies and other organisations to evaluate, report, and improve their environmental performance. EMAS is open to every type of organisation eager to improve its environmental performance. It spans all economic and service sectors and is applicable worldwide (EMAS, 2015).

- Regulation (EC) No 1221/2009 of the European Parliament and of the Council of 25 November 2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), repealing Regulation (EC) No 761/2001 and

Commission Decisions 2001/681/EC and 2006/193/EC. (BEMP on Food and beverage manufacturing, currently under development)

1.8.2 Relevant Ecolabels schemes for the Product Group

A website called 'ecolabel index'[19] presents all available eco-label initiatives worldwide. This website showed 148 eco-labels relevant to food. These eco-labels indicate what is currently important for consumers on the market. Table 21 shows 100 of these eco-labels (selected on the basis that they are either second or third party verified). For the EU GPP criteria, however, only third party verified eco-labels are relevant. These are indicated in the last column (Table 21). The second party verified schemes are indicated in grey (Table 21).

Of all ecolabels, 43 are certified organic labels and 51 stated to be environmental or sustainable labels (not organic). 18 labels focused on marine and aquaculture stewardship and 17 labels focused on animal welfare. 26 labels stated that they included or stood for social standards (human rights, fair trade etc.). As for the third party verified 35 is certified organic, 35 environmental or sustainable, 15 marine & aquaculture, 14 animal welfare and 18 social/ethical standards.

Table 21: Summary of eco-label initiatives worldwide

Table 21: Summary of eco-label initiatives worldwide

Ecolabel Index	**Country**	**Starting year**	Gov **(G)/** Non-profit **(N-P)/** Industry Association **(I)/** For-profit **(F-P)**	ORGANIC	SUSTAINABILITY/ ENVIRONMENT	MARINE AND AQUACULTURE	ANIMAL WELFARE	SOCIAL STANDARDS	CARBON EMISSIONS	REGIONAL	TRACEABILITY/ TRANCPARENCY	**3rd OR 2nd PARTY VERIFIED**
4C Association		2004	N-P		X							**3**
AB (Agriculture Biologique)	FR/ZA	1985	N-P	X								**3**
ABIO	BR	1985	N-P	X								**3**
AfOR Compost Certified	UK	2002	N-P		X							**3**
AIAB (Italian Association for Organic Agriculture	IT	1998	N-P	X								**3**
American Grassfed	US	2010	I				X					**3**
Animal Welfare Approved	US/CA	2006	N-P				X					**3**
Aquaculture Stewardship Council		2012	N-P		X	X						**3**
Australian Certified Organic	AU	2002	N-P	X		X					X	**3**
B Corporation	US/CA	2007	N-P		X	X		X			X	**2**
Best Aquaculture Practices	WW	2002	N-P		X	X		X			X	**3**
BioForum Biogarantie and Ecogarantie	BE	2002	N-P	X								**3**
BIO Hellas	BG/GR	2007	(F-P)	X		X						**2**
BIO Hotels	AT/DE/IT/CH	2001	I	X	X					X		**2**
Biokreis	AT/DE/CH	1979	N-P	X		X						**3**
Bioland	DE	1971	N-P	X			X					**3**
Bio Quebec	CA	2000	G	X								**3**
Bio-Siegel	DE/ZA	2001	G	X								**3**

[19] Website: http://www.ecolabelindex.com/ecolabels/?st=category,food, accessed 2 June 2015.

Table 21: Summary of eco-label initiatives worldwide

Ecolabel Index	Country	Starting year	Gov (G)/ Non-profit (N-P)/ Industry Association (I)/ For-profit (F-P)	ORGANIC	SUSTAINABILITY/ ENVIRONMENT	MARINE AND AQUACULTURE	ANIMAL WELFARE	SOCIAL STANDARDS	CARBON EMISSIONS	REGIONAL	TRACEABILITY/ TRANCPARENCY	3rd OR 2nd PARTY VERIFIED
Bio Suisse	CH	1981	N-P	X		X				X		3
Bird Friendly Coffee	N.Am/S.Am./NL	1998	N-P	X			X					3
Bonsucro	WW	2005	N-P		X			X	X			3
British Columbia Certified Organic	CA	1994	N-P	X								3
C.A.F.E. Practices	WW	2004	(F-P)		X			X				3
California Certified Organic Farmers - CCOF	US	1973	N-P	X								3
Canada Organic	CA	2009	G	X								3
CarbonFree ® Certified	AU/BR/CA/US	2007	N-P						X		X	3
Carbon Neutral Certification	BR/IN/US	2008							X			2
Carbon Neutral Product Certification	AU/CL/JP/SG	2006	(F-P)						X			2
Carbon Reduction Label	WW	2007							X			3
Certified Green Restaurant	CA/US	1990	N-P		X							2
Certified Humane Raised and Handeled	US	2003	N-P		X		X				X	2
Certified Vegan	US	1998	N-P								X	2
Certified Wildlife Friendly®	WW	2007	N-P				X	X				2
Climatop	CH	2008	N-P		X				X			3
Delinat Bio Garantie	AT/FR/DE/IT/CH	1983	(F-P)	X	X		X	X		X		3
Demeter BioDynamic®	US	1940	N-P		X							2
Earthsure	CA/US	2006	N-P		X							3
Ecocert	WW	1991	(F-P)	X	X							3
Eco-Leaf	JP	2002			X							3
Ecomark: India	IN	1991	G		X							3
Environment Product Declaration	BE/GR/IT/NE/SE/CH/CN/UK	1999	G		X	X						3
EU organic products label	EU	1991	G	X	X		X				X	-
Fair for Life	US	2006	(F-P)		X			X				2
Fairtrade	WW	1997	N-P		X			X				3
Fair Trade Certified	CA/US	1998	N-P		X	X		X				3
Fair Trade Organization Mark	AR/BO/BR/CL/MX/ZA	2004	N-P					X				3
Farm and Ranch Certification Program	MX/US	1997	N-P		X		X	X				3
Farm Verified Organic	US	1995	N-P	X								3
Friend of the Sea	DE/IT/ES/CH/UK	2006	N-P			X						3
Global Good Agriculture Practice (GAP)	DE/ZA/UK/US	1997	N-P		X		X	X				3
Green Crane: Ukraine	UA	2002	N-P		X							3
Green Seal	US/CA/ID/(KR/KP)/PR/ZA	1989	N-P		X			X	X			2
Green Table	CA	2007			X							2

Table 21: Summary of eco-label initiatives worldwide

Ecolabel Index	**Country**	**Starting year**	Gov **(G)**/ Non-profit **(N-P)**/ Industry Association **(I)**/ For-profit **(F-P)**	ORGANIC	SUSTAINABILITY/ ENVIRONMENT	MARINE AND AQUACULTURE	ANIMAL WELFARE	SOCIAL STANDARDS	CARBON EMISSIONS	REGIONAL	TRACEABILITY/ TRANCPARENCY	**3rd OR 2nd PARTY VERIFIED**
Green Tick	AU/NZ/US	2001	(F-P)		X	X						**3**
HAND IN HAND	WW	1992	(F-P)	X				X				**3**
Healthy Child Healthy World	US	1991	N-P					X				**3**
IMO Certified	WW	1991	(F-P)	X								**3**
Japanese Agricultural Organic Standard (JAS)	JP	2000	G	X								**3**
Krav	SE	1985	N-P	X	X	X	X	X				**3**
LEAF	CA	2009		X	X					X		**3**
LEAF Marque	IE/UK	2002	N-P		X		X					**3**
LFP Certified	CA	2006	N-P	X	X		X	X	X			**3**
LowCO2 Certificaton	AU/CL/JP/SG	2006	(F-P)		X				X			**2**
Loumuliitto - The Ladybird label	FI	1989	N-P	X						X		**3**
Loumu Sun Sign	FI		G	X								**3**
Marine Stewardship Council	WW	1999	N-P		X	X					X	**3**
Max Havelaar	CH	1992	N-P					X				**3**
Milieukeur: the Dutch environmental quality label	NL	1992	N-P		X	X	X	X				**3**
National Green Pages ™ Seal of Approval	US	2004	N-P		X			X				**2**
Nature's Promise	US		(F-P)	X								**3**
Naturland e.V.	DE/MX/LK	1982	N-P	X		X		X				**2**
Non-GMO	CA/US	2007	N-P								X	**3**
Nordic Ecolabel or Swan	DE/FI/NO/IS/SE/ZA	1989	N-P		X							**3**
Ø-label: Norway	NO	1986	N-P	X		X						**3**
Oregon Tilth	US	1982	N-P	X				X				**2**
Organic Food China	CN	1994	N-P		X							**3**
Organic Food Federation	UK	1986	N-P	X								**2**
Protected Harvest	US	2001	(F-P)		X							**3**
QCS Organic	US	1989	I	X								**3**
Rainforest Alliance Certified	WW	1992	N-P		X			X				**3**
Rhode Island Certified Organic	US	1990	G	X								**2**
RSPO Certified Sustainable Palm Oil	BR/CA/IT/LV/RU/UK/US	2007	N-P		X						X	**3**
RTRS Certified Soy	BR	2010	I		X			X				**3**
Safe Agri-Food Product	CN	2011	G		X							**2**
Salmon-Safe	US	1997	N-P		X	X						**3**
Singapore Green Label Scheme (SGLS)	Asia	1992	N-P		X							**2**
SIP Certified	FI/NO/US	2008	N-P	X	X			X				**3**
Skal Eko Symbol	NL	1985	N-P	X								**3**

Table 21: Summary of eco-label initiatives worldwide

Ecolabel Index	**Country**	**Starting year**	Gov **(G)/** Non-profit **(N-P)/** Industry Association **(I)/** For-profit **(F-P)**	ORGANIC	SUSTAINABILITY/ ENVIRONMENT	MARINE AND AQUACULTURE	ANIMAL WELFARE	SOCIAL STANDARDS	CARBON EMISSIONS	REGIONAL	TRACEABILITY/ TRANCPARENCY	**3rd OR 2nd PARTY VERIFIED**
Soil Association Organic Standard	UK	1973	N-P	X		X						**3**
SPCA Certified	CA	2002	N-P				X					**3**
State of Utah Organic Certification Program	US		G	X								**3**
Stemilt Responsible Choice		1989	I		X			X				**2**
TerraCycle	AR/BR/CA/IL/MX/SE/TR/UK/US	2005	(F-P)		X							**2**
Texas Certified Organically Produced	US	1988	G	X								**2**
USDA Organic	US	2002	G	X			X					**3**
UTZ Certified	WW	2002	N-P		X							**3**
Vermont Organic Certified	US	1985	N-P	X								**3**
Vitality Leaf	RU	2001	N-P		X							**2**
WSDA Organic	US		G	X								**3**
Zque	NZ	2005	(F-P)		X		X				X	**3**

1.8.3 Other schemes

Fairtrade

The FAIRTRADE Mark is an independent consumer label that certifies that products, sourced from developing countries, have offered a good deal to small-scale farmers and workers, such as decent working conditions and better prices. In addition, the FAIRTRADE mark supports local communities to develop and to protect the environment in which they live and work (Fairtrade, 2015).

Green Seal

The Green Seal a label founded in the United States but is used worldwide. It provides life-cycle based sustainability standards for many types of products (Green Seal, 2015).

GLOBAL G.A.P – Good Agricultural Practice

This is a worldwide standard that originally was developed by retailers in order to comply with consumer demand on food safety, environmental impacts, and health, safety and welfare of animals and workers. Today this certification is the leading farm assurance program in the world that transform consumer requirements into standards of Good Agricultural Practice (Global G.A.P, 2015).

Integrated production

As part of the EU GPP are recommendations to purchase food products carrying the regional/national Integrated Production label according to Integrated Production standards as a complementary to buying organic products. According to the EU GPP background report (European Commission, 2008a) there are different Integrated Production Schemes across Europe. Some are called Integrated Farm Management Systems and other Integrated Crop Management Systems, for instance. This means that there is no EU-wide standard for this type of production. Even though there are differences between the different schemes, their main objective is to achieve better productivity by using best available standards of pest management, soil fertilisers, and other modern technologies. The aim of these standards is to minimise the use of pesticides and nitrogen, both to protect the environment and to save money at a farm level. A higher level of food safety is also part of this standard (European Commission, 2008a).

Label Rouge
This is a French label that insures higher quality of food products compared to other current products. It certifies a top quality guarantee of food in terms of regularly checked production and sensory quality of products (Label Rouge, 2015).

NEULAND
This is a German label that certifies that animals are raised in a way that respects both animal welfare and the environment. The label guarantee that meat have good quality and are controlled all the way. Most of the meat sold with the NEULAND label is sold on farms, in local butcher shops, own corporations and in restaurants (NEULAND, 2015).

Nordic Ecolabelling
This label is a comprehensive Ecolabel that takes into consideration the whole life-cycle of products. Climate considerations is the key element of this label. It evaluates a product's total life-cycle impact on the environment and then put in place criteria to limit CO_2 emissions of said product. Both direct and indirect impacts are included in the criteria (Nordic Ecolabelling, 2015).

Rainforest Alliance
The Rainforest Alliance works to safeguard sustainable livelihood and to protect biodiversity. Their main methods are to change land-use practices, business practices and consumer behaviour and areas of expertise are in the world's most vulnerable eco-systems. This organisation has its own symbol called The Rainforest Alliance Certified™ Seal (Rainforest Alliance, 2015).

Red Tractor Assurance
This is a UK certification for farms that assures animal welfare (e.g. free range), food safety, hygiene and environmental protection through entire food supply chains. The standards available cover following food products: crops and sugar beet; fresh produce; beef and lamb; dairy; pigs; broilers and poussin; breeder layers; breeder replacements; free range; hatchery; catching and transport; lairage and slaughtering (Red Tractor Assurance, 2015).

Round Table on Responsible Soy (RTRS)
This initiative is an international mechanism to move soy production and trade into a more sustainable operation. Following are the RTRS principles (RTRS, 2013):

- Legal compliance and good business practice
- Responsible labour conditions
- Responsible community relations
- Environmental responsibility
- Good agricultural practice

The key areas of this standard are that there shall be no deforestation of native forests for the sake of soy production and other important environmental areas are also protected from soy production.

Roundtable on Sustainable Palm Oil (RSPO)
This certification focuses on sustainable palm oil production and have following principles that growers need to comply with (RSPO, 2013):

- Commitment to transparency.
- Compliance with applicable laws and regulations.
- Commitment to long-term economic and financial viability.
- Use of appropriate best practices by growers and millers.
- Environmental responsibility and conservation of natural resources and biodiversity.
- Responsible consideration of employees, and of individuals and communities affected by growers and mills.
- Responsible development of new plantings.
- Commitment to continuous improvement in key areas of activities.

UK GBS (Government Buying Standards)
This is a list of specification that is developed for public procurement in the UK. The standard includes both mandatory specifications and best practice specifications. Environmental impacts that are considered in the standard are: energy and water in use; end of life costs (repairability, upgradeability, recyclability and hazardousness of materials used) and resource use (levels of scarce materials and recycled content) (GOV.UK, 2012).

1.9 Preliminary scope and definition proposals

The existing subject matter for the Product group Food and Catering Services is described below. The subject matter will be revised according to the outcomes of the revision process.

For food is:

- (*Core criteria*) Purchase of food (or a certain food product group) coming at least partially from organic sources.
- (*Comprehensive criteria*) Purchase of food (or a certain food product group) with a percentage of products originating from organic and integrated production and with packaging reduced to a minimum.

For catering services is:

- (*Core criteria*) Contract for catering services with the provision of food with a percentage of products originating from organic sources and carried out in an environmentally friendly way.
- (*Comprehensive criteria*) Contract for catering services with the provision of food with a percentage of products originating from organic and integrated production, and carried out in an environmentally friendly way.

This section presents the first proposals for definitions and scope for food and catering services. This chapter has presented stakeholder feedback for both: scope, definitions and coming criteria. The new definitions are proposed here, but the boundaries of the scope for this report will be further informed by the Market Analysis (Task 2) to determine whether the food categories, food services and sectors are relevant, the Environmental and Technical Report (Task 3) and the Improvement potential and life-cycle costing considerations (LCC) report (Task 4).

1.9.1 Proposals for definitions and scope for food and catering services

The following definitions for scope and for food service have been amended by stakeholder consultation feedback.

Table 22: Scope definition of food and catering services

Scope
The direct procurement of food by public authorities and the procurement of catering services, either using in-house resources or facilities or out-sourced in full or in-part through contract catering firms. Food can be procured directly from producers, wholesalers or importers or can form part of the service provided by the contract catering firms. New proposal: *The direct procurement of food by public authorities and the procurement of catering services, either using in-house resources or facilities or out-sourced in full or in-part through contract catering firms. Food can be procured directly from producers, **manufacturers,** wholesalers or importers or can form part of the service provided by the contract catering firms.*

Table 23: Food service definitions

Food service definitions
Catering service *The preparation, storage and, where appropriate, delivery of food for consumption by the consumer at the place of preparation or at a satellite unit* New proposal: *The preparation, storage and, where appropriate, delivery of food and **drinks** for consumption by the consumer**/client/patient** at the place of preparation, at a satellite unit **or at the premises/venue of the client.***
Contract catering firm *A business engaged in providing a meals service (for example by running a staff restaurant or providing school meals)* New proposal: *A business engaged in (**amongst other activities or services**) providing a meals service (for example by running a staff restaurant or providing school meals) **or providing drinks, snacks or vending.***
Conventional kitchen *Food is prepared on site (the majority made from scratch)* New proposal: *A kitchen (**at the place of consumption**) where all, or a **significant part** of, food is prepared from **raw ingredients**.*
Ready-prepared *Preparation on site of large batches that are then kept frozen or chilled until required. Used in hospitals and prisons.* New proposal: *Preparation on site **or at a central facility** of large batches **of items for consumption** that are then adequately stored frozen or chilled until required.*
Assembly-serve *The food is delivered pre-processed and reheated and assembled on site. (Mostly common in fast-food restaurants)* New proposal: *The food is delivered pre-processed and cooked. Then the food is reheated (if necessary) and assembled on site.*
Centralised *Central kitchens or central food factories, that sends out completed dishes to satellites. For example school kitchens.* Centralised **production unit**, new proposal: *Central kitchens or central food factories that **send** out completed dishes **or pre-processed ingredients/meals** to satellites. **Can include both ready-prepared services and assembly-serve services.***
Vending and coffee machines *Machines that are available at all times with snacks, fruit, drinks and/or sandwiches etc. that are ready to eat/drink or that can be microwaved.*

<u>Vending and **hot drink** machines, new proposal:</u> *Machines that are available at all times with snacks, fruit, drinks and/or sandwiches etc. that are ready to eat/drink or that can be **reheated**.*
Water dispensers *A device for heating or cooling and dispensing drinking water.* <u>New proposal:</u> *A device **specifically** for dispensing drinking water**, which might have the possibility of heating and/or cooling the drinking water**.*

1.9.2 Preliminary scope considerations

Scope boundaries (what is included and what is excluded) will be investigated further in the coming sections of this report. However, a few limitations can be made at this stage based on the stakeholder feedback and on the brief literature reviews conducted. It was decided to follow the structure of COICOP with the food categories. Following are summaries of what will be investigated further. Firstly, Table 24 provides an insight on the grouping of the food categories. The COICOP groups presented will be further investigated in coming chapter.

Table 24: Proposed food categories converted to COICOP standard

Food categories	COICOP
Fruit and vegetables	01.1.6 Fruit 01.1.7 Vegetables
Aquaculture	01.1.3 Fish and seafood
Marine	01.1.3 Fish and seafood
Meat and dairy	01.1.2 Meat 01.1.4 Milk, cheese and eggs
Hot drinks Cold beverages	01.2.1 Coffee, tea and cocoa 01.2.2 Mineral waters, soft drinks, fruit and vegetable juices
New proposed categories	**COICOP**
Eggs (stakeholder survey/literature review)	01.1.4 Milk, cheese and eggs
Cereals (stakeholder survey/literature review)	01.1.1 Bread and cereals
Bread (literature review)	01.1.1 Bread and cereals
sugar and confectionary (literature review)	01.1.8 Sugar, jam, honey, chocolate and confectionery
Oils and fat (stakeholder survey and COICOP)	01.1.5 Oils and fats

As for catering services the meal preparation systems presented in Table 25 will be further analysed. The only difference here is that hot drinks and vending machines are divided. Furthermore, water dispensers are still included, but the relevance of that service will be investigated in the Technical and Environmental Analysis (Task 3).

About half of all stakeholders were satisfied with the food service segments but others proposed additional segments to be included. However, only kindergartens and nurseries were proposed by many. The food service segments will therefore be kept as they are with the inclusion of kinder gardens and nurseries (see Table 25). The Market Analysis (Task 2) will help determine whether all these segments are relevant or not for inclusion in the criteria set.

Table 25: Proposed catering services and food service segments

Catering services	Food service segments
• conventional kitchen • ready-prepared • assembly-serve • centralised production unit • vending machines (i.e. drinks, snacks and food, chilled) • hot drink machines • water dispensers	• schools • universities • hospitals • caring homes (for elderly) • canteens in government buildings • events (conferences, meetings, festivities) • prisons • armed forces New food service segments to consider: • kindergartens • nurseries

2 MARKET ANALYSIS

The aim of this chapter is to update the key figures on the size and structure of the EU market in terms of the public expenditure on food and catering services, and to identify important drivers, trends, innovations and initiatives. This involves the identification of significant changes in the market to inform the revision of the current EU GPP document for food and catering services. The analysis covers the period starting from the current EU GPP document (dated 2008).

A large emphasis in this chapter will be on the catering service part of food provision. In addition, public sectors, food systems and food categories will be presented in more detail in this chapter to evaluate which are most relevant for the public sector as a whole and thereby of most relevance to the revision of the EU GPP criteria. A number of stakeholders from different organisations across Europe (within the food and catering sector) have provided feedback on how public catering services looks like in the EU. Some of their responses will be part of this section.

2.1 EU market overview

Most statistical data available on foodservice in Europe includes both public and commercial data. Eurostat Structural Business Statistics provides data on the NACE Rev 2 category '*Food and Beverages Service Activities*'.
Table 26 shows this category and its three sub-categories. Sub-category '*56.1 Restaurants and mobile food service activities*' is likely to consist mainly of companies working in the private market, as is the sub-category '*56.3 Beverage service activities*' - although this also includes vending machines. Sub-category '*56.2 Event and other food service activities*' may also cover both public and private markets, although public market activities are more prevalent. *'56.29 Other food service activities*' includes industrial catering. In the EIRO (2010) report it is assumed that contract catering is part of this sub-category.

Table 26: NACE Rev. 2 classification of 'Food and Beverage Service Activities' (Eurostat, 2008)

56 Food and Beverage Service activities
56.1 Restaurants and mobile food service activities
56.2 Event catering and other food service activities
56.21 Event catering activities - ***includes the provision of food services based on contractual arrangements with the customer, at the location specified by the customer, for a specific event.***
56.29 Other food service activities ***- includes industrial catering, i.e. the provision of food services based on contractual arrangements with the customer, for a specific period of time. Also included is the operation of food concessions at sports and similar facilities. The food is usually prepared in a central unit.***
56.3 Beverage service activities ***- includes preparation and serving of beverages for immediate consumption on the premises.***

Statistics from 2011 and 2012 from Eurostat Structural Business Statistics has been used in this report, since those years provide the most recent complete sets of data from all Member States. Statistics from 2013 and onwards are not complete or are under development. Figure 6 present the total purchase of 'Food and Beverage Service Activities' in the EU-28, by Member State in 2011. This includes all meals and drinks that are prepared for immediate consumption, also alcoholic beverages (Eurostat, 2008). The estimated expenditure for the 28 Member States is €206.3 billion.

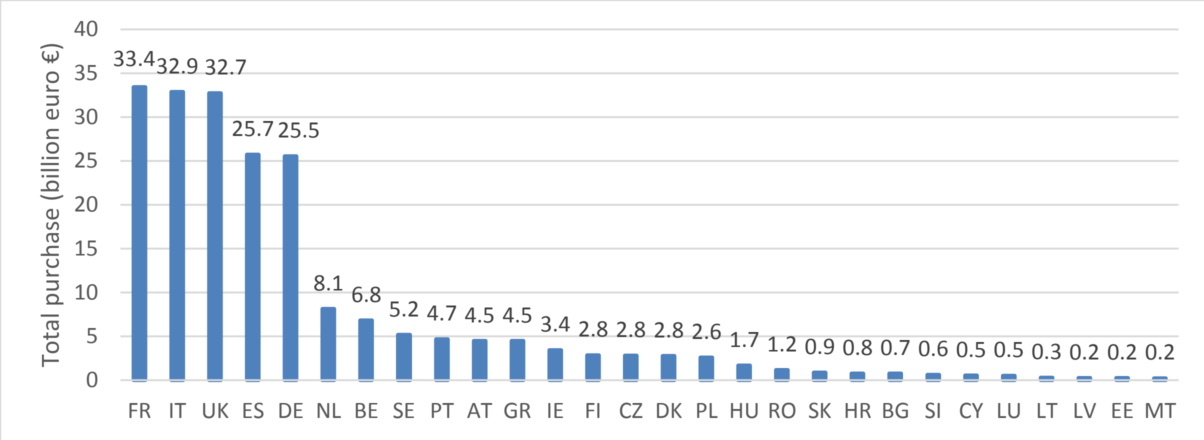

Figure 6: Total purchase cost per EU Member State for 'Food and Beverage Service Activities' in 2011 (Source: Adapted from Eurostat Structural Business Statistics)

The data in Figure 6 is further broken down into its three sub-categories as illustrated in Figure 7. It is clear that '*Restaurants and mobile food service activities*' has the largest purchase value in all countries. '*Event catering and other food service activities*' is small in comparison.

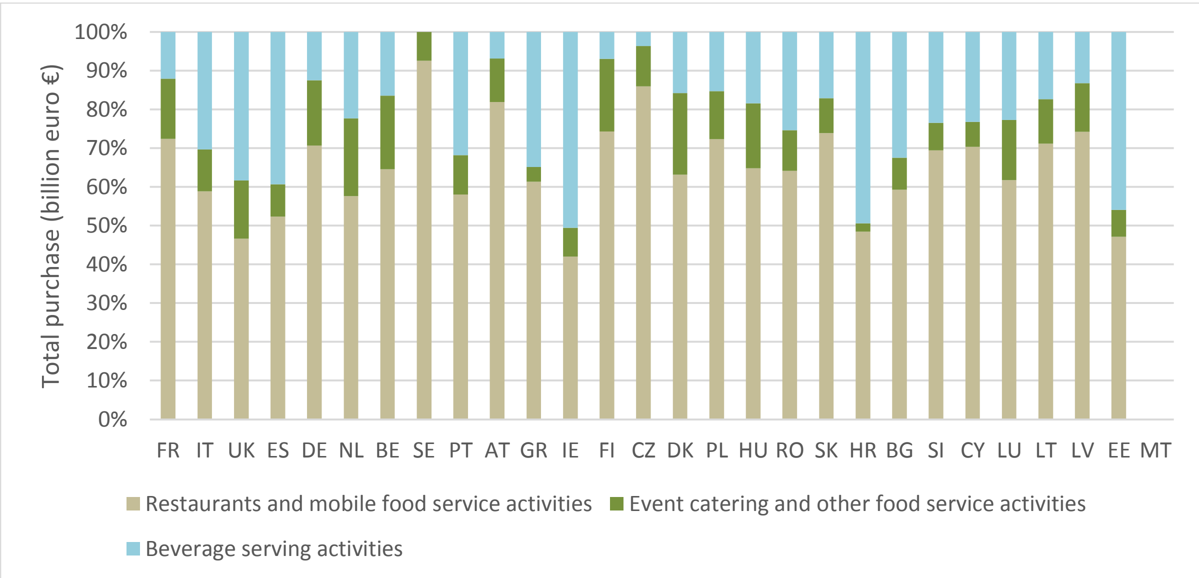

Figure 7: Total purchase cost per Member State (2011), split between the three sub-categories of 'Food and Beverage Service Activities' (Source: Adapted from Eurostat Structural Business Statistics)

In 2012 '*Food and Catering Service Activities*' involved more than 1.5 million enterprises, the sector had a total turnover of approximately €354 billion, and employed 8 million people[20], (Table 28). Table 27 shows the same information, but for 2008. The values are accumulated from all Member States of EU-28.

Between 2008 and 2012 'Restaurant and Mobile Service Activities' sector has had an increase of enterprises (+10.9 %), employees (+12.2 %) and turnover (+16 %). A similar development can be seen for 'Event Catering and Other Food Service Activities' where it has been an increase in number of enterprises (+23.3 %), employees (+9.2 %) and turnover (+17.1 %). 'Beverage Serving Activities, on

[20] "Defined as the total number of persons working in the various industries: employees, non-employees (e.g. family workers, delivery personnel) with the exception of agency workers" (Structural Business Statistics)

the other hand, has seen enterprises decrease (-8.1 %) and turnover decreased (-8.9 %), while the number of employees has increased (+24.1 %).

Table 27: Structure of food and beverages services, by activity, EU-28, 2008 (Source: Eurostat Structural Business Statistics)

	No. enter-prises ('000)	No. of persons employed ('000)[a]	Turnover (EUR million)
Food and beverage service activities	1 496.0	6 990.6	324 573
Restaurants & mobile food service activities	791.1	4 400.0	187 625
Event catering and other food service activities	60.1	961.7	44 396
Beverage serving activities	644.8	1 628.9	92 552

[a] Values for France are estimated based on data for previous years.

Table 28: Structure of food and beverages services, by activity, EU-28, 2012 (Source: Eurostat Structural Business Statistics)

	No. enter-prises ('000)	No. of persons employed ('000)[a]	Turnover (EUR million)[b]
Food and beverage service activities	1 543.9	8 008.3	353 823
Restaurants & mobile food service activities	877.3	4 936.6	217 560
Event catering and other food service activities	74.1	1 050.0	51 970
Beverage serving activities	592.4	2 021.7	84 293

[a] Values for Malta are estimated based on data for previous years.
[b] Values for Malta are estimated based on data for previous years.

GIRA Foodservice (2014) reports that the social foodservice market (as defined in the report includes, B&I, Educational, Health and welfare, and other services provided to public and private institutions), of all Member States in EU-28 was valued €82 billion in 2013. This estimation is based on the data of EU-15 Member States, which represent 88 % of the EU-28 total social foodservice market. This figure comprises the expenditures of both public and private organizations in B&I, Educational, Health and welfare, and other services. GIRA Foodservice (2014) report shows the volume of meals provided to public institutions, estimated to be 55 % of the total meals of the social foodservice market (data from EU-15).

2.2 Market structure

2.2.1 Contract catering market

2.2.1.1 Public bodies vs catering companies

The foodservice sector in Europe is split into markets self-operated by public bodies and markets contracted to catering companies. In 2012, contract caterers in the EU had a 35.2 % share of the total public foodservice market value (FERCO, 2012). This was an increase of 1.7 % since 2008 (when the share was 33.5 %) and had already increased 8.7 % since 2000 (based on EIRO, 2010). Figure 8 illustrates the split of public sector expenditure on food and catering between self-operating public bodies and contract caterers. A wide variation is visible between the 17 Member States. In Germany, Sweden, Finland, Denmark, and Poland public expenditure on self-operating services accounted for over 70 % of the total, whereas Spain, Portugal and Ireland accounted for less than 40 %. Contract caterers represent more than 50 % of the public expenditure in those countries, together with Luxembourg, Austria and Italy.

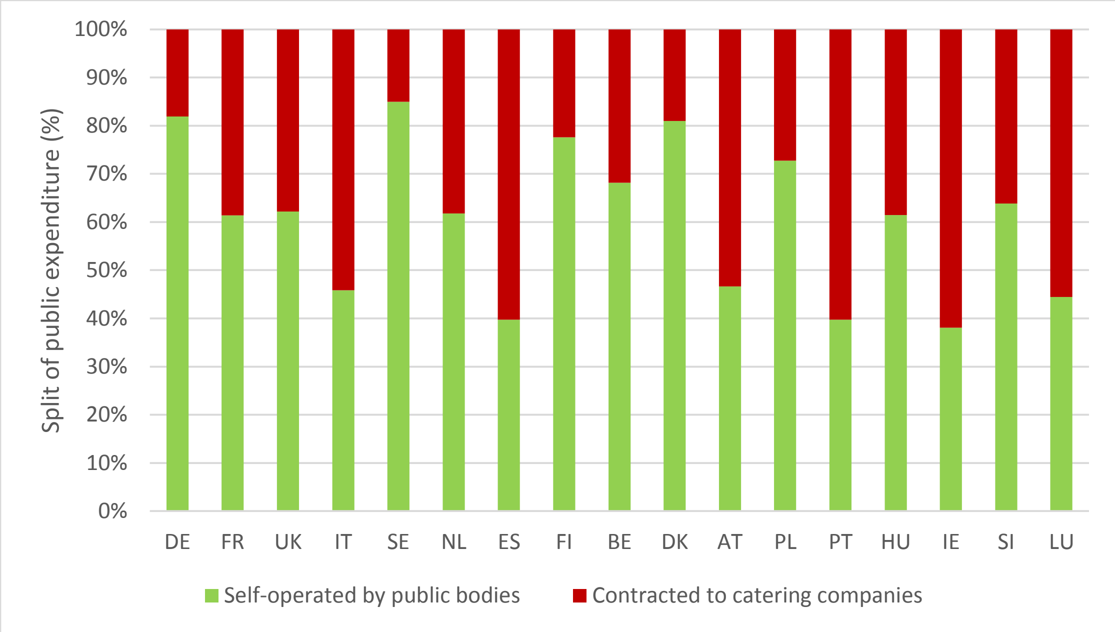

Figure 8: Split of public expenditure on food and catering services per provider (Adapted from: FERCO, 2012)

In 2008 the turnover of the total contract catering industry in the EU was €24.6 billion and around 600 000 people were employed (EIRO, 2010). Table 29 shows the breakdown of employees between Member States and between private and public sector.

Table 29: Number of employees in the European contract catering sector (Source: FERCO, 2012)

Country	Total employees	Private sector employees	Public sector employees
Austria	17 500	8 400	9 100
Belgium	8 500	5 000	3 500
France	78 026 (2010)	-	-
Hungary	60 000	20 000	40 000
Italy	100 000	50 000	50 000
Netherlands	20 000	-	-
Portugal	14 000	8 000	6 000
Slovenia	39 000	22 000	17 000
UK	114 500	59 500	55 000

2.2.1.2 Structure of the contract catering market

Specific arrangements between public sector procurers and contract caterers vary enormously from provision of 'fine dining' to the operation of vending machines and everything in between.[21] In some cases, the contractor will agree to provide a full catering service for a fixed annual fee. In other situations, the contractor may sign a 'zero cost agreement' or even pay, essentially to secure the right to sell food to customers on the public sector organisation's premises.[22] In certain situations (e.g. some of Spain's public hospitals) the contract caterer will simply help the hospital procure raw ingredients but leave the catering to in-house staff (as governed by trade union agreements).[23] This kind of 'middle-man' arrangement is not common in Hungary, where contract caterers generally

[21] Representative of a Catering Association, UK (a). Personal communication, 17 February 2015.
[22] Representative of a Catering Association, UK (a). Personal communication, 17 February 2015.
[23] Representative of a Catering Service Provider, Spain & Portugal. Personal communication, 25 February 2015.

both procure the food and provide the catering service (although in some cases, e.g. in schools, in-house staff will physically serve the food).[24] It is not always obvious to the end consumer that a third-party business is delivering the service. Often the contract caterer will simply take over existing in-house staff and equipment, with the commitment to provide the same or higher level of service at lower cost.[25]

There is currently strong competition within the catering industry as well as a high rate of market concentration in some Member States, both of which are increasing (EIRO, 2010). This has led to a development where major companies acquire smaller competitors as a way of increasing market share (EIRO, 2010). In 2008, there were three contract catering companies dominating the market in many Member States. However, there are still some more fragmented national markets, with local operators and family businesses providing a share of the catering services - such as Spain, Italy and countries in Central and Eastern Europe (EIRO, 2010). Figure 9 illustrates the extreme differences in the market share held by the top 4 contract caterers in each country in 2013. In Austria and Portugal, the top 4 accounts for 86 % of the total contract catering market, whereas, in Poland the top 4 only accounts for 14 %.

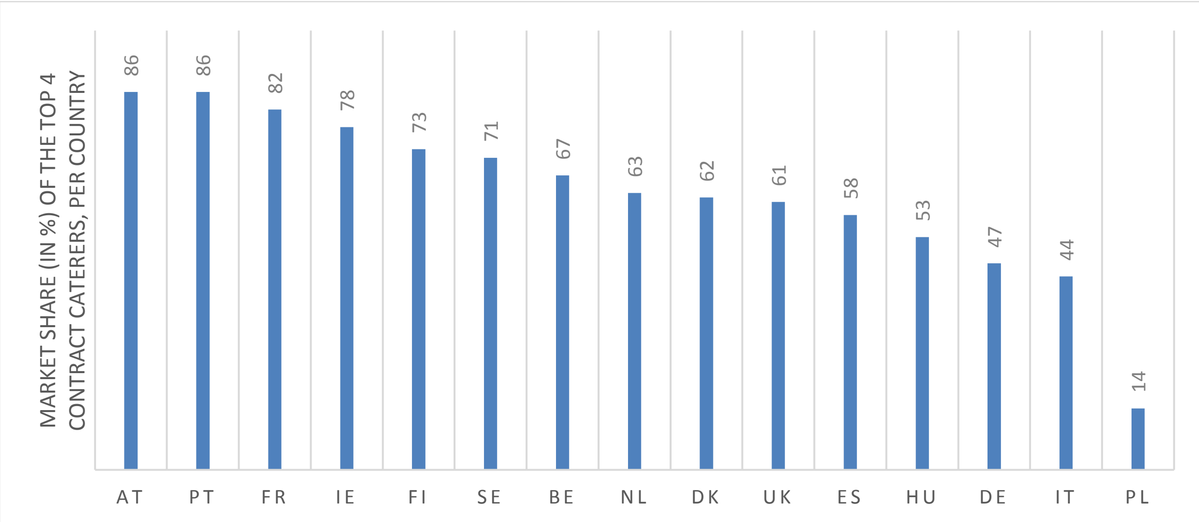

Figure 9: The market share (by financial value) of the top 4 contract caterers in each country (Adapted from: GIRA Foodservice, 2014)

Table 30 shows how the activity in the foodservice sector varies by segment and by country in terms of number of meals provided. The social foodservice market that provided to public institutions accounts for 15 % of the B&I segment (ranging from 5 % in Finland to 34 % in Belgium), for health/welfare the value is 53 % (varying from 12% in the Netherlands to 97 % in Hungary) and 78 % of the education segment consists of public institutions (ranging from 44 % in Belgium to 97 % in Finland).

[24] Representative of a Catering Service Provider, Hungary. Personal communication 10 March 2015.
[25] Representative of a Catering Association, UK (a). Personal communication 17 February 2015.

Table 30: Average breakdown of meals provided to public and private foodservice in 2013 (by volume of meals provided) (Source: GIRA Foodservice, 2014)

Country	Business and Industry (B&I)		Education		Health/Welfare		Other Segments		Total	
	Public %	Private %	Public %	Private %	Public %	Private %	Public %	Private %	Public %	Private %
Belgium	34	66	44	56	34	66	57	43	37	63
Denmark	17	83	85	15	92	8	100	0	77	23
Finland	5	95	97	3	90	10	100	0	85	15
France	20	80	77	23	52	48	43	57	56	44
Germany	11	89	63	37	35	65	100	0	36	64
Hungary	7	93	90	10	97	3	100	0	81	19
Ireland	6	94	92	8	85	15	100	0	52	48
Italy	13	87	78	22	58	42	61	39	57	43
Netherlands	19	81	77	23	12	88	100	0	27	73
Poland	6	94	95	5	90	10	100	0	82	18
Spain	10	90	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sweden	13	87	82	18	80	20	100	0	76	24
UK	18	82	75	25	60	40	90	10	60	40
Total	**15**	**85**	**78**	**22**	**53**	**47**	**74**	**26**	**55**	**45**

2.2.1.3 Food and catering service per public sector – stakeholder feedback

Business and Industry (B&I)

Contract caterers are particularly evident in staff canteens. In the UK for instance, 80-90 % penetration is reported by two stakeholders[26,27]. FrozenFoodEurope (2014) reports that in the German B&I sector, 62 % of the sales volume falls to the classical warm midday meals and this is regarded as an employee's benefit and the company typically provides a subsidy. The remaining 38 % is classified as 'in-between' meals, e.g., snacks and snack drinks and companies can make a profit on these items. In Finland, contract catering – which has developed since 2000 - is still not widespread, due in part to political resistance. Currently it is almost entirely restricted to provision of meals in staff canteens[28].

Education (schools and higher education)

As a whole, contract caterers are less evident in schools. For instance, in the UK, around one third of schools outsource catering.[29] However, arrangements for provision of food in schools vary with the type of institution. In the state-run primary school sector, a Local Authority will procure catering via a single contract covering perhaps 200 to 300 sites.[30] These contracts may be won either by a public-owned entity or by one of eight or nine private contractors.[30] A similar model exists in France, Italy and Spain[31]. By contrast, individual academy[32] schools (or a small cluster) in the UK are able to select

[26] Representative of a specialised magazine, UK. Personal communication, 24 February 2015.
[27] Representative of a Catering Service Provider, UK (b). Personal communication, 6 March 2015.
[28] Representative of a local government, Finland. Personal communication, 27 February 2015.
[29] Representative of a specialised magazine, UK. Personal communication, 24 February 2015.
[30] Representative of a Catering Service Provider, UK (b). Personal communication, 6 March 2015.
[31] Representative of a Catering Service Provider, UK (b). Personal communication, 6 March 2015.

their own caterer, independent of Local Authority control, as can secondary state schools which have 'delegated budgets'.[31] Contract catering is also rare in Ireland's schools, with private caterers active in boarding schools only.[33] There is some evidence of contract catering in the Netherlands, with about 50 % of secondary school canteens operated by small private sector organisations, but the meals offered are simple.[34]

In Germany, contract catering in schools is reportedly a new phenomenon with a low rate of penetration by the private sector and a preponderance of independent not-for-profit actors.[35,36] As in the Netherlands, a substantial proportion of students may go home for lunch.[31] A similar tradition is seen in Poland.[37] In Spain, the picture is rather unusual with all non-teaching functions carried out by third-party contractors including supervision of students at playtime, during travel to and from school and during meal times. Thus, one large contract caterer reports that, of its 18 000 employees, approximately half act as supervisors (*monitores*).[38] In Hungary, the involvement of the private sector in schools is relatively high at 55 %, with the main market being the provision of food to the younger age group (3-15 years).[37]

The penetration of the higher education market by contract caterers is highly variable across Europe. In some Member States (e.g. France, Finland, Germany[39]) food service in universities is provided by nationwide public or not-for-profit organisations. However, in the Netherlands private caterers supply 100 % of the university and colleges (18+ year-old) market.[34] Universities in Ireland employ around 90 % external contractors.[33]

On-site preparation is making a return in UK schools - with the exception of some remote rural schools which might have their meals prepared elsewhere, perhaps at a nearby secondary school, and brought in at lunchtime.[40] Elsewhere in Europe (e.g. Germany[35]), off-site preparation is relatively common in the schools sector for cost-reduction reasons. FoodServiceEurope (2013) reports that low prices remain the most important criterion for eating at a university restaurant and that, over recent years, expectations have risen in terms of the demand for a professional service. The report also stresses that, more than any other segments of society, university students tend to prefer organic, healthy cuisine.

Sweden contrasts with other Member States in that only around 20 % of food and catering contracts are undertaken by private enterprises. The bulk of preparation is instead done by the municipalities themselves, using their own employees, within on-site kitchens.[41] Sweden's universities are unusual in that the bulk of student catering is provided by a country-wide cooperative, although franchises provide additional meals on certain campuses.[41] In Finland most schools, day-care centres, social services and larger hospitals are wholly responsible for their own food service.[42] A local stakeholder

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[32] Academy schools are primary and secondary schools in England, UK, directly funded by central government and independent of direct control by the local authority.
[33] Representative of a Catering Association, Ireland. Personal communication, 9 March 2015.
[34] Representative of a Catering Association, Netherlands. Personal communication, 6 March 2015.
[35] Representative of an Institute, Germany. Personal communication, 6 March 2015.
[36] Representative of a Catering Service Provider, UK (and internationally). Personal communication, 9 March 2015.
[37] Representative of a Catering Service Provider, Hungary. Personal communication, 10 March 2015.
[38] Representative of a Catering Service Provider, Spain & Portugal. Personal communication, 25 February 2015.
[39] *In Germany, it is illegal for universities to outsource food service* (Representative of a Catering Service Provider, UK (and internationally). Personal communication, 9 March 2015).
[40] Representative of a specialised magazine, UK. Personal communication, 24 February 2015.
[41] Representative of a Governmental Authority, Sweden. Personal communication, 25 February 2015.
[42] Representative of a local government, Finland. Personal communication, 27 February 2015.

reports that, in 2011, only 14 % of Finnish catering services to schools, day-care centres, hospitals, and social services came from private sector with the rest supplied by the public sector - usually a municipality-owned public utility.[43] As in other parts of Europe, including Sweden and France, food provision within the universities in Finland is the responsibility of a single catering organisation, among which a relevant organisation specialised in very low priced meals for students.[44]

Health sector

Within the UK, one stakeholder[45] reports that 15-20 % of patient meals are provided by contract caterers, but another[46] estimates that 40 % are outsourced. These contractors generally procure meals which have been prepared by themselves or by specialist manufacturers in off-site central production units. Relevant contract caterers are active in Germany's hospitals, with meals produced off-site by a specialist ready-meal manufacturer [47] In Hungary, dominant contract caterers are responsible for around 40 % of patient meals in the larger hospitals, but smaller sites (e.g. 60-100 patients) tend to prepare their own food.[48] In the Spanish hospital system, contract caterers have failed to get much of a foot-hold due to trade union resistance, and their function is restricted to supplying raw ingredients into hospitals. However, an industry expert predicts that, over time, third-party involvement is likely to grow in the Spanish health sector. In the Netherlands, contract caterers have so far been excluded from the preparation of patient meals in the health system, hospital managers arguing successfully that they are better placed to meet patients' dietary needs, although this is unsurprisingly disputed by private providers.[49] Contract catering is also rare in Ireland's health service, with one stakeholder estimating that 90 % of food provision is undertaken in-house.[50]

Within the health sector across Europe, the predominant preparation method for patient meals is now the off-site, cook-chill, plated meal system – although specific arrangements vary widely.[46] For instance, in one English city, a single central production unit (CPU) caters for eight different hospitals. In the Netherlands, twelve separate hospitals have joint-funded a single CPU[46] and, in a city in Germany, one CPU serves eleven sites.[47]

Visitors to hospitals in Ireland, and employees, are price sensitive and prefer lower priced food. However, if the food provided is of higher quality or greater convenient (grab-to-go), they are willing to pay extra. For patients, the operators focus on providing menus that are healthy and with balanced nutrition (Bord Bia, 2014). However, as budgets are tightened, it is important to keep the cost of food down. In Ireland this is done by having long-term contracts and using central kitchens to provide the foodservice (Bord Bia, 2014).

Social care

With people generally living longer across Europe, the elderly care market represents an attractive target market for contract caterers, manufacturers and suppliers. However, in social care settings, contract catering still tends not to be the norm. In Spain, for instance, the main obstacle is the philosophy of care providers that feeding the residents (or enabling the residents to cook for

[43] Representative of a local government, Finland. Personal communication, 27 February 2015.

[45] Representative of a specialised magazine, UK. Personal communication, 24 February 2015.
[46] Representative of a Catering Association, UK, (b). Personal communication, 18 February 2015.
[47] Representative of an Institute, Germany. Personal communication, 6 March 2015.
[48] Representative of a Catering Service Provider, Hungary. Personal communication, 10 March 2015.
[49] Representative of a Catering Association, Netherlands. Personal communication, 6 March 2015.
[50] Representative of a Catering Association, Ireland. Personal communication, 9 March 2015.

themselves) is a core principle, and this function is less likely to be outsourced in the future.[51] The situation is the same in the Netherlands[49] and Ireland[50]. Contract catering is also almost unheard of in the UK social care sector, since most residential homes employ in-house teams to prepare meals. Private sector involvement is therefore largely restricted to the community meals service, where businesses manufacture ready-meals for delivery to consumers' homes.[52] It is predicted that any future role for the contract caterers might be solely in top-level management of catering staff rather than direct involvement in day-to-day food preparation.[52] Despite this, at least one multinational contract caterer is in talks with some of the larger providers of social care in Spain, France and the UK.[53]

Within the social care sector in the UK[52], Spain[51] and in much of Europe, on-site preparation from raw, fresh ingredients is the primary provision model. The exception is when meals are delivered 'in the community' (i.e. 'meals on wheels' services). Fresh, traditional preparation may be viewed as an integral aspect of 'care' by those operating residential homes.[54] Residents generally expect food to be 'home cooked'.[55] It may be that the widely dispersed nature of residential homes makes the model of a central kitchen serving multiple sites (as in certain health systems) less viable[55], although this is debatable given that manufacturing companies are able to make meals for sites across wide regions of the UK. Furthermore, in the UK at least, ready-to-eat delivered meals seem popular with the private care home sector.[56] An interviewee from a large contract caterer suggested that the 'meals on wheels' market is likely to develop with retired people who are not ready to move into residential care but would like 'help at home'. In France, for instance, the average age at which people enter a residential home is now 87, with those in their late-70s to mid-80s preferring to stay at home.[57]

According to a Finnish stakeholder, the private sector is seeking to gain a foothold in other social food settings, but it is not clear whether it will succeed. A recent example was cited of a contract caterer which had been brought in to provide food in a care home, but then was dismissed and public provision resumed.[58] Another Finnish stakeholder observed that the size of public procurement across all subsectors was growing with centralized procurement activity also increasing.[59] The picture across the rest of Scandinavia is variable, with contract catering achieving a greater foothold in Denmark.[60]

Other sub-sectors (Defence and Prisons)

The UK is unusual in that contract caterers are responsible for almost 100 % of the food provided in Ministry of Defence sites in the UK. 'In-house' chefs only occur in the field.[61] The large share of outsourcing may be a legacy of the Second World War during which the first contract catering companies were formed to make and serve food in large quantities.[62] Elsewhere the private sector

[51] Representative of a Catering Service Provider, Spain & Portugal. Personal communication, 25 February 2015.
[52] Representative of a local government, UK. Personal communication, 26 February 2015.
[53] Representative of a Catering Service Provider, UK (and internationally). Personal communication, 9 March 2015.
[54] Representative of a Catering Service Provider, Spain & Portugal. Personal communication, 25 February 2015.
[55] Representative of a local government, UK. Personal communication, 26 February 2015.
[56] Representative of a Catering Service Provider, UK (a). Personal communication, 27 February 2015.
[57] Representative of a Catering Service Provider, UK (and internationally). Personal communication, 9 March 2015
[58] Representative of a local government, Finland. Personal communication, 27 February 2015.
[59] Representative of a Business Organisation, Finland. Personal communication, 5 March 2015.
[60] Representative of a Governmental Authority, Sweden. Personal communication, 25 February 2015.
[61] Representative of a specialised magazine, UK, Personal communication, 24 February 2015.
[62] Representative of a Catering Service Provider, UK (b), Personal communication, 6 March 2015.

has made less of an impact. In the Netherlands, for instance, a state-owned company caters for military personnel. However, private contractors are hopeful of gaining a foothold in the Dutch market.[63] In France[64] and Hungary (and other countries in central Europe)[65], no contract caterers operate in the defence sector. In the Finnish defence forces, the main catering organisation has been since 2012, wholly state-owned (although it was previously part of the defence forces, so no real change has occurred). It provides over 70 000 meals per day, although some services are provided in conjunction with a private company.[66]

The presence of contract catering is variable in the prison sector. Private companies are providers in some UK prisons[67], with some not only providing food but also building and running the prison[57]. In-house provision is more usual in the older jails.[68] In the Netherlands too, contract caterers are responsible for prison catering (even though all prisons are public).[63] Outsourcing is also reportedly common in French prisons[65] but is rare in Ireland[69] and Hungary[65]. Traditional on-site preparation continues to be the norm in prisons across Europe since inmates provide a ready source of cheap labour.[70]

In Irish prisons, costs cannot increase and operators are putting effort into increasing quality where possible. One method of controlling costs is to have a programme of central/collective buying (similar to that in education and healthcare (Bord Bia, 2014).

Alternative catering services providers

A variety of external not-for-profit enterprises sometimes supplant the role of the private contract caterers. In some parts of southern Europe (e.g. Italy, Spain, Portugal), religious organisations (i.e. the Catholic Church) play a prominent role in providing catering services for the education establishments (e.g. schools, universities) which they run[71]; although such examples are arguably beyond the scope of public sector procurement.

In Italy 'cooperatives' are key food providers within the public sector, consisting in an arrangement which is rather unusual in Europe.[72] Italy, as well as Germany, evidences not-for-profit organisations. In Germany, these not-for-profits take the form of independent GmbHs[73] and cater for business and industry canteens[74] along with schools and universities In Hungary and other parts of Central and Eastern Europe, not-for-profits appear rare[75].

It should also be noted that, in Germany (and certain other large European countries) the application of VAT to outsourced services acts as a significant barrier to the involvement of contract caterers. As

[63] Representative of a Catering Association, Netherlands. Personal communication, 6 March 2015.
[64] Representative of a Catering Service Provider, UK (b), Personal communication, 6 March 2015.
[65] Representative of a Catering Service Provider, Hungary. Personal communication, 10 March 2015.
[66] Representative of a local government, Finland. Personal communication, 2 March 2015.
[67] Representative of a specialised magazine, UK, Personal communication, 24 February 2015.
[68] Representative of a Catering Service Provider, UK (b), Personal communication, 6 March 2015.
[69] Representative of a Catering Association, Ireland. Personal communication, 9 March 2015.
[70] Representative of a Catering Association, UK (a). Personal communication, 17 February 2015.
[71] Representative of a Catering Service Provider, UK (and internationally). Personal communication, 9 March 2015.
[72] Representative of a Catering Service Provider, Spain & Portugal. Personal communication, 25 February 2015.
[73] Gesellschaft mit beschränkter Haftung, i.e. company with limited liability
[74] Representative of an Institute, Germany. Personal communication, 6 March 2015.
[75] Representative of a Catering Service Provider, Hungary. Personal communication, 10 March 2015.

evidence for this link, one stakeholder points to Norway, where there is a 24 % VAT rate and no outsourcing at all: 'it is a 24 % barrier to entry'[76]. In Hungary, the VAT rate is higher still at 27 %.[75]

2.2.2 Market segmentation by type of public food and catering service

GIRA Foodservice (2014) provides a breakdown of the social foodservice sector by segment (Table 31). The analysis shows that over 18 billion meals were served in these 15 countries in 2013 and again there is significant variability by country and by segment. Across the 15 countries, health/welfare represents the most significant segment accounting for an average 42.7 % of the total meals served (ranging from 27.3 % in Ireland to 57.4 % in Belgium). A report on France stated that the sector remained strong through the recession because of a steady demand from an ageing population (GAIN, 2012). This observation would be relevant across many of the EU countries. Education is the second most significant segment accounting for an average 31.4 % (ranging from 14 % in the Netherlands to 57.4 % in Sweden).

Table 31 shows the breakdown of the average cost of meals by sector, which is a rough estimation that might vary within a wide range of values.

Table 31: Average breakdown of Social Foodservice market by segments in 2013 by number of meals (Source: GIRA Foodservice 2014).

Country	B&I		Education		Health/welfare		Other segments		Total
	Million meals	**% of total**	**Million meals**	**% of total**	**Million meals**	**% of total**	**Million meals**	**% of total**	**Million meals**
Austria	72	26.2	54	19.6	119	43.3	30	10.9	275
Belgium	88	18.1	87	17.9	279	57.4	32	6.6	486
Denmark	66	17.1	120	31.0	182	47.0	19	4.9	387
Finland	55	10.8	271	53.3	159	31.3	23	4.5	508
France	436	12.0	1 223	33.5	1 644	45.1	345	9.5	3 648
Germany	974	28.2	683	19.8	1 679	48.6	116	3.4	3 452
Hungary	100	14.2	357	50.9	204	29.1	41	5.8	702
Ireland	85	45.5	39	20.9	51	27.3	12	6.4	187
Italy	228	14.6	438	28.0	627	40.1	269	17.2	1 562
Netherlands	250	29.4	119	14.0	445	52.3	37	4.3	851
Portugal	28	9.3	104	34.7	139	46.3	29	9.7	300
Poland	118	13.1	202	22.4	404	44.8	178	19.7	902
Spain	71	7.3	256	26.2	509	52.0	142	14.5	978
Sweden	72	8.5	484	57.4	268	31.8	19	2.3	843
UK	625	18.9	1 320	40.0	1 124	34.1	231	7.0	3 300
Total	**3 267**	**17.8**	**5 756**	**31.4**	**7 832**	**42.7**	**1 504**	**8.2**	**18 359**

[76] Representative of a Catering Service Provider, UK (and internationally), Personal communication, 9 March 2015.

Table 32: Breakdown of Social Foodservice market by segments in 2013 by expenditure (Source: GIRA Foodservice 2014).

	B&I	Education	Health/welfare	Other segments
Average meal cost (EUR/meal)	5.14	3.16	4.18	3.19

Table 33 shows consumer spending and the purchasing cost of food for the foodservice operator in Ireland, for 2014, with a forecast for 2017. Consumer spending is expected to increase slightly in all sectors, but 'Education' will grow fastest, at almost 6%. For operator purchasing, 'Education' is expected to increase most (circa 5.1 %).

Table 33: Consumer spending and operator purchasing of foodservice, current levels at 2014 and forecasts to 2017 (Bord Bia, 2014)

Irish Institutional Foodservice Market	Consumer spending (€M) Year 2014	Operator Purchasing (€M) Year 2014	Consumer Spending (€M) Year 2017	Operator Purchasing (€M) Year 2017
B&I	283	136	289	139
Health	224	114	229	116
Education	138	59	146	62
Other institutional	38	19	39	20
Total	€638	€328	€703	€337

In the public sector in the UK 'Education' provides most meals per year. However, it is 'Services' and 'Staff Catering' that provide the most meals per outlet. (Outlet being the place of consumption of meals). This is illustrated in Table 34.

Table 34: The UK foodservice market in 2013 (Source: Adapted from Horizons data in GAIN, 2014a)

	Number of outlets	Number of meals (million)	Average number of meals per outlet per year
Staff catering	17 960	787	43 820
Health care	32 116	986	30 700
Education	34 308	1 094	31 887
Services	3 071	257	83 690
Total	**87 455**	**3 124**	**35 720**

2.2.3 Food and catering service supply chain

2.2.3.1 Overview of a general supply chain

The supply chains of food products and catering services are rather complex, but Figure 10 attempts to summarise the main features in a simplified manner. For most products the main stages do not vary whether the food is used for self-operation by public bodies (in-house food service) or by contract caterers. Differences first become apparent where the catering service starts (i.e. when food is prepared and served to end-consumers). For instance, in some cases contract caterers undertake the whole service; in others only parts of the service. In some cases they operate in the customer's facility, in others in their own (e.g. in a central facility). Note that Figure 10 indicates that all actors buy their food products from wholesale: this is a simplification of the supply chain and may not be true for food products with a short shelf life for instance (e.g. milk or meat) - that may be bought direct from the producer/processor. In Ireland, as an example, it is reported that around 85 % of food is supplied through the traditional wholesale route and 15 % through emerging 'buy direct' routes.

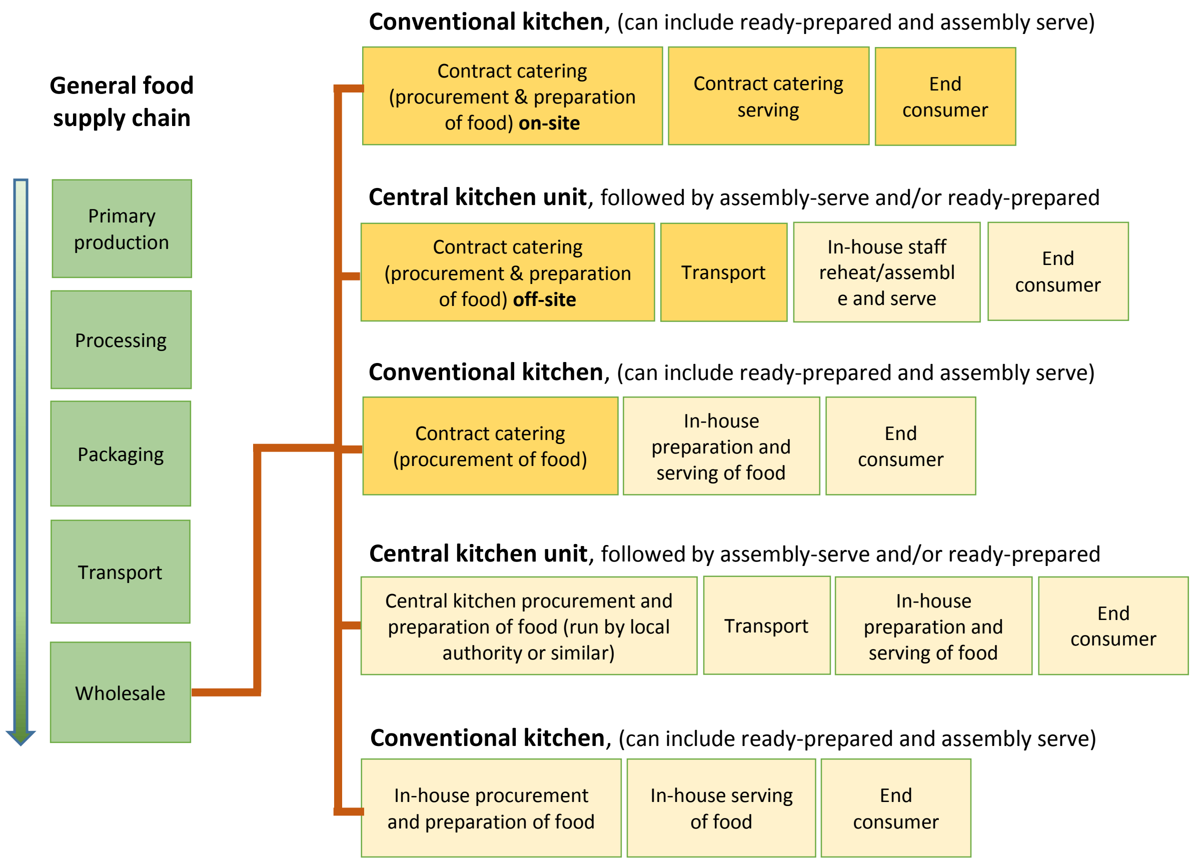
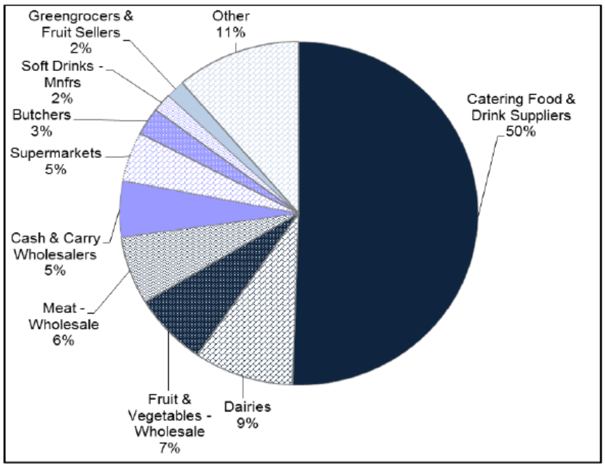


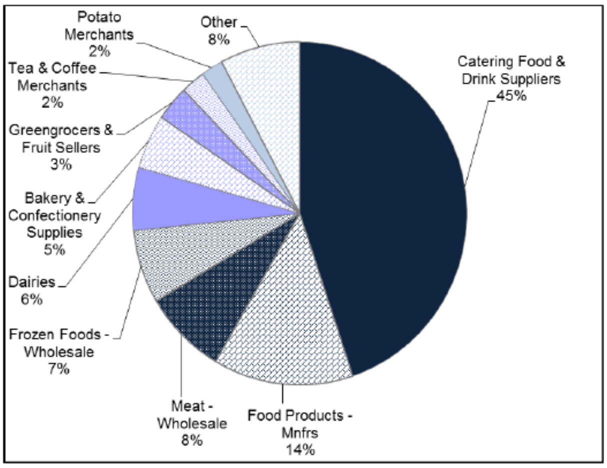
Figure 10: A general food supply chain and different forms of catering service supply chains (using different food systems, the dark yellow colour shows those stages carried out by the catering service companies and the light yellow colour the ones carried out by the public authorities)

In the UK there are three main ways for foodservice operators to obtain food: delivered from wholesale, through contract distributors, and through cash & carry wholesalers (Food Ethics Council, 2009). Other suppliers (such as local bakers or butchers) may be used for fresh produce and specialist distributors are sometimes used for products like coffee, snacks and cheese (Food Ethics Council, 2009).

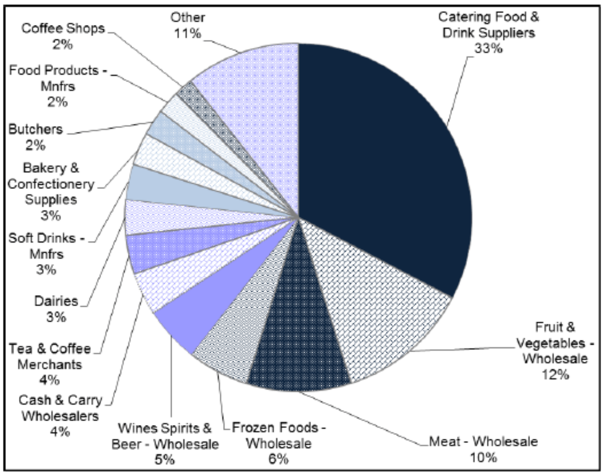
Figure 11 shows a breakdown of food procurement for food and food services in five public sectors in Scotland (namely, local authorities; NHS health boards; colleges and universities; central governments and governmental agencies; and prison services), and highlights the significant differences in what kind of food and foodservice the different sectors procure. It is evident that Local Authorities and the NHS (health sector) procure a large proportion of their food and drink from catering suppliers. Colleges and universities also procure a large share from caterers, but not as large. Prisons do not procure any food and drink from caterers, according to this study. In summary this shows that, although the traditional supply of products through the wholesalers is still prevalent, there is significant activity in buying products direct from the producers.



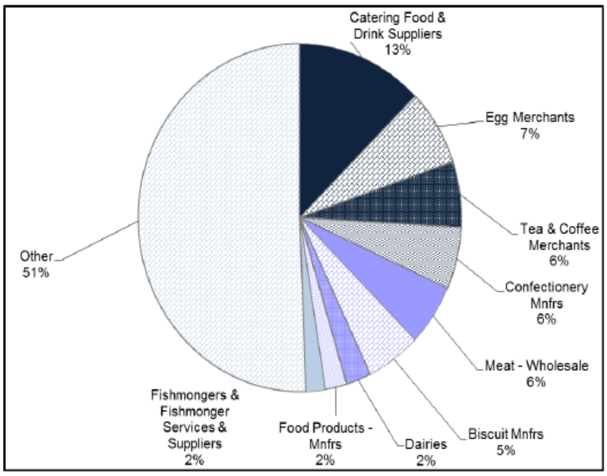
Local Authorities



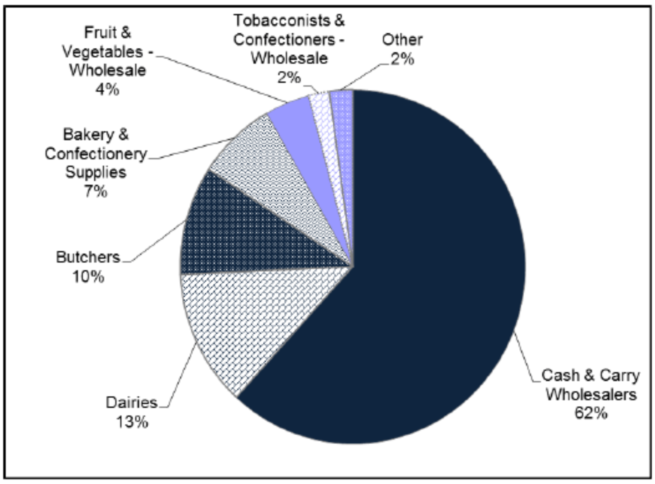
NHS Health Boards



Colleges & Universities



Central Governments and Governmental Agencies



Prison Service

Figure 11: Proportion of total expenditure divided by sector (2012-13) (The Scottish Government, 2014)

To have food delivered through wholesale is the most common channel. However, for large operators, contract distribution (in which the distributor only transports the produce and do not take ownership of it) is also common. Small independent foodservice operators are the ones that use cash & carry (Food Ethics Council, 2009).

2.2.3.2 *Food production per food product*

Data in this section is mainly gathered from the Eurostat PRODCOM database and focuses on the main product groups (produced and consumed). Figures C.1 to C.11 in Appendix C show the production in EU. All values are shown for EU-28, even though values are from 2012 when Croatia was still not a member of the EU.

Fish and seafood: The total production of aquaculture products in the EU-28 in 2012 was 1 million tonnes and was dominated by Spain, United Kingdom, France and Italy (Figure C.1). The UK was the main producer of farmed salmon and captured the largest weight of wild salmon (Figure C.5 and Figure C.6). Outside the EU, Norway is a major producer of farmed fish and its production weight in 2012 was even larger than the EU-28 total of cultivated fish (Figure C.1). As for the total wild capture of fish and seafood, the EU-28 produced 4 million tonnes in 2012; Spain, the UK and Denmark produced the most (Figure C.2). Spain and France caught the most tuna (including bonitos and billfishes) (Figure C.3). Finally, cod (incl. hakes and haddock) were caught mostly by Spain, the UK and France (Figure d). Between 2008 and 2011, the EU was 45 % self-sufficient in seafood. The EU produces enough flatfish and small pelagics for its own consumption, but is dependent on imports for salmon, cod and tuna (European Commission, 2014b). Norway is the major supplier of salmon and cod and the main suppliers of tuna are Ecuador, Mauritius and Thailand (European Commission, 2014b).

Meat: In 2012 the EU-28 produced 22 million tonnes of pig meat, 9.5 million tonnes of chicken meat and 7.6 million tonnes of bovine meat. Germany dominated the production of pig meat and Spain was the second largest producer (Figure C.9). France was a major producer of bovine meat followed by Germany and Italy (Figure C.7). The United Kingdom was a major producer of chicken meat, followed by Poland and Spain (Figure C.8).

Milk and dairy products: In 2012 the EU-28 produced almost 154 million tonnes of milk. Germany and France produced most (Figure C.10), but Denmark, Finland and Sweden exhibited the greatest output of milk per cow (i.e. had the highest productivity). The range between the lowest productivity (Croatia) and the highest (Denmark) was 3 250 to 8 780 tonnes per cow (Figure C.11). Only a small proportion of all milk produced is used as drinking milk; a large part is used for cheese and butter (see Figure 12).

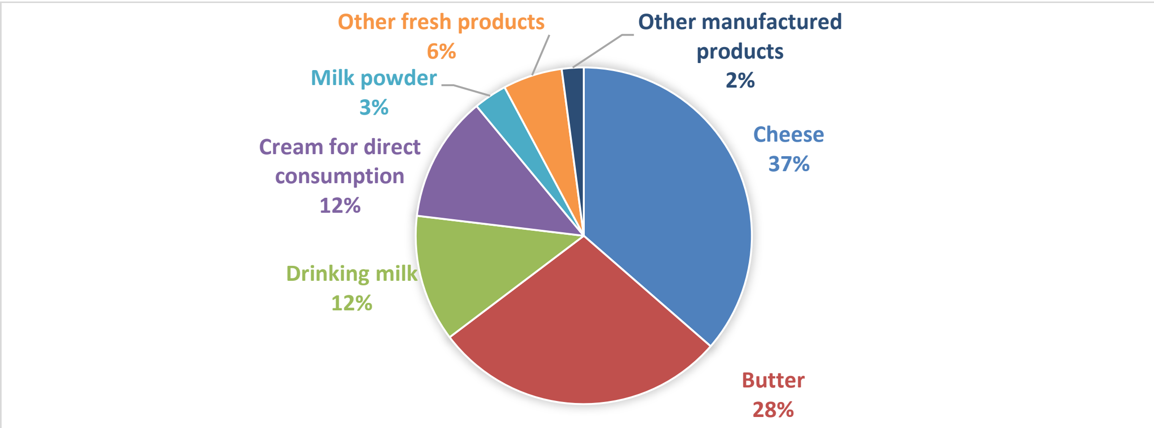


Figure 12: Utilization of whole milk in the EU-28 (2013) (Eurostat Statistics Explained, 2015)

Fruit: Figure 13 shows the fruits with the highest total harvest tonnage in the EU in 2012, dominated by apples and oranges. In 2012, the EU-28 produced a total of 30.5 million tonnes of fruits (aggregated of the fruit types in Figure 13).

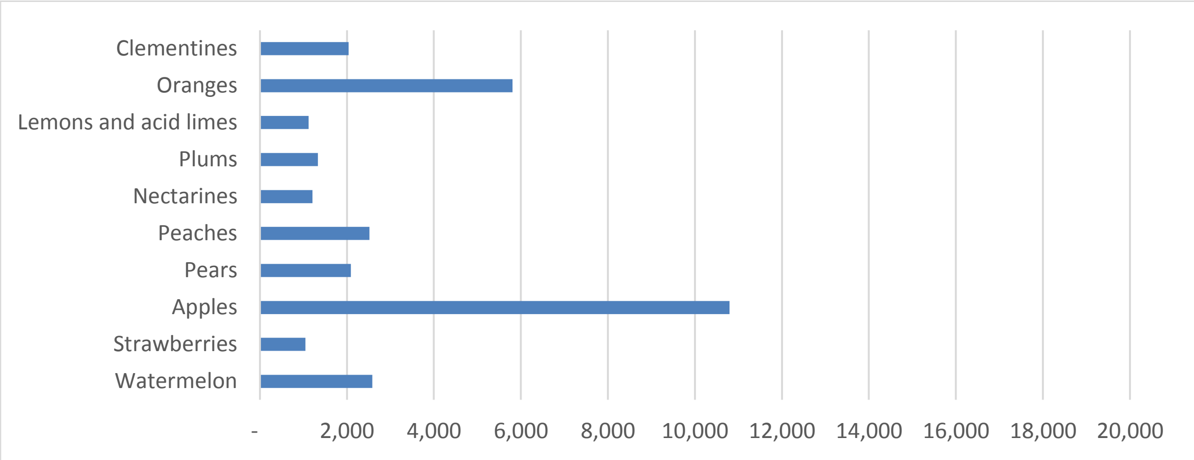


Figure 13: Harvested production of fruit in the EU (2012) ('000 tonnes)

Vegetables: Figure 14 shows the vegetables with the highest total harvest tonnage in the EU in 2012. Tomatoes, onions and carrots dominate. The total EU-28 production of vegetables was 41 million tonnes (aggregated of the vegetable types in Figure 14).

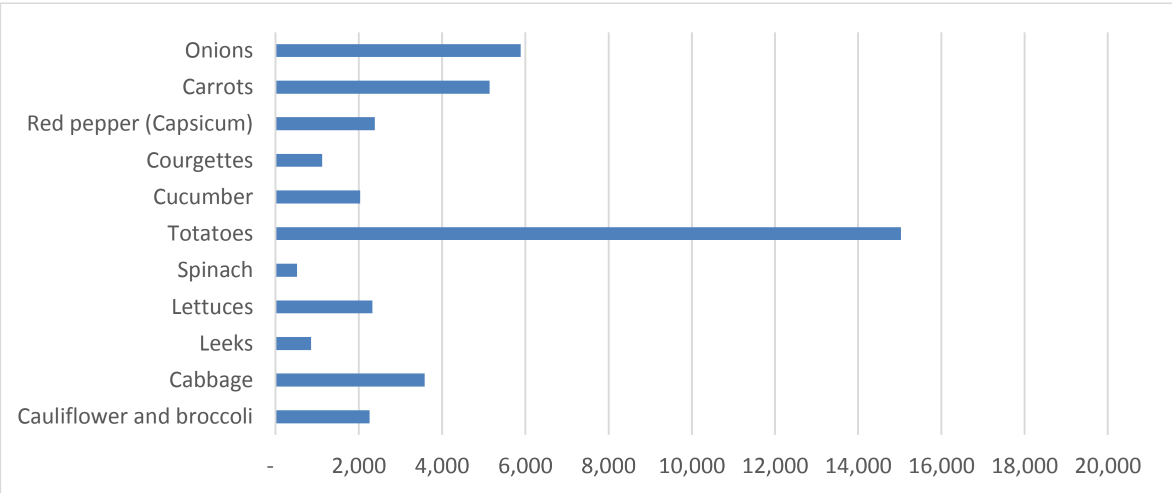


Figure 14: Harvested production of vegetables in the EU (2012) ('000 tonnes)

Cereals, potatoes and rice: Other food products important to consider are shown in Figure 15. Wheat, potatoes and barley are the largest food products in terms of tonnage. It is clear how important these three foods are in comparison to fruit and vegetables. 15 million tonnes of tomatoes and almost 11 million tonnes of apples were harvested in 2012, compared to 134 million tonnes of wheat, almost 54 million tonnes of potatoes and 55 million tonnes of barley. As for cereals in total, there were 287 million tonnes produced in the EU in 2012 (FAOSTAT, 2015), visible in Figure 16.

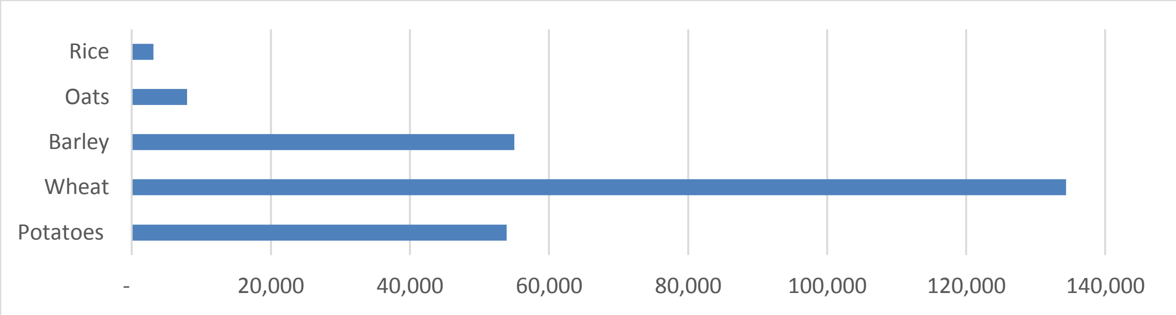


Figure 15: Harvested potatoes, rice and grains in the EU (2012) ('000 tonnes)

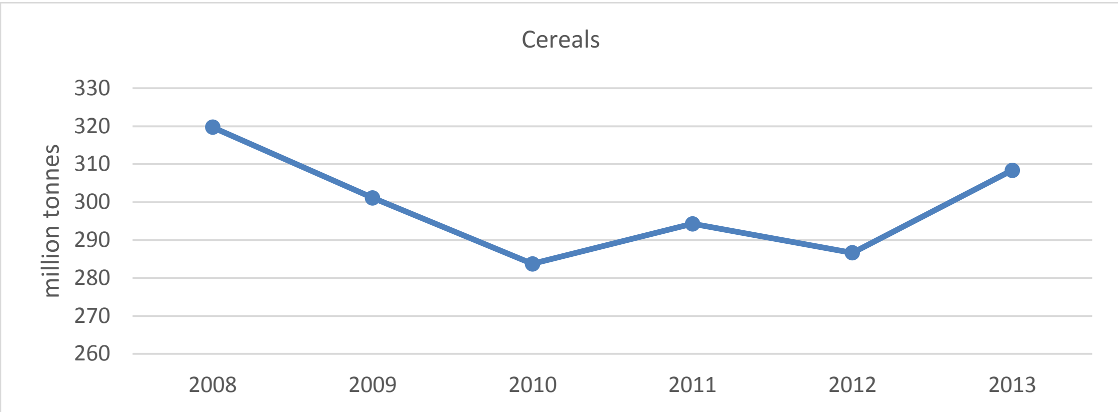


Figure 16: Volume of produced cereals between the years 2008-2013 (FAOSTAT, 2015)

Eggs: In 2012 there were 6.7 million tonnes of eggs produced in the EU, visible in Figure 17.

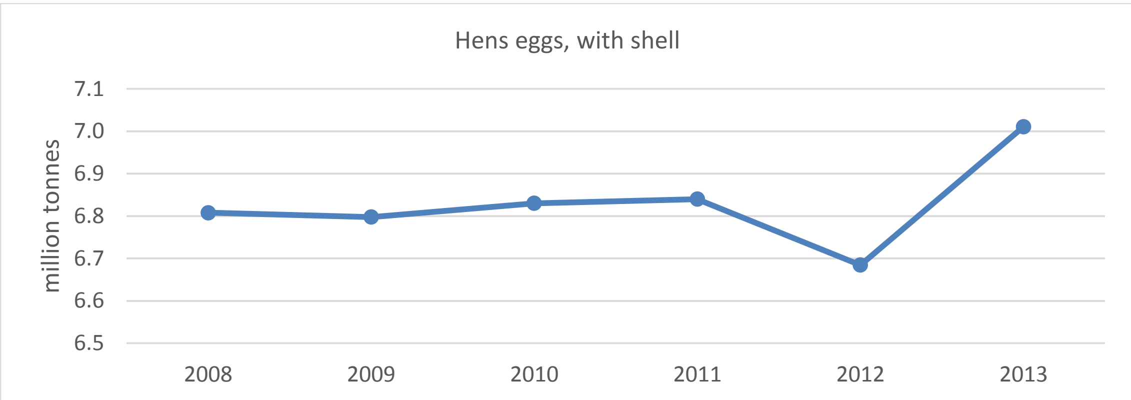


Figure 17: Production of eggs in the EU, from hens, between the years 2008-2013 (FAOSTAT, 2015)

Hot beverages: Coffee is one of the main hot beverages in the EU. Table 35 shows the production of coffee (solid matter) in the EU and it is clear that the processing stage of coffee beans is mainly taking place within the EU, as roasted coffee is far greater in size than the other types of production. The total production, however, of all types of coffee products are 6.3 million tonnes.

Table 35: Production of coffee products (solid matter), EU-28, in 2012 (Source: European Coffee Federation, based on Eurostat data)

Production	Volume (tonne)	Value (million EUR)

Decaffeinated coffee not roasted	251 680	287
Roasted coffee not decaffeinated	5 617 828	10 557
Roasted decaffeinated coffee	83 950	585
Extracts and essences of coffee	331 419	2 981
Total	6.3 million tonnes	€14.4 billion

Table 36 presents a sum up for the total production levels in million tonnes, per food category. It is visible that milk and cereals (mainly wheat) are the major food products to be produced. Fruit and vegetables together stand for 71.5 tonnes, and is thereby the third largest category.

Table 36: Summary of production volumes of some of the most common food categories in 2012

Food product/category	Million tonnes (2012)
Fruit	30.5
Vegetables	41
Fish and seafood	5 (1 farmed, 4 wild)
Meat	39.1
Milk (dairy)	154
Eggs	6.7
Cereals	287
Wheat	134
Potatoes	54
Coffee (solid matter)	6.3

Oils and fats: The EU-28 produces a large amount of vegetable oils within the Union, but also import large quantities of palm oil, as can be seen in Table 37. A third of all oil used is palm oil and the largest single oil type produced in the EU is rapeseed oil.

Table 37: EU domestic use, import and export of vegetable oils (unit: '000 metric tonnes) in 2012/13 (European Commission, 2015n).

Vegetable oils	**Rapeseed**	**Soybean**	**Sunflower**	**Palm**	**Total**
Domestic use	9,410	2,091	3,690	6,718	**21,909**
Domestic production	9,108	2,481	2,642	-	**14,231**
Import (to 3rd countries)	210	272	1,050	6,068	**7,601**
Export (to 3rd countries)	461	1,030	224	132	**1,847**

2.2.3.3 Food consumption per food product

A review of current food consumption in the world, including trends towards 2050, was conducted by Kearney (2010). It was found that, in Europe, around 30 % of the energy intake comes from cereals. Furthermore, meat is still a main part of the diet. However, the consumption of red meat is not increasing as much as pig meat and chicken. Processed products, such as burgers and sausages account for almost 50 % of total meat consumption. Consumption of eggs, cheese and butter is expected to increase while consumption of fresh milk will continue to decrease. (A similar trend was seen in the USA and the reason for the decrease is that milk has been substituted by juices and carbonated beverages.) In Europe the consumption of fish is high in, for instance, Portugal and Spain, but quite low in the UK, however the consumption is expected to rise (Kearney, 2010). In the northern EU Member States processed fish products are popular, while the southern Member States fresh seafood products are preferred (European Commission, 2014b). The consumption of potatoes is falling (Kearney, 2010). Production of fruit and vegetables is increasing, but that does not necessarily mean that consumption is. The report also found that worldwide intake of fruit and vegetables is not enough to cover the nutritional recommended intake (500 g or more per day and person), but that there has been a 50 % increase in the consumption of vegetable oils in industrial countries and thereby a decline in animal fats (Kearney, 2010).

FAOSTAT (FAO, 2011) collects a comprehensive set of global food consumption statistic data. Figure 18 shows the food supply quantity in the EU-28 for the different food categories in 2011. The data are expressed in kg/capita/year and the EU-20 population was 507.4 million.

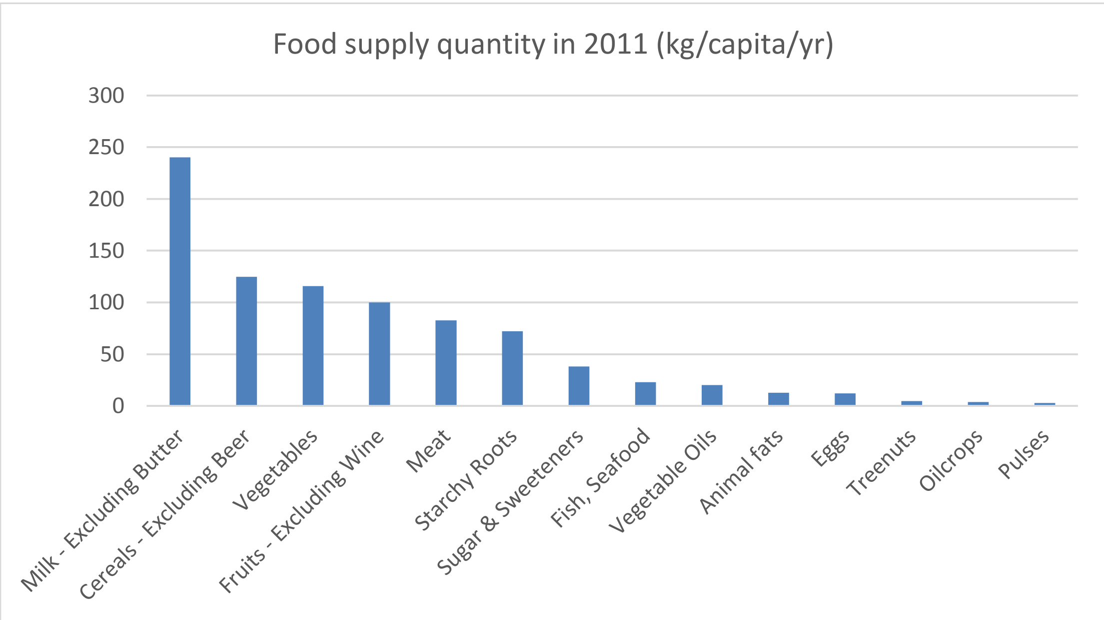


Figure 18: Food supply quantities per food product/category (Source: FAOSTAT)

As it can be observed in Figure 19 the food categories milk, cereals, vegetables, fruits, meat and starchy roots (mainly potatoes) represent almost 90 % of the yearly food intake.

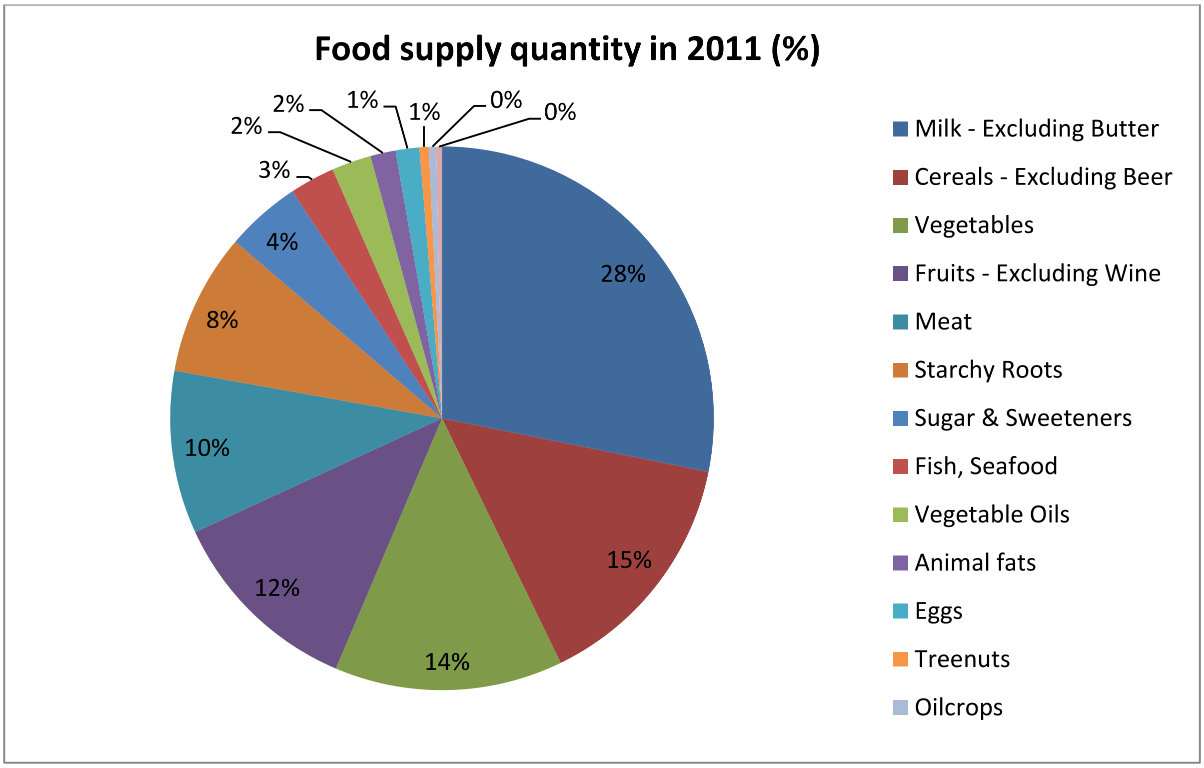


Figure 19: Food supply quantities per food product/category (Source: FAOSTAT)

It is relevant to highlight that the data from FAOSTAT do not distinguish among raw and processed food, meaning for example that the yearly intake of milk includes both milk and dairy products, except butter which is covered by the category animal fat. The category 'cereals' includes bread.

<u>Bread:</u> In 2012 there were 20 million tonnes bread sold. Despite the fact that sold is not consumed it is considered to be the same amount for the purpose of this section. Included in this summary are the two Eurostat categories 10711100: “*Fresh bread containing by weight in the dry matter state <= 5 % of sugars and <= 5 % of fat*” and 10721150: “*Rusks, toasted bread and similar toasted products*”. These are both shown in Figure 20.

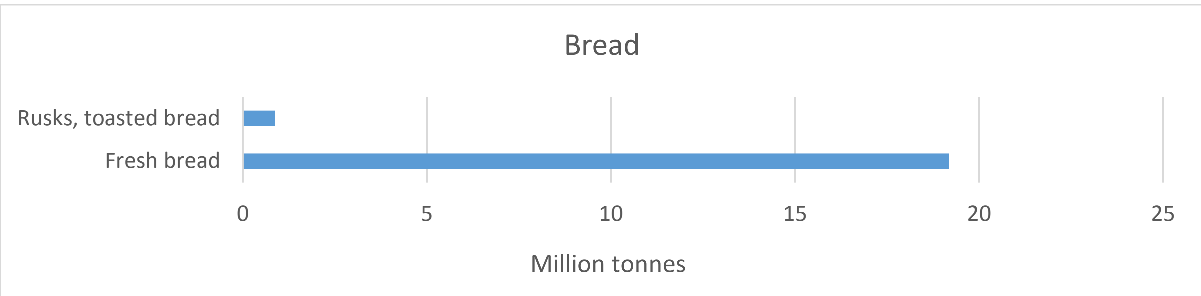


Figure 20: Volume of sold production of bread in 2012 (Source: Eurostat Structural Business Statistics)

<u>Cold beverages:</u> This section also focuses on sold volume and not consumption, but it follows the same rule as for bread. Table 38 shows that soft drinks and mineral waters are sold in much greater quantities than fruit juices. Figure 21 resumes how the Member States of EU-28 differ on the consumption of cold beverages (in 2012).

Table 38: Sold volume of cold drinks, EU-28 (Source: Eurostat – PRODCOM NACE Rev. 2)

	2011	2012
Un-concentrated orange juice	2 416	2 584
Apple juice	1 851	1 922
Mixture of fruit and vegetable juice	2 171	2 166
Mineral water	38 825	41 881
Soft drinks	33 737	36 370
Total volumes of cold beverages	79 000 million litres	84 922 million litres

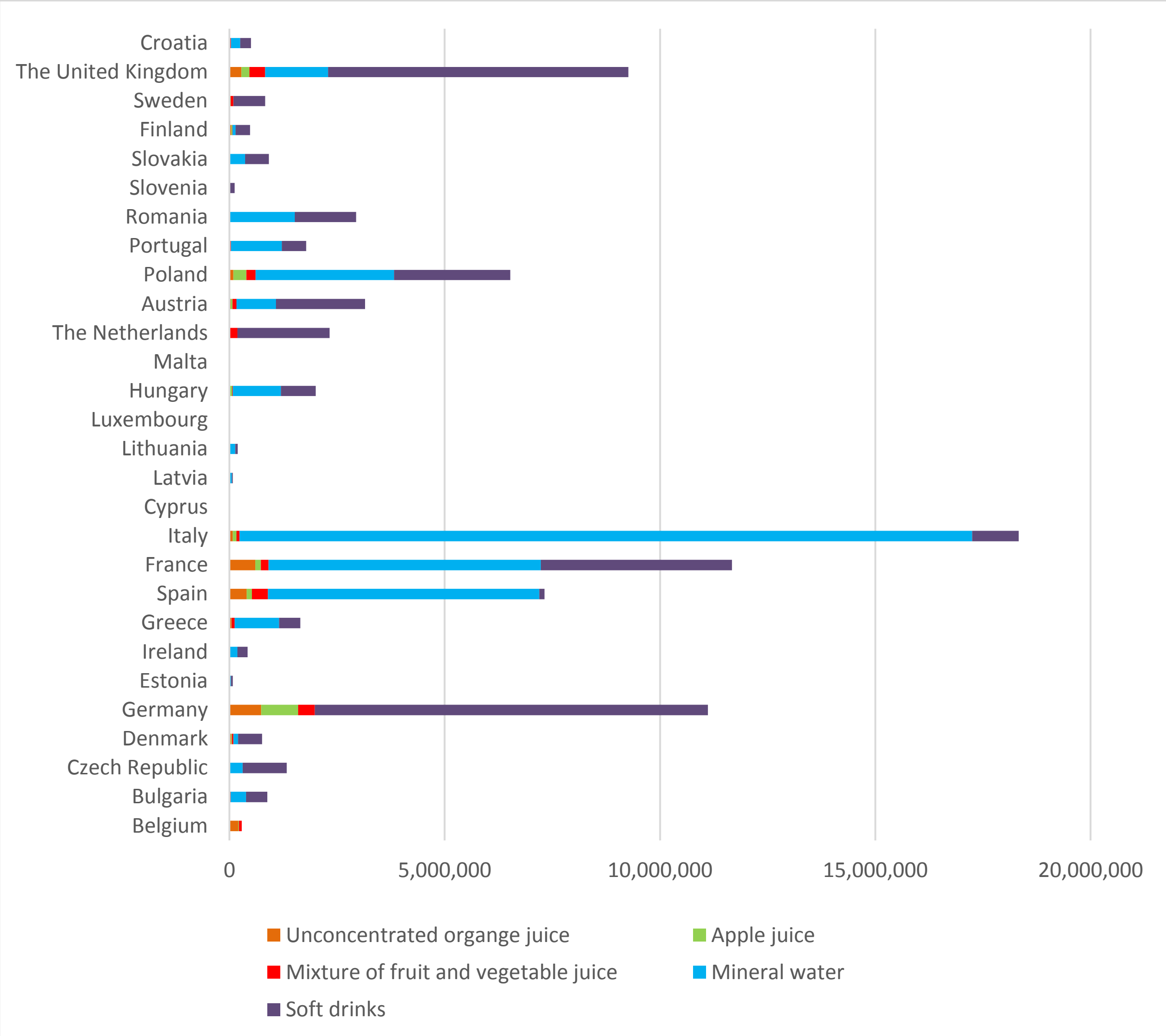


Figure 21: Volume of cold beverages sold in the EU in 2012 ('000 litres) (Source: Eurostat – PRODCOM NACE Rev. 2). *Note*: the analysis above is based on Eurostat data, which does not always show a complete set of data from every country. In some cases, countries decline to state production levels, if it is sensitive information. Hence, although the analysis is based on best available data, it presents some limitations for instance on the reasoning behind the magnitude of sales among different countries.

Stakeholder remark on beverage consumption in the EU

Since 2 000 local authorities in France have not provided any carbonated drinks except water. [77] Branded carbonated drinks have long been outlawed in both UK schools and French schools.[78] In the UK, the policy on sugar-containing drinks has somewhat reversed. Until very recently school children were encouraged to drink fruit juice every day, but concerns over the rise in obesity has now led the Government to recommend restricted consumption of juices due to the high sugar content[77] The Netherlands Government introduced a rule that only 25 % of the choices offered to children (i.e. controlled by the number of buttons on the machine) could be regular (full sugar) options. However, in practice, the proportion of drinks actually chosen and consumed by children is closer to 75 %.[79] Within the UK health service, the attitude towards fizzy drinks is ambivalent; some NHS Trusts will ensure that vending machines offer only 'bottled water and nuts' while others believe that visitors, who are the target market for these machines, should be rewarded with 'treats' including fizzy drinks and snacks high in salt or sugar[77]. The situation in Dutch schools is unusual in that vending machines (widespread throughout the country) will stock both 'healthy' and 'regular' drinks.

Hot beverages: Coffee is a major hot beverage in the EU. The consumption of coffee (solid matter) per capita, on average (in 2012) was 4.84 kg. Figure 22 shows the food supply quantity of stimulants (coffee and products, cocoa beans and products, and tea) in the EU-28 (FAOSTAT, 2011).

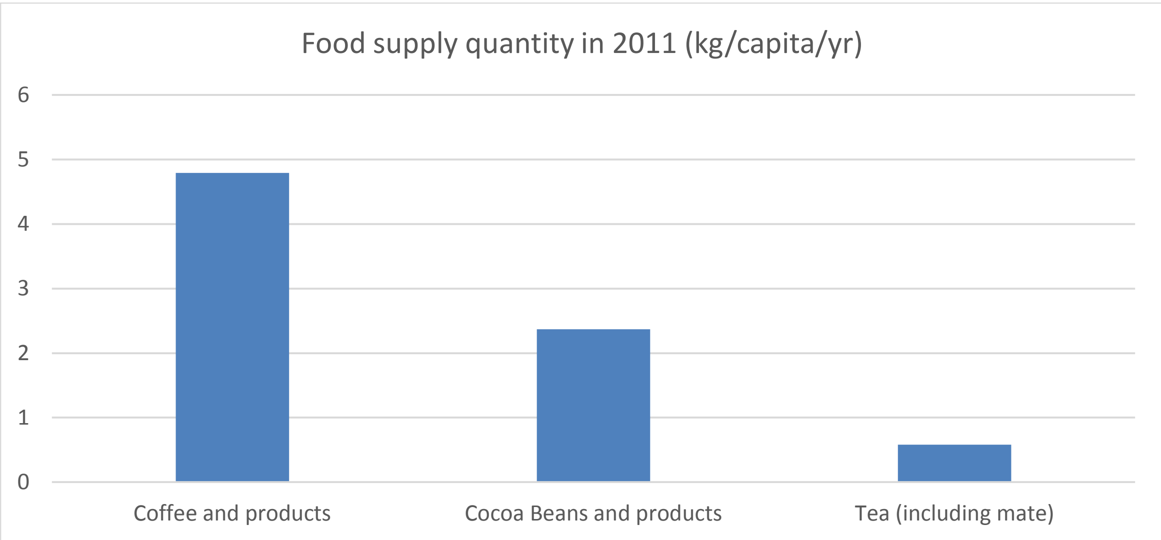


Figure 22: Food supply quantity of stimulants in 2011 (Source: FAOSTAT)

Fish: In 2011 the apparent consumption of seafood products in the EU was around 12 million tonnes (European Commission, 2014b). The consumption per capita was 24.5 kg in 2011. 75 % of all fish consumed in the EU came from capture fisheries. Cod, salmon and tuna are the main species consumed in terms of tonnes (European Commission, 2014b).

[77] Representative of a local government, France. Personal communication, 24 February 2015.
[78] Representative of a specialised magazine, UK. Personal communication, 24 February 2015.
[79] Representative of a Catering Association, Netherlands. Personal communication, 6 March 2015.

2.2.3.4 *Food imports, exports and trade balance*

A study from the European Commission (2013) summarised (in general terms) the main food products or categories that are currently being imported to the EU. These are: tropical fruit and spices, oilcakes, coffee, tea and mate, other fats and oils (not butter or olive oil, but palm oil), soya beans and fruits (fresh or dried) (European Commission, 2013). Fish is not included in this summary. The tropical fruit category includes products like banana, spices and nuts. 70 % of all bananas sold in the EU originate from Colombia, Ecuador and Costa Rica. As for nuts, the USA (generally) provides the EU's almonds, walnuts and pistachios while Turkey provides hazelnuts. Spices have various origins, although pepper usually comes from Vietnam, vanilla is often from Madagascar and cinnamon is supplied by Sri Lanka and India (European Commission, 2013). For coffee, in terms of tonnage most comes from Brazil, and in terms of value Switzerland has a high market share of processed coffee. Soya beans usually originate from Brazil, Argentina and the USA. Indonesia provides a large share of the EU's palm oil (European Commission, 2013).

As for seafood products the EU (in 2011) imported 8.38 million tonnes, produced 5.55 million tonnes and exported only 1.61 million tonnes (European Commission, 2014b).

Table 39 shows the imports and exports of the EU and it is clear that the EU produces more live animals, meat, dairy products, eggs, cereals, miscellaneous edible products and beverages than needed. Furthermore, the EU is importing (and obviously strongly dependent on) fish products, fruits and vegetables. But it is also dependent on coffee, tea and cocoa and animal feed.

Table 39: Value of extra EU-27 trade, 2010, (EUR million) (Source: Eurostat Statistics in focus, 2011)

	Imports	Exports	Net trade
Food & beverages	78 254	73 159	-5 095
Live animals	271	1 378	1 106
Meat & meat products	5 007	6 245	1 238
Dairy products & eggs	665	7 686	7 021
Fish crust. molluscs	17 105	2 996	-14 110
Cereals & cereal prep.	3 364	9 526	6 161
Vegetables & fruit	20 764	8 759	-12 006
Sugars, sugar prep. & honey	2 168	2 103	-65
Coffee tea cocoa	13 581	5 475	-8 106
Animal feeding stuff	8 529	3 112	-5 417
Miscellaneous edible products	2 332	7 639	5 307
Beverages	4 466	18 241	13 775

Table 40 show how different types of coffee is imported and exported. Figure 23 shows where most of the imported green coffee comes from; Brazil and Vietnam are the main suppliers.

Table 40: Import and export of coffee products, in tonnes, EU-28, in 2012, excl. intra-trade (Source: European Coffee Federation, based on Eurostat data)

	Import	Export	Net trade
Green coffee	2 790 370	21 717	- 2 768 653
Green coffee decaffeinated	3 075	97 325	94 250
Roasted coffee	38 540	89 022	50 482
Roasted coffee decaffeinated	3 531	2 811	- 720
Coffee extracts	51 106	43 664	- 7 442

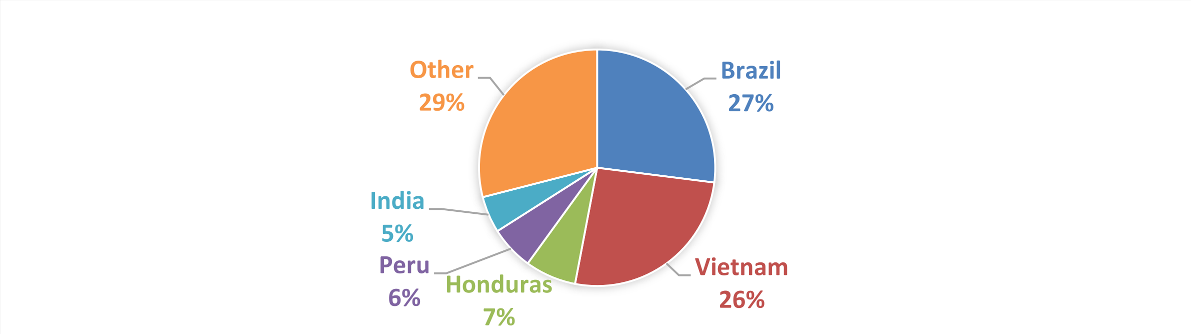


Figure 23: Top 5 green coffee suppliers to the EU, in 2012 (Source: European Coffee Federation, 2014)

2.2.3.5 The market for organic food in the EU

2.2.3.5.1 Economic value

The total value of the EU-27 organic market has been estimated in 19.7 billion EUR in 2011. The largest organic markets in the EU are in Germany (6.6 billion EUR), France (3.6 billion EUR), UK (1.9 billion EUR) and Italy (1.7 billion EUR). Nevertheless, in relative sales, Denmark is highlighted (162 EUR/person), followed by Luxembourg (134 EUR/person) and Austria (127 EUR/person) (Thünen Institute of Farm Economics, 2013).

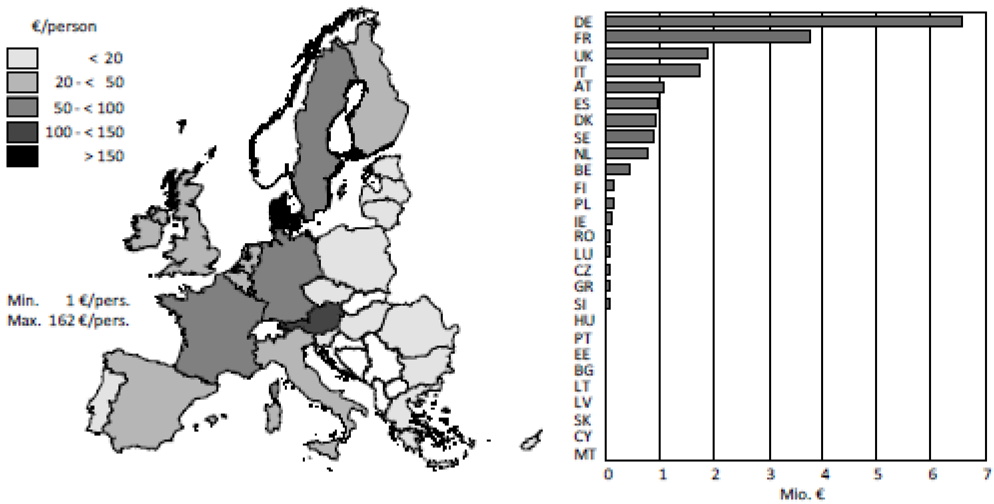


Figure 24: Organic sales per capita (left) and total organic sales (right) in EU MS in 2011 (Thünen Institute of Farm Economics, 2013).

The data collected in Figure 25 (Thünen Institute of Farm Economics, 2013) shows that the organic market grew by 56 % between 2006 and 2011. The highest growths took place in the two largest organic markets: France (+2 055 million EUR) and Germany (+1 990 million EUR) (Thünen Institute of Farm Economics, 2013).

	Organic sales per capita (€/person)				Total organic sales (Mio €)			
	2006	2011	Difference €	Difference %	2006	2011	Difference Mio €	Difference %
Austria	64	127	63	*98*	496	1 065	569	*115*
Belgium	23	40	17	*72*	258	435	178	*69*
Bulgaria	0	1	1	*900*	1	7	6	*775*
Cyprus	2	2	1	*33*	2	2	1	*33*
Czech Republic	3	7	4	*104*	27	59	32	*109*
Denmark	80	162	82	*103*	434	901	467	*108*
Estonia	-	-	-	-	-	-	-	-
Finland	11	22	11	*105*	57	120	63	*112*
France	26	58	32	*120*	1 700	3 756	2 056	*121*
Germany	56	81	25	*45*	4 600	6 590	1 990	*43*
Greece	5	5	0	*0*	55	58	3	*5*
Hungary	2	3	1	*67*	20	25	5	*25*
Ireland	16	22	6	*40*	57	99	42	*72*
Italy	19	28	9	*46*	1 130	1 720	590	*52*
Latvia	-	2	-	-	-	4	-	-
Lithuania	-	2	-	-	-	6	-	-
Luxembourg	85	134	50	*59*	41	68	27	*66*
Netherlands	28	46	18	*64*	458	761	303	*66*
Poland	1	3	2	*131*	50	120	70	*140*
Portugal	-	2	-	-		21	-	-
Romania	1	4	4	*700*	10	80	70	*700*
Slovakia	1	1	0	*0*	4	4	0	*- 7*
Slovenia	5	19	14	*280*	4	38	34	*850*
Spain	2	21	19	*1 213*	270	965	695	*257*
Sweden	42	94	52	*124*	379	885	506	*134*
United Kingdom	42	30	- 12	*- 16*	2 557	1 882	- 675	*- 16*

Figure 25: Changes in organic sales per capita (left) and total sales in EU Member States between 2006 and 2011 (Thünen Institute of Farm Economics, 2013).

The total market of organic products had an estimated value of €20.9 billion in the EU in 2012 (FiBL and IFOAM, 2014) and €22.2 billion in 2013 (FiBL and IFOAM, 2015). In total the organic market is growing, although due to the economic crisis, in some countries the market is stagnating or declining.

2.2.3.5.2 Importers and processors

As shown in Figure 26 (Thünen Institute of Farm Economics, 2013), there were more than 35 000 organic processing companies and 1 600 importers of organic products in the EU in 2011. The processors are concentrated in countries with a large organic market and/or a large organic area or both (Germany, France, Italy, Spain and the United Kingdom). In the case of Greece, the number of processors might stem from an atomized production of olive oil in small plants. Most companies were located in EU-15 countries while, only about 1 500 processors and less than 100 importers were located in EU-12 countries in 2011 (Thünen Institute of Farm Economics, 2013).

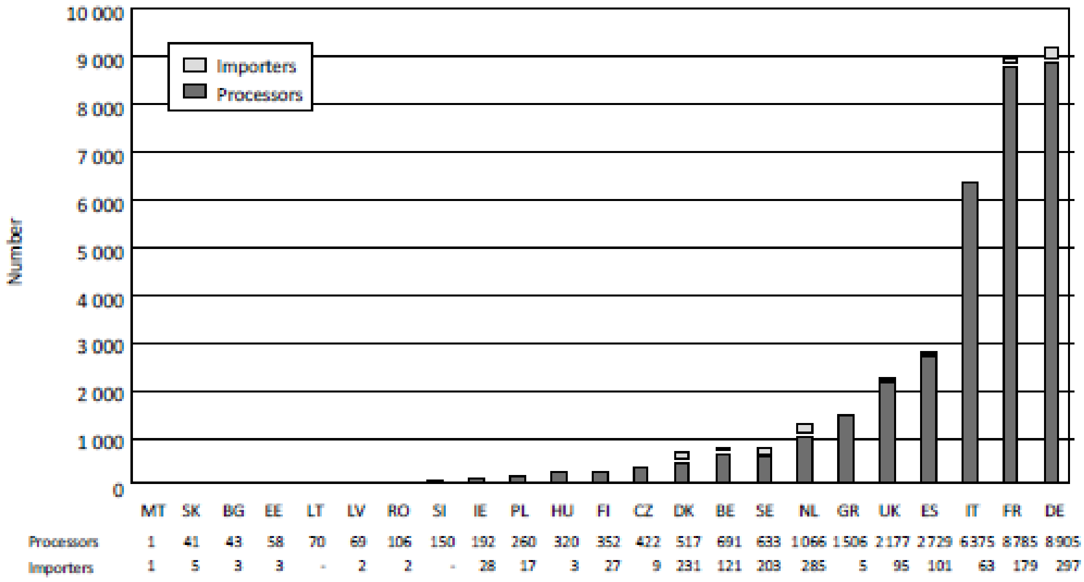


Figure 26: Number of organic importer and processor in 2011*(Thünen Institute of Farm Economics, 2013).
**No data on processors and importers for AT, CY, LU, PT and on importers for LT and SI. Data for IE, LT and UK are from 2010, since no data from 2011 were available.*

2.2.3.5.3 Production of main categories

In 2012, organic land use was 10 million hectares in the EU (5.6 % of total agricultural land) (FiBL and IFOAM, 2014). In 2013 this grew to 10.2 million hectares (5.7 % of the total) (FiBL and IFOAM, 2015) Spain, Italy and Germany have most area of organic production (FiBL and IFOAM, 2014). A report on organic agriculture in EU-27 provides a breakdown of organic crop types per Member State in 2011 (European Commission, 2013b). Table 41 shows the total land use and the share of each category.

Table 41: Main categories of the organic arable land use in the EU (2011) (European Commission, 2013b).

Categories for land use	% area of total organic
Total crops	**100 %**
Permanent grasslands	44.9 %
Permanent crops	13.1 %
Cereals	14.6 %
Dried pulses	2.2 %
Industrial crops	1.9 %

The information about the main categories production are further described below.

<u>Vegetables</u>

The vegetables constitute a marginal share of the organic area: 110 955 ha in 2011 out of 9.6 million ha (1.2 %). Italy holds the largest area of organic vegetables (23 405 ha), Germany 18 000 ha, France 14 529 ha, the United Kingdom 13 618 ha and Spain 11 483 ha. The share of organic vegetables referred to the organic crop area reaches the maximum in Malta (47.8 %) and followed by Netherlands (10.5 %). The vegetable sector is under development in the EU-12, with just 13 837 ha; being Poland and Hungary the largest ones (8 231 ha in Poland and 1 770 ha in Hungary) (European Commission 2013b).

<u>Permanent crops</u>

The organic area of permanent crops equals to 1.2 million ha at the EU level meaning. 13.1 % of all organic areas. This represents 10.9 % of the EU-27 total area under permanent crops in 2011 (European Commission 2013b).

The Member States with the largest organic areas in 2011 are Spain (636 019 ha), Italy (302 000 ha), France (90 668 ha), Poland (85 594 ha), Greece (62 705 ha), and Portugal (25 045 ha). France, Italy and Spain are the largest producers of permanent crops in the EU, but this is not reflected in the share of organic, which is variable across EU: in Italy 13 % of all permanent crop areas are under the organic sector and in Spain this share amounts to 14 %, while in other Member States, the share of organic permanent crops in total permanent crop area varies between 1 % in Malta and the Netherlands to 22 % in Poland. The organic sector represented in 2011 5 % of the total permanent crop areas in Greece and 4 % in Portugal (European Commission 2013b).
Figure 27 shows the share of each crop in the total permanent organic crop area in EU-27 in 2011, where it can be observed that fruit and olives amount together for 52 % of the area.

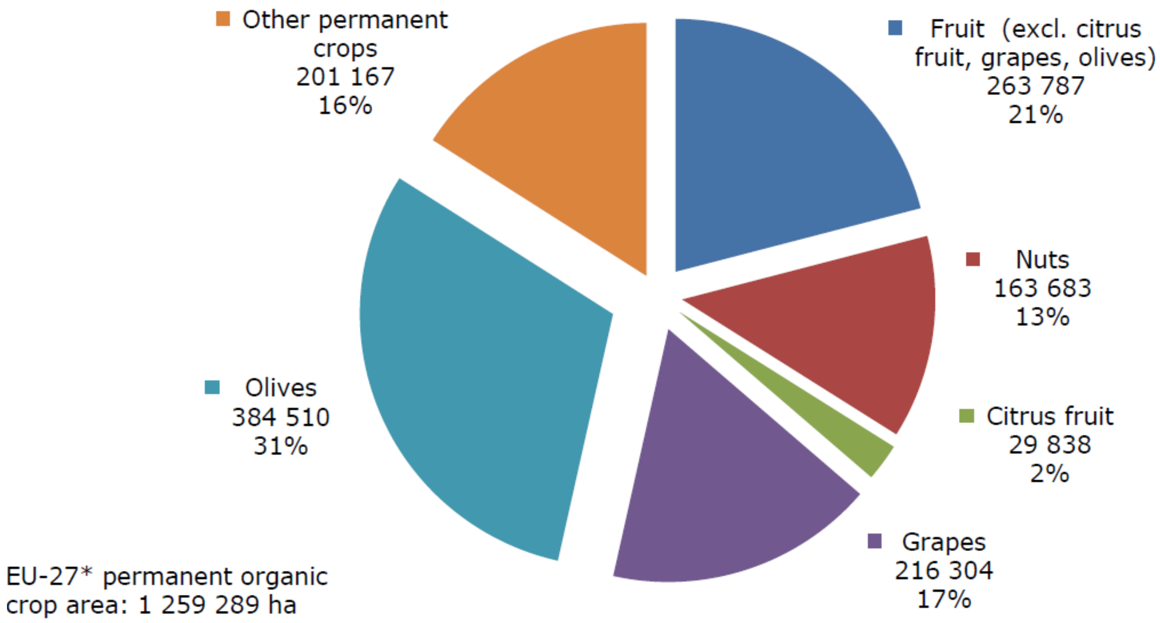


Figure 27: Major organic permanent crops (ha and % of EU total) in 2011 (European Commission, 2013b)

Major arable crops: cereals, oilseeds and dry pulses

2.5 % of the total cereal production in the EU was organic in 2011 and this area represents 14.6 % of the total organic arable land (European Commission, 2013b).The largest cereal areas are in Germany (around 0.20 million ha) and in Italy and Spain (almost 0.18 million ha each). In 2011, France, the largest EU producer of cereals, grew 119 000 ha of organic cereals. Poland comes fifth with 109 511 ha (European Commission, 2013b). The organic oilseed area is approximate 142 048 ha in 2011, 1.4 % of the EU organic crop area (European Commission, 2013b).
With regards of dried pulses, it is estimated that 211 568 ha of organic dried pulses were cultivated in 2011 in the EU-27. Germany is the largest producer (25 500 ha). Organic dried pulses represent 15.9 % of total EU dried pulse area (European Commission, 2013b).

Animal sector

According to the information collected by the European Commission in the report 'Facts and figures on organic agriculture in the European Union' (European Commission 2013b), statistics on the number of organic animals are not complete, however the information available allows building a representative appraisal of the organic animal sector, which reveals that this organic sector is very limited, compared to the total animal production in the EU as shown in Table 42 (European Commission 2013b).

Table 42: Percentage of organic out of total animal heard in the EU-27 (European Commission 2013b)

Animal sector	% organic out of total
Bovines	2.90 %
Sheep and goats	2.82 %
Pigs	0.33 %
Poultry	0.95 %
Total	0.96 %

There has been a 50 % increase of bovine animals and a 70 % increase of poultry between 2007 and 2013 (Table 43). It is likely that laying hens (egg production) and dairy cows are mainly responsible for this growth since the market share of organic milk and organic eggs have increased most on the organic product market (see Section 2.2.4.1). In the UK organic eggs are 2 % of the egg market while free-range are 45 % (Taylor *et al.,* 2014).

Table 43: Organic livestock in the EU for 2013 (Source: Adapted from: FiBL and IFOAM, 2015).

	EU Animals (number of heads)	Share of all animals	Increase 2007-2013
Bovine Animals	3 108 312	3.9 %	+50 %
Sheep	4 156 842	4.2 %	+26 %
Pigs	644 866	0.5 %	+31 %
Poultry	32 738 116	2.2 %	+70 %

2.2.4 Procurement of food

There are not much data available on the food categories mainly procured in the public sector. However, one source was found describing the public foodservice in Ireland. Table 44 presents the expenses breakdown by food product type. Meat is the category on which most of the money is spent. Bakery, vegetables and fruits are following it. This data refers to spending but not volumes of consumption.

Table 44 shows the food categories grouped together, whilst Table 45 shows them individually. Bread is part of bakery, which may be one reason for that group to be so large in expenditure.

Table 44: Product breakdown of Irish Foodservice, per value, of buying prices for operators, in 2014 (Adapted from: Bord Bia, 2014)

Food category	Percentage	Value (€M)
Meat	35 %	791
Vegetables and fruits	16 %	359
Bread/Bakery Savoury	11 %	241
Sweet bakery confectionary desserts	8 %	185
Dairy	8 %	181
Fish	3 %	79
Others (incl. grocery)	19 %	431
Total	---	**2 267**

Table 45: Purchase value of food products in foodservice in Ireland (Source: Bord Bia, 2014)

Product category	Operator Purchase (€ M) Year 2013	Operator Purchase (€M) Year 2014
Poultry	251	254
Beef	248	251
Bacon	186	188
Pork	89	91
Lamb	7	7
Fruits and vegetables	355	359
Bread/Bakery Savoury	238	241
Sweet bakery	127	129
Confectionery	27	27
Desserts	27	29
Dairy	181	181
Fish	78	79
All other	396	393
Grocery	36	38
TOTAL	**2 246**	**2 267**

An amount of 82 million food and drink products are bought in Europe every day (and 30 billion products every year) from vending machines (i.e. by both public and private consumers) (EVA, 2014). There are 3.77 million machines available in Europe and 80 % of all these are in: France, Germany, Italy, Spain, the Netherlands and the UK (EVA, 2014). Furthermore, Figure 28 show which type of vending machines are used in Europe. Of the hot drink machines around 50 % are espresso/bean coffee machines, and the glass-front machines are those that sell both food (snacks) and drinks. The total turnover of these products was, in 2012, €11.3 billion.

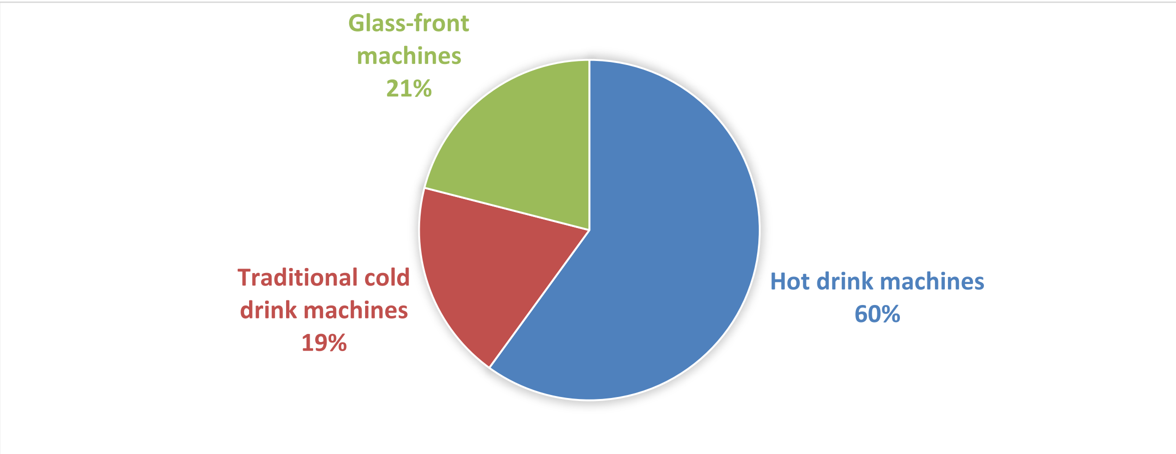


Figure 28: Type of vending machines used in Europe (Source: EVA, 2014).

2.2.4.1 Organic food products

Figure 29 shows that the growth in the EU organic food market continued at a steady rate between 2004 and 2012. The growth between 2011 and 2012 is 6 %. The main driver for the demand is that consumers believe organic products are healthier compared to conventional products and that they are also better for the environment (Kearney, 2010). Sales of organic eggs reflect the high concern of consumers with regard to animal welfare, and their readiness to pay relatively high prices (FiBL and IFOAM, 2014). In Germany, organic eggs are at least double the price of conventional eggs – one of the highest price differentials to be found within organic product groups (FiBL and IFOAM, 2014).

Organic meat and meat products are very successful with market shares of around 10 % in Belgium, the Netherlands, Finland and France. However, in many other countries the markets are not yet well developed due to a lack of production capacity and the higher prices compared to conventional products (FiBL and IFOAM, 2014).

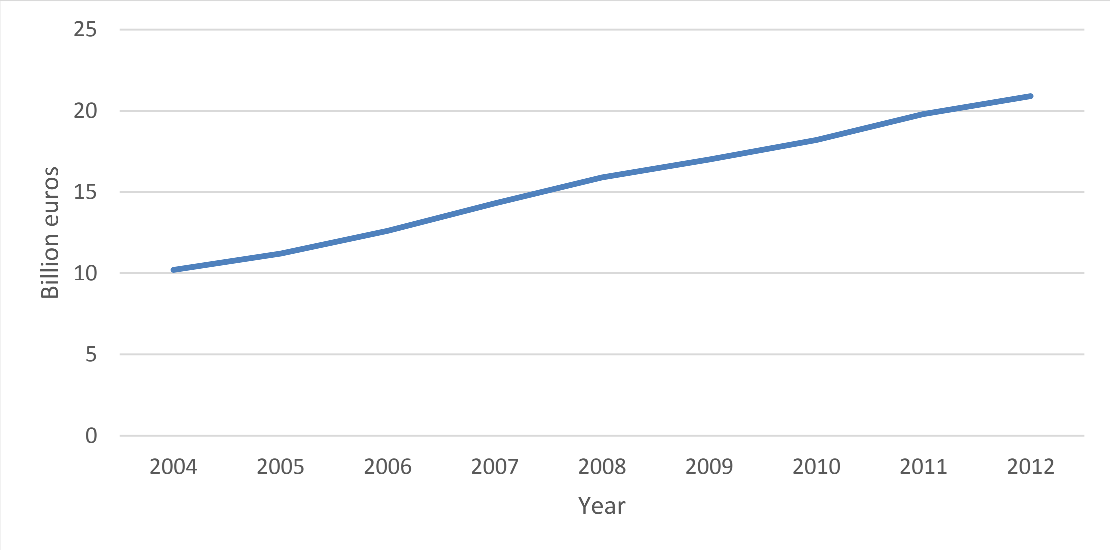


Figure 29: European Union: Organic market development 2004-2012 (Source: FiBL and IFOAM, 2014)

Although Figure 29 shows a steady growth in organic sales this is dominated by a relatively small number of countries: Germany and France account for nearly 50 % of the total market (Figure 30). The FiBL and IFOAM (2014) report concludes that one of the key issues for growth of the organic market across the EU is the development of the domestic markets in many of the new EU Member States.

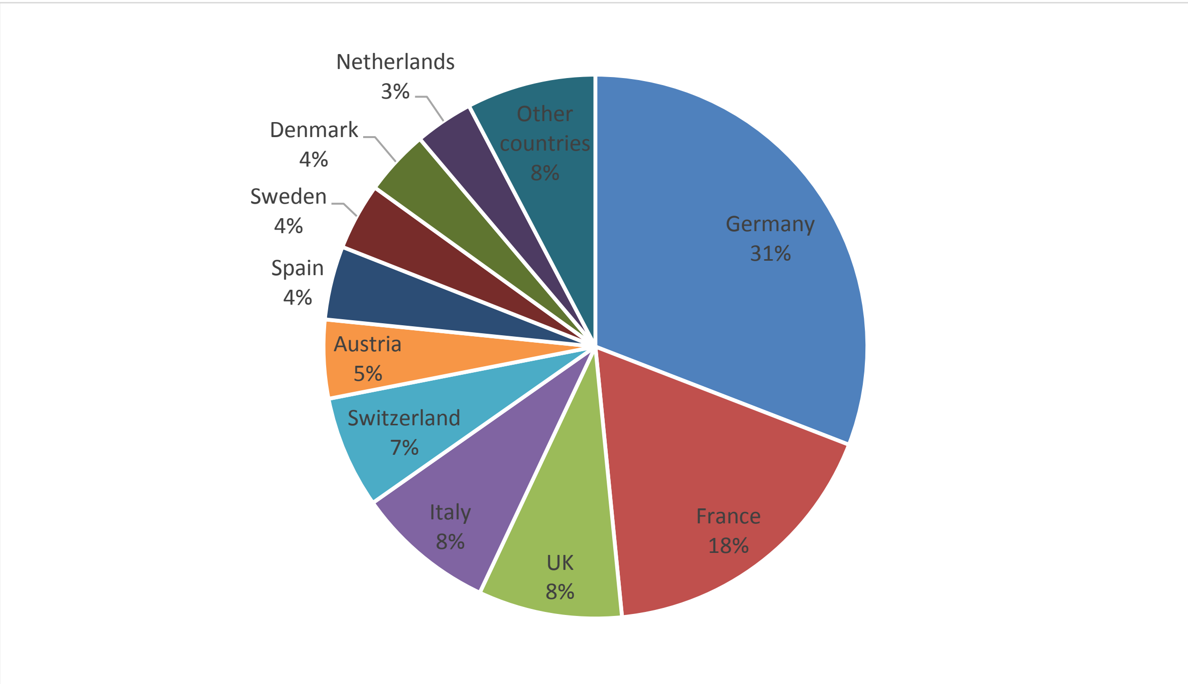


Figure 30: A breakdown of the European market for organic products by country 2012 (Source: FiBL and IFOAM, 2014)

Certain organic products are more dominant than others in the European organic market. The FiBL and IFOAM (2014) report identifies the following key products and product groups:

- Eggs: 20 % market share in Switzerland, and around 10 % in other countries. It is high mainly for animal welfare reasons.
- Fruit and vegetables: shares of between one third and one fifth of many national organic markets.
- Dairy products: 10 % share in Switzerland and around 5 % in other countries
- Meat products: apart from northern Europe, meat has a low market share due to the high cost
- Hot beverages (coffee, tea, cocoa) stand for 3 to 5 % of the overall market
- Bread and bakery also have a share of around 10 % in a few of the Member States

An insight to the sales of organic products in retail and in catering services for nine European countries is given in Table 46. From this example it is highlighted that organic products in the retail sector ranges between 0.3 % (in Hungary) and 7.6 % (in Denmark), of the total retail sales (by value). Furthermore, when comparing the sales of organic products in retail with the sales of organic products in the catering sector, it is clear that the spending of the catering sector in organic food products is substantially lower (by value).

Table 46: The market for organic food in Europe in 2012. (Source: FiBL and IFOAM, 2014)

Country	Organic product sales by the Retail sector		Organic product sales by the catering sector (€m)
	Value (€m)	**Share of all retail sales (%)**	
Austria (2011)	1 065	6.5	64
Denmark	887	7.6	109
France	4 004	2.4	169
Hungary (2009)	25	0.3	0
Italy	1 885	1.5	290
Netherlands	791	2.3	143
Norway (2011)	209	1.2	11
Slovenia	44	1.5	0
United Kingdom	1 950	N/A	20
Total	**10 860**		**806**

2.2.4.2 Food waste

The European Commission (2010) reported that the EU-27 generated 89 million tonnes of food waste. Figure 21 shows that food service and hospitality accounted for an estimated 14 % of total food waste, i.e., circa 12.5 million tonnes. Table 47 shows the summary of a study undertaken in the UK (WRAP, 2013a). It shows that the food waste generated in the health, education and services sectors in 2012 were around 312 000 tonnes with a cost of £592 million (c. €730[80]). The study did not distinguish between public or private staff catering, illustrating only total food wastage per sector (WRAP, 2013a).

[80] Calculated from GBP to Euro by the average exchange rate of year 2012, available in Appendix D (Table D.1).

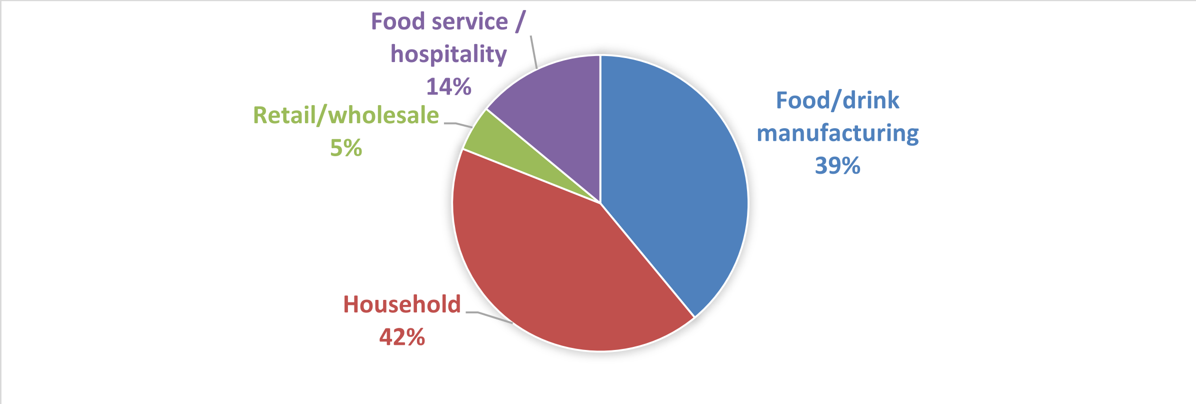


Figure 31: EU-27 food waste percentage by weight by food sector (Source: European Commission, 2010)

Table 47: The quantity and cost of food waste, by the UK Hospitality and Food Service sector, by sub-sector in 2012 (Source: WRAP, 2013a)

Sub-sector	Number of outlets with foodservice	Total food waste ('000 tonnes)	Cost total food waste (€/tonne)	Total cost € million
Restaurants	40 958	199	5 550	1 080
Pubs	45 087	173	3 300	566
Hotels	45 763	79	6 300	504
Quick service restaurants	31 450	76	5 500	439
Leisure	9 255	60	6 300	382
Healthcare	19 257	121	3000	365
Services	2 029	68	2 700	178
Education	34 744	123	3 300	396
Staff catering	7 172	21	3 500	70
Total	**235 715**	**920**	**-**	**3 980**

The value in Euro is approximate and calculated from GBP to Euro by the average exchange rate of year 2012, available in Appendix D - Table D.1.

2.2.4.3 Consumer trends

In Germany there are trends to buy regional and convenience food. Moreover, healthy food is popular and also to buy ready prepared food from retail (GAIN, 2013). In Ireland there has been consumer demand for better quality food and ingredients, which has led to companies providing a larger range of sandwiches (with different types of bread), salads (with new kinds of ingredients) and a wider selection of coffee beverage types. As lunch breaks are short, 'grab-to-go' food has become increasingly popular (Bord Bia, 2014). The market is still cost sensitive, and operators are therefore improving the range of offerings at the same time as trying to avoid cost increases (Bord Bia, 2014).

The provision of food at education facilities has changed much in recent years in Ireland due to health regulations. The foodservice operators have to consider sugar, calories, allergens and to provide more healthy meals overall (Bord Bia, 2014). The number of vending machines is expected to decline. Instead quick serve restaurants and different types of coffee chains are likely to be more common (Bord Bia, 2014). Not only is healthy eating more regulated, there is also a trend amongst students at all levels of education to eat healthily and to consider origin and nutritional composition (Bord Bia, 2014).

As for vending machines, the number of traditional machines that sell cold drinks is declining, whilst glass-front machines are increasing in use. The reason for this is that these vending machines can provide a wider range of products, such as snacks and food. Furthermore, there is a movement away from cans towards 50 cl PET bottles, which the glass-front machines help achieve (KioskMarketplace, 2014).

The Sustainable Restaurant Association in the UK conducted a study in 2009 and again in 2013 that asked consumers what issues they thought were most important for restaurants to focus on. There were a number of suggestions available, such as seasonality, animal welfare, organic produce, and sustainable fish. The results from 2013 stated that 'food waste' and 'customer health and nutrition' shared first place as the main issue that restaurants should focus on, whilst 'locally sourced' came second and 'employee treatment' came third. The most notable changes were that 39 % more consumers in 2013 thought food waste should be focused on, and 33 % more consumers thought that health and nutrition was important. Meanwhile 'organic produce' dropped 39 % in perceived importance since 2009 (Sustainable Restaurant Association, 2013).

2.2.4.4 Trends and practices of supply chains

Changing political will - in response to pressure from consumers, NGOs, civil society and the media (e.g. celebrity chefs in the UK[81] and Ireland[82]) - seems to be the main driver behind the emerging interest in the provision of 'fresh' in some parts of Europe. In Sweden, for instance, media stories on 'bad food', 'bad caterers' and so on are considered by one stakeholder to have played a large part in accelerating the popularity of fresh, organic, seasonal produce.[83] This has in turn driven government initiatives such as the 2010-2014 programme '*Sweden: The New Culinary Country*' which aims to increase the quality of public sector food provision and improving food education, which are likely to be taken up later in 2015 by a new initiative called '*Better Meals*'.[83] Public procurement criteria in Sweden are also now framed in such a way as to promote these sustainability priorities.

For Member States such as Spain, 'proximity' of food - i.e. encouraging 'local' food - is another key trend, with consumer demand for 'fresh', 'seasonal' or 'organic' produce less apparent than for instance in the UK and Sweden. According to a representative of a leading contract caterer, this localism is being driven by the political imperative to reduce the environmental impacts of transportation but also, and perhaps more importantly, by the desire of autonomous regions to protect their own identity.[81]

One aspect of changing consumer preference - the increasing demand for transparency in the supply chain and assurance about provenance and traceability - may be tied in a series of media events from fears over salmonella in egg production and foot-and-mouth outbreaks, to the recent Europe-wide horsemeat scandal. Even the largest contract caterers in Europe find that demonstrating traceability 'from farm to fork' can be extremely challenging. Part of the reason for this is the huge diversity in suppliers, and particularly the wholesalers (or traders) from which they purchase ingredients. Even the largest wholesalers geared to the food service sector operate in no more than a handful of Member States.

Impact

Any increase in the use of fresh, rather than longer shelf-life frozen or ambient, ingredients can result in more food waste due to inaccuracies in matching supply and demand. To a certain extent,

[81] Representative of a Catering Service Provider, Spain & Portugal. Personal communication, 25 February 2015.
[82] Representative of a Catering Association, Ireland. Personal communication, 9 March 2015.
[83] Representative of a Governmental Authority, Sweden. Personal communication, 25 February 2015.

waste can be offset by skilled chefs who are able to use safe, edible leftovers in new recipes, and some argue that the rising costs of landfill is incentive enough for waste to be prevented.[84] However, hospitals, schools, universities have been known to find alternative disposal routes for the waste such as sending it for composting or anaerobic digestion, rather than reaping the greater savings opportunity of preventing it arising in the first place. In certain contexts, the innovations discussed above which can reduce the lead time between ordering and serving, may also play a role in cutting food waste while providing 'fresh' meals of the rising quality demanded by consumers.

According to several industry experts interviewed, moves towards increased procurement of fresh, local, seasonal or organic food will invariably lead to rising costs which - given recent economic turbulence across Europe - public sector organisations are currently reluctant to countenance. Any move towards favouring local food is generally resisted by contract caterers concerned that their ability to source goods from the cheapest source, regardless of origin, is hampered.[85] Public procurers are still loath to prioritise nutritional or sustainability criteria in tenders for new catering contracts, awarding around 80 % of the points on price alone.[85] The same stakeholders, however, note that - as pressure from consumers and government grows - procurers may eventually be forced to accept these higher costs and to start favouring non-cost-related aspects of bids. In Ireland, too, dramatic public sector cuts and mass emigration linked to the 2007-2008 recession are influencing the quality of public meals. Not only are the procurement and staff training budgets low, but potential new recruits are unavailable. [86] In Sweden the situation is very different, with the greater potential cost of GPP of meals seemingly less of an obstacle.[87]

Average costs per meals

A study undertaken in Northern Ireland (DE & DFP, 2012) highlighted that the scale of production is a key factor in the cost per meal (Figure 32). It is clear that more meals per kitchen bring down cost per meal. According to one stakeholder, cost has been the most important driver of centralisation across Europe in subsectors such as hospitals and schools.

[84] Representative of a specialised magazine, UK. Personal communication, 24 February 2015.
[85] Representative of a Catering Service Provider, Spain & Portugal. Personal communication, 25 February 2015.
[86] Representative of a Catering Association, Ireland. Personal communication, 9 March 2015.
[87] Representative of a Governmental Authority, Sweden. Personal communication, 25 February 2015.

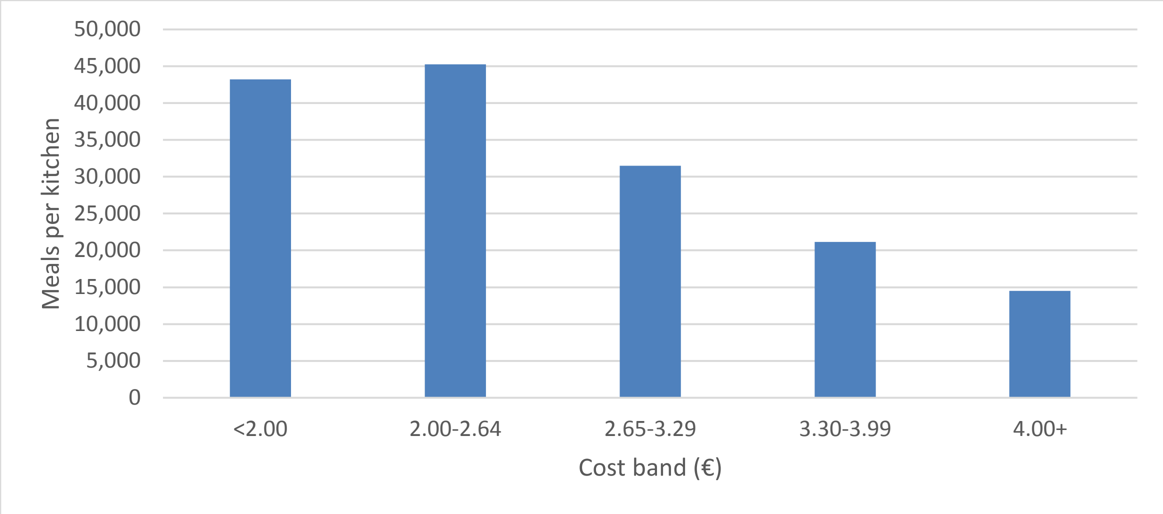


Figure 32: Scale of production by cost band (Source: DE & DFP, 2012)

Additionally, a study undertaken by WRAP in the UK (WRAP, 2013b) shows the significance of food purchase costs and labour costs (Table 48). Reducing the impact of these two cost elements is a major driver to the move to centralised production.

Table 48: Average labour and food purchase costs in the UK (Source: adapted from WRAP, 2013b)

Segment	Food purchases (€/meal)	Labour costs (€/meal)
Staff catering	1.296	1.072
Healthcare	0.777	0.777
Education	0.730	0.924
Services	0.931	0.704

The HACCP (Hazard Analysis and Critical Control Points) rules have had a big impact on public sector catering in France and potentially elsewhere, and it has been suggested that the state ministry of health used new food safety regulations to drive change in the sector leading to higher costs and further pressure on public authorities to move to off-site preparation.[88] The need to cut food waste while maintaining food quality may also be a motivator, especially for the introduction of cook-freeze systems within the health sector.

One stakeholder from Germany suggests that a driver for the hospitals sector is that the average length of time patients spend in hospital has significantly reduced.[89] The precise linkage is not clear, but the interviewee was possibly referring to the fact that the cook-chill systems used with centralised production enable lead times to be reduced allowing caterers to respond to rapid patient turnover.

Forecast

In Member States such as Finland at least one stakeholder believes that the trend towards off-site preparation will remain "strong".[90] This would support the off-site preparation model in combination with franchises which have been evidenced in the UK and the Netherlands. However, while several large contract caterers are pioneering these delivery models, others suggest that

[88] Representative of a local government, France. Personal communication, 24 February 2015.
[89] Representative of an Institute, Germany. Personal communication, 6 March 2015.
[90] Representative of a Business Organisation, Finland. Personal communication, 10 March 2015.

growing customer preference across Europe for 'fresh' food when prepared on site from raw ingredients, might militate against off-site approaches and are not planning to introduce these.[91]

A representative of a large contract caterer predicts that companies like this will grow their business in Europe as governments continue to seek to cut costs. Moreover, he asserts, the private sector has the ability to innovate and adapt far more quickly – and cost-effectively – to growing customer expectations than can in-house operations.[91] A stakeholder believes that public sector organisations will choose to focus on their core functions, and delegate catering to the private sector. [90]

An interviewee from another multinational contract caterer suggests that the near future will see a continuing trend in northern Europe for companies such as his to offer 'bundled' services, with food offered alongside cleaning, reception and security. However, in countries such as Italy, Spain, France, Portugal and Switzerland, public sector procurers will tend to purchase food services separately.[92] Among other anticipated trends may be the expectation among hospital patients that they will be able to order their meals electronically. Such innovations are predicted to arise across Europe including in Central and Eastern European Member States.[93]

2.2.4.5 Impact of VAT

After the financial crisis in 2008, many Member States introduced lower rates of value added tax (VAT) for foodservice, in the hope of strengthening the industry and its ability to employ more people. For instance, in 2011 Ireland introduced a VAT rate of 9 % and the outcome has been higher consumer spending on foodservice as well as a driver for tourism (Bord Bia, 2014). France lowered its VAT in 2009 from 19.9 % to 5.5 % but this led to only a marginal increase in eating out (GAIN, 2012). FERCO (2012) raises the issue that VAT rates are being applied in a way that favours self-operating public bodies and gives them a competitive advantage over contract catering firms.

2.3 Trends in foodservices

2.3.1 In-house vs. outsourced services

Contract caterers are specialists in what they do and argue that they can marshal the technical, human and financial resources necessary to deliver a significantly more cost-effective and safer service than in-house caterers. Contract caterers contend that, given the size of their organisations, they can often enjoy greater buying power than their clients and can thus procure ingredients at lower prices.[94] Furthermore, when tendering for new contracts third-party catering companies will often, as part of their sales proposal, include an offer to invest in upgrading and updating of cooking and serving areas which can be viewed as 'an easy win' by the procuring organisation.[95] One representative from a large contract catering organisation reports that the recent economic recession had led to a 'huge demand' for their organisation's services over the last 5-7 years, whereas during the previous 20 years when the economy was doing well it was difficult to engage with the public sector.[96]

91 Representative of a Catering Service Provider, UK (b). Personal communication, 6 March 2015.
92 Representative of a Catering Service Provider, UK (and internationally). Personal communication, 9 March 2015.
93 Representative of a Catering Service Provider, Hungary. Personal communication, 10 March 2015.
94 Representative of a Catering Association, UK (a). Personal communication, 17 February 2015.
95 Representative of a specialised magazine, UK. Personal communication, 24 February 2015.
96 Representative of a Catering Service Provider, UK (and internationally). Personal communication, 9 March 2015.

According to a representative of another large multinational contract caterer, one driver of success is that diners now expect a more diverse range of food offerings and this expectation is better met by specialist caterers than by in-house operations. This is part of the reason offered for why contract catering has yet to take off in the less developed parts of eastern Europe where consumers are, at least historically, less likely to demand a similar range of meals.[97]

In France, one reason for the success of third-party contractors lies in their ability to interpret and adhere to ever more complex food safety legislation, itself driven by the HACCP Regulations[98] in the late 1990s – something that in-house providers have struggled with.[99] However, since 2008, France has experienced a slowdown in the previously rapid growth of the contract catering industry. According to one local authority stakeholder, this in part reflects recognition that costs can, in practice, be lowered when food provision is taken back in-house. In the French health service, for example, a major re-organisation in 2009 resulted in the new ARS system (*Agences Régionales de Santé* – Regional Health Agencies) which is better equipped to understand and comply with all the necessary HACCP rules.[99] Thus, reliance on the expertise of private third-party providers, in the health service at least, was lessened.

According to one Finnish stakeholder[100], critics of outsourcing argue that external caterers provide a lower quality service than in-house staff, and they also fear that jobs are lost due to outsourcing. Despite this, however, this interviewee anticipates that contract catering will in fact grow in Finland. In the opinion of another interviewee from Eastern Europe, contract caterers are indirectly disadvantaged there by the expectation that they must provide 'additional value' if supplanting in-house incumbents – although there is no explicit 'veto' on outsourcing.[101]

2.3.2 Possible impacts on sustainability by outsourcing

One example of an impact arising from the way agreements are framed concerns the resource efficiency of catering equipment purchased. In some cases, as noted above, contract caterers will simply use the equipment already owned by the client. In other cases, the contractors are required to supply the equipment.

Depending on the agreement, the contractors may pay a fee proportional to the energy and water consumption, and hence contractors integrate these costs in their budgets and they may as well take them into account to select kitchen equipment. If those fees are not part of the agreement, contractors may base their choice of equipment just on the price, and not on the energy or water consumption performance. This scenario may result in equipment being purchased and operated with a poor energy or water efficiency performance, and the contractor may have little incentive to invest in regular and comprehensive servicing of the equipment.[102] In such situations, third-party companies are also unlikely to invest sufficiently in staff training[103] which could again impact negatively on resource efficiency, as well as on safe food preparation.

Similarly, where the client pays the energy or water bill for the site then there is no incentive for the contract caterer to be resource efficient. There is, however, an emerging phenomenon of facilities

[97] Representative of a Catering Service Provider, UK (b). Personal communication, 6 March 2015.
[98] Hazard Analysis Critical Control Point
[99] Representative of a local government, France. Personal communication, 24 February 2015.
[100] Representative of a Business Organisation, Finland. Personal communication, 10 March 2015.
[101] Representative of a Catering Service Provider, Hungary. Personal communication, 10 March 2015.
[102] Representative of a Catering Association, UK (a). Personal communication, 17 February 2015.
[103] Representative of a Catering Service Provider, Spain & Portugal. Personal communication, 25 February 2015.

management (FM) companies diversifying into offering a full package of services within a building (a 'turnkey' solution) including not just catering but also security, cleaning and gardening. In such cases, the contractor is generally responsible for the overall environmental impacts, encompassing - for example - the energy use of the building. Often FM companies will assess the whole life costs of the building and take all measures necessary to minimise these.

It should be noted that the distinction between FM company and contract caterer is blurred, with food service often simply one of many functions: many of the larger contract caterers will offer a 'bundle' of services including, for example, cleaning and laundry[104]. It has also been suggested that certain universities are starting to take a more 'joined up' approach to mitigating site-wide environmental impacts with the example given of purchasing departments subsidising catering departments to invest in more expensive, but more energy efficient, equipment.[105]

2.3.3 Barriers to sustainability

Organisations like the Soil Association and the Sustainable Restaurant Association are trying to drive the development of sustainable catering and food service. The Soil Association had an event called *Big Food Debate* (25 June 2014) at which stakeholders from a wide range of sectors were present. During this event they summarised the main barriers for development of sustainable catering (Soil Association, 2014):

- the real cost of sustainable food production compared to what consumers are willing to pay
- the difficulties to find markets for products of small scale producers
- the understanding and awareness of consumers of sustainable farming and food

Furthermore, based on stakeholder feedback, the major barriers to sustainability include:

- Higher costs of food in price sensitive markets. (For example organic products may be out of scope for public organisations due to budget constraints)
- Poor availability of sustainable products.
- Lack of life cycle costing/thinking. (If contracts are short or the contract caterer does not stand for costs of water and electricity, there is a risk that contract caterers buy or rent equipment that is not eco-efficient.)

2.3.4 Initiatives of sustainable food and catering service

The Soil Association in the UK has launched three new handbooks to be used by caterers in different foodservice sectors in order to make their operations more sustainable (Soil Association, 2015a). It includes a so called "Food for Life Catering Mark", where there are three levels of sustainable standards: bronze, silver and gold (Soil Association, 2015b). This label is voluntary label that ensures fresh ingredients are used, free from GMO, harmful additives and trans-fats, and a higher animal welfare (Soil Association, 2015b). In 2014 this catering mark was used on meals in 25 % of English schools and 20 % of the Universities in England. Additionally more than 100 hospitals and care homes and more than 300 nurseries used this mark as well in England. In total this catering mark was used on one million meals, per day (Soil Association, 2015c).

In Sweden the National Food Agency has launched new guidelines for diets. This new guideline includes environmental aspects (based on the Swedish environmental policy) as an addition to

[104] Representative of a Catering Service Provider, UK (and internationally). Personal communication, 9 March 2015.
[105] Representative of a Catering Association, UK (a). Personal communication, 17 February 2015.

health considerations (INNOCAT, 2015a). Not only Sweden is investigating sustainable diets, also the Netherlands, Germany, the UK, Brazil and Australia are looking into it.

INNOCAT (2015b) is a three years project which began in March 2013. It is supported by the European Commission's Competitiveness and Innovation Framework Programme (CIP). INNOCAT aims to bring together a group of public and private buyers to publish a series of tenders for eco-innovative catering products, services and solutions. The aim is to help encourage eco-innovation in the catering sector by providing a sizeable launch market for new solutions. The main environmental and social hotspots addressed by this project are (INNOCAT, 2015e):

- Transport
- Waste re-use and recycling
- Bio-based products
- Energy-efficient equipment

The purchasing sectors targeted by INNOCAT are School catering services, vending machines, Bio-waste disposal systems, health and welfare catering services. INNOCAT tenders cover biodegradable/compostable packaging and cutlery material.

Another objective is to disseminate project results and to promote an active experience exchange between buyers interested in eco-innovative catering.

2.4 Limitations of the study

There has been a lack of comprehensive data for the foodservice sector, especially data that separates public and commercial food and catering services. Furthermore, data on food consumption, production, import and export have also been limited in some aspects. Another issue has been that data available in the different studies is very unclear about what is included and excluded in scope. This has in some instances led to a high variance of numbers. Furthermore, stakeholders were contacted for telephone interviews to provide insight to the Market Analysis about the trends and practices in different Member States. Their information helped confirm some findings and values but they could not help provide more detailed data at country level. There is therefore not a complete set of data for each Member State in EU-28, although those countries with highest spend on food and catering services have been in focus. Therefore the results are relevant for the overall findings.

Specific limitations that were noted (which includes data gaps):

- **Limited European market data** on food and catering services has been found; especially for public sector activities, most likely because this is a small sector in comparison to the commercial sector.
- It was possible to find data on contract catering companies, such as expenditure and number of employees, but this data was **not available at a detailed level**, allowing distinction between contract catering for public sector and private sector.
- **Procurement volumes of anything except food (ingredients) and catering service** (as a whole) was not readily available; such as procurement of equipment, water, electricity, and other accessories.
- It was found that Education and Health/welfare are procuring most of the food and catering services in the public sector. However, **what type of food they procure** and what catering services they use (food systems) was not possible to find, except whether the service is kept in-house or outsourced.
- **Estimates of market share** between large contract catering companies and SMEs for foodservice has also been found as limited.

- As for food, the total data for production, consumption and trade in EU-28 as a whole was used. This provides the best available picture on **what food products is of relevance** and an assumption is that the occurrence of these food categories does not differ much between the public and private sector.
- **Data for food production, imports and exports** was not always available for the same year, some data is from 2012 and other from 2011, but it was assumed that the difference would not be too substantial.

2.5 Preliminary findings

EU market overview - The total expenditure on food and catering services in Europe is €206.3 billion (2011 data from Eurostat). France, Italy, United Kingdom and Spain spend the most. The sector (in total) includes 1.5 million enterprises, has a turnover of €354 billion, and employs 8 million people (2012 data from Eurostat). In 2008, the turnover of the total contract catering industry in the EU was €24.6 billion and around 600 000 people were employed (EIRO, 2010).

Structure of the market - Self-operating public bodies and contract caterers on average share the food and catering market around 50/50, but the difference is large between Member States (FERCO, 2012). The market penetration of contract catering organisations varies significantly across Member States and across public sector segments. In many Member States markets are dominated by the large multinational contract catering organisations. They overall have the largest market share in EU-28. There are a total of 3.77 million Vending machines in Europe, serving 82 million food and drink products per day. 80 % of these are in France, Germany, Italy, Spain, the Netherlands and the UK (EVA, 2014). Of all machines available in Europe 60 % are hot drink machines, 21 % is glass-front machines (drinks, food and snacks) and 19 % is cold drink machines.

Market segmentation - The most important sectors (in terms of purchase volume and value) in Europe that procure food and catering services are: health/welfare, Education and B&I. It is important to note that different sectors are included in calculations for different countries. For instance, the term 'institutional food service' (from GAIN, 2013) was used differently between Member States.

Market elements for big caterers - What drives the success of large contract catering companies seems to be economies of scale: less labour and lower prices per meal.

Conclusions on food production and consumption - EU-28 is a large producer of dairy, cereals (e.g. wheat), fruit and vegetables, meat, potatoes, bread and cold beverages. But the EU is also dependent on imports of fish, fruit, vegetables, animal feed, coffee, tea and cocoa (Eurostat Statistics in focus, 2011). The main food categories found to be relevant for this project are:

- **Meat:** beef, pig and poultry
- **Fish:** wild caught cod and tuna; farmed salmon
- **Dairy and eggs:** milk and eggs
- **Fruit:** apples and oranges; (possibly imports of tropical fruits)
- **Vegetables:** tomatoes, onion, carrots
- **Other carbohydrates**: potatoes, bread and wheat (rice not included)
- **Hot drinks:** coffee
- **Cold drinks:** mineral water and soft drinks

It is likely that there are other food products too that are relevant, but the above are the ones that have been found during this investigation to have sufficient data to base decisions upon.

The consumption of organic production in the EU has been on a steady rise since 2004 (FiBL and IFOAM, 2014). Germany (31 %), France (18 %), UK (8 %) and Italy (8 %) are the countries that buy most organic products. All together these countries sum up about two thirds of the overall EU organic food sales in 2012. The most popular organic food products are: eggs, dairy, fruit, vegetables, hot beverages, meat (mainly in Northern Europe) and bread and bakery (in some Member States). However, it is stressed in Germany that the cost of procuring organic food can be significantly higher than for conventional products. The IFOAM study (2014) presents some single country data for the share of all retail sales for organic food at European market in 2012. Looking at the main consuming countries, it shows that for Germany the share of organic food in all retail sales is 3.7 %. For France the share is 2.4 % and for Italy 1.5 %. No figure is made available for UK (IFOAM, 2014). Denmark is leading, despite presenting a share below 10 % (and equal to 7.6 %).

Procurement of food - It was difficult to find data from Member States on what type of food is procured by public foodservice, but one study from Ireland showed that meat, fruit & vegetables and bread are the food categories on which most money is spent.

Trends and practises - There is a rising demand for healthy food and drink products both from private consumers and governments, especially in the education and health sectors. The cost of meals in the public sector is generally low, but a high level of variability occurs between countries and public sectors (GIRA Foodservice, 2014). It is clear that the more meals a kitchen makes, the lower the cost will be per meal (DE & DFP, 2012). Labour cost and food purchase cost, are the two most important factors that influences the price per meal (WRAP, 2013b). This may lead to public procurers choosing contract catering instead of having in-house personnel preparing meals, however other factors might influence in the decision making, for instance, the different VAT applied in each Member State to the procurement of catering services If contract caterers are not liable for the electricity, gas and water use in the facility, and their contracts do not include fees linked to these consumptions, they may have minimal incentive to reduce the use of these resources.

Sustainable aspects in the service - In terms of future sustainability there is a significant focus in the catering industry on energy savings, packaging and food waste. In respect to the **Future trends in food services** it is likely that contract caterers will continue to grow in market share, due to their ability to provide a broad service to a low price. However, some sectors will be easier to develop in than others. The Soil Association in the UK and the Swedish National Food Agency are, among other, two examples of market innovations initiatives at country level where national dietary guidelines considers environmental aspects. Another initiative, INNOCAT, aims to gather public and private buyers to publish a series of tenders for eco-innovative catering products, services and solutions.

3 TECHNICAL AND ENVIRONMENTAL ANALYSIS

This chapter is divided in two sections. The environmental analysis (section 3.1) reviews the LCA studies for the food categories in analysis, the distinct production processes and the catering services. These constitute the LCA scientific evidence base to inform on the revision of the EU GPP criteria set. The technical analysis (section 3.2) informs on the current schemes and labels for food products and food production but also for catering services. Some aspects related to the food service provision are not captured by the LCA studies (e.g. integrated production, animal welfare, fair trade) are also part of the technical analysis section.

3.1 Environmental analysis of food and catering services

The revision of the EU GPP criteria for 'Food and Catering Services' is evidence-based and designed to focus on the main environmental hotspots identified along the supply chain for this sector. This chapter aims to identify the main environmental hotspots of the in-scope food categories and catering services through a detailed review of life cycle assessments (LCAs). The intent is to investigate full supply chains (cradle to grave) and find where most significant hotspots occur and what is driving them (the root-causes). As far as possible (i.e. within the boundaries of data availability) the three agro-food production systems: organic, conventional and integrated production will also be examined from an LCA perspective.

Relevant LCAs for food and catering services were identified and reviewed. The review focuses on the studies' robustness (including, for example: the publishing year, methods used and type of data used) and their compliance with the ISO standards for LCAs (e.g. ISO 14040). The two areas of focus strictly related to the scope of this study are:

- Food production and processing (food supply chains).
- Catering services (preparation, cooking, serving and disposal of waste).

3.1.1 Evaluation of the comprehensiveness of selected LCA studies

All LCA studies were reviewed based on the following aspects:

- **Study subject**: Focus on the food categories, catering services (food systems) and agricultural production systems (this focus was itself based on the outcome of the Market Analysis). The focus is on Europe-based studies (unless otherwise appropriate, e.g. for imported products or when there is insufficient European data available).
- **Age of data used:** Focus on recent studies: ideally with inventory data which is less than four years old. A second preference, in the absence of data, is given to publications after 2008 (after the current EU GPP was published).
- **Comprehensiveness and robustness**: Investigate the environmental impacts in focus in the reviewed studies. Ideally, the studies will have taken a cradle-to-grave approach, but other type of system boundaries are accepted, if the studies are found to be relevant in other aspects. The studies should also follow a recognised methodology for LCAs, such as ISO 14040 and 14044, or PAS 2050 (Carbon Footprint studies) which applies a life cycle approach.
- **Reliability:** Give priority to reports that have been peer reviewed.

The following tables (Table 49 to Table 51) show a summary of all LCAs relevant for Food and Catering Services that were included in the detailed analysis because they were considered comprehensive enough. Table 49 (is presented as 1a-1j) sums up LCAs for different foodstuffs. Table

50 for catering services and Table 51 for agricultural production systems found to be relevant for this product group.
For some food categories no recent scientific articles were identified and, to cover this gap, a few older studies were used. Additionally, a few studies that had not been peer reviewed (but that followed the ISO standard) were included in the comprehensive detailed analysis.

Later in this chapter (section 3.1.4) a table (Table 65) sums up the articles found to be relevant, but were not comprehensive enough to be included in this detailed analysis. These articles did not *conduct* LCAs. Some of them were literature reviews of existing LCAs to compare findings of environmental impacts for foodstuffs, catering services and agricultural production. The summary in Table 65 is used at the end of this chapter as an additional source of information to identify the main environmental hotspot for this products group.

Table 49: Overview of selected LCAs for different food categories (not including studies that compare production systems)

1a: Food category - MEAT

Type	**Source**	**Functional unit**	**System boundary**	**Time related coverage**	**Environmental Impact categories**	**Reliability**		**Results**
						Data quality	External critical review	Summary of environmental hotspots
Chicken	Leinonen *et al*. (2012a)	1,000 kg of expected edible carcass weight at the farm gate	Cradle to gate	Energy consumption: Average 2009-2010	Global warming potential IPCC (GWP_{100}) GWP, EP, AP, land occ., pesticide use, abiotic resource use, PEU	Primary and secondary	Peer-reviewed for Poultry Science	Feed for chicken is the process in the chain that has the largest environmental impact mainly due to the use of soy (land use change and transport/fuel use). Organic wheat also has environmental impact due to lower yields and road transport. These results are supported by Bengtsson and Seddon (2013). The study from Silva (2014) also confirms that crop-production stage is the largest contributor to overall environmental impacts along the chicken meat production supply chain. The study by González-García (2014) confirms that chicken farm processes as the main contributors to environmental impacts and energy use. Specifically, feed production and on-farm emissions were found to be the main environmental hotspots. The production of packaging materials and electricity requirements played a major role in the environmental profile of the slaughterhouse.
Chicken	da Silva *et al*. (2014)	1 tonne of cooled and packaged chicken, ready for distribution	Cradle to gate	2004-2011	GWP, AP, EP, terrestrial eco-toxicity, land occupation, cumulative energy demand	Primary and secondary	Peer-reviewed for J. Environ. Manage.	The feed is the hotspot for most impact categories and the ammonia emissions from the bird house is the second.
Beef, lamb, chicken	Webb *et al*. (2013)	1 tonne of produce as delivered to the RDC and based on the final commodity sold to the consumer. <u>Chicken</u>: frozen breast <u>Beef</u>: frozen hind beef cut	Cradle to Retail Distribution Centre (RDC)	The baseline year was 2005; however, an average of 5 years were calculated to even out annual differences	GWP, AP, EP, PEU, abiotic resource depletion, water consumption, land occupation, pesticide use	Primary and secondary	Peer-reviewed for publ. in Int. J. LCA	Meat is responsible for the largest emissions of GHG of all food products. Ruminant meat has the largest impact due to methane emissions that largely contribute to GWP. <u>Beef:</u> rearing indoors leads to high energy use and abiotic resource use. Application of N fertiliser on fields dedicated to feed growth leads to high AP and EP. Outdoor-reared cattle are need more land and they grow slower, leading to larger methane emissions per animal. <u>Lamb:</u> As well as high methane emissions in the production stage, processing (slaughter) leads to a high share of PEU. <u>Chicken:</u> the concentrated feed (soya) is responsible for around 80 % of the GWP pre-farm gate. The remainder is due to heating or cooling bird houses. Using renewable

Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
						Data quality	External critical review	Summary of environmental hotspots
		Lamb: chilled, or frozen from NZ						energy for heating or cooling lowers the GWP.
Pig (org.)	Halberg *et al*. 2010	1 kg of live weight pig delivered from the farm.	Cradle to gate	Not stated	GWP, EP, AP, ozone depletion, land use	Secondary	Peer-reviewed for publ. in Agron. Sustainable Dev.	Of three organic production systems: 1) indoor fattened (sows are outdoors), 2) free-range (outdoors whole life cycle), 3) tent systems (outdoors on a deep litter bed), system (1) had lowest overall impact on the environment and (2) had the largest impact (due to high nutrient emissions in fields and a large share of imported feed – a consequence of high land use on farm). All organic systems had larger environmental impacts than conventional production. However, if carbon sequestration was taken into account the organic systems all had lower GWP than conventional production.

1b: Food category - MILK CHEESE EGGS

Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
						Data quality	External critical review	Summary of environmental hotspots
Milk	Hietala *et al.*, (2014)	1 kg of energy-corrected milk (ECM)	Cradle to (farm) gate	Not stated	GWP	Primary and secondary	Peer-reviewed for publ. in Org. Agri.	The dairy sector in Europe is responsible for large emissions when compared to other food categories. For example, enteric fermentation (which releases methane to the atmosphere) is the main cause for the release of GHG emissions and thus is the major cause of the large contribution to GWP of dairy products. N_2O emissions from fields were also a hotspot. Carbon sequestration was not included in the analysis but, if it were, it could lower the GHG emissions on farm if the share of permanent grass pastures is high.
Milk	González-García *et al*. (2013)	1 kg of packaged ECM, corrected based on fat and protein content including co-products leaving the dairy-gate (i.e. milk, cream and butter)	Cradle to (dairy plant) gate	2008	GWP, AP, EP, abiotic depletion, ozone layer depletion, photo-chemical oxidant formation, human toxicity, fresh water aquatic eco-toxicity, marine aquatic eco-toxicity, terrestrial eco-toxicity, non-renewable energy demand.	Primary and Secondary	Peer-reviewed for publ. Sci. Total Enviro.	The study from González-García (2013) shows the production of raw milk in a conventional dairy farm is a hotspot in several categories. Main flows affecting the results are: emissions from enteric fermentation, emissions of nitrogen compounds to air, leaching to water from manure management, and production and application of fertilisers. In addition, on-site emissions derived from the dairy factory (excluding from the dairy farm) are important. Tetra-brik production for milk packaging and energy requirements in production are the main flows here. The dairy farm causes a large part of the impact especially for EP, AP and terrestrial eco-toxicity. It is mainly the production of animal feed (in particular concentrated feed) that is the hotspot. In the dairy plant packaging, electricity use and cleaning detergents lead to human toxicity and eco-toxicity. Transport and fuel oil use are major root causes for ozone depletion, abiotic resource use and non-renewable energy use.
Dairy produce	Djekic *et al.* (2014)	1 kg of final product: • Pasteurized milk, • UHT milk, Yoghurt,	Cradle to grave	2011	GWP, AP, EP, Ozone layer depletion potential, Photochemical smog potential,	Primary and secondary	Peer-reviewed for publ. Journal of Cleaner Production	This study confirmed previous research that the largest contributor to the environmental profile is the raw milk production at dairy farms. Contributions of the dairy processing plants are mainly due to energy requirement and inputs of goods at the dairy gate. Mitigation options for optimization of

Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
						Data quality	External critical review	Summary of environmental hotspots
		• Cream, • Butter, • Cheese			Human toxicity potential			environmental impacts rely on the choice of the production/packaging portfolio, energy fuel profile, water optimization and waste management.
Eggs (org.)	Dekker *et al*. (2013)	1 kg eggs leaving the farm gate	Cradle to (farm) gate	Not stated	GWP, energy use, land occupation, AP, N deficit, P deficit, N surplus, P surplus	Primary and secondary	Peer-reviewed for publ. Livestock Science	The main hotspots and contributors to hens' overall environmental impact are: cultivation of crops for feed, laying hen manure emissions and transport (of manure, hens, and feed ingredients). The main characteristics of hen diet that minimise ecological impacts are: (1) low feed conversion ratio (efficient use of feed), (2) short transport distances (45 % of feed ought to originate from less than 100 km from the egg farm), (3) a balanced use of manure combined with high yields, (4) use of oil expeller instead of whole grains.
Eggs (free range)	Taylor *et al*., (2014)	Per unit product Kg of eggs, dozen eggs, litre of milk, and kg live weight of: spent hens, lambs and beef	Cradle to (farm) gate	October 2008 to September 2009 (collected farm data)	GWP	Primary and secondary	Peer-reviewed for publ. Poultry Science	Concentrated feed is the hotspot for free range eggs (due to its imported soya content that has large GWP due to land use change). A different diet made up of other types of crop (or more sustainable soy) is likely to lower the GHG emissions for eggs. The N content of manure applied on fields leads to N_2O emissions, which also is a hotspot for free-range egg production.

1c: Food category - FRUIT

Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
						Data quality	External critical review	Summary of environmental hotspots
Apples, straw-berries	Webb *et al*., (2013)	1 tonne of produce as delivered to the RDC and based on the final commodity sold to the consumer. Strawberries: whole Apples: whole	Cradle to RDC	The baseline year was 2005, however an average of 5 years was calculated to even out annual differences	GWP, AP, EP, PEU, abiotic resource depletion, water consumption, land occupation, pesticide use	Primary and secondary	Peer-reviewed for publ. in Int. J. LCA	Apple: Yields are higher in NZ than in the UK. The GWP was relatively low for both countries 0.2 tCO_2e per tonne at farm gate in the UK and 0.1 tCO_2e in NZ. The GWP post farm-gate in the UK was divided between storage of apples (29 %), packaging (26 %) and processing (23 %). Whilst NZ apples 80 % of the GWP was due to transport. Strawberry: The strawberry yield in Spain is double the yield in the UK and hence Spanish production has a lower GWP. In Spain EP is an issue since N is not utilised efficiently. In the UK PEU is an issue because of the need of infrastructure (e.g. glass cover) to compensate for the climate. Post farm-gate packaging is a significant hotspot.
Oranges	Giudice *et al*. (2013)	1 ton oranges	Cradle to grave	Not stated	Human Health: Ozone layer depletion, Ionizing radiations, photo-chemical oxidation, human toxicity, respiratory inorganics Ecosystem Quality: Aquatic AP, Aquatic and terrestrial EP, Aquatic and terrestrial eco-toxicity, land occupation, Climate change: GWP	Primary and secondary	Peer-reviewed for publ. Ital. J. Food Sci.	The environmental impacts in the life cycle of oranges are distributed between three stages: cultivation, processing and transport. In the cultivation stage the production of pesticides and fertilisers is a hotspot as well as the irrigation of water (water and energy use), and what cultivation techniques are used. In the processing stage the plastic boxes to transport oranges accounts for 70 % of total impact. In the transporting stage the main causes are diesel use, production of vehicles and production and maintenance of infrastructure (roads). Climate change is only 25.5 % of total impact. Resource use (35.8 %) and human health impacts (31.5 %) are also hotspots.

Type	**Source**	**Functional unit**	**System boundary**	**Time related coverage**	**Environmental Impact categories**	**Reliability**		**Results**
						Data quality	External critical review	Summary of environmental hotspots
					Resources Non-renewable energy, mineral extraction			
Bananas	Iriarte *et al*., (2014)	1 kg of Ecuadorian premium quality banana delivered to a European port	Cradle to gate	2009-2011	GWP	Primary and secondary	Peer-reviewed for publ. Sci. Total Enviro.	Transport is a hotspot: which type of vessel is used and whether or not it returns empty. In the farming stage the application of fertilizer is a main hotspot since it leads to N_2O emissions. Packaging is a hotspot due to the major use of it for transport.

1d: Food category - VEGETABLES

Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
						Data quality	External critical review	Summary of environmental hotspots
Tomato products	Del Borghi *et al.* (2014)	1 kg packaged product (excl. weight of packaging)	Cradle to (factory) gate	2011	GWP, ozone depletion, AP, EP photochemical ozone-creating potential, human toxicity, fresh-water aquatic eco-toxicity, marine eco-toxicity, terrestrial eco-toxicity	Primary and secondary	Peer-reviewed for publ. in J. Clean. Prod.	Irrigation, fertiliser use and packaging materials are hotspots for all tomato products. <u>Cultivation:</u> fossil fuel use drives GWP. Water use is large in this stage. Nitrogen leaching from fertilisers that leads to EP is also an issue. <u>Packaging:</u> material use gives the highest impact at this stage (steel & glass are hotspots) and weight is also an important factor. AP and oxidant formation is driven by electricity and fuel use. In the supply chain, packaging waste is the main type of waste. <u>Processing:</u> it is assumed that wind power is used at this stage – hence GWP is low.
Tomatoes	Webb *et al.*, (2013)	1 tonne of produce as delivered to the RDC, based on the final commodity sold to the consumer. <u>Tomatoes</u>: loose classic, on-the-vine, cherry and plum	Cradle to RDC	The baseline year was 2005, however an average of 5 years were calculated to even out annual differences	GWP, AP, EP, PEU, abiotic resource depletion, water consumption, land occupation, pesticide use	Primary and secondary	Peer-reviewed for publ. in Int. J. LCA	<u>Greenhouses heated by fossil fuels</u> drives PEU (heating) and abiotic resource depletion (material to greenhouses). If greenhouses were heated with waste heat, then PEU (and GWP) would be lower than for Spanish production. <u>Grown on field (in Spain):</u> energy and water use for irrigation is a hotspot, as is the large use of pesticides. GWP in Spain is 0.3 tCO_2e compared to 2.1 tCO_2e in the UK.
Potatoes	Webb *et al.*, (2013)	1 tonne of produce as delivered to the RDC, based on the final commodity sold to the consumer. <u>Potatoes</u>: main and early	Cradle to RDC	Baseline: 2005	GWP, AP, EP, PEU, abiotic resource depletion, water consumption, land occupation, pesticide use	Primary and secondary	Peer-reviewed for publ. in Int. J. LCA	In the UK, potatoes have a competitive advantage at the primary production stage compared to Israel. A hotspot for potatoes is cold storage which drives PEU and GWP.

1f: Food category - FISH AND SEAFOOD

Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
						Data quality	External critical review	Summary of environmental hotspots
Wild cod and farmed salmon	Ellingsen and Aanondsen (2006)	200 g farmed salmon fillet/ 200 g wild caught cod fillet	Cradle to gate	Not stated	Energy use, nutrient emissions, antifouling (eco-toxicity), land use	Primary and secondary	Peer-reviewed for publ. in Int. J. LCA	Aquaculture: Feed ingredient production for salmon is the stage responsible in the chain for the largest environmental impact (both from fishmeal and arable crops production). Marine: Fuel use is the responsible for the largest impact for cod fishing.
High-sea fish and farmed salmon	ESU-services (2011)	1 kg of fish fillet sold in a Swiss supermarket	Cradle to retail	2004	GWP and eco-point	Primary and Secondary	No – but conducted the LCA following ISO 14040/44	Frozen cod: fuel use for fishing stage. Herring: aluminium production for can. Mackerel: aluminium production for can and production of virgin olive oil. Farmed smoked salmon: fish feed production and emissions into surface water.
Wild hake	Vázquez-Rowe *et al.* (2011)	500 g of raw gutted fresh hake fillet reaching an average consumer household in 2008	Cradle to grave	2008	GWP, AP, EP, ozone depletion potential, abiotic depletion potential, marine eco-toxicity potential	Primary and secondary	Peer-reviewed for publ. Fisheries Research	For all impact categories included in the study the fishing stage was the major contributor to environmental impacts. AP: 89.2%, EP: 87.2%, GWP, ozone depletion potential and abiotic depletion potential were all above 75% and marine eco-toxicity potential only became 51.6% at this stage. Wholesale and retail contribution was the second largest stage for GWP and marine eco-toxicity.

1g: Food category - OILS AND FATS

Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
						Data quality	External critical review	Summary of environmental hotspots
Olive oil	Tsarouhas *et al*. (2015)	1 bottle of extra virgin oil with a volume of 1 litre	Cradle to gate	Not specified	GWP, AP,EP, photo-oxidant formation, water use, energy use	Primary and secondary	Peer-reviewed for publ. in J. Clean. Prod.	GWP: olive cultivation creates 40 % of GHG emissions, followed by production and transport of bottles (22 %) and production of olive oil (21 %). Acidification Potential: Olive cultivation creates the largest share (44 %), followed by the production of olive oil and the production, transport and use of fertilisers. Photo-oxidant formation: olive cultivation has the largest share (68 %). Eutrophication Potential: olive oil production has the highest effect (82 %). Water consumption: olive oil production and olive tree cultivation have the largest water usage in the life cycle. Energy use: olive tree cultivation, olive oil production, and production and transport of bottles require most energy. Production and transport of fertilisers and packing also require a large amount of energy. It is the use of fuel, energy and water that are the main causes of environmental impact.
Palm, soybean, rapeseed, sunflower and peanut oil	Schmidt (2015)	1 tonne of refined vegetable oil at refinery gate	Cradle to gate	2001-2011	GWP, land occupation (impact on biodiversity), water consumption (blue water), water stress	Secondary	Peer-reviewed for publ. in J. Clean. Prod.	GWP: driven by land use and associated land use change emissions (CO_2), cultivation methods and oil mill processes also had an impact. Sunflower and rapeseed had lowest GWP, peanut oil had the largest. Water use: rapeseed and sunflower oils have a net saving of water (even though they are irrigated) since, by choosing these oil types, water will be saved that would have been used in the other oil productions. Comparing oil mix: 1) Reduce the use of peanut oil (will lower GHG emissions) 2) Do not reduce use of sunflower and rapeseed oil to the benefit of one of the other oils (that will increase GHG emissions since the other oils have higher burdens).
Palm oil	Yusoff and Hansen (2007)	1,000 kg of crude palm oil	Cradle to grave	Not stated	Human health: Carcinogens, Respiratory	Secondary	Peer-reviewed for publ. in	Respiratory inorganics and depletion of fossil fuels are the main environmental impacts of crude palm oil production. The respiratory inorganics are mainly

Type	**Source**	**Functional unit**	**System boundary**	**Time related coverage**	**Environmental Impact categories**	**Reliability**		**Results**
						Data quality	External critical review	Summary of environmental hotspots
					inorganics, Respiratory organics, Climate change, Radiation, Ozone layer Ecosystem quality: Eco-toxicity, AP/EP Resources: Minerals, Fossil fuels		Int. J. for LCA	derived from the oil mill stage. The fossil fuel depletion on the other hand is mainly driven by the production of fertilisers and from transport. Methane emissions from anaerobic digestion ponds and discharge from them to waterways are not included in the analysis and would significantly increase the results of EP/AP. Pesticide use was not included in the analysis but is assumed (based on other sources) to have a low impact as integrated (biological) pest management systems were in place and therefore only small doses of pesticides were needed. The most polluting process in palm oil production was production of chemical fertiliser, then transport and lastly the oil mill processes.

1h: Food category - COLD BEVERAGES

Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
						Data quality	External critical review	Summary of environmental hotspots
Orange juice	ESU-services, (2013)	1 litre of NFC orange juice in 1.0 l PET bottle, one-way, at bottling plant	Cradle to gate	2011 (primary data)	GWP, human toxicity (cancer and non-cancer effects), AP, EP terrestrial, EP marine, EP freshwater, freshwater eco-toxicity, abiotic resource depletion, water depletion, land use	Primary and secondary	No – but conducted the LCA following ISO 14040	Orange cultivation: had more than 70 % of total environmental impacts for the impact categories: land use, water depletion, eco-toxicity of freshwater, human toxicity – non-cancer effects, and marine eutrophication. Mainly due to the use of N and P_2O_5 fertiliser, pesticide use and production, electricity use and irrigation. Bottling process: had more than 50 % of the total emissions for GWP and abiotic resource depletion, mainly due to electricity use (coal) and thermal energy use (natural gas), and the packaging material and associated processes with production of PET bottles.
Carbonated soft drinks	Amienyo *et al*. (2013)	1 litre of a carbonated drink/ total annual production and consumption of carbonated drinks in the UK	Cradle to grave	2008-2011	GWP Packaging: PEU, AP, EP, abiotic depletion, human toxicity potential, marine aquatic eco-toxicity, freshwater eco-toxicity, terrestrial eco-toxicity, ozone depletion, photo-chemical oxidant creation potential	Primary and secondary	Peer-reviewed for publ. in Int. J. LCA	Packaging creates most of the environmental impact for carbonated soft drinks. The ingredients (mainly the sugar) create a smaller part. The process of bottling and packaging the soft drinks also adds to the total – because of the energy needed. Glass bottles have the highest environmental impact. This can be lowered if the bottles are re-used; however, only to the same level as aluminium cans and 0.5 litre bottles. The most environmentally friendly bottle is the 2 litre PET bottle. Transport has a minor impact. Beverages should only be refrigerated when needed, as the shelf life is the same in ambient temperature. Refrigeration has a significant impact on the GWP if used.

1i: Food category - HOT BEVERAGES

Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
						Data quality	External critical review	Summary of environmental hotspots
Coffee	Humbert *et al*. (2009)	To provide a 1 dl cup of coffee ready to be drunk, at the consumer's home	Cradle to grave	Not stated	GWP, energy use, water use	Primary and secondary	Peer-reviewed for publ. in J. Clean. Prod.	In total, spray dried soluble coffee has lower energy use and GWP than filter coffee and espresso. The user phase in the supply chain is responsible for the largest emissions, due to heating water and washing cups. As for packaging, glass jars have highest impacts which can be lowered by using stand-up pouches instead.

1j: Food category - BREAD AND CEREALS

Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
						Data quality	External critical review	Summary of environmental hotspots
Breakfast cereals	Jeswani *et al*. (2015)	Production of 1 kg of breakfast cereal products	Cradle to grave	2011	GWP, AP, EP, Primary energy demand, Water footprint, Abiotic depletion potential, Freshwater aquatic eco-toxicity potential, Human toxicity potential, Marine aquatic eco-toxicity potential, Ozone layer depletion potential, Photochemical oxidant creation potential, Land use	Primary and secondary	Peer-reviewed for publ. in Sustainable Production and Consumption	The ingredients for the cereals account for the largest part of GWP (48 %) - rice is worst. The ingredients are also the main contributors to land use (97 %), eutrophication (71 %), element depletion (61 %), human toxicity (54%) and photochemical smog (50 %). The ingredients also represent the largest water use. Manufacturing accounts for the largest part of primary energy use (electricity and natural gas use) which drives GWP (23 % of total). Packaging mainly impacts abiotic resource depletion as well as marine and freshwater eco-toxicity, but also GWP (15 %). Primary packaging accounts for a much larger share of GWP compared to secondary packaging. Transport also leads to ozone layer depletion, acidification and photochemical smog creation. It also drives GWP (15 %). When the consumption stage is included (i.e. when cereals are eaten with milk) the milk will increase the environmental impacts significantly. Without milk, cereals have a GWP of 2.64 kg CO_2e but with milk that rises to 8.84 kg CO_2e.

AP - Acidification Potential; **EP** - Eutrophication Potential; **GWP** - Global Warming Potential; **IP -** integrated production; **PEU** - Primary Energy Use; **tCO_2e –** tonnes of CO_2 emissions (equivalent)
Primary data: gathered directly from farms or production sites, **Secondary data**: gathered from other sources (e.g. literature, databases)

Table 50: Overview of selected LCAs for different catering service activities

Catering service type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
						Data quality	External critical review	Impact hotspot summary
Restaurant and foodservice (USA)	Baldwin *et al*. (2011)	Operation of a restaurant or food service per month	Farm to fork	2008 Data was averaged over 12 months	GWP, EP, AP, respiratory inorganics, land use, fossil fuel use, human toxicity – cancer, eco-toxicity	Primary and secondary	Peer-reviewed for publ. in Int. J. Life. Cycle Assess. IF (impact factor)=3.988.	The **food procurement** stage has a large contribution to the total and is especially large for the impact categories: land use, respiratory organics, AP, EP and GWP. **Operational support** *(lighting, ventilation, air conditioning, heating, water use, supplies (cleaning, toilets, disposable products) and administration stage*) has a high impact on carcinogens, eco-toxicity and fossil fuels. Whilst **food storage** and **food preparation** only have a marginal impact on the total, the food procurement part created 94.7 % of the total environmental impact (after normalising results).
Professional kitchens: Cook-warm and cook-chill (pasta)	Fusi *et al*. (2015)	Preparation and distribution of 1 kg of cooked pasta	Preparation to consumption	1999-2013	GWP, ozone depletion, human toxicity, photochemical oxidants formation, terrestrial AP, freshwater EP, terrestrial, freshwater and marine eco-toxicity, metal depletion, fossil fuel depletion, (water footprint – for cooking pasta)	Primary and secondary	Peer-reviewed for publ. in J. Clean. Prod. IF (impact factor)=3.844	The cooking stage creates the highest share of emissions for both systems and transport is negligible for both systems. Cook-warm (preparation to place of consumption) has lower impact than cook-chill since food in the latter needs to be chilled, stored cool and reheated before consumed, whereas cook-warm is ready to eat when arrived. However, since the cook-chill chain has much lower levels of food waste, the overall impact is lower than cook-warm.
Ready meals	Calderón *et al*. (2010)	1 kg of finished product ready to be consumed. 1 kg of packaging (including food containers) material	Cradle to grave	2007	GWP, EP, AP, abiotic depletion, ozone layer depletion, human toxicity, fresh water aquatic-, marine aquatic- and terrestrial eco-toxicity, photochemical oxidation, radiation, respiratory inorganics, carcinogens, land use, fossil fuels, minerals	Primary and secondary	Peer-reviewed for publ. in Resources Conservation and Recycling IF (impact factor)=2.564	The largest environmental hotspots were identified for: Food ingredients (primarily from the meat) Solid waste management (food waste and tin cans go to landfill - had a large impact on marine and fresh water eco-toxicity). **Transport** (incl. overseas transport of pulses by ship) and **energy use** are large contributors to the total environmental impact. From an environmental perspective it is more important to reduce electricity use than natural gas use, as electricity has higher environmental impact (especially when it is derived from fossil fuels). **Solid waste management:** alternative **end-of-life**

								scenarios with different packaging systems show that impacts of 1 kg of (PLA) compostable/biodegradable biopolymer were also high in fossil fuels consumption and marine aquatic ecotoxicity, but lower than conventional plastics. Advanced composting facilities will help to take advantage of biopolymer packaging systems in this food sector, thus reducing the amount of food wastes sent to landfill and complying with European Regulations on reducing the amount of biodegradable wastes disposed of in this way.
Compostable cutlery	Razza, *et al*. (2009)	Catering of 1000 meals	Cradle to grave		Non renewable energy use NREU, greenhouse gases emissions GHG, solid waste production SWP, eutreophication potential EP, acidification potential AP	Primary and secondary	Peer-reviewed for publ. in Waste Management IF (impact factor)=3.228	Assessing the environmental impacts of different end-of-life scenarios: mixed waste including non-biodegradable cutlery and food waste, which is disposed in landfill or incineration; organic waste including compostable cutlery and food waste, which is composted. The second scenario allows remarkable savings in all impact categories. Compostable/biodegradable cutlery is instrumental in increasing waste recyclability and improving waste management.
Compostable biobased plastic	Weiss *et al.* (2012); Groot et al. (2010)	1 kg of bio-based material; 1 tonne of biobased PLA	Cradle to gate; cradle to gate, end-of-life options		Global warming potential GWP, stratospheric ozone depletion SOD, acidification potential AP, eutrophication potential EP, primary energy use PEU, non-renewable energy use NREU, photochemical ozone formation POF, abiotic depletion AB, human toxicity HT, carcinogenic potential CP, solid waste production SWP, land use LU	Primary and secondary	(Weiss et al.)Peer-reviewed for publ. in Journal of Industrial Ecology IF (impact factor)=3.227; (Groot et al.)Peer-reviewed for publ. in Int. J. Life. Cycle Assess IF (impact factor)=3.988	The paper by Weiss is a review of 44 LCA studies of biobased materials. Focusing on the results about bioplastic the comparison of the environmental impacts of bio-based plastic to conventional plastic shows positive savings of non-renewable energy, greenhouse gases, tropospheric ozone formation and acidificiation potentials. Moreover, biobased materials exert lower human and terrestrial eco-toxicity as well as carcinogenic potentials than conventional materials. Biobased plastic results in higher eutrophication and stratospheric ozone depletion than conventional fossil-based plastic. The paper by Groot confirms the above results for PLA and PLLA about primary energy use, acidification and eutrophication potentials, photchemical ozone formation, human toxicity potential. Moreover, the abiotic resource depletion potential of PLA is lower than in fossil-based plastic. End-of-life options are assessed, showing that composting or anaerobic

								digestion of PLA would lead to low CO2 emissions and moderate carbon retention, while landfilling is not considered sustainable.

AP - Acidification Potential; **EP** - Eutrophication Potential; **GWP** - Global Warming Potential; **PEU** - Primary Energy Use ; **POF** - photochemical ozone formation **AB** - abiotic depletion, **HT** - human toxicity, **CP** - carcinogenic potential, **SWP** - solid waste production, **LU** - land use , **SOD** - stratospheric ozone depletion, **HET** - human eco-toxicity,**TET** - terrestrial eco-toxicity, **CP** - carcinogenic potential. We assume that PEU=NREU and GHG=GWP and that abiotic resource depletion potential is the same as "Resource Depletion – mineral, fossil" in the next tables .

Primary data: gathered directly from farms or production sites, **Secondary data**: gathered from other sources (e.g. literature, databases)

Table 51: Overview of selected LCAs of comparisons between agricultural production systems

Production systems	Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
							Data quality	External critical review	Impact hotspot summary
Org/conv.	Milk	Guerci *et al*. (2013)	1 kg of energy-corrected milk (ECM)[106]	Cradle to (farm) gate	Not stated	GWP, EP, AP, non-renewable energy use, land occupation, biodiversity	Primary and secondary	Peer-reviewed for publ. in J. Clean. Prod.	The variability between farms was large and hence it is hard to tell the differences between organic and conventional systems. Improving feed efficiency of animals can help lower the impact categories of GWP, EP and AP. The proportion of grassland used for cows grazing during the summer positively affects GWP, PEU and AP. This occurs if carbon sequestration is included in the calculation. Biodiversity is also positively affected by a high % of grassland – this was most evident in organic systems where the share of grassland is higher than in conventional production.
Org/conv.	Milk	Cederberg and Mattsson, (2000)	1,000 kg ECM leaving the farm gate	Cradle to gate	Not older than 1995	GWP, AP, EP, photo-oxidant formation, (ozone depletion), material use, primary energy use, land use, pesticide use	Primary and secondary	Peer-reviewed for publ. in J. Clean. Prod.	**Organic:** larger impact on EP, photo-oxidant formation, land use, and on uranium, hydropower, diesel and limestone. **Conventional:** larger impact on GWP, AP, PEU, pesticide use and the materials crude oil, natural gas, coal, P and K. The main environmental benefits of organic systems are the avoided use of pesticides and phosphorus. Cow diets can be improved in organic systems by decreasing roughage and increasing concentrated feed – decreasing methane emissions. Yields for fodder crops can be improved per hectare, possibly by using more productive crops.
Org/ free-range/ conv.	Eggs	Leinonen *et al*. (2012b)	1,000 kg of marketable eggs at the farm gate	Cradle to gate	Not stated	GWP, EP, AP, abiotic resource depletion, pesticide use, land use	Primary and Secondary	Peer-reviewed for publ. in Poultry Science	The conventional barn system has lowest EP and AP, although the free-range system is close behind. The free-range system has lowest GWP and the organic system has lowest pesticide use whilst the free-range system has the largest use.
Org/ free-	Chicken	Leinonen *et*	1,000 kg of	Cradle to	Energy	GWP IPCC	Primary	Peer-reviewed	The length of life of chickens is relevant for determining

[106] kg ECM = kg milk*(0.25 + 0.122 * Fat% + 0.077* Protein%) (Guerci *et al*., 2013)

Production systems	Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
							Data quality	External critical review	Impact hotspot summary
range/ conv.		*al*. (2012a)	expected edible carcass weight at the farm gate	gate	consumption: Average 2009-2010	(GWP_{100})GWP, EP, AP, land occ., pesticide use, abiotic resource use, PEU	and secondary	for Poultry Science	environmental impacts. Organic chickens live longest (compared to conventional and free range systems) and hence need more feed, water, electricity etc. In total, organic chickens have higher impact in most impact categories and feed is the main contributor to the total impact.
Org/ conv.	Banana	Roibás *et al*., (2014)	1 ton of banana arriving to consumption stage	Cradle to grave	Not stated	GWP	Primary and Secondary	Conference paper - LCA - following ISO 14067 and PAS 2050:2011	The main stages that contribute to emissions are: sea transport, consumption stage and the plantation stage. At the plantation stage organic bananas are responsible for a lower emission of CO_2e than conventional bananas.
Org/ conv.	Darjeeling tea	ESU-services, (2010)	Preparing 1 cup (250 ml) of tea ready to drink at home in Europe (using 1.75 g of dry tea leaves)	Cradle to grave	2010 (primary data)	GWP and Ecological Scarcity 2006	Primary and secondary (overall lack of data)	No – but conducted the LCA following ISO 14040	Boiling the kettle at the consumer stage has the largest environmental impact in the life cycle of tea. The second largest impact comes from the cultivation of tea leaves. Two methods of impact assessment were used: **Carbon footprint:** Conventional production showed a slightly lower global warming potential than organic, due to methane emissions from the compost used for fertiliser in organic production but not used in the conventional production. **Ecological scarcity:** Organic production showed lower impact due to the conventional production emissions to topsoil associated with the pesticide uses.
Palm oil (RSPO/ non-RSPO)	Oils & fats	Saswattecha, *et al.* (2015)	1 tonne crude palm oil (CPO)	Cradle to gate	Not stated	GWP, EP, AP, human toxicity, freshwater eco-toxicity, photochemical oxidant formation	Primary and Secondary	Peer-reviewed for publ. in J. Clean. Prod.	Within crude palm oil production there are five activities that contribute most to environmental impact: 1) Burning fibres in boilers 2) Fertilizer use 3) Treatment of wastewater and disposal of empty-fruit-bunch 4) Use of gasoline when cutting weed 5) Weed control using glyphosate The palm oil produced according to RSPO standard had overall lower impact than the non-RSPO productions.
Org/ conv.	Bread wheat,	Williams *et al*. (2010)	1 tonne of fresh weight	Cradle to gate	Not stated	GWP, EP, AP, abiotic resource	Secondary	Peer-reviewed for publ. in Int.	The main hotspot for **PEU** for conventional production is the production of fertiliser (57 %); in organic

Production systems	Type	Source	Functional unit	System boundary	Time related coverage	Environmental Impact categories	Reliability		Results
							Data quality	External critical review	Impact hotspot summary
	oilseed rape and potatoes		of each product, standardised to 86 % dry matter for wheat, 92.5 % for rape and 20 % for potatoes.			depletion, energy use, pesticide use, land occupation		J. Life. Cycle Assess.	production it is field work (60 %). The use of pesticides minimises the need to mechanically manage the soil. Organic production does not use pesticides and therefore needs more mechanical field work. Furthermore, the lower yields in organic production lead to a higher energy usage per tonne. **N_2O emissions** are a hotspot for arable crop production and emission of greenhouse gases is a problem for both organic and conventional production. With organic production, bread wheat needed about 80 % of the energy, potatoes needed 13 % more energy because the lower fertiliser use (and hence energy use) is offset by more energy for fieldwork and lower yields, and main crop potato energy is dominated by cold storage. While pesticide use was always lower in organic production, other burdens were generally (inconsistently) higher or lower and land occupation was always higher. With reduced nitrogen application production systems, bread wheat energy use and GWP are reduced, but also the proportion of wheat is of bread-quality is reduced. Arable crop production depends heavily on fossil fuel in current major production systems. The emissions causing GWP are very dependent on N_2O, more than fuel consumption.

AP - Acidification Potential; **EP** - Eutrophication Potential; **GWP** - Global Warming Potential; **PEU** - Primary Energy Use
Primary data: gathered directly from farms or production sites, **Secondary data**: gathered from other sources (e.g. literature, databases)

3.1.2 Summary of comprehensiveness of selected LCA studies

The LCAs studies included in Table 49 (namely Table 1a to 1j) to Table 51 were reviewed in detail because they were peer-reviewed (or followed an adequate LCA method), most of them were recent, and the scope of those studies was within the scope of this report. However, the comprehensiveness in terms of their coverage of impact categories varied. This section provides a more detailed analysis of the previously identified studies. Table 52, Table 53 and Table 54 show the analysis performed for, respectively, food categories, type of catering service, and the distinct production systems.

Moreover, the comprehensiveness of the selected LCAs in terms of their impact category coverage was evaluated against the European Commission's Product Environmental Footprint (PEF) (EC/JRC, 2012). Currently pilot projects are being conducted on food products for PEF for the following products: beer, coffee, dairy, feed for food-producing animals, fish, meat (bovine, pigs, sheep), olive oil, packed water, pasta, pet food (cats and dogs) and wine (European Commission, 2015h). However, due to the fact that these pilot project results are not yet available a detailed insight was not here carried out. In addition, the PEF methodology for bio-based (biodegradable/compostable material) is being currently developed by (EC/ JRC).

Additional impact categories, not used in the PEF, but mentioned in the LCAs are also listed in Table 52 to Table 54. Table 52 shows that most studies cover the main stages of the food chain for the food products. It appears that **acidification potential (AP), eutrophication potential (EP), global warming potential (GWP), (primary) energy use (PEU) and land use** are the impact categories mostly explored, being those commonly impact categories associated with agricultural products. **Eco-toxicity** and **human toxicity** were also highlighted in some articles. Overall it seems that the remaining impact assessment categories were not considered significant when compared to the ones in mentioned above.

Table 53 shows that the LCA studies for catering services provide a good overview on the distinct life cycles stages associated with catering provision. In terms of the environmental impact categories covered, they provide a good coverage of the environmental impact categories for ready meals. These are also compared with the environmental impact categories identified in PEF.

Table 54 overviews the reviewed studies that compare different production systems. It is clear that they mainly focus on the impact categories: global warming potential, acidification and eutrophication potential and hence do not have a good coverage of the categories identified in PEF, instead the focus are on other impact categories such as pesticide use, land use and energy use.

Table 52: List of impact categories for food categories, covered by the selected LCA studies

Source	Tsarouhas *et al.* (2015)	Schmidt, (2015)	Yusoff and Hansen (2007)	Webb *et al.* (2013)	Halberg *et al.* 2010	da Silva *et al.* (2014)	Ellingsen and Aanondsen (2006)	ESU-services, (2011)	Vázquez-Rowe *et al.* (2011)	Hietala *et al.* (2014)	Taylor *et al.* (2014)
Product sub-category	Oils and fats	Oils and fats	Oils and fats	Meat/ fruit/ vegetables	Meat	Meat	Fish and seafood	Fish and seafood	Fish and seafood	Milk, cheese, and eggs	Milk, cheese and eggs
Scope	Extra virgin olive oil	Palm, soybean, rapeseed, sunflower & peanut oil	Crude palm oil	Beef, lamb, chicken, potatoes, apples, strawberries, tomatoes	Pig (org.)	Broiler chicken	Wild caught cod/ farmed salmon	High-sea fish and farmed salmon	Wild hake	Milk (org)	Eggs (free range)
Project scope alignment (as defined by the Technical Analysis)											
Pre-production	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Primary production	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Processing	✓	✓	✓	✓		✓	✓	✓	✓		
Packaging	✓			✓		✓		✓	✓		✓
Storage	✓			✓		✓	✓	✓	✓		✓
Distribution/transport	✓	✓	✓	✓			✓	✓	✓	✓	
Impact category assessment (as defined by PEF)											
Climate change (GWP)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ozone depletion			✓	✓	✓		✓		✓		
Eco-toxicity for aquatic fresh water			✓								
Human toxicity – cancer effects			✓	✓			✓				
Human toxicity – non-cancer effects											
Particulate matter/ Respiratory inorganics			✓	✓			✓				
Ionising radiation – human health effects			✓								
Photochemical ozone formation											
Acidification	✓		✓	✓	✓	✓	✓		✓		
Eutrophication – terrestrial	✓		✓	✓	✓	✓	✓		✓		
Eutrophication – aquatic											
Resource depletion – water											
Resource depletion – mineral, fossil			✓						✓		
Land transformation											
Other impact category assessments used in LCA reports											
Phosphorous use											

Nitrogen use											
Water use	✓	✓		✓							
Water stress		✓									
Energy use	✓			✓		✓	✓				
Fossil fuel use				✓			✓				
Photo-oxidant formation	✓										
Photochemical ozone-depleting potential											
Photochemical oxidant formation											
Terrestrial eco-toxicity						✓					
Marine eco-toxicity							✓		✓		
Land occupation/use		✓		✓	✓	✓	✓				
Abiotic resource use			✓	✓							

Table 52 (cont.): List of impact categories for food categories, covered by the selected LCA studies

Source	**Dekker *et al*. (2013)**	**Djekic *et al*. (2014)**	**González-García *et al.* (2013)**	**Iriarte *et al.*, (2014)**	**Giudice *et al.* 2013**	**Del Borghi *et al*. (2014)**	**Jeswani *et al*. (2015)**	**ESU-services, (2013)**	**Amienyo *et al*. (2013)**	**Humbert *et al*. (2009)**
Product sub-category	Milk, cheese, eggs	Milk, cheese, eggs	Milk, cheese and eggs	Fruit	Fruit	Vegetables	Bread and cereals	Cold drinks	Cold drinks	Hot drinks
Scope	Eggs (org)	Dairy products	Milk	Bananas	Oranges (IP)	Tomato products	Breakfast cereals	Orange juice	Carbonated soft dinks	Spray dried soluble coffee / drip filter/ espresso
Project scope alignment (as defined by the Technical Analysis)										
Pre-production	✓		✓	✓	✓	✓		✓		✓
Primary production	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Processing		✓	✓	✓	✓	✓	✓	✓	✓	✓
Packaging		✓	✓	✓		✓	✓	✓	✓	✓
Storage	✓		✓	✓		✓	✓		✓	✓
Distribution/transport			✓	✓	✓	✓	✓	✓	✓	✓
Impact category assessment (as defined by PEF)										
Climate change (GWP)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ozone depletion		✓	✓		✓	✓	✓		✓	
Eco-toxicity for aquatic fresh water			✓		✓	✓	✓	✓	✓	
Human toxicity – cancer effects		✓	✓		✓	✓	✓	✓	✓	
Human toxicity – non-cancer effects								✓		
Particulate matter/ Respiratory inorganics					✓					
Ionising radiation – human health effects					✓					

Photochemical ozone formation			✓			✓			✓	
Acidification	✓	✓	✓		✓	✓	✓	✓	✓	
Eutrophication – terrestrial	✓	✓	✓		✓	✓	✓	✓	✓	
Eutrophication – aquatic					✓			✓		
Resource depletion – water								✓		
Resource depletion – mineral, fossil					✓			✓	✓	
Land transformation										
Other impact category assessments used in LCA reports										
Phosphorous use	✓									
Nitrogen use	✓									
Water use							✓			✓
Water stress										
Energy use	✓		✓	✓	✓					✓
Fossil fuel use										
Photo-oxidant formation					✓					
Photochemical ozone-depleting potential						✓				
Photochemical oxidant formation		✓	✓			✓	✓			
Terrestrial eco-toxicity			✓	✓	✓	✓				
Marine eco-toxicity			✓	✓			✓		✓	
Land occupation/use					✓		✓			
Abiotic resource use			✓	✓			✓	✓		

Table 53: List of impact categories for catering service, covered by the selected LCA studies

Source	Calderón *et al*. (2010)	Baldwin *et al*. (2011)	Fusi *et al*. (2015)	Razza *et al*. (2009)	Weiss *et al*. (2012), Groot *et al*. (2010)
Product sub-category	Catering service	Catering service	Catering service	Catering service	Catering service
Scope	Ready meals	Restaurant and foodservice	Professional kitchens: Cook-warm and cook-chill (pasta)	Compostable cutlery	Compostable biobased plastics
Project scope alignment (as defined by the Technical Analysis)					
Pre-production	✓	✓			
Primary production	✓	✓			
Processing	✓	✓			
Packaging	✓	✓		✓	✓
Storage	✓	✓	✓		
Distribution/transport	✓	✓	✓		
Preparation	✓	✓	✓		
End of life (waste management)	✓			✓	✓
Impact category assessment (as defined by PEF)					
Climate change (GWP)	✓	✓	✓	✓	✓
Ozone depletion	✓		✓		✓
Eco-toxicity for aquatic fresh water	✓	✓	✓		
Human toxicity – cancer effects	✓	✓	✓		✓
Human toxicity – non-cancer effects					✓
Particulate Matter/ Respiratory Inorganics	✓	✓			
Ionising Radiation – human health effects	✓				
Photochemical Ozone formation					✓
Acidification	✓	✓	✓	✓	✓
Eutrophication – terrestrial	✓	✓	✓	✓	✓
Eutrophication – aquatic			✓		
Resource Depletion – water					
Resource Depletion – mineral, fossil	✓		✓		✓
Land Transformation					✓
Other impact category assessments used in LCA studies					
Water use			✓		
Material use/depletion			✓		
Fossil fuel use	✓	✓		✓	✓

Land occupation/use		✓			✓
Photo-oxidant formation	✓		✓		
Photochemical oxidation	✓				
Terrestrial eco-toxicity	✓				✓
Marine eco-toxicity	✓				
Solid waste production				✓	

Table 54: List of impact categories for comparison of production systems, covered by the selected LCA studies

Source	Leinonen *et al.* (2012a)	Guerci *et al.* (2013)	Cederberg and Mattsson, (2000)	Leinonen *et al.* (2012b)	Roibás *et al.* (2014)	ESU-services, (2010)	Williams *et al.* (2010)	Saswattecha, *et al.* (2015)
Product sub-category	Meat	Milk, cheese and eggs	Milk, cheese and eggs	Milk, cheese and eggs	Fruit	Hot drinks	Bread and cereals/ vegetables	Oils and fats
Scope	Broiler chicken (Org/ free-range/ conv.)	Milk (Org/ conv.)	Milk (Org/ conv.)	Eggs (Org/ free-range/ conv.)	Banana (Org/conv.)	Darjeeling tea (Org/conv.)	Bread wheat, oilseed rape, potatoes (Org/ conv.)	Palm oil (RSPO/ non-RSPO)
Project scope alignment (as defined by the Technical Analysis)								
Pre-production	✓	✓	✓	✓	✓	✓	✓	✓
Primary production	✓	✓	✓	✓	✓	✓	✓	✓
Processing	✓				✓	✓		✓
Packaging	✓				✓	✓		
Storage	✓				✓	✓	✓	
Distribution/transport	✓	✓	✓		✓	✓		✓
Preparation					✓	✓		
End of life (waste management)					✓	✓		
Impact category assessment (as defined by PEF)								
Climate change (GWP)	✓	✓	✓	✓	✓	✓	✓	✓
Ozone depletion	✓		✓					
Eco-toxicity for aquatic fresh water								✓
Human toxicity – cancer effects								✓
Human toxicity – non-cancer effects								
Particulate matter/ Respiratory inorganics								
Ionising Radiation – human health effects								
Photochemical ozone formation								✓
Acidification	✓	✓		✓			✓	✓
Eutrophication – terrestrial	✓	✓	✓	✓			✓	✓
Eutrophication – aquatic								
Resource depletion – water								
Resource depletion – mineral, fossil								
Land Transformation								
Other impact category assessments used in LCA reports								
Energy use	✓		✓	✓			✓	
Water use								
Material use			✓					
Pesticide use				✓			✓	
Non-renewable energy demand/use		✓				✓		
Photo-oxidant formation	✓		✓					
Land occupation/use	✓	✓	✓	✓			✓	
Abiotic resource use	✓		✓	✓			✓	
Biodiversity		✓						

3.1.3 Detailed analysis of the selected LCA studies

3.1.3.1 Base parameters of the selected LCA studies

The following base parameters were examined:

- Goal and scope.
- Functional units and system boundaries.
- Cut-off criteria.
- Allocation.
- Data quality requirements and data sources.
- Impact categories and assessment methods.
- Assumptions.

3.1.3.2 Goal, scope, functional units and system boundaries

LCAs are generally meant to have a scope from 'cradle-to-grave'. In this detailed analysis, however, most of the LCAs focused on a 'cradle-to-(farm) gate' approach, although there were exceptions. Two LCAs for catering services cover cradle-to-grave (Calderón *et al*., 2010; Baldwin *et al*., 2011), whilst the third focuses solely on the preparation stage (Fusi *et al*., 2015).

The functional unit (FU) according to ISO 14040 is a reference unit in a production system that can quantify performance. This is the unit chosen to report the environmental impacts. The system boundaries specifies the main processes that are included in the LCA analysis and hence which are excluded. Table 55 provides the results of the analysis carried out.

Table 55: Goal and scope of the studies

Category	Product/ service	Study	Goal	Scope	Functional unit(s)	System boundary
Oils & fats	Olive oil	Tsarouhas *et al*. (2015)	To take into account all key parameters that are associated with the LCA of olive oil in Greece (and find hotspots). Therefore analyse 14 sub-systems.	**Including:** fertilizer production, transport and use; pesticide production, transport and use; agricultural equipment manufacture; olive cultivation; transport from field to manufacturer; prod., olive oil; prod., bottles and transport; prod., lids; bottling of olive oil; prod., packaging and transport; adhesive tape; palettes; stretch film; palletizing of olive oil bottles.	1 bottle of extra virgin olive oil with a volume of 1 litre	Cradle to gate
	Palm, soybean, rapeseed, sunflower and	Schmidt (2015)	To find environmental info on major vegetable oils that is substitutable,	**Including:** oil crop cultivation, oil mill and refinery. Palm oil has an additional step; palm kernel oil mill. Indirect land use change is also included.	One tonne of refined vegetable oil at refinery gate	Cradle to gate

Category	Product/ service	Study	Goal	Scope	Functional unit(s)	System boundary
	peanut oil		and to evaluate environmental impacts and how markets react when oils are removed from the market and replaced by a new oil mix. A consequential approach.	All oils except soybean oil are demanded for the oil. Soybean is demanded for the by-product of the mill: protein meal.		
	Crude palm oil	Yusoff and Hansen (2007)	Investigate through an LCA the environmental consequences of crude palm oil production in Malaysia.	**Including:** Plantation (nursery stage, energy use, fertiliser and pesticide production, use and emissions, reuse of organic litter), transportation (diesel use and emissions), Mill (emissions from boiler stack, production of electricity, reuse of organic residues).	The production of 1000 kg of CPO (crude palm oil) in Malaysia.	Cradle to gate
	Crude palm oil (RSPO/ non-RSPO)	Saswattecha, *et al.* (2015)	Assess environmental impact of management practices of palm oil production in Thailand	**Including:** inputs (production and transports), oil palm plantations, palm oil mill, and by-products.	1 tonne crude palm oil (CPO)	Cradle to gate
Meat/ Fruit/ Vegetables	Beef, lamb, chicken, potatoes, apples, strawberries, tomatoes	Webb *et al*. (2013)	To conduct a comparative LCA, looking at resource use and environmental burdens for seven different food products. Comparing out-of-season and seasonal domestic production in the UK with imports, to assess where the hotspots are.	**Including:** All direct inputs and outputs connected to production, transport, storage, refrigeration, distribution, use and production of heat, electricity and fuel, maintenance and use of products, product and waste water disposal, recovery of used products, ancillary material manufacture, capital burdens (manufacture, maintenance and decommissioning), and other burdens (e.g. heating and lighting). Rules were applied for some steps such as construction of ships and vehicles. If the capital burdens of road vehicles are >10 % of total transport burdens, or >1 % of total burdens, they were included. Out-of-season production was included for the crops.	1 tonne of produce delivered to RDC and based on the final commodity sold to the consumer. Tomatoes: loose classic, on-the-vine, cherry & plum (UK/Spain) Strawberries: whole (UK/Spain) Apples: whole (UK/New Zealand) Potatoes: main & early (UK/Israel) Chicken: frozen breast – weight as sold (UK/Brazil) Beef: frozen hind beef cut – weight as sold (UK/Brazil) Lamb: chilled, or frozen (UK/NZ)	Cradle to Retail Distribution Centre
Vegetables	Tomato products	Del Borghi *et al*. (2014)	To present and discuss LCA results of 13 tomato products (tomato purée, chopped tomatoes and	**Including:** inputs to cultivation (plants, seeds, pesticides, fertilizers), cultivation of products (raw material, energy, water consumption, emissions), transport to processing, Production of packaging,	1 kg packaged product (excl. weight of packaging)	Cradle to (factory) gate

Category	Product/ service	Study	Goal	Scope	Functional unit(s)	System boundary
			peeled tomatoes in tomato juice) that was produced in Italy.	prod., of tomato products (water and energy use, raw materials, waste), packaging and labelling, storage (energy use and waste), prod., of additives and ingredients, wastewater management, transport to distribution centre (average), disposal of primary packaging.		
Bread and cereals/ vegetables	Bread wheat, oilseed rape, potatoes (org/ conv.)	Williams *et al*. (2010)	To calculate environmental burdens of the food products in scope, and compare it to future and current other production methods.	**Including:** seed production, pesticide and fertiliser production, crop production, fuel use, manufacture of buildings and machines, and storage, drying, cooling of crops before leaving the farm. Processes in soil up to 0.3 m deep were also included.	1 tonne of fresh weight of each product, standardised to 86 % dry matter for wheat, 92.5% for rape and 20 % for potatoes	Cradle to gate
Bread and cereals	Breakfast cereals	Jeswani *et al*. (2015)	To estimate environmental impacts and find improvement potentials throughout the supply chain.	**Including:** There are two scopes. 1) Includes: agriculture, manufacturing, packaging, transport and waste management. 2) Includes all as 1) plus consumption with milk.	Production of 1 kg of breakfast cereal products	Cradle to grave
Fruit	Banana (org/conv.)	Roibás *et al*. (2014)	To analyse the carbon footprint of conventional and organic bananas produced in Ecuador and consumed in Spain.	**Including:** Farm (fertilizers, pesticides, primary packaging material, crop protection material, pesticide application, farm waste), collection centre (waste creation and use of secondary packaging), departure port (emissions, fuel use), destination port (emissions, fuel use), ripening (ethylene, waste creation), RDC (waste, secondary packaging), Retail (rejected fruit, waste primary packaging), consumption (waste). Also energy input throughout the chain and transport (fuel use and emissions) throughout the chain).	1 ton of banana arriving to the consumption stage	Cradle to grave
	Banana	Iriarte *et al*. (2014)	To analyse carbon footprint of premium bananas from Ecuador by developing production and inventory data.	**Including:** on farm production, handle fruit (post-harvest), packaging, transport within Ecuador, and sea transport to Europe (Hamburg).	1 kg of Ecuadorian premium quality banana delivered to a European port	Cradle to gate
	Oranges	Giudice *et al*. (2013)	To quantify environmental impacts of integrated orange production through LCA.	**Including:** production, transport, processing and end of life	1 tonne of oranges	Cradle to grave
Meat	Chicken -	Leinonen *et*	To quantify	**Including:** Crop production, non-crop nutrient	1,000 kg of expected edible	Cradle to gate

Category	Product/ service	Study	Goal	Scope	Functional unit(s)	System boundary
	(org/free range/ conv.)	*al*. (2012a)	environmental burdens of three broiler (chicken) production systems (organic/ free range/ standard indoor - conventional) through LCA, to find reduction opportunities.	production (pure amino acids, fish meal, palm oil and sunflower meal), processing of feed, breeding (incl. maintain the flocks that breed, hatching and rearing of pullets), production (incl. rearing and finishing of broilers), water and energy use in housing, feed, gaseous emissions, management of manure and general waste. All inputs were traced to their origin, for example electricity from primary fuels. Overheads such as extraction, transport and delivery of energy carriers were incorporated. Bird performance was also included (food intake, growth, nutrient excretion). Land-use change impact was included in production of some crops.	carcass weight at the farm gate	
	Chicken	da Silva *et al*. (2014)	To investigate environmental impacts of whole processed chicken.	**Including:** crop inputs (machines, fertilisers, pesticides, diesel, other), day-old chicks (breeders, eggs for hatching, prod. of day-old chicks), feed factory (electricity), other feed ingredients (salt, DL methionine, dicalcium phosphate, premix, other), slaughter (electricity), packaging and outputs (also co-products).	1 tonne of cooled and packaged chicken, ready for distribution	Cradle to gate
	Pig (org.)	Halberg *et al*. 2010	To compare three different systems of organic: free-range, indoor fattening and tent system in terms of environmental impacts. To analyse importance of land use and carbon sequestration.	**Including:** Indoor fattening: Sows are kept on grassland that has small huts for protection, and the fattening pigs are moved indoors with access to deep bed area and outdoor concrete area. Free-range: outdoors all year round, no manure collection. Tent system: A tent on top of an outdoor area with a deep litter pen and layer of seashells on the soil (to reduce nutrient leaching). The litter is ultimately removed and used as fertiliser.	1 kg of live weight pig delivered from the farm	Cradle to gate
Fish and Seafood	Wild caught cod/ farmed salmon	Ellingsen and Aanondsen, (2006)	To investigate environmental impacts of farmed salmon and wild cod from Norway and compare the results with chicken production (from Norway), through a Life Cycle Screening.	**Including:** breeding, catching, farming, processing and transport. Also feed processing, raw material provision.	200 g fillet	Cradle to gate
	High-sea fish	ESU-services,	To determine	**Including:** Farming (also hatchery), catch,	1 kg of fish fillet sold in a Swiss	Cradle to retail

Category	Product/ service	Study	Goal	Scope	Functional unit(s)	System boundary
	and farmed salmon	(2011)	environmental impacts on different kind of fish products that are sold in supermarkets in Switzerland.	processing, transport, packaging material, and storage and distribution. Frozen cod, canned herring and mackerel (with and without added oil), and smoked salmon.	supermarket	
	Wild hake	Vázquez-Rowe *et al*. 2011	To collect inventory data for European Hake and then through LCA identify environmental impacts and improvement potentials.	**Including:** fishing vessel operations (input of energy and materials and associated impacts; production of diesel, construction of fishing vessels, anti-fouling paint manufacture, ice production), impact from bait production, landing and auction operations (transport at port, conservation of fresh fish at fish market, auction), wholesale and retail operations (transport to wholesale, processing at wholesale, transport to retail, processing at retail), and household consumption (Spanish household).	500 g of raw gutted fresh hake fillet reaching the household of an average consumer in the year 2008	Cradle to grave
Milk, cheese and eggs	Eggs (organic)	Dekker *et al*. (2013)	To assess what potential there is in Dutch organic egg production to replace imported feed with domestically produced feed. Integral ecological impact.	**Including:** litter (organic wheat straw and sand) and diet production, hatching, rearing of hens, laying hen husbandry and transport.	1 kg eggs leaving the farm gate	Cradle to (farm) gate
	Eggs (free range)	Taylor *et al*. (2014)	Conduct LCAs on free range eggs from mixed-enterprise farms in Wales. Comparing free range eggs with red meat production systems.	**Including:** Livestock, land management, energy use and other direct inputs. In-direct, direct and embedded emissions.	Per unit product: kg of eggs, dozen eggs, kg live weight of: spent hens, lambs beef, litre of milk	Cradle to (farm) gate
	Eggs (Org/ free-range/conv.)	Leinonen *et al*. (2012b)	To quantify environmental impacts of four different egg production systems through the use of LCA.	**Including**: non-crop nutrient production, crop production, processing of feed, breeding, hatching and pullet rearing. Energy and water use of the facilities, general waste management and manure management.	1,000 kg of marketable eggs at the farm gate.	Cradle to gate
	Milk	González-García *et al*. (2013)	To assess environmental impact of UHT milk (standard and cocoa) at dairy factory gate in Portugal.	**Including:** pre-production and agricultural production (animal feed – forage, straw, concentrates, fertiliser production, electricity production, diesel production), dairy plant (cooled storage, pre-warming, skimming, homogenisation,	1 kg of packaged energy-corrected milk (ECM), corrected based on fat and protein content including co-products leaving the dairy-gate (i.e. milk,	Cradle to (dairy plant) gate

Category	Product/ service	Study	Goal	Scope	Functional unit(s)	System boundary
				pasteurisation etc.), packaging, energy and fuel use, waste treatment).	cream and butter)	
	Milk (org)	Hietala *et al*. (2014)	Comparing GHG emissions from organic dairy farming and conventional farming through an LCA to find hotspots. Attributional approach.	**Including:** 34 organic farms in 6 different countries in Europe. From 6 to 480 dairy cows. Focus on GHG emissions. Direct emissions (enteric fermentation and manure handling/storage) and emissions from activities of animals (feed/ imported feed/ manure application on land/ purchase of live animals and manure/ fuel/ electricity/ transport/ fallen cattle destruction/ capital goods, farm and services).	1 kg of ECM	Cradle to (farm) gate
	Milk (org/ conv.)	Guerci *et al*. (2013)	To assess environmental impacts of different farming systems of milk production to find hotspots (strengths and weaknesses) regarding minimising the pressure on the environment.	**Including:** On-farm activity (crop production, forages, energy, fuel and electricity use, manure and livestock management) and associated emissions. Off-farm activity (production of pesticides and fertilisers, bedding materials and fodder, concentrate to feed, fuel and electricity, breeding of replacement animals). Transport of feed, bedding material and roughages. Carbon sequestration.	1 kg of ECM	Cradle to (farm) gate
	Milk (org/ conv.)	Cederberg and Mattsson, (2000)	To identify hotspots in the systems and suggest improvements, to test hypothesis that organic is better than conventional, to collect data for concentrated feed production.	**Including:** Production of inputs (diesel, fertilisers, pesticides, seeds), cultivation and production of concentrated feed (oil/starch crops, sugar beet), local production of peas and grains. <u>Conventional farms:</u> use pesticides and (chemical) fertilisers. <u>Organic farms:</u> use peas for fodder and a smaller intake of concentrated feed.	1,000 kg of ECM leaving the farm gate	Cradle to gate
	Dairy products	Djekic *et al*. (2014)	To investigate environmental impact of seven dairy products.	**Including:** dairy farm, dairy plant and treatment of waste water. Water, fossil fuels, raw materials (farm), cleaning agents, fuels, electricity and packaging (plant)	1 kg of final product to the customer	Cradle to grave
Cold drinks	Orange juice	ESU-services, (2013)	A case study to investigate the LCA of non-from concentrate (NFC) orange juice produced in Spain.	**Including:** cultivating oranges, packing house, juice processing plant, facility for juice processing (orange juice and pulp), filling plant – bottling process, PET-bottle production and transport between all stages of the chain. Waste management.	1 litre of NFC orange juice in 1.0 l PET bottle, one-way, at bottling plant	Cradle to gate
	Carbonated soft	Amienyo et al	To find environmental	**Including:** raw materials, packaging, manufacturing	1 litre of a carbonated drink/	Cradle to grave

Category	Product/ service	Study	Goal	Scope	Functional unit(s)	System boundary
	drinks	(2013)	hotspots for carbonated soft drinks in the UK, and to investigate how different packaging affects total impacts.	and filling, retail, consumer use and waste management (throughout the chain). Transport between operations were also included.	total annual production and consumption of carbonated drinks in the UK	
Hot drinks	Darjeeling tea (org/conv.)	ESU-services, (2010)	To investigate which environmental impacts tea have in different life cycle stages and to assess which packaging type is best.	**Including:** cultivation of tea bush, harvest leaves, processing, primary and final packaging, transport (from India to Germany), distribution, retailer, consumer travel and preparation of tea (boil water).	The preparation of one cup (250 ml) of tea ready to drink at home in Europe (using 1.75g of dry tea leaves)	Cradle to grave
	Coffee	Humbert *et al*. (2009)	To find environmental hotspots for spray dried soluble coffee and the alternatives filter coffee and espresso.	**Including:** cultivation and irrigation of green coffee, green coffee treatment, delivery of green coffee, manufacturing of packaging, processing and packaging (spray dried soluble coffee/roast and ground), overheads, distribution, manufacture of: boiler, drip filter machine, espresso machine, cup, dishwasher, consumer use, end-of-life, (packaging and coffee grounds).	To provide a 1 dl cup of coffee ready to be drunk, at the consumer's home	Cradle to grave
Catering services	Ready meals	Calderón *et al*. (2010)	To use LCA to find potential improvements for the ready meal food sector.	**Including:** food ingredients (farm activities and processing of food), packaging material, transport to factory, cooking of the canned sausage dish, canning process (associated energy, water and cleaning product use) transport to household, consumption in household (energy use), solid waste management and waste water treatment.	1 kg of finished product ready to be consumed	Cradle to grave
	Restaurant and foodservice	Baldwin *et al*. (2011)	To conduct an LCA on restaurant and foodservice activities to find areas for improvements in terms of sustainability.	**Including:** Food procurement (*production, processing and waste*); food storage (*energy use*); food preparation and cooking (*energy and water use*); food service and operational support (*energy for heating, lighting, ventilation and air condition, supplies – toilets, cleaning, disposable products, water use and administrative support - paper*).	The operation of a restaurant or food service per month	Farm to fork
	Professional kitchens: Cook-warm and cook-chill (pasta)	Fusi *et al*. (2015)	To evaluate environmental impact of preparing pasta in foodservice.	**Including:** pasta cookers: gas, electric, liquefied petroleum gas, hobs: electric, gas, infrared and induction. Life cycle: cooking operation (water, electricity, emissions from fuel combustion, wastewater). Cook-warm: truck transport fuel	Preparation and distribution of 1 kg of cooked pasta	Preparation to consumption

Category	Product/ service	Study	Goal	Scope	Functional unit(s)	System boundary
				(diesel), ambient transport, emissions from transport. Cook-chilled: blast chilling, portioning and packaging, refrigerated storage and transport, regeneration of food – electricity use, use of refrigerants, fuel for truck and emissions.		
	Compostable cutlery	Razza *et al.* (2009)	To evaluate environmental impact of using compostable cutlery in catering service to be disposed together with food waste to an industrial composting plant	**Including**: raw material production, biodegradable and compostable intermediate material production, disposable cutlery production, electricity consumption, meal consumption, waste management, composting.	Catering of 1000 meals	Cradle to grave
	Compostable biobased plastics	Weiss *et al.* (2012); Groot *et al.* (2010)	(Weiss *et al.*) To evaluate the environmental impacts of biobased materials compared to fossil based ones; (Groot *et al.*) To evaluate the environmental impacts of PLA and PLLA compared to fossil based plastic.	**Including**: (Weiss et al.) biomass feedstock cultivation and harvesting, transport of biomass, production of biobased materials; (Groot et al.) sugarcane plant cultivation and harvesting, processing of sugarcane, production of other chemical, transportation, production of PLA.	(Weiss *et al.*) 1 kg of bio-based material; (Groot *et al.*) 1 tonne of biobased PLA	(Weiss *et al.*) Cradle to gate; (Groot *et al.*) Cradle to gate, end-of-life options

3.1.3.3 Cut-off criteria, allocation, data quality requirements and sources

The cut-offs indicate what has been excluded from the LCA studies. According to the ISO 14040, this may include some of the product systems, the quantity of energy and material flows or the significance of environmental impacts when related to each unit processes. Concerning allocation, in some cases when food is produced the process generates by-products that have a value on alternative markets. If this is the case then a part of the total environmental impact can be allocated to those by-products. There are different allocation methods available (such as mass allocation and economic allocation). The analysis carried out identifies, whenever possible, the distinct allocation methods used. Most studies used both primary and secondary data sources, but few studies stated in detail the time-related coverage of the data used. In this project, primary data was defined as collected on-site, whereas secondary data was derived from other sources as for instance, databases and scientific articles. Table 56 provides the results of the analysis carried out.

Table 56: Cut-off criteria, allocation and data quality requirements and sources

Category	Product/ service	Study	Cut-off		Allocation parameter	Data quality requirements and sources			
			Cut-off criteria	Estimate of the cut-off		Time-related	Geography	Data source of primary data:	Data source of secondary data:
Oils & fats	Olive oil	Tsarouhas *et al*. (2015)	**Exclusions:** Planting olive trees; construction of infrastructure and facilities of the mill; maintenance of the plant and agricultural machinery; manufacture and installation of industrial equipment; raw material packaging; prod., of diesel; printing and ink; waste storage; raw materials, emissions and waste of pesticide prod. Not taken into account: the % of defective plastic and bottles; oil leaking from pumps or engine blocks.	Not stated	Not stated	Not specified	Greece	Contact via telephone and personal meetings with farmers and small oil producing units	No national production data available. Used reports of Governmental Agencies and other published olive oil studies
	Palm, soybean, rapeseed, sunflower and peanut oil	Schmidt, (2015)	**Exclusions:** (Follows the structure of Ecoinvent v3 database). Does not include inputs of services (marketing, business travelling, accounts, lawyers, cleaning), R&D (offices, equipment, laboratories) and overhead (office equipment, overhead energy). Apart from Ecoinvent, pesticide use is not included but indirect land use	Not stated	Not stated	Yields: 2011 Production functions (oil mill and refinery): 2011 (2005 to 2010)	Oil palm: Malaysia/ Indonesia Soybean: Brazil Rapeseed: Europe EU-27 Sunflower: Ukraine	No data	Published reports/articles FAOSTAT Ecoinvent v3. Ecoinvent v2.2

Category	Product/ service	Study	Cut-off		Allocation parameter	Data quality requirements and sources			
			Cut-off criteria	Estimate of the cut-off		Time-related	Geography	Data source of primary data:	Data source of secondary data:
			change is included.				Peanut: India		
	Crude palm oil	Yusoff and Hansen (2007)	**Exclusions:** quantification of: land clearing, biogas production, methane emissions from palm oil mill effluent and palm oil mill effluent discharge to waterways.	Not stated	Not stated	Not specified	Malaysia	No data	Reports & stats from other studies, SimaPro 5 database, Eco-Indicator 99
	Palm oil (RSPO/non-RSPO)	Saswattecha, *et al.* (2015)	**Exclusions:** effects on land-use change are excluded. Palm residue burning is not included (because it does not take place yet). Seedling production were not included.	Seedling production is insignificant.	Mass allocation	Not specified	Thailand	In depth interviews with 21 farmers and 2 mills.	Literature review.
Meat/ Fruit/ Vegetables	Beef, lamb, chicken, potatoes, apples, strawberries, tomatoes	Webb *et al*. (2013)	**Exclusions:** Leaching of refrigerants were not included since they were so small in comparison to energy use, therefore GWP for refrigeration was only based on energy use for it. Emissions from land use change are not included since the plantations have not changed in 20 years.	Not stated	Economic allocation for food categories of which a number of products were made (such as different meat products)	The baseline year was 2005, however an average of 5 years was calculated to even out annual differences.	The UK (all foods), Spain (tomatoes, strawberries) Brazil (poultry, beef), Israel (potatoes) New Zealand (apples, lamb)	Data from a few local producers	Defra, SUNDIAL/ IPCC and other published academic reports, Ecoinvent database/ NAEI (UK's National Air Emissions Inventory)/ EC's ILCD database/ International Energy Agency/ etc.
Vegetables	Tomato products	Del Borghi *et al*. (2014)	**Exclusions:** Transport of sludge and by-products from processing plants to field. Weight of packaging not included in FU. Avoided burdens from recycling. Carbon sequestration.	Not stated	Not stated	2011	Italy	Data collected from farms and processing plants etc.	Ecoinvent v.2.2/ LCA food databases.
Bread & cereals/	Bread wheat,	Williams *et al*. (2010)	**Exclusion:** Transition from one production system to another and	Not stated	Allocation between grain	Not stated	England and Wales	No data	Research articles/

Category	Product/ service	Study	Cut-off		Allocation parameter	Data quality requirements and sources			
			Cut-off criteria	Estimate of the cut-off		Time-related	Geography	Data source of primary data:	Data source of secondary data:
vegetables	oilseed rape, potatoes (org/ conv.)		associated emissions.		and straw through a mathematical formula				databases
Bread and cereals	Breakfast cereals	Jeswani *et al*. (2015)	**Exclusions**: Treatment of human excretion. Packaging for ingredients are not considered as they are packaged in bulk and the bags are re-used.	Not stated	Economic allocation	2011	**Processing:** UK, Germany, Spain, **Ingredients:** Argentina, Egypt, France, Germany, Italy, Spain, Thailand, US, UK, African, Caribbean and Pacific states	Production data has been collected from Kellogg Europe	Ecoinvent, CCaLC database
Fruit	Banana (org/conv.)	Roibás *et al*., (2014)	**Exclusions:** Transport of secondary processes has been excluded unless it was regarded as an important stage. Emissions from production of capital goods with a long life-cycle has not been included.	Not stated	Not stated	Not stated	Ecuador	Collected data from 9 organic farms and 8 conventional farms	Ecoinvent
	Banana	Iriarte *et al*., (2014)	**Exclusions:** Capital goods production, human energy requirements, consumer transport to retail, transport of employees to workplace, storage and removal of carbon during the growth of bananas.	Not stated	Economic allocation	2009-2011	Ecuador	Collected from the one case study farm, and from experts	National studies on production of banana, Ecoinvent
	Oranges	Giudice *et al*. (2013)	**Exclusions:** cultivation phase of orange nursery.	Not stated	Not stated (although 100 kg non-edible	Not stated	Italy	Collected from people in the sector	Literature, Ecoinvent database,

Category	Product/ service	Study	Cut-off		Allocation parameter	Data quality requirements and sources			
			Cut-off criteria	Estimate of the cut-off		Time-related	Geography	Data source of primary data:	Data source of secondary data:
					parts are produced per tonne of oranges)				
Meat	Chicken - (org/ free range/ conv.)	Leinonen *et al*. (2012a)	**Exclusions:** The FU excluded actual burdens associated with processes and slaughter, and any losses which take place between farm gate and to the end of the chain.	Not stated	Economic allocation	Energy consumption: Average 2009-2010	The UK	Data provided by broiler production companies (stakeholders of the report)	UK national inventories, and other published academic reports
	Chicken	da Silva *et al*. (2014)	**Exclusions:** Not including building and maintenance of machines and buildings.	Not stated	Not stated	2004-2011	Brazil and France	Interviews with local advisors on agriculture	EPAGRI/ EMBRAPA, AURORA/ INRA UMR SAS/ other published reports
	Pig (org.)	Halberg *et al*. 2010	**Exclusions:** Not stated.		Not stated	Not stated	Denmark	No data	Empirical data from on-farm studies/ academic journal articles/ database LCAfood/ Ecoinvent
Fish & seafood	Wild caught cod/ farmed salmon	Ellingsen and Aanondsen (2006)	**Exclusions:** Waste treatment, packaging materials, buildings and fishing vessels.	Contribution of buildings and vessels assumed to be of little importance.	Mass allocation when calculating energy use of cod fishing by trawlers and economic allocation for other respects	Not stated	Norway	Telephone conversations and meetings	Literature surveys, other data sources
	High-sea fish	ESU-	**Exclusions:** Not stated.	Not stated	Economic	2004	Data mainly	Some primary	Literature

Category	Product/ service	Study	Cut-off		Allocation parameter	Data quality requirements and sources			
			Cut-off criteria	Estimate of the cut-off		Time-related	Geography	Data source of primary data:	Data source of secondary data:
	and farmed salmon	services, (2011)			allocation		from Denmark	data on mackerel from a scientist that gathered it for his own report.	review of published articles, ecoinvent v2.2, ESU data-on-demand
	Wild hake	Vázquez-Rowe *et al*. 2011	**Exclusions:** Damage to seafloor from fishing activities. Treatment of waste in fishing operations.	Not stated	Mass allocation	2008	Spain	From questionnaires for skippers, and collected data from fish auctions along the Galician coast	Other reports, Ecoinvent database
Milk, cheese & eggs	Eggs (org.)	Dekker *et al*. (2013)	**Exclusions:** Hen house production, farm equipment to laying hens, production of detergents and medicines. Water use, deforestation, biodiversity, and carbon sequestration.	Not stated	Economic allocation of outputs (eggs, slaughter hens etc.)	Not stated	Netherlands Brazil, Ukraine Italy, Belgium Germany	Farm interviews and samples	Ecoinvent, Other publish reports and academic journals
	Eggs (free range)	Taylor *et al*. (2014)	**Exclusions:** Flow of GHG emissions in and out of plants and soil is not included.	Not stated	Economic allocation	October 2008 to September 2009 (collected farm data)	Wales (the United Kingdom)	Real farm data	Other published reports/ academic articles
	Eggs (Org/ free-range/conv.)	Leinonen *et al*. (2012b)	**Exclusions:** pesticide use, land occupation and abiotic resource use were not included in the sensitivity analysis.	Lack of data.	Economic allocation	Not stated	The UK	Data from industry	Other scientific reports, European reference life-cycle database
	Milk	González-García *et al*. (2013)	**Exclusions:** cleaning agents not included due to lack of data. Production of machines, buildings and infrastructure was not included. Land use change and soil quality change was not included.	Ozone depletion might be larger than found in this study since the cooling	Mass allocation, but also protein allocation and economic allocation	2008	Portugal	Inventory data for the dairy industry was collected from a dairy industry	Ecoinvent/ other scientific literature/ International Energy Agency

Category	Product/ service	Study	Cut-off		Allocation parameter	Data quality requirements and sources			
			Cut-off criteria	Estimate of the cut-off		Time-related	Geography	Data source of primary data:	Data source of secondary data:
			Cooling media are not included due to lack of data.	media is not included.					
	Milk (org)	Hietala *et al*. (2014)	**Exclusions:** Carbon sequestration is not included.	Generally assumed that land under crops releases, while grass lands bind, carbon. Therefore the results would benefit farms using more grassland. If this were included in the analysis, result would be different.	Since it is an attributional approach the emissions are allocated to the end product	Not stated	Austria, Belgium, Denmark, Finland, Italy and the UK	Real farm data	Ecoinvent database v2.2 Other published reports/ academic articles
	Milk (org/ conv.)	Guerci *et al*. (2013)	**Exclusions:** Not stated.	Not stated	Biological allocation	Not stated	Denmark Germany Italy	Annual farm data from 12 farms, interviews	IPCC/ other scientific articles
	Milk (org/ conv.)	Cederberg and Mattsson, (2000)	**Exclusions:** Machinery and buildings are excluded, as well as medicine, minor stable supplies (salt for cows, disinfectants) and washing detergents.	Not stated	Economic and mass allocation	No further back than 1995	Sweden	Two medium size farms with high quality data available (since both had continuous measurement procedures)	Based on previous published reports/ data from public authorities and private organisation reports
	Dairy products	Djekic *et al*. (2014)	**Exclusions:** transport to retail, final consumption (including everything associated with the purchase of dairy products), and	Not stated	Mass allocation and physic-chemical allocation	2011-2012	Serbia	Questionnaire to dairy plants and data from on-site visits	Literature, (CCaLC) database and Ecoinvent

Category	Product/ service	Study	Cut-off		Allocation parameter	Data quality requirements and sources			
			Cut-off criteria	Estimate of the cut-off		Time-related	Geography	Data source of primary data:	Data source of secondary data:
			handling of food waste and packaging waste.						database v2.2
Cold drinks	Orange juice	ESU-services, (2013)	**Exclusions:** Oranges going to the fresh market, processing of by-products (animal feed, D-limonene, essential oils), processes of recycling.	Not stated	Economic allocation	2011 (primary data)	Spain	Foreground inventory data from a major manufacturer of NFC-orange juice	Database of ESU-services, scientific papers. Ecoinvent v2.2, and other public available sources, ESU data-on-demand
	Carbonated soft drinks	Amienyo *et a*l. (2013)	**Exclusions:** Ingredient packaging, ingredients that are minor (i.e. create less than 1 % of drink consumption by weight), transport and storage by consumers.	Not stated	Not stated	2008-2011	UK	Primary production data from a manufacturer of beverages	Ecoinvent, ILCD, Gabi, EAA, CCaLC
Hot drinks	Darjeeling tea (org/conv.)	ESU-services, (2010)	**Exclusions:** Organic tea is sent directly to consumers homes – hence distribution to retailer is not included.	Not stated	Not necessary	2010 (primary data)	India (Darjeeling area)	Teekampagne provides info on Darjeeling supply chain and provided data on yield levels and processing levels	Very low availability of data, some unverified data has been used and other reports about tea, ESU data-on-demand
	Spray dried soluble coffee / drip filter/ espresso	Humbert *et al.* (2009)	**Exclusions:** Not stated.	Not stated	Not stated	Not stated	Europe Brazil Colombia Vietnam	Obtained from coffee producers (Europe) and green coffee suppliers (Brazil, Vietnam, Colombia)	Internal database, published academic literature/ ecoinvent database
Catering	Ready meals	Calderón *et*	**Exclusions:** Not stated.	Not stated	Not stated	2007	Spain	Inventory data	Ecoinvent, LCA

Category	Product/ service	Study	Cut-off		Allocation parameter	Data quality requirements and sources			
			Cut-off criteria	**Estimate of the cut-off**		**Time-related**	**Geography**	**Data source of primary data:**	**Data source of secondary data:**
services		*al*. (2010)						from a factory of canned meat	Food DK,
	Restaurant and foodservice	Baldwin *et al*. (2011)	**Exclusions:** Seasonal variation, packaging of food, construction of buildings and the transport of raw material and of staff.	Not stated	Energy use was allocated to the preparation stage according to industry average: cooking (35%), heating, air conditioning and ventilation (28%), dishwashing (18%), lighting (13%) and refrigeration (6%)	2008 Data was averaged over 12 months	USA	Questionnaire data sheets/ tel. interviews/ meetings	SimaPro LCA/and other published reports National databases/ ecoinvent
	Professional kitchens: Cook-warm and cook-chill (pasta)	Fusi, *et al*. (2015)	**Exclusions:** Environmental impact of production of pasta, packaging, food serving and waste management post-consumer (since they are the same for both preparation types). Manufacture of equipment is not included, as the impact over the life cycle is minor. When cooking pasta, emissions of SO_2 are excluded as is particular matter.	Not stated	Not stated	1999-2013	Italy	Cooking centre: personal communication	Ecoinvent v. 2.2, ILCD, scientific literature, legislation, specifications of manufactures
	Compostable cutlery	Razza *et al.* (2009)	**Exclusions:** meal production, transport activities of disposable cutlery to catering service	Not stated	Not stated	2009	Italy	ANPA2000; Ecoinvent 1.01 database	Novamont, scientific literature
	Compostable biobased plastics	Weiss *et al.* (2012), Groot *et al.* (2010)	**Exclusion**: (Weiss et al.) additional land use related impacts; (Groot et al.) application of a cut off criteria for some material inputs	(Weiss et al.) The additional land use impacts, such	(Weiss *et al.*) Not stated, many (Groot *et al.*)	(Weiss et al.) 2002-2012 (Groot *et al.*)2009	(Weiss et al.) JRC ISPRA, Italy (Groot *et al.*)	~~Many~~ Various (e.g. Nguyen, 2007; Dones et	~~Many~~ Various (e.g. plant data from the Sulzer

Category	Product/ service	Study	Cut-off		Allocation parameter	Data quality requirements and sources			
			Cut-off criteria	Estimate of the cut-off		Time-related	Geography	Data source of primary data:	Data source of secondary data:
			constituting in total less tha 1% in wheight of the total material input to the overall production system.	as , such as water consumption, soil erosion, soil carbon losses and change in biodiversity, are considered predominant at the local and regional scales. (Groot *et al.*) not relevant.	System expansion has been used to avoid allocation for the electricity co-product in the sugar mill process. For all other valuable by-products, economic allocation based on selling prices has been used.		Europe	al., 2007)	Chemtech design for Synbra; AkzoNobel's database)

3.1.3.4 Assumptions

Assumptions are made mainly done to cover data gaps for some of the unit processes and on cases where data complexity is large. The majority of assumptions were focused on the production stage. Most of the studies provide details in what was assumed (such as transport distances, what type of truck used, what source of electricity etc.), whilst other articles were more brief on this matter. Table 57 summarises the assumptions made in the LCA studies.

Table 57: Assumptions made in the reviewed LCA studies

Category	Product	Source	Production	Distribution	Preparation	End of life
Oils & fats	Olive oil	Tsarouhas *et al*. (2015)	Production of agricultural machinery is limited to the materials iron and rubber; 1 litre extra virgin oil requires 4 kg olives; at point of harvest (on a 25-acre farm) 6 workers are needed, for 8 days and for 8 h/ day; the tractors used have 80 HP engines – consumption is 5 litres of diesel per 100 km for light tasks (fertilizing, spraying) and 6.5 litres for heavy tasks (transportation, ploughing)	Tractors remain on farm, other transport is made through: 2.4 diesel pickup truck, uses 7.5 litre diesel per 100 km for the weight 1,100 kg; transports are calculated based on residents of workers – average 4 km between workers and farm, and 5 km from farm to manufacture; all work conducted outside of farm only needs one farmer	--	--
	Palm, soybean, rapeseed, sunflower and peanut oil	Schmidt, (2015)	Lack of data on palm oil and peat soils led to the use of the National average usage (Malaysia and Indonesia). 18 % of palm oil was cultivated on peat. It is assumed that 50 % of biogas from anaerobic digestion is flared and the rest used for electricity production. 34 % of shells are removed and the rest kept (for sunflower and peanut oil).	Where data was not available it was assumed that materials are transported 200 km by truck	--	--
	Crude palm oil	Yusoff and Hansen (2007)	Not specified	Not specified	--	--
	Palm oil (RSPO/non-RSPO)	Saswattecha, *et al.* (2015)	Assumed the burning of fibre in the oil extraction phase is carbon neutral (e.g. do not create CO_2 emissions).	Not specified	--	--
Meat/ Fruit/ Vegetables	Beef, lamb, chicken, potatoes, apples,	Webb *et al*. (2013)	Lack of data for Brazilian beef production; it was modelled as the production taking place for the UK export market, no other production systems were included; emission factors are the same for	Assumed 70 % re-load efficiency.	--	--

Category	Product	Source	Production	Distribution	Preparation	End of life
	strawberries, tomatoes		all countries and also the same between open land and poly tunnels; An average apple composition (in production) for NZ and the UK was assumed; mutton carcasses and wool are worth more in NZ. Manure is managed equally well for poultry in all countries, and crops respond in the same way per unit of manure N.			
Vegetables	Tomato products	Del Borghi *et al*. (2014)	If arable land has been used for 30 years, no land change occurs. Only wind power is used in the processing stage.	Not specified	--	--
Bread and cereals/ veg	Bread wheat, oilseed rape, potatoes (org/ conv.)	Williams *et al*. (2010)	1/12th of the grain was sold direct and did hence not need drying or cooling. A lower P and K status was assumed in organic crops hence 50 % lower leaching compared to conventional.	Not specified	--	--
Bread and cereals	Breakfast cereals	Jeswani *et al*. (2015)	Not specified	Transport distance for disposal of all solid waste are assumed at 100 km.	Per 30 g serving 125 ml semi-skimmed cold milk is used.	Not specified
Fruit	Banana (org/conv.)	Roibás *et al*., (2014)	At the RDC the energy requirements have been calculated assuming a 0.20 % loss occur in the facilities.	Ecoinvent calculates that the sea transport returns empty, but according to shipping companies 20 % of the total capacity is used for the return journey.	Assuming ripening of bananas takes place in Spain.	It was assumed that all bananas reaching the consumer are eaten. Waste management follows current distribution in Spain.
	Banana	Iriarte *et al*., (2014)	Land use change not included since land has been producing banana for more than 20 years. Inputs and outputs for the crop cycle is steady during the period of data collection.	Transport goes directly to the European Port. For the worst-case calculation ships were assumed to return empty.	--	--
	Oranges	Giudice *et al*. (2013)	A citrus grove lasts for 50 years, of which 30 years is full production. That it is using integrated production methods.	Euro 3 vehicle for between farm and plant. Euro 4 vehicle between plant and distribution centre.	--	Organic waste (peel etc.) is composted.
Meat	Chicken (org/free range/ conv.)	Leinonen *et al*. (2012a)	Land occupation for crop production: average yields for land with a grade 3a; GHG release from non-organic crop production due to land use change – not occurring in organic production: Daily feed intake is equal to the minimum levels necessary to fulfil energy and nutrient requirements of birds; All manure is used for soil improvements (none burnt to obtain energy);	Not specified	--	--

Category	Product	Source	Production	Distribution	Preparation	End of life
			That energy use on farms is more likely to be closer to average that to extreme levels: fish meal is produced 50 % by by-products and 50 % of caught fish for the purpose of feed			
	Chicken	da Silva *et al*. (2014)	Calculated the same amount of breeders in all systems investigated. In Central Brazil 1 % of soy was assumed to come from rainforest and 3.4% from Cerrado. The GWP of land use change was assumed to be 7.5 times greater for rainforest than for Cerrado (for Central Brazil). It was assumed Southern Brazil does not have recent land use change because it does not have deforestation. Soil loss in Central Brazil was assumed to be 2 t/yr for no-tillage systems and 10 t/yr for tillage systems. In Southern Brazil these values are 1.5 and 8. Processing chickens is assumed to be similar for all locations (both France and Brazil).	Transport of live chickens to slaughter houses distances: 40 km in France, 60 km in Central Brazil and 95 km in Southern Brazil.	--	--
	Pig (org.)	Halberg *et al*. 2010	A maximum of 15 % of the land could be used to grow peas and rapeseed, if more feed was needed it was imported. All areas of grass/clover are ploughed every year. The remaining N for coming cereal is 70 kg per ha.	Not specified	--	--
Fish & Seafood	Wild caught cod/ farmed salmon	Ellingsen and Aanondsen, (2006)	Nutrient emissions from salmon farming.	Not specified	--	--
	High-sea fish and farmed salmon	ESU-services, (2011)	Codfish is caught by trawl or gillnet in the Northeast Atlantic Ocean. Mackerel and herring are only caught by trawl nets. Cod fillets are packaged in cardboard boxes that are laminated in plastic – and kept frozen throughout the supply chain. Mackerel and herring is stored in room temperature since they are canned. Herring is canned with rape oil whilst mackerel is canned with virgin olive oil. Salmon is raised in farms that have net-pens. When smoked, the salmon is packaged in plastic. Farmed salmon is grown and processed in Norway, whilst the caught fish is landed and processed in Denmark.	All products are transported in refrigerated lorries to supermarkets e.g. no air-freight.	--	--

Category	Product	Source	Production	Distribution	Preparation	End of life
	Wild hake	Vázquez-Rowe *et al.* 2011	Bait (European pilchard) was captured by Galician purse seining.	Average distance for retail activities was 50 km, transport was with van	Retail cut fish into fillets before reaching consumer	Consumed in average Spanish household,
Milk, cheese and eggs	Eggs (organic)	Dekker *et al.* (2013)	Many assumptions were made on levels of N and P in different types of fertiliser, as well as how N is fixated in crops etc.; Hens stay on the farm for 398 days, and lay 276 eggs per hen per round, the weight per egg is 62.7 g	Distances between field and feed factory were 100 km. Distance for rapeseed expeller and potato protein was 100 km between field and processing and another 100 km to feed factory.	--	--
	Eggs (free range)	Taylor *et al.* (2014)	Birds use the outdoors pasture 12 hours per day. There were no data for the production of point-of-lay pullets which was regarded as an important part, hence values came from UK broiler data.; A longer but less intensive production cycle for layers was assumed to be comparable to a short intensive system, in terms of energy use, indirect emissions and feed consumption.	Not specified	--	--
	Eggs (Org/ free-range/conv.)	Leinonen *et al.* (2012b)	Daily intake of birds would equal what birds need in terms of protein and energy. All organic crops are derived from mature farmland. In the cage system 50 % of pullets came from floor rearing and 50 % from cage rearing. In the other systems 100 % came from floor rearing. All manure (that could be collected) where transported to be used as soil improvement. Organic winter wheat are produced in between production cycles (nutrients from manure).	--	--	--
	Milk	González-García *et al.* (2013)	The definition of one kg FPCM, an average milk density of 1.03 kg/L has been assumed and that 1 kg of average milk corresponded to 0.99 kg FPCM (0.96 kg FPCM/L) according to the protein and fat content in the raw milk at the Portuguese dairy farm.	--	--	--
	Milk (org)	Hietala *et al.* (2014)	Calculations on NH_4 from enteric fermentation depend on gross energy intake. The lower the energy intake the lower the emissions.	Not specified	--	--
	Milk (org/	Guerci *et al.*	30 % of the N from manure and fertiliser is lost	Not specified	--	--

Category	Product	Source	Production	Distribution	Preparation	End of life
	conv.)	(2013)	through leaching			
	Milk (org/ conv.)	Cederberg and Mattsson, (2000)	P-losses were estimated to 0.35 kg P per hectare in conv. And 0.25 kg P per hectare for org.	Not specified	--	--
	Dairy products	Djekic *et al*. (2014)	Not specified	Not specified	Not specified	--
Cold drinks	Orange juice	ESU-services, (2013)	Pesticide name and amount of applied active ingredients are used to calculate environmental fate. It is assumed to be 100% environmental fate to soil.	Standard distances: prod. to processing, infrastructure has a lifetime of 50 years and a construction time of 2 years.	Electricity and tap water are based on national specific datasets	PET bottles: 51% recycled and the rest incinerated
	Carbonated soft drinks	Amienyo *et a*l. (2013)	Glass bottles contain of 35 % recycled material. Refrigerant is R404A, annual refrigerant leakage is 15 %. The CO_2 in the beverage is a waste product from whiskey fermentation and hence has a biogenic origin.	Manufacturer to retailer: 10 km transport (although 200 km was also investigated in the sensitivity analysis)	Drinks are refrigerated 24 h before being sold.	Average waste management of UK is assumed (e.g. plastic recycling 24 %)
Hot drinks	Darjeeling tea (org/conv.)	ESU-services, (2010)	Since there was a lack of data for tea it was assumed environmental impacts were similar to those of coffee.	Not specified	Not specified	One cup of tea is 250 ml and contains 1.75 g loose tea.
	Spray dried soluble coffee / drip filter/ espresso	Humbert *et al.* (2009)	Not specified	Same delivery distance for roast and ground plant.	Espresso uses an exact amount of water. Spray dried soluble uses 200 % of the amount needed - boiled in a kettle. Filter coffee - 1/3 of the coffee made is wasted. Washing: cup is only used once before being washed.	Glass, paper and cardboard are recycled and the rest incinerated. Gross electric and thermal efficiency for municipal waste are 10% and 20% respectively.
Catering services	Ready meals	Calderón *et al*. (2010)	Not specified	Not specified	The packaging system used in this study uses the same amount of material as a conventional packaging system.	20 % of the food on consumers' plate is wasted and sent to landfill together with packaging. Alternative end-of-life scenarios with compostable/biodegradable packaging . Compostable

Category	Product	Source	Production	Distribution	Preparation	End of life
						packaging can be sent to composting facilities, reducing the amount of food wastes sent to landfill and complying with European Regulations (on reducing the amount of biodegradable wastes disposed in landfill).
	Restaurant and foodservice	Baldwin *et al*. (2011)	Not specified	Not specified	Not specified	Not specified
	Professional kitchens: Cook-warm and cook-chill (pasta)	Fusi, *et al*. (2015)	--	Refrigerant is assumed to be R404A with a leaking of 7.5 % per year in storage and 22.5 % in distribution, chilled-pasta: 20-28 tonnes fully loaded truck – 50 km, with empty return journey	Italian energy mix, pasta cookers: mean capacity, water to cook pasta is used twice, electricity for storage is 26 kWh/ kg h,	--
	Compostable cutlery	Razza *et al.* (2009)	Cutlery made with Mater-Bi®	Not specified	Not specified	Industrial composting of food waste and compostable cutlery.
	Compostable biobased plastics	Weiss *et al.* (2012), Groot *et al.* (2010)	(Weiss *et al.*) Biomass feedstock from dedicated crops; (Groot *et al.*) sugarcane	Not specified	Not specified	Not specified

3.1.3.5 Impact categories and assessment methods

The impact categories used in the reviewed LCAs are presented in Table 58 for the different food categories and in Table 59 for catering services. As mentioned earlier, the LCAs are evaluated against the impact categories used in the European Commission's Product Environmental Footprint (PEF) methodology (EC/JRC, 2012). Other impact categories mentioned in the LCAs but not covered by PEF were also included in Table 58. This aims to provide a more complete overview of the environmental hotspots that may have been identified for the several food product categories in regard.

Many of the PEF impact categories are not covered by the selected LCA studies. However, most of the studies cover among each other the same impact categories. It appears that **acidification potential (AP), eutrophication potential (EP), global warming potential (GWP), (primary) energy use (PEU) and land use** are the impact categories mostly considered (Table 58). **Eco-toxicity** and **human toxicity** were also highlighted in some articles. This indicates that the remaining impact assessment categories were not considered significant when compared to the ones common to most of the studies. The review made on the LCA studies addressing the catering services show that they cover most of the main life cycle stages of the service provision. Moreover, a large number of impact categories are covered (also when confronted with the ones identified within PEF). This indicates that despite the small number of studies available they may constitute a good basis for the supporting evidence on the environmental hotspots for the catering services provision.

Table 58: Environmental impact categories and assessment methods of LCAs for food

Source	**Tsarouhas *et al.* (2015)**	**Schmidt, (2015)**	**Yusoff and Hansen (2007)**	**Webb *et al.* (2013)**	**Halberg *et al.* 2010**	**da Silva *et al.* (2014)**	**Ellingsen and Aanondsen (2006)**	**ESU-services, (2011)**	**Vázquez-Rowe *et al.* (2011)**	**Hietala *et al.* (2014)**	**Taylor *et al.* (2014)**
Product sub-category	Oils and fats	Oils and fats	Oils and fats	Meat/ fruit/ vegetables	Meat	Meat	Fish and seafood	Fish and seafood	Fish and seafood	Milk, cheese, and eggs	Milk, cheese and eggs
Scope	Extra virgin olive oil	Palm, soybean, rapeseed sunflower and peanut oil	Crude palm oil	Beef, lamb, chicken, potatoes, apples, strawberries, tomatoes	Pig (org.)	Broiler chicken	Wild caught cod/ farmed salmon	High-sea fish and farmed salmon	Wild hake	Milk (org)	Eggs (free range)
Project scope alignment (as defined by the Technical Analysis)											
Pre-production	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Primary production	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Processing	✓	✓	✓	✓		✓	✓	✓	✓		
Packaging	✓			✓		✓		✓	✓		✓
Storage	✓			✓		✓	✓	✓	✓		✓
Distribution/transport	✓	✓	✓	✓			✓	✓	✓	✓	
Impact category assessment (as defined by PEF)											
Climate change (GWP)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ozone depletion			✓	✓	✓		✓		✓		
Eco-toxicity for aquatic fresh water			✓								
Human toxicity – cancer effects			✓	✓			✓				
Human toxicity – non-cancer effects											
Particulate matter/ Respiratory inorganics			✓	✓			✓				
Ionising radiation – human health effects			✓								
Photochemical ozone formation											
Acidification	✓		✓	✓	✓	✓	✓		✓		
Eutrophication – terrestrial	✓		✓	✓	✓	✓	✓		✓		

Eutrophication – aquatic											
Resource depletion – water											
Resource depletion – mineral, fossil			✓						✓		
Land transformation											
Other impact category assessments used in LCA reports											
Phosphorous use											
Nitrogen use											
Water use	✓	✓		✓							
Water stress		✓									
Energy use	✓			✓		✓	✓				
Fossil fuel use				✓			✓				
Photo-oxidant formation	✓										
Photochemical ozone-depleting potential											
Photochemical oxidant formation											
Terrestrial eco-toxicity						✓					
Marine eco-toxicity							✓		✓		
Land occupation/use		✓		✓	✓	✓	✓				
Abiotic resource use			✓	✓							
Impact assessment categories e or eq. = equivalent: hence CO_2e = CO_2-equivalent	**GWP):** gCO_2e/g **AP:** gCO_2e/g **EP:** gPO_4^-3e/g **Photo-oxidant formation:** gC_2H_6-eq./g **Water use:** (litres) **Energy use:** (MJ)	**GWP_{100}:** tCO_2e **Land occ.** m^2 /year **Water use:** (blue water): m^3 **Water stress:** m^3-eq	Human health: Carcinogens, Respiratory inorganics, Respiratory organics, Climate change, Radiation, Ozone layer Ecosystem quality: Eco-toxicity, AP/EP Resources: Minerals, Fossil fuels	**GWP:** t CO_2e/t **AP:** kg SO_2e/t **EP:** kg PO_4e/t **Abiotic resource depletion**: Kg Sb eq./t **PEU:** GJ/t **Water use:** m^3/t **Land occ.:** m^2/t **Pesticide use:** dose/ha	**GWP:** g CO_2e **EP:** g NO_3e **AP:** g SO_2e **Ozone depletion:** g $CFC_{11}e$ **Land use:** m^2 per year	**GWP**: kg CO_2e **EP:** kg PO_3^4e **AP**: kg SO_2e **Terrestrial eco-toxicity**: kg 1.4-DCB-eq. **Land occupation:** m^2 per year **Cumulative energy demand:** GJ	**GWP** **Energy use:** MJ/FU **EP** **AP** **Eco-toxicity:** g copper/FU **Respiratory inorganics** Ammonia, NO_x, SO_x **Land use:** m^2/FU	**GWP_{100}:** kg CO_2e **Ecological scarcity method 2006:** ecopoints per kg fish	**GWP:** g CO_2e **AP:** g SO_2e **EP:** g PO_4^3e **Abiotic Depletion Potential**: g Sb-eq. **Ozone Depletion Potential**: g CFC 11-eq. **Marine Eco-toxicity Potential**: g 1,4DCB-eq.	**GWP_{100}:** kg CO_2e	**GWP:** kg CO_2e

Table 58 (cont.): Environmental impact categories and assessment methods of LCAs for food

Source	Dekker *et al.* (2013)	Djekic *et al.* (2014)	González-García *et al.*	Iriarte *et al.*, (2014)	Giudice *et al.* 2013	Del Borghi *et al.* (2014)	Jeswani *et al.* (2015)	ESU-services, (2013)	Amienyo *et al.* (2013)	Humbert *et al.* (2009)

			(2013)							
Product sub-category	Milk, cheese and eggs	Milk, cheese, and eggs	Milk, cheese and eggs	Fruit	Fruit	Vegetables	Bread and cereals	Cold drinks	Cold drinks	Hot drinks
Scope	Eggs (org)	Dairy products	Milk	Bananas	Oranges (IP)	Tomato products	Breakfast cereals	Orange juice	Carbonated soft dinks	Spray dried soluble coffee / drip filter/ espresso
Project scope alignment (as defined by the Technical Analysis)										
Pre-production	✓		✓	✓	✓	✓		✓		✓
Primary production	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Processing		✓	✓	✓	✓	✓	✓	✓	✓	✓
Packaging		✓	✓	✓		✓	✓	✓	✓	✓
Storage	✓		✓	✓		✓	✓		✓	✓
Distribution/transport			✓	✓	✓	✓	✓	✓	✓	✓
Impact category assessment (as defined by PEF)										
Climate change (GWP)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ozone depletion		✓	✓		✓	✓	✓		✓	
Eco-toxicity for aquatic fresh water			✓		✓	✓	✓	✓	✓	
Human toxicity – cancer effects		✓	✓		✓	✓	✓	✓	✓	
Human toxicity – non-cancer effects								✓		
Particulate matter/ Respiratory inorganics					✓					
Ionising radiation – human health effects					✓					
Photochemical ozone formation						✓			✓	
Acidification	✓	✓	✓		✓	✓	✓	✓	✓	
Eutrophication – terrestrial	✓	✓	✓		✓	✓	✓	✓	✓	
Eutrophication – aquatic					✓			✓		
Resource depletion – water								✓		
Resource depletion – mineral, fossil					✓			✓	✓	
Land transformation										
Other impact category assessments used in LCA reports										
Phosphorous use	✓									
Nitrogen use	✓									
Water use							✓			✓
Water stress										
Energy use	✓		✓	✓	✓					✓
Fossil fuel use										

Photo-oxidant formation					✓					
Photochemical ozone-depleting potential						✓				
Photochemical oxidant formation		✓	✓			✓	✓			
Terrestrial eco-toxicity			✓	✓	✓	✓				
Marine eco-toxicity			✓	✓			✓		✓	
Land occupation/use	✓				✓		✓			
Abiotic resource use			✓	✓			✓	✓		
Impact assessment categories e or eq. = equivalent: hence CO_2e = CO_2-equivalent	**GWP:** gCO_2e **Energy use:** MJ **Land occ.:** m^2 /year **AP:** g SO_2e **(EP):** **N deficit:** g N kg^{-1} **P deficit:** g P kg^{-1} **N surplus:** g N kg^{-1} **P surplus:** g P kg^{-1}	**GWP**: kg CO_2e **AP**: kg SO_2e **EP**: kg PO_4e **Ozone layer depletion potential**: kg R11 **Photo-chemical smog potential:** kg C_2H_4 **Human toxicity potential**: kg DCB	**GWP:** kg CO_2e **EP**: g PO_3^{4}e **AP**: g SO_2e **Abiotic depletion:** g Sb-eq. **Ozone depletion:** Mg CFC-11-eq. **Human toxicity:** g 1.4-DB-eq. **fresh water, marine and terrestrial eco-toxicity:** g 1.4-DB-eq. **photo-chemical oxidant formation:** g C_2H_4e non-**renewable energy demand:** MJ-eq.	**GWP:** kg CO_2e	*Focused on:* **GWP:** kg CO_2e **Respiratory inorganics:** kg $PM_{2.5}$e **Non-renewable energy:** MJ primary <u>*Other:*</u> Aquatic AP, Aquatic & terrestrial EP, Ozone layer depletion, Ionizing radiations, photochemical oxidation, human toxicity, Aquatic & terrestrial eco-toxicity, Land occ, mineral extraction	**GWP_{100}:** kg CO_2e **Ozone Depletion$_{20}$:** kg CFC-11 **AP:** SO_2e **Photo-chemical ozone-creating potential:** kg C_2H_4e **EP**: kg PO_4^{3-}e **Human toxicity** **Fresh-water aquatic eco-toxicity** **Marine eco-toxicity** **Terrestrial eco-toxicity**	**GWP**: CO_2e **PEU**: MJ/ kg product **Water footprint**: litre per kg product **AP:** g SO_2e **EP**: g PO_4e **Abiotic depletion potential:** *Elements:* mg Sb-eq. *Fossil:* MJ **Freshwater aquatic eco-toxicity potential**: g DCB eq. **Human toxicity potential**: kg DCB eq. **Marine aquatic eco-toxicity potential:** kg DCB eq. **Ozone layer depletion potential:** mg R11e **Photo-chemical oxidant**	**GWP:** kg CO_2e **Human toxicity:** CTUh **AP:** molc H+ eq. **EP terrestrial**: molc N eq. **EP freshwater:** Kg P eq. **EP marine**: kg N eq. **Eco-toxicity freshwater:** CTUe **Land use:** kg C deficit **Abiotic resource depletion:** Kg Sb eq. **Water depletion:** m^3 water eq.	**GWP:** g CO_2e <u>Packaging:</u> **PEU**: GJ **AP**: kg SO_2e **EP**: kg PO_4e **Abiotic depletion:** kg Sb-eq **Human toxicity potential**: kg DCB eq. (x100) **Marine aquatic eco-toxicity:** t DCB eq. (x100) **Freshwater eco-toxicity:** kg DCB eq. **Terrestrial eco-toxicity:** kg DCB eq. **Ozone depletion:** mg R-11 eq. (x10) **Photo-chemical oxidant creation potential:** g C_2H_4e (x10)	**GWP_{100}:** g CO_2e **Water use:** Non-turbined litre/ turbined per cup **Energy consumption:** MJ primary non-renew.

							creation potential: g C_2H_4e **Land use**: m^2 year			

Table 59: Environmental impact categories and assessment methods of LCAs for catering services.

Source	Calderón *et al*. (2010)	Baldwin *et al*. (2011)	Fusi *et al*. (2015)	Razza *et al*. (2009)	Weiss *et al*. (2012), Groot *et al*. (2010)
Product sub-category	Catering service	Catering service	Catering service	Catering service	Catering service
Scope	Ready meals	Restaurant and foodservice	Professional kitchens: Cook-warm and cook-chill (pasta)	Compostable cutlery	Compostable biobased plastics
Project scope alignment (as defined by the Technical Analysis)					
Pre-production	✓	✓			
Primary production	✓	✓			
Processing	✓	✓			
Packaging	✓	✓		✓	✓
Storage	✓	✓	✓		
Distribution/transport	✓	✓	✓		
Preparation	✓	✓	✓		
End of life (waste management)	✓			✓	✓
Impact category assessment (as defined by PEF)					
Climate change (GWP)	✓	✓	✓	✓	✓
Ozone depletion	✓		✓		✓
Eco-toxicity for aquatic fresh water	✓	✓	✓		
Human toxicity – cancer effects	✓	✓	✓		✓
Human toxicity – non-cancer effects					✓
Particulate Matter/ Respiratory Inorganics	✓	✓			
Ionising Radiation – human health effects	✓				
Photochemical Ozone formation					✓
Acidification	✓	✓	✓	✓	✓
Eutrophication – terrestrial	✓	✓	✓	✓	✓
Eutrophication – aquatic			✓		
Resource Depletion – water					
Resource Depletion – mineral, fossil	✓		✓		✓
Land Transformation					✓
Other impact category assessments used in LCA studies					
Water use			✓		
Material use/depletion			✓		
Fossil fuel use	✓	✓		✓	✓
Land occupation/use		✓			✓
Photo-oxidant formation	✓		✓		
Photochemical oxidation	✓				
Terrestrial eco-toxicity	✓				✓

Marine eco-toxicity	✓				
Solid waste production				✓	
Impact assessment categories e or eq. = equivalent: hence CO_2e = CO_2-equivalent	**GWP, EP, AP, abiotic depletion, ozone layer depletion, human toxicity, fresh water-, marine aquatic- and terrestrial eco-toxicity, photochemical oxidation, radiation, respiratory inorganics, carcinogens, land use, fossil fuels, minerals**	**GWP, respiratory inorganics, land use, fossil fuels, AP, EP, eco-toxicity, carcinogens**	**GWP:** g CO_2e, **Ozone depletion:** mg CFC-11e, **Human toxicity:** g 1.4-DBe, **Photochemical oxidants formation:** g NMVOC, **Terrestrial AC:** g SO_2e, **Freshwater EP:** mg P e **Terrestrial eco-toxicity:** mg 1.4-DB-eq., **Freshwater and marine eco-toxicity:** g 1.4-DB e, **Metal depl.:** g Fe e **Fossil fuel depl.:** g oil e	**PED**: MJ eq., **GWP**: kg CO_2 eq., **SWP**: kg, **EP**: kg O_2 eq., **AP**: H^+ moles eq., solid waste production **SWP** kg,	PED: GJ/t, GWP: t CO_2 eq./t, EP kg PO_{4-} eq./t (and PO_{4-} eq./(ha*a)), AP: kg SO_{2-} eq./t (and SO_{2-}eq./(ha*a)), Stratospheric **Ozone depletion**: kg N2O eq./t, **Photochemical ozone formation**: kg C2H4 eq./t, AD: kg oil eq., LU: m2/year, HT: kg DB eq.,

Table 60: Environmental impact categories and assessment methods of LCAs for production system comparisons.

Source	Leinonen *et al*. (2012a)	Guerci *et al.* (2013)	Cederberg and Mattsson, (2000)	Leinonen *et al*. (2012b)	Roibás et al. (2014)	ESU-services, (2010)	Williams *et al.* (2010)	Saswattecha, *et al.* (2015)
Product sub-category	Meat	Milk, cheese and eggs	Milk, cheese and eggs	Milk, cheese and eggs	Fruit	Hot drinks	Bread and cereals/ vegetables	Oils & fats
Scope	Broiler chicken (Org/ free-range/ conv.)	Milk (Org/ conv.)	Milk (Org/ conv.)	Eggs (Org/ free-range/ conv.)	Banana (Org/conv.)	Darjeeling tea (Org/conv.)	Bread wheat, oilseed rape, potatoes (Org/ conv.)	Palm oil (RSPO/ non-RSPO)
Project scope alignment (as defined by the Technical Analysis)								
Pre-production	✓	✓	✓	✓	✓	✓	✓	✓
Primary production	✓	✓	✓	✓	✓	✓	✓	✓
Processing	✓				✓	✓		✓
Packaging	✓				✓	✓		
Storage	✓				✓	✓	✓	
Distribution/transport	✓	✓	✓		✓	✓		✓
Preparation					✓	✓		
End of life (waste management)					✓	✓		
Impact category assessment (as defined by PEF)								
Climate change (GWP)	✓	✓	✓	✓	✓	✓	✓	✓
Ozone depletion	✓		✓					
Eco-toxicity for aquatic fresh water								✓
Human toxicity – cancer effects								✓
Human toxicity – non-cancer effects								
Particulate matter/ Respiratory inorganics								
Ionising Radiation – human health effects								
Photochemical ozone formation								✓
Acidification	✓	✓		✓			✓	✓
Eutrophication – terrestrial	✓	✓	✓	✓			✓	✓
Eutrophication – aquatic								

Resource depletion – water								
Resource depletion – mineral, fossil								
Land Transformation								
Other impact category assessments used in LCA reports								
Energy use	✓		✓	✓			✓	
Material use			✓					
Pesticide use				✓			✓	
Non-renewable energy demand/use		✓				✓		
Photo-oxidant formation	✓		✓					
Land occupation/use	✓	✓	✓	✓			✓	
Abiotic resource use	✓		✓	✓			✓	
Biodiversity		✓						
Impact assessment categories e or eq. = equivalent: hence CO_2e = CO_2-equivalent	**GWP_{100}:** t CO_2e **EP:** kg of PO_4e **AP:** kg of SO_2e **Land occ.:** ha **Pesticide use:** dose/ha **Abiotic resource use:** antimony (Sb) eq. kg **PEU:** GJ	**GWP_{100}** kg CO_2e **EP:** g PO_4^{3}e **AP:** g SO_3e **Non-renewable energy use**: MJ-eq. **Land occ**: m^2 **Biodiversity:** Damage Score (DS)	**GWP_{100}:** kg CO_2e **AP:** kg SO_2e **EP:** kg O_2e **Photo-oxidant formation:** kg NO_x **(Ozone depletion)** **Material use:** kg **Energy use:** MJ **Land use:** M^2 **Pesticide use:** g active substance	**GWP_{100}**: 1000 kg CO_2e **EP**: kg PO_4e **AP**: kg SO_2e **PEU**: GJ **Pesticide use**: dose per ha **Abiotic resource use**: kg antimony eq. **Land occupation**: ha	**GWP:** t CO_2e	**GWP:** kg CO_2e **Non-renewable energy demand:** MJ-e	**GWP:** t CO_2e **EP:** kg PO_4^{3-}e **AP:** kg SO_2e **Abiotic resource use:** kg Sb-e **Primary energy use:** GJ **Land occupation:** Grade 3a-e **Pesticide use:** dose/ha	**GWP:** kg CO_2e **EP:** g PO_4e **AP:** g SO_2e **Human toxicity**: g $C_6H_4C_{12}$-eq. **Freshwater eco-toxicity:** mg $C_6H_4C_{12}$-eq. **Photochemical oxidant formation:** G C_2H_4-eq.

3.1.3.6 Results of the detailed analysis of the LCA studies

The LCA studies provide a good insight on the environmental hotspots within the food supply chains. This section summarises the main results of the LCA studies reviewed. The hotspots identified in each study reveal the main areas contributing to the overall environmental impact for food categories, catering services and food production systems.

3.1.3.6.1 Food categories

Table 61 provides information on environmental impacts and root causes associated with the production of food. Also LCAs that focused on comparing production systems are included in this section.

Note: common abbreviations in this section: AP = Acidification Potential, EP = Eutrophication Potential, FU = Functional Unit, GWP = Global Warming Potential, PEU = Primary Energy Use, e or eq. = equivalent (hence tCO_2e = equivalent to 1 tonne of CO_2).

Table 61: Summary of detailed analysis for food products (including production system comparison LCAs)

Food category	Food product	Source	Environmental hotspot
Fruit	Apples	Webb *et al.* (2013)	GWP at farm gate was: 0.2 tCO_2e per tonne in the UK and 0.1 tCO_2e per tonne in New Zealand. The difference is mainly due to higher yields in New Zealand. The GWP after farm gate in the UK was divided between storage (29%), packaging (26%) and processing (23%). Apples from New Zealand had transport as a major contributor to GWP after farm gate (80%) although that also includes refrigeration during transport. Pesticide use was also large, especially for apples from New Zealand that had 2.2 doses per hectare compared to the UK that had 0.3 doses per hectare.
	Strawberries	Webb *et al.* (2013)	GWP at farm gate was: 0.8 tCO_2e per tonne in the UK and 0.3 tCO_2e per tonne in Spain. The reason for the difference is mainly due to that in Spain the yield of strawberries is double that of the UK. Strawberries also have a high EP: 2.6 kg PO_4e in the UK and 3.6 kg PO_4e in Spain. EP is an issue in Spain since N fertiliser is not managed optimally and hence leaches. Pesticide use is also an issue for strawberries: 1.1 dose per hectare in the UK and 0.4 doses per hectare in Spain. PEU is an issue in UK due to the need of infrastructure (e.g. glass cover) to grow strawberries.
	Bananas	Iriarte *et al.* (2014)	GWP: 0.45 – 1.04 $kgCO_2e$ per kg banana (best and worst case – transport type and method is the only difference). The main hotspots for GWP (for both scenarios) are cultivation, packaging and transport (***cradle to gate***) Cultivation: in the best case scenario cultivation is the hotspot (53 %). Manual labour is mostly used, hence the nitrogen applied on soil to fertilise is the main hotspot for GWP as it emits N_2O. Packaging: the production of cardboard boxes and kraft paper is the main cause of GWP. Transport: In the worst case scenario the transport is the main hotspot (67 %). In the best case it is only 27 % of the total. The results vary depending on what type of vessel is used for transport at sea and whether the vessel returns to the harbour empty or not.
	Banana (Org/conv.)	Roibás *et al.* (2014)	GWP (at plantation stage): 0.25 tCO_2e per tonne organic banana and 0.31 tCO_2e per tonne conventional banana. In the banana supply chain 22.1% of the GWP is due to the plantation phase, 18.7% due to transport and 19.2% to the consumer phase. (***Cradle to grave***). (In this case it was assumed the ships would return with 20 % cargo and not empty.) At consumer stage the GWP was 0.84 tCO_2e per tonne banana (any).
	Oranges	Giudice *et al.* (2013)	Climate change (*GWP*) accounts for 25.5% of total impact. Resource use

			(*Non-renewable energy, mineral extraction*) accounts for 35.8%, human health impacts (*human toxicity, respiratory inorganics, Ionizing radiation, ozone layer depletion, photochemical oxidation*) for 31.5% of the total and ecosystem quality (aquatic and terrestrial eco-toxicity, aquatic and terrestrial AP, aquatic EP, land occupation) accounts for 7.2% of the total impact. The total life cycle impacts of oranges are distributed between three stages: cultivation, processing and transport. In the cultivation stage the production of pesticides and fertilisers is a hotspot as well as the irrigation of water (water and energy use), and what cultivation techniques are used. In the processing stage the plastic boxes to transport oranges accounts for 70% of total impact. In the transport stage (within Italy) the main causes are diesel use, production of vehicles and production and maintenance of infrastructure (roads).
Summary hotspots for fruit: • Cultivation stage stands for a large share of the total emissions and the yield levels have an impact on the total global warming potential. The main activities responsible for the hotspots are: • Nitrogen fertiliser on fields leads to the emissions of N_2O. Main responsible for the GWP. • Nitrogen leaching. Main responsible for the EP. • Production of chemical fertilisers and pesticides. Main responsible for emissions contributing to eco-toxicity to air and water and also energy consumption • Pesticide use. Main responsible for emissions contributing to eco-toxicity to air and water • Irrigation. Main responsible for water and energy use. • Transport and Packaging especially for fruit that travel long distances. Leading to emissions contributing to the GWP. • Storage due to the need of electricity for refrigeration. Leading to emissions contributing to the GWP.			
Vegetables	Tomato	Del Borghi *et al*. (2014)	Cultivation: Use of fossil fuels and electricity is a hotspot which drives GWP and human toxicity. Irrigation is a main cause of PEU and also of water use. Nitrogen chemical fertiliser drives EP that can be minimised by using organic fertiliser with lower N content. (The study do not accounts for leaching of pesticides due to absence of data. Toxicity would play an important role if it was accounted for). Packaging: marine eco-toxicity was primarily driven by packaging (release of heavy metals, phenol or crude oil). Glass bottles with metal lids drove marine eco-toxicity more than metal tins. Carton-based packaging had barely any impact on toxicity in comparison. The production of the packaging uses electricity and fuel – which drives AP. Processing: GWP is low if renewable energy is used. Some water is used at this stage. Processing and packaging are also large contributors to GWP (i.e. not only the cultivation stage).
	Tomato	Webb *et al*. (2013)	*Greenhouses vs. production on field (in different climate).* Using fossil fuel to heat greenhouses is a main root cause of GWP from UK tomatoes. This impact can be greatly lowered if renewable energy were used. GWP: 2.1 tCO_2e per tonne at farm gate (UK - greenhouse), 0.3 tCO_2e per tonne (Spain – on fields). Greenhouses also lead to abiotic resource deletion (both of materials needed to build them and energy needed to heat them). GWP was three times greater and PEU was four times greater in the UK than in Spain. When growing on fields (in this case in Spain) irrigation was a big hotspot, both the water use and the energy needed to operate it (causing GWP). Pesticide use was seven times larger in Spain (2.2 doses per hectare) than the UK, due to the climate. Land use can be lowered if applying more N fertiliser on fields, but the consequence will be increased leaching of N and hence a higher EP per area. Spain had twice as large EP and AP than the UK. Transport between the UK and Spain was of minor importance to overall environmental impact.
	Potato	Webb *et al*. (2013)	Potatoes were compared between the UK and Israel. The UK has a competitive advantage in growing potatoes (when in season). In Israel the need to irrigate drives PEU and thereby GWP. The lower yields in Israel and longer transport (if the potatoes are going to the UK) also have an impact on the total GWP. EP and AP were greater in Israel. However, Israeli potatoes need less pesticide and less land. The yield

			level is an important factor to determine environmental impact per FU. Cold storage of UK potatoes (for months) drives PEU and GWP. Packaging is not significant for unpeeled potatoes.
	Potato (org/conv.)	Williams *et al*. (2010)	Of the total energy use, 50 % is due to cold storage. If irrigation is increased (from 0 % to 100 %) it will increase PEU by 4 % by minimising the need of pesticides and land use. Yield levels and wastage levels at field is important factors that influence total environmental impact.
<u>Summary hotspots for vegetables:</u> • At the cultivation stage the yield and wastage levels at field largely affects the total environmental impact. The main activities responsible for the hotspots are: • The use of fossil fuels. Main responsible for the GWP and eco-toxicity to air, water and soil. • Irrigation. Main responsible for the water use and energy use, but it improves yields (and minimises land and pesticide use). • N fertiliser on fields. Main responsible for EP. • Greenhouses drive abiotic resource depletion and PEU. If the energy is from fossil fuel it drives GWP substantially. Using renewable energy for heating can lower impact. • Cold storage for long periods. Main responsible for PEU and GWP. • Packaging materials. Leading to emissions contributing to AP (especially steel and glass), carton-based packaging has lowest impact. • Processing and packaging. Responsible for a large share of GWP.			
Fish and seafood	Wild cod and farmed salmon	Ellingsen and Aanondsen, (2006)	In <u>aquaculture</u> the main impact is the feed for fish (both fishmeal and arable crops) which requires fuel (0.04 kg oil per kg fish) and is responsible for the release of respiratory inorganics. Production of 1kg farmed fish requires 1.3kg wild fish. Eco-toxicity to water is also an issue with farmed fish because of antifouling from the cages used. Nutrient emissions to the water in which the farmed fish are grown lead to increased levels of nutrient salts (not quantified in the study). For <u>wild caught</u> fish the fuel use for the fish catch is the hotspot and leads to GWP and release of respiratory inorganics. The use of bottom thawing of cod has a negative impact on the seafloor and a large consumption of fuel (0.47 kg oil per kg fish). Paint on fishing boats contains copper (anti-fouling) and 90 % of this copper will leak into the sea – which leads to marine eco-toxicity.
	Frozen cod, canned herring, mackerel (in olive oil), smoked farmed salmon	ESU-services, (2011)	<u>Aquaculture:</u> Salmon has the highest GWP in total of all fish investigated (6.6 kgCO_2e per kg FU). This is mainly due to the production of fish feed (58 % of the total GWP). <u>Marine:</u> Canned mackerel and herring (without oil) have lower GWP than cod. The aluminium packaging is a hotspot and so is olive oil if that is included. For cod, fuel use in the catching stage is the main hotspot. Both salmon and cod require cold storage and that adds to total GWP. Refrigeration is not needed for canned fish. <u>Processing</u> of fish requires energy. If this energy is renewable it will lower the GWP of this stage. <u>Packaging:</u> aluminium cans have significantly higher emissions than plastic packaging. If virgin olive oil is used to keep the fish in, it will increase the environmental impact of the fish product substantially.
	Wild hake	Vázquez-Rowe *et al*. (2011)	For all impact categories included in the study, the <u>fishing stage</u> was the major contributor to environmental impacts. AP: 89.2 %; EP: 87.2 %; GWP, ozone depletion potential and abiotic depletion potential were all above 75 % and marine eco-toxicity potential only became 51.6 % at this stage. Wholesale and retail contribution was the second largest stage for GWP and marine eco-toxicity. <u>Carbon footprint for two fishing methods:</u> GWP: 3.83 gCO_2e per 500 g hake fillet (7.66 gCO_2e per 1 kg hake fillet) for long-line fishing. GWP: 5.74 gCO_2e per 500 g hake fillet (11.48 gCO_2e per 1 kg hake fillet) for offshore trawling. Marine diesel consumption is the main hotspot: For **fish captured by long-line fishing** the <u>fishing stage accounts for 90 %</u> of total impact for all categories except marine eco-toxicity which stood for 86.4 % For **fish captured by trawlers**, the <u>fishing stage accounts for 95%</u> of the

			total – in all impact categories. <u>Post-fishing stages:</u> Transport (fuel use) contributed to ozone depletion potential (89.5 %), GWP (38.6 %) and AP (51.1 %). Waste treatment activities (e.g. waste water, plastic and organic residues) contributed 59.4 % to EP and 85.5 % to marine eco-toxicity. Packaging operations were one of the main contributors to abiotic resource depletion (51.2%). <u>Discards to sea:</u> 1 kg landed European hake produces 5.08 kg discard with trawling operations but only 0.21 kg discards with long-line fishing.

<u>Summary hotspots for fish and seafood</u>:
<u>Aquaculture</u>
- The feed is a hotspot (the production of fishmeal and arable crops). Main responsible for the GWP and the emissions of respiratory inorganics.
- Leaching of nutrients. Main responsible for the EP.
- Farmed fish is also responsible for eco-toxicity to water due to use of anti-fouling.

<u>Marine</u>
- Fuel (diesel) use at fishing stage is a hotspot for all impact categories.
- Anti-fouling used on fishing vessels and cages in aquaculture contributes to eco-toxicity.
- Wild caught fish (using bottom trawling) has a large impact on the seafloor. The fuel use for bottom trawling is much larger than other fishing methods.

<u>Both fishing methods</u>
- *Processing*: energy consumption is leading to emissions contributing to GWP. The use of renewable energy will lower GWP. Waste treatment activities are leading to emissions contributing to EP and eco-toxicity.
- *Packaging*: Aluminium material and the use of olive oil is showed to have a larger contribution environmental impact. Packaging also has a large impact on abiotic resource depletion due to the use of raw materials.

Meat	Chicken (conv. / free-range/ org.)	Leinonen *et al*. (2012a)	**GWP:** 4,410 kgCO_2e (conventional), 5,130 kgCO_2e (free-range), 5,660 kgCO_2e (organic) per FU. The main responsible for the GWP are the feed. In terms of <u>non-organic feed</u> soy is responsible for a large GWP due to land use change (converting natural habitats into arable land), vegetable oil (such as palm oil) also had large contribution for GWP due to land use change. Amino acids and fish meal also contributed to the GWP. Fuel for transport of feed (Import to Europe) also increased GWP. <u>Organic feed</u> has a large contribution to GWP since the yields are low and since a high proportion of the feed is imported by large transport distances. **EP:** 20.31 kgPO_4e (conv.), 24.26 kgPO_4e (free-range), 48.82 kgPO_4e (org.) per FU. The main cause is N leaching from fields. **AP**: 46.75 kgSO_2e (conv.), 59.73 kgSO_2e (free-range), 91.55 kgSO_2e (org.) per FU. The main cause is the emissions of ammonia from manure. The longer manure stays on the floor the more ammonia it accumulates, hence organic has larger contribution to AP than conventional. **Pesticide use:** 2.77 dose per ha (conv.), 3.46 dose per ha (free-range), 0.29 dose per ha (org.) per FU. **Abiotic resource depletion:** 18.0 kg of antimony eq. (conv.), 22.3 kg of antimony eq. (free-range), 34 kg of antimony eq. (org.) per FU. **Land occupation:** 0.56 ha (conv.), 0.72 ha (free-range), 2.5 ha (org.) per FU. Organic has higher land use due to lower yield levels. Organic systems generally has a larger contribution to all impact categories, except pesticide use. The main reason is because of feed conversion ratio. Birds live longer in organic systems and need more feed. In addition during that time their manure is able to accumulate more ammonia which is the main responsible for the AP. Conventional birds contribute less to the environmental impact as they are most resource efficient (have fastest feed conversion ratio).
	Chicken	da Silva *et al.* (2014)	**GWP:** Feed production is the main responsible representing 67-78 % of the overall GWP. Chicken production is responsible for 20-31 % of the total GWP. The CO_2 emissions show to contribute more to the global warming potential. About 83 % of the CO_2 (for most systems) occurred during to crop production, the use of fossil fuels and due to transport. Only Central Brazil had a large contribution of CO_2 because of

			deforestation (CO_2 release due to land use change). The emission of N_2O occurred during crop production (70 %) and in bird houses (24 %). In general transport of feed was a big hotspot as well as soy and maize production. The slaughter stage is responsible for a large PEU. **AP:** In Brazil 51-55 % of the overall AP is caused by feed production and the ammonia emissions from fertiliser application on fields. In France 69-77 % is caused by ammonia emissions from manure in chicken houses. **EP:** Feed production accounts for 54-61 % and chicken production for 32-41 % of EP in France. Feed production accounts for 70 % and chicken production for 23 % of EP in Brazil. Fertiliser use and emissions from the bird houses were the main causes of EP. **Terrestrial eco-toxicity:** 75-87 % was due to feed production, and the main cause was the production and application of fertilisers which is causing the release of heavy metals.
	Chicken	Webb *et al.* (2013)	**GWP:** 2.5 tCO_2e in the UK at farm gate and 2.1 tCO_2e in Brazil. 80 % of pre-farm gate GWP is due to concentrated feed (in particular the use of soy) and due to energy used for heating and cooling the bird houses. If renewable energy is used (as in Brazil) the GWP is minimised. After farm gate a main hotspot area is the slaughter process of birds. This process is responsible for a large **PEU** leading to the emission of greenhouse gases.
	Beef	Webb *et al.* (2013)	**GWP**: 23.8 tCO_2e per tonne at farm gate in the UK and 31.7 tCO_2e per tonne in Brazil. In both systems methane emission is the main cause of the GWP. In Brazil there are higher methane emissions since cattle are reared outdoors on pastures with low productivity. Slow cattle growth and reproduction causes more methane emissions. In the UK the GWP is (beside methane emissions) driven by large PEU and abiotic resource depletion from rearing cattle indoors. Application of N on fields also leads to **EP** and **AP**. Beef produced with calves from the dairy sector have lower environmental impact than calves of suckler cows, because will be allocated to the dairy products some of the emissions.
	Lamb	Webb *et al.* (2013)	Production stage**:** **GWP:** 13.5 tCO_2e per tonne at farm gate in the UK and 9.7 tCO_2e per tonne in New Zealand. Grazing is the main source of food for lamb. Therefore methane emission is the main responsible for the GWP for both systems. In New Zealand the pastures are more productive, so less land is needed. Grazing in the UK has higher impact on EP than in New Zealand because the pastures in the UK have been fertilised with nitrogen. In New Zealand there is a larger reliance on clover (that binds N from the atmosphere) and there is more solar radiation. Transport of meat for long distances drives AP and to some extent EP. Pesticides are not applied on pastures. The processing stage (abattoirs) has high PEU.
	Pig (org.)	Halberg *et al.* (2010)	Three organic systems were investigated: **indoor fattening** (*pigs are reared on pasture in the beginning of their life and then taken indoors for the last fattening stage, in which they still have outdoor access on a concrete floor*), **free-range** (*reared on pasture all life*), **tent system** (*reared outdoors all life but on a straw bed and with access to a tent*). **GWP:** 2.92 $kgCO_2e$ (indoor fattening), 3.32 $kgCO_2e$ (free-range), 2.83 $kgCO_2e$ (tent system) per FU. Imported feed stands for 33 % of the GWP. Crop production and use of tractor stood for 12 %. **Soil C sequestration:** -398 gCO_2e (indoor fattening), -413 gCO_2e (free-range), -623 gCO_2e (tent system) per FU. **EP**: 269 gNO_3e (indoor fattening), 381 gNO_3e (free-range), 270 gNO_3e (tent system) per FU. The N leaching from fields is the major responsible for the EP. **AP**: 57.3 gSO_2e (indoor fattening), 61.4 gSO_2e (free-range), 50.9 gSO_2e (tent system) per FU. Transport and diesel use accounts for 5-10 % of total AP. The AP is due to ammonia emissions to the atmosphere. **Ozone depletion:** 0.69 $mgCFC_{11}e$ (indoor fattening), 0.77 $mgCFC_{11}e$ (free-range), 0.68 $mgCFC_{11}e$ (tent system) per FU. **Land use:** 6.9 m^2 per year (indoor fattening), 9.2 m^2 per year (free-range), 8.5 m^2 per year (tent system) per FU.

<table>
<tr><td></td><td></td><td></td><td><u>Comparing organic systems:</u>
The hotspot for free-range pigs is the related to the large losses of N (due to a surplus on fields). Both emissions to the atmosphere as N_2O (main responsible for the GWP) and leaching of N from soil to water (leading to the EP). Furthermore, as the free-range pigs are kept on fields their manure cannot be collected and used as fertiliser for on-farm cereal production. This is why such a high share of the feed in free-range systems is imported (which also drives GWP). Another reason for the high imported feed is that the land use is largest for free-range pigs (leading to less land available to produce cereals).

In conclusion the most beneficial system from both an environmental and economic perspective is the organic indoor fattening system.</td></tr>
<tr><td colspan="4">Summary hotspots for meat:
<u>Beef, lamb</u>
• Methane emissions from ruminants are the main responsible for the GWP.
• Rearing animals indoors are the main responsible for the PEU and the abiotic resource depletion.
• Rearing animals outdoors are the main responsible for the land use (especially if the pastures are not productive).
• Long transport is the main responsible for the AP (and partially EP).
• The processing stage uses much primary energy and has the largest GWP in the post farm-gate.
<u>Chicken</u>
• Concentrated feed are the main responsible for the GWP (soya has large GWP because of land use change and long transport distances, organic wheat has high GWP due to low yields and long road transport).
• Hen's manure releases ammonia, which leads to AP.
• Fertiliser use and bird houses emissions of ammonia are the main responsible for the EP.
• Production of fertiliser and application on fields releases heavy metals which is the main cause of terrestrial eco-toxicity.
• Heating and cooling houses and processing at abattoirs are responsible for the PEU and GWP.
• Processing of chickens are responsible for the PEU and GWP.
<u>Pig</u>
• Emissions on farm and associated emissions from imported feed are the main drivers of GWP.
• Organic free-range pigs have largest environmental impacts, mainly because of nitrogen leaching (EP) and emissions contributing to the GWP.
<u>All meat:</u>
• N leaching from soil is the main responsible for the EP (and AP).
• Ammonia emissions from manure are the main responsible for the AP.</td></tr>
<tr><td>Milk, cheese and eggs</td><td>Milk (dairy products)</td><td>González-García et al. (2013)</td><td>GWP: The three largest contributors to GWP were CH_4, N_2O and CO_2. The methane emissions were derived from enteric fermentation and storage of manure. N_2O came from synthetic nitrogen fertiliser and management of manure. CO_2 was driven by diesel usage from the dairy farm and from animal feed production. In the dairy plant the main cause of GWP was from CO_2 emissions from energy use.
EP: Manure and fertiliser application lead to N leaching and ammonia emissions which both lead to EP.
AP: Ammonia emissions from manure account for 90 % of the total.
Eco-toxicity: The major contributing step is animal feed production (primarily concentrates) because of the diesel required and because of the use of commercial fertiliser due to its emission of metals (terrestrial eco-toxicity). In the dairy plant, packaging is a major root cause for human toxicity and eco-toxicity. Electricity use and the use of cleaning agents also add to the total.
Abiotic depletion: mainly driven by energy use in the agricultural (animal feed) production, but also for transport and fuel oil use.
Ozone depletion and photochemical oxidant formation: driven by diesel usage and transport. Can also be driven by the use of refrigerant, but this impact was excluded from this study due to lack of data. Methane emissions also drive photochemical oxidant formation.
Non-renewable energy demand: mainly needed in the animal feed production.
<u>The dairy farm</u> is the major contributor to AP, EP and terrestrial eco-toxicity.</td></tr>
</table>

			The dairy factory is the major contributor (more than 60 %) of: abiotic depletion, human toxicity, aquatic freshwater eco-toxicity, aquatic marine eco-toxicity, photochemical oxidant formation and non-renewable energy demand. Both processes are almost equally responsible for: GWP and ozone depletion. **Transport** and **fuel oil** are major contributors for ozone depletion, abiotic depletion and non-renewable energy demand.
	Milk (org.)	Hietala *et al*. (2014)	**GWP:** Enteric fermentation (methane) from dairy cows was the largest contributor of GHG emissions (33 %). Further, raising of dairy calves contributed to 12 %, and 22 % were driven by N_2O from crop fields and from housing of animals. This study did not include carbon sequestration by pasture, which potentially could lower total GHG emissions on farms that have a larger share of permanent pastures with grass. Average result of study: 1.32 kgCO_2e per 1 kg of energy-corrected milk (ECM). Emissions between farms vary between 0.99 and 1.94 kgCO_2e per kg ECM.
	Milk (Org/conv.)	Guerci *et al*. (2013)	**GWP:** the main driver is methane emissions from enteric fermentation and manure storage (together account for 44-66 %). On-farm production of feed accounted for 10.5-28.0 % of GWP, driven by N_2O from fertiliser use. **AP**: strongly affected by ammonia emissions from manure storage on-farm but also from fields due to crop production. **EP**: ammonia emissions from manure storage and leaching of N from fields drive EP (together 81.8-94.5 % of total EP). The feed conversion rate of milking cows has an impact on GWP, AP and EP. The better conversion rate the lower environmental impact. When correlating the impact categories it became clear that GWP, EP, AP and energy use are strongly correlated (improving one will help improve the others), whilst land use is not correlated significantly to the other three. Biodiversity it is not significantly correlated with GWP, EP and AP, but is correlated with energy use. Land use have a negative impact on biodiversity, however, this negative impact can be minimised if the crop management system is more considerate to the environment (e.g. organic production). General results shows that minimising GHG emissions will improve overall environmental impacts of dairy farming.
	Milk (Org/conv.)	Cederberg and Mattsson, (2000)	**GWP**: The cows' diet affects methane emissions – the more roughage in the diet the more methane emissions there are. N_2O emissions from fields and CO_2 emissions from fuel use also drive GWP. **AP** is driven by emissions from manure storage. **EP** is driven by leaching of N from fields. **Photo-oxidant formation** is driven by diesel usage and extraction by the oil industry.
	Dairy products	Djekic *et al*. (2014)	Most of the total impact (from cradle to grave) of GWP, EP and AP are affected by the farm (raw milk production) stage. **GWP:** methane emissions from enteric fermentation and from manure storage are responsible for the GWP as well as the use of non-renewable energy in the production of fertiliser. In the processing stage the energy use (non-renewable) is contributing to GWP as well as input and packaging materials – since the processes to produce those things require non-renewable energy. **AP:** is driven by denitrification (of manure and of soils), nitrogen fertilizer and degradation of manure. Fuel combustion of machinery in agriculture also has an impact on NO_x and SO_2 emission which drives AP. **EP:** is driven by the (over-) use of N and P fertilisers (both organic and mineral) when producing fodder. Butter has significantly higher impact than the other dairy products in the categories GWP, EP and AP (because of the substantially greater need of raw milk to produce one kg butter). Cheese comes after butter in terms of environmental impact and is followed by cream. Processing stage: if the impact of raw milk is excluded, then yoghurt has the largest impact and butter the lowest (for GWP, EP and AP). This

			is driven by energy use (for most dairy products).
	Eggs (Org.)	Dekker *et al*. (2013)	**Main hotspots:** feed crop cultivation, emissions from manure of the laying hens, and transport (of feed, manure and hens). The faster hens convert feed the better for the total impact. Shorter distances of feed would lower impact, as would matching manure on fields more closely to crop needs and replacing whole grains with oil expeller feed. **GWP**: driven by CO_2 emissions from burning fossil fuels, and NH_4 and N_2O emissions from manure. **AP:** caused by NH_4 emissions from manure of laying hens. **EP:** driven by N and P leaching from fields. Not using chemical fertiliser will increase land use but decrease EP and energy use.
	Eggs (free-range)	Taylor *et al*. (2014)	**The main cause** of GHG impact for concentrated feed (cereals and soy) is caused by land use change, but production of N fertiliser and transport also have a high impact. The embodied carbon of purchased point-of-lay pullets was also high. **GWP**: driven by N_2O emissions from soil which was driven by the N content in manure. In one of the case studies diesel use on farm led to high CO_2 emissions.
	Eggs (Org/ free-range/conv.)	Leinonen *et al.* (2012b)	**GWP:** Is driven by the use of feed (mainly from land use change of soy). Electricity for heating or cooling bird houses also drives GWP. **EP:** is driven by ammonia emissions from manure and N leaching from fields. **AP:** mainly driven by ammonia emissions from manure. **Abiotic recourse use**: the buildings contribute most to this impact category.

Summary hotspots for milk, cheese and eggs:

Milk:

- Methane emissions from ruminants are the main responsible for the GWP (*the more roughage in a cow's diet the more methane is created*).
- N_2O emissions from fields and CO_2 emissions from fossil fuel contribute to the GWP.
- N leaching and ammonia emissions from fields contribute to the EP.
- Ammonia emissions from manure storage contribute to the AP.
- Overall animal feed production (in particular concentrated feed) is a hotspot for most of the environmental impact categories.

Eggs:

- Concentrated feed (with soya content) is the main responsible for the GWP (due to land-use change at cropping stage).
- N_2O emissions from field are the main responsible for the GWP.
- Ammonia emissions from manure leads to AP and EP. Leaching of N from fields leads to EP.
- Methane and N_2O emissions from manure drive GWP. Long transport of feed emits CO_2 and hence drives GWP.

Abiotic resource use is largely driven by material for buildings.

Note: Carbon capture (sequestration) by grasslands is not always included in LCAs. Many LCA studies from Britain do not take into account how much carbon is captured in agriculture - only what is emitted (APPG, 2013). A study focussing on lamb and beef (that, according to LCAs, emit the most GHG emissions) found that these systems can be carbon neutral - or at least emit less in total - if the binding of carbon is included (APPG, 2013). The same was found for dairy cows (Hietala et al., 2014; Guerci et al., 2013).

Bread and cereals	Bread wheat, rapeseed (Org/conv.)	Williams *et al*. (2010)	Bread wheat: Burning of fossil fuels (releasing CO_2) only has a minor impact on the total **GWP**. N_2O emissions from fields contribute most (80 % of the total). This emission is caused by applying N on fields. For this emission it is irrelevant whether the nitrogen is derived from manure, N-fixation or from chemical fertilisers. Sandy soils have more impact on the environment than clay soils (they require more energy to crop in and hence have higher GWP). Rapeseed: Same hotspots as for bread wheat.
	Breakfast cereals	Jeswani *et al.* (2015)	**GWP:** Ingredients to cereals account for the largest fraction of GWP (38 %). (*Including: wheat etc., cocoa and chocolate, cornflour, sugar and sweeteners*). The manufacturing uses most primary energy (electricity and natural gas) which drives GWP (23 %). Packaging accounts for 15 % of GWP. (Primary packaging accounts for a much larger share of GWP than secondary packaging.) Transport account for another 15% of GWP. When the consumption stage is included (i.e. when cereals are eaten with milk) the milk will increase the environmental impacts significantly. Without milk, cereals emit 2.64 $kgCO_2e$. With milk the figure is 8.84 $kgCO_2e$.

			The ingredients also contribute to **land use** (97 %), **eutrophication** (71 %), **element depletion** (61 %), **human toxicity** (54 %) and **photochemical smog** (50 %) and account for the largest **water use**. Cocoa and chocolate use most 'green' water while rice use most 'blue' water (due to irrigation). Packaging mainly impacts abiotic resource depletion and marine and freshwater eco-toxicity. Transport leads to ozone layer depletion, acidification and photochemical smog creation.
Summary hotspots for bread and cereals: • N_2O emissions from fields are the main responsible for the GWP. • Field work and fertiliser production contributes to the GWP. • Packaging contributes to the GWP, abiotic resource depletion and marine and freshwater eco-toxicity. • Transport contributes to the GWP, acidification, ozone layer depletion and photo oxidant formation • Food ingredients (such as cereals) account for the majority of environmental impact categories (as e.g. EP and AP).			
Oils and fats	Olive oil	Tsarouhas *et al.* (2015)	Cultivation of olive trees has the largest impact in all impact categories. After that the production of olive oil, transport, and use of fuel, energy and water – are the main causes of environmental impact. **GWP:** The cultivation of olives is responsible for 40.4 %, production and transport of bottles of 22.4 % and production of olive oil for 21.4 %. **EP:** The production of olive oil is responsible for 82 %. **AP:** Olive cultivation is responsible for 43.8 %, followed by the production of olive oil and the production, transport and use of fertilisers. Transport and production of fertilisers are drivers of AP. **Photo-oxidant formation:** Cultivation of olives accounts for 67.9 %, mainly caused by production of bottles and transport of them.
	Palm, soybean, rapeseed, sunflower and peanut oil	Schmidt, (2015)	**GWP:** The agricultural stage is the most emitting stage for all oils, but palm oil had largest GWP impact, driven by N_2O and CO_2 emissions that arise when cultivating peat (assuming 18 % of all palm oil is cultivated on peat). Palm oil also had high methane emissions at the oil mill because effluents were put in anaerobic digestion in open ponds. Peanut oil had largest impact at the oil mill stage of all oils. In the refinery stage palm oil has highest impact. In conclusion: <u>rapeseed oil</u> and <u>sunflower oil</u> had lowest total impact. Palm oil and soybean oil had medium impact, whilst peanut oil had the largest environmental impact. GWP (cultivation stage and land use change emissions), mill process and water use were hotspots.
	Crude palm oil	Yusoff and Hansen (2007)	**Respiratory inorganics** and **depletion of fossil fuels** are the main environmental impacts of crude palm oil production. The respiratory inorganics are mainly derived from the oil mill stage. Fossil fuel depletion is mainly driven by the production of fertilisers and from transport. **EP/AP:** methane emissions from anaerobic digestion ponds and discharge from them to water ways are not included in the analysis and would significantly increase the results of EP/AP. Pesticide use was not included in the analysis but is assumed (based on other sources) to have a low impact as integrated (biological) pest management systems were in place and therefore only small doses of pesticides were needed. <u>In conclusion</u> the most polluting processes in palm oil production were: the production of chemical fertiliser, then transport and lastly the oil mill processes.
	Palm oil (RSPO/non-RSPO)	Saswattecha, *et al.* (2015)	**GWP:** N-fertiliser create N_2O emissions on fields and CO_2 emission from production of fertiliser. POME (*palm oil mill effluent*) treatment and EFB (*empty-fruit-bunch*) disposal both create methane (CH_4). CO_2 from gasoline use for weed control. **EP:** N-fertiliser leaching of NO_3^- from fields. **AP:** N-fertiliser emission of NO_x from fields and oil extraction (fibre combustion). **Human toxicity:** partially caused by N-fertilisers but also in the mills when extracting the oil (fibre combustion). **Freshwater eco-toxicity:** Was caused by the use of glyphosate (herbicide) for weed control. **Photochemical ozone formation:** caused by oil extraction (fibre combustion), EFB disposal, weed control and POME treatment.

<table>
<tr><td></td><td></td><td></td><td>Conclusion: there are five activities that contribute most to environmental impact:
6) Burning fibres in boilers
7) Fertilizer use
8) Treatment of wastewater and disposal of empty-fruit-bunch
9) Use of gasoline when cutting weed
Weed control using glyphosate</td></tr>
<tr><td colspan="4">Summary hotspots for oils and fats:
• The cultivation stage, olive oil production and transport are the main responsible for GWP.
• Cultivation (production/use of fertilisers), production of olive oil and transport drive AP.
• Production and use of chemical fertiliser is a major polluting process for palm oil production, as is the palm oil extraction process at the oil mill (burning of fibre). Those two impacts human toxicity, EP and AP.
• In the case of palm oil, respiratory inorganics and depletion of fossil fuels are contributing to the overall environmental hotspots.
• POME treatment releases methane to the atmosphere (unless processed under cover).
• EFB treatment is a strong contributor to GHG emissions if disposed of to landfill.
• Rapeseed oil and sunflower oil have a low impact compared with other oils (not including olive oil).</td></tr>
<tr><td rowspan="2">Coffee, tea and cocoa</td><td>Coffee</td><td>Humbert et al. (2009)</td><td>GWP: the main driver throughout the life cycle is energy consumption (cultivation, processing and packaging each account for 10 % of the total) and the rest is connected with energy use at the consumer stage. N_2O emissions from the coffee cultivation stage is also a large contributor, but is variable depending on how much N fertiliser is used.
<u>Production</u>: fertiliser use is the main driver of energy use (due to production of fertilisers) and N_2O emissions is the main source of GWP.
<u>Processing:</u> energy use is the main driver of GWP. One example is the use of firewood from unsustainable managed forests (i.e. deforestation) which contributes to CO_2 emissions.
<u>Packaging</u>: the type of material affects the GWP. Glass (which is heavy) has an impact on transport and CO_2 emissions.
<u>User phase:</u> 50-75 % of total energy use – depending on behaviour. Has a large total impact on GWP.
Spray dried soluble coffee had lowest environmental impact (of the three systems investigated) since least dry matter (coffee beans) was needed. The espresso used a bit more coffee and its single-use packaging system added to the total. Filter coffee had the greatest impact since it was assumed that too much is brewed and 1/3 of the total is wasted. Hence the use of coffee was highest and also the use of heated water for making the coffee.</td></tr>
<tr><td>Darjeeling tea (org/conv.)</td><td>ESU-services, (2010)</td><td>GWP: The main impact throughout the life cycle is boiling the water in the consumer phase as the electricity use drives GWP. The second largest impact is the production of tea leaves and the energy used for drying the leaves. In organic production much methane is emitted when using compost as fertiliser. In conventional production the GWP is affected by the use of chemical fertiliser.
(There was a lack of data for this study so these results should be treated with care).</td></tr>
<tr><td colspan="4">Summary hotspots for hot drinks:
• Energy use throughout the life cycle is the main responsible contributing to the GWP.
• In coffee cultivation the emission of N_2O is the main responsible for the GWP.
• In the cultivation stage the production of fertiliser drives is responsible for a large amount of energy use.
• In the processing stage the energy used to dry and roast the green coffee beans is responsible for GWP.
• The type of packaging contributes to the overall GWP.
• Energy is used to heat water and that contributes to GWP.
• Filter coffee had largest impact on the environment, followed by espresso - and the coffee with lowest impact was instant coffee. One reason is that it is easy to make too much filter coffee. Best practice is to make the right amount of coffee and not use more dry matter (e.g. coffee grind) nor heat more water than needed. The espresso had increased impact by its single-portion packaging.</td></tr>
<tr><td>Mineral waters, soft drinks, fruit and vegetable</td><td>Orange juice</td><td>ESU-services (2013)</td><td>Cultivation of oranges created more than 70% of the total life cycle impact in following categories: land use, water depletion, eco-toxicity of freshwater, human toxicity – non-cancer effects, and marine EP. The bottling process had two impact categories that together created more than 50 % of the total: GWP and abiotic resource depletion. The juice</td></tr>
</table>

juice			processing did not lead on an impact category but had over 20 % contribution on GWP, freshwater EP and abiotic resource deletion. **GWP:** Strongly affected by the production of bottles, but also driven by electricity and natural gas use (for irrigation). N_2O emissions from fields due to N use and from production of pesticides. **EP**: terrestrial and marine: mainly from N use on fields (NO_x and ammonia emissions), freshwater: due to run-off of P, electricity production, pesticide production and from waste water from the processing stage. **AP:** 50 % due to use of N fertiliser (ammonia and NO_x emissions), but also largely affected by the production of bottles. **Freshwater eco-toxicity**: due to pesticide use. **Human toxicity (cancer):** a large part is from production and the use of P_2O_2 fertiliser (because it contains of cadmium, zinc and copper), but also from diesel and electricity use. The bottle production also contributes. **Human toxicity (non-cancer)**: a large part is from production and the use of P_2O_2 fertiliser (because it contains of cadmium, zinc and copper) **Abiotic resource depletion**: bottling process, electricity use, production of pesticides, diesel and fertilisers. **Water depletion:** due to irrigation at fields and water use in the processing stage.
	Carbonated soft drinks	Amienyo *et al*. (2013)	The packaging creates the most significant environmental impact for carbonated soft drinks for all impact categories. (PEU, AP, EP, GWP, eco-toxicity, human toxicity, abiotic resource depletion, ozone depletion and photochemical oxidant creation). The only impact categories where the ingredients (mainly sugar) has larger share of the impact is for EP, and a little bit for AP and primary energy demand. This is mainly due to the use of fertilisers The manufacturing stage of the soft drink has a large share on the impact on freshwater eco-toxicity, terrestrial eco-toxicity and EP. Energy use and creation of waste water are root causes. Glass bottles have the highest environmental impact, compared to meals cans and PET plastic bottles. This can be lowered if the bottles are re-used, but then it is only then at the same level as aluminium cans and 0.5 litre bottles. The most environmentally friendly bottle is the 2 litre PET bottle. Transport has a minor impact even though transports are long within the supply chain. The beverages should only be refrigerated when needed, as shelf life is the same in ambient temperature. Additionally, recycling PET bottles or reusing glass bottles would lower carbon footprint substantially.
Summary hotspots for cold drinks: • For orange juice, the fruit content stage is the main contributor to the overall environmental impact but packaging contributed substantially as well. • For carbonated soft drinks, packaging appears to be the largest contributor to the overall environmental impact. • For cold beverages the bottling process and the energy use associated with it is contributing to the overall impact. • Whenever drink refrigeration is needed it is responsible for the increase of the GWP.			

3.1.3.6.2 Catering services

Table 62 provides information on what environmental impacts that are connected to catering service activities (food preparation and provision).

Table 62: Summary of detailed analysis for catering services

Catering service	Type of service	Source	Environmental hotspot
Catering service	Restaurant and foodservice	Baldwin *et al*. (2011)	The **food procurement** stage has a large contribution to the total environmental impact, especially for: land use, respiratory organics, AP, EP and GWP. **The operational support** (lighting, ventilation, air conditioning, heating, water use, supplies (cleaning, toilets, disposable products) and

			administration stage) have a high impact on carcinogens, eco-toxicity and fossil fuels. **Food storage and food preparation** only have a marginal impact on the total. With this result in mind the authors proposed to minimise environmental impacts buy buying organic produce, seasonal and local produce, to reduce amount of meat eaten, reduce energy used in kitchens and to minimise overall food waste. Food transported by airfreight of food should be avoided.
	Cook-chill and cook-warm	Fusi *et al*. (2015)	*Only preparation of pasta (at a central production unit) and transport to the place of consumption are included – comparing cook-chill with cook-warm.* The cooking stage creates the highest share of emissions for both systems and depend on how much energy is used and what type of energy is used. For instance, natural gas cookers are better for the environment than electrical cookers in almost all impact categories, a part from ozone depletion. The catering transport is negligible for both systems. **Cook-warm** (preparation to place of consumption) had lower impact than **cook-chill** since food in the latter system needs to be both chilled, stored cool and reheated before consumption, whereas cook-warm is ready to eat on arrival. However, since the cook-chill chain has much lower levels of food waste, cook-chill has a lower overall impact than cook-warm does.
	Ready meals	Calderón *et al*. (2010)	This study also found that the **ingredients in ready meals** have the largest environmental impact. Land use (98%), carcinogens (62%), EP (79%), AP (48%), respiratory inorganics (39 %), terrestrial eco-toxicity (35%) and GWP (34%). **Transport** also contributed. Fossil fuels (43 %), respiratory inorganics (45%), AP (36%), abiotic depletion (33%) and GWP (25%). **Packaging materials** (largely affected by tinplate – that was baseline) also had an impact. Abiotic depletion (17 %), GWP (13 %), fossil fuels (11%) and terrestrial eco-toxicity (8%). **Solid waste management** had a significant impact on freshwater (90%) and marine (56%) eco-toxicity, but also on carcinogens (32%) and GWP (10%). **Cleaning products** only had an impact on terrestrial eco-toxicity (14%). *Note: different methods were used to derive the percentages for different impact categories.* In total the main environmental impacts for ready meal production are: land use, use of fossil fuels and marine and freshwater eco-toxicity. Food ingredients and solid waste management are the two parts in the supply chain with highest environmental impact on this. **Land use:** caused by food primary production. **Use of fossil fuels:** driven by electricity, natural gas and fuel use. **Marine and freshwater eco-toxicity** is strongly effected by sending food waste and tinplate cans to landfill. When comparing different packaging materials then glass jar had the largest environmental impact, much due to its weight and the volume of material needed (compared with tinplate, conventional and biopolymer plastics). Furthermore, menus can be improved by reducing the meat content to lower environmental impact.
	Compostable cutlery	Razza, et al. (2009)	The impacts of cutlery in catering services are mostly due to the cutlery production (both the granule production and its processing into cutlery) and end-of-life. The largest impacts are on GHG emissions, acidification and eutrophication of water. The compostable cutlery diverting solid waste from landfill to composting, will save emissions: primary energy demand from 1490 to 128 MJ eq., GWP from 64 to 22 of kg CO_2 eq., eutrophication potential from 4200 to 790 g O_2 eq., acidification potential from 11.2 to 5.9 mol H^+ eq.. The amount of solid waste from the catering of 1000 ready-prepared meals sent to landfill will decrease from 21 kg to 1.8 kg.
	Compostable biobased plastic	Weiss *et al.* (2012), Groot et al. (2010)	The environmental impacts of bioplastic as an average of the LCAs reviewed in the scientific literature are compared to conventional materials showing a greater eutrophication, + 22 kg PO_4 eq./t and stratospheric ozone depletion, + 3 kg N_2O eq./t, but a lower global warming potential, - 9 t CO_2 eq./t, primary energy resources use, -170 GJ/t, and acidificiation potential, -40 SO_2 eq./t. The higher eutrophication potential of biopolymers is due to farming

			practices using conventional fertilizers.

Summary hotspots for catering services:

- Food procurement accounts for the largest part of emissions.
- Lighting, ventilation, air conditioning, heating, water use, supplies and administration stage – together have a large impact on carcinogens, eco-toxicity and fossil fuels.
- Transport only has a marginal impact at the end of the chain where ready meals are transported to point of consumption, but transport can have a significant impact in the beginning of the chain, especially for imported produce or feed.
- Solid waste management has a high total impact. (embedded emissions and disposal of it).
- Food waste (embedded emissions and disposal of it) has a substantial influence on the total impact.
- Electricity from fossil fuels should be avoided.

3.1.3.6.3 Food production systems

Table 63 provides information on different production systems. It compares organic, free-range (access to pasture) and conventional production systems. Unfortunately there were no comparative LCAs available that included integrated production.

Table 63: Summary of detailed analysis for different production systems (conventional/organic/integrated production)

Production system	Type of food product	Source	Environmental hotspot
Free-range	Eggs	Taylor *et al.* (2014)	**Impact category: GWP.** The carbon footprint of the entire free-range egg producing farm was 6 t CO_2e /ha. The carbon footprint of 1 kg free-range eggs were 1.6 kg CO_2e. The embodied carbon in the concentrated feed stood for 50 % of that impact, diesel use stood for 19.5 %, the point of lay (POL) pullets themselves stood for 11 %, N_2O emissions from fields as a result of N application stood for 8% and cardboard boxes stood for 7% in total.
Label Rouge	Chicken	da Silva *et al.* (2014)	**Impact categories: GWP, AP, EP, land occupation, terrestrial eco-toxicity, energy demand.** The French eco-label 'Label Rouge' is a label for high quality meat products where chickens must grow slowly - 89 days instead of 40-42 days - to obtain the meat quality required. To do that they need more feed, which was the largest hotspot for chicken production. Label Rouge-produced chickens had the highest environmental impact across all impact categories. To improve this system the feed-conversion rate has to be better, there has to be a reduction of fossil fuels in the supply chain and carcass yields has to improve. *Note: Label Rouge is a label used in France where the focus is to produce high quality meat by allowing chickens more space and to grow slower.*
RSPO and non-RSPO	Palm oil	Saswattecha et al. (2015)	**Impact categories: GWP, AP, EP, human toxicity, freshwater eco-toxicity and photochemical ozone formation.** The palm oil produced according to RSPO standard had overall lower impact than the non-RSPO productions. The main reason being that the farmers were getting education in how to use fertilisers according to the need of the crop and thereby were able to minimise that impact. They also had good management systems in place in the oil mills to minimise emissions etc. from POME (*palm oil mill effluent*) treatment and EFB (*empty-fruit-bunch*) disposal. In the POME treatment the methane emissions are captured in a biogas facility and used as energy, leading to a lower need of electricity (while conventional producers treat POME in open lagoons with no cover). The RSPO producers also transfer the EFB disposal to the plantations to mulch (while conventional producers dispose of it on open landfill sites). Land use change was not included in this LCA.

Conventional	Tomatoes	Webb *et al*. (2013)	**Impact categories: GWP, PEU, EP, AP, abiotic resource use, pesticide use, ozone depletion and land occupation.** Greenhouse vs. produced in field: There are lower emissions associated with producing tomatoes on fields in Spain including the transport to the UK, compared to growing tomatoes in fossil-fuel heated greenhouses. Since Spain has a competitive advantage due to the climate, the UK has to boost domestic production using fossil fuels. However, if the greenhouse (in this case in the UK) is heated by waste heat (from a nearby facility that creates waste heat through its processes), the total impact is similar to importing Spanish tomatoes.
Organic/ conventional	Milk	Guerci *et al*. (2013)	**Impact categories: GWP, EP, AP, non-renewable energy use, land occupation, biodiversity.** (Carbon sequestration was included). A general finding was that minimising GHG emissions also will be beneficial for the other impact categories as well. Pasture vs. indoor: A high share of grassland on farm (where cows are let on pasture when season for it) have lower biodiversity loss and significantly lower impact on GWP, PEU and AP. (Due to lower N_2O emissions from fields, more carbon storage in soils and lower emissions from manure storage). High vs. low stocking rate: At the farms with low stocking rate the self-sufficiency of forage and concentrate feed was higher. The farms with high stocking rates had intensive systems where the milk production was in one case 10 times higher than the farm with lowest yields. The productivity of land was also significantly higher than the farm with lowest productivity. One reason for the productivity is a much higher use of N per hectare. (The cows in the most intensive systems where not let out on pasture). Organic vs. conventional: The organic farms used most land but had the lowest impact on biodiversity loss. One of the farms had the lowest GWP of all and the other farm had among the highest GWP. Hence the variability between farms were large. *Note: small sample size of case studies.*
	Milk	Cederberg and Mattsson, (2000)	**Impact categories: GWP, EP, AP, PEU, land use, pesticide and material use.** Organic: CH_4 emissions are higher since cows have more roughage in their diets, but in total GWP is lower than for conventional. EP is higher in organic production because yields are low and that leads to high N leaching per FU. Organic uses most electricity, diesel and limestone. Organic needs almost twice as much land as conventional to produce 1 FU, but has almost no pesticide use. Conventional: CO_2 emissions are higher (due to the use of chemical fertiliser) as are N_2O emissions. In total conventional has higher GWP. Conventional also has higher AP, PEU and pesticide use. Conventional uses more crude oil, natural gas (synthetic fertiliser production), coal (refinery of conc. feed) and a larger use of phosphorus and potassium.
	Pig	Halberg *et al*. (2010)	**Impact categories: GWP, EP, AP.** Organic indoor fattening systems have the lowest environmental impact (compared to organic tent and organic free-range systems) and in this case organic indoor fattening only had 7% larger GWP compared to conventional pigs. Organic free-range pigs on the other hand have 22% higher GWP than conventional pigs. If carbon sequestration were included, the indoor fattening and tent system would have lower GWP than conventional production. EP is lowest in conventional production. Indoor fattening had 21% higher EP and free-range 65% higher EP (because of leaching of nutrients from the pastures). AP is lowest in conventional systems. The different organic systems had 18-43% higher AP due to ammonia emissions from outdoor areas. The benefits of organic systems compared to conventional systems are agro-ecological gains and better animal welfare.
	Potatoes	Williams *et al*. (2010)	**Impact categories: GWP, EP, AP, energy use, land use and pesticide use.** Organic potatoes have 13 % higher GWP, 2% higher energy use than conventional potatoes. EP and AP are also both higher for organic potatoes. The pesticide use on organic potatoes is only 14% than that of conventional. Yields are lower for organic potatoes, but field work is the

			same as for conventional. There is a 50% higher wastage of organic potatoes. Increased irrigation can lower land use and pesticide use.
	Bread wheat, rapeseed	Williams *et al*. (2010)	**Impact categories: GWP, EP, AP, abiotic resource use, energy use, land use and pesticide use.** Organic bread wheat has higher GWP, EP and AP. Conventional bread wheat production use pesticides (which organic do not) and conventional has higher abiotic resource depletion. In conventional crop production the production of chemical fertiliser is the most energy consuming activity (53 %) whereas in organic production the field work uses most energy (60 %). Conventional production uses 20 % more energy but organic production needs 3 times more land. Emissions from N fertiliser is an issue in both organic and conventional production and it does not matter where the N comes from – the N_2O emissions will be created anyway in both systems since that is part of the natural N-cycle. The N leaching is much higher in organic systems which explains the 3 times larger EP.
	Banana	Roibás *et al*. (2014)	**Impact category: GWP.** Organic bananas have lower GWP than conventional bananas. Because the use of N fertiliser in the conventional systems lead to high N_2O emissions.
Organic/ free-range/ conventiona l	Chicken	Leinone n *et al*. (2012a)	**PEU (GJ):** Organic (40.3), free-range (25.7), conventional (25.4). **GWP (kg CO_2e)**: Organic (5.7), free-range (5.13), conventional (4.4). **EP** (kg PO_4e): Organic (48.8), free-range (24.3), conventional (20.3). **AP (kg SO_2e):** Organic (91.6), free-rang (59.7), conventional (46.8). **Abiotic resource use (kg of antimony eq.):** org (34), free-range (22.3), conv (18.9). **Land occupation (ha):** Organic (2.5), free-range (0.72), conventional (0.56). **Pesticide use (dose/ha):** Free-range (3.46), conv (2.77), organic (0.29). Feed is a hotspot for all production systems of birds. Free-range birds have approximately the same diet as conventional birds; the only main difference from conventional production is that the birds are reared on (or have access to) pasture. Lifespan: conventional 39 days, free-range 58 days and organic 73 days. The longer the birds' life the higher environmental impact, since a longer life means more feed is needed. There will also be more ammonia emissions from the manure created – which leads to higher AP the longer the bird live. N leaching from organic fields is not always higher than conventional production – but since more land is needed (due to low yields) the total N leaching will be greater per FU. Conventional birds have lowest environmental impact, followed by free-range birds. Organic birds have higher impact in all impact categories except pesticide use, of which organic production had lowest impact and free-range the highest.
	Eggs	Leinone n *et al*. (2012b)	**GWP (tCO_2e):** Free-range (3.38), organic (3.42), barn-conventional (3.45). **EP (kgPO_4e):** Organic (37.6), free-range (22), barn (20.3). **AP (kgSO_2e):** Organic (91.6), free-range (64.1), barn (59.4). **Abiotic resource use** (**kg antimony eq.)**: Org (20.3), free-range (15.4), barn (14.6). **Land occupation (ha):** Organic (1.7), free-range (0.5), barn (0.4). **Pesticide use (dose per ha):** Free-range (2.3), barn (2.2), organic (2.07). *Note: All hens are free to move, in this case 'barn' means free movement indoors and free-range means free movement indoors with access to pasture.* The feed was the main driver of GWP. In the organic system the GWP was high because the combination of a high feed intake (volume) compared to the other systems and a low egg production (yield). EP is caused by ammonia emissions and leaching of N from fields. AP is mainly caused by ammonia emissions. Buildings account for a large contribution to abiotic resource use. As a conclusion: the barn system has lowest EP and AP, although the free-range system is close behind. The free-range system has lowest GWP and the organic system has lowest pesticide use whilst the free-range system has the largest use. Organic and free-range systems have 6 bird per m^2

			whilst conventional systems (barn) have 11.7 per m^2 (floor area).

Summary hotspots for food production systems:

Pig

- Conventional production has lower impact in total, but if carbon sequestration were included, organic would have the same or lower impact than conventional production.

Chicken

- Conventional chicken has lowest environmental impact in all impact categories, followed by free-range and last organic chicken.
- Label rouge chickens (that grow slow to gain a high quality meat) has higher environmental impact than conventional chicken production.
- Animal welfare is likely better in free-range and organic systems as birds are allowed to grow slower and have access to pasture.

Milk

- Organic and conventional systems have both pros and cons and it is difficult to state which has lowest environmental impact in total.
- According to one study organic milk has lower GWP and pesticide use but larger EP, AP and land use – than conventional.
- A high share of grasslands (pasture) have positive impacts on biodiversity, GWP, AP and PEU (when including carbon sequestration in the analysis).

Egg

- In terms of carbon footprint free-range eggs have lowers impact, followed by organic and last conventional (barn).
- For all the rest impact categories conventional hens have lowest environmental impact in total, although free-range hens are close behind. Organic hens have largest impact which is a consequence of life span and concentrated feed.
- Free-range and organic hens are let out on pasture and have lower stock-density (animal welfare).

Vegetables

- Conventional potatoes have lower environmental impact than organic in a number of impact categories.
- Vegetables (tomatoes) grown in greenhouses (heated with fossil fuel) have larger impact than vegetables grown in fields.

Fruit

- In the case of bananas, organic is better than conventional from a carbon footprint perspective.

Cereals

- Organic bread wheat has larger GWP, EP and AP. Conventional bread wheat production use pesticides (which organic do not) and conventional has higher abiotic resource depletion.

Oil

- In the case of palm oil the RSPO (Roundtable on Sustainable Palm Oil) production had lower environmental impact in all impact categories, mainly due to the good management practices in place at plantations and at oil mills.

3.1.4 Additional information: findings from other studies

The Environmental Impact of Products (EIPRO) study presents the environmental impacts of food and beverage products when compared with other sectors and aggregated to an EU-25 level (Table 64) (Tukker *et al.*, 2006). The unit in the matrix presents the fraction (expressed in % in the last row) of the total EU impact each food category is responsible for. This is done for the several environmental impact categories studies (such as global warming, eutrophication and acidification).

In the top of Table 64, it is presented that the **'Food and non-alcoholic beverages'** sector account generally for around 20-30 % of the total environmental impact in EU-25 for all impact categories. The exception is for eutrophication which accounts for almost 60 % of the overall impact (Tukker *et al.*, 2006). Within the food and drink sector the six largest contributing food categories (of each impact category) has been highlighted. They have also been aggregated (in the bottom of Table 64). As an example it can be seen that the six food categories with the largest contribution to eutrophication together account for 35.1 % of the overall environmental impact for the EU-25.

Table 65 provides information from additional resources, mainly about environmental impact of different food categories and production systems.

Table 64: Summary of the contribution of several food and foodservice on the environment. Represented as a fraction of the total impact of all sector in EU-25 (Tukker *et al.*, 2006). *Note: Food product groups with largest impact share are highlighted for each product category.*

		Global warming	Eutrophication	Acidification	Abiotic depletion	Ozone depletion	Human toxicity	Eco-toxicity	Photo-oxidant formation
	Contribution of Food and non-alcoholic beverages sector for the overall environmental impact.	**0.293**	**0.581**	**0.297**	**0.206**	**0.236**	**0.236**	**0.316**	**0.255**
A2	Poultry and eggs		0.0085						
A10	Fruits		0.0076					0.0072	
A12	Vegetables	0.0071						0.0108	
A52	**Meat packing plants**	0.0554	0.1100	0.0614	0.0301	0.0332	0.0359	0.0488	0.0388
A53	**Sausages and other prepared meat products**	0.0252	0.0483	0.0280	0.0142	0.0166	0.0178	0.0219	0.0193
A54	**Poultry slaughtering and processing**	0.0393	0.0668	0.0446	0.0253	0.0311	0.0296	0.0315	0.0342
A56	**Natural, processed, and imitation cheese**	0.0211	0.0432	0.0234	0.0147	0.0157	0.0164	0.0230	0.0181
A57	Dry, condensed, and evaporated dairy products		0.0109	0.0060					
A59	**Fluid milk**	0.0238	0.0491	0.0263	0.0172	0.0187	0.0186	0.0261	0.0208
A65	Prepared fresh or frozen fish and seafood	0.0057							
A66	Frozen fruits, fruit juices, and vegetables	0.0075	0.0073	0.0062	0.0061	0.0075	0.0077	0.0089	0.0078
A68	Flour and other grain mill products		0.0067						
A69	Cereal breakfast foods		0.0231						
A70	Prepared flour mixes and dough		0.0251						
A75	**Bread, cake, and related products**	0.0089	0.0331	0.0083	0.0075	0.0081	0.0084	0.0110	0.0089
A76	Cookies and crackers		0.0122						
A78	Sugar		0.0095						
A81	Candy and other confectionery products		0.0103					0.0094	
A86	**Bottled and canned soft drinks**	0.0091	0.0081	0.0095	0.0079	0.0116	0.0107	0.0104	0.0116
A92	Roasted coffee	0.0071	0.0092		0.0062	0.0075	0.0073	0.0092	0.0068
A93	**Edible fats and oils, nec**	0.0129	0.0178	0.0096	0.0088	0.0113	0.0100	0.0166	0.0115
A96	Potato chips and similar snacks		0.0115			0.0063		0.0071	0.0062

Total contribution of the top 6 (highlighted) categories	**17.8%**	**35.1%**	**19.3%**	**11.0%**	**12.7%**	**12.9%**	**16.8%**	**14.3%**

Table 65: Overview of other reviewed articles that were not selected for the detailed analysis but are included in the results section

Study topic	Subject	Description	Main findings	Source
Hot drinks (coffee, tea and cocoa)	Cocoa (sustainable/ conv.)	Benefits of supplying cocoa from certified (sustainable) production in Ghana.	Certified cocoa was found to have lower GHG emissions than conventional production. The certification programs educate and train farmers in good agricultural practices, which leads to certified production becoming more efficient (higher yields) and better for the environment compared to conventional cocoa production. Furthermore, the cover trees bind carbon and certified growers did not cause land use change.	Afrane *et al*. (2013)
Hot drinks (coffee, tea and cocoa)	Green coffee beans	LCA of green coffee bean production	According to the Eco-indicator 99 LCA tool, the major impact of green coffee beans (cradle to roaster) are from transport. The main reason for transport being the most emitting process was because the coffee was grown according to sustainable methods. The coffee was grown under shade, using limited amounts of fertilisers and no pesticides. If the roasting stage were part of the LCA, it would add a significant impact to the total.	Salinas, (2008)
Hot drinks (coffee, tea and cocoa)	Coffee serving	LCA on comparing single-use prepared coffee with bulk prepared coffee	Single-use capsules of coffee were compared with bulk brewed coffee from initial extraction of resources to end-of-life waste treatment. It was found that the single-use coffee had lower environmental impact than bulk coffee. The main reason was that, in the single use system, the amount of coffee grind, water and energy were controlled by the coffee machine - whilst for brewed coffee all those aspects were controlled by the consumer and it is hence up to consumer behaviour to lower environmental impact and minimise resource use. A single-serve system has lower energy use associated with a machine that switches off after use rather than a machine that keeps warm water at the ready.	Quantis, (2015)
Fruit	Banana (Chiquita)	An LCA (non-scientific – but following appropriate standards)	This is an executive summary of LCA of Chiquita bananas from Central and Southern Europe. It was found that, for a box of bananas arriving in Europe, the carbon footprint is approximately 23 kgCO_2e per box. The main stages which emit carbon are: ocean transport, logistics around the destination, and use of chemicals on-farm. Proposed reduction strategies: (1) Utilize ocean vessels better; (2) Reduce the use of pesticides, fertilisers and herbicides on farm; (3) Improve the management of cold-logistics (efficient ripening centres and refrigerated containers).	Craig and Blanco, (2013)
Fruit	Oranges and lemons (organic and conventional)	An LCA to investigate different production systems in terms of a life cycle of an orchard (50 years)	Organic management systems were more sustainable than conventional ones both per hectare and per kg of final product, thanks to the use of environmentally friendly crop inputs (fertilizers, not use of synthetic products, etc.). An increased use of non-renewable energy formats would reduce the negative effects on the environment and maintain sustainability and decrease energy consumption. In addition, replacing pesticides and chemical fertilizers with other more environmentally friendly products could have a positive effect on biodiversity and human health. Conventional producers should use organic techniques in order to meet the increasing international demand for sustainable products; to avoid depletion of nitrogen, phosphorus, potassium and water resources, and to spend less money in terms of pest/weed control and the lack of heavy agricultural operations. Carbon sequestration should be included in the LCAs as it will provide a more realistic analysis.	Pergola *et al*. (2013)
Meat	Pig (Conv/ free-range/ org.)	A multi-criteria decision analysis that looked into environmental impacts of three different pig	A multi-criteria decision model aggregates impacts in order to rank different systems. This study looked at the impacts: GHG emissions, ammonia, nitrogen assessment and odour discomfort. A sample of 21 farms, 7 of each kind, was used – with primary data. **Ammonia emissions** were higher from farms with straw litters (always used in organic production) compared to slatted floors (always used in conventional production). **N_2O** was the main contributor to **GHG emissions**, and these levels were greater from manure under slatted floors than from straw litter. **Molecular nitrogen emissions** were higher in both organic and free-range production	Degré *et al*., 2007

Study topic	Subject	Description	Main findings	Source
		production systems. (Not LCA).	because of the straw litter. And **odour** was a main problem in conventional production due to the size of the stock and due to the type of buildings used. Litter in organic farms helped reduce odour impacts. A board of experts weighted the impacts (i.e. which is more or less important) and agreed that odour was the main impact to consider since local residents around farms can oppose production of pigs and innovations in the production, due to the fear of odour "pollution". The emission of ammonia was ranked second. GHG emissions were not considered of main importance as the pig production industry is not the main emitter of them. Based on this rationale, when all impacts were combined, it was found that **free-range production is the best option** (because small herd size and the use of litter reduced the occurrence of odours), followed by organic, and conventional production was the least preferred production method in this case (because of the risk of odour and the high spread of N on fields). However, the study did point out that there was a large variation between the farms investigated – the best conventional farm had almost the same results as the best free-range and organic. Again pointing out the limitations of results generalisation.	
Meat & dairy	Beef, pork, chicken, eggs and milk	This study conducts a review on existing LCAs of different livestock productions and compares them to find environmental hotspots.	Land use: Per kg of product, beef required most land (27-42 m^2), followed by pigs (8.9-12.1 m^2) and chicken (8.1-9.9 m^2). Eggs (4.5-6.2 m^2) and milk (1.1-2.0 m^2) need least land in this measurement. Eggs and milk have less need for land per kg of product because of the high water content. The large difference in land use for beef depends on where the calves come from. If they are bred from suckler cows, more land is allocated to the meat than if the calves come from the dairy sector (as a by-product); most of the land use is allocated to the milk cow. Fossil energy use: 1 kg beef requires most energy, but the gap between beef and the other meat types for energy is not as great as it is for land use. This is because the feed for chickens and pigs comes from concentrate which often has been imported and transported long distances, whilst the roughage for ruminants is produced locally. Chicken is most energy efficient due to the high feed conversion rate. Climate change: 1 kg beef emitted 14-32 $kgCO_2e$, whilst pork emitted 3.9-10 $kgCO_2e$, and chicken 3.7-6.9 $kgCO_2e$. The main reason underlining the larger emissions of beef was a higher energy usage, as well as more methane emissions than pork and poultry. Methane emissions from beef comes from manure (25 %) and the digestive system (75 %). Cattle need more feed per kg outcome, which also adds to the total GHG emissions of beef.	de Vries and de Boer, (2010)
Milk, cheese and eggs	Eggs	Carbon footprint of Danish organic eggs	Feed efficiency is the main cause underlining GWP of organic egg production. Electricity for heating and cooling bird houses also has a small share of the total GWP.	Ingemann Nielsen *et al.* (2013)
Eggs	Eggs (Org/ free-range/ conv.)	Sustainability assessment of different egg production systems in the Netherlands.	As a result of consumer concern over animal welfare, the conventional cage system has been banned in Europe and replaced with enriched cages (with a minimum requirement of 750 cm^2 per hen). Three other systems that has also emerged (that do not use cages): barn (indoors), free-range (in and outdoors), organic (in and outdoors). In the Netherlands the enriched cages are proposed to be banned by 2021 as well. In this study these systems where compared from a sustainability perspective including environmental, social and economic aspects. Animal welfare was evaluated from an objective perspective; through an approach called Welfare Quality Monitor; only including four aspects: good feeding, housing, health and appropriate behaviour of hens**. If all aspects were equally weighted than the results of the study were that enriched cages had the highest sustainability score (61),** followed by free-range, (49), organic (42) and barn (39). In the **environmental dimension** (*GWP, energy use and land use – direct and indirect*) the enriched cages had significantly higher score than the other systems and the free-range	van Asselt *et al.* (2015)

Study topic	Subject	Description	Main findings	Source
			system had lowest score. In the **economic dimension** the organic and enriched cages had as high a score and in the **social dimension** (*animal welfare, human welfare and food security*) the free-range system had significantly higher score than the other systems.	
Meat and dairy and fish & seafood	Animal products	A **literature review of 52 LCA studies**, including: beef, pork, poultry, eggs, mutton and lamb, milk, cheese, seafood from fisheries and from aquaculture, substitutes to meat containing milk protein or eggs, substitutes to meat containing only vegetable ingredients and pulses.	Land requirements and carbon footprint are discussed in this review. (It covers conventional production widely - except eggs that are free range). The results of land use per kg of product show that beef from extensive systems has the largest amount of land use. Values found range from 400 m^2 to 0 m^2 (for wild caught fish) annually per kg. In terms of GHG emissions, ruminant meat show to have the largest emissions in total (between 9 - 129 kg CO_2e per kg, however, the results significantly vary between studies). One reason is the differences in production systems. Some of the reasons for the larger emissions are that enteric fermentation leads to the release of methane, and that cattle and sheep have a slow feed conversion rate, slow reproduction and use a lot of land (mainly in extensive systems). Beef from the dairy sector has lower impact than from the beef sector, since some of the burdens are allocated to milk production. For milk, enteric fermentation creates the largest share of emissions and the processing stage is small in comparison. Dairy cows do not go far from the farm since they need to be milked regularly, and the dairy processing plant is also located nearby for the same reason. Milk, cheese and eggs have a medium impact (roughly the same as pork) at around 5 kgCO_2e per kg (according to the reviewed studies). LCA results from pork and poultry show little variation in results. One study says that organic pork production has 20 % higher GHG emissions compared to conventional, whilst another study finds organic pork has 12 % lower GHG emissions. Chicken has lowest production emissions of the meat products (around 3 kgCO_2e per kg). Some seafood products have low environmental impact, but the results vary a lot between LCA studies (1-86 kgCO_2e per kg). Spanish mussels, North-East Atlantic mackerel and Baltic herring are some of the species with low GWP, while trawled Norwegian lobster has the largest GWP. Fishing methods have an impact on the results as well as the distance the vessel has to travel to reach the goal species. Bottom trawling and long-line fishing use more energy than purse seines, gill-nets and mid-water trawling. Long traveling distances also increase energy use. Alaskan Pollock creates around 3 kgCO_2e per kg and cod varies between 3 and 7 kgCO_2e per kg. Farmed salmon generally emits 3-8 kgCO_2e per kg and fish that require only a vegetable diet emit around 3 kgCO_2e per kg. Beef/dairy: enteric fermentation (methane emissions). Pork: crop production (NOx emissions) – improving feed conversion rates are one way of minimising this impact. In Europe 50 % of beef originates from culled dairy cows. Dairy cows in Europe are not let out for meadow grazing regularly (due to intensive systems).	Nijdam *et al*. (2012)
Fish and seafood	Eco-labels	A comparison of eco-labels for fish and seafood from an LCA perspective	A study on wild caught seafood found that not all eco-labels have a life cycle scope. In capture fisheries the process that has the largest impact throughout the life stage is the fishing stage. At this stage there is a high amount of fuel use which increases GHG emissions, eutrophication and AP. It is also at this stage that fish stocks are affected (biotic resource use) and anti-fouling is used on fishing boats (eco-toxicity). The processing stage is also an important contributor of impacts for some fish species such as mackerel in aluminium cans, where both the preparation stage of the fish and the aluminium can increase the total impact. Lastly the transport, retail and consumer stage is also important since seafood products have to be kept chilled or frozen, which requires energy. Currently fuel use is not addressed in the MSC label (which is one of the eco-labels that are most commonly used). KRAV (Swedish) and DSLS	Thrane et al. 2009

Study topic	Subject	Description	Main findings	Source
			(Danish) labels do include criteria on reducing fuel use and on use of anti-fouling agents, and also take into consideration the stages after the fishing stage, but these two labels are national and not necessarily applicable at a global level, and the Danish label has not been in use for many years, which leaves KRAV to be the only currently available eco-label that has a LCA approach.	
Several food products	LCA of bread, tomato ketchup, milk, meat, potato, tomato and packaging (review)	This study reviewed existing **LCAs on a number of food categories**, not only looking at the production stage, but also processing, packaging, food waste and waste management.	(*Not much detail was provided in this study results*). Bread: primary production and transport are the major areas for most impact categories. The baking stage uses much energy and contributes to photo-oxidant formation. Eutrophication is mainly caused by nitrogen leaching on fields due to fertiliser use. Tomato ketchup: processing and packaging are the hotspot areas for many impact categories. Milk: organic milk production can lower the surplus of minerals in the ground and reduce pesticide use, compared to conventional, but organic production also requires much more arable land. In the life cycle of milk, the agricultural stage is the main hotspot. Furthermore, packaging (amount of packaging material), cleaning products and waste management have an impact. There are by-products of milk production that have economic value, e.g. meat and manure that are allocated some of the emissions (a system expansion). N fertilizer increases economic and production efficiency, but reduces environmental efficiency. Eutrophication is the main consequence of N leaching. Meat: the main areas that impact the environment are feeding duration, type of feed, feed production, manure storage and animal housing. For pork it can help to replace soya with rapeseed cake and peas. If protein is considered as the FU then chicken has lowest total impact, followed by pigs, and beef has highest impact. In terms of energy content as FU, pigs have lowest impact. The enteric emissions (methane) from beef and dairy cows increase the total impact. Potato: when shifting from conventional to organic, the energy used for fertilizer production is shifted to energy needed to operate machines, and more land is required. Tomato: there are several aspects that contributes to the variability of life cycle impacts of tomatoes e.g. method of cultivation (organic/conventional, on field/greenhouse, hydroponic/soil based), location of cultivation, variety, distribution system and packaging. Packaging is an important element for almost all food products; it creates both waste and a large share of the total environmental burden. Packaging is needed to protect food and to improve its shelf life. Minimising the use of primary and secondary packaging is one way of realising savings for businesses. Lowering the weight of primary packaging and increasing recycling rates are two ways of reducing the associated impact. An example is beer in glass bottles. The production and transport of the bottles created one third of the total global environmental impact. Reusable glass bottle systems were found to have the lowest impact on the environment in comparison to disposable glass bottles, steel and aluminium cans. As for tomatoes from Spain, modified atmosphere packaging is better than cold chain and paper box distribution.	Roy *et al*. (2009)
Organic vs. conventional	Organic and conventional food systems	A literature review of 34 LCAs that compared **organic and conventional agriculture**.	It is not yet possible to draw a conclusion between LCAs that compare organic and conventional food products, since the studies do not take into account the differences of the farming systems at an inventory level. This is to say that, often, assumptions made for organic systems are based on the nitrogen values for conventional agriculture. (One reason can be that there is little data available on extensive systems.) Furthermore, organic farming provides non-commodity outputs such as enhanced soil quality, biodiversity and ecosystem services to society. Some of these aspects related to the multi-functionality of agriculture, such as biodiversity and soil quality, are still rather difficult	Meier *et al*. (2015)

Study topic	Subject	Description	Main findings	Source
			to integrate into LCA methodology. LCAs are more product-efficiency driven, which usually favours intensive (high input agricultural) systems, even though other types of measures show that those systems are environmentally unsustainable. The study mentions that, for an LCA-based comparison of farming systems, there is a need to use distinct functional units to acknowledge multifunctional outputs or to allocate environmental impacts to the whole set of agricultural outputs.	
Organic vs. conventional	Does organic reduce environmental impacts?	This study conducted a systematic review on published journals that compared organic and conventional production methods.	Per unit of area, organic farming has lower impact for most impact areas compared to conventional systems. However, per product unit organic systems have lower energy use, but larger land use and hence higher EP and AP. Improvement potentials can be realised by managing nutrients better and working towards increasing yields. For conventional farming the key areas to improve are to recycle nutrients, enhance the quality of soil and protect biodiversity. Integrated production is proposed as a way to achieve better environmental impact.	Tuomisto *et al.* (2012b)
Organic/ integrated production/ conventional	Comparing GHG emissions, energy balance and biodiversity (org/int./ conv.)	Title: Comparing global warming potential, energy use and land use of organic, conventional and integrated winter wheat production. Includes different types of fertilisers, including own biogas production.	An integrated farming system (IFS), a combination of best practice from conventional and organic systems, was found to be best for the environment (when comparing all three systems). IFS minimises negative environmental impacts without affecting yields negatively. The organic system had lowest energy use per unit of area and IFS had lowest energy use per product unit. The conventional system had the highest GWP both per unit pf production and per unit of land area, and IFS had lowest GWP for both measures. Compared to IFS and conventional farming the organic system needed 120 % more land. For wheat, the best way of reducing GWP and energy use is to replace synthetic fertilisers with N-fixing cover crops and anaerobically treated food waste (assuming yields are unchanged by doing so). One downside of this change is the possibility of increased leakage of N, which leads to increased EP and AP. In organic systems the low yields (compared to the other systems) are usually caused by soil nutrient deficiencies as well as outbreaks of diseases and issues with pests and weeds. Furthermore, both crops and animals have to be bred to suit organic systems in order to achieve better outcomes, as they are currently bred to suit conventional systems.	Tuomisto *et al.* (2012a)
Organic/ integrated production/ conventional	Winter wheat	An LCA that compared organic, conventional and integrated production methods, but also included alternative land use.	It was assumed that organic production needs 100 % of the land, whilst conventional production only needs 50 % and if the remaining 50 % is used for energy crop production; the overall farm GHG and energy balances are better than the organic per product unit. In crop production a large part of the energy use originated from use of machinery, cold storage (especially of potatoes) and drying crops. As for GHG emissions the N2O emissions from land use was the main contributor.	Tuomisto *et al.* (2012c)
Food service	Food service in the tourism sector	A study on how foodservice providers can manage their	Purchasing renewable energy to kitchens lowers overall impact. With separate food waste collection, it is easier for the foodservice to see what and how much is being wasted (especially if the food waste bins also are separated into food types). Armed with this knowledge it is easier to target that waste in order to prevent it. Planning the purchase of food also minimises the risk of food waste.	Gössling *et al.* (2011)

Study topic	Subject	Description	Main findings	Source
		service and thus decrease the carbon footprint of tourism.	It is recommended to buy seasonal food, or food with minimal energy use for storage. For fish it is recommended to purchase species that are not endangered and species that have low environmental impact in the catching phase (such as pelagic fish). If serving food in a buffet, it is advised to use smaller plates to minimise the risk of food waste.	
Food service	Food service sector in the UK	Environmental impacts of food service	A study from the UK found that the CO_2e emissions of a meal in the public sector foodservice is significantly impacted by the energy use in the preparation stage. Transport, packaging, water use and waste associated with foodservice have a marginal impact in comparison. This study found that the cooking and cold storage stage stood for the majority of CO_2e emissions from energy use.	SKM Enviros, (2010)
Food waste	Food waste study	Focused on Swiss food service industry **food waste;** looked at four stages in a food service supply chain: storage loss, preparation losses, serving losses (remaining from buffet) and plate waste. Also looked at potential to reduce food waste.	**Investigated two foodservices, one each in education and business:** In total there was a food loss in the supply chain of approximately 11 % for company A and 8 % for company B, out of total delivery of food. In terms of avoidable waste, the study concludes the following: Waste in storage accounts for 1 % in company A and 4 % in company B (this can be completely avoidable). Preparation losses were 10 % in A and 32 % in B (around 50 % in each was unavoidable), serving losses were 63 % in A and 38 % in B (most avoidable in both cases) and left-overs on consumer plates were 27 % in A and 26 % in B. The survey found that around 30 % of the waste was starch and around 27 % was vegetables. The consumers stated that the reason for plate waste was mainly "portion served by staff too large", but also "lack of hunger" or "ingredients I don't like". In terms of improvement potential, staff training was found to be important. Changing portion sizes was also mentioned. According to a quality assurance warranty, uneaten food must be disposed of if it has left the kitchen. Hence smaller bowls for serving, or only serving half full bowls by the end of lunchtime, is a way of dealing with this.	Betz *et al*. (2015)

AP - Acidification Potential; **EP** - Eutrophication Potential; **FU** - functional unit; **GWP** - Global Warming Potential; **PEU** - Primary Energy Use
Primary data: gathered directly from farms or production sites, **Secondary data**: gathered from other sources (e.g. literature, databases)

3.1.5 Environmental hotspots of food, catering services and production systems

This section details the environmental hotspots for conventional production for several food products (section Fruit3.1.5.1.1 to 3.1.5.1.10), for catering services (section 3.1.5.2) and the at the end for several production systems (such as organic production, free range and integrated production) (section 3.1.5.3).

3.1.5.1 Food categories

In this section the results of the detailed analysis on the LCA studies reviewed (Table 61 to Table 63) are concluded and further related to the findings of the EIPRO study resumed in Table 64 (Tukker *et al.*, 2006). This section presents the findings per food category, for the catering services and also for the production systems. For each of the mentioned activities is provided a summary of the main hotspots based on the evidence collected from the detailed analysis on the LCA review (3.1.3.6), the EIPRO study (section 3.1.4, Table 64) and the additional information (section 3.1.4, Table 65). The EIPRO study and the additional information aim to further support the evidence on the environmental hotspots and the reasoning underlining those relevant hotspots. Moreover, these additional references are included as they may be a mean of further supporting (or contradicting) the evidence collected.

3.1.5.1.1 Fruit

The EIPRO study informs that fruit seems to be not a major contributor to the overall environmental impact of the EU-25 (Tukker *et al*., 2006). Fruit show to have a comparatively small contribution to eutrophication (0.76 %) and eco-toxicity (0.72 %). However, if frozen fruit is included it has a small impact on all impact categories most likely due to energy use for the refrigeration and possibly due to leaking of refrigerants.

Table 66: A summary of how large an impact fruit has on the environment, as a fraction of the total impact of all sectors, in EU-25 – based on EIPRO study (Tukker *et al.*, 2006).

	Global warming	Eutrophication	Acidification	Abiotic depletion	Ozone depletion	Human toxicity	Eco-toxicity	Photo-oxidant formation
Contribution of Food and non-alcoholic beverages sector for the overall environmental impact (%)	**29.3**	**58.1**	**29.7**	**20.6**	**23.6**	**23.6**	**31.6**	**25.5**
Contribution of fruits		**0.76**					**0.72**	
Contribution of frozen fruits, fruit juices and vegetables	**0.75**	**0.73**	**0.62**	**0.61**	**0.75**	**0.77**	**0.89**	**0.78**
Total Contribution of Fruit (%)	**0.75**	**0.76**	**1.49**	**0.61**	**0.75**	**0.77**	**1.61**	**0.78**

<u>Detailed analysis</u>: Eutrophication is found to be a hotspot and the main cause of it was due to non-efficient nitrogen use at farm that ultimately led to leaching from soil. Eco-toxicity is also identified as an impact category due to the fertilisers and pesticide production and use in the fields. Global warming potential were found to be due to nitrogen fertiliser on fields, transport (especially long distance), packaging and storage (Iriarte *et al*., 2014; Roibás *et al*., 2014; Webb *et al*., 2013). Additionally, irrigation was an identified hotspot requiring much energy and water (Giudice *et al*. 2013).

Additional information: The carbon footprint for banana identified ocean transport, refrigeration, pesticide and fertiliser use as the main contributors for the emission of greenhouse gases (Craig and Blanco, 2013). The comparison made for organic and conventional oranges and lemons found that replacing pesticides and chemical fertilizers with other more environmentally friendly products could have a positive effect on biodiversity and human health (Pergola et al., 2013).

3.1.5.1.2 Vegetables

The EIPRO study informs that vegetables seem to be not a major contributor to the overall environmental impact of the EU-25 (Tukker *et al*., 2006) (Table 67). Vegetables global warming (0.71 %) and eco-toxicity (1.08 %).

Table 67: A summary of how large an impact vegetables has on the environment, as a fraction of the total impact of all sectors, in EU-25 – based on EIPRO study (Tukker *et al*., 2006)

	Global warming	Eutrophication	Acidification	Abiotic depletion	Ozone depletion	Human toxicity	Eco-toxicity	Photo-oxidant formation
Contribution of Food and non-alcoholic beverages sector for the overall environmental impact (%)	**29.3**	**58.1**	**29.7**	**20.6**	**23.6**	**23.6**	**31.6**	**25.5**
Total Contribution of Vegetables (%)	**0.71**						**1.08**	

Detailed analysis: Global warming is greatly affected by fossil fuel and energy use. The most substantial drivers of PEU are heating of greenhouses (Webb *et al*., 2013), irrigation (Del Borghi *et al*., 2014) and long term cold storage (Williams *et al*., 2010). Processing and packaging of tomato products account for a large share of GWP (Del Borghi *et al*., 2014). Fuel use leads to human toxicity and pesticide use drives toxicity (Del Borghi *et al*., 2014). As for eco-toxicity, pesticide use is likely the main cause. Abiotic resource depletion was also mentioned to be caused by the material used for greenhouses and energy used to heat them (Webb *et al*., 2013). Yield levels is an important factor for overall environmental impact of potatoes (Webb *et al*., 2013).

Additional information: In the case of tomato ketchup, processing and packaging are the main causes of most environmental impact (Roy *et al*., 2009).

3.1.5.1.3 Fish and seafood

The EIPRO study informs that fish and seafood do not contribute much to the total environmental impact of the EU-25 (Tukker *et al*., 2006) (Table 68). The fish and seafood category only has a small impact on global warming (0.57 %).

Table 68: A summary of how large an impact fish and seafood have on the environment, as a fraction of the total impact of all sectors, in EU-25 – based on EIPRO study (Tukker *et al*., 2006)

	Global warming	Eutrophication	Acidification	Abiotic depletion	Ozone depletion	Human toxicity	Eco-toxicity	Photo-oxidant formation
Contribution of Food and non-alcoholic beverages sector for the overall environmental impact (%)	**29.3**	**58.1**	**29.7**	**20.6**	**23.6**	**23.6**	**31.6**	**25.5**
Total Contribution of Prepared fresh or frozen fish and seafood (%)	**0.57**							

Detailed analysis: For wild caught fish, the fishing stage accounts for most of the global warming potential, as well as eutrophication, acidification, ozone depletion potential, marine eco-toxicity and abiotic resource depletion; all as a consequence of diesel use (Vázquez-Rowe *et al*., 2011). Ellingsen and Aanondsen (2006) also found that the fishing stage accounted for most of the global warming potential and release of respiratory inorganics, both due to fuel use. Long-line fishing has a lower carbon footprint than trawling, since trawling requires a vast amount of diesel (Vázquez-Rowe *et al.*, 2011). As for discard at sea, long-line fishing produces 0.21 kg discard per kg landed European hake, whilst trawling produces 5.08 kg discard per kg landed European hake (Vázquez-Rowe *et al.*, 2011). Additionally, bottom trawling destroys the seafloor (Ellingsen and Aanondsen, 2006). The main environmental impact of farmed fish is the carbon footprint associated with feed production (Ellingsen and Aanondsen, 2006; ESU-services, 2011). 1 kg farmed salmon requires 2.8 kg wild fish as feed (Ellingsen and Aanondsen, 2006). Eco-toxicity was an issue to both fishing methods due to anti-fouling on vessels and equipment (Ellingsen and Aanondsen, 2006). Eco-toxicity and eutrophication is also caused by wastewater from fish processing (as the water contains of plastic and organic residues) (Vázquez-Rowe *et al.*, 2011). Eutrophication is also caused by nutrient leaching from farmed fish (Ellingsen and Aanondsen, 2006). Packaging is largely responsible for abiotic resource depletion (Vázquez-Rowe *et al.*, 2011) as well as carbon footprint, especially for metal (aluminium) packaging (ESU-services).

Additional information: the carbon footprint of seafood varies substantially depending on goal species, distance at sea to goal species and fishing method (Nijdam *et al.*, 2012). These aspects have an impact on energy (fuel) use (Nijdam *et al.*, 2012). In the case of wild caught fish, the fuel use at the fishing stage is the main hotspot because the use of fossil fuel that leads to GWP, EP and AP (Thrane *et al.*, 2009). Furthermore, it is at this stage that fish stocks are depleted (biotic resource use) and where anti-fouling on fishing boats is used (eco-toxicity) (Thrane *et al.*, 2009). The processing stage is also an important contributor of impacts for some fish species such as mackerel in aluminium cans, where both the preparation stage of the fish and the aluminium can itself increases the total impact (Thrane *et al.*, 2009).

3.1.5.1.4 Meat

The EIPRO study informs that the meat food categories are some of the most contributing categories to the total environmental impact of the EU-25 (Tukker *et al.*, 2006) (Table 69). They affect all impact categories, but primarily eutrophication (22.5 %), acidification (13.4 %), global warming (12 %) and eco-toxicity (10.2 %).

Table 69: A summary of how large an impact meat has on the environment, as a fraction of the total impact of all sectors, in EU-25 – based on EIPRO study (Tukker *et al.*, 2006)

	Global warming	Eutrophication	Acidification	Abiotic depletion	Ozone depletion	Human toxicity	Eco-toxicity	Photo-oxidant formation
Contribution of Food and non-alcoholic beverages sector for the overall environmental impact (%)	**29.3**	**58.1**	**29.7**	**20.6**	**23.6**	**23.6**	**31.6**	**25.5**
Total Contribution of Meat packing plants	5.54	11	6.14	3.01	3.32	3.59	4.88	3.88
Total Contribution of Sausages and other prepared meat products	2.52	4.83	2.8	1.42	1.66	1.78	2.19	1.93
Total Contribution of Poultry slaughtering and processing	3.93	6.68	4.46	2.53	3.11	2.96	3.15	3.42
Total Contribution of meat (%)	**12.0**	**22.5**	**13.4**	**7.0**	**8.1**	**8.3**	**10.2**	**9.2**

Detailed analysis: Nitrogen is needed in soils for crops to grow efficiently, but there is always a run-off of it into streams and rivers which leads to eutrophication (Halberg *et al.*, 2010). Eutrophication is a large hotspot for pig production (Halberg *et al.*, 2010), lamb and beef production (Webb *et al.*,

2013) and broiler production (Leinonen *et al*., 2012a; da Silva *et al*. 2014) because of nitrogen leaching from fertilised soils. Acidification is a hotspot for broiler production (Leinonen *et al*., 2012a), pig production (Halberg *et al*., 2010) and beef production (Webb *et al*., 2013) because of ammonia emissions from manure. For lamb production the main cause of acidification is long distance transport (Webb *et al*., 2013). Ruminants create methane through enteric fermentation in their digestive system, and methane is a very potent greenhouse gas. Global warming is driven by methane emission from ruminants (Webb *et al*., 2013), N_2O emission from fields (Halberg *et al*., 2010; Leinonen *et al*., 2012a), and CO_2 emissions from crop production (da Silva *et al*. 2014). Methane emissions also occur from slurry (liquid manure) storage in pig production (Halberg *et al*., 2010). Imported feed also contributes to global warming (e.g. imported soy and palm oil because of land use change (da Silva *et al*. 2014; Leinonen *et al*., 2012a) or organic wheat because of low yields and long transport (Leinonen *et al*., 2012a)). Heating of bird houses also contributes to global warming due to the use of fossil fuel energy (Leinonen *et al*., 2012a; Webb *et al*., 2013). The energy needed at the processing stage (e.g. in abattoirs) drives GWP which can be lowered by using renewable energy (Webb *et al*., 2013). Furthermore, rearing ruminants indoors drives PEU and abiotic resource depletion. On the other hand, rearing them outdoors drives land use (Webb *et al*., 2013). Terrestrial eco-toxicity for chicken production is primarily caused by feed production (75-87 %) where the main cause is the production and use of fertilisers (emissions of heavy metals) (da Silva *et al*., 2014).

<u>Additional information:</u> 75 % of the methane emissions from beef is derived from the cattle's digestive system and 25 % from their manure (de Vries and de Boer, 2010). Ammonia emissions are higher from pig production if straw litter is used on floors compared to no litter (slatted floors – floors with narrow gaps in which slurry can fall down and get automatically scraped to the slurry storage) (Degré et al., 2007). However, N_2O emissions are higher from slurry under slatted floors compared to floors with litter (Degré et al., 2007). Per kg of product, beef required most land (27-42 m^2), followed by pigs (8.9-12.1 m^2) and chicken (8.1-9.9 m^2) (de Vries and de Boer, 2010). For beef, more land is allocated to the meat if the calf comes from suckler cows compared to if they come as a co-product from the dairy industry (de Vries and de Boer, 2010). Land use is greater in extensive beef production (Nijdam *et al*., 2012). Beef requires most energy per kg, but the gap between this and the other meat types is not as great as for land use (de Vries and de Boer, 2010). This is because the feed for chickens and pigs comes from concentrate which often has been imported and transported long distances, whilst the roughage for ruminants is produced locally. GWP for the different meat products was found to be in the range 14-32 $kgCO_2e$ per kg beef, 3.9-10 $kgCO_2e$ per kg pork and 3.7-6.9 $kgCO_2e$ per kg chicken. The main reasons for the higher emissions of beef was a higher energy usage, as well as higher methane emissions than pork and poultry (de Vries and de Boer, 2010). Feed production, duration of feeding, storage of manure and housing are general hotpots for meat products (Roy et al., 2009).

3.1.5.1.5 Milk, cheese and eggs

The EIPRO study informs that fluid milk and cheese products contribute to all environmental impact categories, but primarily to eutrophication (10.3%) (Tukker *et al*., 2006), as illustrated in Table 70.

Table 70: A summary of how large an impact milk and cheese have on the environment, as a fraction of the total impact of all sectors, in EU-25 – based on EIPRO study (Tukker *et al*., 2006)

	Global warming	Eutrophication	Acidification	Abiotic depletion	Ozone depletion	Human toxicity	Eco-toxicity	Photo-oxidant formation
Contribution of Food and non-alcoholic beverages sector for the overall environmental impact (%)	**29.3**	**58.1**	**29.7**	**20.6**	**23.6**	**23.6**	**31.6**	**25.5**
Total Contribution of natural, processed, and imitation cheese	2.11	4.32	2.34	1.47	1.57	1.64	2.3	1.81
Total Contribution of dry, condensed, and evaporated dairy products		1.09	0.6					
Total Contribution of fluid milk	2.38	4.91	2.63	1.72	1.87	1.86	2.61	2.08
Total Contribution of dairy (%)	**4.5**	**10.3**	**5.6**	**3.2**	**3.4**	**3.5**	**5.0**	**3.9**

Detailed analysis: Eutrophication and acidification largely caused in the primary production, especially by the production of animal feed (concentrated feed) (González-García *et al*., 2013; Djekic *et al.,* 2014). The carbon footprint is caused equally much by primary production and the processing stage (González-García *et al*., 2013; Djekic *et al.,* 2014). In primary production it is driven by methane emissions from ruminants and manure storage (González-García *et al*., 2013; Djekic *et al.,* 2014; Cederberg and Mattsson, 2000; Guerci *et al.,* 2013; Hietala *et al.,* 2014). In the dairy plant it is caused by CO_2 emissions from energy use (González-García *et al*., 2013). At the farm stage the GWP could be lowered if including carbon sequestration in the analysis (Hietala *et al.,* 2014). Furthermore, the more forage in a cow's diet the more methane emission the cow will produce (Cederberg and Mattsson, 2000). Human toxicity, marine toxicity and freshwater toxicity is mainly caused by packaging, cleaning detergents and electricity use (González-García *et al*., 2013). Terrestrial eco-toxicity is caused by diesel use and use of commercial fertiliser since they release metals to the environment (González-García *et al*., 2013). Butter has a much higher impact on the environment in GWP, EP and AP compared to other dairy products because of the quantity of raw milk required to make butter (Djekic *et al.,* 2014). The more raw milk needed, the larger impact on the environment. Full-fat dairy products have a larger environmental impact than half-fat dairy products (Djekic *et al.,* 2014). If the impact of raw milk is not included then yoghurt has the highest environmental impact in the dairy industry (Djekic *et al.,* 2014).

Additional information: The agricultural stage has the highest impact in the life cycle of milk; then packaging material, cleaning products and waste management have an impact (Roy *et al.,* 2009). Packaging is important to protect food and extend its shelf life but it creates general waste and leads to negative environmental impacts while being produced. To lower the environmental impact of packaging, the primary packaging can be made with less material and with recyclable material (Roy *et al.,* 2009). It would also be beneficial to reduce secondary packaging (Roy *et al.,* 2009). Another finding is that fat content in dairy products have an impact on the environment. The higher fat content the higher impact (Scholz, 2013).

In respect to eggs the EIPRO study informs that they seem to be not a major contributor to the overall environmental impact of the EU-25 (Tukker et al., 2006) (Table 71). Eggs show to have a comparatively small contribution to eutrophication (0.85%).

Table 71: A summary of how large an impact egg has on the environment, as a fraction of the total impact of all sectors, in EU-25 – based on EIPRO study (Tukker *et al.*, 2006).

	Global warming	Eutrophication	Acidification	Abiotic depletion	Ozone depletion	Human toxicity	Eco-toxicity	Photo-oxidant formation
Contribution of Food and non-alcoholic beverages sector for the overall environmental impact (%)	**29.3**	**58.1**	**29.7**	**20.6**	**23.6**	**23.6**	**31.6**	**25.5**
Total Contribution of poultry and eggs (%)		**0.85**						

Detailed analysis: Eutrophication is driven by nitrogen leaching from fields and ammonia emissions from manure (Leinonen *et al.*, 2012b). Both nitrogen leaching and phosphorus leaching drive eutrophication (Dekker *et al.,* 2013). Acidification is caused by ammonia emissions from manure (Leinonen *et al.*, 2012b; Dekker *et al.,* 2013). Feed is a main hotspot for carbon footprint (Leinonen *et al.*, 2012b; Taylor *et al*., 2014; Dekker *et al.,* 2013). Land use change of soy production is a large driver of GWP for feed (Taylor *et al*., 2014; Leinonen *et al.*, 2012b). N_2O emissions from fields driven by nitrogen fertiliser application is a hotspot for GWP (Taylor *et al*., 2014). Methane emissions from manure also drives GWP (Dekker *et al.,* 2013). Heating or cooling birdhouses uses electricity that drives GWP (Leinonen *et al.*, 2012b).

Additional information: Feed was found to account for the majority of GHG emissions in Danish organic egg production. Electricity for heating and cooling also had an impact on the total (Ingemann Nielsen *et al.,* 2013).

3.1.5.1.6 Bread and cereals

The EIPRO study informs that bread and cereals have a minor impact on most impact categories on the total EU-25, except for eutrophication in which the categories combined contribute 8.8 % (Tukker *et al*., 2006) (Table 72).

Table 72: A summary of how large an impact bread and cereals have on the environment, as a fraction of the total impact of all sectors, in EU-25 – based on EIPRO study (Tukker *et al*., 2006)

	Global warming	Eutrophication	Acidification	Abiotic depletion	Ozone depletion	Human toxicity	Eco-toxicity	Photo-oxidant formation
Contribution of Food and non-alcoholic beverages sector for the overall environmental impact (%)	**29.3**	**58.1**	**29.7**	**20.6**	**23.6**	**23.6**	**31.6**	**25.5**
Total Contribution of flour and other grain mill products		0.67						
Total Contribution of cereal breakfast foods		2.31						
Total Contribution of prepared flour mixes and dough		2.51						
Total Contribution of bread, cake, and related products	0.89	3.31	0.83	0.75	0.81	0.84	1.1	0.89
Total Contribution of bread and cereals (%)	**0.89**	**8.80**	**0.83**	**0.75**	**0.81**	**0.84**	**1.10**	**0.89**

Detailed analysis: In the production of bread wheat and rapeseed oil, N_2O emissions are much more significant drivers of carbon footprint in comparison to CO_2 emissions from combustion of fossil fuels

(Williams *et al.,* 2010). The ingredients to breakfast cereals account for the majority of environmental impacts, but energy for manufacturing, use of packaging and transport are also hotspots (Jeswani *et al.,* 2015).

Additional information: In the case of bread, the crop production stage and transport are the largest areas of impact for most impact categories (Roy *et al.,* 2009). The baking process uses most energy and leads to photo-oxidant formation (Roy *et al.,* 2009). Eutrophication is mainly caused by nitrogen leaching from fields due to fertiliser application in crop production (Roy *et al.,* 2009).

3.1.5.1.7 Oils and fats

The EIPRO study informs that oils and fats have quite a large contribution to the total environmental impact in EU-25. In the case of global warming, acidification, abiotic depletion and eco-toxicity (the highlighted categories), the 'edible fats and oils' category is sixth in terms of contribution to total emissions (within impact categories) (Tukker *et al*., 2006). Illustrated in Table 73.

Table 73: A summary of how large an impact oils and fats have on the environment, as a fraction of the total impact of all sectors, in EU-25 – based on EIPRO study (Tukker *et al*., 2006)

	Global warming	Eutrophication	Acidification	Abiotic depletion	Ozone depletion	Human toxicity	Eco-toxicity	Photo-oxidant formation
Contribution of Food and non-alcoholic beverages sector for the overall environmental impact (%)	**29.3**	**58.1**	**29.7**	**20.6**	**23.6**	**23.6**	**31.6**	**25.5**
Total contribution of edible fats and oils, nec	1.29	1.78	0.96	0.88	1.13	1	1.66	1.15
Total Contribution of oils and fats (%)	**1.29**	**1.78**	**0.96**	**0.88**	**1.13**	**1.00**	**1.66**	**1.55**

Detailed analysis: In the detailed analysis the main focus was on edible vegetable oils as they are used to a great extent in EU-28. Most articles summarised the environmental hotspots, but did not clearly specify what the root causes were. There is a gap in evidence here. It was found that the cultivation stage of vegetable oil production is where most of the environmental impacts occur (Tsarouhas *et al.,* 2015; Schmidt, 2015). The oil mills also have high impacts, especially palm oil (Schmidt, 2015; Yusoff and Hansen, 2007) but also for peanut oil (Schmidt, 2015). At the refinery stage the palm oil has largest impact (Schmidt, 2015). The production of chemical fertiliser is the main cause of pollution in production of crude palm oil (Yusoff and Hansen, 2007). The five most impacting activities are: to burn fibres in boilers, use of fertiliser, treatment of wastewater, disposal of empty fruit-bunch, the use of gasoline when cutting weed and weed control using glyphosate (Saswattecha *et al.,* 2015). Pesticide use was not included in the analysis in another LCA, but it was assumed pesticides were not heavily used as integrated (biological) pest management was in place (Yusoff and Hansen, 2007).

Additional information: None

3.1.5.1.8 Coffee, tea and cocoa (hot drinks)

The EIPRO study informs that roasted coffee have a small impact on the total environmental impact of EU-25, on all impact categories (Tukker *et al*., 2006) (Table 74).

Table 74: A summary of how large impact hot drinks has on the environment, as a fraction of the total impact of all sectors, in EU-25 – based on EIPRO study (Tukker *et al.*, 2006).

	Global warming	Eutrophication	Acidification	Abiotic depletion	Ozone depletion	Human toxicity	Eco-toxicity	Photo-oxidant formation
Contribution of Food and non-alcoholic beverages sector for the overall environmental impact (%)	**29.3**	**58.1**	**29.7**	**20.6**	**23.6**	**23.6**	**31.6**	**25.5**
Total contribution of roasted coffee (%)	**0.71**	**0.92**	**---**	**0.62**	**0.75**	**0.73**	**0.92**	**0.68**

Detailed analysis: Few LCA articles were available that focused on hot drinks and the ones that were available only focused on carbon footprint, energy use and water use. As for GWP energy use throughout the life cycle were the main driver of GWP (Humbert *et al.,* 2009; ESU-services, 2010). The only exception were in the cultivation stage of coffee where the N_2O emissions from fields were the main driver of GWP.

Additional information: If only looking at the green coffee bean production (cradle to roaster) then the transport of the coffee beans stand for the largest impact, but when including the energy use for roasting process that would contribute more to the total energy use and by that the GWP (Salinas, 2008). Consumer behaviour can also contribute largely to the total carbon footprint, especially in terms of unnecessary energy use when making more coffee than needed (Quantis, 2015).

3.1.5.1.9 Mineral waters, soft drinks, fruit and vegetable juice (cold drinks)

The EIPRO study informs that bottled and canned soft drinks have a small impact on the total environmental impact of the EU-25, on all impact categories (Tukker *et al*., 2006) (Table 75). But the category is among the six largest contributors for ozone depletion, human toxicity and photo-oxidant formation.

Table 75: A summary of how large impact cold drinks has on the environment, as a fraction of the total impact of all sectors, in EU-25 – based on EIPRO study (Tukker *et al*., 2006).

	Global warming	Eutrophication	Acidification	Abiotic depletion	Ozone depletion	Human toxicity	Eco-toxicity	Photo-oxidant formation
Contribution of Food and non-alcoholic beverages sector for the overall environmental impact (%)	**0.293**	**0.581**	**0.297**	**0.206**	**0.236**	**0.236**	**0.316**	**0.255**
Contribution of bottled and canned soft drinks	**0.91**	**0.81**	**0.95**	**0.79**	**1.16**	**1.07**	**1.04**	**1.16**
Total of cold drinks (%)	**0.91**	**0.81**	**0.95**	**0.79**	**1.16**	**1.07**	**1.04**	**1.16**

Detailed analysis: Few LCA articles were available that focused on cold drinks but the ones that were available focused on a large range of impact categories. Ozone depletion, human toxicity and photo-oxidant formation are primarily caused by the bottle – in the case of carbonated soft drinks (Amienyo *et al.,* 2013). For (pasteurised non-from concentrate) orange juice on the other hand the primary production stage has a larger impact although the production of bottles still contributes much in total to the environmental impact (ESU-services, 2013). Environmental impact of transport is minimal in both cases (Amienyo *et al.,* 2013; ESU-services, 2013).

Additional information: No other references.

3.1.5.1.10 Sugar, jam, honey, chocolate and confectionery

The EIPRO study informs that confectionery and snacks (put together as one) contributes to eutrophication (3.35%), ozone depletion (0.63%), eco-toxicity (1.63%) and photo-oxidant formation (0.62%) (Tukker *et al.*, 2006). Illustrated in Table 76.

Table 76: A summary of how large impact confectionery and snacks has on the environment, as a fraction of the total impact of all sectors, in EU-25 – based on EIPRO study (Tukker et al., 2006).

	Global warming	Eutrophication	Acidification	Abiotic depletion	Ozone depletion	Human toxicity	Eco-toxicity	Photo-oxidant formation
Contribution of Food and non-alcoholic beverages sector for the overall environmental impact (%)	**29.3**	**58.1**	**29.7**	**20.6**	**23.6**	**23.6**	**31.6**	**25.5**
Contribution of Cookies and crackers		1.22						
Contribution of Sugar		0.95						
Contribution of Candy and other confectionery products		1.03					0.94	
Contribution of Potato chips and similar snacks		1.15			0.63		0.71	0.62
Total contribution of confectionary and snacks (%)		**3.35**			**0.63**		**1.63**	**0.62**

There was little information available for this section therefore this food category is not covered by the detailed analysis. There was only one additional information (from Table 65) about environmental impact of cocoa production. Certified cocoa was found to have lower GHG emissions than conventional cocoa (Afrane *et al*., 2013). The certification programs educate and train farmers, which leads to certified production becoming more efficient and better for the environment compared to conventional cocoa production. Furthermore, cover trees bind carbon and certified growers do not cause land use change (Afrane *et al*., 2013).

3.1.5.2 Catering services

Detailed analysis: Only three LCAs was found on catering services; two for the whole life cycle (Baldwin *et al*., 2011; Calderón *et al*., 2010) and one for the cooking and transportation stage only (Fusi *et al*., 2015) and one on the whole life cycle of single-use cutlery, comparing compostable to non-compostable ones. Another LCA group of studies have been included about cradle-to-gate life cycle of compostable bioplastic (PLA) from which compostable packaging, food containers including dishware, tablewareand cutlery can be produced. The two first ones found that the food ingredients stand for the major environmental impact throughout the life cycle. Calderón *et al*. (2010) additionally discovered that solid waste management, when sending all the waste to landfill including organic waste and packaging waste plays and important role (especially when sent to landfill) as it strongly affects marine and freshwater eco-toxicity. Energy use in kitchen operations has an impact on fossil fuels, carcinogens and eco-toxicity (Baldwin *et al*., 2011). Fusi *et al*. (2015) only looked at the preparation stage of cook-warm and cook-chill food and found that cook-warm food (that was transported to the consumer at ambient temperature) had lower environmental impact than cook-chill food. This was because the cook-chill food had to be chilled, transported refrigerated and re-heated – before reaching the consumer (Fusi *et al*., 2015). However, the cook-warm chain created substantially more food waste compared to the cook-chill system and when all those aspects were considered the cook-chill system had lower impact (Fusi *et al*., 2015). This shows the importance of minimising food waste. Baldwin *et al.* (2011) also gave proposals for menu planning an said that a more sustainable menu could be obtained with buying organic, seasonal, local, produce, to reduce meat intake, to minimise food waste and t lower energy use in kitchens. The paper on compostable cutlery (Razza et.al, 2009) shows how the environmental impacts of cutlery in catering services are mostly due to the production phases and the end-of-life of the products. The compostable cutlery reduces the emissions of greenhouse gases, and decreaes the acidification and eutrophication potential of convential single-use cutlery production, diverting solid waste from landfill to composting. The group of studies (Weiss etal., 2012) about LCA of compostable bioplastic (PLA), shows that the impacts of bioplastics on environment and human health are globally lower than conventional plastic, especially about global warming and human carcinogenic potentials. These studies are supportative to the thesis porposed by Calderón *et al*. (2010) to take advantage of compostable biopolymer packaging systems, thus reducing the amount of food wastes sent to landfill and complying with European Regulations on reducing the amount of biodegradable wastes disposed.

<u>Additional information:</u> one other study also highlighted the importance of reducing food waste and introducing waste separation to do so (Gössling *et al.,* 2011; Edjabout et al 2015)). Other recommendations of the first of the two (Gössling *et al.,* 2011) were to buy seasonal food, to use food that to not require cold storage and to procure fish from sources that uses less fuel in catching and that are not from endangered species. The second article (Edjabou etal. 2015), dealing with food waste generated in office areas, suggests that continuous information campaign are necessary to maintain the participation of employees in the sorting activities. If serving buffet it was also recommended to use smaller plates (and thus reduce the risk of food waste) (Gössling *et al.,* 2011; Betz *et al.,* 2015). Energy use in kitchens, primarily from cooking and food storage are the main cause of GHG emissions (SKM Enviros, 2010). The global warming impact can be reduced it the kitchen uses renewable energy (Gössling *et al.,* 2011). When serving coffee it should be mentioned that brewed coffee (filter coffee) is not always better than single-use portion made coffee, as the latter optimises water and energy use and do not create more coffee than needed (Quantis, 2015). The performance of single-use portion coffee is controlled by the machine whilst the performance of filter coffee is controlled by the consumer (Quantis, 2015). The report *Industrial Energy Efficiency Accelerator, 2012. Sector Guide. Contract Catering Sector* (IEEA, 2012), shows the analysis carried out on four sites that were chosen to be representative of the four main client sectors for B&I, Schools, Hospitals and Defence. Energy use was measured directly at 3 sites, and detailed estimates were made for a fourth site. The metering covered 60% of the catering energy consumed. The results showed that almost 40% of the energy the four sites is used for cooking with refrigeration at 28%, extraction at 17% and dishwashing at 5%. In carbon terms cooking is responsible for 27%, while 34% is due refrigeration is less important than refrigeration at 34%. This is due to the lower carbon impact of gas which accounts for 68% of cooking energy. Altought it is not mentioned in the report, it seems that CO2e emissions calculated do not take into account the effect of refrigerant leakages.

3.1.5.3 Production systems

There was not enough LCAs studies available to in depth investigate all food categories and determine which production systems perform best, but it was possible to provide some general findings. In some impact categories **organic production** has lower impact, such as for pesticide use (eco-toxicity) and global warming potential. But the impact categories eutrophication and acidification was found to be worse for organic production in most cases. Some LCAs also found that

organic production often requires more land than other production systems (because it has lower yields than conventional) which means that even if the environmental impact is lower per hectare in organic production (compared to conventional) the impact per functional unit will be larger. However, recently a study from Ponisio (2015) revealed that the organic-to-conventional yield ratio is being estimated as an average over many disparate systems and crop types. The over-representation of specific practices or crops in the dataset may therefore influence the current estimatations for the yield gap between the conventional and the organic farming systems. In addition, the many management practices used in both organic and conventional farming, a broad-scale comparison of organic and conventional production may not provide the most useful insights for improving management of organic systems(Ponisio, 2015).
In terms of the organic meat production, life spans of animals are longer in organic production which leads to that the animals need more feed in total (compared to conventional). A few articles mentioned that if carbon sequestration were included in the LCA, the carbon footprint for organic animal products would be the same as for conventional (Hietala et al., 2014; Pergola et al. 2013), or lower than conventional if the farm has a large proportion of grassland (Hietala et al., 2014; Halberg et al., 2010).
However these are only some aspects of environmental impacts considered in this study. For a more comprehensive analysis see also section 3.2.1.2 related to organic production.

Free-range systems were also investigated. A study that compared different organic pig production systems fount that there was a greater leaching of nutrients and emissions from manure in the free-range system compared to indoor-fattening and tent systems, which led to higher eutrophication potential and acidification potential. Note that the study looked at farms with sandy soils, which strongly leach nutrients (Halberg *et al*., 2010). Two studies also looked at egg and chicken production and it was found that in both cases conventional production had lowest environmental impact in almost all impact categories, although the free-range systems were not far behind in performance (Leinonen *et al.,* 2012a; Leinonen *et al.,* 2012b).
Chickens with a Label Rouge label are meant to grow slowly – in order to produce high quality meat. Label Rouge is a label used in France where the focus is to produce high quality meat by allowing chickens more space and to grow slower. This system is similar to that of organic in terms of life-span. Label Rouge chickens had largest environmental impact when compared to intensive chicken production in Brazil (da Silva *et al.,* 2014).

In the case of milk there was very hard to conclude which production system that has lowest environmental impact, but the difference between organic and conventional was not very large and the two production systems had an impact on different impact categories (Cederberg and Mattsson, 2000). Guerci *et al.* (2013) found large variability between farms and could only conclude that land use is larger for organic systems, but since a large portion is used for grazing it had a positive impact on biodiversity.
According to Council Regulation (EC) No 834/2007 (EU organic labelling), animals shall have regular access to pasture or roughage. It was shown in the detailed analysis that ruminants that have a high proportion of roughage in their diet emit more methane compared to ruminants with a higher proportion of concentrated feed (if that has low environmental impact) (Cederberg and Mattsson, 2000). Furthermore, the pastures cannot provide enough energy to maximise milk production; concentrated feed has to be given to sustain high production levels of milking cows (BSAS, 2011).
As for eutrophication and global warming potential (N_2O emissions) the application of nitrogen on fields was a great hotspot and this was evident for both conventional and organic production. It was found that synthetic fertiliser (that are not allowed in organic production) require much energy to produce and when applied on fields has an impact on terrestrial eco-toxicity, since it releases heavy metals (da Silva et al. 2014).

The use of phosphorus as a fertiliser on fields was not highlighted as a hotspot in most LCAs. Nevertheless, it does have an impact on the environment as phosphorus also can leach from arable land and contribute to eutrophication (Carpenter, 2008). It is a vital nutrient for growth of organisms and the sources of phosphorus in the world are running out (Cordell and White, 2011). Estimates have been made that reserves of rock phosphorus will be gone in between 69 and 130 years depending on calculations and assumptions (Schröder *et al*., 2009). Furthermore, as the phosphorus depletes, use of lower quality phosphorus will become more common, which contains cadmium and uranium that are toxic to humans (Cordell and White, 2011). Organic farming returns phosphorus to the soil by applying manure from livestock, hence their source of phosphorus is not directly derived from rock phosphate. Using manure to apply phosphorous is though not necessarily the most efficient way of utilising phosphorous (Schröder *et al*., 2009). In both cases some phosphorus is lost through leaching of soils (Schröder *et al*., 2009).

However, organic food products seems to have benefits for human health. As a general overview on the non LCA related aspects associated to the organic production, a comprehensive systematic review of 343 research articles about organic and conventional crops, found statistical significant results that organic crops (i.e. cereals, fruit and vegetables) contain more antioxidants, less pesticides and less heavy metals (such as cadmium that accumulates in the body) than do conventional crops (Barański et al., 2014).

Some researchers have proposed that **integrated production** can be the way forward, since it is a combination of organic and conventional practices (Tuomisto *et al*., 2012b; Tuomisto *et al*., 2012c). However, there were few LCAs available (within the scope of this study) that investigated integrated production and thus this environmental analysis cannot conclude what production systems is most preferable – it depends on the food category and sometimes also the farmer.

3.1.5.4 Summary of the main environmental hotspots and its causes

The EIPRO study summarised the main environmental impact categories that are relevant for the food and beverage sector in the EU 25 (Tukker *et al*., 2006). The four impact categories that the food and drink sector is mainly responsible for are: eutrophication, eco-toxicity, acidification and global warming. The results from the detailed analysis allow to conclude that **eutrophication** is mainly caused my leaching of nitrogen and phosphorous from soils, but also from ammonia emissions. **Eco-toxicity** is caused by pesticides, synthetic fertilisers, anti-fouling agents on boats and fishing equipment and from solid waste management. **Acidification** is largely caused by ammonia emissions from manure storage and manure on fields and the combustion of fossil fuels. **Global warming** is mainly caused by methane emissions from ruminants, N_2O emissions from soil and CO_2 emissions from burning fossil fuel and as a consequence of land use change (deforestation). Table 77, Table 78 and Table 79 provides the conclusions of the whole chapter (i.e. results obtained in the LCA detailed analysis, complemented with findings from additional sources of information).

Table 77: summary from the detailed analysis: environmental impacts and root causes from fish and seafood, meat, milk, cheese and eggs.

Fish and seafood	Meat	Milk and cheese	Eggs
Summary of the environmental hotspots:			
Wild caught: - Fuel use in fishing vessels - Antifouling (anti corrosion paint in fishing vessels) - Depletion of fish stocks **Aquaculture:** - Feed for fish (both from fishmeal or arable crops). - Antifouling (anti corrosion paint in fish cages) • ***Activities common to both fishing:*** **Processing:** - energy use on processing - wastewater treatment - oils used in fish canning **Refrigeration:** - energy and refrigerants used for cold storage **Packaging materials:** - Production of cans (e.g. aluminium)	**Animal feed production:** - Land use - Land use change (e.g. destruction of natural habitats and CO_2 emissions associated with e.g. soy) - pesticide use (in non-organic feed) - long transport emissions - Production and use of fertilisers **Animal production:** - methane emissions from ruminants - emissions of ammonia from manure (chickens) and manure storage - energy use (heating and cooling birdhouses) **Processing:** - energy use on slaughtering	**Animal feed production:** - Land use - Land use change (e.g. destruction of natural habitats and CO_2 emissions associated with e.g. soy) - pesticide use (in non-organic feed) - long transport emissions - Production and use of fertilisers **Animal production:** - methane emissions from ruminants - emissions of ammonia from manure storage - energy use (heating and cooling birdhouses) **Processing:** - energy use in dairy plant	**Animal feed production (cereals and soy):** -Land use -Land use change (e.g. destruction of natural habitats and CO_2 emissions associated with e.g. soy) - Pesticide use (in non-organic feed) - Long transport emissions - Production and use of fertilisers **Animal production:** - Energy use (heating and cooling birdhouses) - Emissions of ammonia from manure storage **Transport** - Fuel use (feed, manure and hens)
Detail on the environmental hotspots:			
Global warming			
Emissions of CO_2 - Fishing stage: (i.e. diesel use and marine transport distance) (Vázquez-Rowe *et al.*, 2011; Ellingsen and Aanondsen, 2006; ESU-services; Nijdam *et al.*, 2012). **Emissions of N_2O, CO_2** - Feed production for aquaculture	**Emissions of CH_4** - Ruminants (digestive system) (Webb *et al.*, 2013; de Vries and de Boer, 2010). - From slurry (manure) storage (Halberg *et al.*, 2010; de Vries and de Boer, 2010). **Emissions of N_2O** - From fields (Halberg *et al.*, 2010; Leinonen *et al.*, 2012a). - From slurry under slatted floors (Degré et	**Emissions of CH_4** - From ruminants enteric fermentation and manure (González-García *et al.*, 2013; Hietala *et al.*, 2014; Guerci *et al.*, 2013; Cederberg and Mattsson, 2000). **Emissions of N_2O** - From arable land (González-García *et al.*, 2013; Hietala *et al.*, 2014; Guerci *et al.*, 2013; Cederberg and Mattsson, 2000).	**Emissions of CO_2** - Burning fossil fuels (Dekker *et al.*, 2013). - Electricity for heating and cooling bird houses drive GWP (Ingemann Nielsen *et al.*, 2013; Leinonen *et al.*, 2012b). **Emissions of N_2O** - From fields (Taylor *et al.*, 2014). - From manure (Dekker *et al.*, 2013). **Emissions of CH_4**

(fishmeal and arable crops) for farmed fish (Ellingsen and Aanondsen, 2006; ESU-services, 2011).	al., 2007). **Emissions of CO_2** - Heating/cooling bird houses (Webb *et al*., 2013; Leinonen *et al*., 2012a). **Emissions of CO_2, N_2O** - Concentrated imported feed (Halberg *et al*., 2010; Webb *et al*., 2013; Leinonen *et al*., 2012a).	**Emissions of CO_2** - Using fossil fuels (González-García *et al*., 2013; Cederberg and Mattsson, 2000). - The non-renewable energy use when producing chemical fertiliser (Djekic *et al.,* 2014).	- From manure (Dekker *et al.,* 2013). **Emissions of N_2O, CO_2** - Production of concentrated feed (especially soy) drives GWP through land use change (Taylor *et al*., 2014; Leinonen *et al.*, 2012b). - Feed production is the main cause of GWP in the life cycle (Ingemann Nielsen *et al.,* 2013).
Eutrophication			
- Diesel usage at fishing stage (Vázquez-Rowe *et al*., 2011; Thrane *et al*., 2009a). - Waste water disposal (Vázquez-Rowe *et al*., 2011). - Nutrient emissions from aquaculture (Ellingsen and Aanondsen, 2006: Thrane *et al*., 2009a).	- Nitrogen leaching from fields (Halberg *et al*., 2010; Webb *et al*., 2013; Leinonen *et al*., 2012a).	- Nitrogen leaching from fields (Cederberg and Mattsson, 2000; Djekic et al., 2014; González-García *et al*., 2013; Guerci *et al.,* 2013; Roy *et al.*, 2009). - Because of overuse of nitrogen and phosphorous (Djekic *et al.,* 2014). - Also caused by ammonia emissions (González-García *et al*., 2013; Guerci *et al.,* 2013).	- Nitrogen leaching from fields (Leinonen *et al*., 2012b; Dekker *et al.,* 2013). - Phosphorous leaching from fields (Dekker *et al.,* 2013). - Ammonia emissions from manure (Leinonen *et al.*, 2012b).
Acidification			
- Diesel usage (Vázquez-Rowe *et al*., 2011; Thrane *et al*., 2009a).	- Ammonia emissions from manure (Halberg *et al*., 2010; Leinonen *et al*., 2012a; Webb *et al*., 2013). - Emissions from transport due to the use of fossil fuel (Webb *et al*., 2013).	- Ammonia emissions from manure storage (Cederberg and Mattsson, 2000; Djekic et al., 2014; Guerci *et al.,* 2013). - Due to crop production on fields (Guerci *et al.,* 2013). - Fuel combustion also lead to AP because NO_x and SO_2 emissions are released (Djekic *et al.,* 2014).	- Ammonia emissions from manure (Leinonen *et al.*, 2012b; Dekker *et al.,* 2013).
Eco-toxicity			
- Waste water from processing (Vázquez-Rowe *et al*., 2011). - Anti-fouling from fishing vessels and equipment (Ellingsen and Aanondsen, 2006). - Diesel use (Vázquez-Rowe *et al*., 2011).	- Nitrogen fertilisers (with heavy metal content) drive eco-toxicity (da Silva *et al*., 2014).	*Terrestrial eco-toxicity* - Animal feed (concentrates) production uses diesel and commercial fertilisers that both emits metals (González-García *et al*., 2013). *Marine and freshwater eco-toxicity* - The packaging, cleaning detergents and electricity use is the main root causes	

		(González-García *et al*., 2013).	
Human toxicity			
		- Packaging, cleaning detergents and electricity use is the main root causes of human toxicity (González-García *et al*., 2013).	
Abiotic resource depletion			
- Packaging (Vázquez-Rowe *et al*., 2011). - Diesel usage (Vázquez-Rowe *et al*., 2011: Thrane *et al*., 2009a).	-	- Driven by fuel use and transport, mainly in the agricultural stage (González-García *et al*., 2013).	
Ozone depletion			
- Diesel usage (Vázquez-Rowe *et al*., 2011).		- Diesel use and transport are main root causes (González-García *et al*., 2013). - Can also be driven by the use (and leaching) of refrigerants (González-García *et al*., 2013).	
Photochemical oxidant formation			
		- Driven by methane emissions and diesel usage (González-García *et al*., 2013). - Driven by diesel usage and extraction from the oil industry (Cederberg and Mattsson, 2000).	

Table 78: summary from the detailed analysis: environmental impacts and root causes from different crops.

Fruit	Vegetables	Bread and cereals	Oils and fats
Summary of the environmental hotspots:			
Cultivation stage: - Production of chemical fertilisers and pesticides - Use of fertilisers and pesticides - Energy and water use for irrigation **Processing** - energy use on fruit processing **Refrigeration** - energy use for long term cold storage **Packaging materials** - Production of cardboxes, kraft paper and plastic boxes **Transport** -Long distance transport	**Cultivation stage:** - Production of chemical fertilisers and pesticides - Use of fertilisers and pesticides with ammonia emission - Energy and water use for irrigation - Energy use when cultivation in greenhouses **Processing** - water and energy use on processing **Refrigeration** - energy use for long term cold storage **Packaging materials** - Production of steel, glass, carton based	**Cultivation stage:** - Production of chemical fertilisers and pesticides - Use of fertilisers and pesticides - Energy use in field work **Manufacture** - Energy use **Packaging materials** - Production of packaging materials **Transport** - Fuel use	**Cultivation stage:** - Production of chemical fertilisers and pesticides - Use of fertilisers and pesticides - Energy use in field work **Manufacture (mill process)** - Energy use (fossil fuel) - Methane release (anaerobic digestion of effluent in open pounds) -Disposal of Empty Fruit Bunch in landfills leads to GHG emissions **Packaging materials** - Production of packaging materials (e.g. glass bottles) **Transport** - Fuel use
Detail on the environmental hotspots:			
Global warming			
Emission of CO_2 - Production of pesticides and chemical fertiliser (Giudice *et al.* 2013). - Energy and water use for irrigation (Giudice *et al.* 2013). - Production of packaging materials (Iriarte *et al.*, 2014; Giudice *et al.* 2013). - Energy use for processing fruit (Webb *et al.*, 2013). - Inefficient or long distance transport (Iriarte *et al.*, 2014; Roibás *et al.*, 2014; Webb *et al.*, 2013). **Emission of N_2O**	**Emission of CO_2** - Heating greenhouses (using fossil fuels) (Webb *et al.*, 2013). - Energy use for irrigation (Del Borghi *et al.*, 2014). - Energy use for long term cold storage (Williams *et al.*, 2010). - For tomato products energy use for processing and packaging accounts for a large part of GWP (Del Borghi *et al.*, 2014; Roy *et al.*, 2009). - Energy use for irrigation (Giudice *et al.* 2013).	**Emission of CO_2, N_2O** - The main driver of GWP for bread wheat and rapeseed production is N_2O emissions from field (80%), CO_2 emissions from using fossil fuels only has a marginal impact in comparison (Williams *et al.,* 2010). - For breakfast cereals ingredients account for 38 % of GWP, whilst energy use for manufacturing accounts for 23 %, packaging 15 % and transport 15 % (Jeswani *et al.,* 2015).	**Emission of CO_2, N_2O** - Cultivation olive oil (Tsarouhas et al., 2015). - Production of olive oil (Tsarouhas et al., 2015). - N_2O and CO_2 emissions from palm oil when cultivating on peat (Schmidt, 2015). - Processes at oil mill for peanut oil (Schmidt, 2015). - Production and transport of bottles (Tsarouhas et al., 2015).

- Applying nitrogen on soil (Iriarte *et al*., 2014).			
Eutrophication			
- Applying too much nitrogen on fields (Webb *et al*., 2013).	-	- Nitrogen leaching on fields due to fertiliser use is the main root cause (Roy *et al.,* 2009). - Of breakfast cereals the ingredients account for the majority of eutrophication throughout the life cycle (71 %) (Jeswani *et al.,* 2015).	- Production of olive oil (Tsarouhas et al., 2015).
Acidification			
-	-	- Transport is causing acidification (Jeswani *et al.,* 2015).	- Cultivation and production of olive oil, as well as production and transport of fertilisers (Tsarouhas et al., 2015).
Eco-toxicity			
- Using pesticides (Pergola *et al*., 2013). - Using chemical fertilisers (Pergola *et al*., 2013).	- Pesticide use (Del Borghi *et al*., 2014).	*Marine and freshwater eco-toxicity* - Are partially caused by packaging (Jeswani *et al.,* 2015).	- Palm oil production in Malaysia were assumed not to use great quantities of pesticides as they used integrated (biological) pest management instead (Yusoff and Hansen, 2007).
Human toxicity			
	- Fuel use (Del Borghi *et al*., 2014).	Human toxicity - Of breakfast cereals the ingredients stood for 50 % of human toxicity throughout the life cycle (Jeswani *et al.,* 2015).	Respiratory inorganics Oil mill stage for palm oil (Yusoff and Hansen, 2007).
Abiotic resource depletion			
-	- Building and heating greenhouses (Webb *et al*., 2013).	- The production of ingredients are responsible for 61 % (Jeswani *et al.,* 2015). - The packaging of breakfast cereals are also a cause for abiotic resource depletion (Jeswani *et al.,* 2015).	- Fossil fuel depletion due to the production of fertilisers (Yusoff and Hansen, 2007).
Ozone depletion			
-		- Caused by transport (Jeswani *et al.,* 2015).	
Photochemical oxidant formation			

		Photochemical smog creation - Ingredients stood for 50 % of photochemical smog formation throughout the life cycle of breakfast cereals (Jeswani *et al.,* 2015). - Transport also contributes (Jeswani *et al.* 2015).	

Table 79: summary from the detailed analysis: environmental impacts and root causes from beverages, confectionery and catering services.

Hot drinks	Cold drinks	Confectionery	Catering services
Summary of the environmental hotspots:			
Energy consumption during the consumer stage is a larger contributor to the overall environmental impact. **Cultivation stage:** - Production and use of chemical fertilisers - Production and use of pesticides **Manufacture:** **-** Drying of tea leaves **Consumer** - energy use for water boiling **Packaging materials** - Production of materials (e.g. glass)	*Energy consumption associated to the packaging, bottling and refrigeration is a larger contributor to the overall environmental impact.* **Cultivation stage (e.g. orange juice):** - Production and use of chemical fertilisers - Production and use of pesticides - Energy use in irrigation **Manufacture:** **-** energy use in the bottling process - water use **-** packaging **Consumer** - energy use for refrigeration **Packaging materials** - Production of materials and weight of packaging (e.g. glass)	*Amount of information available is scarce.*	*<u>Food procurement (ingredients)</u> together with the <u>solid waste management</u> show to have a large contribution to the overall environmental impact.* **Food procurement:** - Embedded environmental impacts in food ingredients in ready meals **Operational support** (*lighting, ventilation, air conditioning, heating, water use, supplies (cleaning, toilets, disposable products) and administration stage*): - use of energy and cleaning products has a large impact on carcinogens, eco-toxicity and fossil fuels. **Food storage and food preparation** only have a marginal impact on the total. - Among the food preparation operations, the cooking stage shows a large contribution. Cook chill systems show a comparatively larger impact when compared to the cook-warm. Cook chill requires chill, stored cool and reheated. Cook warm is ready to eat. But since the cook chill system has less food waste than cook warm it has a lower impact in total (if including the effect of food waste). **Transport** - fuel use **Packaging materials** - Production of materials (e.g. tinplate) **Solid waste management** **-** Production and disposal of organic waste (e.g. air emissions due to landfilling) - Use and disposal of packaging

Detail on the environmental hotspots:			
Global warming			
- Energy consumption (Humbert et al., 2009; ESU-services, 2010). - Type of packaging has an impact on GWP (Humbert et al., 2009). - N2O emissions from cultivation of coffee beans (due to fertiliser use) (Humbert et al., 2009). - In organic tea leaf production much methane is emitted due to the use of compost as fertiliser (ESU-services, 2010). - Consumer behaviour have an impact on energy use and hence GWP (Quantis, 2015). - The processing stage (roasting of coffee) uses much energy which drives GWP (Salinas, 2008). - The energy used for drying tea leaves also have an impact on GWP (ESU-services, 2010). - Transport also contributes to GWP (Salinas, 2008).	- Production of bottles (Amienyo *et al.,* 2013; ESU-services, 2013). - Electricity and natural gas use for irrigation (ESU-services, 2013). - Electricity use in processing stage (Amienyo *et al.,* 2013; ESU-services, 2013). - N_2O emissions from fields due to use of nitrogen fertiliser (ESU-services, 2013). - Production of pesticides (ESU-services, 2013). - Recycling PET bottles or reusing glass bottles would lower carbon footprint substantially (Amienyo *et al.,* 2013). - Both types of drinks can maintain shelf-life in ambient temperature. Therefore, if refrigeration is used it will increase carbon footprint (ESU-services, 2013; Amienyo et al., 2013).	- Certified cocoa was found to have lower GHG emissions than conventional cocoa (Afrane et al., 2013). The certification programs educate and train farmers, which leads to certified production becoming more efficient and better for the environment compared to conventional cocoa production. Furthermore, cover trees bind carbon and certified growers do not cause land use change (Afrane et al., 2013).	- Energy use in kitchens (and other catering service activities) have a large contribution for GWP (Baldwin et al., 2011; SKM Enviros, 2010). - Landfilling of food waste causes large amount of GHG emissions (WFD, Calderon 2010)
Eutrophication			
-	- Terrestrial: is because of N use in fields (ESU-services, 2013). - Freshwater: is because of P run-off from fields, electricity use, production of pesticides (ESU-services, 2013). The waste water created in the processing stage also contributes (ESU-services, 2013). - In carbonated soft drinks the ingredient sugar stand for a large part (Amienyo et al., 2013).	-	

Acidification			
-	- Due to N use on fields (ammonia and NOx emissions) (ESU-services, 2013). - The packaging stand for a large part (ESU-services, 2013; Amienyo et al., 2013). - The sugar in soft drinks stand for a part of it too (Amienyo et al., 2013).		-
Eco-toxicity			
	- Pesticide use (ESU-services, 2013).		- Energy use (Baldwin *et al.,* 2011). *Marine and freshwater eco-toxicity* - Solid waste management sent to landfill (Calderón *et al.,* 2010).
Human toxicity			
	- Production of bottles (Amienyo *et al.,* 2013; ESU-services, 2013). - Use of phosphorous fertiliser (since it contain of cadmium, zinc and copper) (ESU-services, 2013).	-	- Energy use (Baldwin *et al.,* 2011).
Abiotic resource depletion			
-	- Material for packaging (ESU-services, 2013; Amienyo et al., 2013). - Energy use (ESU-services, 2013). - Production of pesticides, diesel and chemical fertilisers (ESU-services, 2013).	-	- Energy use lead to fossil fuel depletion (Baldwin *et al.,* 2011).
Ozone depletion			
-	- Production of bottles (Amienyo *et al.,* 2013).	-	
Photochemical oxidant formation			
	- Production of bottles (Amienyo *et al.,* 2013).	-	

3.2 Technical analysis of food and catering services

Environmental hotspots for food and catering services were found in the previous environmental analysis section, together with the root causes of the impacts. This technical analysis section will expand on that learning by collecting evidence on available schemes and labels for food products, food production and catering services to see whether they cover the identified environmental impacts and target the found root causes for the environmental hotspots. The purpose for collecting this data is to find evidence for the EU GPP criteria update. If there are labels available (for all Member States) that target these issues they could be used in the updated criteria set.

In the case of food production there are a few non-LCA based aspects, including environmental related and ethical aspects that ought to be considered as they are strongly correlated with the food service provisions. Some of the aspects include integrated production. In respect of the ethical aspects, animal welfare and fair trade issues are associated with current practices occurring during food provision. In addition, health aspects should be considered as the detailed analysis primarily focused on comparing food products by weight. The following sections illustrates and reviews the labels and schemes relevant to the EU GPP criteria set revision.

3.2.1 Schemes and labels relevant for food products and food production

3.2.1.1 Integrated production

Integrated production has been defined by the IOBC[107] as "*an agricultural system for producing food which makes optimal use of natural resources and regulation mechanisms by ensuring that farming is viable and sustainable over the long term. Under this system, biological methods, cultivation techniques and chemical processes are carefully selected, seeking a balance between the environment, profitability and social requirements*" (OJEU, 2014).

Like organic production, integrated production also employs practices of soil conservation (European Commission, 2008a). The system does not completely avoid the use of pesticides and synthetic fertilisers, but restricts their use (Theocharopoulos et al., 2012). Integrated production includes not only ethical, social and environmental aspects of farming, but also food quality and safety (OJEU, 2014). To that end it may make use of modern technology (such as GPS[108]) to minimise the use of pesticides and fertilisers, by applying them with precision on an 'only where needed' principle.

Integrated production is a voluntary production method and currently, in the EU, it has no Community guidelines or legal framework (OJEU, 2014). There have been integrated production initiatives at a national level in some Member States (e.g. Belgium, France, Portugal, Spain and the United Kingdom), which have developed regulatory frameworks. Private large-scale distributors have also developed guidelines. Since these are all being developed separately, there has been no cohesion over definitions and objectives (OJEU, 2014). As of 2006, the European Initiative for Sustainable Development in Agriculture (EISA) published a European 'Common Codex for Integrated Farming', and in 2013 the AREFLH[109] published a Guide for the European practices of integrated production (OJEU, 2014). As for labels of compliance, currently only regional and national labels for integrated production are available in some countries in the EU, but there is no EU-wide logo or standard.

[107] IOBC: The International Organisation for Biological and Integrated Control of Noxious Animals and Plants
[108] Global Positioning System
[109] AREFLH: Assembly of the European Regions producing Fruit, Vegetables and Ornamental Flowers and Plants

In 2008, more than 12.1 million hectares of agricultural land in the EU were used for sustainable farming, of which 55 % were used for organic, and 45 % for integrated, production (Theocharopoulos *et al*., 2012). The number of farmers using integrated production practices is increasing in Europe for economy, safety and quality reasons, because of the savings farmers can realise and due to greater environmental awareness among farmers (Theocharopoulos *et al*., 2012). However, there is as yet no demand from society for integrated production, since few consumers are even aware that this standard exists (OJEU, 2014). Integrated production is in theory applicable to all food categories.

A review of national schemes for agricultural products and foodstuffs was conducted for EU-27 in 2010 (Areté, 2010a; Areté, 2010b). Table 80 shows the results regarding integrated crop or pest management schemes and it supports the statement that national schemes are not yet available to a great extent in the EU - with the exception of Spain and Italy that are front runners. Fruit and vegetables are the product groups with most integrated crop / pest management schemes connected to it, followed by meat, cereals and milk.

Table 80: Number of national schemes on integrated crop / pest management in EU-27 (Source: Areté, 2010b)

Country	Food product group											Total per country
	Meat	Milk	Eggs	Fish	Fruit & veg	Cereals	Oils & fats	Sugar & confectionery	Wine & spirits	Other agricultural products	Other processed food products	
Total per food product/ category	**20**	**15**	**9**	**9**	**41**	**19**	**9**	**6**	**8**	**9**	**4**	**---**
Austria	2	2			1	1				1		**7**
Belgium	1	1	1	1	3	1						**8**
Bulgaria												**0**
Czech Republic												**0**
Denmark					1							**1**
Estonia												**0**
Finland												**0**
France	2	1	2	1	3	2	2	1	1			**15**
Germany					1							**1**
Greece	1				1	1						**3**
Hungary												**0**
Ireland												**0**
Italy	6	5	2	5	10	2	3	3	2	2	1	**41**
Latvia												**0**
Lithuania	1	1	1		1	1					1	**6**
Luxembourg												**0**
Malta												**0**
Netherlands												**0**
Poland												**0**
Portugal	1	1	1		1	1	1	1				**7**
Romania												**0**
Slovakia												**0**

Slovenia												**0**
Spain	4	3	2	2	18	8	3	1	5	4	2	**52**
Sweden	1				1	1						**3**
UK	1	1				1				2		**5**

In the following an insight on the practices carried in countries having the largest number of national schemes on integrated crop / pest management (Spain and Italy).

Integrated production in Spain

In 2013, Spain used 766,070 hectare (ha) of land for integrated production. The main crops were: olives (371,084 ha), rice (73,582 ha), cereals (80,645 ha), cotton (48,378 ha), citrus (42,135 ha), stone fruits (41,134 ha), grapes for wine making (29,315 ha) and vegetables (27,525 ha) (AREFLH, 2013). In Spain, 12 regions have their own regulations for integrated production, although they have adapted their regulations to the Spanish Ministry of Agriculture's national standards that have been in place since 2004 (AREFLH, 2013).

Integrated production in Italy

Italy also has regional regulations for integrated production that will continue to be relevant (as in Spain), although national regulations for integrated production were put in place through a Committee in 2014. In Italy, integrated production has been defined as: "*a food production system that uses all the methods and means of production by defending agricultural products against diseases and attackers to minimize the use chemical synthesis, streamline fertilization in accordance with the principles of ecology, economy and "toxicology*." (AREFLH, 2013).

3.2.1.2 Organic production

The key characteristic of organic production is that all agricultural processes must take into account environmental aspects. The production system must preserve natural resources (e.g. soil, water), support biodiversity, only use natural substances, ensure animal welfare and restrict the use of external inputs (such as un-naturally derived substances) (OJEU, 2007b). Organic production in the EU must, as a minimum, follow the requirement of the Council Regulation (EC) No 834/2007 and Commission Regulation (EC) No. 889/2008 of 5 September 2008 with detailed rules on production, labelling and control. The use of pesticides is avoided to protect wild animals and biodiversity so that natural predators can survive and protect crops from pests (Wageningen UR, 2015). Another reason to avoid pesticides is possible risks to human health (FAO, 2012b). Furthermore, chemical fertilisers are rarely permitted to be used in organic systems. Instead, soils have to be managed in a way that increases biological activity and fertility, such as applying animal manure (or other organic matter) as compost and increasing the use of multiannual crop rotations (OJEU, 2007b). Products based on genetically modified organisms are prohibited in organic production and animal welfare is taken into consideration (OJEU, 2007b). For animal welfare there are requirements on what breeds are used, what feed animals are given, and living conditions must be comfortable with access to the outdoors (European Commission, 2014e). Animals must be healthy and must have their special needs acknowledged and furthermore enjoy freedom of pain, which entails rules on transport and slaughter methods (European Commission, 2014e). The label "free range" denotes a production method similar to conventional production but in which the animals are guaranteed outdoor access (Organic Trust Ltd, 2015).

National organic farming schemes are available in almost all Member States, although countries such as Germany and Italy have a significantly larger activity (Table 81). Many Member States only have one or two national organic farming schemes available. There is an even distribution of schemes across food product groups, although fruit and vegetables, milk, meat, cereals and eggs are leading food product groups. As these labels are organic they have been third party verified.

Table 81: Number of national schemes on organic farming in EU-27 (Source: Areté, 2010b)

Country	Product group											Total per country
	Meat	Milk	Eggs	Fish	Fruit & veg	Cereals	Oils & fats	Sugar & confectionery	Wine & spirits	Other agricultural products	Other processed food products	
Total	**58**	**61**	**51**	**38**	**63**	**52**	**37**	**31**	**33**	**7**	**21**	---
Austria	7	8	6	6	6	6	4	4	5	2	1	55
Belgium	1	1	1		1	1	1	1	1		1	9
Bulgaria	1	1	1		1							4
Czech Republic												0
Denmark	1	1	1		1	1						5
Estonia	1	1	1	1	1	1	1			1	1	
Finland	1	1	1	1	1	1	1					7
France	1	1	1	1	1	1	1	1				8
Germany	15	14	11	10	14	14	9	9	12	1	6	115
Greece	1	1	1		1	1						5
Hungary												0
Ireland	2	2	2	2	2	2	1	1	1			15
Italy	7	10	7	4	10	6	7	7	4	1	2	65
Latvia	2	2	1	1	2	2					1	11
Lithuania	1	1		1	1	1	1				1	7
Luxembourg	1	1	1	1	1							5
Malta					1						1	2
Netherlands	2	2	2	1	2	2	2	2	2	1	1	19
Poland	1	1	1	1	1	1		1			1	8
Portugal					1							1
Romania	1	1	1	1	1	1	1				1	8
Slovakia	2	2	2	1	2	2	1	1	1		2	16
Slovenia	1	1	1		1		1		1		1	7
Spain	3	3	2	1	3	2	2	1	3	1	1	22
Sweden	2	2	2	2	2	2	1	1	1			15
UK	4	4	5	3	6	5	3	2	2			34

Table 81 provides an insight in number of the food products that are covered by organic schemes, but not the name of the schemes. Table 82 shows what third party certified organic labels are available in the EU and their coverage of Member States (based on the Ecolabel Index, 2015). It is clear that few organic labels have coverage across the entire EU. Only the EU organic products label is available for all Member States. The label 'HAND IN HAND' is also available for many countries.

Table 82: Available organic labels in the EU that are third party verified (based on the Ecolabel Index, 2015)

Organic labels in the EU	Country	Starting year	Government (G), Non-profit (N-P), Industry Association (I), For-profit (F-P)

AB (Agriculture Biologique)	France	1985	N-P
AIAB (Italian Association for Organic Agriculture	Italy	1998	N-P
BioForum Biogarantie and Ecogarantie	Belgium	2002	N-P
Biokreis	Austria, Germany	1979	N-P
Bioland	Germany	1971	N-P
Bio-Siegel	Germany	2001	G
Bird Friendly Coffee	The Netherlands	1998	N-P
Delinat Bio Garantie	Austria, France, Germany, Italy	1983	(F-P)
Ecocert	France, Germany, Portugal, Romania, Spain	1991	(F-P)
EU organic products label	EU-28	1991	G
HAND IN HAND	Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Luxembourg, Poland, Portugal, Romania, Slovenia, Spain, Sweden, United Kingdom	1992	(F-P)
IMO Certified	Bulgaria, Croatia, Ireland, Spain	1991	(F-P)
KRAV	Sweden	1985	N-P
Loumuliitto - The Ladybird label	Finland	1989	N-P
Loumu Sun Sign	Finland		G
SIP Certified	Finland	2008	N-P
Skal Eko Symbol	The Netherlands	1985	N-P
Soil Association Organic Standard	United Kingdom	1973	N-P

Among the labels previously identified there are only few labels that consider the entire supply chain of food production. Most of the labelling schemes focus on the agricultural stage and a large number has a national coverage only. Table 83 shows a selection of these schemes (along with a few other schemes that are not organic but eco-labels) and identifies the main characteristics of these key leading labels (Oakdene Hollins, 2011).

Table 83: Ecolabels available in the European market for food, feed and drink (Source: Oakdene Hollins, 2011)

Key leading labels	Food products coverage	Criteria range	Organic	Life cycle approach	Geographic reach	Basis of criteria
EU Organic label	Broad	Multiple environmental issue and ethical/ social	Yes	No	Europe	Principles of organic agriculture
KRAV Demeter BioSuisse	Broad	Multiple environmental issue and ethical/ social	Yes	Limited	Inter-country, Regional	Principles of organic agriculture
Soil Association. Bioland Standard Biozebra Agricultura Ecologica (Spain)	Broad	Multiple environmental issue And ethical/social	Yes	No	National or regional reach	Principles of organic agriculture

Some environmental aspects are, however, overlooked by organic labels. For instance, the EU Organic Label does not specify to reduce emissions of N_2O from soil as well as ammonia and methane emissions from animals (OJEU, 2007b). However, some animal welfare aspects are taken into consideration as it is being specified the limitation of the number of animals in an area in order to *"minimising overgrazing, poaching of soil, erosion, or pollution caused by animals or by the spreading of their manure"* (OJEU, 2007b).

3.2.1.3 Wild and aquaculture fish and seafood

The Marine Stewardship Council (MSC) and Aquaculture Stewardship Council (ASC) labels are likely to be most relevant for the fish and seafood criteria as the MSC targets marine fishing and the ASC targets aquaculture. MSC label does not consider the hotspots along the life-cycle. Instead it focuses on not over-exploiting fish stocks and the label has regulations concerning by-catch (Thrane *et al.,* 2009). The MSC label does not have specific restrictions in place for fuel use, but do encourage fishing methods which uses less fuel (MSC, 2015).

The KRAV label has a life-cycle approach, thus targeting fuel use at the catching stage, and prohibits the use of beam trawling (Thrane *et al*., 2009). KRAV has maximum allowance levels of fuel use per kg landed fish (KRAV, 2015). In the case of aquaculture the use of concentrated feed was a major hotspot, especially the use of conventional soy. For farmed fish the ASC label states that 100 % of soya content has to be labelled with the 'Roundtable for Responsible Soy' label. The following areas are also included in the label (ASC, 2012):

- comply with national laws and local regulations
- conserve habitats, biodiversity and ecosystem functions
- protect genetic integrity and health of wild fish populations
- use resources efficiently and responsibly
- manage pests and diseases responsibly
- operate farms in socially responsible manner
- and to be a conscientious citizen and good neighbour.

Table 84 illustrates all seafood eco-labels available across the EU-28. The MSC label is available in all Member States. There is no data on the availability of the ASC label in Member States on the Ecolabel Index (2015).

Table 84: Available labels on fish and seafood aspects in the EU that are third party verified (based on the Ecolabel Index, 2015)

Labels on fish and seafood in the EU	Country	Starting year	Government (G), Non-profit (N-P), Industry Association (I), For-profit (F-P)
Aquaculture Stewardship Council (ASC)	-	2012	N-P
Best Aquaculture Practices	Italy, United Kingdom	2002	N-P
Biokreis	Austria, Germany	1979	N-P
Environment Product Declaration	Belgium, Italy, the Netherlands, Sweden, United Kingdom	1999	G
Friend of the Sea	Germany, Italy, Spain, United Kingdom	2006	N-P
KRAV	Sweden	1985	N-P
Marine Stewardship Council	EU-28	1999	N-P
Milieukeur: the Dutch environmental quality label	The Netherlands	1992	N-P
Soil Association Organic Standard	United Kingdom	1973	N-P

WWF Sustainable Seafood guide provides information on many fish species and also take into consideration geographical differences (WWF, 2015). This means that wild caught fish that do not have an MSC label but are procured according to the WWFs green level, still can be beneficial for the environment as it puts less pressure on depleting fish stocks.

3.2.1.4 Animal welfare

In this report the term 'animal welfare' comprises animal health and ethical animal rearing methods (i.e. availability for animals to practice natural behaviour or natural speed of growth). This particular issue is not covered by the reviewed LCA studies, because LCA studies disregards such aspects as social, economic or ethical matters, by focussing on productivity and resource use and efficiency.
However, it is important to consider animal welfare, not only because consumers find it important, but also because animal welfare is linked with animal health and food quality. For example, conventional broiler chickens have a short life since the focus of the production is to reach goal weight of birds as efficiently as possible. Animal breeding and optimisation of feed have resulted in the efficient growth that is current in conventional broiler production. A consequence of this intensive production is that the chickens' muscles (breast) grow faster than their legs do, which means that when they reach their goal weight many cannot stand properly (Dawkins and Layton, 2012).
In organic production slow-growing breeds of broiler are used, as opposed to fast-growing broilers in conventional production (Cobanoglu *et al*., 2014). A dairy cow health study found that organic cows had significantly lower occurrence of common dairy cow health problems (Hamilton, 2000). These health problems ultimately impact the performance of cows in terms of milk quality and quality. A study on pigs found that free-range pigs had better stress level indicators and better meat quality compared to pigs reared on slatted floors (Foury *et al*., 2011). The results of these studies are not necessarily true for all animals reared with organic methods, but they do indicate that animal welfare is not only an ethical consideration, but also a quality consideration.

Currently there is no EU wide label on animal welfare (European Commission, 2015k; Eurogroup4animals, 2015). Organic labels include animal welfare aspects more or less comprehensively (depending on the label). The EU organic products label has minimum requirements that all other organic labels in the EU have to comply with (European Commission, 2014e). For example, there are regulations concerning the density of bird flocks and freedom from pain throughout life including at transport and slaughtering stages (European Commission, 2014e). These animal welfare considerations cover all domestic animal products. Table 85 provides a list of eco-labels (taken from the Ecolabel Index, 2015) that specify that animal welfare is part of the label. The Dutch label Milieukeur is not an organic label but does include animal welfare aspects. Animal welfare is also included for farmed fish and covers, for instance, water quality and stock density – to prevent outbreaks of pests and diseases and to minimise the need for veterinary medicine (ASC, 2012).

Table 85: Available labels on animal welfare in the EU that are third party verified (based on the Ecolabel Index, 2015; Eurogroup for animals, 2015)

Labels on animal welfare in the EU	Country	Starting year	Government (G), Non-profit (N-P), Industry Association (I), For-profit (F-P)
Aquaculture Stewardship Council (ASC)	-	2012	N-P
EU organic products label	EU-28	1991	G
Bioland	Germany	1971	N-P
Bird Friendly Coffee	The Netherlands	1998	N-P
Delinat Bio Garantie	Austria, France, Germany, Italy	1983	(F-P)
EU organic products label	EU-28	1991	G
Global Good Agriculture Practice (GAP)	Germany, United Kingdom	1997	N-P
KRAV	Sweden	1985	N-P

LEAF Marque	Ireland, United Kingdom	2002	N-P
Milieukeur: the Dutch environmental quality label	The Netherlands	1992	N-P
Soil Association Organic Standard	United Kingdom	1973	N-P

Furthermore, some Eurogroup members have developed voluntary farm assurance schemes that have provided millions of animals with a better quality of life, and we support the development and trade of these products (Eurogroup4animals, 2015). Some examples are indicated below for five EU members:

- In Austria (and other countries, including Germany) [110]
- In Denmark [111]
- In Germany [112]
- In the Netherlands [113]
- In the United Kingdom [114]

3.2.1.5 Sustainable and ethical labels

In terms of the EU GPP criteria it is important to consider aspects when procuring food commodities from developing countries, and thereby procure commodities that have used a label that certifies that appropriate standards have been met. There are a number of eco-labels available in the EU-28 that has a strong emphasis on sustainable and ethical aspects and that have minimum environmental standards (Table 86).

Table 86: Available labels on sustainable and ethical aspects in the EU that are third party verified (based on the Ecolabel Index, 2015)

Labels on sustainable and ethical aspects in the EU	Country	Starting year	Government (G), Non-profit (N-P), Industry Association (I), For-profit (F-P)
Bonsucro	Denmark, France, Luxembourg, the Netherlands, United Kingdom	2005	N-P
Delinat Bio Garantie	Austria, France, Germany, Italy	1983	(F-P)
Fairtrade	EU-28	1997	N-P
Global Good Agriculture Practice (GAP)	Germany, United Kingdom	1997	N-P
HAND IN HAND	Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Luxembourg, Poland, Portugal, Romania, Slovenia, Spain, Sweden, United Kingdom	1992	(F-P)
KRAV	Sweden	1985	N-P
Milieukeur: the Dutch environmental quality label	The Netherlands	1992	N-P
Rainforest Alliance Certified	Austria, Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, Poland, Portugal, Spain, Sweden, the United Kingdom	1992	N-P
RSPO (Roundtable on Sustainable Palm oil)	Italy, Latvia, The United Kingdom	2007	N-P

[110] Available at http://www.vier-pfoten.de/service/guetesiegel/
[111] Available at http://www.dyrenesbeskyttelse.dk/#pV6g9tleutc26SOS.97
[112] Available at http://www.tierschutzlabel.info/home/
[113] Available at http://beterleven.dierenbescherming.nl/
[114] Available at http://www.freedomfood.co.uk/industry/rspca-welfare-standards

RTRS (Round Table on Responsible Soy)	(Brazil – but imported to the EU)	2010	I
SIP Certified	Finland	2008	N-P
UTZ Certified	Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Poland, Slovakia, Sweden, United Kingdom	2002	N-P

The **Fairtrade** label is available across all of EU-28 (Table 86). It has standards available for coffee, tea, chocolate, sugar and bananas (Fairtrade Foundation, 2015b). The certification additionally covers the environmental aspects listed below (Fairtrade International, 2015). In addition, some social aspects as for example cover worker conditions, no child labour, fair pay and improved livelihoods (Fairtrade Foundation, 2015c).

- Pest management: certain hazardous materials are forbidden or should be treated with care and not applied near human activity. There also has to be equipment available to deal with spills and accidents. Integrated pest management is promoted and training must be given to members. Training on how to handle chemicals safely must also be provided. Pesticide use must be documented. Protective clothing and equipment must be used when handling hazardous chemicals and pesticides. Use of herbicides should also be minimised. There must be training on applying the right amount of fertilisers.
- Soil and water: identify and prevent soils from eroding through training. A report should be prepared on what measures to use to improve soil fertility. Water sources must be listed and the sources must be checked regularly to make sure the source of water is not depleted, in collaboration with local authorities. Training on how to utilise the water source sustainably should be provided. Waste water must be handled properly and without negative impact on the environment and food safety. Training should be provided to inform about the risks.
- Waste: handling, storage, recycling and proper disposal of waste.
- Genetically modified crops: may not intentionally use GM crops and have practices in place to avoid the risk of contamination.
- Biodiversity**:** high conservation value areas and protected areas should not be negatively affected by the project, and must follow national legislation on agricultural land use. There should be buffer zones next to protected areas and water bodies, and pesticides must not be applied on these.

HAND IN HAND is available in a large number of Member States (Table 86). HAND IN HAND is a fair-trade label that belongs to the Rapunzel organic label (Rapunzel, 2015). It ensures not only organic standard but also social standards.

The **Rainforest Alliance** label is also available in many Member States (Table 86). The label is specialised in protecting biodiversity and to build sustainable livelihoods (Rainforest Alliance, 2015). The label stands for avoiding un-sustainable forestry (de-forestation), minimising impacts on climate change, conserve biodiversity, relieving poverty and transform business practices into sustainable methods (economic, social and environmental) (Rainforest Alliance, 2015).

The **UTZ Certified** label is also available in many Member States (Table 86). A farmer who is part of the label will be given training in better agricultural practices to minimise negative impact on the environment and to improve yields and quality of the coffee beans (UTZ Certified, 2014). Besides training the label also includes the areas of better working conditions, livelihood, income and school for children etc. (UTZ Certified, 2014).

RSPO (Roundtable on Sustainable Palm Oil) is used on 2.56 million hectares and the label covers 20 % of all palm oil produced. The labels has created both social and environmental criteria in order to improve palm oil production and the supply chains (RSPO, 2015).

RTRS (Round Table on Responsible Soy) is a label that is promoting a responsible production methods, processing and trade of soy. The label has both environmental, social and economic criteria (RTRS, 2014).

3.2.2 Schemes and labels relevant for catering services

3.2.2.1 Catering equipment

The European Energy Label and Ecodesign schemes cover professional and commercial refrigeration equipment commonly used by catering services. Professional refrigeration equipment includes appliances used in professional kitchens. Commercial refrigeration equipment includes appliances used to show and make accessible refrigerated food to the final consumers (supermarkets, shops, vending machines, etc.)

Refrigeration

For professional refrigeration, the Ecodesign Regulation EU No 2015/1995 sets minimum requirements for professional refrigerated storage cabinets, blast cabinets, condensing units and process chillers as shown in Table 87:

Table 87. Energy efficiency requirements for professional refrigerated appliances

Tier	**Max EEI**	**Energy class relation**
1 July 2016	EEI < 115	Bans appliances worse than class G
1 January 2018	EEI < 95	Bans class G
1 July 2019	EEI < 85	Bans class F

The Energy Label Regulation EU 2015/1995 settles the energy classes for professional refrigerated storage cabinets. The energy classes and energy efficiency indexes are showed in Figure 33.

Energy efficiency classes of professional refrigerated storage cabinets

Energy efficiency class	EEI
A+++	EEI < 5
A++	5 ≤ EEI < 10
A+	10 ≤ EEI < 15
A	15 ≤ EEI < 25
B	25 ≤ EEI < 35
C	35 ≤ EEI < 50
D	50 ≤ EEI < 75
E	75 ≤ EEI < 85
F	85 ≤ EEI < 95
G	95 ≤ EEI < 115

Figure 33: Energy efficiency classes of professional refrigerated storage cabinets

There is another Ecodesign and Energy Labelling study ongoing whose scope includes commercial refrigeration (Lot 12) as listed below (EC/JRC, 2014).. supermarket segment refrigerated display cabinets

- beverage coolers
- small ice-cream freezers
- soft scoop ice-cream cabinets
- refrigerated vending machines

For the appliances within the scope of Lot12, the discussion on the energy classes and ecodesign thresholds is still ongoing

Cooking appliances and dishwashers

The other energy consumers within the catering services, i.e. the professional cooking appliances and dishwashers, lack European Ecodesign or Energy Labelling policy tools, which are just developed (or under development) for domestic appliances, that are out of the scope of the criterion.
Regarding professional dishwashers, the current Ecodesign and Energy labelling for domestic dishwasher are under revision, and it is planned to include professional appliances as well

US Energy star

The US Energy Star sets minimum energy efficiency requirements for the following (please notice the US Energy Star uses the term 'commercial' to refer to professional kitchen appliances):

- Commercial hot food holding cabinets
- Commercial fryers
- Commercial griddles
- Commercial steam cookers
- Commercial ovens

- Commercial dishwashers

Standards and methodologies

It has been found that there several standards of energy efficiency in catering services equipment currently under development.

EFCEM (European Federation of Catering Equipment Manufacturers) has been working on performance measuring standards for a range of equipment, which included the industry's views on how to measure the energy performance of catering equipment. They are mainly based on the best available EU local standards. The so-called EFCEM Energy Performance standards cover the following appliances:

- Open topped hobs
- Gridles
- Open flame burners
- Boiling pans
- Bratt pans
- Fryers
- Combi ovens
- Convection ovens
- Dishwashers
- Refrigeration
- Pre-rinse spray heads (for pot wash)
- Fry tops and griddles
- Coffee machines
- Water boilers
- Induction equipment
- Rethermalisation equipment
- Solid top hobs

These standards are aimed at describing methodologies to measure and calculate the energy efficiency of the appliances but they do not set any threshold or energy efficiency grading.

3.2.2.2 Transport

Euro standards

With regards to air emissions covered by Euro standards, for light commercial vehicles, the Euro 5 standard applies as of 1 September 2009 for the new types of cars and vans sold in the EU market and as of 1 September 2011 for the PN limits to diesel vehicles. In January 2015 it became mandatory for all new registrations. As for Euro 6, it sets diesel NOx limits 55% lower than Euro 5, so diesel NOx limits are only 25% higher than gasoline. It also includes PN limits for gasoline vehicles, which were set for diesel vehicles by Euro 5b. This extension of the PN limits solves the gap found in gasoline direct injection technology, which emits more ultrafine particles than conventional gasoline engines. Euro 6 was mandatory for new types in September 2014. For all vehicles, it is implemented in three stages (ICCT, 2015):

- Before September 2015: no particle number (PN) limits for gasoline vehicles and relaxed requirements on on-board diagnosis (OBD) requirements
- After September 2015: OBD requirements for all vehicles, but less restrictive OBD thresholds (when exceeded the vehicle will signal a fault), and more lenient PN limit for direct injection gasoline engines.

- After September 2018: OBD requirements and PN limits will be mandatory for all vehicles. Real drive emissions requirements will be introduced and the New European Driving Cycling will be replaced by Worldwide harmonized Light vehicles

For heavy duty vehicles, the Euro V standard applies as of October 2008 for the new types of vehicles sold in the EU market and one year later it became mandatory for all new registrations. EURO VI was required to all new vehicles registration in January 2014, and some specific parts of it in 2017. It reduces 67% the PM emissions limit compared to EURO IV and V, and includes a PN limit. It also decreases the NOx emissions limit 77% relative to EURO V. The standard also replaces the European Stationary Cycle and Transient Cycle used for testing by the World harmonized Transient cycle, which covers cold and hot start, and in general stricter testing conditions (load, idle time). EURO VI introduces in-service conformity testing using Portable Emission Measurement System, the first one to be carried out within 18 months of the approval and then every 2 years. Other changes are a new limit for ammonia emissions due to the selective catalytic reduction systems using urea and stricter limits for methane on CNG and LPG vehicles. Nevertheless, it is not clear how relevant these heavy duty vehicles are for distribution of food in the catering service activities.

3.2.2.3 Cleaning products (dishwashing)

There are many eco-labels available in the EU for cleaning products, as can be seen in Table 88. The three labels that are available in most Member States are the EU Ecolabel, AISE Charter for Sustainable Cleaning and the Blue Angel label, according to the Ecolabel Index (2015).

Table 88: Available labels on cleaning products in the EU that are third party verified (based on the Ecolabel Index, 2015)

Labels on packaging in the EU	Country	Starting year	Government (G), Non-profit (N-P), Industry Association (I), For-profit (F-P)
AIAB (Italian Association for Organic Agriculture)	Italy	1998	N-P
AISE Charter for Sustainable Cleaning	Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Spain, Sweden, United Kingdom	2005	I
BASF Eco-Efficiency	Germany	2002	F-P
Blue Angel	Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Poland, Slovakia, Slovenia, Spain, Sweden, United Kingdom	1978	G
Environmentally Friendly Label: Croatia	Croatia	1993	G
Environmental Product Declaration	Belgium, Greece, Italy, the Netherlands, Sweden, United Kingdom	1999	G
EU Ecolabel	EU-28	1992	G
Good Environmental Choice "Bra Miljöval"	Denmark, Finland, Sweden	1987	N-P
GREENGUARD	Austria, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Poland, Portugal, Spain, Sweden, United Kingdom	2001	F-P
Hungarian Ecolabel (Környezetbarát Termék	Hungary, Romania	1993	N-P

Védjegy)			
National Programme of Environmental Assessment and Ecolabelling in the Slovak Republik (NPEHOV)	Austria, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Poland, Romania, Slovakia, Slovenia	1997	G
NF-Environnement Mark	France	1991	N-P
Nordic Ecolabel (Swan)	Denmark, Finland, Sweden	1989	N-P
SMaRT Consensus Sustainable Product Standards	Austria, Denmark, Finland, France, Germany, Ireland, the Netherlands, Portugal, Spain, United Kingdom	2002	N-P
SustentaX	Greece, Portugal	2008	F-P

There are a number of **EU Ecolabels** available for cleaning products that are relevant for catering services. These are: all-purpose cleaners and sanitary cleaners, detergents for dishwashers, industrial and institutional automatic dishwasher detergents, hand dishwashing detergents, laundry detergents, industrial and institutional laundry detergents (European Commission, 2015j). These includes environmental aspects such as for instance:

- Does not contain of dangerous substances that are harmful for humans and aquatic environment.
- Uses less packaging.
- Are to a great extent biodegradable.
- Have information available on how to use it.

4 IMPROVEMENT POTENTIALS

The aim of this chapter is to conduct a short review on current best practices in the food service sector in terms of sustainable food procurement and environmental performance of food provision. The chapter is primarily based on the Best Environmental Management Practice in the Tourism sector and in the Best Environmental Management Practice in the Food and Beverage Manufacturing by the European Commission. The project INNOCAT (procurement of eco-innovative catering) is also overviewed and some best GPP case studies held in different Member States. The chapter ends with concluding remarks on the review of these best practice documents and the applicability of these standards to the EU GPP criteria when including the findings of the detailed environmental analysis.

4.1 Best Environmental Management Practices (BEMP)

The following section offers a brief review of existing BEMP reference documents relevant for food and catering services.

4.1.1 BEMP in the Tourism Sector

This reference document provides benchmark of excellence recommendations on how to perform better and emit less greenhouse gas emissions in the tourism sector (European Commission, 2013c). One of these areas is relevant for the EU GPP for food and catering services, namely, the ones referring to *restaurant and hotel kitchens best environmental management practices* (European Commission, 2013c).

4.1.1.1 Green sourcing of food and drinks

The BEMP document highlights that the environmental impacts of food and drink are significantly larger within the production of food and drinks when compared to the food preparation stage. For this reason the environmental impacts of food service provisions can be minimised through buying low-impact food products. It is also recommended in the document that fresh produce should be locally sourced, and that menus should contain seasonal produce, that a larger proportion of fruit, vegetables, pulses and cereals should be served (in meals include meat or fish), that there should be a more thoughtful portioning of meat and dairy, and that portion sizes should be optimised to minimise the creation of food waste (European Commission, 2013c). The benchmarks of excellence for procurement of food and drink, expressing aggregate percentages for all food and drink products purchased, expressed by purchase value are stated below. Further to that relevant standards and criteria for procurement across a broad range of product groups is summarised in Table 89.

Benchmarks of excellence for green procurement of food and drink products include (European Commission, 2013c):

- *The enterprise is able to provide documented information, at least including country of origin, for all main ingredients.*
- *At least 60 % food and drink products, by procurement value, are certified according to basic or high environmental standards or criteria.*
- *At least 40 % food and drink products, by procurement value, are certified according to high environmental standards or criteria (European Commission, 2013c).*

Table 89: Relevant standards and criteria for a broad range of food product groups classified as basic and high environmental performance (European Commission, 2013c).

Product groups	Basic standard	High standard
Coffee, chocolate, tea		4C, FT, OC, UTZ
Dairy	GAP, NPC	OC

Fruit and vegetables	GAP (avoid airfreight, from heated greenhouses)	FT, NPC, OC (in season)
Fats and oils	GAP, NPC	RSPO, RTRS, OC
Grains and pulses	GAP, NPC	OC
Poultry, eggs	GAP, NPC	OC
Red meat	GAP, NPC, RA	
Fish and seafood (*)	RLF	ASC, MSC
Soft drinks	See sugar, below	
Sugar	GAP	BSI, FT, OC (cane sugar)
Water		(filtered) tap water
ASC: Aquaculture Stewardship Council; BSI: Better Sugarcane Initiative; FT: Fairtrade; GAP: Good Agricultural Practice; MSC: Marine Stewardship Council; NPC: National (or regional) Production Certification; OC: Organic (labels such as BioSuisse, EU leaf, KRAV, Soil Association); RA: Rainforest Alliance; RLF: Red listed fish; RSPO: Roundtable on Sustainable Palm Oil; RTRS: Round Table on Responsible Soy.		
(*)all fresh and saltwater fish, fish eggs and shell fish		

The BEMP document highlights that there are both positives and negatives for organic products, but the overall conclusion is that organic overall brings most environmental benefits (European Commission, 2013c). Table 90 and Table 91 provides their rationale for the procurement of organic products as bringing an environmental benefit when compared to the conventional ones.

Table 90: Background to the recommendation to procure organic products rather than conventional products (European Commission, 2013c). ***Note: The references in this table can be found in the European Commission (2013c).***

Organic farm system advantages	**Organic product life cycle advantages (*)**
Higher on-farm biodiversity (Mäder *et al.,* 2002; Nemecek *et al.,* 2011)	Lower abiotic resource depletion (Nemecek *et al.,* 2011)
Improved soil quality (organic matter and microbe content) (Mäder *et al.,* 2002)	Lower energy use (Corré *et al.,* 2003)
Higher rates of soil biological nutrient cycling (Mäder *et al.,* 2002)	Lower eco-toxicity (Nemecek *et al.,* 2011)
Soil carbon sequestration (IFOAM, 2009; Pimental *et al.,* 2005)	Lower GHG emissions for cereals, crops and some meat production (Hirschfield *et al.,* 2008).
Crop-breeding for good performance under low-input conditions (CoopCH, 2010)	
	(*) per kg product

Table 91: Strengths and weaknesses of organic and conventional systems (European Commission, 2013c). Note: The references to this table can be found in the European Commission (2013c).

Average non-organic systems	**Average organic systems**
+ Higher yields	+ Low inputs of finite resources
+ Can utilise less fertile soils	+ Soil quality (and carbon sequestration)
+ Innovation (e.g. precision agriculture)	+ Lower eco-toxicity
+ Lower GHG emissions beef	+ Innovation (e.g. crop breeding)
- Lower on-farm biodiversity	+ Lower GHG emissions crops + Higher on farm biodiversity (*these results are debatable since more land is needed due to low yields and that can have indirect negative effects)*
- High inputs of finite resources	- Lower yields
- Soil degradation	- Higher GHG emissions beef
	- Higher price

The rationale for locally sourced fruit and vegetables is partially to avoid airfreight transportation, which emits substantial greenhouse gas emissions compared to other transport modes (European Commission, 2013c).

4.1.1.2 Organic waste management

Landfilling organic waste is responsible for a large emission of greenhouse gas emissions. This can be avoided by more adequate procedures for waste management as for instance, by minimising the generation of (avoidable) food waste and/or by separating organic waste from general waste to avoid it going to landfill (European Commission, 2013c). The benchmarks of excellence for organic waste management are stated below:

Benchmarks of excellence for organic waste management *(European Commission, 2013c)*:

- *"≥95 % of organic waste separated and diverted from landfill, and, where possible, sent for anaerobic digestion or alternative energy recovery.*
- *Total organic waste generation ≤0.25 kg per cover[115].*
- *Avoidable waste generation ≤0.18 kg per cover".*

If less food is wasted it means that less food has to be bought, which minimises both costs and the pressure on the environment. In the UK it was found that if a 20 % reduction of food waste could be achieved it would save approximately €2,300 annually per restaurant, or €530 per tonne of food waste saved (European Commission, 2013c).

It is also very important that the food waste does not end up in the landfill (199/31/EC Landfill Directive banning the disposal of biodegradable waste above mandatory targets). This will require clear strategies for food waste management which should favour, separate collection of bio-waste and encourage: organic recycling (composting and digestion of bio-waste) versus recovey for energy purposes (EC Waste directive and waste management hierarchy herein) or landfill.

4.1.1.3 Energy consumption

The main energy-consuming operations in commercial kitchens are: cooking, dishwashers (water heating), refrigeration, cooling and ventilation, and lighting (European Commission, 2013c). A large part (60%) of the energy used for these appliances is lost through waste heat (European Commission, 2013c). Proposed areas to improve are illustrated in Table 92 (European Commission, 2013c). The benchmarks of excellence for energy consumption are stated below:

Benchmarks of excellence for energy consumption *(European Commission, 2013c)*:

- *Implementation of a kitchen energy management plan that includes monitoring and reporting of total kitchen energy consumption normalised per dining guest, and the identification of priority measures to reduce energy consumption.*
- *Installation of efficient equipment and implementation of efficient practices described in this technique, including: (1) induction hobs or gas flame hobs with pot sensor control; (2) commercial fridges and freezers with specific energy consumption of ≤1.14 and ≤3.6 kWh per L (water consumption) volume per year, respectively (European Commission, 2013c).*

[115] The term is used in food and drink industry - means 'one dining guest' (European Commission, 2013c).

The BEMP document highlights some improvement potentials for energy consumption. Table 92 and Table 93 provide improvement potentials from this reference document on how to save energy. Table 92 illustrates and describes the best practices relevant for all main operations in commercial kitchens, while Table 93 focuses more in depth on potential energy savings when changing cooking equipment.

Table 92: BEMP to reduce energy consumption in commercial kitchens (European Commission, 2013c)

Aspect	Measures	Description
Management	Appoint kitchen energy champion	- An appropriate person working in the kitchen may be appointed as an 'energy champion' with responsibility for monitoring energy consumption and ensuring continuous implementation of energy efficiency measures.
Cooking	Install efficient cookers	- Installation of induction or gas hob cookers. - Installation of boiler less steamers.
	Efficient cooking techniques	- Correct sizes of pots and pans used and matched to hobs. - Careful planning of food preparation. - Avoid unnecessary use of quenching.
Water heating	Install efficient dishwashers and use efficiently	- Installation of appropriately sized efficient dishwashers that recycle rinse water, recover heat from drying air and wastewater, and use heap pumps or gas. - Optimum loading.
	Efficient water heating source	- Use of heat pumps or renewable energy sources.
Cooling and ventilation	Optimised HVAC system	- Heat recovery and efficient distribution within centralised building HVAC (heating, ventilating and air conditioning) systems. - Appropriate temperature control.
	Efficient ventilation control	- Variable speed fans controlled by air management system, and insulated hoods.
Refrigeration	Installation of efficient refrigeration system	- Appropriate sizing and positioning of refrigeration storage. - Adequate installation and air-tightness. - Correct capacity compressors and efficient motors. - Heat recovery. - Use of low global warming potential refrigerants.
	Efficient maintenance and operation	- Regular maintenance and seasonal adjustment of compressors, careful temperature control, efficient stocking and use (e.g. not leaving doors open).
Lighting	Efficient fittings	- Installation of correct lighting capacity (lumens) provided by low-energy sources (florescent tubes and LEDs in kitchen).
	Lighting control	- Use of motion sensors to control lighting in areas such as walk-in refrigeration, and efficient control by staff.

Table 93: Potential environmental savings when replacing current cooking equipment by best performing equipment (European Commission, 2013c).

Measure	Environmental benefit
Replace electric hob with induction hob.	15–20 % reduction in cooking energy. 50–80 % reduction in total energy consumption (*).
Replace electric hob with gas hob (optimised burners).	30 % reduction in primary energy consumption.
Replace gas hobs with new hobs controlled by pot sensors.	50–80 % reduction in total energy consumption (*).
Replace uninsulated food heating unit with insulated model.	70 % reduction in energy.
Replace conventional oven with convection oven.	30 % reduction in energy consumption.
Use a combi oven or pressure cooker instead of	50–70 % reduction in energy consumption.

conventional oven.	
Use microwave instead of oven or hob to (re)heat food.	70–90 % reduction in energy consumption.
(*) In commercial kitchens where hobs typically not switched off between uses by operatives. *Source: USDE (1997); Fisher (2006); Tyson (2010); EC (2011).*	

4.1.1.4 Water consumption

Water use for dishwashers is around two thirds of the total water use in kitchens (European Commission, 2013c). Many commercial kitchens use high pressure rinsing with pre-rinse spray valves (PRSVs) before placing dishes and cooking ware in the dishwasher. If these are standard appliances they use approximately 15 litres of water per minute. An easy and cheap solution to minimise water use is to have low-flow nozzles installed, since they create more efficient spray and thereby save 6 litres of water per minute, or 570 litres of hot water per day for an average sized SME kitchen (European Commission, 2013c). This solution also saves energy and reduces the amount of detergents (chemicals) used per day (European Commission, 2013c). Washing dishes by hand uses 60 % more water than a dishwasher would (European Commission, 2013c). The benchmarks of excellence for water consumption are stated below.

<u>*Benchmarks of excellence for water consumption*</u> *(European Commission, 2013c)*:

- *Implementation of a kitchen water management plan that includes monitoring and reporting of total kitchen water consumption normalised per dining guest, and the identification of priority measures to reduce water consumption.*
- *Installation of efficient equipment and implementation of relevant efficient practices described in this document, as far as possible within demonstrated applicability and economic constraints.*
- *At least 70 % of the purchase volume of chemical cleaning products (excluding oven cleaners) for dish washing and cleaning are eco-labelled (European Commission, 2013c).*

The BEMP document highlights some improvement potentials for water use. Table 94 illustrates and describes the best practices and Table 95 illustrates the possible annual savings if best practices are implemented.

Table 94: BEMP to reduce water (and energy) use in commercial kitchens (European Commission, 2013c).

Aspect	Measure	Description
Dishwashing	Efficient pre-rinse spray valves	Install or retrofit PRSVs nozzles to produce a maximum flow of 6 L/min. Install or retrofit sensor- or trigger- activation.
	Efficient dishwashers	Select an appropriate size and type of efficient dishwasher with water consumption ≤2 L per rack (tunnel dishwasher).
	Heat recovery	Install heat-recovery.
	Optimised loading and programming	Maximise dishwasher loading, and set programmes to optimise water, chemical and energy consumption (e.g. avoid prewash).
	Green procurement of chemicals	Avoid environmentally harmful chemicals and select eco-labelled dishwasher chemicals.
Food preparation	Low flow sink taps	Install efficient taps, or retrofit with pressure regulators and/or aerators to achieve flow rates ≤12 L/min.
	Efficient food preparation techniques	Avoid use of continuously flowing water to defrost and wash food.
	Replace older boiler steam cooker and water-cooled wok ranges	Replace old boiler steam cooker with modern boiler less version using ≤8 L water per hour. Replace wok ranges that require water cooling.

Cleaning	Efficient floor cleaning	Avoid the use of hosepipes for floor cleaning (use a mop or water-broom).
	Efficient cleaning of food surfaces	Use correct dilution volumes and select eco-labelled cleaning products.
	Avoid tablecloths	Purchase tables with attractive wipe-down surface that can be used without tablecloths.

Table 95: Possible water savings if implementing best practice (European Commission, 2013c based on *Smith et al. (2009); Alliance for Water Efficiency (2009; 2011); Karas (2005)).*

Measure	Achievable reduction in specific consumption	Typical SME annual saving
Efficient PRSVs	67 % (from 15 to 5 L/min)	200 m^3
Efficient dishwasher	50 % (from 4 to 2 L/rack)	150 m^3
Low flow sink taps	40 % (from 20 to 12 L/min)	50 m^3
Efficient steam cookers	92 % (from 100 to 8 L/hour)	200 m^3
Waterless thawing	100 % (from 10 hrs per week under running water)	10 m^3

4.1.2 BEMP in Food and Beverage Manufacturing

This reference document focuses on the manufacturing stage in food supply chains (European Commission, 2015e). Energy and water consumption, as well as the generation of solid waste and waste water are the most relevant environmental aspects of food and drink manufacture (European Commission, 2015e). Environmental aspects are elements of an organisation's activities, products or services that have or can potentially have an impact on the environment.

This reference document lists few labels including not for profit initiatives and certification schemes that are available to the manufacture of food and drinks to guide ingredients purchasing (European Commission, 2015e):

- *"The Roundtable on Sustainable Palm Oil*
- *OTZ certification (cocoa, coffee and tea)*
- *The Rainforest Alliance certification (food, beverages and paper products derived from forests environment)*
- *Marine Conservation Society certification*
- *Global GAP*
- *The Sustainable Agriculture Initiative (SAI) Platform".*

In addition to the more widely applicable labels, large food and drink manufacturers have developed their own organisation policies and practices to minimise their environmental impact. As an example, Danone has a policy called 'Forest Footprint' in which they have identified a few key hotspot areas to consider when procuring ingredients and materials derived from forests, such as wood energy, sugar cane, palm oil, soy for animal feed, paper and cardboard packaging and bio-sourced raw materials to be used for packaging (European Commission, 2015e).

4.1.2.1 Improving potentials in packaging

There are a number of generically applicable improvement potentials available for food and drink packaging in the manufacturing sector such as (European Commission, 2015e):

- **Light weighting packaging -** *minimise the quantity of material used per packaging, but only to the point where the protection of food is not negatively affected*

- **Bulk packaging** - *reduces the need of packaging, but is obviously only beneficial when the buyer is dealing with large quantities that will be used before the food expires*.
- **Refillable packaging** - *has traditionally been most applied for beverages but is also used for other products, such as coffee*.
- **Returnable packaging** - *returnable plastic crates is one example that minimises the need for secondary packaging.*
- **Packaging using recycled material** - *minimises the need for virgin materials*.
- **Biodegradable/recyclability/bio-based packaging are made from renewable materials and** can undergo organic recycling. Materials need to meet the strict criteria of the European norm EN 13432 on industrial compostability.
- **Modified atmosphere packaging** - *has the ability to extend shelf-life of food, sometimes for weeks instead of days*.
- **Optimal portion-size -** *investigate how much the average consumer consumes so the packaging and volume of food can be optimised to minimise the risk of food waste creation*.
- **Informative messages on the packaging for optimised storage of the food product -** *to inform the consumers on how best to store products to minimise food waste, and how best to cook them to minimise energy use*.

The potentials to reduce the environmental impact by applying the above mentioned improvement potentials, together with the applicability of these improvement potentials within the food supply chain are summarised in Table 96.

Table 96: Environmental impacts and applicability of different food packaging (European Commission, 2015e).

Packaging type	**Environmental impact** (include a not exhaustive list of case examples)	Applicability
Lightweight	- Reducing material use and weight of packaging can contribute to lower the emission of greenhouse gases. However, packaging can become less recyclable and may require more energy to produce, which can offset the environmental benefits. - Cucumbers in 1.5 g of wrapping stay fresh for 11 days more than a cucumber without packaging. There is a limit to how far packaging can be reduced.	- All food products.
Bulk	- Less primary packaging for raw material is needed which lowers the emission of greenhouse gases.	- Not possible for all food products. - Only relevant for buyers that use large quantities of food quickly (before the food expires).
Refillable	- Refillable glass beverage packaging has to be collected (after use) and transported to a cleaning facility before it can be reused. - For instant coffee the consumer can have a refillable (e.g. glass) package at home and buy the coffee in refill packaging (in other more light material). Will minimise material use and weight of packaging and hence save much energy.	- Relevant for national/ local/ less complex supply chains with an infrastructure that can optimise return journeys of the bottles. - Is also applicable for global supply chain products.
Returnable	- Returnable plastic crates (i.e. secondary/ tertiary packaging) have to be collected (after use) and transported to a cleaning facility	- Relevant for national/ local/ less complex supply chains with an

	before it can be reused. In Sweden in 2004, there were 1,753,000 crates circulation. It was estimated that this saved over 28,000 tonnes of packaging waste, 260,000 km lorry journeys per year (180 tonnes of CO_2e) and 53 million kWh of energy per year. Additionally these crates reduced the amount of damaged goods by 20 % and costs of transportation by 25 %.	infrastructure that can optimise return journeys of the crates.
Contains of recycled material	- Optimising the recycled content of glass packaging has great environmental benefits. Every 1,000 tonnes of recycled glass (which is used for new glass packaging) saves 1,200 tonnes of raw material, 345,000 kWh energy and 314 tonnes of CO_2e. - Recycling aluminium only uses 5 % of the energy needed to produce the virgin material (primary production).	- In some cases consumer safety restricts what recycled material can be used in food packaging.
Biodegradable/recyclability and bio-based	- Impacts of bioplastics on environment and human health are globally lower than conventional plastics: as an average of the LCAs reviewed (Weiss etal, 2012) bioplastics show a greater eutrophication and stratospheric ozone depletion, but lower global warming, potential primary energy resources use and acidificiation potential - Both the higher eutrophication and stratospheric ozone depletion potentials of biopolymers are due to farming practices using conventional fertilizers (Weiss eta., 2012). Thus, to minimise environmental impact of bio-plastics further the materials have to be responsibly sourced. - Biodegradable compostable packaging greatly improves the end-of-life option of the unavoidable foodwaste by making it possible to jointly recycle (compost) food waste and used compostable packaging, food containers, tableware etc Reducing landfill/incineration and increasing recycling in line with EC directives.	-In theory, applicable to all food products
Modified atmosphere	- Significantly improves shelf-life of food products which will help reduce the creation of food waste.	- In theory, applicable to most food products.

Different packaging materials have their own environmental characteristics. For beverage cartons, 88 % of the raw material were sustainably sourced in Europe in 2012 (European Commission, 2015i). In terms of rigid metal packaging (aluminium and steel), 70 % were recycled in 2010 leading to an estimated 70-95% of energy savings. The corrugated board packaging has a recycling content in Europe of 85%. For plastics, 50 % of all packaging in Europe is plastic but that only accounts for 17 % of the total weight of packaging. For glass, when one tonne of glass is recycled, 1.2 tonnes of raw materials (avoiding an equivalent to 700 kg CO_2) are saved. Additionally, 30 % of the energy is saved when 10 % of glass is recycled (European Commission, 2015i). The BEMP document identifies the following as appropriate environmental performance indicators for packaging:

<u>Environmental performance indicator</u> (European Commission, 2015i):

- *Packaging related CO_2-eq. per unit weight of product manufactured.*
- *Volume/weight packaging per unit weight of product manufactured.*
- *% of packaging which is recyclable.*
- *% recycled material content in packaging.*
- *Weight of packaging per unit product.*
- *Average density of product category in kg (net) product per litre of (gross/packaged) product* (European Commission, 2015i).

4.1.2.2 Improving potentials in cleaning operations

For cleaning operations there are three areas that are important: water use, energy use and chemical use (European Commission, 2015i). Frontrunners implement this BEMP in a number of ways, including:

- Implementing and optimising of Cleaning In Place (CIP) systems
- Optimising manual cleaning operations
- Minimising or avoiding the use of harmful chemicals
- Better production planning
- Better plant design

The BEMP document identifies the following as appropriate environmental performance indicators for cleaning operations:

<u>Environmental performance indicator</u> *(European Commission, 2015i):*

- *Cleaning-related energy (kJ) per unit of production.*
- *Cleaning-related water use (m^3) per unit of production.*
- *Waste water generation (m^3) per unit of production.*
- *Waste water generation (m^3) per clean.*
- *Water consumption volume (m^3) per day.*
- *Mass (kg) or volume (m^3) of cleaning product (e.g. caustic soda) used per unit of production.*
- *Share of chemical-free cleaning-agents.*
- *Share of cleaning-agents with recognised environmental certification (e.g. EU ecolabel)* (European Commission, 2015i).

4.1.2.3 Improving potentials in transport and distribution

There are a number of environmental impacts associated with transport, such as air pollution (human health effects, acidification and ozone formation), resource depletion (e.g. oil), water pollution (e.g. PAH and heavy metal run-off from roads and chemical spillages), ozone depletion (from leaking of refrigerants) (European Commission, 2015i). Table 97 shows environmental performance of different EURO standard trucks and it is clear that the latest EURO VI/EURO 5 has lowest impact per kWh.

Table 97: Comparison of different EURO models for heavy duty trucks in terms of environmental performance (European Commission, 2015i)

TIER	DATE	TEST	CO	HC	NO_X	PM	SMOKE
					g/kWh		m^{-1}
EURO I	1992	ECE R-49	4.5	1.1	8.0	0.36	
EURO II	1998		4.0	1.1	7.0	0.15	
EURO III	2000	ESC + ELR	2.1	0.66	5.0	0.1	0.8
EURO IV	2005		1.5	0.46	3.5	0.02	0.5
EURO V	2013		1.5	0.46	2.0	0.02	0.5
EURO VI	2013		1.5	0.13	0.4	0.01	

Note: Values are for steady state testing (ECE R-49), European Stationary Cycle (ESC) and European Load Response (ELR). From summary data presented in DieselNet (2009).

This BEMP for food and beverage manufacturing recommends the following indicators for environmental performance (that are deemed relevant for catering activities) (European Commission, 2015i). The BEMP document identifies the following as appropriate environmental performance indicators for transport and distribution:

<u>*Environmental performance indicator*</u> *(European Commission, 2015i):*

- *kg CO_2-eq. emitted during transport per: tonne, m^3, pallet, or case (according to relevance) or kg CO_2-eq. per net amount of product delivered.*
- *L/100 km (vehicle fuel consumption) or mpg; or: kg CO_2-eq. /tonne·km.*
- *% of truck empty runs.*
- *% of deliveries carried out through back-hauling* (European Commission, 2015i).

As for biofuels there is a debate on how environmentally friendly they really are, especially the crop-based fuels, since they require much land, energy and chemicals to be produced. They are not included in best practice for these reasons (European Commission, 2015i). The second generation biofuels derived from (for instance) low input grass and wood may have better potential (European Commission, 2015i).

4.1.2.4 Improvement potentials within refrigeration

The reference documents provides some recommendations on how to minimise the environmental impact on refrigeration, and many of these recommendations are down to management of the refrigeration systems (staff behaviour) whilst others are dependent on the technology used. Below is a summary of the recommendations (European Commission, 2015i):

- **Smarter selection of temperature:** the standard for freezing is -23°C even though -18°C is sufficient. The lower temperature is to create a buffer if doors to the freezer are kept open or if ambient air is let in. For every degree of extra cooling significantly more energy is needed. Therefore it is recommended to have doors/seals or cooling curtains to the freezer, and to group food according to the temperature they need (as some products are kept at unnecessarily low temperatures).
- **Pre-cooling:** let a hot dish cool from 100°C to 30°C before refrigeration.
- **Minimise volume kept in cold storage:** avoid stock that requires refrigeration.
- **Avoid leakage of temperature:** replace leaking doors.
- **Stop using hydrofluorocarbons (HFCs):** instead use natural refrigerants as they have a lower global warming potential.
- **Use more advanced cooling systems:** for example carbon dioxide based systems.
- **'Leak-free warranty':** agree with the supplier of the cooling equipment that they have to maintain the equipment if it starts to leak.
- **Improving equipment:** invest in smarter, more efficient equipment.
- **Recover and reuse waste heat:** find a use of the waste heat created by freezers and refrigerators.
- **Maintaining and inspecting equipment:** is a very important routine.

4.2 The INNOCAT project

INNOCAT is a three year project which began in March 2013. It is supported by the European Commission's Competitiveness and Innovation Framework Programme (CIP) (INNOCAT, 2015b). INNOCAT aims to bring together a group of public and private buyers to publish a series of tenders for eco-innovative catering products, services and solutions. The aim is to help encourage eco-innovation in the catering sector by providing a sizeable launch market for new solutions. The main environmental and social hotspots addressed by this project are:

- Transport
- Waste re-use and recycling
- Bio-based products
- Energy-efficient equipment.

The purchasing sectors targeted by INNOCAT are school catering services, vending machines, bio-waste disposal systems, health and welfare catering services. Another objective is to disseminate project results and to promote an active experience exchange between buyers interested in eco-innovative catering.

4.2.1 School/Health and welfare catering services

A report on sustainable public procurement within school catering services has been published by INNOCAT (2015c). The main purpose of this report was to summarise best practice for sustainable public procurement of food across the EU in schools. Case studies from Sweden, Italy, Denmark and Scotland (the UK) were included, as well as examples from other countries. A few examples of sustainable practices that have been implemented in some EU schools include (INNOCAT, 2015c):

More environmental practices:

- A **meat-free day** a week (to reduce both environmental impact and costs).
- Allow parents to **order organic products for their children** (when they pay for the meal): because of that structure the schools could procure organic produce in bulk and hence reduce costs.
- **Compose meals differently** to be able to afford to procure organic food within a conventional budget. This is done by procuring less meat, purchasing seasonal food, balancing expensive and cheap food ingredients and minimising food waste.
- **Increase the quality of meals** to increase the uptake of food amongst children. This brought in more money which could be used to procure high quality ingredients from sustainable sources.
- **Investment in a machine to process food** to better control the quality of the meat used (e.g. meatballs). This has reduced time, cost and waste to make meals.
- Use of eco-innovative food containers and associated waste management to favour the organic recycling (composting) of food containers with unavoidable food waste (INNOCAT, 2015f).

Some other social elements are included within food procurement, including t**enders with small lot sizes** to help SMEs be part of the bidding process and to r**equire higher than average animal welfare** standards.

Health and Welfare

INNOCAT (2015e) tender from Réseau des acheteurs hospitaliers d'Ile-de-France, the network for hospital procurers in the Paris region, focused on innovative solutions for more environmental practices of the food waste management including:

- The use of recyclable food containers including the recycling service, and biodegradable dishes. Solutions has to comply with EN13432 standard for compostable/biodegradable materials
- The organisation of the logistics of sorting organic from non-organic waste.

4.2.2 Vending machines

Typically, vending machines operate non-stop and thereby use 2,500–4,400 kWh of electricity per year. Energy-efficient vending machine technology is available that can reduce this consumption by 24–76 %, hence the carbon emissions associated with the energy use can be reduced substantially (INNOCAT, 2015d). In addition, procurement of vending machines also include the content of it (food or drink products). Following is a case example from the University of Sheffield in the UK providing insights into the needs of the customers. In the following an overview on what students would like to see more of in vending machines (INNOCAT, 2014):

- *Fair trade*
- *Organic*
- *Vegan and other dietary needs*
- *Healthy options*
- *Be able to use own cup*
- *Low noise and low vibration*
- *High energy efficiency*
- *Aesthetically in tune with client environment*
- *Hot food*
- *Cashless payment*
- *Price and size options*
- *Reporting for lost coins*
- *Clean and hygienic*
- *Zero waste packaging* (INNOCAT, 2014).

4.3 Green Public Procurement case studies

This section provides a brief summary of case studies from different Member States on sustainable catering services in the public sector, to identify improvement potentials for the EU GPP for Food and Catering Services.Table 98 sums up the criteria set for some of the GPP schemes for food and catering services. For Italy, Sweden and France the summary is made below the table.

Table 98: GPP case studies for food and catering services (European Commission, 2015o; Wrap, 2012)

Country	Description of the organisation	Subject matter	Technical specifications	Award criteria	Contract Performance Clauses
Austria	The Federal Procurement Agency of Austria has set out to create a national framework for green dairy products (European Commission, 2014f). The focus of the framework is organic produce, non-GMO products, inclusion of SMEs (dairy production) providing one day delivery and value for money.	Supply and deliver of dairy products in Austria.	15 % (21 items) of the core product list must be organic. Most basic products must comply with Austria's action plan on sustainable procurement where the AMA (Agrarmarkt Austria) certification is deemed to comply.	---	Contractor should have IFS (international featured standards) certification to ensure quality, safety and legality.
Denmark a)	The Municipality of Copenhagen has set out to procure 100 % organic and seasonal produce (European Commission, 2014g). The focus has been on the quality and sustainability of food served in the municipality.	Procurement of 100 % organic, seasonal fruit and vegetables.	Provide fresh and high quality fruit and vegetables. Minimum EU requirements for fruit and vegetables have to be met. For instance, traceability (country of origin) must be known. Fruit and vegetables that are not covered by that standard have to be of good quality. All food have to be labelled according to EU standards (i.e. country of origin, content, nutritional value and sustainability). Products sold as 'organic' have to be certified and labelled properly on the packaging. Produce from Denmark has to comply with Danish regulations on organic, and produce from elsewhere has to comply with EU regulations. Packaging: limit packaging, and packaging must be recyclable and not contain PVC. Environmental zone: the supplier must use vehicles and raw materials with least possible environmental impact and pollution. Transportation: specific requirements for type of vehicle (less than 3,500 kg vehicle must be EURO 5 or if it is a diesel it has to have particle filter) and fuel (document and explain fuel consumption).	Extra points if the supplier can provide a wide range of fruit and vegetables.	---
Finland	The City of Helsinki investigated the environmental impact of catering services by calculating CO2 emissions for: food procurement, direct energy consumption and internal logistics (European Commission, 2014o). The findings were that, of the total carbon footprint, food procurement (i.e. the ingredients)	---	---	---	---

Country	Description of the organisation	Subject matter	Technical specifications	Award criteria	Contract Performance Clauses
	accounted for 58 % (of which meat accounted for 35 % and dairy products for 46 %), and direct energy use (when preparing the food) accounted for 41 %. Internal logistic only had a marginal contribution of 1 %.				
France	In the City of Lens they have created a requirement for organic food procurement in school catering services (European Commission, 2014h). There is a large focus on food quality and a minor focus on organic food products.	Procurement of supplying and preparing cold food.	20 % must be organic. Ensure traceability. Provide example on three organic menu examples. Staff training on meal composition, balance and nutrition.	---	---
Spain	Barcelona City Council aims to minimise environmental impacts of food for kindergartens by procuring organic food (European Commission, 2014k). Seasonal produce was also promoted.		Staff training regarding waste minimisation, selective waste collection, environmental properties of food products and environmentally friendly cleaning agents and methods. Waste management plan. Always procure fresh vegetables (i.e. never frozen). Fresh fish must be used at least 3 times per month (the rest can be frozen). Yoghurts and fruit juices must be organic.	If cleaning agents used are labelled with the EU Ecolabel, Nordic Swan or an equivalent standard. If organic ingredients are used daily.	---
UK	In Scotland the East Ayrshire Council has worked towards improving sustainability of school meals (European Commission, 2014m). In this case there is a significant focus on avoiding processed products, ensuring food with high nutritional values, and moving more towards organic food.	Supply fresh/organic produce.	Certified organic. Where relevant compliance with animal welfare standards. Clear sourcing details or HACCP systems. Arrangements on production and transport.	---	---
UK	London Olympics (Wrap, 2012)	Compostable products and packaging in close venue events	Use of compostable packaging and non-packaging products would help to maximise the amount of quality compost made from biodegradable wastes (food waste and used compostable packaging and non-packaging products). Making arrangements at the event and with the composter(s) who will treat the event's biodegradable waste stream	Compostable finished products has to comply with the compostability standards	

Country	Description of the organisation	Subject matter	Technical specifications	Award criteria	Contract Performance Clauses
Canada	The Vancouver metropolitan has initiated the "Green2go" restaurant waste reduction project (Gree2go, 2013).	Sustainable to-go food containers	Restaurants should be encourage to use reusable containers If this is not possible recoment restaurants to consider switching to compostable containers Recomment not to use non-compostable plastics as their recycling rates a considerable low and production impact is high. Strongly discourage the use of syrofoam		

a) to off-set the higher price of organic produce and lower overall cost, more vegetables and less meat were used in kitchens.

Italy

There is a case study from the Municipality of Rome on sustainable food procurement in schools in Rome. In Rome there is a strong drive to support organic food and organic farming (European Commission, 2014i). Additionally, there is a great emphasis on nutritional food and food safety.

b) Minimum criteria for food:

- Procure organic food.
- GMO-free food including GMO-free feed for animal products.
- Guaranteed freshness for fruit and vegetables (i.e. no more than 3 days between harvest and consumption).
- Meat freshness: red and white meat must be delivered in vacuum pack within 4 days of being packaged. Also introduce 'protection of denomination of origin' and 'protected geographical indication' according to Council Regulation (EC) No 510/2006 of 20 March 2006.
- Buy seasonal (according to the local seasons) and plan menus thereafter. Meat is only served twice a week and in a nine-week cycle the foodservice must use 160 different recipes.

Minimum non-food criteria:

- Separate organic waste from other waste.
- Use low environmental impact sanitisers and detergents.
- Single use items (e.g. napkins) must be recyclable and biodegradable. Use stainless steel cutlery, glass and ceramic tableware and plates.

Award criteria:

- Improve staff training, procure from social cooperatives, work to preserve 'freshness guaranteed' and procurement of Fairtrade products (bananas, biscuits and chocolate).

Another case study from Italy is from the City of Turin that wanted to achieve low carbon impact from catering services in schools (European Commission, 2014j). The process is still ongoing but the main areas for improvement that have been highlighted are the following:

- The use of energy efficient equipment.
- The use of tap water.
- Low impact transport.
- A large reduction in waste and packaging.
- Promoting reusable, refillable and biodegradable packaging.
- Waste management.
- Using eco-cleaning agents.
- Positive impact of labelling of food products as organic or Fairtrade.

Sweden

In the City of Malmö there is a strong focus on procuring sustainable food to schools (European Commission, 2014l). The approach has been to try to procure 100 % organic food. Following are the specific requirements:

- Meat must be hormone-free.
- Fish must comply with MSC or equivalent.
- Organic products must be included in the collection and be properly labelled.
- There should be a once a week delivery of food except for food products that need a more frequent delivery.
- Transport has to comply with the sustainability criteria of the City, which entails to use EURO 5 when using heavy weight vehicles.

The higher cost of buying organic was compensated by procuring less meat and procuring seasonal (not grown in heated greenhouses) fruit and vegetables, leading to almost no cost differences compared to previously. These two actions were also the main contributors to a lower carbon impact. Staff training also helped the transition into a more sustainable menu.

FRANCE

The network for hospital procurers in the Paris region, recently issued two Calls for Tender as part of the INNOCAT (2015f) project. The tenders are targeted at catering service providers who can provide eco-friendly and innovative solutions, recyclable food containers, biodegradable dishes, and a consultancy service to reorganise internal logistics in order to sort organic waste from other wastes. Solutions has to comply with EN13432 standard for compostable/biodegradable materials.

Legislation was adopted 17 Agust 2015 (Loi sur la Transition énergétique pour la croissance verte), which includes the ban of single use plastic tableware (food containers, dishes etc) which by 2020 at latest, has to be replaced by compostable tableware with a certain biobased content.

4.4 Other improvements

Throughout the work of this report other complementary catering service improvement potentials emerged from the literature review. These are briefly mentioned in this section as a supplement to the previous information.

4.4.1 Staff training

Table 99 illustrates a case study from the UK in which different public and private foodservice sectors were audited; it was found that staff training and awareness were identified as important in reducing environmental impacts (SKM Enviros, 2010). In many cases, the environmental impacts of catering services are dependent on staff behaviour, such as water use, energy use and food waste creation. More efficient equipment and water/energy using appliances can be implemented in kitchens to partially lower the use, but the rest is down to behaviour. Additionally, waste separation is in the hands of staff. Hence there are many environmental impact reductions that can be achieved by implementing on-going staff training.

Table 99: Key areas in foodservice to reduce environmental impacts (SKM Enviros, 2010)

Sub sector **[sites audited]**	Number of sites where measure identified									
	Cold storage equipment maintenance	Cold storage equipment management	Cooking equipment maintenance	Cooking equipment management	Servery heating and cooling equipment control	Lighting control	Lighting replacement	Staff Training and awareness	Waste management	Other
Business & Industry **[11]**	4	3		2	5	3	4	8	5	5
Healthcare **[11]**	1	2	1	4	2	2	4	9	2	8
Pubs **[11]**	1			5	2	5	4	7	5	4
QSR **[12]**	2			1		3	1	4		1

Restaurant **[12]**	2			5	1	2	5	7	4	7
Schools **[11]**	1	1	1	1	8	4	3	8	6	5
Total	**11**	**6**	**2**	**18**	**18**	**19**	**21**	**43**	**22**	**30**

4.4.2 Energy saving measures

The Carbon Trust in the UK states that energy use in commercial kitchens accounts for 4 to 6 % of the total operating costs (Carbon Trust, 2008) and hence energy efficiency can result in significant economic benefits. Furthermore, if energy is managed more efficiently then it can lower the temperature in kitchens and thus reduce the need for air conditioning or will create a more comfortable environment for staff to work in (Carbon Trust, 2008).

4.4.2.1 Energy saving potentials for coffee

In the detailed analysis of the environmental analysis (Task 3) one article (Humbert *et al.,* 2009) supplied information on different coffee types. The end of the report listed improvement potentials for coffee:

- Do not boil more water than needed (for spray-dried soluble coffee).
- Do not brew more coffee than needed (filter coffee).
- Re-use the cup before washing and fill the dishwasher full before using it.
- Avoid glass packaging and choose pouches instead.

4.4.2.2 Best available technology on equipment

As there are no energy labels available for procuring equipment for commercial kitchens it is important to investigate other energy saving methods. Using best available technology is one method.

Defra (2013) provides a list of best available technology for traditional equipment in the food service sector (Table 100). These recommendations are based on buying new equipment, but improving energy and water efficiency can also be achieved through retrofit existing equipment, e.g. by adding smart control appliances such as on-off switches and pan sensors for hobs (Defra, 2013).

Table 100: Traditional kitchen equipment – best available technology (Defra, 2013)

Equipment type	Best available technology
Combination oven	- Triple glazed viewing door. - Automatic fan switch off (when door opened). - Multi speed fans. - Recycle exhaust heat for incoming water steam generation.
Microwave	- Ensure correct size for requirements (avoid use of domestic).
Hobs and ranges	- Induction hobs use up to 50 % less electricity than traditional electric hob. - Automatic switch off (sensors to detect product presence).
Grills	- Sensors for switch on/off. - Reduce pre-heat (the most advanced grills need only seconds to heat up).
Fryers	- Fast cooking and temperature recovery times and less oil requirements (burner and heat exchange and insulated pans can reduce heat loss, and maximise heat retention in the oil). - Automated tracking systems for oil changes (intelligent filtration system can inform the operator of when oil needs changing).
Dishwashers	- Heat recovery condenser device (to re-use hot water for heating of incoming water). - Reduced size wash tanks. - Efficient wash pumps and more effective water filtration technology. - Optimised rinse arm efficiency through improved design. - Effective insulation of unit.

Refrigerators	- Electronically commuted motor fans run through DC rather than AC supplies, and are significantly more efficient. - Optimised air movement circuit design (improves performance and lowers energy consumption). - High density foam insulation for better temperature control. - Self-closing doors with automatic fan switch-off when opened. - Automatic switch-off for ice making.
Heating, ventilation and air conditioning	- Variable speed drivers (to match fan speed with service requirement). - Heat recovery system (recycling heat to warm incoming air or water elsewhere).

4.4.2.3 Best practices in professional kitchens

On the other hand, IEEA (2012) gathers recommendations and options available to reduce the energy consumed by professional kitchen equipment.
In the case of cooking appliances, the report recommends the following:

For ovens:

- Specify more smaller ovens and a choice of oven sizes to increase operational flexibility and reduce energy use.
- Purchase ovens with highest food energy efficiency and lowest idle rate e.g. Energy Star.
- Purchase gas ovens in preference to electric ovens, where possible.

For hobs

- Purchase gas hobs in preference to electric hobs, where possible.

For cookers

- Specify cookers with the shortest warm-up times and automatic ignition (cf behaviour).
- Purchase gas cookers in preference to electric cookers where possible.

The recommendations from IEEA (2012) report for refrigeration equipment are the following

- A larger fridge/freezer can be more efficient than 2 smaller ones.
- If possible choose an efficient refrigerant (such as R744 / CO_2).
- Renewal of equipment – make sure fridge/freezer is the most efficient possible, and meets or exceeds the energy performance benchmarks.
- Specify equipment from the Energy Technology List to benefit from enhanced capital allowances.
- Double-door units are in general more efficient than single-door.

The report summarized the parameters affecting the power of extraction as the choice of cooking fuel, the layout of the appliances, the fan efficiency and the system resistance to be overcome including any filtration requirements. Regarding operating factors, it highlights the control method and the hours of operation. Its recommendations for extraction are:

- Consider vertical stacking of ovens to reduce the area of the extraction hood.
- Ensure that the minimum air flow required for plume extraction from the cooking equipment is calculated to avoid over-specification.
- Specify high efficiency fans types and fan motors.
- Install variable speed drives on the fan motors so that system power can be varied to minimise energy use.
- Ensure automatic or manual control is in place with automatic reset of the gas control valve.

Regarding dishwashers, the recommendations are as follows

- Purchase the most energy efficient equipment (in kWh/100 dishes) when replacing.

- Consider models with heat recovery from hot sanitation.
- Purchase water-efficient dishwashers as these tend to be the most energy-efficient.
- Where centrally-generated hot water is available provide hot feed to the dishwasher as this can reduce running costs.
- Where local hot water generation exists, it may enable heat recovery from refrigeration.
- Hot feed from a central gas-fired boiler can reduce running costs.

4.4.3 Use of refrigerants

The current GPP criteria refer to the non-use of HCFCs and HFCs in refrigeration equipment. The situation since 2008 has not changed significantly. HCFCs and HFCs are still widely used as refrigerants in freezers and refrigerators. Although they are unlikely to have any impact on the environment in the immediate vicinity of their release, they can end up in the stratosphere where they can destroy the ozone layer, thus reducing the protection it offers the earth from the sun's harmful UV rays. HCFCs and HFCs also have very high global warming potential (GWP). There are now many substitute refrigerants based on hydrocarbon technology which are being used in commercial refrigeration equipment. Therefore this ‘award’ criterion is still valid.
The F-Gas Regulation (Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006). aims at the phase out of HFC refrigerants with a high global warming potential, particularly for commercial and professional refrigeration, it sets the following deadlines to ban high and medium GWP refrigerants (Table 101).

Table 101: Phase out deadlines for refrigerants with a high GWP according to the F-Gas Regulation (Regulation (EU) No 517/2014)

Refrigerators and freezers for commercial use (hermetically sealed equipment)	That contains HFCs with GWP of 2500 or more	1 January 2020
	That contains HFCs with GWP of 150 or more	1 January 2022

Table 102 identifies the commonly used refrigerants and their GWP.

Table 102: Commonly used refrigerants and their GWP

Refrigerant	GWP
R134a	1430
R404A	3990
R290 (propane)	3
R600a (isobutene)	3
R600 (butane)	4
R717 (ammonia)	0
R744 (CO_2)	1

4.4.4 Packaging

Packaging protects food on its journey to the consumer and is hence an important attribute of food (Defra, 2009). However, packaging waste is an issue in the EU. In 2008 the EU-27 disposed of 17 million tonnes of packaging (EUROPEN, 2011). Sustainability of packaging not only applies to the sourcing materials from sustainable sources, but also in choosing the right material, right packaging type and having an adequate system in place for reusing or recycling (including organic recycling: composting) packaging.

4.4.4.1 Choice of material

An LCA was conducted on extra virgin olive oil packaging to compare glass packaging with plastic packaging. It was reported that 1 kg of glass is enough to create two bottles while 1 kg of PET (plastic) is enough for 28 bottles (Accorsi *et al.,* 2015). When excluding the end-of-life phase, the glass bottle has the highest environmental impact. However, since glass is more likely to be recycled, the environmental impact shifts, and olive oil in a PET bottle has the highest impact throughout the life cycle (Accorsi *et al.,* 2015).

Humbert *et al*. (2009) conducted an LCA on spray dried soluble coffee and compared four packaging alternatives: glass jar, metal can, stand-up pouch (laminate), and 'stick' in a cardboard box. It was found that the glass jar had the highest impact since it required most material (in quantity) and hence led to heavier transport loads. The stand-up pouch had the lowest environmental impact as less material was required and the packaging was very light (Humbert *et al*., 2009).

4.4.4.2 Recycling

It is worth recalling that the processes of recycling are defined in the so-called Waste Framework Directive 2008/98/EC as any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but not include energy recovery.

Landfill is the waste management option which creates the largest environmental burden for packaging (from a life cycle perspective). If a packaging instead is recycled some of those burdens can be mitigated, which is for instance the case of PET bottles (Amienyo *et al.,* 2013).
The Landfill Directive 1999/31/EC in fact, demands for a strategy in waste management finally aiming at reducing down to 35% the total amount of biodegradable municipal waste produced (Art. 5). The Waste Framework Directive 2008/98/EC designs the targets for preparing for re-use and recycling of waste materials such as least paper, metal, plastic and glass (Art. 11) diverting them from landfilling and incineration.

A study on the hospitality sector in the UK found the recycling rates in different public and private sectors, as shown in Figure 34. This shows much higher levels of non-readily recyclable packaging and other wastes in the public sector (i.e. healthcare, services, education and staff catering), where recycling rates are generally lower than in the profit sector (WRAP, 2013d). This is largely because the profit sector (especially pubs and restaurants) have high levels of readily recyclable glass packaging. This is, in other words, an area for improvement in the public sector where environmental impacts can be lowered.

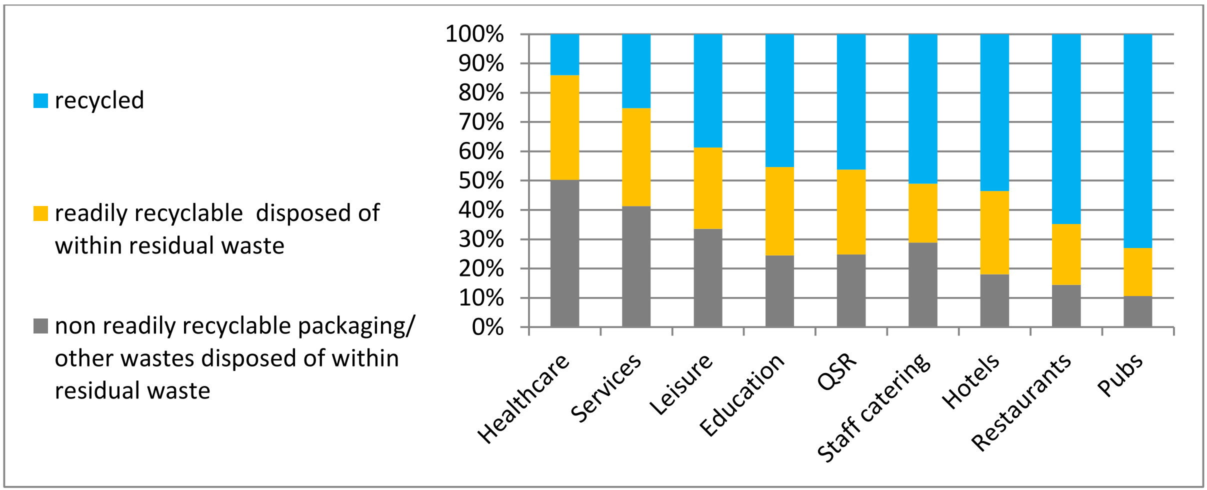


Figure 34: Management of packaging and other wastes by sub-sector (%) weight. (Source: WRAP, 2013d)

WRAP (2010a) conducted a review on LCAs on the environmental impact of recycling material. Following are the preferred options for how to manage waste by material type. WRAP (2010a):

- **Paper and cardboard**: landfilling should be avoided as it creates methane. In terms of climate change recycling and incineration perform similarly (if the energy created from incineration replaces energy based on fossil fuels). In terms of energy demand and water use recycling has lowest impact.
- **Plastics**: landfill is the worst option. Recycling is preferred to incineration since then the production of virgin material can be avoided (if the recycled plastic is of high quality the environmental impacts will be optimised). Incineration for energy recovery has a large impact on climate change. However, recyclability of plastic in food packaging is difficult due to the mixed levels of food waste contamination even in the separately collected fractions.
- **Biopolymers:** recycling of biopolymers for most indicators assessed provides more environmental benefits than other waste management options.
- **Food and garden waste**: In terms of climate change and depletion of natural resources, anaerobic digestion performed best. Second comes composting as it off-sets the need for fertilisers and peat. It was highlighted that this type of waste must be managed well as it (under some conditions) can create high levels of methane. Anyway, recycling food and garden waste comply EU Regulation (see above).

It takes 70 % less energy to produce paper from recycled material compared to using virgin material (RE3, 2015). It takes 95 % less energy to recycle aluminium compared to using virgin material (European Commission, 2015i).

4.4.4.3 Reuse

When reusing packaging the demand for raw material is mitigated, the energy needed to recycle is avoided as well as disposal to landfill (PRAG, 2009). In contrast the reusable packaging must be robust and hence need more material and energy to be produced and further environmental impacts will occur due to the need to clean the packaging between the uses (PRAG, 2009). Reuse is relevant both for primary and secondary packaging.

WRAP (2010b) conducted a study on single-use and reusable packaging and found that the preferred option is dependent on the situation. Reusable packaging is a preferred option when the distances of transport are not too long and when the number of trips the packaging is enough to outweigh the higher environmental impact associated with the initial stage of the life time. Figure 35 illustrates these differences between single-use and returnable packaging. In the case of single-use packaging the environmental impact is constant whereas for the returnable packaging the environmental impact decreases with the number of trips.

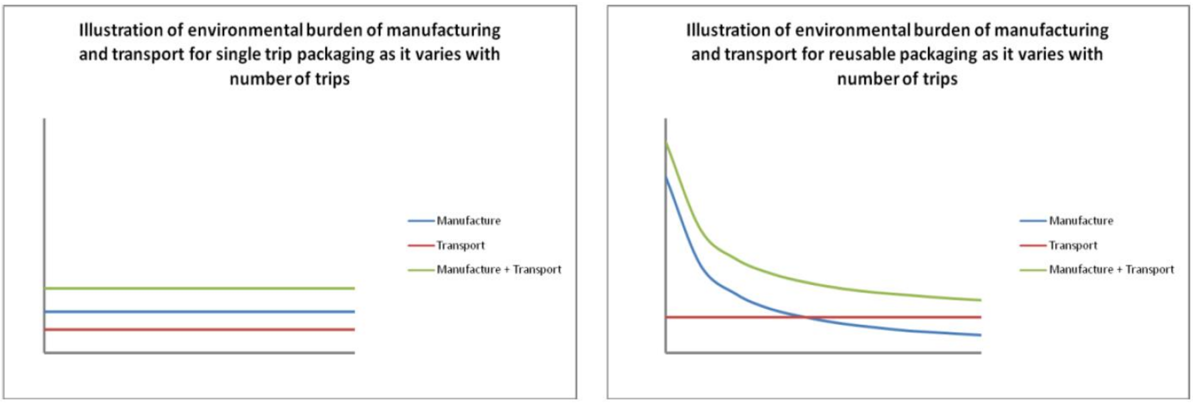


Figure 35: How environmental impact varies depending on number of trips (x-axis: number of trips, y-axis: size of impact (WRAP, 2010b).

An LCA study from Canada compared reusable and single-use coffee cups. It included a reusable stainless steel travel mug with a polypropylene handle (*hand washed after one use*), a reusable ceramic mug (*washed in a commercial dishwasher after one use*) and a disposable paper cup which was lined with polyethylene and with a lid of polystyrene (*disposed to landfill after use*) (CIRAIG, 2014). Five environmental impact categories were considered: human health, eco-system quality, climate change, resource depletion and water consumption. The ceramic cup was best in all impact categories and the travel mug in stainless steel was as good in the climate change and resource depletion category (when they were used at least 200-300 times). The travel mug would score almost as good as the ceramic mug if it was only rinsed in cold water between uses (CIRAIG, 2014). The disposable paper cup was significantly worse, also in terms of cost for the restaurant (CIRAIG, 2014). This highlights that in certain situations it is more environmentally beneficial to have reusable tableware rather than disposable.

4.4.4.4 Reuse and recycle targets for packaging

In 2011 the total packaging waste generated in the EU was 2.5 billion tonnes, of which only 40 % was recycled. The remainder was either landfilled (37%) or incinerated (23%) and a large part of that (500 million tonnes) could have been reused or recycled (European Commission, 2014p). In light of this the European Commission (2014p) has published a proposal on future targets for reuse and recycling of packaging in all Member States. These are hence appropriate to use as targets for the EU GPP criteria.

Table 103: The European Commission’s proposed reuse/recycling targets for all Member States.

Material	2020	2025	2030
Plastic	45%	60%	
Wood	50%	65%	80%
Ferrous metal	70%	80%	90%
Aluminium	70%	80%	90%
Glass	70%	80%	90%
Paper and cardboard	85%	90%	

4.4.4.5 Recycled content

Glass, aluminium and steel can theoretically be recycled indefinitely whilst plastic, cardboard and paper cannot (PRAG, 2009). Additionally, from a food safety perspective recycled cardboard or recycled plastic can only be used as primary packaging if it previously was part of a closed loop system (According to EU Legislation) (PRAG, 2009).

Glass, aluminium, steel and cardboard (for secondary packaging) usually contain of recycled material as a standard – at least in the UK (PRAG, 2009).

Masternak-Janus and Rybaczewska-Błażejowska (2015) conducted an LCA comparing the manufacturing stage of tissue paper made from recycled waste paper with tissue paper made from virgin pulp. The tissue from recycled material was found to have the lowest impact in all impact categories (human health, eco-systems and resource use).

ERM (2007) conducted a full life cycle LCA comparing different tissue products that were containing virgin pulp or recycled paper. It was found that both materials have pros and cons. The article concluded:

- When using recycled material it is better for the environment if the fibre/paper source is of high quality.
- When using virgin material it is better for the environment to source the material from sustainable sources (e.g. Forest Stewardship Council).

4.4.4.6 Recyclability

Most of the single stream food packaging types such as glass, aluminium, steel paper and plastic are readily recyclable, although not all Member States (or regions within Member States) have an infrastructure in place to actually recycle the material. Additionally, some packaging types such as composite packaging and some plastic streams (e.g. some types of polystyrene) are more problematic. The GPP is a tool to incentivise markets to develop sustainable practices and in this case to incentivise the development of more readily recyclable packaging to increase the opportunity for recycling (including organic recycling: composting).

4.4.5 Preparation of food

A major research and development focus in the foodservice sector has been on advanced forms of pre-preparation of meals and efficient preparation methods, aligned with the move to centralised production. A case in point is the Compass' Steamplicity system, in which vacuum packed food is heated using steam. In this system specialised patented packaging is used that is designed to function as a mini pressure cooker, and microwave technology is used to create the steam. Compass lists the key benefits of the system from an environmental perspective (Defra, 2013):

- Compared to conventional central production unit the energy savings are 40 %.
- The containers are 100 % recyclable and contain 50 % recycled PET.
- Food deliveries can be every other day and not every day, which reduces food miles by half.
- Patients can order food as late as at 10.30 am for lunch which provides better demand forecasting. The system only has 2-3 % waste which is 8 % lower than the norm in the UK National Health Service.

4.4.6 Minimise food waste

EU-27 generated 89 million tonnes of food waste in 2006 and the food service and hospitality sector accounted for circa 12.5 million tonnes of that (European Commission, 2010). An EU project called FUSIONS created a paper on the current state of food waste generation, future threats of an increase of food waste and reduction opportunities (Canali *et al.,* 2014). A summary of that paper is available in Table 104. Chapter 3 and chapter 4 of this report had similar findings as is shown in Table 104.

Table 104: Institutional drivers (business and economy) on the cause of food waste and related examples (Canali *et al.,* 2014).

<table>
<tr><th>Food supply chain segment</th><th>Identified food waste drivers (Institutional business)</th><th>Related examples of current causes of food waste</th></tr>
<tr><td rowspan="6">Food Services</td><td>Difficulty to estimate and calculate the right amount of food to cook</td><td>• Overproduction; overly extensive menus in canteens.</td></tr>
<tr><td>Inflexibility in portioning</td><td>• Too much on plate and assortment which is not adapted to consumer/patients.</td></tr>
<tr><td>Situational reasons "food being served but not eaten"</td><td>• Portions are too large or with undesired accompaniments. Time for lunch is short at schools: Food is left uneaten on the plate and thrown away because of stress and perceived lack of time to sit down and eat in the school canteen.
• Assortment does not match children's requests (e.g. more un-healthy food); the single largest source of loss is the food left over on the plates (plate scrap), constituting about 10% in all kitchens (in one study). Plate scrap in restaurants is mostly vegetables; since customers have already paid, restaurants are not interested in reducing waste here. In school canteens, pasta, potatoes, and rice make up most of the plate scrap for various reasons, such as food appearance or a desire to get out and play.</td></tr>
<tr><td>Operational reasons "food being prepared, but not served"</td><td>• There are rules that leftovers cannot be used for new meals. Production errors, packaging errors, or the like prohibit the meal being served. The packaging size is larger than the required quantity. Better matching portion sizes would help reduce the waste.</td></tr>
<tr><td>Consumer expectations prediction and demand forecasting</td><td>• Assortment too wide: Extended menus complicate inventory management and require more ingredients to be kept on hand.
• Menus are planned centrally and cannot be adapted to regional preferences; similar inflexibility concerns the composition of plates or size of portions. Menu options and alternatives are not sufficiently communicated.
• Incorrectly forecast orders result in products passing their expiration date. (Weather, seasonality, and the periods before and after holidays also have an impact). Better training and computer systems can minimize this.
• Difficulty to estimate and calculate the right amount of food to cook: varying estimates of customers, needed preparation times, unpredictable factors such as weather, etc.</td></tr>
<tr><td>Food deterioration</td><td>• Knowledge about expiration dates is limited, including what to do after opening a product. Providing information on the label can offer a solution for users.</td></tr>
</table>

4.5 Concluding remarks

In this section the findings (improvement potentials) are compared with the evidence gathered in Chapter 3 (technical and environmental analysis) in order to provide a strong evidence base for the revision and update of the current EU GPP criteria for Food and Catering Services. These concluding remarks are drawn for food procurement and catering services.

4.5.1 Food procurement

The results of the Environmental and Techniocal Analysis indicate similar findings to those of the BEMP for Tourism Sector. The food products themselves account for a larger environmental impact than their preparation (the activities within foodservice). Below is provided a summary of preliminary conclusions on some of the main aspects associated with food procurement.

4.5.1.1 Organic

The conclusions of the BEMP for Tourism were that organic products (all except red meat) have lower environmental impact than conventional products. It is also clear that most GPP case studies have assumed (in some cases based on the current EU GPP background report for Food and Catering Services from 2008) benefits of using organic food products which is why they have put so much effort into increasing the share of organic food.

The BEMP document highlights that there are both positives and negatives for organic products, but the overall conclusion is that organic overall brings most environmental benefits (European Commission, 2013c).

4.5.1.2 Integrated production

Integrated production was not mentioned in the BEMP documents, by INNOCAT or by any GPP case study. This suggests that this production method is still largely unknown/unapplied. In the technical analysis of Task 3 it was found that there are integrated production labels available but that they are mostly only national or regional, and the majority of existing labels are available in Spain, Italy and France (Areté, 2010b). There were not many LCAs available that compared integrated production with conventional and organic production, hence there is not enough evidence to assess its environmental performance. Tuomisto *et al.* (2012a) and Tuomisto *et al.* (2012b) argue that integrated production could be a way forward for sustainability in food production as it is a combination of organic and conventional production methods. It is also found that no EU-wide labelling system is yet in place for animal welfare but there are some national or individual schemes requiring higher animal welfare standards.

4.5.1.3 Fish and seafood

The BEMP for Tourism propose to use Marine and Aquaculture Stewardship Councils labels on the procurement of fish and seafood. The GPP case study from Sweden also states that fish should be bought using the MSC label. In the technical analysis of task 3 it was found that the MSC, ASC and KRAV all certify more responsible fishing and aquaculture.

4.5.1.4 Seasonal

The BEMP for the Tourism sector and INNOCAT both recommend the purchase of seasonal produce. The GPP case studies from Denmark, Italy, Spain and Sweden also promoted seasonal produce. This is supported by the findings of the environmental analysis of Task 3 since seasonal produce often needs fewer resources. However, it does not differentiate between imported and home grown products. In some cases it is better to import a product in season in another country, rather than boosting domestic production (extend season), as for instance through heated greenhouses or by keeping harvested crops (e.g. potatoes) in cold storages for months (Webb *et al.,* 2013). Seasonal produce is also likely to be cheap as there is high supply.

4.5.1.5 Locally produced

Many of the GPP case studies highlighted that food products should be locally sourced (where supporting arguments are based on the reduction in transport distances or to enhance freshness). Buying local is not something the EU GPP can propose due to discriminatory purposes related with trading within and outside the EU. However, it could be possible to state "avoid transport by air", since this has been identified as a major cause of emissions for imported fresh produce.

4.5.1.6 Less meat in menus

Many of the GPP studies that promoted the purchase of organic products also promoted the reduction in the amount of meat, to keep costs down and for environmental reasons. The BEMP for the Tourism sector and the INNOCAT report also promoted this.

In the environmental analysis of Task 3, meat was found to have a large environmental impact in total - especially red meat. In addition Baldwin *et al.* (2011) and Calderón *et al.* (2010) that conducted LCAs on foodservice, recommended decreasing the amount of meat in menus to lower the environmental impact.

4.5.1.7 Animal welfare

The INNOCAT report promoted buying food products with higher than average animal welfare standards (as a social criteria, not environmental). The GPP case study from the UK also mentioned animal welfare. In the environmental analysis of Task 3 it became clear that higher animal welfare standards do not seem to have a beneficial impact on the environmental impact categories. Longer lives and more space (reduced stocking density) require more resources (per unit of production), hence, from an LCA perspective that will increase the total burden of meat production. Therefore there is a trade-off between environmental and ethical aspects for livestock production. In contrast, one study on pigs found that free-range pigs had better meat quality and stress level indicators than pigs kept indoors on slatted floors (Foury *et al.,* 2011). Though, there is little evidence to confirm that better animal welfare always leads to better food quality.

4.5.2 Catering service

The two BEMP documents reviewed both present best practice when preparing food and include among others the aspects of energy use, water use and food waste reduction and management schemes (e.g. separate collection for reducing the amount landfilled). The case studies on GPP, on the other hand, have a strong focus on the procurement of ingredients and the production methods used. Below is provided a summary of preliminary conclusions on some of the main aspects associated with the catering service.

4.5.2.1 Kitchen equipment

The BEMP for the Tourism sector recommended implementing an energy management system, procuring more energy efficient equipment and implementing energy saving routines/standards. The BEMP for Food and Beverage Manufacturing proposed improvements for cold storage, as that is a stage when a large consumption of energy occurs. INNOCAT mentioned savings to be made for vending machines if investing in new, more energy-efficient ones. Defra (2013) also provided best available technology recommendations for equipment in commercial kitchens that can be used for the new EU GPP criteria development. The detailed analysis in Task 3 found that the use of electricity (and other fossil fuel derived energy) do impact many impact categories, not just global warming.

The BEMP for the Tourism sector also proposed implementing a water management systems in kitchens, using more water saving equipment and appliances and observing water saving routines/standards.

4.5.2.2 Waste management and staff training

Staff straining has been highlighted throughout the whole document as important for the reduction of environmental impacts in kitchens. Water and energy use can be mitigated through good practices in kitchens. In addition, the BEMP for Tourism document recommended uptake of practices to avoid the creation of food waste and to separate the organic waste from other waste to avoid sending it to landfill. The BEMP for Food and Beverage Manufacturing and INNOCAT both had similar recommendations. Sending food waste and other solid waste to landfill was in the environmental analysis found to cause freshwater and marine eco-toxicity. Advanced composting facilities and separate waste collection was presented as an alternative to reduce the amount of food wastes sent to landfill and help complying with European Regulations on reducing the amount of biodegradable wastes disposed of in this way (Calderón *et al.,* 2010). The detailed analysis of Task 3 and Task 4 proposed to reduce food waste through a number of measures.

4.5.2.3 Transport

The BEMP for Food and Beverage Manufacturing had recommendations on transport. It is made evident that the newer model of EURO vehicle, the lower environmental impact. But there were also recommendations on how vehicles are used. It is good practice to avoid empty loads and to use back-haul. Furthermore, the document found that biofuel derived from crops are not necessarily 'better' than other fuel types. Defra (2013) showed that when they were able to avoid daily deliveries of food and instead delivery every other day the impact of transport can be reduced by 50 %. In the environmental analysis of Task 3, transport was found to contribute to overall impacts although it did not contribute significantly to eutrophication, acidification, global warming and eco-toxicity, not compared with other activities.

4.5.2.4 Packaging

The BEMP for Food and Beverage Manufacturing provided in-depth information on different packaging types and its applicability in different situations, which can be used as a base for the revision of the EU GPP criteria set. As for the GPP case studies, Denmark, France, UK and Italy promoted the reduction in the use of packaging and the use of packaging that is recyclable, based on recycled materials or biodegradable.

As for coffee, Humbert *et al.* (2009) recommended not using glass packaging and using pouches instead. Furthermore, in the case of food service where cook-chill, cook-warm was compared it was found that single-portion packaging (that can be stored for longer) is better than bulk (that has to be eaten at once), since the latter creates more food waste (Fusi *et al.,* 2015).

Oil-based polymers used in food packaging are particularly difficult to recycle due to mix levels of food contamination. Compostable biopolymer packaging systems, have the advantage that they can be composted together with the food waste, thus reducing the amount of biodegradable wastes sent to landfill complying with European Regulations on reducing the amount of biodegradable wastes disposed (Calderon et al, 2010).

4.5.2.5 Cleaning agents

Both BEMP documents found that the use of cleaning detergents directly relate to the use of water. Automatic dosing systems may be used to decrease both. The BEMP documents also recommended to, where possible, use more environmentally friendly cleaning agents, by mentioning the use of EU Ecolabel products. This was also proposed by two GPP case studies from Italy and Spain. In the environmental analysis of Task 3 cleaning agents were often not included in scope or found to be of minor relevance. Calderón *et al.* (2010) found that cleaning products contributes with 14 % to terrestrial eco-toxicity, however, this was also of minor significance compared to fresh water and marine eco-toxicity that were to a great extent caused by solid waste management.

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APPENDIX A – The COICOP product classifications

Division	Group	Class	Explanatory notes
01 - Food and non-alcoholic beverages	01.1 - Food	01.1.1 - Bread and cereals	Rice in all forms;
			maize, wheat, barley, oats, rye and other cereals in the form of grain, flour or meal;
			Bread and other bakery products (crisp bread, rusks, toasted bread, biscuits, gingerbread, wafers, waffles, crumpets, muffins, croissants, cakes, tarts, pies, quiches, pizzas, etc.);
			mixes and doughs for the preparation of bakery products;
			pasta products in all forms; couscous;
			Cereal preparations (cornflakes, oat flakes, etc.) and other cereal products (malt, malt flour, malt extract, potato starch, tapioca, sago and other starches).
			Includes: farinaceous-based products prepared with meat, fish, seafood, cheese, vegetables or fruit.
			Excludes: meat pies (01.1.2); fish pies (01.1.3); sweetcorn (01.1.7).
		01.1.2 - Meat	Fresh, chilled or frozen meat of:
			bovine animals, swine, sheep and goat;
			horse, mule, donkey, camel and the like;
			poultry (chicken, duck, goose, turkey, guinea fowl);
			hare, rabbit and game (antelope, deer, boar, pheasant, grouse, pigeon, quail, etc.);
			fresh, chilled or frozen edible offal;
			dried, salted or smoked meat & edible offal (sausages, salami, bacon, ham, pâté, etc.);
			other preserved or processed meat and meat-based preparations (canned meat, meat extracts, meat juices, meat pies, etc.).
			Includes: meat and edible offal of marine mammals (seals, walruses, whales, etc.) and exotic animals (kangaroo, ostrich, alligator, etc.); animals and poultry purchased live for consumption as food.
			Excludes: land and sea snails (01.1.3); lard and other edible animal fats (01.1.5); soups, broths and stocks containing meat (01.1.9).
		01.1.3 - Fish and seafood	Fresh, chilled or frozen fish;
			fresh, chilled or frozen seafood (crustaceans, molluscs and other shellfish, sea snails);
			dried, smoked or salted fish and seafood;
			other preserved or processed fish and seafood and fish and seafood-based preparations (canned fish and seafood, caviar and other hard roes, fish pies, etc.).
			Includes: land crabs, land snails and frogs; fish and seafood purchased live for consumption as food.
			Excludes: soups, broths and stocks containing fish and seafood (01.1.9).
		01.1.4 - Milk, cheese and eggs	Raw milk; pasteurized or sterilized milk;
			condensed, evaporated or powdered milk;
			yoghurt, cream, milk-based desserts, milk-based beverages and other similar milk-based products;
			cheese and curd;
			eggs and egg products made wholly from eggs.
			Includes: milk, cream and yoghurt containing sugar, cocoa, fruit or flavourings; dairy products not based on milk such as soya milk.
			Excludes: butter and butter products (01.1.5).
		01.1.5 - Oils and fats	Butter and butter products (butter oil, ghee, etc.);
			margarine (including "diet" margarine) and other vegetable fats (including peanut butter);
			edible oils (olive oil, corn oil, sunflower-seed oil, cottonseed oil, soybean oil, groundnut oil, walnut oil, etc.);
			edible animal fats (lard, etc.).
			Excludes: cod or halibut liver oil (06.1.1).
		01.1.6 -	Fresh, chilled or frozen fruit;

		Fruit	dried fruit, fruit peel, fruit kernels, nuts and edible seeds;
			Preserved fruit and fruit-based products.
			Includes: melons and water melons.
			Excludes: vegetables cultivated for their fruit such as aubergines, cucumbers and tomatoes (01.1.7); jams, marmalades, compotes, jellies, fruit purées and pastes (01.1.8); parts of plants preserved in sugar (01.1.8); fruit juices and syrups (01.2.2).
		01.1.7 - Vegetables	Fresh, chilled, frozen or dried vegetables cultivated for their leaves or stalks (asparagus, broccoli, cauliflower, endives, fennel, spinach, etc.), for their fruit (aubergines, cucumbers, courgettes, green peppers, pumpkins, tomatoes, etc.), and for their roots (beetroots, carrots, onions, parsnips, radishes, turnips, etc.);
			Fresh or chilled potatoes and other tuber vegetables (manioc, arrowroot, cassava, sweet potatoes, etc.);
			preserved or processed vegetables and vegetable-based products;
			Products of tuber vegetables (flours, meals, flakes, purées, chips and crisps) including frozen preparations such as chipped potatoes.
			Includes: olives; garlic; pulses; sweetcorn; sea fennel and other edible seaweed; mushrooms and other edible fungi.
			Excludes: potato starch, tapioca, sago and other starches (01.1.1); soups, broths and stocks containing vegetables (01.1.9); culinary herbs (parsley, rosemary, thyme, etc.) and spices (pepper, pimento, ginger, etc.) (01.1.9); vegetable juices (01.2.2).
		01.1.8 - Sugar, jam, honey, chocolate and confectionery	Cane or beet sugar, unrefined or refined, powdered, crystallized or in lumps;
			jams, marmalades, compotes, jellies, fruit purées and pastes, natural and artificial honey, maple syrup, molasses and parts of plants preserved in sugar;
			chocolate in bars or slabs, chewing gum, sweets, toffees, pastilles and other confectionery products;
			cocoa-based foods and cocoa-based dessert preparations;
			Edible ice, ice cream and sorbet.
			Includes: artificial sugar substitutes.
			Excludes: cocoa and chocolate-based powder (01.2.1).
		01.1.9 - Food products n.e.c.	Salt, spices (pepper, pimento, ginger, etc.), culinary herbs (parsley, rosemary, thyme, etc.), sauces, condiments, seasonings (mustard, mayonnaise, ketchup, soy sauce, etc.), vinegar;
			prepared baking powders, baker's yeast, dessert preparations, soups, broths, stocks, culinary ingredients, etc.;
			Homogenized baby food and dietary preparations irrespective of the composition.
			Excludes: milk-based desserts (01.1.4); soya milk (01.1.4); artificial sugar substitutes (01.1.8); cocoa-based dessert preparations (01.1.8).
	01.2 - Non-alcoholic beverages	01.2.1 - Coffee, tea and cocoa	Coffee, whether or not decaffeinated, roasted or ground, including instant coffee;
			tea, maté and other plant products for infusions;
			Cocoa, whether or not sweetened, and chocolate-based powder.
			Includes: cocoa-based beverage preparations; coffee and tea substitutes; extracts and essences of coffee and tea.
			Excludes: chocolate in bars or slabs (01.1.8); cocoa-based food and cocoa-based dessert preparations (01.1.8).
		01.2.2 - Mineral waters, soft drinks, fruit and vegetable juices	

APPENDIX B – info from available GPP initiatives

Table 105: Sectors and food products covered in the reviewed GPP initiatives for Food and Catering services

ID	Sector(s)									Food products covered																					
	All/Multiple (unspecified)	Schools	Prisons	Higher Education	Government offices	Business canteens	Sports arenas/Leisure	Defence	Health & Social Care	All/Multiple (unspecified)	Fruit & Veg (loose)	Fruit & Veg (packaged, tinned, etc)	Dried/bottled goods	Cereals/grains (raw)	Nuts	Breakfast cereals	Aquaculture	Wild caught seafood	Meat	Dairy	Bakery	Pasta, rice, potatoes	Eggs	Soya	Ready-meals	Sandwiches	Soups & sauces	Chocolate	Oils/spreads	Juices/soft drinks	Tea/coffee
	9	20	5	4	4	3	3	4	11	13	14	3	2	4	2	2	2	11	15	13	8	5	9	1	3	2	3	2	4	3	3
1		1								1																					
2		1								1																					
3	1									1	1			1				1	1	1			1								
4			1							1									1	1	1		1								
5		1								1											1										
6									1										1												
7	1	1	1		1			1	1	1	1					1		1	1	1	1		1		1	1	1		1		1
8		1							1	1	1								1	1	1										
9		1								1	1	1		1				1	1		1	1	1					1	1		
10		1									1		1						1	1			1								
11		1				1	1		1	1																					
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22				1							1							1	1	1							1				
23				1																											
24	1	1	1	1	1		1		1		1	1		1	1				1	1										1	
25	1	1				1			1													1									
26											1						1	1	1	1			1								1
27	1	1							1																						
28	1	1																													
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30								1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
31	1	1	1	1	1	1	1	1	1	1								1	1	1			1								

Table 102 (cont.): Sectors and food products covered in the reviewed GPP initiatives for Food and Catering services

	Catering services																													
ID	Organic production	Integrated Production	Seasonal products	Aquaculture/marine products	High livestock welfare	Sustainable palm oil	GMOs - free	Authenticity & traceability	Freshly prepared food	Reducing meat consumption	No packaging of meals	Recycled content of 2nd/3rd packaging	Renewable raw materials in packaging	Avoid single-unit/portion packaging	Env-friendly paper products	Catering equipment: Energy efficient	Catering equipment: Water efficient	Cleaning products	Re-usable cutlery, crockery, etc	Selective waste collection	Reduced per-vehicle emissions	Staff training in env. aspects	Recyclable/biodegradable	Waste management plan	Food waste prevention/minimisation	Food waste: surpluses redistributed	Food waste collection & landfill diversion	Energy management/efficiency	Transport - reduce frequency of deliveries	Ethical trading: Supporting 'Fair trade'
	16	2	15	7	7	1	8	6	10	10	1	1	0	0	1	2	1	2	5	1	4	6	1	1	4	2	3	3	3	11
1																														
2																														
3			1	1	1		1			1		1									1				1					1
4																														
5																														
6	1																													
7	1	1	1	1	1	1		1							1	1	1		1			1			1	1	1	1		1
8	1		1	1	1					1											1								1	1
9	1		1				1	1	1	1								1	1			1	1			1	1	1		1
10	1		1	1	1		1		1	1												1								
11			1					1	1	1											1				1					
12	1			1	1		1		1	1	1																			1
13	1		1					1	1												1	1							1	1
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15	1		1							1									1											
16	1								1									1		1		1		1						
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29			1	1	1																	1								
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31	1		1	1												1			1								1	1		1

APPENDIX C – Food production

All data is sourced from Eurostat PRODCOM

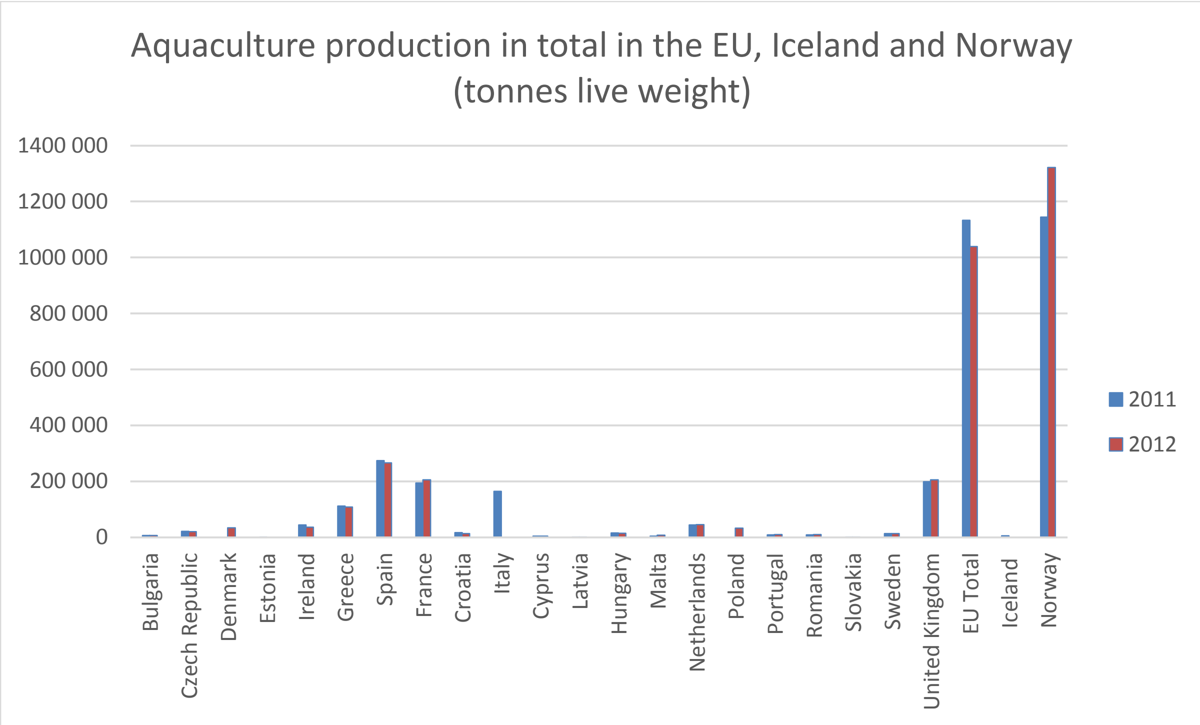

Figure C.1: Aquaculture production of total fishery products

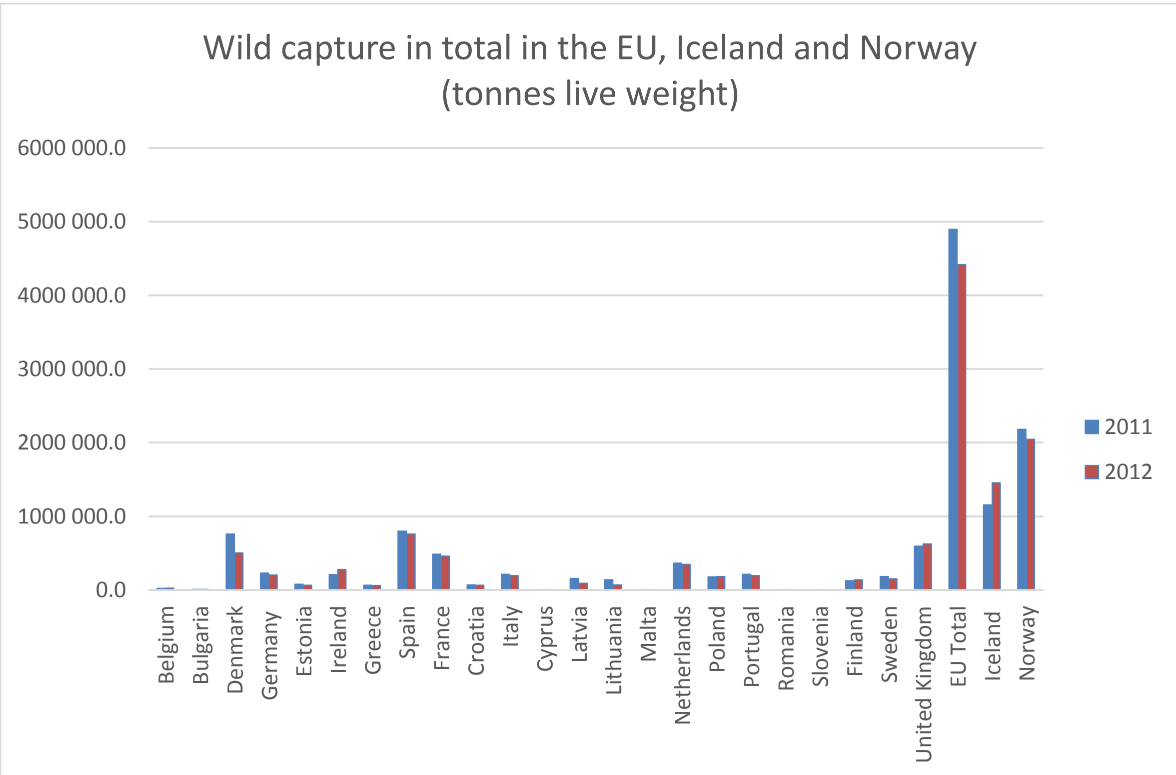

Figure C.2: Wild capture of total fishery products

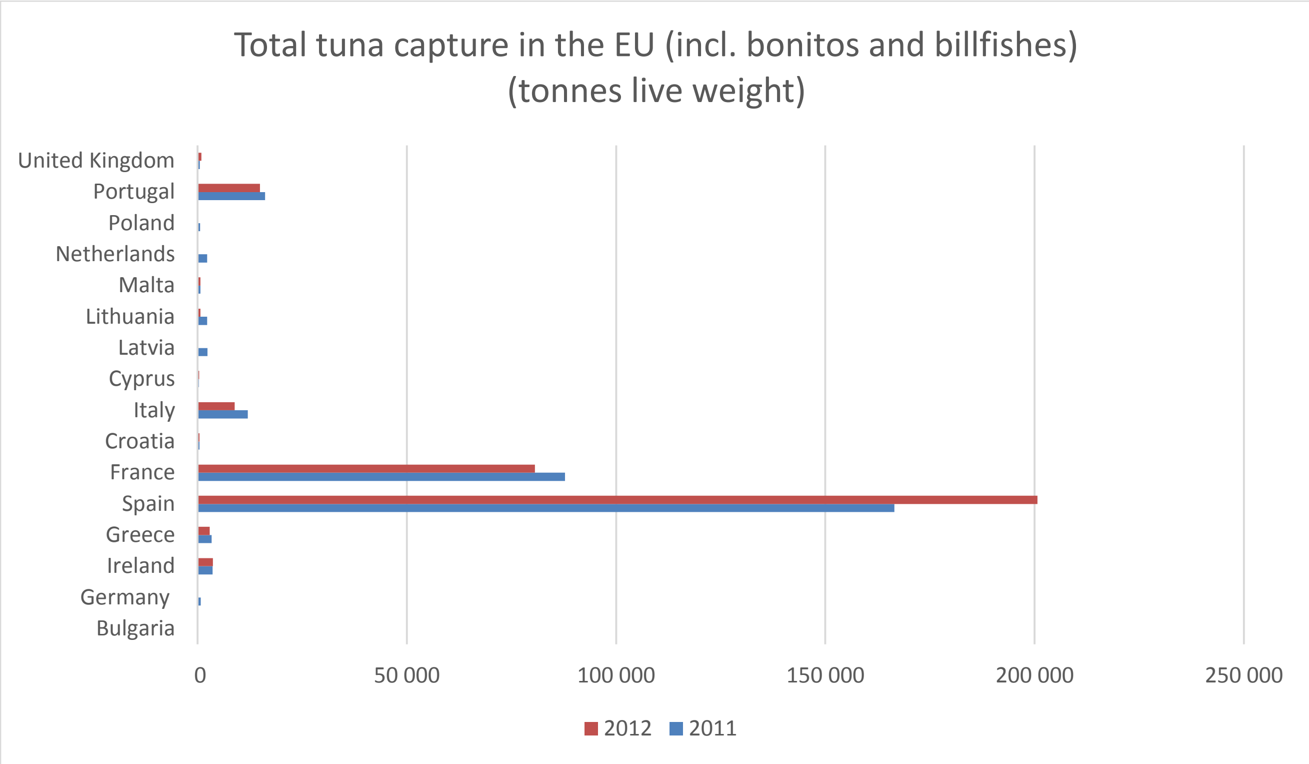

Figure C.3: Total tuna capture

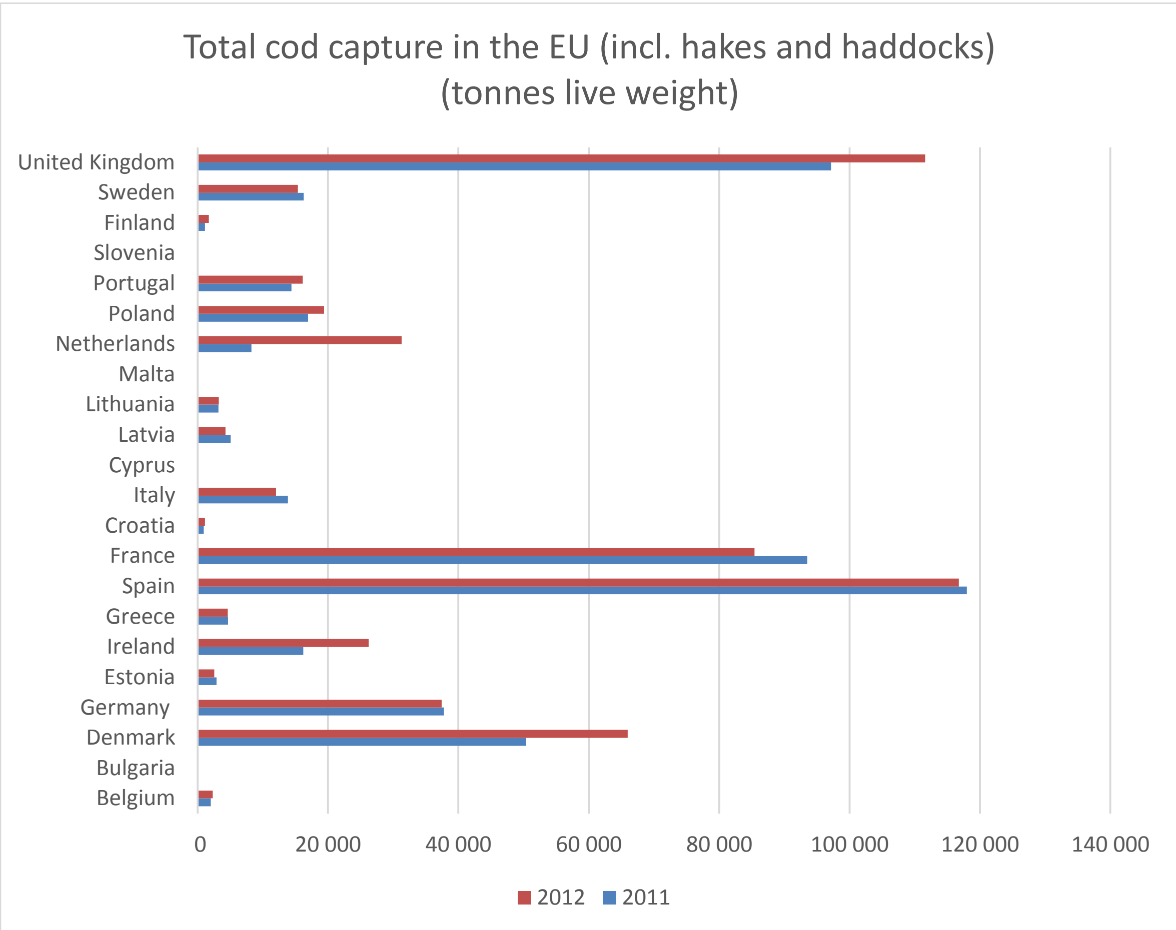

Figure C.4: Total cod capture

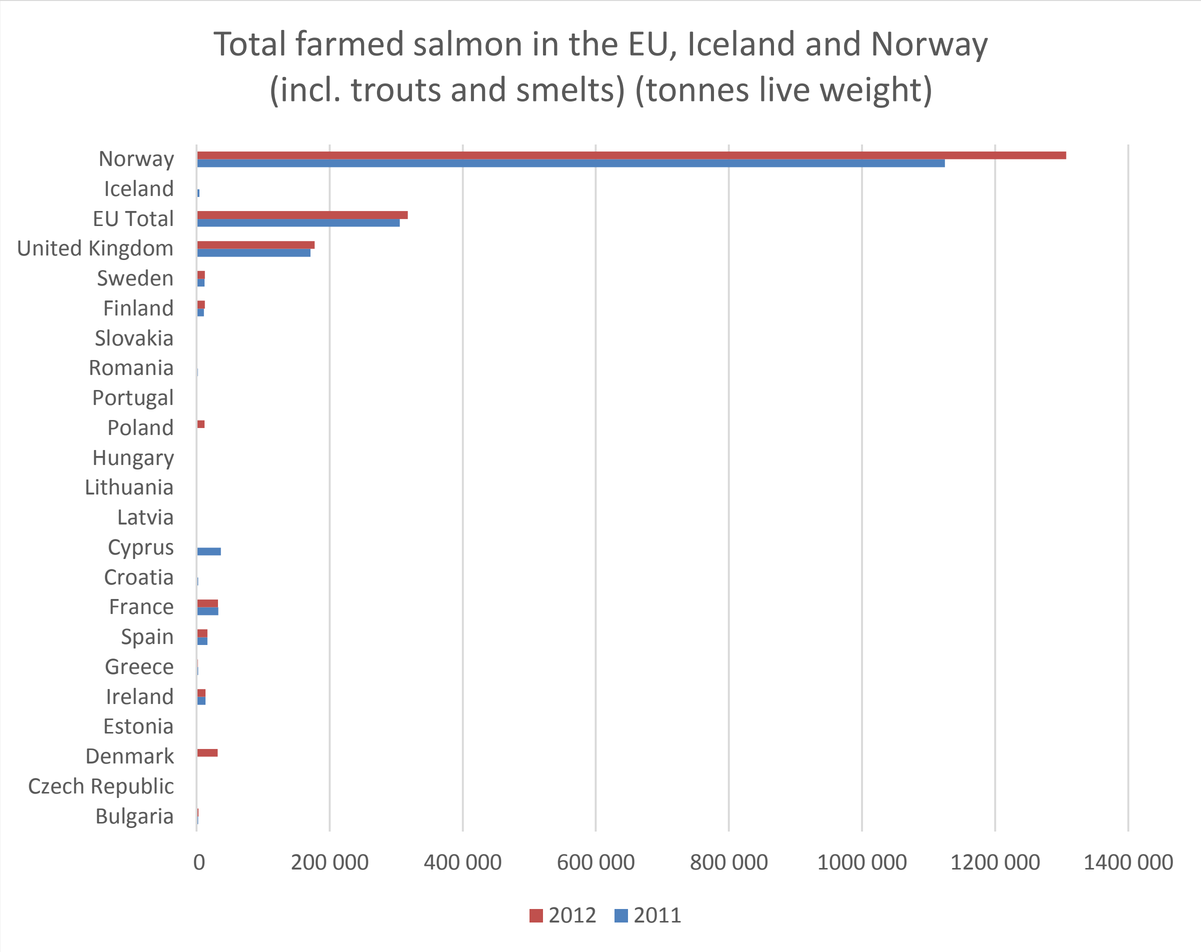

Figure C.5: Total farmed salmon

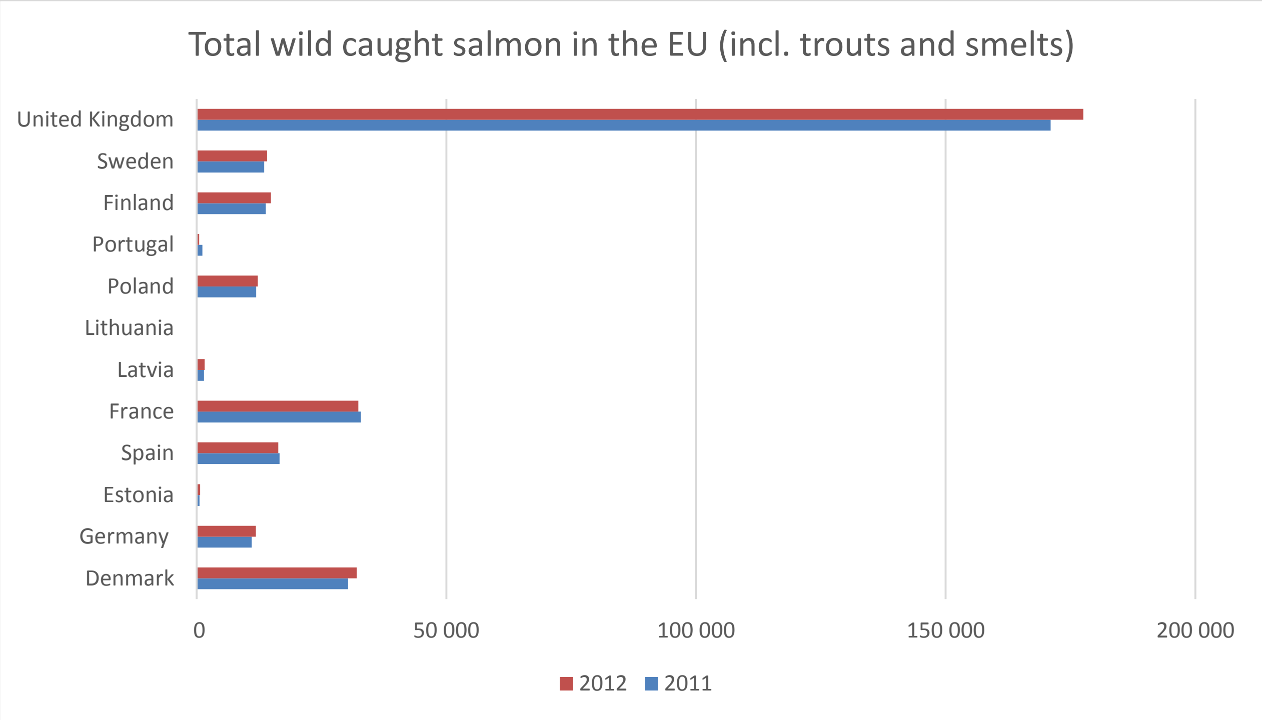

Figure C.6: Total wild caught salmon

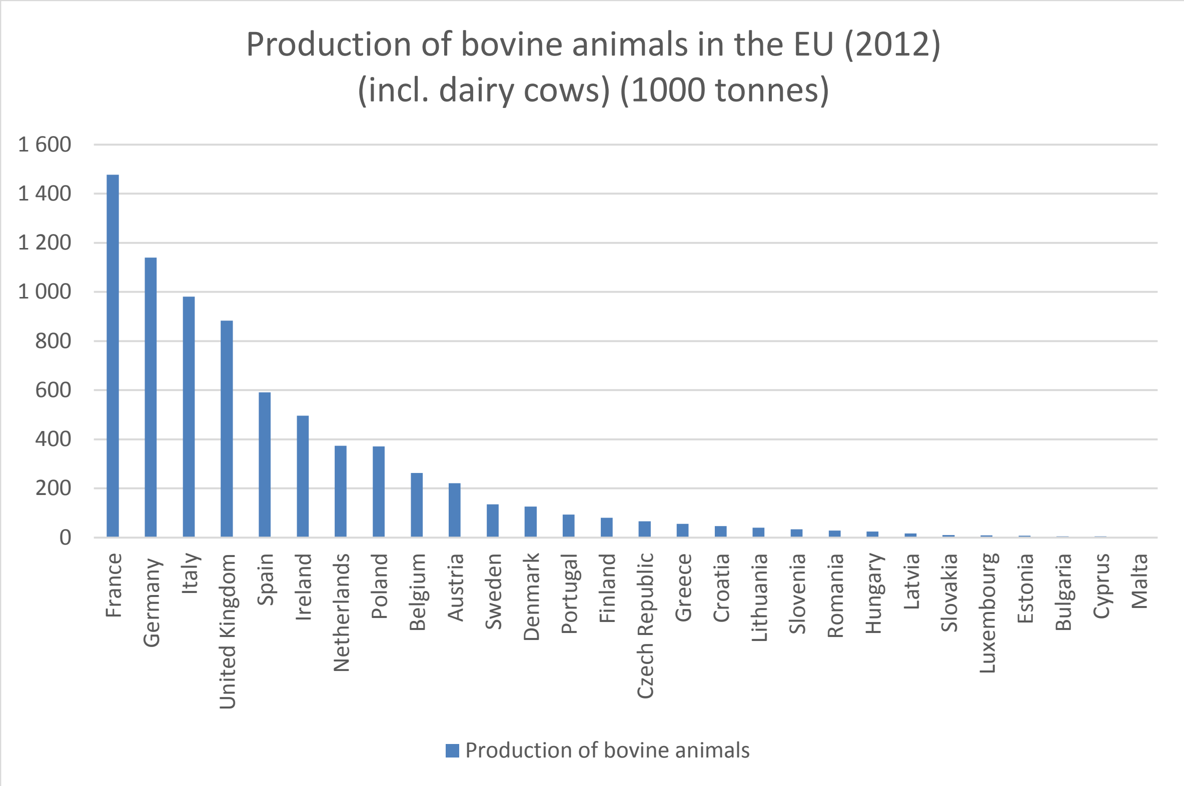

Figure C.7: Production of bovine animals

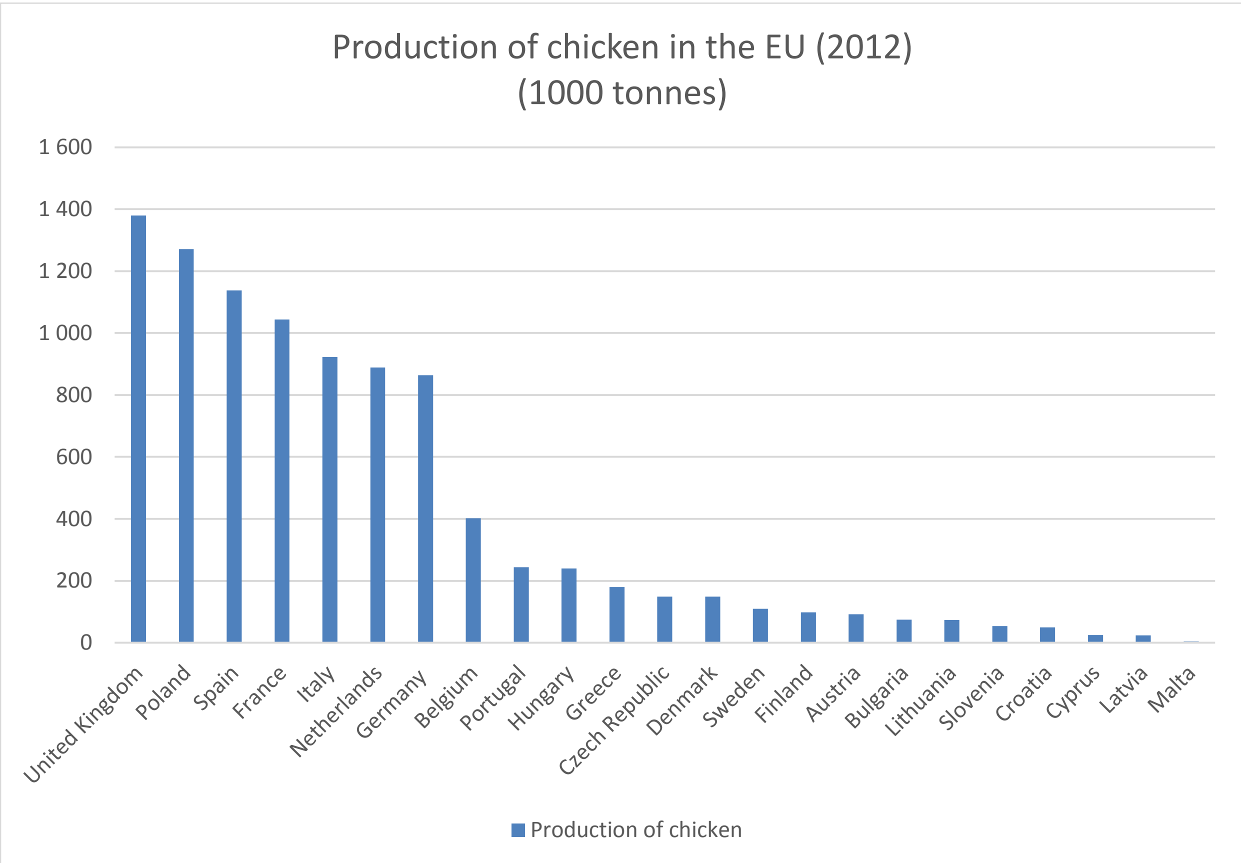

Figure C.8: Production of chicken

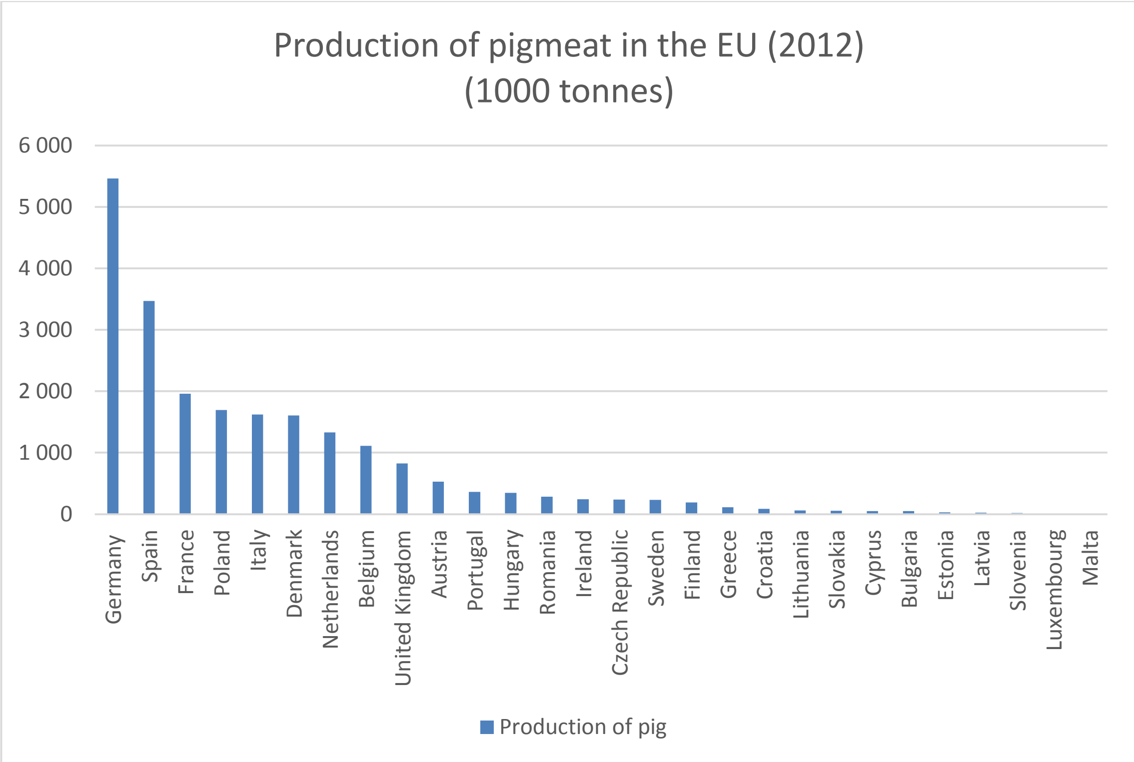

Figure C.9: Production of pig meat

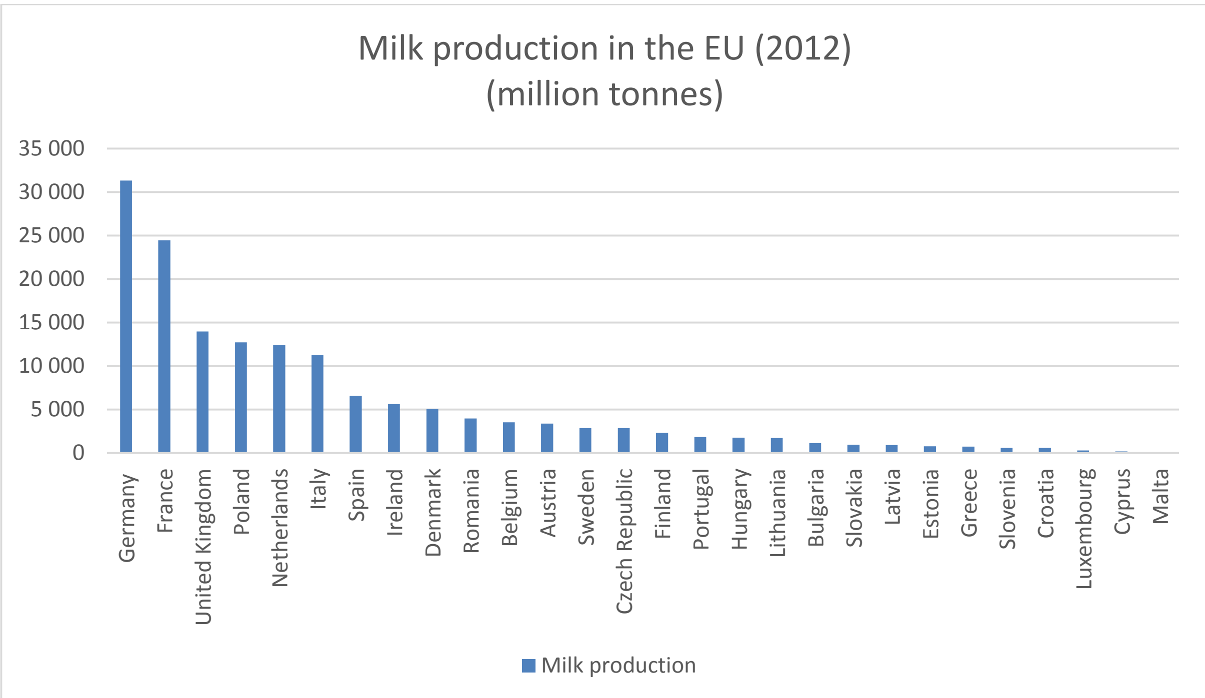

Figure C.10: Milk production

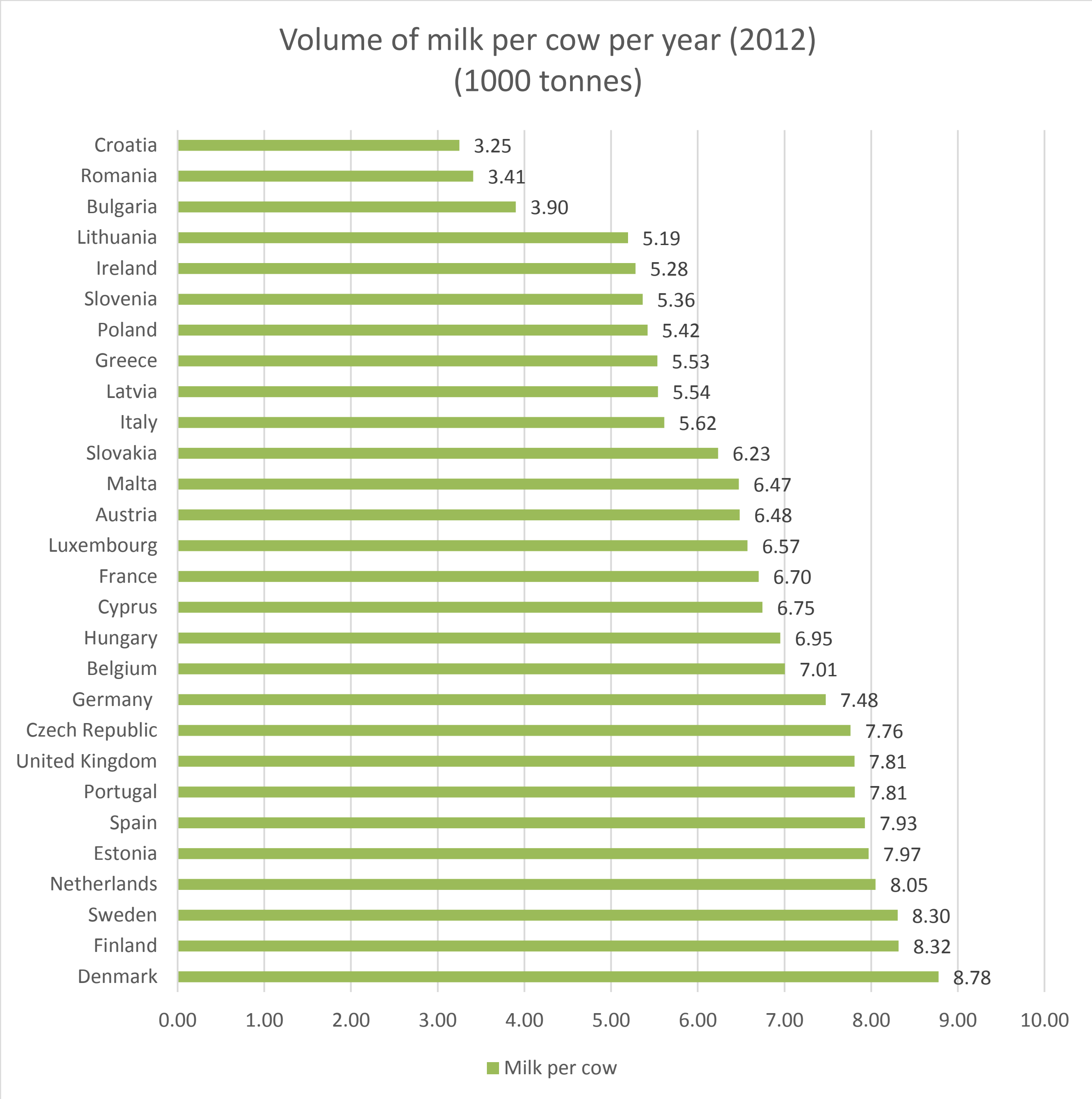

Figure C.11: Weight of milk per cow

APPENDIX D - Market elements for sector companies

Compass Group operates worldwide in 50 countries and works in the following sectors: B&I (*canteens in workplaces*); healthcare and seniors (*hospitals, residential homes*); education (*kindergarten to college*); sports and leisure (*world sports events, exhibition centres, major events, visitor attractions*); defence, offshore and remote (*defence, mining, construction, oil and gas industries*)(Compass Group, 2014). Compass' revenue in Europe and Japan combined was £5.7 billion (c. €7.1 billion[116]) in 2014, which accounted for 34 % of the whole group's revenue. This revenue is broken down by sector in Figure D.1. and it is clear that B&I is the major customer. The operating profit in 2014 was £409 million (c. €507[117] million). The revenue is 5 % lower than that in 2013, and the profit is almost 3 % lower.

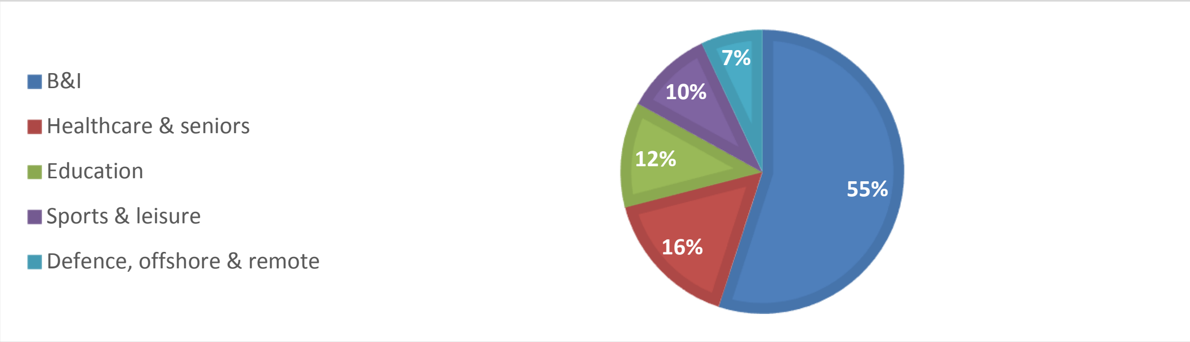

Figure D.1 Compass Group revenue by sector in % for Europe & Japan (Source: Adapted from Compass Group, 2014).

Sodexo group is operating in 80 countries and are working in the following sectors: education, health care, seniors, corporate, defence, sports and leisure, justice services and remote sites (Sodexo, 2014). Figure D.2. below shows the activity per sector, in percent. Corporate, education and health care are the largest sectors. Sodexo serves 75 million customers daily, had revenue in 2014 of €18 billion and employed 419 000 people (Sodexo, 2014). Europe stands for 34 % of the total revenue.

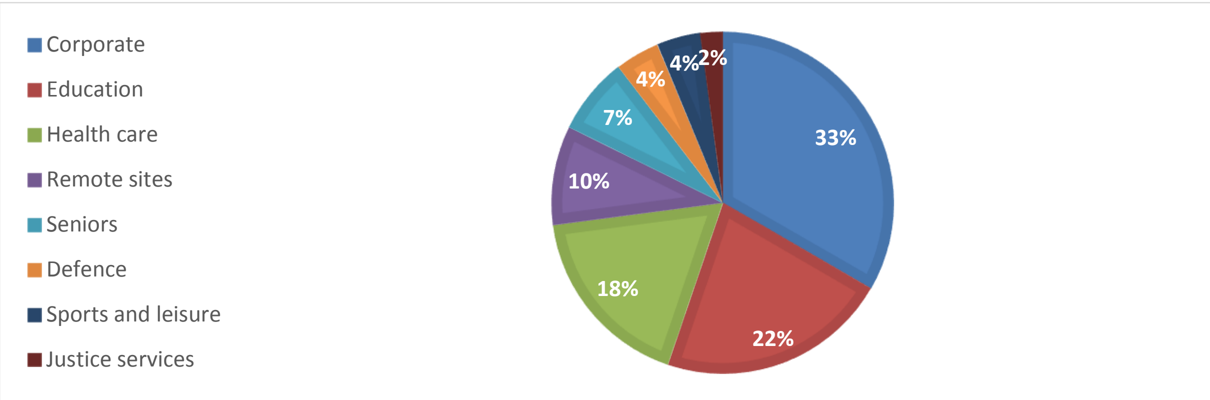

Figure D.2. Sodexo group on-site services by activity (Sodexo, 2014).

Elior operates in 13 countries and in following sectors: B&I, education, health care, motorways, airports, and city sites & leisure (Elior, 2014). Elior has a total revenue of €5.341 billion out of which B&I, education and health care stand for 70.7 % of the total. Elior serves 3.8 million customers yearly (Elior, 2014).

[116] Calculated from GBP to Euro by the average exchange rate of year 2014, available in Table a, Appendix D.
[117] Calculated from GBP to Euro by the average exchange rate of year 2014, available in Table a, Appendix D.

Table D.1: Exchange rates (UKForex, 2015)

Average annual exchange rates GBP to Euro (£1 = xx€)	
2005	1.461216
2006	1.466612
2007	1.461786
2008	1.259467
2009	1.12246
2010	1.165737
2011	1.15258
2012	1.233263
2013	1.177964
2014	1.240494

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Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new standards, methods and tools, and sharing and transferring its know-how to the Member States and international community.

Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security including nuclear; all supported through a cross-cutting and multi-disciplinary approach.

Publications Office