METRICS, MODELS AND FORESIGHT FOR EUROPEAN SUSTAINABLE FOOD AND NUTRITION SECURITY

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D1.1 A Framework for Assessing and Devising Policy for Sustainable Food and Nutrition Security in EU: The SUSFANS conceptual framework

Public Report

WP1 Conceptual framework and FNS sustainability metrics

Lead UOXF (no. 06)

Abstract: This deliverable reports on Task D1.1., the development of a conceptual framework for the SUSFANS project. Drawing on a literature review and feedback from the SUSFANS stakeholder core group, the conceptual framework describes the actors of the EU food system, their activities, the food system outcomes and the factors directly and indirectly driving actor behaviour. The framework also shows the relationships between the food system and the key policy goals the EU has formulated for the system. The report highlights the benefits of adopting a food systems approach to analysing EU sustainable food and nutrition security and ends with describing the use of the conceptual framework within the project and externally.

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A Conceptual Framework for Assessing and Devising Policy

for Sustainable Food and Nutrition Security in the EU: the SUSFANS conceptual framework

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1 Introduction

The European food system is a complex entity. Governed by a wide array of EU and member state policies, concerned with issues ranging from food production practices, health outcomes, environmental impacts and business considerations, the way how it is decided in the EU to produce, process, trade and consume food has implications for producers and consumers in the EU and around the globe. Assessing in which direction the EU food system moves and how to make sense of the different trends that we see emerging across the whole system, from food prices, rising obesity trends, GHG emissions, etc. and to evaluate possible future directions for the food system is therefore not an easy undertaking. Nevertheless there is a need for aiming at a coherent and cohesive analysis across the key goals that the different actors in and outside the system have formulated for the food system, especially as these goals are intertwined and have considerable implications. New policies to shape the direction of the EU food system need to be informed by an understanding of available choices and the potential trade-offs they imply for all participants in the system, i.e. farmers and fishermen, the food industry and consumers. The SUSFANS project aims to create a tool box that enables policy and decision makers to better assess the status of the EU food system and possible options for change across old and newly emerging goals.

Since its creation over the second half of the 20th century the EU food system has been able to deliver on its promise of affordable and sufficient food for its member state populations. Driven by a set of policies for increasing the productivity of agricultural and fisheries systems, securing a decent income for producers and ensuring sufficient food for consumers across Europe the system delivers a wide variety of outcomes. Many of outcomes are beneficial but by all means not all of them, especially when considering the environmental impacts of the current food system or the rising trends in obesity, diabetes and other non-communicable diseases related to food consumption.

This paper presents the conceptual framework developed by the SUSFANS project to describe the lay out and basic relationships of the EU food system and to serve as a guide for selecting the metrics to assess food system outcomes with respect to the goal of achieving sustainable food and nutrition security for EU citizens (project deliverable D1.2 and D1.3 will describe the metrics for assessing the food system). Section 2 briefly reviews the origins of the Sustainable Food and Nutrition Security concept and then describes the purpose and the foundations of the SUSFANS conceptual framework. It ends with an overview of the framework itself. Section 3 provides a detailed description of the various components of the EU food system as described in the conceptual framework and thus gives a detailed portray of the actors and the driving forces currently shaping the system. Section 4 describes the uses of the conceptual framework to guide analysis within the SUSFANS project as well as for external purposes.

2 A framework to assess sustainable food and nutrition security: The SUSFANS conceptual framework

This section provides a brief review of the origins of the Sustainable Food and Nutrition concept and also describes the purpose and the foundation of the SUSFANS conceptual framework. It ends with a short overview of the framework itself. Section 2.1 outlines the evolution of the food security, nutrition security and the Sustainable Food and Nutrition security concepts. Section 2.2 describes the purpose of the SUSFANS conceptual framework and its characteristics, while Section 2.3 reviews

existing approaches to describing food systems that contributed to the SUSFANS framework. Section 2.4 gives an overview over the conceptual framework and its components.

2.1 Definition of Sustainable Food and Nutrition Security

Over the years various terms and terminologies have been used to capture the complexities of describing the (desired) outcomes of a working food system. These terms have come from different scientific communities, such as the agricultural, the development or the nutrition communities, and reflect the main discourses prevalent at the time.

Arising from the times around the World War II the terms 'food security' and 'nutrition security' were first used in a conference in Hot Springs, USA, in 1943 to describe a status of 'secure, adequate and suitable supply of food for every man, woman and child' (CFS 2012). Due to looming famines in post-war Europe and other parts of the world food security was in the following years mainly interpreted as fighting hunger and supplying a minimum level of dietary energy, leading to a focus on producing a sufficient amount of grain versus other crops (CFS 2012, Pangaribowo et al. 2013). This was also reflected in the definition of food security that was adopted by the World Food Summit in Rome in 1974 which defined the term as "*Availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices*", focusing on 'availability'. Particularly in response to earlier grain market crisis and rising food prices in many countries, the then created Committee of World Food Security (CFS) was tasked with stimulating global grain production and stabilizing grain markets. The so-called Administrative Committee on Coordination Sub-committee on Nutrition (ACC SCN), founded also in 1974, was asked to focus on ensuring access everywhere to a well-balanced diet that would allow a healthy and active life (CFS 2012).

Amartya Sen's work in the 1980s added another component to the food security discussion, namely the demand side and the notion that having an adequate supply of food in a country does not directly lead to everyone in the country having physical and economic access to it. Again against a background of global food crisis the 'access dimension' was added to the food security definition in 1983, now encompassing three interrelated goals: adequacy of food supplies, stability in food supplies and markets, and security of access to supplies (FAO 2003, CFS 2012).

In the 1970s, 1980s and well into the 1990s the nutrition community focused on the problem of malnutrition (i.e. eating a diet with either not enough or too many nutrients resulting in health problems) and its causes. The community argued that in addition to food availability also poverty and deprivation are determinants of malnutrition. Nutrition planning was seen as central to overall development planning (CFS 2012). A framework developed by UNICEF in 1990 further proposed that both food and non-food related factors (such as care, sanitation and health) were underlying child nutrition. The nutrition community has since then kept on focusing on enlarging the concept of Nutrition Security and currently various stakeholders have come together to better mainstream nutrition considerations into planning, which lead to the SUN (Scaling Up Nutrition) Movement in 2010.

The most recent officially accepted definition of Food and Nutrition Security was proposed in 1996 and modified in 2002 (FAO 2002). It is included in the 2009 Declaration of the World Summit on Food Security is: "*Food security [is] a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*". In this definition, availability is not mentioned anymore and the key words are 'people', 'access' and 'sufficient'. When originally coined about 20

years ago, the word 'sufficient' referred to those with insufficient food. Nowadays it equally applies to those with too much.

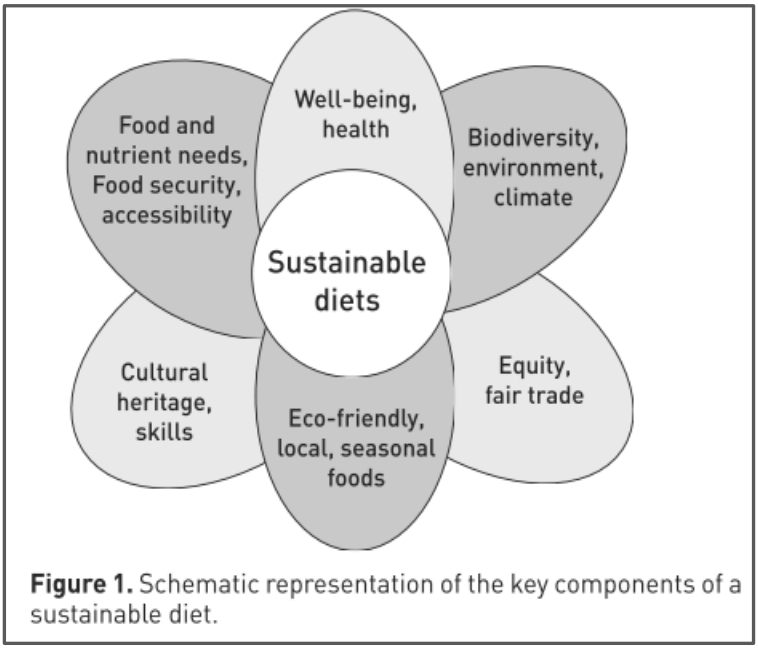
The concept has since then expanded to also include environmental sustainability aspects. At the 2010 International Scientific Symposium "Biodiversity and Sustainable Diets: United Against Hunger" organized jointly by FAO and Bioversity International, a definition of healthy and sustainable diets was agreed (FAO 2010). Sustainable Diets were defined as:

"those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources."

Such a concept aligns diets and health with a food chain and environmental protection perspective (Figure 1).

Balanced diets are also an integrated part of recent strategies in relation to the Sustainable Development Goals (SDGs), underlining that a balanced diet should also include other dimensions like among others, environmental and economic sustainability and ethical aspects (Assembly & Goals 2015). Further, sustainable balanced diets should also include the needs for both the economically disadvantaged and the future generations.

Figure 1: Schematic representation of the key components of a sustainable diet.

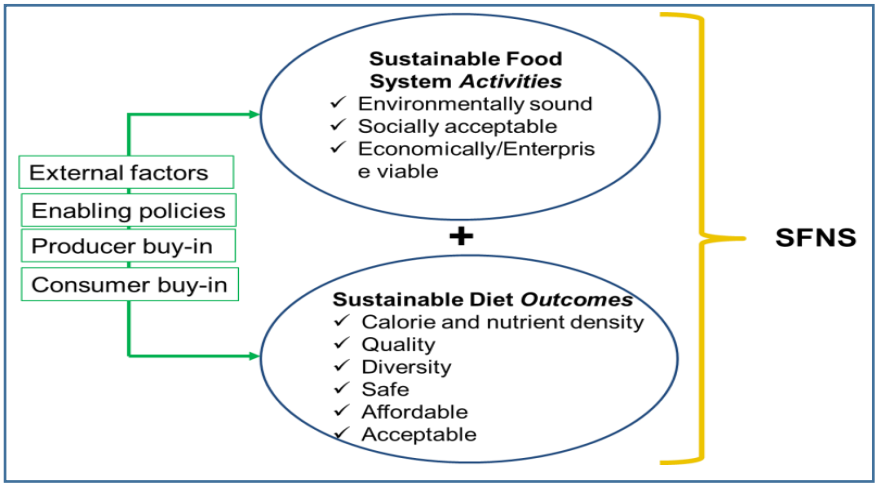


From Lairon D 2012 in Burlingame B (2012).

In a Foresight study, the EC Joint Research Centre (JRC) concluded that the provision and consumption of healthy diets involves the whole food chain and the consumer and that this is interlinked with any other areas such as economy, environment, healthcare, individual lifestyles, etc. Making progress towards healthy diets for all is a very complex challenge which should include the shaping of the 2050 food system (Maggio et al. 2014).

The SUSFANS project builds on these definitions of food and nutrition security but also expands them to address four broad policy goals that EU and member state policy makers have postulated for the EU food system. These policy goals are that the food system should 1) deliver a balanced, healthy diet to consumers, 2) reduce its negative environmental impacts, 3) be built on viable, competitive and socially balanced agri-businesses, and 4) contribute to global food security (a detailed description of the policy goals can be found in Section 3.1). The project has thus coined the term 'Sustainable Food and Nutrition Security' to describe the outcome that the food system should deliver. Sustainable Food and Nutrition Security is seen as a combination of two issues: sustainable food systems which encompass a set of activities, and sustainable diets, which should be the outcome of these activities (Figure 2). Sustainable food systems are attributes of the food system activities and do (or do not) deliver a sustainable diet.

Figure 2: Elements of Sustainable Food and Nutrition Security as conceptualized by the SUSFANS project



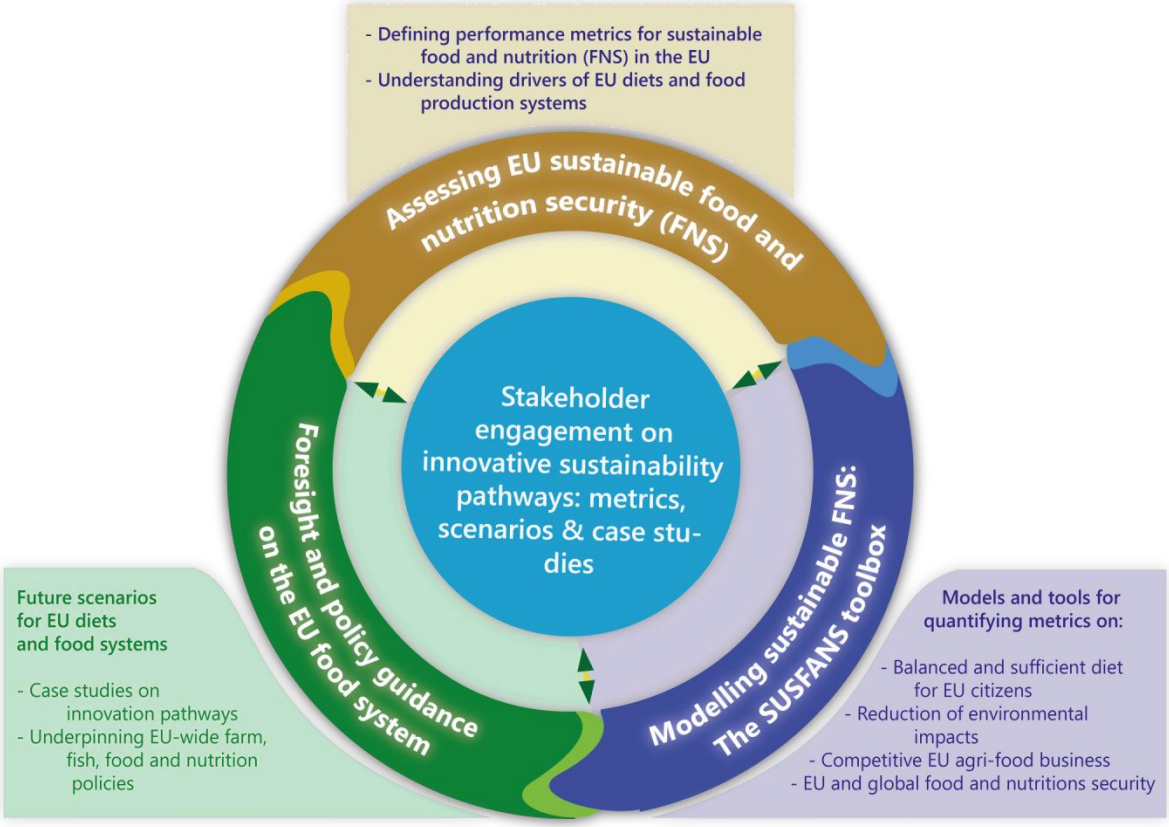
2.2 Purpose of the conceptual framework for assessing Sustainable Food and Nutrition Security

As the EU food system is quite complex and consists of various elements, a prerequisite for a proper analysis and the assessment of its status is a conceptual framework that ensures that all the important elements of the system are addressed. The conceptual framework developed for SUSFANS was created with the input of all the scientific partners of the SUSFANS consortium and discussed in detail with the SUSFANS Stakeholder Core Group, which consists of 30 selected experts and decision makers representing a wide range of stakeholder communities and hence 'worldviews' (e.g. primary producers, food industry, retail, consumer groups, investors, regulators, policymakers and academics; details can be found on the SUSFANS website).

The SUSFANS conceptual framework aims to serve multiple purposes. The most important is to visualize and document the project's understanding of the different components and actors of the EU food system and their interactions which are ultimately shaping the system and the outcomes it provides. Having created a coherent, logical structure describing the EU food system allows for a

detailed analysis of the system and an assessment of its status, which is one of SUSFANS' main objectives (Figure 3). The assessment establishes to which degree the current shape of the EU food system contributes towards achieving the main EU policy goals and what possible entry points might exist for shaping the system and improving its performance. The system's perspective ultimately allows for the identification of a wide set of policy and technical recommendations which have been assessed not just against a number of specific objectives or for specific actors but which can also be examined against their ripple effects through the whole system and the potential unintended consequences/trade-off effects they might have. Another purpose of the conceptual framework is to bring the expertise of the different scientific groups within SUSFANS together in a coherent manner which results in a shared understanding of the whole food system across disciplinary boundaries, the use of a consistent terminology and the creation of new, interdisciplinary insights.

Figure 3: The SUSFANS project and its components



The SUSFANS conceptual framework highlights the dynamic aspects of the system to help understand what drives the system and lays out the interactions and feedback mechanisms across it. To this end it aims to be:

- *Descriptive*, in that it describes the different food systems components and the basic pathways towards achieving the four EU policy goals.

- *Precise*, in using the terms and terminology defined by the project therefore also lays out the glossary of terms used within the project. It thus also specifies which variables, aggregate indicators and metrics the project needs to develop to evaluate systems performance.
- *Decision oriented*, and geared towards providing support for decision makers thinking through options for better achieving and balancing across the four EU policy goals. It thus shows entry points for system change and the roles of different actors in achieving the stated goals.
- *Applicable at multiple levels*, in that its basic setup represents the main food system components at the EU, member state and local level. Thus who for example the different actor are at each scale or what drives their choices in specific might vary, but in terms of analysing and representing the components of the system, the SUSFANS conceptual framework aims to capture the key components present at each geographical scale.

2.3 Review of existing approaches and frameworks: contributions of the SUSFANS Conceptual Framework

As the SUSFANS project aims to assess the whole EU food system with its key components and the relationship with the main policy goals for the system the project builds in its conceptual framework specifically on the literature describing a 'Food System' approach. This approach was seen as the most useful in the context of the project in that its aim is to map all the different components of the system important for analysis, their relationships and the outcomes of the system. In the following we describe the origin of the 'food systems' approach and how it was applied to the SUSFANS project.

2.3.1 The Food Systems framework

The term "food systems" is increasingly seen in science, policy and business fora but is used to convey a range of meanings. One particular approach has emerged strongly over the last decade, substantially based on work in the global environmental change community (Ericksen 2008, Ingram 2011). In essence it relates all the food system *activities* (growing, harvesting, processing, packaging, transporting, marketing, consuming, and disposing of food and food-related items) to the *outcomes* of these activities not only for food security and other social issues, but also for the environment and the agri-food businesses. The food security outcomes are grouped into three components (Availability, Access and Utilization), each of which comprises three elements (Figure 4). All nine elements are either explicit or implicit in the widely-cited FAO food security definition "*when all people, at all times, have physical, economic and social access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life*"; all nine have to be satisfied and stable over time (other than increasing, if too low) in order for food security to be met.

The concept also recognizes the motives of different food system "actors" and the range of policy, market, social, technological and biophysical environments that influence their actions. The food system approach thus allows the food chain activities to be linked to their social, economic and environmental context (Figure 4). Moreover, as actors in each section of the food chain affect each other's behaviour, two-way linkages are taken into account. This food system concept has proved useful in a number of ways – for example, in helping define international, climate change-food security agendas (FAO 2008); in assessing sustainable nutrition security (Acharya, Fanzo et al. 2014); in futures thinking (Vervoort et al. 2014) and in international and national assessments (Porter, Xie et al. 2014).

Figure 4: Food systems Activities *and* Outcomes*, adapted from Ericksen (2008) and Ingram (2011)*

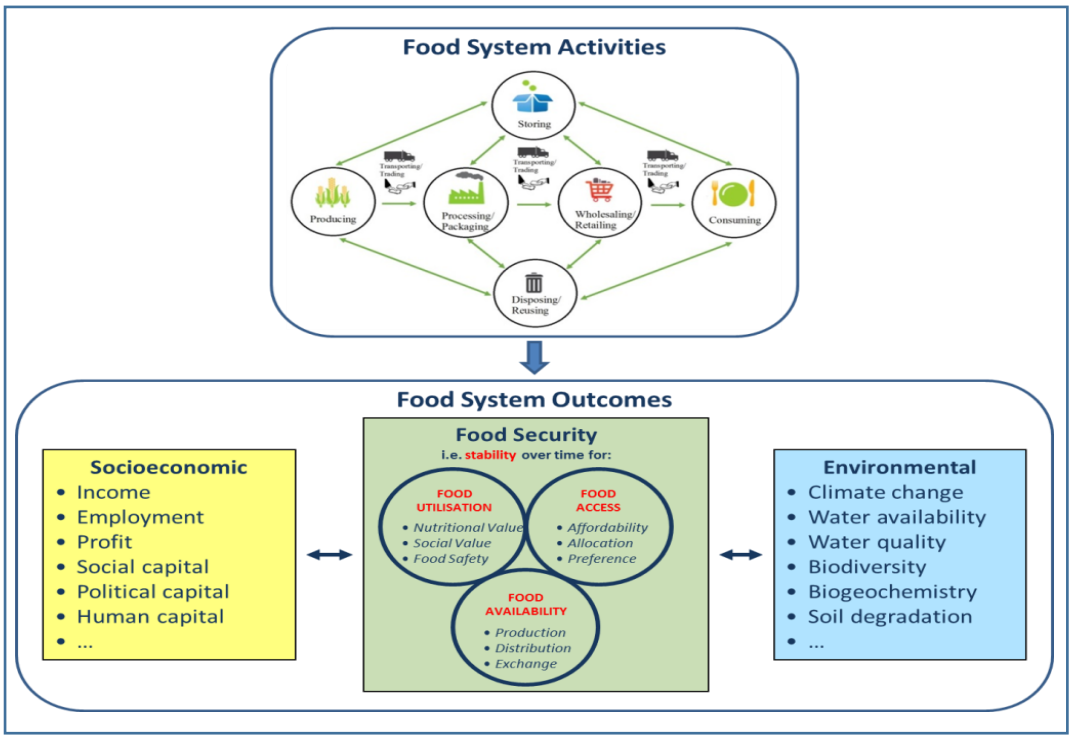
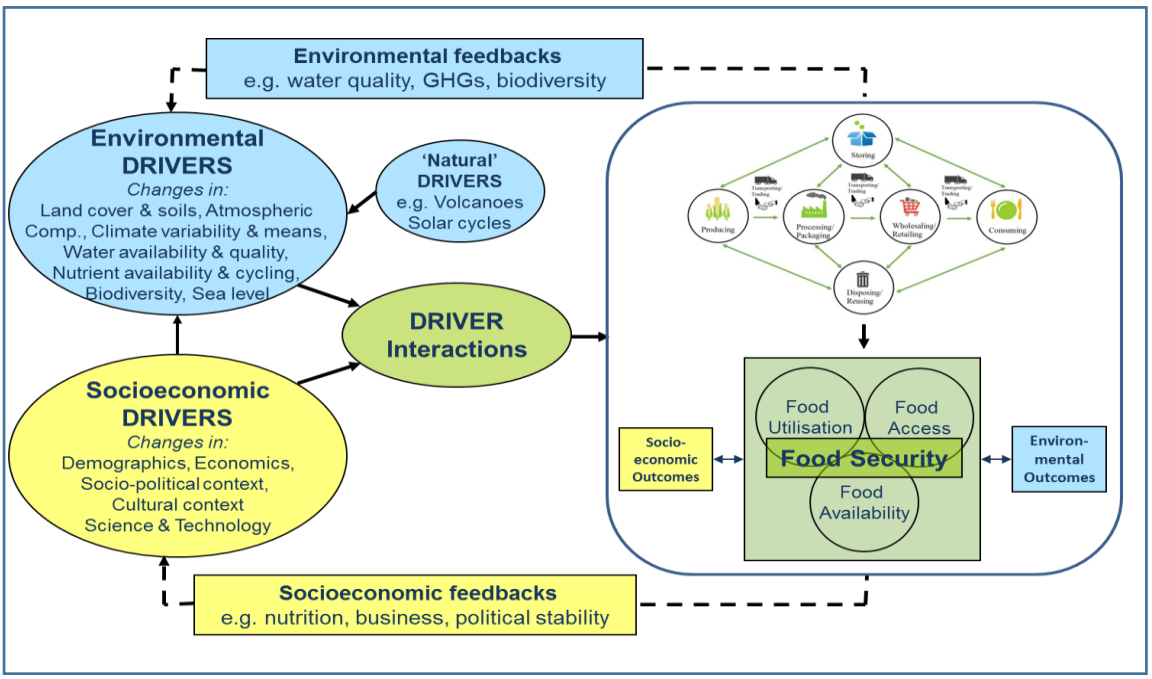


Figure 5: Food systems Drivers *and* Feedbacks*, adapted from Ericksen (2007) and Ingram (2010)*



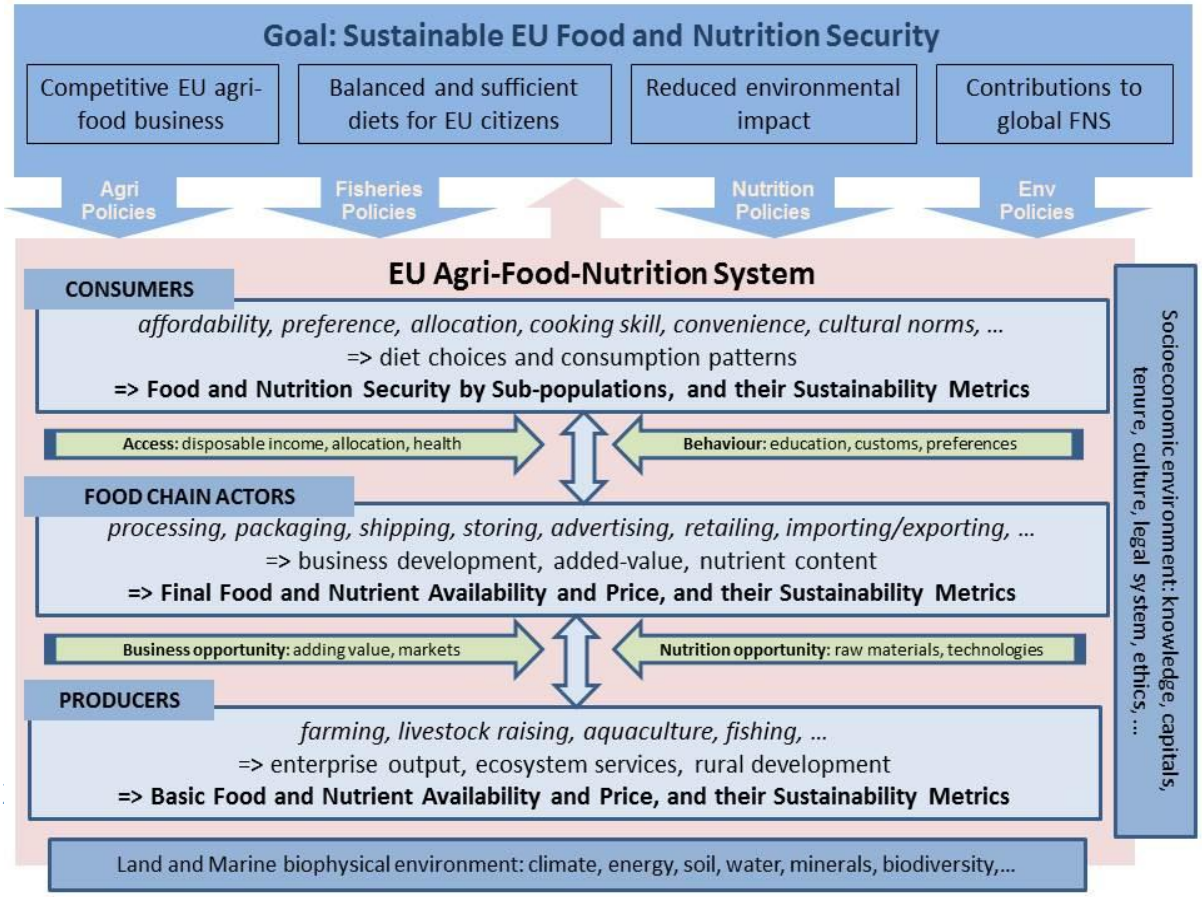
The food systems approach helps to engender discussion of adaptation options to improve outcomes across the full set of food system activities (i.e. along the length of the food chain) rather

than just, say, in the agricultural domain. It also provides a framework for systematic analysis of synergies and trade-offs of possible interventions, balanced across a range of societal goals (Figure 5). Further, it serves as a "checklist" to ensure that the right people are engaged in discussion and that the right range of outcomes (some hitherto unforeseen) is being considered by those planning and/or implementing adaptation (Ingram 2011). This is particularly valuable for considering how to improve health and wellbeing using an "Innovation System" perspective, as this recognizes that need for multiple dialogues among stakeholders (Smits, Kuhlmann et al. 2010).

2.3.2 The initial SUSFANS framework

SUSFANS aims at understanding the complex relationship between the EU-Agri-Food-Nutrition System on the one hand and EU- and national policies for sustainable EU food and nutrition security on the other. A framework that the SUSFANS conceptual framework could build on was the work done by the Center for Integrated Modeling of Sustainable Agriculture and Nutrition Security (CIMSANS) described in Acharya et al. (2014). The CIMSANS framework includes main relationships and interactions between policy goals (Figure 6, top); consumers, food chain actors and producers in the agri-food-nutrition system (Figure 6, horizontal boxes), as well as the short term and long term socioeconomic and biophysical factors that drive changes in the food system (Figure 6, boxes at the base and side, and horizontal arrows). The framework will serve policy objectives for (a) the competitiveness of the agro-food business, (b) balanced and sufficient diets for EU consumers and in line with the objectives of "Healthy Diet for a Healthy Life", (c) environmental sustainability of the system, and (d) FNS at the level of the members states, the EU, and globally.

Figure 6: The CIMSAMS conceptual framework



The EU food system consists of various components that work at different geographical and temporal levels (from global to local; short-term to long-term) and interact with each other in a number of ways. This makes the system complex and difficult to analyse. For that reason SUSFANS developed a schematic representation of the EU food system in its conceptual framework, using a food systems lens (see section 2.3) to ensure consistency of analysis, terminology and conceptual understanding. Figure 7 shows a visual representation of how the project describes the food system components and dynamic at an EU level, in the context of the policy goals SUSFANS addresses. The diagram therefore also portrays the hypotheses of the project about the relationships between actors in the system, the outcomes the system produces, and feedback loops between the various system components. Understanding these feedback loops will be important when assessing options to change the system set up and/or performance in order to achieve or move closer towards achieving the EU policy goals.

For the purpose of SUSFANS, we describe the basic components of the EU food system as:

- The various actors within and outside of the EU food system.
- The direct and indirect factors driving the behaviour of food system actors and therefore influencing change within the food system (drivers of change),
- The outcomes of the EU food system and its activities;
- The goals at the EU level that are shaping the drivers and the EU wide and national policies affecting the food system;
- The interactions and feedback loops that exist between the various food system components.

Actors of the food system:

In order to understand the different activities and outcomes of the food system the project defined five types of actors interacting and influencing other. These include actors within the actual system as well as outside the system. Within the food system we find three types of actors (details on the actors can be found in Section 2):

- primary producers such as farmers and fishermen,
- food chain actors such as primary and secondary food processors, and retailers and input suppliers, and
- consumers.

Outside of the food system per se, but acting upon it, are

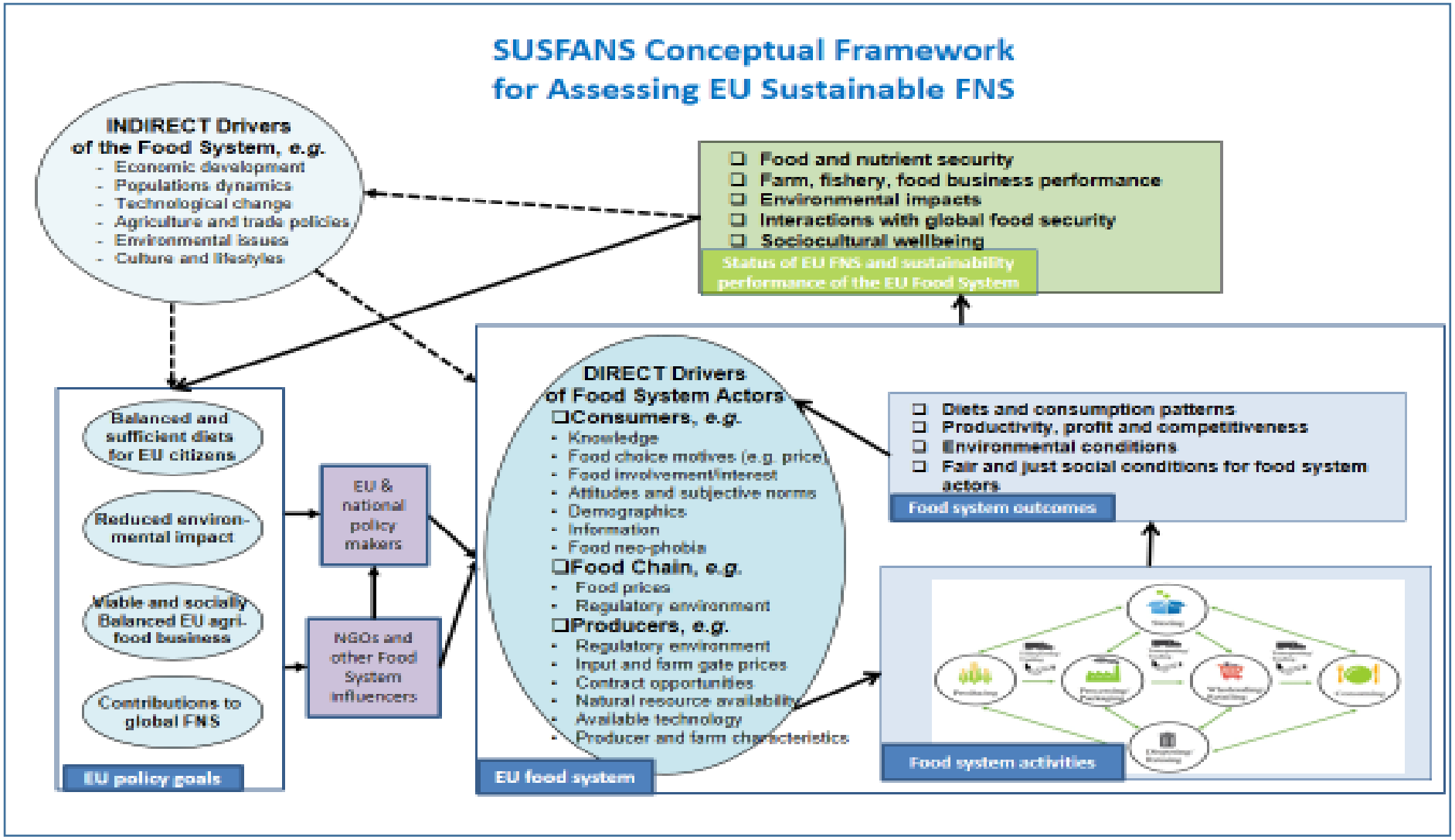
- EU level and national policy and decision makers (e.g. EU commission, ministries of agriculture, finance or health etc. at member state level), and
- food system influencers such as NGOs, think tanks, and academia.

Indirect and direct driving forces shaping the EU food system:

SUSFANS distinguishes between two types of driving forces, direct and indirect drivers (Ash et al. 2010) (which are sometimes also called proximate and ultimate drivers in the land use change literature, see Geist & Lambin 2002). The Millennium Ecosystem Assessment (2003) defined the

different drivers' categories as: "A direct driver unequivocally influences (eco)system processes and can therefore be

Figure 7: The SUSFANS conceptual framework



identified and measured to differing degrees of accuracy. An indirect driver operates more diffusely, often by altering one or more direct drivers, and its influence is established by understanding its effect on direct drivers". Distinguishing between direct and indirect drivers can also be useful from a decision making point of view as in most cases individual decision makers can influence/change direct drivers while indirect driver often depend on joint decision making at a larger, societal scale. Understanding the drivers will allow identifying possible options for changing their direction and/or intensity and with that influence the activities and the behaviour of food chain actors (MA 2003).

In SUSFANS the conceptual framework describes indirect drivers that fall into six categories. These are (more detail can be found in section 2)

- economic developments,
- population dynamics,
- technological change,
- agriculture and trade policies,
- environmental issues, and
- culture and lifestyle choices.

With respect to direct drivers, SUSFANS decided to explore factors for each actor group within the food system separately in order to be able to take a deeper look at what drives their choices (details can be found in Section 3.4). Each individual direct driver is usually the result of a specific combination of indirectly acting forces. A better understanding of the individual drivers will help to better assess potential policy or technological options to influence or change direct drivers' intensity or direction.

The direct drivers for primary producers considered are:

- Regulatory environment
- Input and farm gate prices
- Contract opportunities
- Natural resource availability
- Available technology
- Producer and farm characteristics.

The direct drivers for food chain actors considered are:

- Food prices
- Regulatory environment

The direct drivers for consumers considered are:

- Knowledge
- Food choice motives (e.g. price)
- Food involvement/interest
- Attitudes and subjective norms
- Demographics
- Information
- Food neo-phobia

EU policy goals:

The EU policy goals in the SUSFANS conceptual framework represent a synthesis of goals and desired outcomes currently expressed either by the European commission or the EU member states for the food system. These goals are usually expressed in EU or member state policies or articulated in policy fora. SUSFANS summarized these goals into four overarching ones:

- Balanced and sufficient diets for EU citizens
- Reduced environmental impacts of the food system
- Viable and socially balanced EU agri-food business
- Contributions to global food and nutrition security

Outcomes of the EU food system activities:

The activities of the EU food system result in a number of outcomes that determine the overall system performance. In the food systems literature these outcomes are related to the traditional food security goals of food availability, access and utilization (Ericksen 2008), all of which need to be stable over time. As SUSFANS aims to also assess the sustainability dimensions of the EU food system, the project recognizes the other following food system outcomes and evaluates their status:

- the diet and consumption patterns of EU citizens which ultimately determine if food and nutrition security is achieved,
- the productivity, competitiveness and profits achieved by the agriculture and food sector that determine the performance of the food, fisheries and food industry sector ,
- the environmental conditions resulting from the various food system activities, including GHG emissions, biodiversity, water and soil impacts,
- the social conditions of the food system, i.e. how fair and just the working conditions are for food system actors across the whole system,
- The impact of the EU food system performance on global food security targets.

Interactions and feedback loops:

The SUSFANS conceptual framework depicts four nested feedback loops:

- Feedbacks and circular interactions are hypothesized across food systems actors and their activities as shown in the 'Food system activities' box.
- A feedback loop is seen within the 'EU food system' box, from the 'direct drivers' to the 'food systems activities' and back to the 'direct drivers' via 'food system outcomes'.
- Another feedback mechanism is described from the 'EU food system' box to the 'EU policy goals' box via changes in the 'Status of the EU FNS' box. 'EU and national policy makers' as well as 'Food system influencers' mediate the interaction between the 'EU policy goals' the 'EU food system'.
- A fourth feedback is described from the 'EU food system' box to the 'Indirect Drivers' box again via changes to the 'Status of EU FNS'. 'Indirect drivers' then impact on 'EU policy goal' setting which in turn influences the 'EU food system'.

3 The components of the SUSFANS conceptual framework

This section provides a detailed description of the various components of the food system at EU level as conceptualized by the SUSFANS project. Section 3.1 synthesizes the policy goals that the EU and/or its member states have formulated for the food system and which guide the SUSFANS analysis. Section 3.2 describes the three categories of food systems actors within the food system (primary producers, food chain actors and consumers) and their activities that the project analyses. This section also portrays the main actors outside the actual food system which nevertheless influence the system through policies and other measures. Section 3.3 then gives an overview of the key direct and indirect factors driving food system actors and performance.

3.1 The EU food system policy goal

The four EU policy goals that SUSFANS explores (1) balanced and sufficient diets for EU citizens, 2) viable and socially balanced agri-food businesses, 3) reduced environmental impacts of the EU food system, and 4) contribution to global food and nutrition security) result from a diverse number of sources and have been expressed in various ways. While for some goals, the ideas behind them have existed for a longer time (e.g. reduction of environmental impacts), for others definitions and clearer ideas of what they encompass are only emerging and need to be defined. SUSFANS hopes to contribute to the debate by presenting the project's current thinking and by presenting these goals at an equal footing to each other. This will later better allow looking across all goals and how and if all these goals might be pursued at the same time. And what effects interventions to achieve different goals might have for the others.

3.1.1 Balanced and sufficient diets for EU citizens

A healthy diet can be defined as a balanced diet that provides adequate amounts of energy and nutrients for a healthy life and well-being for the whole population. Diet composition is a major modifiable determinant of a number of the chronic non-communicable diseases (NCDs) - including obesity, diabetes mellitus, cardiovascular disease, hypertension and stroke, and some types of cancer - that are considered significant causes of mortality and premature death. The scientific evidence increasingly supports the view that dietary intakes can have considerable effects, both positive and negative, on health throughout life.

NCD's make the largest contribution to the burden of disease in the European countries (WHO - Regional Committee for Europe 2014), contributing to around 68% of all deaths (38 million) in 2012 up from 60% in 2000, with a worryingly disproportionate number of people from poorer or lower income countries (Anon n.d.). Surveillance of the health status in the EU countries and prospects for the next decades suggest that the impact of the major NCDs is economically alarming both in relation to disease burden and number of deaths (WHO, 2016; http://www.euro.who.int/en/health-topics/noncommunicable-diseases, assessed June 17th, 2016).

Similarly, an alarmingly rise is seen in the EU countries in relation to the proportion of the adult population who are overweight and obese. The latest WHO estimates that overweight affects 30-70% and obesity affects 10-30% of adults in the EU countries (WHO, 2016, http://www.euro.who.int/en/health-topics/noncommunicable-diseases/obesity/data-and-statistics, assessed June 17, 2016). Also, the prevalence of overweight and obesity among children and adolescents is increasing steadily. In spite of several actions at the European and national levels to reverse the current trend in the rise in the proportion of children and young people being

overweight or obese, the impact has been disappointing and worrying since studies show that over 60% of children who are overweight before puberty will be overweight in early adulthood (European Union 2014).

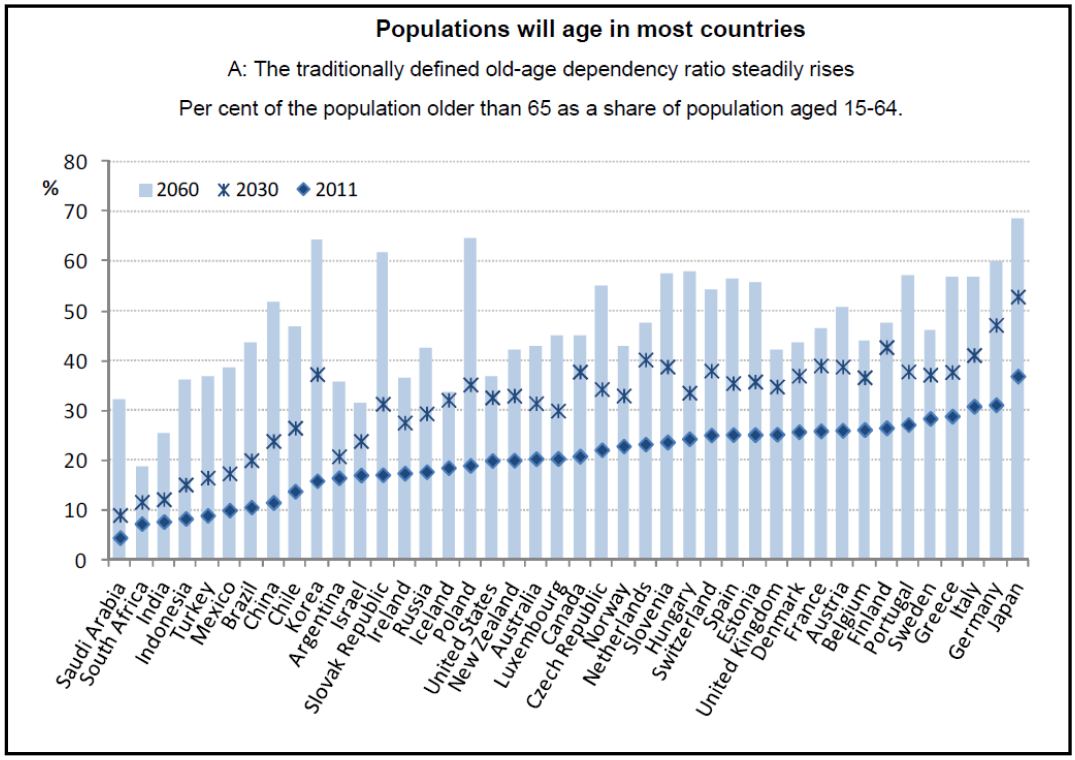
Recent estimates in the EU show that around 2.8 million deaths per year result from causes associated with overweight and obesity (European Union 2014). It is well established that overweight and obesity are closely associated with the risk of NCDs. It is estimated that around 7% of national health budgets across the EU are spent each year on diseases linked to obesity.

Like the rest of the world the EU region is faced with major demographic challenges. While today, 10% of the global population lives in Europe (738 million), in 2050 Europe's share is expected to decline to 7% (707 million) (OECD et al. 2016). During the same time period, the demographic changes will increase the share of elderly people and while the proportion of over-60s in the EU was 24% of the population in 2015, it is projected to reach 34% in 2050 (Melorose et al. 2015) (Figure 8).

Balanced diets are consistently advocated among the potential strategies for prevention of the major diet-related diseases (NCDs) and are also included in the recent EU strategic health objectives for improvements of health for all and reduction of health inequalities (WHO - Regional Committee for Europe 2014; WHO Regional Office for Europe 2013).

A number of policies and actions have been adopted in the EU to meet the societal challenges in relation to achieving healthy diets for the EU population. Examples are the Green paper on "Promoting healthy diets and physical activity: a European dimension for the prevention of overweight, obesity and chronic diseases" in 2005 (Communities 2005) and a White paper on a "Strategy for Europe on Nutrition, Overweight and Obesity-related Health issues" in 2007 (Commission Of The European Communities 2007).

Figure 8: Age distribution in 2011 and projected for 2030 and 2060, OECD 2016



In relation to defining an evidence based set of reference values for a healthy diet, the EU Commission requested the European Food Safety Authority (EFSA) to provide the most up-to-date and comprehensive scientific advice on Dietary Reference Values (DRVs) to support EU policy makers in their decisions for making process in the field of nutrition. EFSA published Scientific Opinions on DRVs for fats, carbohydrates, dietary fiber, and water in 2010, for protein and energy in 2012 and 2013, respectively, and since 2013 and till the end of 2016 DRVs for minerals and vitamins (https://www.efsa.europa.eu/en/topics/topic/drv).

EFSA published in 2010 a scientific opinion on food-based dietary guidelines (FBDG) which can be used as advice to policy makers on how to translate nutrient based dietary recommendations into FBDGs, intended for the European population as a whole, on the contribution of different foods or food groups to an overall diet that would help to maintain good health through optimal nutrition (EFSA NDA Panel 2010). The scientific opinion underlines that the FBDGs are intended for consumer information and education and as such, they should be appropriate at the region or country level, taking into account culturally acceptable and practical aspects. Thus, contrary to DRVs that are set at the EU level, FBDGs should be developed and implemented at national/regional level.

In a Foresight study, the EC Joint Research Centre (JRC) concluded that the provision and consumption of healthy diets involves the whole food chain and the consumer and is interlined with any other areas such as economy, environment, healthcare, individual lifestyles, etc., making progress towards healthy diets for all a very complex challenge which should include the shaping and coping with the 2050 food system (Maggio et al. 2015).

3.1.2 Viable and socially balanced EU agri-food business

The EU food systems is built by a large number of agri-food businesses of all sizes working across all different geographical scales, from local to regional to global. Underlying the functioning of the system is a basic understanding that these businesses must be competitive at these various scales as well as that the food system as a whole must also provide livelihoods and jobs to all the people working in it in a just and fair way. This is what SUSFANS refers to as the EU goal of a 'viable and socially just EU agri-food business'. While the concept of 'competitiveness' has been extensively explored the question of what a socially-balanced agri-food business for the EU implies has not been well developed so far.

Competitiveness is a relative and multi-dimensional concept, having different aggregation levels and can be assessed from different theories, is defined in diverse ways for different time horizons, and its linkages with policies are unclear. According to the 2016 EC study, 'competitiveness' is defined as: "*The ability of a firm, sector and/or a nation to offer products and services that meet the quality standards of the local and world markets at prices that are competitive in relation to the offers of other firms or nations. A number of indicators have been employed in this study to assess the competiveness of the food and drink sector. "*

The study's conclusions reveal that *"the (EU) food and drink industry and all its sub-sectors have a good international trade position with all sectors demonstrating improvement over the past years, despite weakening labor productivity and value added. This development can largely be attributed to the global perception of the high quality of European products and increasing incomes driving higher*

consumer demand for food and drinks products in emerging countries. The conclusion of a series of free trade agreements with non-EU countries in the last years has also contributed to increased market opportunities." It also provides a number of recommendation in order to strengthen the competitiveness of European industry namely: strengthening the international trade position, supporting productivity, and improving the functioning of the supply chain.

According to the competitiveness Report 2013-2014 by Food&Drink Europe, "*the EU food and drink industry maintains the characteristics of a stable, non-cyclical and robust manufacturing sector, in spite of the current economic downturn. It also generates the largest percentage of EU GDP, ahead of sectors such as engineering, automobile and chemicals*" However, according to the Food&Drink Report, in terms of labor productivity the EU is not keeping pace with other international competitors like the U.S. and Switzerland. Two reasons for this lower productivity have been pointed out, namely lower investment in machinery and technologies as well as in skilled workers compared to other international competitors; and, a large number of companies operating in the EU food sector with small scale operations. It has been also highlighted that despite the EU having maintained a level of private R&D investment it still is below its international partners, such as Japan and U.S (Food&Drink Europe, 2015).

In 2010, a High-Level Forum for a Better Functioning Food Supply Chain was established by the EC with the strategic mission of improving the efficiency of the food supply chain and thus the competitiveness of the agri-food sector, a key segment of the EU economy. A new mandate has been given by the European Commission for setting up a new High Level Forum for a better functioning food supply chain for the period 2015-2019. The Forum identifies eight key policy issues for continued multi-stakeholder dialogue in the food supply chain, namely: Competitiveness and SMEs, Business-to-business trading practices, Internal Market, Market access, Sustainability, Social dimension, Innovation, and Prices (European Commission, 2014)

3.1.3 Reduced environmental impact of the EU food system

The agriculture sector manages 47% of the EU's territory, contributes with 11% to total anthropogenic greenhouse gas (GHG) emissions in the EU (EEA 2015) not including pre-chain GHG emissions, about 95% of NH3 emissions and about 60% of nitrogen losses to the EU waters (Leip *et al.* 2015). Large quantities of food are lost or wasted adding further pressure on resource availability and causing avoidable environmental pollution (Vanham *et al.,* 2015).

It is thus obvious that legislation aiming at protecting the environment and maintaining resources available are of high relevance of the European food system, including both the farming and the processing and retailing industry. Some environmental concerns have been integrated into agricultural policy (such as cross compliance and CAP greening) others are not yet an integral part of agricultural policy, as for example the mitigation of GHG emissions, but the need of the food sector to contribute to emissions reductions is clear.

The present section briefly introduces a selection of relevant environmental legislation.

3.1.3.1 CAP 2003 – Cross Compliance

Cross-compliance has been introduced in the Common Agricultural Policy (CAP) reform of 2003, which also introduced the 'decoupling' of income support to farmers. Cross compliance links direct payments to respecting a number of statutory management requirements and to maintain all agricultural land in good agricultural and environmental conditions (EC 2003).

The Statutory Management Requirements (SMRs) refer to 13 legislative standards in the field of the environment, food safety, animal and plant health and animal welfare, of which five target the environment. Of main relevance for the environmental protection are the Nitrates Directive and the Natura2000 directives: wild bird (EC 2009) and habitats directives (European Council 1992).

Good agricultural and environmental conditions (GAECs): The obligation of keeping land in good agricultural and environmental condition refers to a range of standards related to soil protection, maintenance of soil organic matter and structure, avoiding the deterioration of habitats, and water management.

3.1.3.2 CAP 2013 – greening

With the adoption of the 2013 CAP reform, the environment concerns received an enhanced focus by explicitly linking the agricultural support to "agricultural practices beneficial to the climate and environment" (so called 'CAP greening') (EU 2014, 2013; European Commission 2013a). Green direct payments account for 30% of EU countries' direct payment budgets. Farmers receiving an area-based payment have to make use of various straightforward, non-contractual practices that benefit the environment and the climate. These require action each year. They include: (i) diversifying crops; (ii) maintaining permanent grassland; and (iii) dedicating 5% of arable land to 'ecologically beneficial elements' ('ecological focus areas'). Green direct payments supplement cross-compliance rules.

3.1.3.3 Climate Policy: UN Framework Convention on Climate Change and the EU 2020 climate & energy package

The European Union, its Member States and Iceland have agreed to fulfil jointly their quantified emission limitation and reduction commitments for the second commitment period of the Kyoto Protocol. This quantified emission reduction commitment limits the average annual emissions of greenhouse gases from the EU28+Iceland during the second commitment period to 80% of the sum of their base year emissions (European Union 2015).

Within EU legislation, GHG emission reductions are regulated by the 2020 climate & energy package that sets three key targets:

- 20% cut in greenhouse gas emissions (from 1990 levels)
- 20% of EU energy from renewables
- 20% improvement in energy efficiency

The key tool for achieving the targets are the EU Emissions Trading System (EU ETS, European Parliament & Council of the European Union 2014, 2003) and the Effort Sharing Decision (ESD, European Parliament & Council of the European Union 2009a) which regulates the sectors that are not included in the EU ETS, including agriculture. The Effort Sharing Decision establishes binding annual greenhouse gas emission targets for Member States for the period 2013–2020, expressed as percentage changes from 2005 level (see Figure 9 9).

The 2030 climate and energy framework builds on the 2020 climate & energy package and sets three key targets for the year 2030 (European Commission 2014a):

- At least 40% cuts in greenhouse gas emissions (from 1990 levels)
- At least 27% share for renewable energy
- At least 27% improvement in energy efficiency

This is in-line with the EU "low-carbon economy roadmap" which suggests that by 2050, the EU should cut emissions to 80% below 1990 levels, to which all sectors need to contribute.

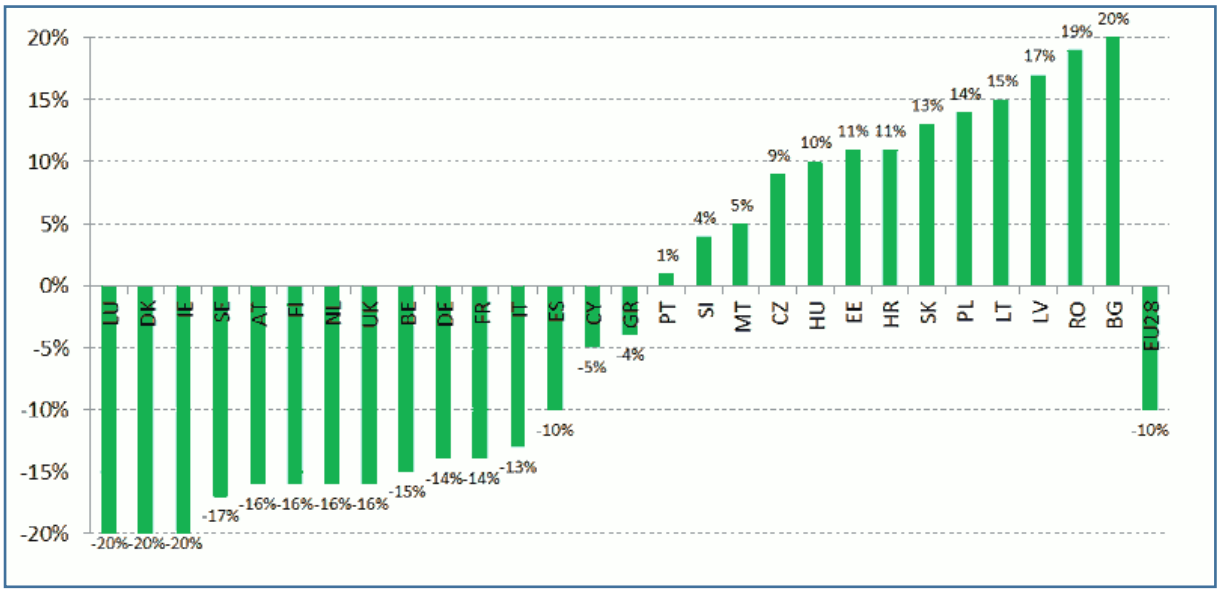
How the land use sector (agriculture and LULUCF) will be considered within the 2030 climate and energy framework is still discussed and the European Commission launched a public consultation proposing three options (European Commission 2014b) :

- Option 1 — LULUCF pillar: Maintain non-CO_2 agriculture sector emissions in a potential future Effort Sharing Decision, and further develop a LULUCF sector policy approach separately;
- Option 2 — Land use sector pillar: Merging the LULUCF and agriculture sector non-CO_2 emissions into one new and independent pillar of the EU's climate policy;
- Option 3 — Effort Sharing: Include the LULUCF sector in a potential future Effort Sharing Decision.

3.1.3.4 Nitrates Directive

The Nitrates Directive forms an integral part of the Water Framework Directive and is one of the key instruments in the protection of waters against agricultural pressures. It has the objective of reducing water pollution caused or induced by nitrates from agricultural sources and preventing further such pollution (EC 1991). The corner stones of the directives are (i) the designation of vulnerable zones; (ii) the establishment of a Code of Good Agricultural Practice, and (iii) the implementation of Action Programmes describing required measures. Such Action Programmes can vary regionally depending on local conditions and pollution levels. The only pre-scribed quantitative measure given in Annex III of the ND is the limit of applied livestock manure of 170 kg ha^{-1} yr^{-1}. However, some countries have asked derogation. Currently there are eight derogations in force.

Figure 9. Member State greenhouse gas emission limits in 2020 compared to 2005 levels (European Commission 2013b)



3.1.3.5 National Emissions Ceilings Directive

The National Emission Ceilings Directive (NECD) (EC 2001b) has the objective to limit emissions of acidifying and eutrophying pollutants and ozone precursors in order to improve the protection in the Community of the environment and human health against risks of adverse effects from acidification, soil eutrophication and ground-level ozone and to move towards the long-term objectives of not exceeding critical levels and loads and of effective protection of all people against recognised health risks from air pollution by establishing national emission ceilings.

The emission ceilings are defined at the national level, for the agriculture sector emissions of ammonia (NH_3) are most relevant, as more than 90% of NH_3 emissions originates from agricultural sources. The directive requires Member States to draw up a National Programme which includes information on adopted and envisaged policies and measures and quantified estimates of their effects on the emissions.

The NECD is currently being reviewed as part of The Clean Air Policy Package (European Commission 2013c). This will ensure that the national emission ceilings (NECs) set in the current Directive 2001/81/EC for 2010 onwards for SO_2, NO_x, NMVOC and NH_3 shall apply until 2020 and establishes new national emission reduction commitments ("reduction commitments") applicable from 2020 and 2030 for SO_2, NO_x, NMVOC, NH_3, fine particulate matter (PM2.5) and methane (CH_4).

Parallel to the development of the EU NEC Directive, the EU Member States together with Central and Eastern European countries, the United States and Canada have negotiated the "multi-pollutant" protocol under the Convention on Long-Range Transboundary Air Pollution (the so-called Gothenburg protocol, agreed in November 1999). The emission ceilings in the protocol are equal or less ambitious than those in the NEC Directive.

3.1.3.6 Biodiversity Strategy

With the Biodiversity Strategy, the EU adopted in 2011 six ambitious targets and 20 actions to halt the loss of biodiversity and ecosystem services in the EU by 2020 (European Commission 2011). Target 3 (Achieve more sustainable agriculture and forestry) and Target 4 (Make fishing more sustainable and seas healthier) are of direct relevance for EU food production systems.

The corresponding actions were:

- Target 3 - Action 8: Enhance CAP direct payments to reward environmental public goods such as crop rotation and permanent pastures; improve cross-compliance standards for GAEC (Good Agricultural and Environmental Conditions) and consider including the Water Framework in these standards
- Target 3 - Action 9: Better target Rural Development to biodiversity needs and develop tools to help farmers and foresters work together towards biodiversity conservation
- Target 3 - Action 10: Conserve and support genetic diversity in Europe's agriculture
- Target 3 - Action 11: Encourage forest holders to protect and enhance forest biodiversity
- Target 3 - Action 12: Integrate biodiversity measures such as fire prevention and the preservation of wilderness areas in forest management plans
- Target 4 - Action 13: Ensure that the management plans of the Common Fisheries Policy are based on scientific advice and sustainability principles to restore and maintain fish stocks to sustainable levels.
- Target 4 - Action 14: Reduce the impact of fisheries by gradually getting rid of discards and avoiding by-catch; make sure the Marine Strategy Framework Directive is consistently carried out with further marine protected areas; adapt fishing activities and get the fishing

sector involved in alternative activities such as eco-tourism, the monitoring of marine biodiversity, and the fight against marine litter.

3.1.3.7 Industrial Emissions Directive

The Industrial Emissions Directive (IED, European Parliament & Council of the European Union 2010) is the main EU instrument regulating pollutant emissions from industrial installations. Around 50,000 installations undertaking the listed industrial are required to operate in accordance with an integrated approach (permit) taking into account the whole environmental performance and operating according to Best Available Techniques (BAT). Industries listed (Annex I) include

- Operating slaughterhouses with a carcass production capacity greater than 50 tonnes per day and installations for treatment and processing of animal or vegetable raw material above defined quantities
- Disposal or recycling of animal carcases or animal waste with a treatment capacity exceeding 10 tonnes per day
- Intensive rearing of poultry or pigs: (a) with more than 40 000places for poultry; (b) with more than 2 000places for production pigs (over 30 kg), or (c) with more than 750 places for sows

The list of pollutants include both air pollutants (e.g. NO_x and other Nitrogen compounds, VOCs, particulate matter, etc.) and water pollutants (e.g. substances with contribute to eutrophication or have an unfavourable influence on the oxygen balance).

Relevant BAT reference documents (so-called BREFs) include best available techniques for intensive rearing of poultry and pigs (European Commission 2003), slaughterhouses and animal by-products industries (European Commission 2005), food, drink and milk industries (European Commission 2006a), and waste treatment (European Commission 2006b). Key environmental data from industrial facilities are made available at the European Pollutant Release and Transfer Register (E-PRTR, http://prtr.ec.europa.eu/).

Additionally, there is the possibility for industries to voluntarily participate in the EU Eco-Management and Audit Scheme (EMAS, European Commission 2013d; European Parliament & Council of the European Union 2009b). In support of EMAS, documents describing 'best environmental management practices' (BEMPs) are developed, amongst others the reference document for the Agriculture (Crop and Animal Production) sector (JRC 2015a)and the reference document for the Food and Beverage Manufacturing sector (JRC 2015b).

3.1.3.8 EU action plan for the Circular Economy

The EU Circular Economy Package (European Commission 2015) which include revised legislative proposals on waste will contribute to 'closing the loop' of product lifecycles through greater recycling and re-use, and bring benefits for both the environment and the economy. Food waste is one of the priority areas; for example UN 2030 Sustainability Goal 12 (ensure sustainable consumption and production patterns) sets the target to halve per capita food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses. In order to support the achievement of this target, the following is foreseen (European Commission 2015):

- develop a common EU methodology to measure food waste and define relevant indicators.

- create a platform involving Member States and stakeholders in order to support the achievement of the SDG targets on food waste, through the sharing of best practice and the evaluation of progress made over time.
- take measures to clarify EU legislation relating to waste, food and feed and facilitate food donation and the use of former foodstuff and by-products from the food chain in feed production without compromising food and feed safety; and
- examine ways to improve the use of date marking by actors in the food chain and its understanding by consumers, in particular the "best before" label.

3.1.3.9 EU fertilizer regulation

As part of the Circular Economy Package, a proposal for the revision of the Fertilisers Regulation (European Commission 2014c) is proposed acknowledging that innovative fertilising products are developed including nutrients or organic matter recycled from bio-waste and providing a clearance procedure for such organic fertilisers (European Commission 2016). The proposal underwent public consultation early 2016. Amongst others, the proposal introduces new harmonised requirements for all CE marked fertilising products regarding (i) quality – such as minimum nutrient content, organic matter content, neutralizing values that are specific to each category of fertilising products; (ii) safety – such as maximum limits for heavy metals, including cadmium, for organic contaminants, for microbial contaminants and for impurities specific to each category of fertilising products; and (iii) labelling – such as the actual nutrients content and their forms which will allow the farmers to modulate the use of the fertilisers depending on the plant needs. It also includes recovery rules for bio-waste transformed into composts and digestates. If these products are incorporated in CE marked fertilisers, they are no longer considered to be waste within the meaning of the Waste Framework Directive.

3.1.3.10 Environmental Footprints

The Single Market for Green Products initiative proposal from the European Commission (European Commission 2013e) proposes a set of actions to overcome problems created by the increasing demand of green products on one hand, and the huge diversity of 'ecolabels', methods, and initiatives, reducing the trust of consumers in environmental information. The Single Market for Green Products initiative establishes two methods to measure environmental performance throughout the lifecycle, the Product Environmental Footprint (PEF) and the Organisation Environmental Footprint (OEF) (European Commission 2013f).

The approach is tested between 2013-2016 together with more than 280 volunteering companies and organisations. The aim is to understand the real potential of the methods before proposing new policies. These so-called "Product Environmental Footprint pilots" cover a large range of products, amongst them several of relevance for the EU agri-food system: beer, coffee, dairy, feed for food-producing animals, marine fish, meat (bovine, pigs, sheep), olive oil, paste, pet food (cats and dogs), wine, and leather (see http://ec.europa.eu/environment/eussd/smgp/ef_pilots.htm).

3.1.4 Contributions to global Food and Nutrition Security

The fourth EU Food and Nutrition security goal - contributing to global food and nutrition security - is related to food and nutrition security in the non-EU territory, especially developing countries. Apart from direct EU development policy actions to affect FNS in developing countries, EU sectoral policies might have indirect impacts on global food and nutrition security. Given the multidimensional challenges of global food and nutrition security, EU development policies can address a wide range of topics. The basic mechanism of EU development policy is focused on affecting various aspects of

the indirect drivers of the food system (i.e. economic developments, population dynamics, technological change, policies, environmental issues, and culture and lifestyle issues) and by doing so to affect the behaviour of the actors of the food system (i.e. primary producers, food chain actors, consumers, policy makers and food system influencers). In this subsection we discuss a number of EU development policy actions and some impacts of sectoral policies on global FNS.

3.1.4.1.1 EU development policy commitments

In 2010 the Council adopted an EU policy framework to assist developing countries in addressing food security challenges (COM (2010) 127). The Council requested an implementation plan, that was issued in 2013: 'Boosting food and nutrition security through EU action: implementing our commitments'' (EC, 2013). These commitments are grouped into six policy areas with a number of interventions:

1. *Improving smallholder resilience and rural livelihoods*

a) Support policies and programmes which focus on sustainable agricultural intensification and diversification for smallholder farmers, particularly women, including through enhanced public private partnerships.
b) Support policies and programmes in partner countries which aim to increase access for smallholder farmers, in particular women farmers, to land and water resources, improved farm inputs, credit, and extension services, and which aim to reduce post-harvest losses and improve storage facilities.
c) Assist partner countries in addressing climate change and its effects on food and nutrition insecurity and agricultural development through adaptation, mitigation and resilience-building measures.
d) Support pro-poor, demand-led research for development and technology transfer, extension and innovation, and ensure that this research is accessible to, and used by, smallholder farmers and in particular, women.
e) Support programmes in rural areas which aim to build resilience and generate income and off-farm employment, including by assisting smallholder and women farmers, to add value to their produce and to develop viable agribusinesses, to improve the links between smallholder farmers and markets and to enhance the efficiency.

2. *Supporting effective governance*

a) Support the progressive realisation of the right to safe, sufficient and nutritious food for all in partner countries, and the implementation of the Voluntary Guidelines to support the progressive realisation of the right to adequate food in the context of national food security.
b) Support national, regional and international initiatives for good governance and security of land tenure and use rights, including the implementation of the Voluntary Guidelines and responsible governance of tenure of land, fisheries and forests in the context of national food security, and facilitate responsible agricultural investments and investments in land.
c) Support initiatives to strengthen and enhance the functioning of civil society organisations in partner countries and farmers' organisations, particularly those which actively target poor smallholder and women farmers as members, contributing to their empowerment to participate in decision-making and implementation and evaluation of programmes.
d) Support programmes which focus on empowering women, strengthening their decision-

making role at household level, including in relation to decisions about food production, consumption and the use of household assets, and which seek to ensure that women's voices are heard and integrated into decision making at national and local levels.

e) Increase support to continental, regional and national Comprehensive Africa Agriculture Development Programme (CAADP) programmes and plans.
f) Strengthen global governance for food and nutrition security and take a strong leadership and advocacy role internationally to ensure that food and nutrition security is prioritised in global and regional development fora.
g) Promote coherence between relevant internal policies and the objectives of external development assistance polices.

3. *Supporting regional agriculture and food and nutrition security policies*

a) Support the development and implementation of regional level agricultural policies and strategies to step up integration of regional food markets and disease control programmes, including food safety against foodborne illness.
b) Reinforce regional and national information systems in support of agriculture and food and nutrition security policies, including those for early warning systems and transparency in markets.

4. Strengthening social protection mechanisms for food and nutrition security, particularly for vulnerable population groups

a) Support countries to develop nationally owned and led comprehensive social protection systems which are flexible, adapted to local contexts, and target both labour and non-labour constrained vulnerable population groups, and funded increasingly from domestic resources.
b) Support existing social protection programmes to expand their coverage and linkages with other sectors and enhance predictability, reliability, sustainability, scalability, resilience and the crisis response capacity of the interventions.

5. Enhancing nutrition in particular for mothers, infants and children

a) Increase advocacy with partner country governments to raise the profile of nutrition within their respective national strategies and programmes, and to align their resources accordingly.
b) Increase financial and technical support to partner countries to scale up and effectively address under-nutrition and improve national governance on nutrition, with a particular focus on those countries which have signed up to the Scaling Up Nutrition Movement.
c) Increase financial support for scaling up proven direct nutrition interventions, in particular those which combat maternal, infant and child under-nutrition and the irreversible effects of chronic under-nutrition in early childhood, targeting the 1,000 day window of opportunity from pregnancy to the age of 2.
d) Support to continental, regional and national nutrition research programmes and plans.
e) Support partner countries to integrate nutrition into national sectoral polices including agriculture, food safety, health and HIV/AIDS, education, gender, environment, social protection, and water, sanitation and hygiene, and increase awareness-raising and financial support for scaling up proven nutrition sensitive interventions in partner countries.

f) Incorporate nutrition specific objectives and indicators into the design and evaluation of EU supported agriculture and food security policies and programmes.

6. Enhancing coordination between development and humanitarian actors to build resilience and promote sustainable food and nutrition security

a) Support integration of resilience-building into partner countries' policies and planning, in particular into national development, poverty reduction and food and nutrition security strategies and encourage ownership of resilience priorities at national and local levels.
b) Support programmes and activities which strengthen the capacity of partner countries and local communities and assist them to anticipate, prevent and prepare for food security crises and to enhance crisis response, recognising the differential impacts and capacities of women, men and vulnerable groups.
c) Build capacity to improve risk monitoring, including climate risk, and vulnerability assessments in partner countries and regions prone to food crises.
d) Provide specific support to food insecure countries in transition and fragility to build resilience according to the Fragile States principles and the New Deal.
e) Promote principles of aid effectiveness as outlined in the Busan conclusions.
f) Ensure that humanitarian and development funding mechanisms are flexible, predictable, and sufficient to support resilience in food insecure partner countries.

The timeframe for carrying out this multidimensional plan is 2014-2020. In 2014, over half of the funds have been spent on priority 1 (improve smallholders' resilience and livelihoods), 15 % on priority 2 (support effective governance) and also 15% on priority 5 (enhance nutrition) (EC, 2016a). The other three priorities each received about 5% of the funds. The Sub-Sahara African countries are the largest beneficiaries with a share of 45% in total funds (EC, 2016b).

3.1.4.1.2 Impacts of sectoral policies on global food and nutrition security

Although sectoral policies in the EU, like the CAP, food safety policy and trade policy are not directly targeted at global food and nutrition security, they might have an impact on it. Below we discuss the relationship of some of these sectorial policies and global food and nutrition security.

- *CAP (Common Agricultural Policy)*

The CAP mainly influences global food and nutrition security via its impact on world market prices. Due to the exports of surplus production and a low import demand of the EU, in the past CAP exerted a downward pressure on world market prices, which tended to be beneficial for consumers in developing countries (cheaper food) and detrimental for producers in developing countries (lower prices for agricultural products). As a result of the successive CAP adjustments, EU agricultural commodity prices under the current CAP follow the fluctuations in world market prices and export subsidies have more or less dropped to zero. Hence consumers and producers in developing countries do no longer face a downwards pressure on world market prices due to CAP support (Helming et al., 2016).

- *EU food safety policy*

In the scope of the EU food safety policy standards for agricultural trade have been introduced. Such standards can be, but are not necessarily, protectionist. The empirical evidence on the costs related to EU food standards is limited and mixed (Berkhout et al., 2016). Some authors find evidence of

high compliance costs with public standards - especially for small producers - while other studies have estimated that the costs of compliance with EU standards are only a small fraction (less than 5%) of total production costs. EU standards can also facilitate developing countries' access to EU food markets as standards and certification schemes can reduce transaction costs and enhance consumer confidence in food product safety and quality. As such they may provide a bridge between consumer preferences high-income markets and producers in developing countries and increase developing countries' access to international markets. Moreover, standards may induce upgrading of the production system and supply chain modernization and allow developing countries to reposition themselves in the global market.

- *EU trade policy*

Over the past decades the EU has agreed to a number of preferential trade agreements with developing countries, granting them preferential access to a number of products. Although these agreements may increase trade flows, their impact on food and nutrition security in developing countries is questioned as this impact is difficult to isolate from other determinants (Bureau et al., 2016). These determinants refer amongst others to the structure of the value chain (Swinnen, 2015) and harmonization of standards (Disdier et al., 2014).

- *Indirect global effects of sectoral policies*

Reforms of EU policies may have indirect consequences on global food and nutrition security through complex deformation of the world prices vector. For example, policies that aim to reduce negative externalities of EU agriculture or to reduce CO_2 emissions in the EU may have global price effects through indirect land use changes (Bellora and Bureau, 2016). These indirect land use changes could arise if reductions of negative externalities result in the reallocation of the production of polluting goods to emerging countries such as China. Land use changes may result in a destruction of biodiversity and an increase in greenhouse gas emissions overseas.

3.2 Food systems actors and their activities

The SUSFANS conceptual framework differentiates between various categories of actors who constitute the EU food system and whose behaviour drive system performance. The framework distinguishes between actors that are 'within' and 'outside' of the system. Actors within the food system are primary producers (i.e. farmers and fishermen), the food chain actors such as processors and retailers, and the consumers. The actors outside the food system are policymakers at EU and member state level, whose policies directly or indirectly influence the system, and food system influencers. Influencers are for example civil society organizations or researchers that work on food related issues and whose work helps to shape and develop agriculture, food, health or environmental policies and technologies. In the following we first describe the actors within the EU food system in more detail and then the actors outside of the system.

3.2.1 Actors within the food system

3.2.1.1 Primary Producers

Agriculture contributes around 1.5% to EU GDP and receives around 30% of the EU's total spending in terms of subsidies. For the production of fish products, the EU28 is ranked 5th of the main world producers. Below, first the current farm and fishery structure in the EU are described, followed by the employment rates in the sector.

Figure 1010 shows the distribution of different agricultural land uses in the EU28 across total land use. Cereal production accounted for about one third of the total utilized agricultural area in 2013. Grassland (pasture and meadow, rough grazing and permanent grassland) accounted for more than another third of total utilized agricultural area (34.1%).

Figure 10. Utilised agricultural area by land use, EU-28, 2013 ([1]) (% share of utilised agricultural area), (European Commission, 2015a)

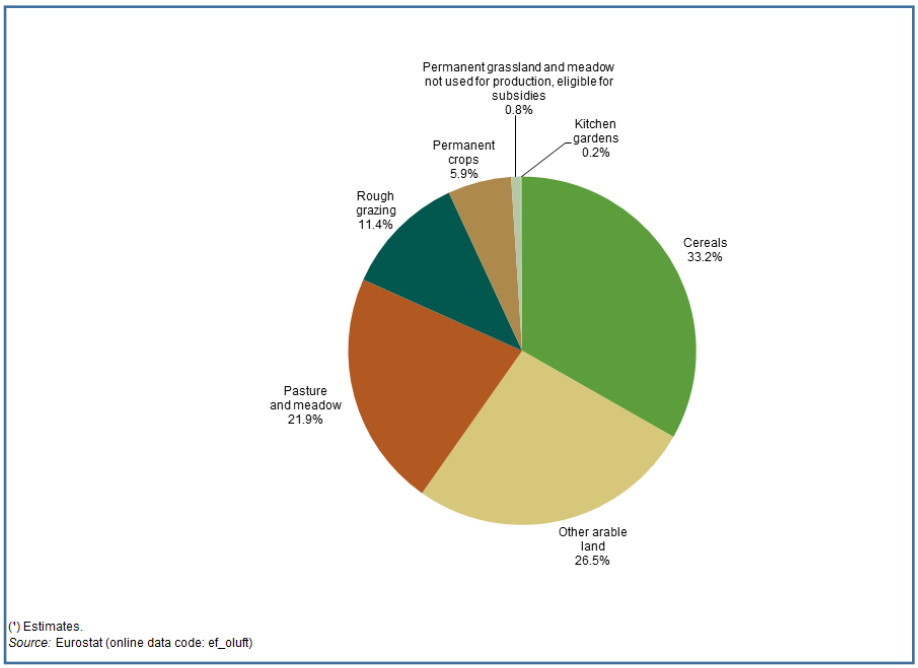


Figure 1111 describes the average utilized agricultural area per holding in 2010 and 2013 at EU Member State level. Average farms size is largest in the Czech Republic (133 ha), followed by the UK (94 ha) and Slovakia (around 80 ha). The on average smallest farms are located in Romania, Cyprus and Malta (averages below 10 ha). The average size of agricultural holdings in the EU28 rose from 14.4 ha per holding in 2010 to 16.1 ha per holding in 2013. Most of the EU Member States recorded an increase in the average utilized agricultural area per holding between 2010 and 2013 with the Czech Republic as an exception (smaller reductions are recorded in Greece and Ireland).

Figure 1212 shows the basic fishery structure in the EU28. Capture production accounted for 81% of the total seafood production in 2013, the remaining 19% came from aquaculture of which 14% are from marine, 4% from freshwater and 1% from brackish water aquaculture.

In 2013, the EU fishing fleet comprised of 83 734 vessels with a combined gross tonnage (GT) of 1.6 million tonnes and engine power of 6.5 million kilowatts (kW) (STECF 2015). The EU fleet consists of vessels that are more or less active in fishing; of the active vessels, 74% were small-scale, 26% were large-scale and less than 1% were distant-water vessels. Figure 1313 provides an overview of the number of the fishing vessels and seafood production in Europe in 2013. Norway leads the seafood production, producing 3191.7 thousand tonnes of seafood, Spain has the largest production (1130.3

thousand tonnes) in the EU-28, followed by France (729 thousand tonnes). The total income earned by the EU fishing fleet in 2013 (excl. Bulgaria, Croatia, Cyprus, Greece and Malta) was estimated at €6.9 billion (STECF 2015).

Figure 11. Average utilised agricultural area per holding, 2010 and 2013 ([1]) (hectares) (European Commission, 2015a)

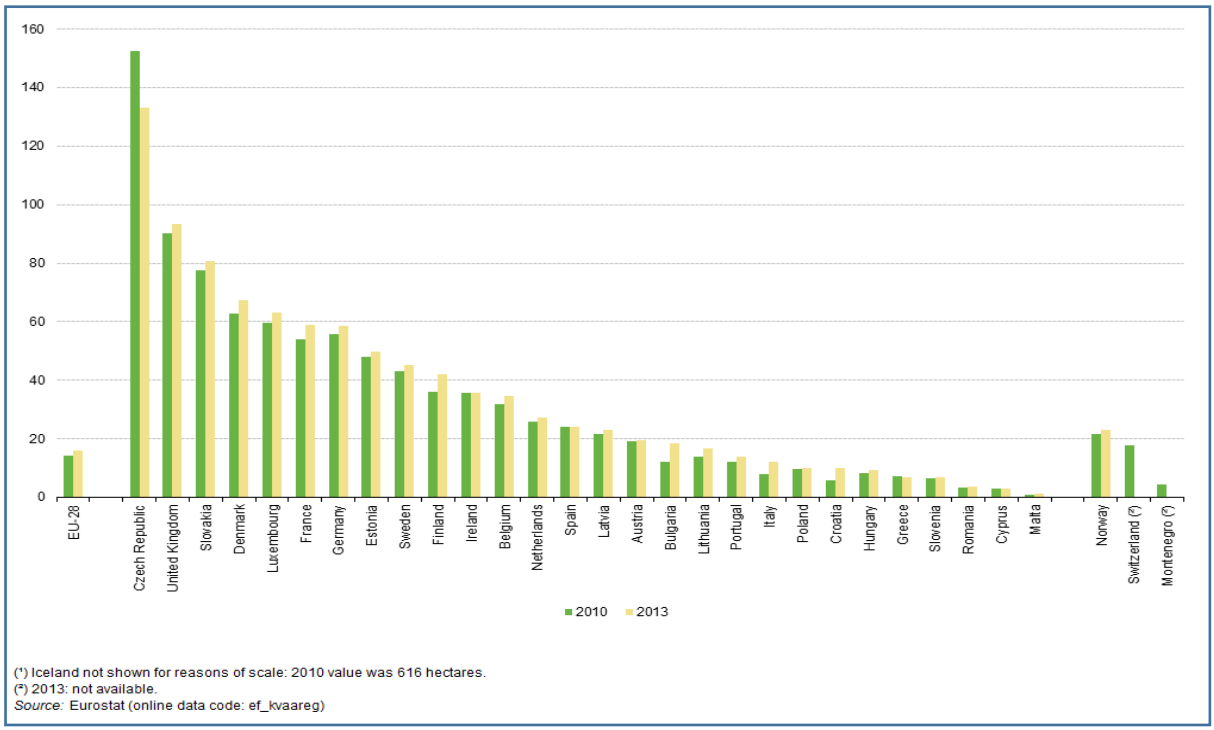


Figure 12. Fisheries production by production source, EU-28, 2013 (by weight) (FAO FishStat, 2016)

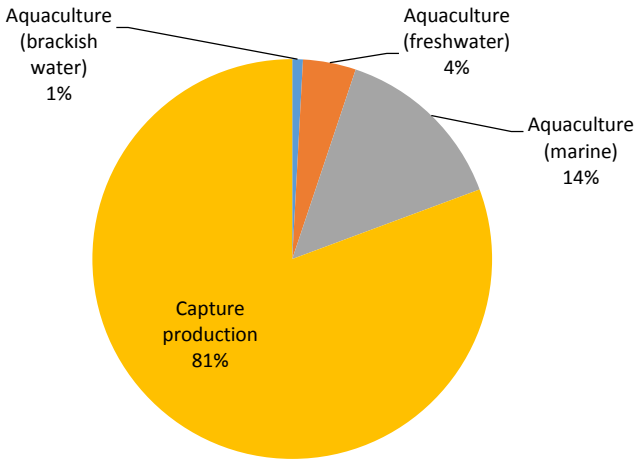


Figure 14 offers a general picture of the seafood production respectively from aquaculture and capture fisheries in 2013. Norway maintains its leadership both in aquaculture or capture production in Europe. In the EU 28, Spain is the biggest producer in the regarding capture fisheries, whose landing amount is nearly 1000 thousand tonnes (top three species landed being skipjack tuna, sharks and hake); followed by Denmark (herring, small pelagics, mackerel); the UK (mackerel, herring, scallop) and France (yellowfin tuna, hake, scallop). For all EU fisheries, the top three target species in volume are small pelagics (herring, mackerel, sprat, sardine), much destined for feed. In terms of aquaculture,

Figure 13. Fisheries production by production source, EU-28, 2013 (by weight) (European Commission 2016)

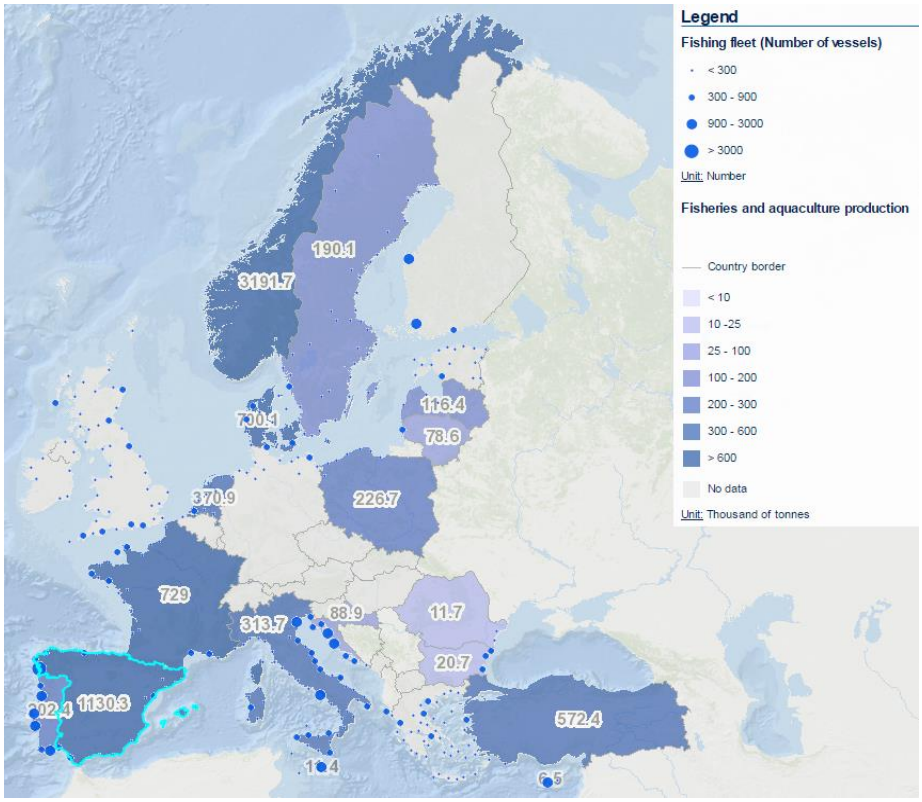
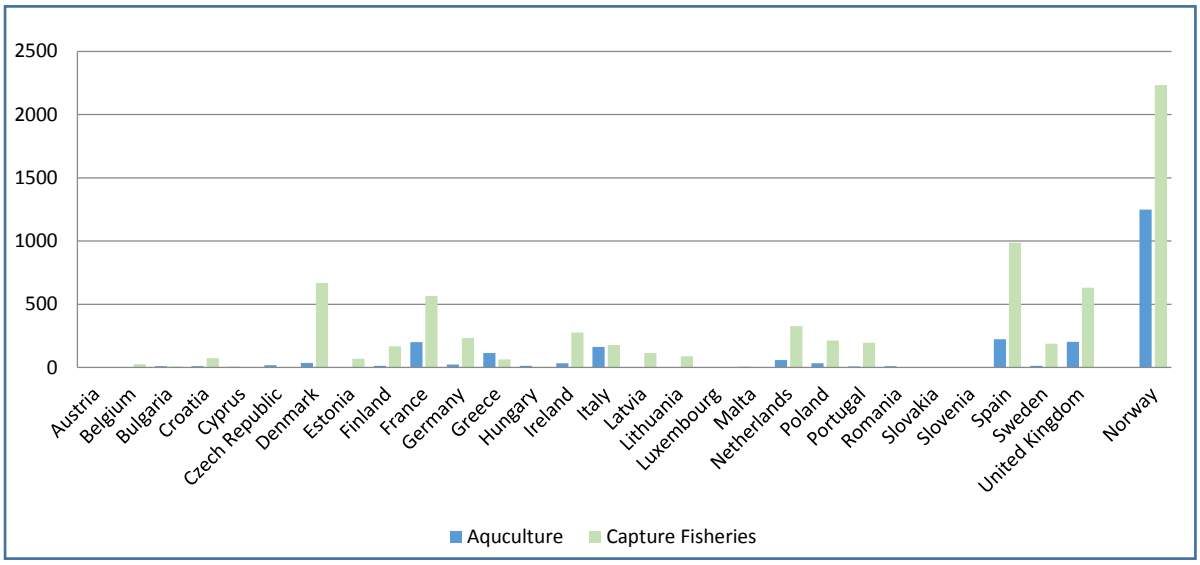


Figure 14. Fisheries production, 2013 (Thousand tonnes) (FAO FishStat, 2016)



the top three producers are Spain (top three farmed species being seabass, mussel and gilt-head seabream); France (oyster, mussel, trout); and the UK (salmon, mussel, trout). Overall EU aquaculture production is dominated in volume by mussel, trout and salmon (EU 2016). However,

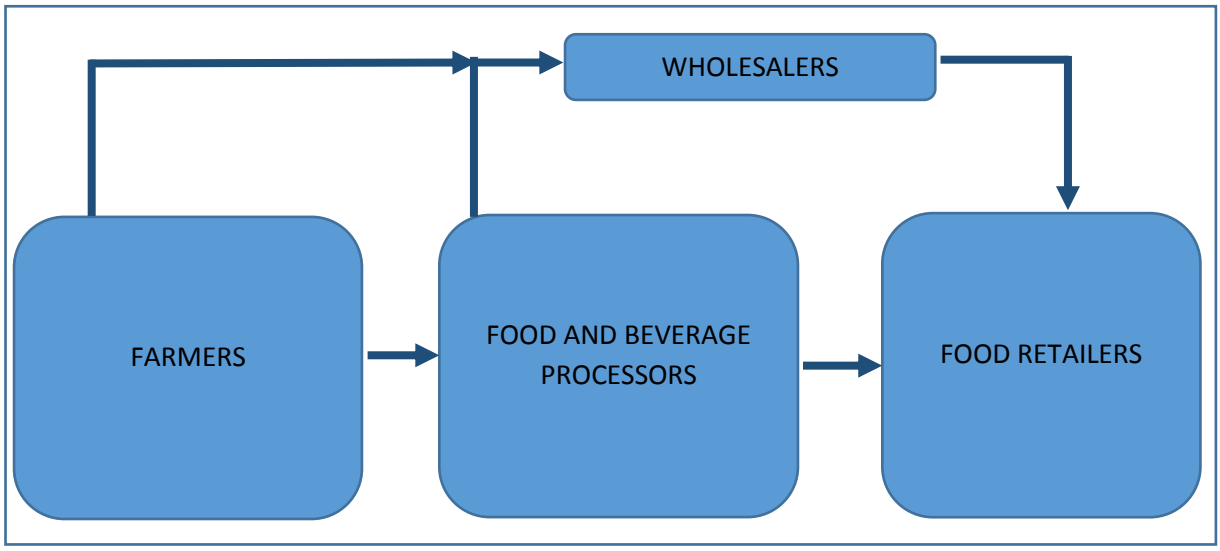
the EU is highly dependent on seafood imports. The self-sufficiency rate (ratio between own production and consumption) has been stable around 45% in the latest estimates (2008-2012).

With respect to employment, the sectors agriculture, forestry and fishing have a share of about 5 % of total employment in 2013 within the EU28. More than 20 million persons work on a regular basis in agriculture in this time frame, whereas family labour contributes with three quarters most to the labour input on farms. Up to 20 % of labour input comes from non-regular, often seasonal employees (European Commission, 2015b). Among the EU Member States the highest agricultural labor force was recorded in Poland (20% of the EU-28 total), Romania (16%) and Italy (9%). From 2000 to 2014 the share of agriculture, forestry and fisheries in the EU-28's total economic activity (as measured by gross value added) fell from 2.2 % to 1.6 % (Eurostat, 2016). In general, employment trends in the agricultural sector vary significantly between different member states and the employment situation is also dependent on farm sizes and overall structural differences within the prevalent farm sector (Dries et al., 2012). Seafood production employs over 122 thousand persons in the processing sector, 170 thousand in fisheries and 73 thousand in aquaculture in full-time equivalents (FTE) according to latest available data (2012-2013; EU 2016).

3.2.1.2 Food chain actors

The EU food supply chain is characterized as a series of complex vertically-related markets (McCorriston, 2016). Although distinctive food supply chains exist for each single food product it is useful to present an approximate and schematic representation of the EU food supply chain, as Figure 14 outlines in order to see its functioning. It links three main sectors: the agricultural sector, the food processing industry and the food distribution sector (wholesale and retail), all of whom operate in different markets across and sell a variety of food products (Figure 15).

Figure 15: Schematic representation of the EU food supply chain by players, based on McCorriston (2016) and European Commission (2015)



In the EU, more than 10 million agricultural holdings primarily sell their output to around 290 thousand food and processing enterprises, but sometimes also sell directly to the wholesalers, comprising of more than 360 thousand firms.

The EU agri-food chains have always played a significant role in economies of the EU (Table 1). In 2013, the EU value added almost reached €685 billion, accounting for 5.6% of total EU value added, and its turnover exceeds €3.9 trillion. There were more than 12 million of holdings or enterprises in the EU food supply chain sectors which employed almost 22 million people, accounting for approximately 10 % of total EU employment. The food and drink industry sector has the highest share in total employment in Denmark, the Netherlands and Germany, the food wholesale in Malta, Denmark, Lithuania and Spain, and the food retail in the UK, the Netherlands and Germany (Figure 16).

Table 1: Structural overview of the food supply chain in the EU (2013), Eurostat and Food&Drink Europe

	Agriculture	**Food & Drink Processing**	**Wholesale**	**Retail**
N. firms (million)	10.84	0.29	0.36	0.92
N. Employees (million)(1)	9.51	4.25	1.96	6.27
Turnover (EUR billion)	422	1,089	1,279	1,121
Value Added (EUR billion)	204	212	105	164

(1) The number of persons employed in agriculture corresponds to the labor force directly employed by the holding. The figure differs from those used in the FSS: individuals which have carried out farm work on the holding during the 12 months (around 22 million personsfor the EU-28).

Figure 16: Number of persons employed in the food supply chain in the EU Member States by sector 2013, Eurostat

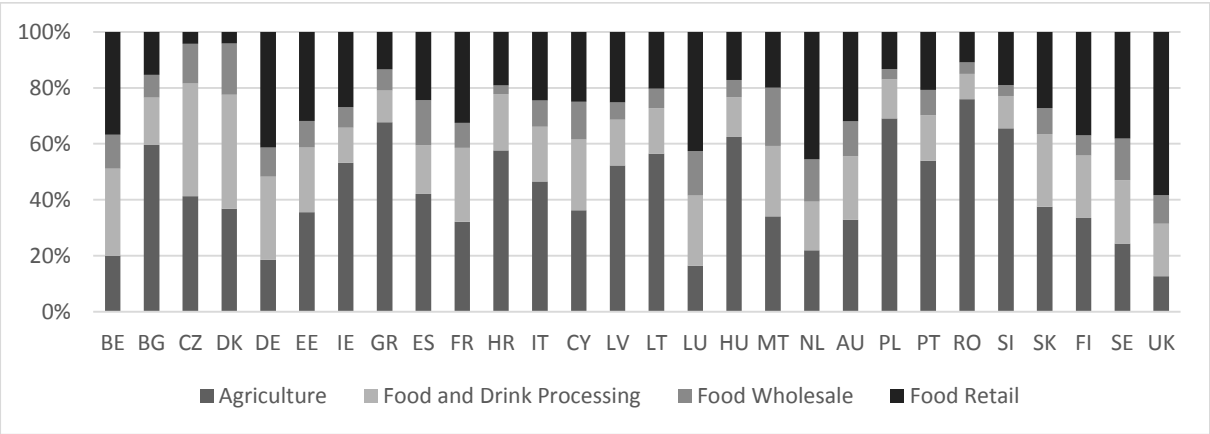
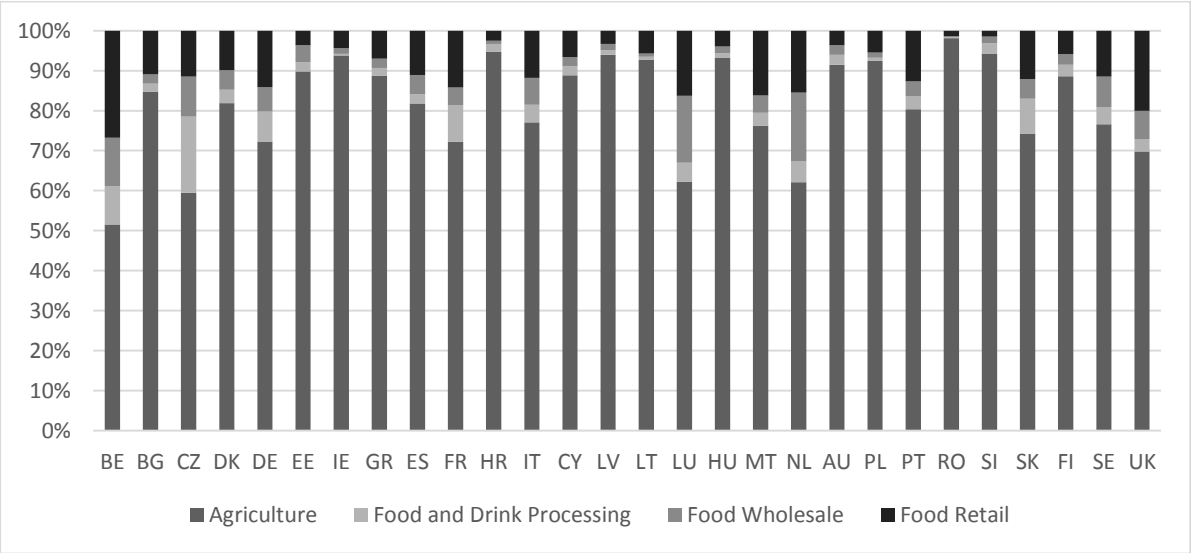


Figure 17: Number of enterprises in food supply chain in the EU Member States by sector 2013, Eurostat



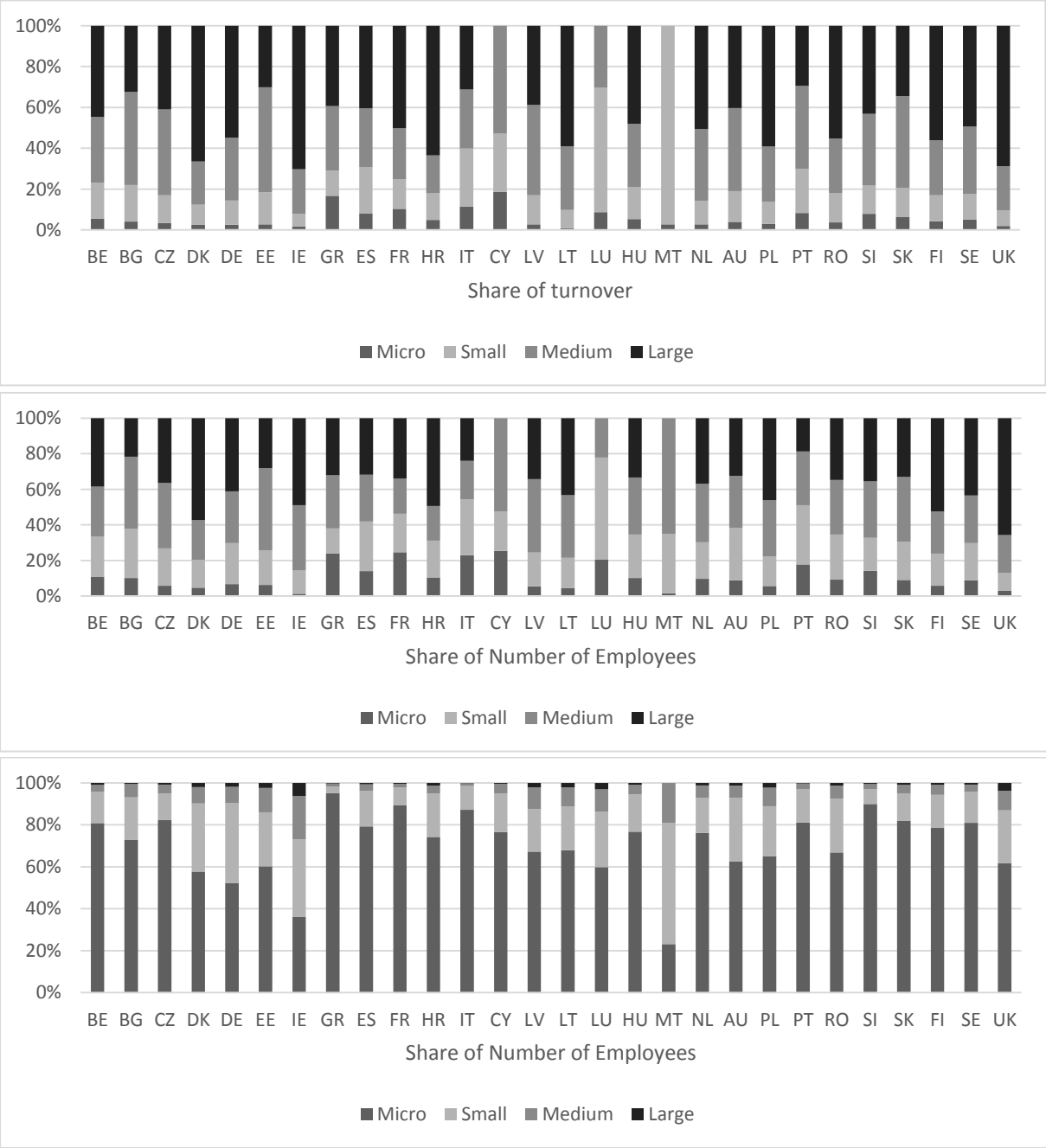
The food and drink processing was the largest within the EU manufacturing in 2013, both in terms of employment, turnover and employment. There were 287.9 thousand enterprises operating with food and drink industry, as their main activity in the EU-28 in 2013 (Figure 17). Together, they employed more than 4 million persons, representing 15% of total manufacturing and generated an annual turnover of €1,088 billion, accounting for 16% of total manufacturing. Although the EU food and drink industry is a key job provider, compared to other manufacturing sectors, its labor productivity[11] remains below that of the average of the manufacturing industry as a whole, reflecting a lower value added per employee on average (European Commission, 2016). The food and drink industry is highly fragmented in nature. Micro-sized enterprises account for more than 80% of total EU food and drink firms. The highest shares of micro-sized enterprises was recorded in Greece, followed by France and Slovenia (90% each). Large firms account for about 39% of total employment and 50% of total turnover in the sector (Figure 18).

In terms of international trade, the European Union is a key player on the world food market. EU's exports grew by nearly 8% per year from 2005-2015 and imports by 6% over the same period (European Commission, 2016a). While agricultural commodities imports increased by more than 70%, exports of processed products between 2005 and 2014 (European Commission, 2016a). Top three best performing exports of the food and drink industry in 2014 were dairy products, chocolate and confectionery and grain mill and starch products (Food & Drink Europe, 2015).

The sectors making up the food distribution -wholesale and retail trade- jointly produced a turnover amounted to €2,400 billion, more than 1.5 times as much as the agricultural and the food industry sectors combined. Compared to the other players of the agri-food chain, the wholesaling sector has the lowest number of employees (around 360,000), but it generated the largest share of turnover

[11] Apparent labor productivity is defined as value added at factor costs divided by the number of persons employed. This ratio is generally presented in thousands of euros per person employed. (Eurostat)

Figure 18: Structure of the EU MS food and drink industry, in the EU Member States *by size in 2013, Eurostat*



(exceeding the amount of €1,200 billion). France has the highest share of wholesaler turnover across EU MS, followed by Germany and the UK.

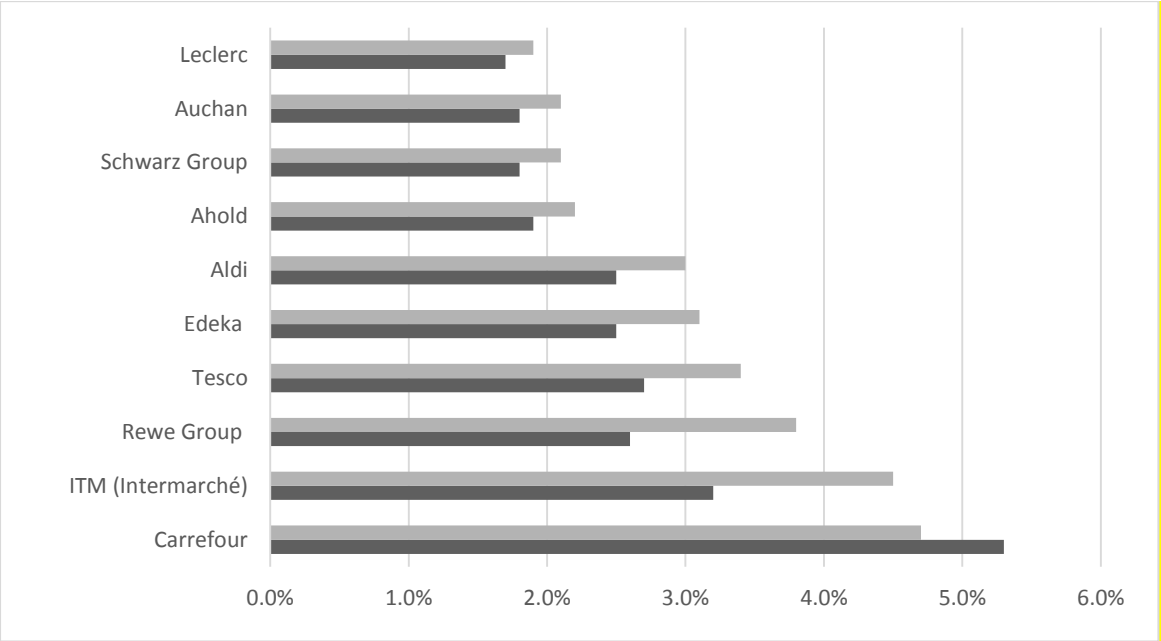
Over the past few decades, consolidation is taking place at all levels of the food supply chain. In particular, the food retailing sector has experienced significant structural change across the EU Member States, mainly pulled by the strong development of modern retailers[12.] A 2014 European

[12] The term ''modern retailers' refers to hypermarkets, supermarkets and discount stores, For more details on the definition see European Commission (2014)

Commission study (European Commission, 2014) shows that a clear trend towards highly concentrated retail markets, through the higher market share of large retailers and the creation of buying alliances, has been observed in many Member States. The number of Member States, where the share of the top five retailers exceeded 60% has increased from 8 to 13 between 2000 and 2011.

At the same time the EU market share of the top 10 European food retailers increased from 26% in 2000 to 31% in 2011. The EC study also noted that even though there have been changes in the market shares, the group of companies representing the top 10 European retailers has not changed during the 2000-2011 period (**Fout! Verwijzingsbron niet gevonden.**19).

Figure 19: Market share (edible grocery) of top 10 retailers in EU (2000-2011,) European Commission, 2014

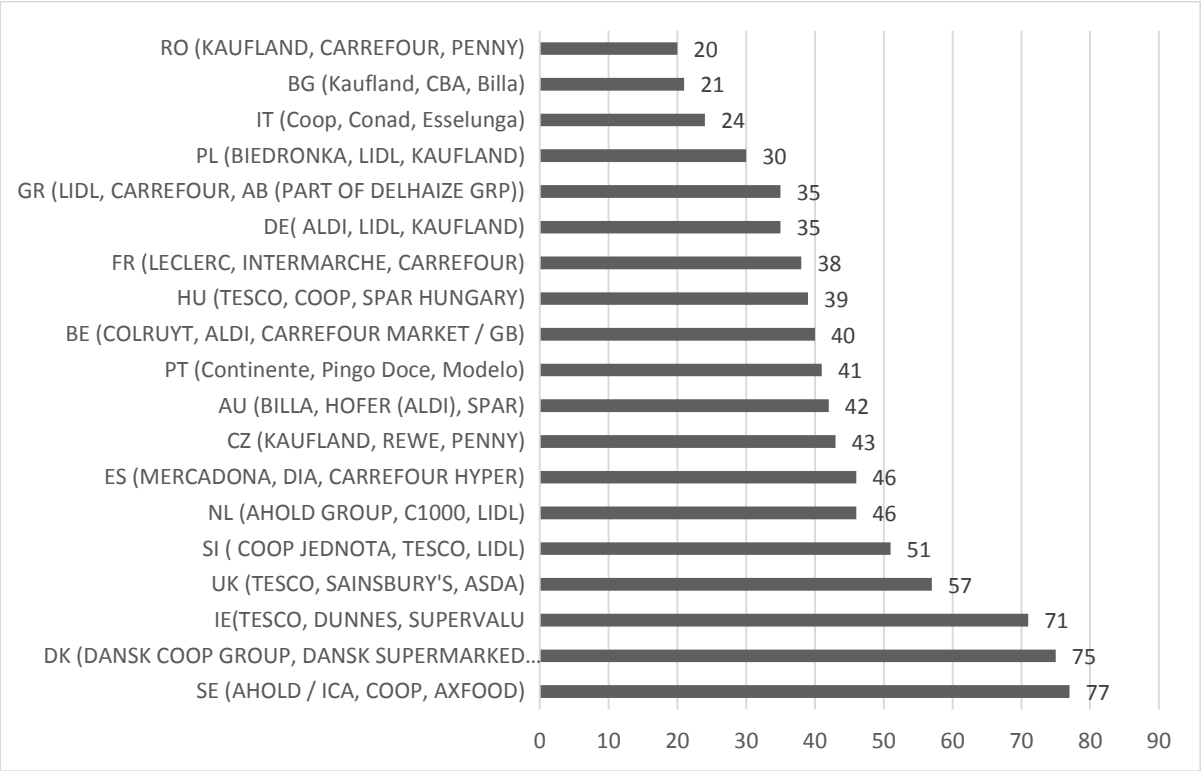


However, there are significant differences across EU Member States with market share of the top three retailers ranging from 30% to 50%. It is significantly above 70% in Sweden, Denmark and Ireland (see **Fout! Verwijzingsbron niet gevonden.**20).

In terms of evolution of retail concentration in the total food retail sector[13], including both modern and traditional retailers, Figure 21 shows a positive trend in all Member States except for Ireland, Luxembourg, Sweden, and the UK. Some Member States with the lowest share in 2011, such as Romania and Bulgaria have experienced the greatest growth over the period 2004-2012.

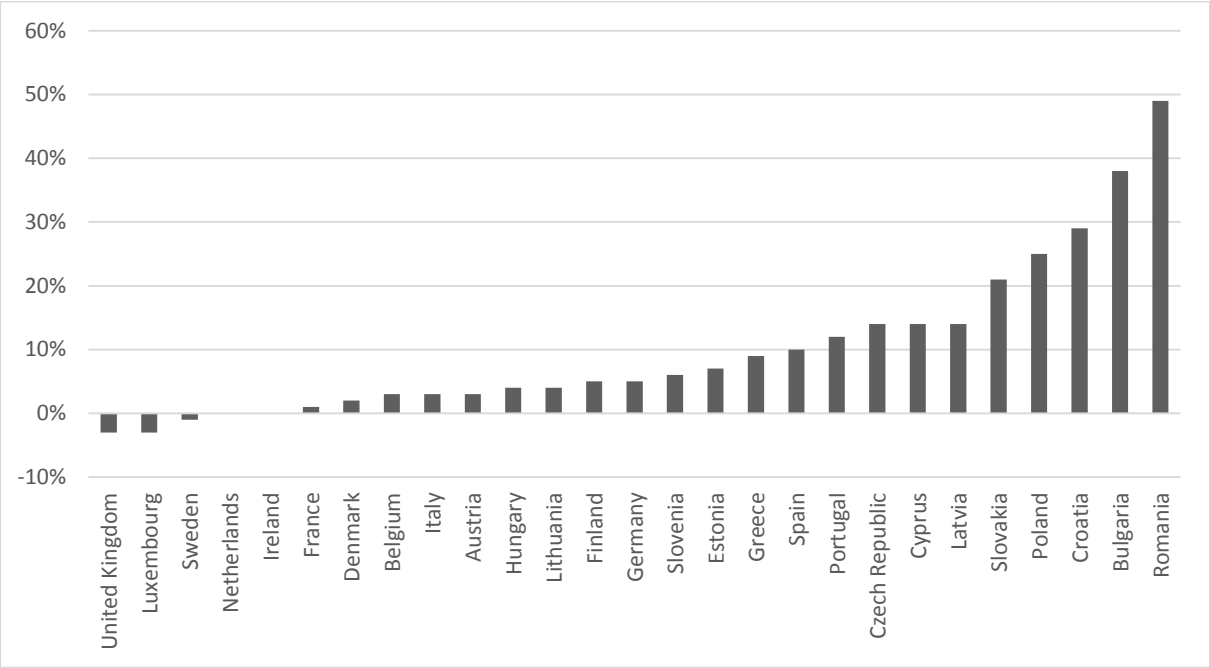
[13] This is measured by the Compound Annual Growth Rate ('CAGR') The CAGR is the year-over-year growth rate of a certain measure over a specified period of time. It is calculated by taking the nth root of the total percentage growth rate, where n is the number of years in the period being considered.

Figure 20: Market share of top 3 retailers across EU Member States, 2011 (%), Food & Drink Europe (2012)



Internationalisation has been an important feature of the EU retailing sector over the past two decades. Although domestic markets remain their main market, domestic share of European grocery banner sales has generally decrease for almost all top European retailers, with the notable exception of ITM and Edeka. Following the EU enlargement, new member states experienced a fast growth of modern retail sectors with very few of the top grocery retailers being locally based. This was mostly due to the expansion of retailers from old Member States rapidly into the new markets in Central and Eastern Europe to benefit from a stronger economic growth coupled with lower competition. In recent years, the trend of further expansion of modern retail groups have been focusing on non-EU markets (European Commission, 2014).

Figure 21: Change in retail concentration[14] in total edible grocery, in the EU Member States (2004–2012), author's elaboration from European Commission, 2014



3.2.1.3 Consumers

European diets are quite varied and each country in Europe has its own traditional cuisine, although they influence each other. Northern European diets tend to be heavy on meats and tubers, like potatoes, and lower in whole grains, fruits and vegetables compared to Southern European ones. Most of the Southern European countries eat similar foods, but the method of preparation and presentation varies from country to country. In general red meat, chicken and eggs are eaten sparingly; though fish is popular.

Consumers' behaviour are influenced by many parameters and drivers. Consumers' purchases are swayed by their habits, their tastes, their preferences, their knowledge, their perceptions, the time they spent for cooking, their beliefs, their motivations (to quote a few of possible influences), and obviously by the prices of foods. All these previous parameters are influenced by private and public actions like advertising, labelling, recommendations, media coverage, food availability, per-unit tax and/or subsidies imposed on products (like the sugar tax or the fat tax). Moreover, sustainability particularly raises the question of the complexity of food systems implying challenges for conveying credible and reliable information to consumers. In other words, as sustainability gathers various environmental and nutritional criteria, consumers face difficulties to know and define sustainability. For improving the sustainability of consumption patterns, it is essential to study the consumption habits and to understand the consumers' knowledge about sustainability.

[14] Retailers' concentration is based on the Herfindahl–Hirschman Index (HHI), calculated as sum of the squares of the market shares of all market players.

3.2.2 Actors outside the food system

3.2.2.1 Food system policy makers

In section 3.1 we have identified four major policy goals in relation to sustainable food and nutrition security in the EU: balanced and sufficient diets for EU citizens; viable and socially balanced EU agri-food business; reduced environmental impact; and contributions to global Food and Nutrition Security. The four goals galvanise a range of objectives in the domain of agriculture, food and nutrition, in relation to the environment, the economy, law and social justice and public health. The political responsibility for these objectives is scattered over various EU policy areas and various national ministries.

3.2.2.1.1 European Commission supported by Directorate Generals

At EU level, the European Commission (EC) is the 'Guardian of the Treaty', ensuring the correct application of the Treaties and any regulation arising from them (Kunst, 2010). Every EU Member State has one representative within the EC, which is responsible for a particular EU policy area. The Commissioners are supported by over 40 directorates-general (DGs) and services. These include policy directorates-general (such as DG Agriculture and Rural Development, DG Health and Food Safety, DG Environment, DG Energy, and DG Regional and Urban Policy), directorates-general for foreign affairs (such as DG Trade and DG International Cooperation and Development), five general services (including Secretariat General and Communication) and 12 internal services (such as interpreters and the Legal Service). The DGs particularly involved in sustainable European food and nutrition security in the EU are presented in Table 2.

Table 2: Overview of directorates-general particularly involved in FNS in the EU, adaptation by LEI after Kunst (2010) and Candel (2016)

Directorates-general	*Acronym*
DG Agriculture and Rural Development	AGRI
DG Environment	ENVI
DG Health and Food Safety	SANTE (SANCO[1)])
DG Humanitarian Aid & Civil Protection	ECHO
DG International Cooperation and Development	DEVCO
DG Maritime Affairs and Fisheries	MARE
DG Regional and Urban Policy	REGIO
DG Research and Innovation	RTD
DG Trade	TRADE

1) In the previous Barosso Commission known as the Directorate General Health and Consumers Affairs (DG SANCO).

The main food and nutrition security topics within the DGs listed in Table 2 are briefly discussed below.

- DG AGRI is focussed on the CAP. Its activities include a large number of items related to food and nutrition security such as direct support for farmers, agricultural market measures, rural development, agriculture and environment, bioenergy, climate change, organic farming,

quality policy, biotechnology, promotional measures, forest resources, state aid, research and innovation, food and feed safety, animal health and welfare, plant health, school schemes and fair trade practices (DG AGRI, 2016a).

- DG ENVI deals mainly with policy development and implementation via multiannual Environment Action Programmes (DG ENVI, 2016a). The current European environment policy until 2020 is guided by the 7th Environment Action Programme to 2020 'Living well, within the limits of our planet'. Policy topics include natural capital, green economy and health.
- DG SANTE strives after an EU integrated approach of food safety. It aims to assure a high level of food safety, labeling and nutrition, animal health, animal welfare and plant health within the EU through coherent farm-to-table measures and adequate monitoring, while ensuring the effective functioning of the internal market (DG SANTE, 2016). This approach includes the development of legislative and other actions (1) to assure effective control systems and evaluate compliance with EU standards in the food safety and quality, animal health, animal welfare, animal nutrition and plant health sectors within the EU and in third countries in relation to their exports to the EU; (2) to manage international relations with third countries and international organisations concerning food safety, animal health, animal welfare, animal nutrition and plant health; and (3) to manage relations with the European Food Safety Authority (EFSA) and ensure science-based risk management. Specific food and nutrition security issues are amongst others labelling and human nutrition, biological and chemical safety, the General Food Law, the fitness check (i.e. review of the entire body of legislation in a certain policy area with the purpose of identifying excessive burdens, overlaps, gaps, inconsistencies and/or obsolete measures) to the food chain, international affairs and official controls and enforcement. In addition, DG SANTE also aims at contributing to the improvement of health and the prevention of illness by bringing EU countries together to discuss strategies for healthy lifestyles and tackling issues such as obesity.
- DG ECHO provide assistance to people affected by humanitarian crises and disasters worldwide (DG ECHO, 2016). More than 120 million victims of disasters or conflicts around the globe receive the EU's life-saving humanitarian support (food, water and other vital goods and services) each year. In addition, disaster risk reduction activities in countries most prone to disasters aim at reinforcing the resilience of local communities by better preparing them to face emergencies. Specific activities in the field of food and nutrition security include providing access to safe drinking water and sanitation facilities for families and communities; free access to health care for children and pregnant and lactating mothers; treatment of moderate and severe acute malnutrition through a community-based approach; and organising information sessions on appropriate diet and feeding practices.
- DG DEVCO is responsible for designing European development policy and delivering aid throughout the world through a set of financial instruments with a focus on ensuring the quality of EU aid and its effectiveness (DG DEVCO, 2016). Its view on good governance, human and economic development and the tackling of universal issues, such as fighting hunger and preserving natural resources is set out in the 2030 Agenda for Sustainable Development. Within the theme of food and nutrition security DG ENVI seeks to build resilience to food crises and help countries ensure that no one is left hungry, in particular fighting under-nutrition of children.

- DG MARE manages the common fisheries policy (CFP) and the integrated maritime policy (DG MARE, 2016). By doing so, it aims to help increase the fisheries sector's production and competitiveness and to foster 'blue growth' (economic growth based on different maritime sectors) and marine knowledge.
- DG REGIO targets it regional policy on all regions and cities in the European Union in order to support job creation, business competitiveness, economic growth, sustainable development, and improve citizens' quality of life (DG REGIO, 2016). Food and nutrition security issues include SME competitiveness, a low carbon economy, climate change and risk prevention, and environment and resource efficiency.
- DG Research and Innovation (RTD) defines and implements European research and innovation policy with a view to achieving the goals of the Europe 2020 strategy and its key flagship initiative of the Innovation Union (RTD, 2016). Within the EU research program Horizon 2020 there is a specific work program with calls on the theme of Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy. In October 2016 DG Research and Innovation intends to launch its Food 2030 strategy for a coherent research and innovation policy framework for Food and Nutrition Security.
- DG Trade helps to develop and implement EU trade and investment policy (DG TRADE, 2016). By doing so, it aims to shape a trade and investment environment that is good for people and for business. EU trade policy is working to (1) create a global system for fair and open trade; (2) open up markets with key partner countries; (3) make sure others play by the rules; (4) ensure trade is a force for sustainable development (5) support the fight to protect our environment and reverse global warming; (6) strive to improve working conditions for workers in developing countries; and (7) ensure the highest standards of health and safety for the products we buy and sell.

This overview of food and nutrition security topics reveals that this theme is fragmented over many DGs. In implementation even more DGs, like DG Competition, DG Climate Action and DG Budget, are involved.

3.2.2.1.2 Three institutions involved in the EU legislation procedure: the EC, the Council and the EP

The EC has the exclusive initiative to propose new legislation in the EU, which has to be agreed by the Council and the European Parliament (EP). The Council consists of government representatives (ministers) of the Member States. This Council meets in 10 official formations (EU, 2016). Food and nutrition security is mainly dealt with in the Council for Agriculture and Fisheries and the Council for Employment, Social Policy, Health and Consumer Affairs. Decision-making in the EP is prepared in Committees, each covering 40 EP members. EP Committees especially involved in food and nutrition security work are listed in Table 3.

With respect to dossiers in which there is a mandate for EU legislation, the legislation procedure in the EU is made up of the following steps (Kunst, 2010). The EC first launches a proposal for legislation in a certain area. This proposal is tested via stakeholder consultations in advisory or expert groups. After such a consultation, the EC usually produces a Memorandum, Communication or Reflection Paper for a further extension and structuring of the debate. As a next step the EC prepares a formal legal proposal, which is often affected by input received from a Council Conclusion or a Recommendation from the EP. If the Council and the EP accept the legal proposal, it can be laid

down in an EU Regulation or an EU Directive. A Regulation has a general application and is binding and directly applicable in all Member States, whereas a Directive is binding to the Member State to which it is addressed and it leaves the choice of form and methods to the national authorities.

Table 3: Overview of Committees of the European Parliament particularly involved in FNS in the EU , Candel (2016)

EP Committee on:
Agriculture and rural development
Development
Environment
Fisheries
Foreign Affairs
International trade

3.2.2.1.3 Policy makers at national level

Considerable parts of food and nutrition security policies are the competence of the Member States, particularly around public health and nutrition. Legislation procedures, the distribution of policy topics among ministries and political preferences vary among EU Member States. As a result, food and nutrition security may be part of the competence of various ministries in the EU Member States and the precise implementation of EU Directives on food and nutrition security may differ by Member State. As an illustration, we give an overview of how the four studied countries in the SUSFANS project implemented the food-based dietary guidelines (FBDG) from the EFSA (EFSA NDA Panel, 2010) (Table 4).

Table 4: Summary of food based dietary guidelines in teh Czech Republic, Denmark, France and Italy (the SUSFANS case study countries), Geleijnse et al. work in progress under SUSFANS WP2

Food based recommendations	**CZ**	**DK**	**FR**	**IT**
Eat wide variety of foods	✓	✓	✓	
Eat at least *200 grams* of **vegetables**	✓	✓	✓	✓
Eat at least *200 grams* of **fruit**	✓	✓	✓	✓
Limit the consumption of **red meat**, particularly **processed meat**	✓	✓	✓	✓
Take daily of *few portions* **dairy** products, including milk or yoghurt	✓	✓	✓	✓
Eat **legumes** *weekly*	✓			✓
Eat daily at least *15 gram* of **unsalted nuts**				
Eat daily at least *90 grams* of brown bread, wholemeal bread or other **whole grain products**. *Replace* refined cereal products by whole grain products	✓	✓	✓	✓
Replace butter, hard **margarines and cooking fats** with soft margarines, liquid cooking fats, and	✓		✓	✓

vegetable oils.				
Eat *weakly 1/2 servings* of **fish**, preferably oily fish	✓	✓	✓	✓
Drink daily *three* cups of **tea**				
Replace unfiltered coffee by filtered **coffee**				
Minimise consumption of **sugar-containing beverages**	✓	✓	✓	
Don't drink **alcohol** or no more than *one glass* daily	✓		✓	
Limit **salt** intake to *5-6 grams* daily	✓	✓		
Reduce **sweet and candy**	✓	✓	✓	
Drink *as much* **water** as you like	✓	✓	✓	
Nutrient/ Food based				
Choose lean meat and lean cold meats/ poultry instead of fat meat	✓	✓	✓	
Choose low fat dairy	✓	✓		
Eat foods with less salt	✓	✓	✓	
Eat daily 1-2 portions of meat, poultry, fish, or egg			✓	
Give preference to cheeses with high calcium, less fat, less salt			✓	
Nutrient based recommendations				
Eat less saturated fat	✓	✓		
Eat less sugar	✓	✓	✓	
Eat less fat	✓			
Use salt fortified with iodine	✓		✓	

3.2.2.2 Food system influencers

3.2.2.2.1 NGOs and civil society organizations

A wide range of groups and organizations representing specific interests are lobbying to influence the decisions made by the EU. In order to make the EU decision process as transparently as possible, the EU opened a Transparency Register for lobbyists in 2011. Currently the register includes almost 9,500 lobbying groups (Table 5). Over half of them are in-house lobbyists and trade, business or professional organisations and about a quarter are NGOs, organizations, platforms and networks. However, despite the Transparency Register, there are still unregistered lobbyists. It is estimated that about 3,000 lobbying entities have an office in Brussels (Transparency International, 2016). A part of the lobbing groups is involved in influencing the food system. In order to illustrate how lobbyists attempt to influence EU decisions on food security, we discuss their views in the debate on the CAP 2013 reform and the debate on the Communication on sustainable food.

3.2.2.2.2 Scientists and researchers

Researchers play a major role in creating new knowledge to tackle the challenges of food and nutrition security: to provide sufficient safe, nutritious, food for a healthy life for all and to cope with climate change and resource efficiency. Researchers may be employed at universities, institutes for applied research, international institutions, industry, consultant firms, NGOs, etc. National and

international R&D programs, such as Horizon2020, provide finical support for research on food and nutrition security topics. At national and international conferences, journals and websites new knowledge is disseminated. Researchers also participate in discussions on social media and public consultations of the Commission.

Table 5: Lobbying groups registered in the EU Transparency Register, mid-2016 [1)], Europa Transparency Register (2016), Why a transparency register; Via website: http://ec.europa.eu/transparencyregister/public/consultation/statistics.do?locale=en&action=prepareView.

		N	%
I	Professional consultancies/law firms/self-employed consultants	1093	12
II	In-house lobbyists and trade/business/professional associations	4854	51
III	Non-governmental organisations, platforms and networks and similar	2392	25
IV	Think tanks, research and academic institutions	671	7
V	Organisations representing churches and religious communities	44	0.5
VI	Organisations representing local, regional and municipal authorities, other public or mixed entities, etc.	438	5
	Total	9492	100

1) Dated at July 13, 2016.

3.2.2.2.3 Food system influencers in the CAP 2013 reform debate

Since the start of the CAP in the 1960s, its content has periodically been adjusted. Since the turn of the century, the CAP is programmed for periods of seven year. In order to discuss the contents of the CAP for the programming period 2014-2020, the EC organized several consultations with stakeholders, the public and other interested parties In the years 2009-2012 (DG AGRI, 2016b). Candel (2016) analysed which lobbyists put forward food security arguments in these consultations and which views they had on the relationship between the CAP and food security. For categorizing the claims, Candel used frames. A frame structures the way in which people perceive reality and communicate about it (Van den Brink, 2009). Candel (2016) found six frames on food security in the CAP 2013 reform debate:

1. *the productionist frame*

In this frame the emphasis is on stimulating production and increasing productivity in the agricultural sector. Through its focus on food production, the CAP is considered to be a cornerstone for EU food security policy. Challenges in this frame are severe price volatility, dependency on

imported goods like feeding stuffs, and the impacts of climate change. In the future CAP farmers' competitiveness could be safeguarded by continued income support and market measures.

2. *the environmental frame*

In this frame, food security is coupled with the environmental concerns. Traditionally the CAP has focussed too much on food production, thereby paying too little attention to the negative effects of agriculture for nature, landscape and the countryside. Sustainable food production and the provision of environmental services are seen as integral part of EU agriculture. Challenges in this frame are climate change and environmental degradation. For the future CAP far-reaching greening measures are proposed.

3. *the development frame*

The focus of this frame is on the impact of the CAP on food security in the developing countries. The frame argues that the CAP has limited the opportunities of the developing countries for realizing autonomy or self-sufficiency regarding food provision. Three main problems are perceived: the income support for EU farmers makes it hard for non-EU parties to enter the EU market, the EU imports of protein rich feeding stuffs have detrimental effects on the environment and rural viability in other parts of the world, and the occasional use of export subsidies results in unfair competition. The future CAP should eliminate arrangements that distort developing countries' market development.

4. *the free trade frame*

In this frame it is thought that food security is best served by facilitating free international trade. Free trade gives farmers all over the world an opportunity to enter commodity markets and allows consumers to buy products at the lowest price. The future CAP should eliminate all trade distorting elements such as export subsidies and import tariffs.

5. *the regional frame*

Stakeholders in this frame are primarily concerned about the impact of the CAP on regional differences in food security in the EU. Farmers in less-favoured areas and less-developed regions have difficulties to produce at world market prices and therefore these areas are in risk of farm marginalization and land abandonment. This endangers regional food security and the viability of the countryside. The future CAP should focus on a redistribution of CAP funds with a fair support for small and middle sized farmers in less-favoured areas.

6. *the food sovereignty frame*

Stakeholders in this frame are highly critical of the term food security, which is seen as primarily used in favour of the neo-liberal interests, by governments and by agri-industrial actors. Food sovereignty forms an alternative interpretation of food security and focusses attention on people's right to food and to decide about the modes of production, entailing local and regional self-sufficiency. The future CAP should prioritize regional food provision: local food produced in a sustainable way, payments directed at small farmers, and payments for greening services.

Candel (2016) distinguished 110 different lobbyists in the consultation on the future of the CAP (Table 6). It appears that over 40% of the stakeholders involved used the productionist frame on the relationship between the CAP and food security. Most of these stakeholders originate from trade,

business or professional associations. More than one third of the stakeholders - mainly NGOs and platforms - argued from the environmental frame. The regional, food sovereignty, development and free trade frames were each used by a small minority of the stakeholders: some 5-10%. Finally, also 5% of the stakeholders used more than one frame on the relationship between the CAP and food security, denoted as multiple frame.

Table 6: Stakeholders in the CAP 2013 reform debate associated with the used frames on the relationship of CAP and food security, 2009-2012, Candel (2016)

Frame	N	%	Type of actors
Productionist	41	37	Agri-chemical industry (3) Farmers' organizations (10) Other food producers and processers' organizations (11) Agri-technological organizations (4) Member states (4) EP groups (2) Academia (2) Others (5)
Environmental	36	33	Environmental and nature organizations (11) Health organizations (13) Sustainable agriculture businesses and organizations (3) EP groups (1) Others (8)
Regional	9	8	Local authorities (5) Regional development organizations (3) Farmers' organizations (1)
Food sovereignty	8	7	Food sovereignty organizations (6) Labor unions (1) EP groups (1)
Development	6	5	Fair trade organizations (3) Associations of churches (1) NGOs (1) Research institutes (1)
Free trade	5	5	Food producers and processers' organizations (2) Trade organizations (1) EP groups (1) Member states (1)
Multiple	5	5	Member states (2) EP groups (1) EP Lyon report European Commission
Total	110	100	

3.2.2.2.4 Debate on the Communication on Sustainable Food

In the EC Roadmap to a resource efficient Europe (EC, 2011) – which was a follow-up of the Europe 2020 strategy towards a resource efficient Europe – food was identified as a key sector. In this roadmap, the EC committed itself to produce a Communication on sustainable food by 2013 in order to assess how best to limit waste throughout the food supply chain, and consider ways to lower the environmental impact of food production and consumption patterns (DG ENVI, 2016b). In the summer of 2013 a public consultation was launched to support policy making on sustainable food. The consultation focussed on five areas of discussion: (1) Better technical knowledge on the environmental impacts of food; (2) Stimulating sustainable food production; (3) Promoting sustainable food consumption; (4) Reducing food waste and losses; and (5) Improving food policy coherence. The public consultation received over 600 responses, of which more than 350 from individuals. The remainder of the response originated from farmers/fishery groups, producers associations, industry, NGOs, researchers, local end national authorities, and international bodies (DG ENVI, 2016c). Within the responses, the view on the precise balance of people, profit and planet and the measurement of the environmental impacts of food products widely varies. Opinions how to achieve sustainable food production vary in a range from extensive, integrated agriculture to productive, intensive agriculture. Ideas about sustainable food consumption included to provide a common set of guiding principles of what constitutes a sustainable diet, food labelling schemes highlighting more sustainable choices, and the promotion of more sustainable food choices in retail outlets by increasing their availability/ accessibility. Views on the reduction of food waste covered amongst others the proper planning of food purchases, a proper storage of food, information on the meaning of food date labels, exchange of good practices on food waste prevention etc. In spring 2014, a Communication called 'Building a Sustainable European Food System' was ready to be published. However, the Communication was blocked as its environmental proposals might conflict with the then strong EC focus on promoting economic growth (Eating better, 2014). Despite pressure from lobbyists the Communication on Sustainable Food is still pending. The new Commission Juncker has reassigned the theme of waste to DG SANTE and it is unclear where the responsibility for sustainable food sits (Eating better, 2014).

3.3 Drivers of food system actors and their behaviour

The SUSFANS project distinguishes between two types of driving forces that influence the EU food system actors and thus system's performance, namely 'direct' and 'indirect' drivers (see section 2.4). As the factors directly driving decisions are different across actors the conceptual framework describes the direct drivers for primary producers, food chain actors and consumers separately. This will allow a detailed analysis and enables the project to develop interventions that specifically address the drivers related to each actor category. For indirect drivers though the frameworks describes these for all actors jointly as these drivers usually work in combination to influence a set of direct drivers. In this section first all the direct drivers acting upon the different actors within the food system are discussed, followed by a description of the indirect drivers.

3.3.1 Direct drivers of food system actors

3.3.1.1 Direct drivers for producers

Hazell and Wood (2008) define a driver as 'any natural- or human-induced factor that directly or indirectly brings about change in an agricultural production system'. They distinguish global-scale drivers, country-scale drivers and local-scale drivers. According to their nomenclature, global-scale drivers affect all agriculture around the world and include trade expansion, value chain integration, climate change, agricultural support in the Organisation for Economic Cooperation and Development (OECD) and the Word Trade Organisation (WTO), globalization of science and knowledge, technology and products relevant to agricultural development. As such, they are almost identical with our indirect drivers of the agro-food system. Country-scale drivers affect agriculture within a country (e.g. infrastructure, market access) and local-scale drivers are specific to each local geographical area and different types of agricultural production systems. However, the drivers they subsume under country- and local-scale drivers largely differ from our category of direct drivers. In our framework, direct drivers are defined as drivers that directly affect the decision-making on site.

The ultimate decision-making of agricultural production takes place on the farms. The farmers/fishers or producers make their decisions based on a variety of drivers. Examples of decision-making processes in fisheries and their influence on the efficiency of the fishery and its products are given in Ruttan and Tyedmers (2007) and Ziegler et al. (2015). Drivers that affect the producers directly are reviewed in the following.

Öhlmér et al. (1998) identify eight elements of decision-making at the farm level: (1) values and goals, (2) problem detection, (3) problem definition, (4) observation, (5) analysis, (6) development of intention, (7) implementation, and (8) responsibility bearing. Values and goals are internal direct drivers and briefly reviewed below. External direct drivers mainly affect the problem detection. Once a problem due to a change in external drivers is detected, more information is gathered in the elements problem definition and observation, which finally lead to a decision process and a potential change in production activities (Öhlmér et al., 1998).

Within the EU food system, several drivers that influence actions and decision-making processes of primary agricultural and fishery producers can be distinguished. Although a strict assignment of these factors to different categories is barely possible due to their interdependencies, the drivers that are mentioned in the literature are broadly classified into a number of categories in the following. Positive development in prices for both farmed and fished species and increase in seafood consumption per capita are important drivers for seafood production (FAO 2014).

3.3.1.1.1 Regulatory environment per country

The regulatory environment for agriculture in the EU is determined by the Common Agricultural Policy (CAP), the regulatory environment for fishery is determined by the Common Fisheries Policy (CFP). Below, first the agricultural, then the fisheries part are described.

The CAP, agricultural regulations from supranational EU institutions and their implementation at national and local levels are among the most important drivers for EU farmers and agricultural production. Whereas trade policies are described in the section on indirect drivers, the CAP premium scheme affects the farmers very directly. Plenty of evidence exists for the impact of policies and regulations on primary agricultural production (e.g. Britz et al., 2012; Britz and Delzeit, 2013; Gocht et al., 2013; Zimmermann and Britz, 2013; Schneeberger et al. (2002); Ericsson et al., 2009).

Besides EU regulations that are applied across all Member States similarly, many decisions reach the member countries in form of a directive. The water framework directive that was adopted in 2000 is

one of these and has an impact on the agricultural sector (e.g. Bazzani et al., 2004). Furthermore, the Marine Strategy Framework Directive (MSFD) stipulates achieving or maintaining good environmental status (GES) in coastal seas by 2020 based on a number of defined descriptors for GES (covering e.g. eutrophication and fisheries exploitation) and indicators to measure progress.

Food safety and related standards can be regarded as drivers for primary production as well. Food scandals in recent times have increased consumer awareness and led to regulatory changes. To fulfil new regulations, producers might adapt their production techniques and hygienic standards (Jaffee and Masakure, 2005; Asfaw et al., 2009).

Figure 22. CAP premiums, Britz and Witzke, 2014

1992 MacSharry Reform	1999 Agenda 2000	2003 CAP Reform (Mid-Term Review)	2008 Health Check	2013 CAP Reform
• Direct, coupled payments • Country specific ceiling levels	• Direct, coupled payments • Country specific ceiling levels	• Single Payment Scheme (SPS) • Single Farm Premium (SFP) and its trade • Support Scheme Regulation 583/2004 Single Area Payment Scheme (SAPS) • Implementation models for direct payments of Member States • (EC) No. 552/2007 budgetary ceilings for SPS	• Reduction of direct payments under SPS • Remaining coupled payments under Art. 68 (EC) No 73/2009 • Decoupling of remaining coupled payments and inclusion into SPS • Milk quota data before reform of dairy sector	• Greening Top-ups • Premium Updates

Further included Premiums

- Second Pillar Payments: Less Favored Area support, agri -environmental measures, Natura 2000 support
- Nordic Aid premiums
- Premiums established with Luxembourg compromise
- EU Sugar Reform 2006

The CAP is traditionally divided into two pillars. Pillar 1 includes market and farm support policies. **Fout! Verwijzingsbron niet gevonden.**22 provides an overview of the first pillar premium schemes.

The different reform steps of the CAP premium scheme are briefly described in chronological order:

- 1992 CAP Reform (MacSharry)
- 1999 CAP Reform (Agenda 2000): Alignment of oilseed and cereal payments, increase in direct payments for male animals and suckler cows, introduction of new slaughter premium, dairy subsidy per ton of milk quota, milk quota maintained and increased
- 2003 CAP Reform (Mid-term review):
  - Introduction of single payment scheme (SPS): Single farm payment independent from production, limited coupled elements maintained as for protein crops, fruit and vegetables are decoupled since 2008, Member States could opt for historical, regional or hybrid model for implementation of direct payments

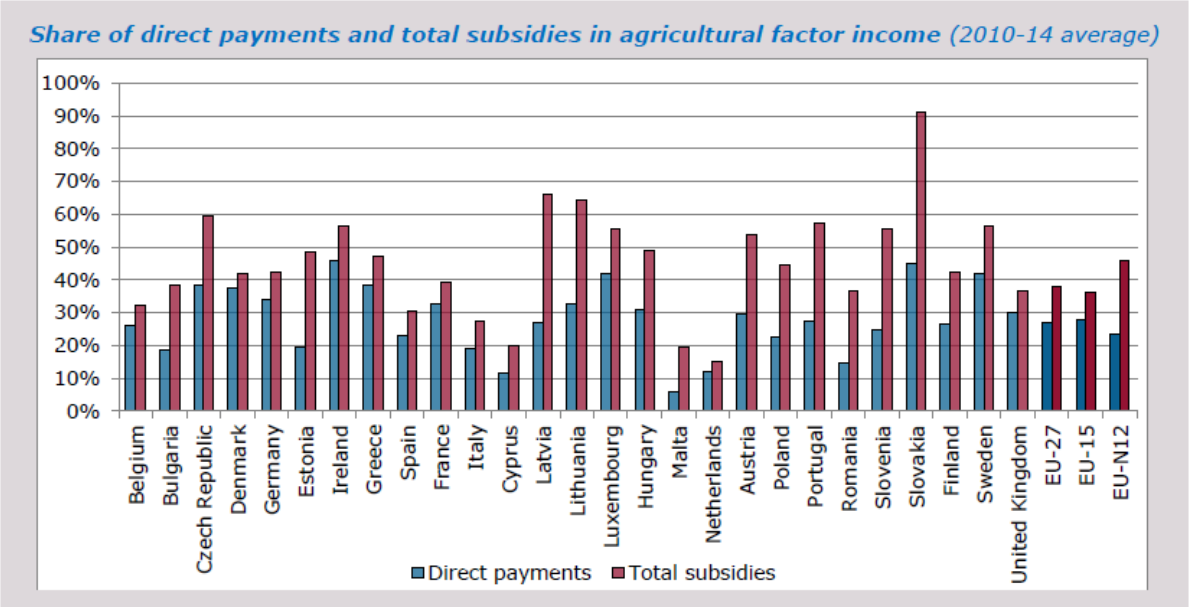
- New EU Member States could apply for single are payment scheme (SAPS) for transition period until 2010 or join SPS as well immediately
- Single Farm Premium (SFP) is tradable

- 2008 CAP Reform (Health Check of CAP):
  - Abolishment of arable set-aside, increase of milk quotas (leading to abolition in 2015), reduction of direct payments under SPS (money to Rural Development Fund)
  - Remaining coupled payments should be decoupled and moved into Single Payment Scheme (SPS) (exception of suckler cow)
  - A series of small support schemes are decoupled and shifted to SPS, abolishment of energy crop premium
- 2013 CAP reform:
  - Greening top-ups
  - Premium updates

The second pillar of the CAP refers to rural policy. Rural policy measures differ by country and are co-financed by the Member States. A large share of EU's pillar 2 expenditure is dedicated to agri-environmental measures (24% in the programming period 2007-2013) (Zimmermann and Britz, 2016).

Fout! Verwijzingsbron niet gevonden.23 shows the average share of direct payments and total subsidies in agricultural income at Member State level averaged over 2010 to 2014. The figure shows that EU producers are highly dependent on public support provided through the CAP. The EU average share of direct payments in agricultural factor income in 2010-2014 was 28%, ranging from 15% or less in Cyprus, Malta, the Netherlands and Romania to more than 40% in Ireland, Luxembourg, Slovakia and Sweden. Considering all subsidies, total public support in agricultural income reached 33% on average in the EU. The wide variation in the share of public support in agricultural income reflects historical levels of production in the EU15, farm structure differences, eligible land in the New Member States (EU13), specialization in different agricultural sectors and differences in the competitiveness.

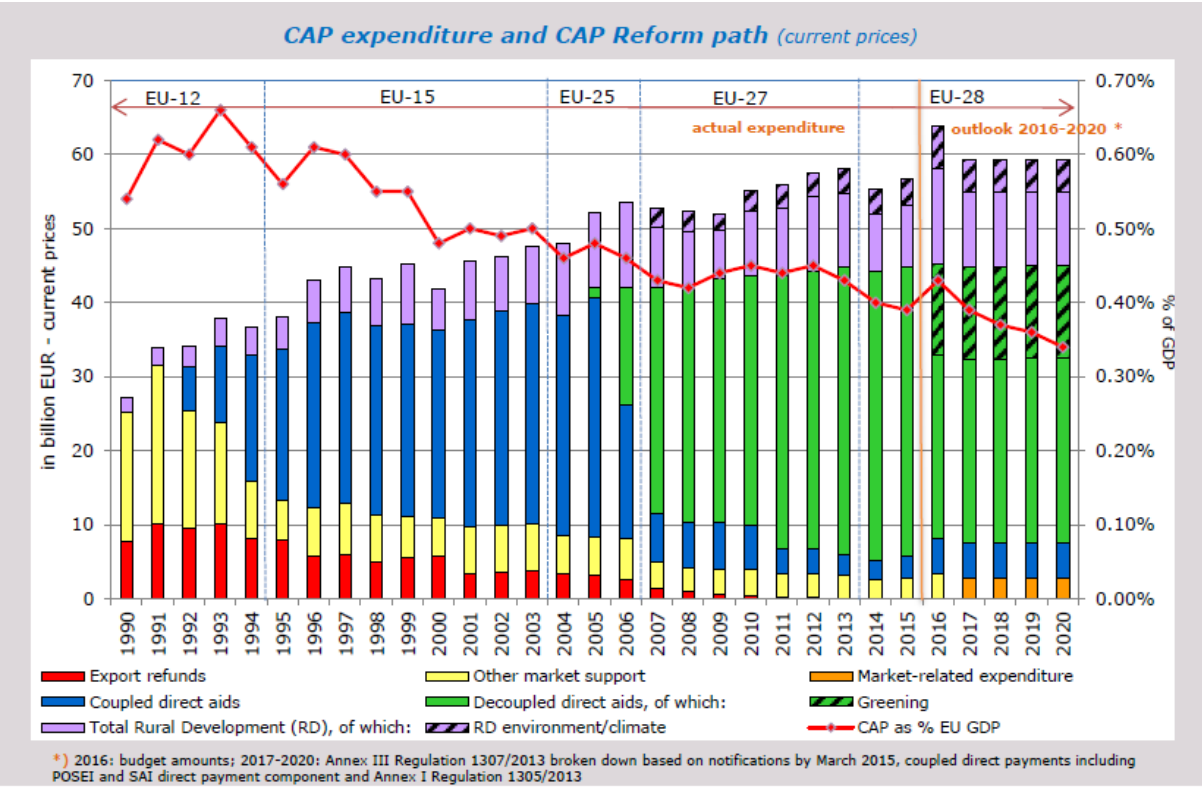
Figure 23. Share of direct payments and total subsidies in agricultural factor income (2010-2014 average), European Commission, 2016a



Sources: *CAP expenditure: European Commission, DG Agriculture and Rural Development (Financial Report).GDP: Eurostat. Annual expenditure in 2011 constant prices.*

Fout! Verwijzingsbron niet gevonden.24 shows the development of CAP expenditure in total in current prices and as share of GDP from 1990 to 2020. The CAP expenditure as share of EU GDP decreased from 1993 onwards. According to the policy reforms, the graph shows the abolishment of export refunds, a clear decrease in market support and coupled direct aids. Rural development expenditure considerably increased. Decoupled direct aids were introduced in 2005 has and accounted for a high share of total CAP expenditure since then.

Figure 24. CAP expenditure and CAP reform path, (European Commission, 2016b)



Sources: *CAP expenditure for past years: European Commission, DG Agriculture and Rural Development (Financial Report). GDP: Eurostat and Global Insight.*

The European fishery policy was originally part of the CAP in the early 1970s. Currently, the fishing and aquaculture industries in Europe are regulated by the Common Fisheries Policy (CFP) that aims to ensure sustainable fishery and provide healthy food. The CFP has four policy areas: Fisheries management, International policy, Market and trade policy, and Funding of the policy (EU 2016). Important parts of the CFP in terms of management are how to give access to a fishery, how to distribute fishing rights between nations (the so called relative stability) and between fishers in a country. The current CFP opens up for using other criteria than fishing history for this distribution. Another important and new part of the current CFP (in force since 2013) is the landing obligation for species with a quota, saying that all catches should be landed, although there are several exceptions to this. An overview of the different reform steps of the CFP is given below.

- 1970
- Rules were set regarding access to EC fishing grounds, markets and structures
- 1976
- Member States followed an international movement which extended rights over marine resources from 12 to 200 miles from a nation's coasts
- 1983
- The Common Fisheries Policy (CFP) was launched
- 1992 CFP Reform
- The first reform of the CFP
- 2002 CFP Reform

- Introduction of a simple system to limit fishing capacity and funding for modernization of the fishing fleet
- Funding for the modernisation of the fishing fleet was made available through the Financial Instrument for Fisheries Guidance (FIFG; 2000-06) and the European Fisheries Fund (EFF; 2007-13)
- "A strategy for the sustainable development of European aquaculture" was introduced

• 2004 CFP Reform

- Aim for environmentally, economically and socially sustainable fisheries and aquaculture

• 2009 CFP Reform

- "Green Paper" was issued
- Outline of the challenges of European's fishery

• 2011 CFP Reform

- A new fund for the EU's maritime and fisheries policies for the period 2014-2020 was proposed

• 2013 New CFP Reform

- Introduction of sustainable catch limits and a landing obligation

The CAP is explicitly considered in some of the economic agricultural sector models in the SUSFANS toolbox. CAP reform scenarios will be considered in the SUSFANS scenarios. The CFP is planned to be considered in some of the economic models in the SUSFANS toolbox.

3.3.1.1.2 Input and farm gate prices

In economic theory, the price for any specific good is determined by the interplay between supply and demand. As market conditions change (supply and/or demand shocks), price adjustments take place. This way, prices transfer information about markets. The most important prices at primary production level are input and farm gate or producer prices. The relationship between input and producer prices is one of the most important drivers for decision-making on the farms.

Input quantities weighted by their prices enter producer balances as costs. Inputs are generally categorized into fixed, quasi-fixed and variable inputs. Depending on the time horizon considered, fixed and quasi-fixed inputs are not clearly defined. Usually, they include labour, land, building and machinery, i.e. everything that has to be paid irrespective of the current production. Important variable inputs are, for example, energy, water, fertilizers and plant protection (e.g. Moore et al., 1994; Just et al., 1983).

Fout! Verwijzingsbron niet gevonden.25 gives an overview of the average shares of intermediate inputs in the EU28 in 2014. Intermediate inputs cover purchases made by farmers for raw and auxiliary materials that are used as inputs for crop and animal production and expenditure on veterinary services, repairs, maintenance and other services. The highest share of intermediate inputs is used for feeding stuffs in animal production (36.9%). It is followed by energy and lubricants for crop and animal production (12.0%). Fertilisers and soil improvers account for 7.6%. Seeds and planting stock account for 5.1% and plant protection products for 4.9%.

Figure 25. Intermediate inputs consumed by the agricultural industry at basic prices, EU-28, 2014, European Commission, 2015c

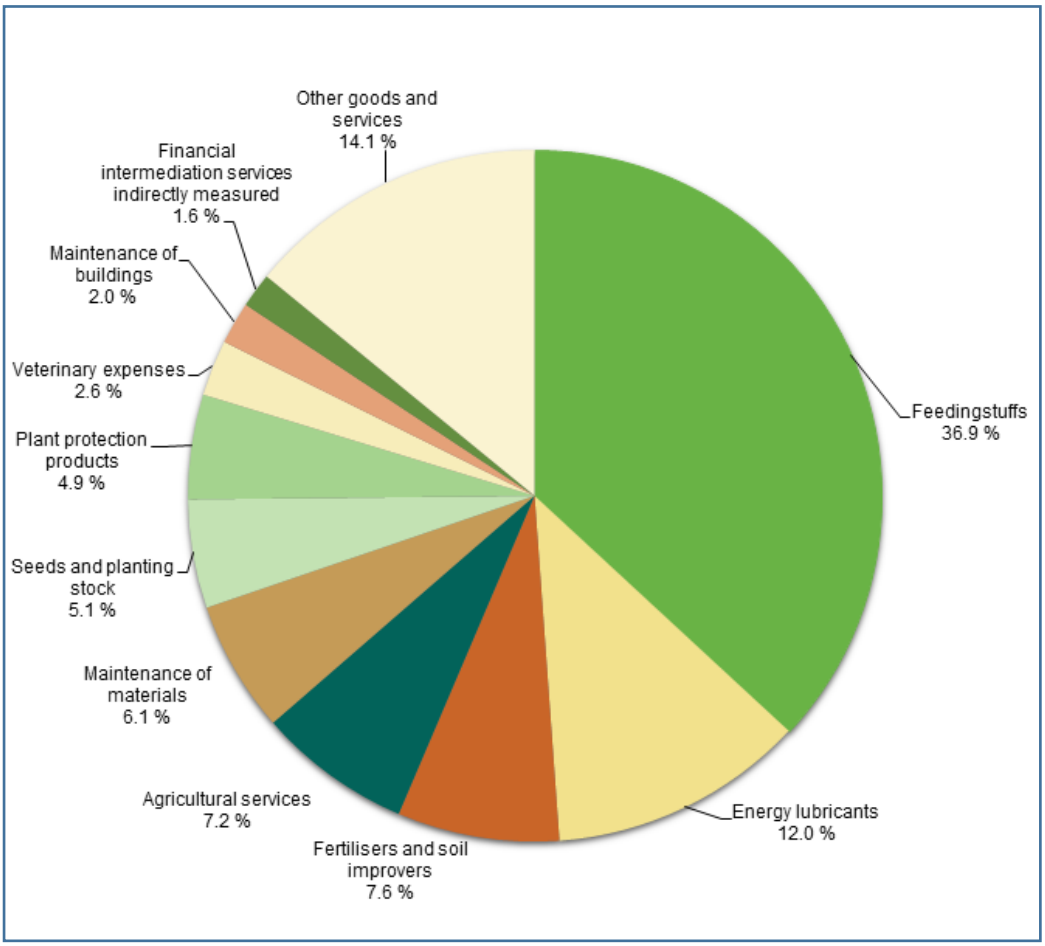
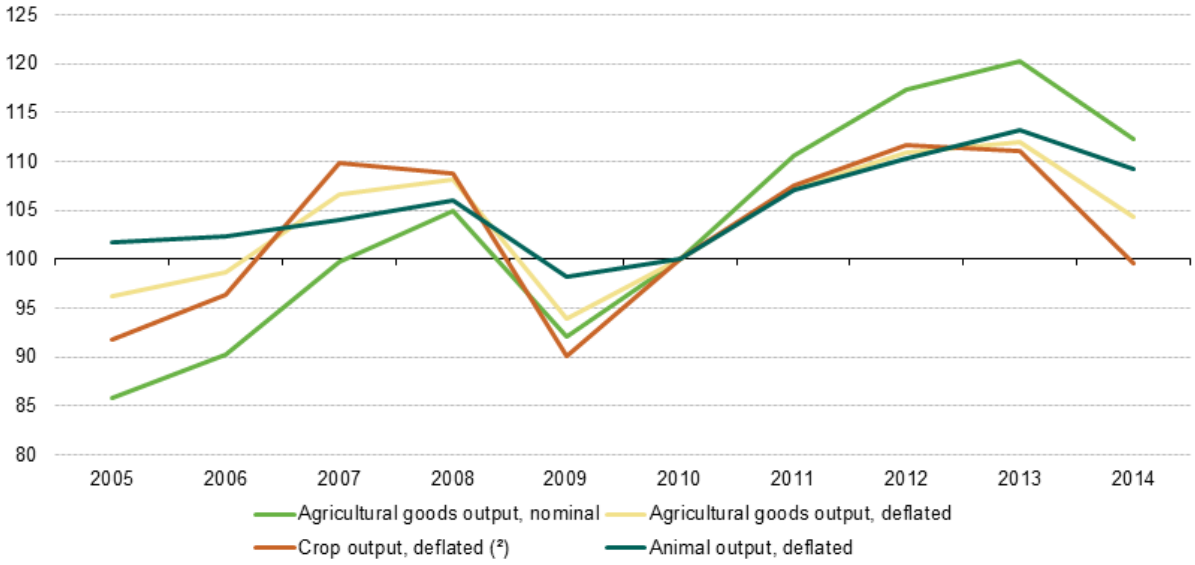


Figure 26 shows output price indices of agricultural goods in the EU28 from 2005 to 2014. In nominal terms, output prices for agricultural goods increased by 31.0% from 2005 to 2014. The real increase in output prices (deflated) of agricultural products was 8.4%. After the price rise in 2007 and 2008, prices fell in 2009 and increase from there until 2013. Prices fell again in 2014. Crop prices tended to increase at a slightly faster pace than animal prices.

Fout! Verwijzingsbron niet gevonden.27 provides a comparison of deflated price indices for intermediate inputs and agricultural outputs. The figure shows the change in deflated price indices in the EU28 from 2010 to 2014. Prices for intermediate inputs rose by 6.2%, while output prices rose by 4.3% over the same period.

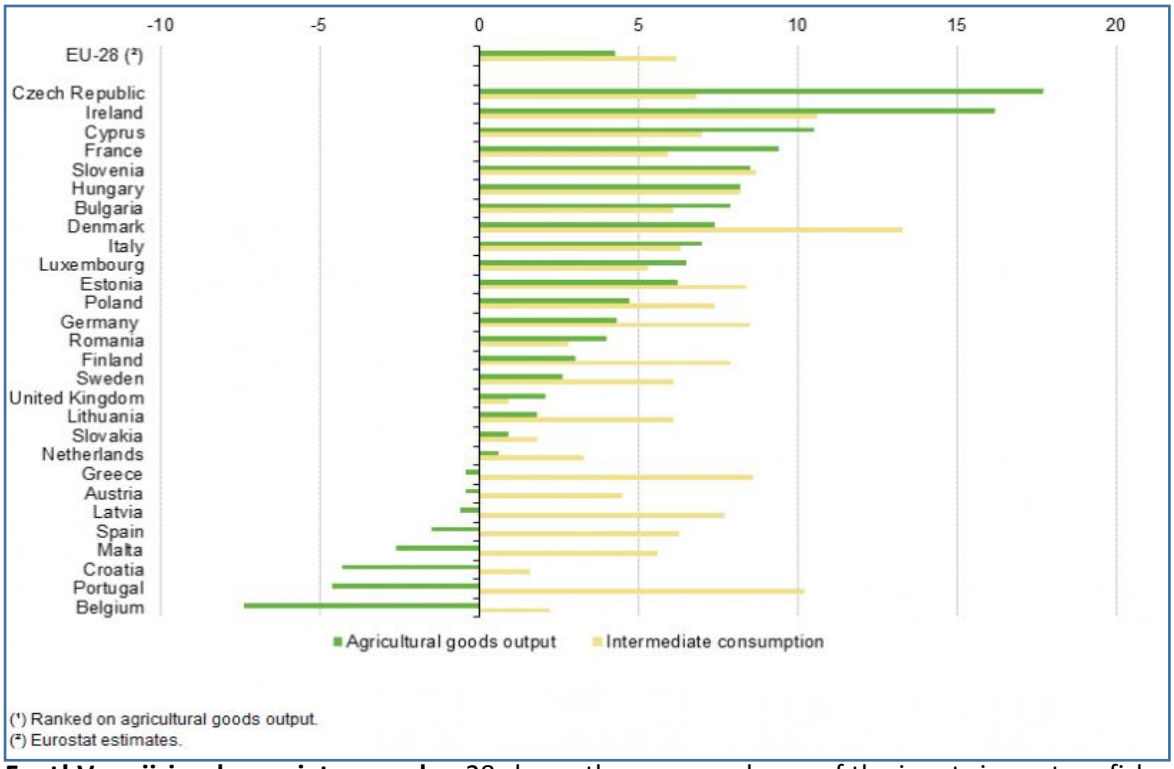
Seafood production consists of two practices – capture fisheries and aquaculture. The requirement of inputs for fisheries depends on the type of fishery, the scale of the fishing intensity and the targeted species. For aquaculture, resource use depends much on factors such as feed ingredients and amounts, farming system and species farmed. In fisheries, the most important variable costs are labor and fuel and increasingly important are prices paid to lease or buy quotas. Those of aquaculture are labour, energy, livestock, feed and capital.

Figure 26: Output price indices, EU-28, 2005–14, European Commission, 2015c



(¹) Eurostat estimates.
(²) Including fruit and vegetables.

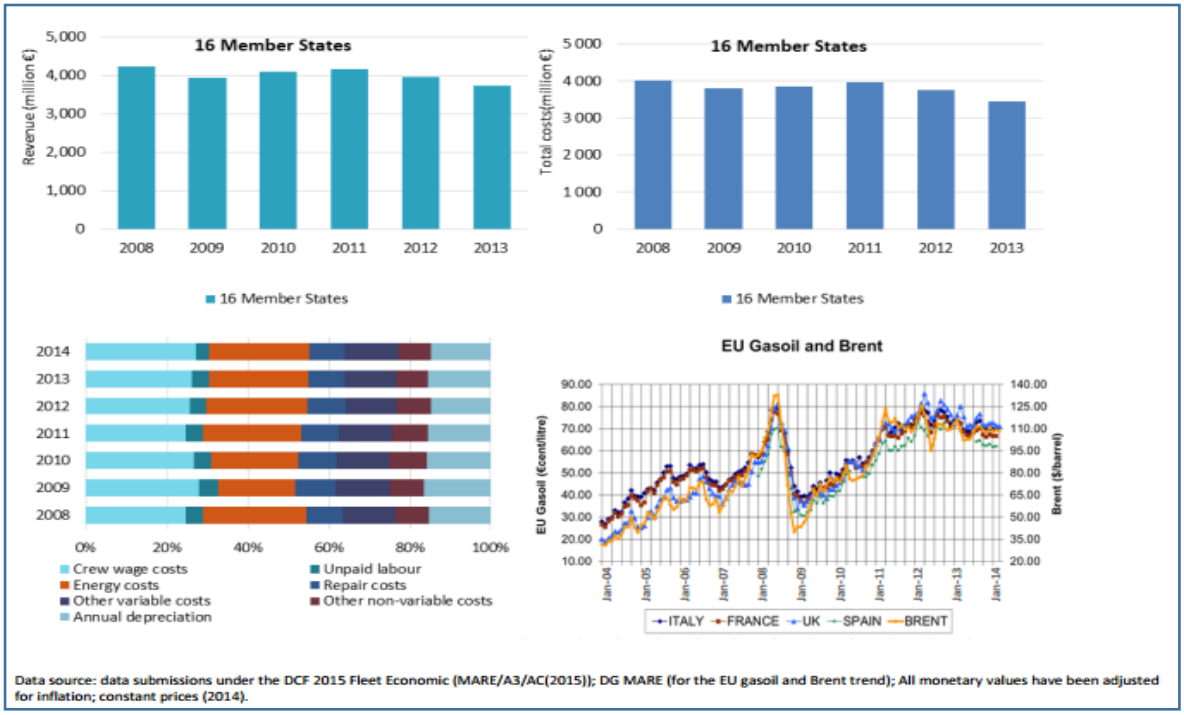
Figure 27. Change in deflated price indices for agricultural outputs and inputs, 2010–14, %, European Commission, 2015c



(¹) Ranked on agricultural goods output.
(²) Eurostat estimates.

Fout! Verwijzingsbron niet gevonden.28 shows the average shares of the inputs in capture fisheries for 16 member states in the EU from 2008 to 2013. Those inputs cover labour, fuel and expenditure on repairs, maintenance and other services. The highest two shares of the inputs are labour and fuel (around 50% in total), followed by repair.

Figure 28: Trends in revenue and cost structure for the 16 Member States fleets: 2008-2013, Paulrud et al., 2015



Fout! Verwijzingsbron niet gevonden.29 offers an overview of the average shares of the inputs in aquaculture in the EU in 2011. Different from capture fisheries, the highest share inputs is due to raw materials (feed for marine and freshwater aquaculture and livestock for shellfish farming) instead of labour and fuel.

Figure 29: Costs breakdown, 2011 for the EU aquaculture by culture environment, Paulrud et al., 2015

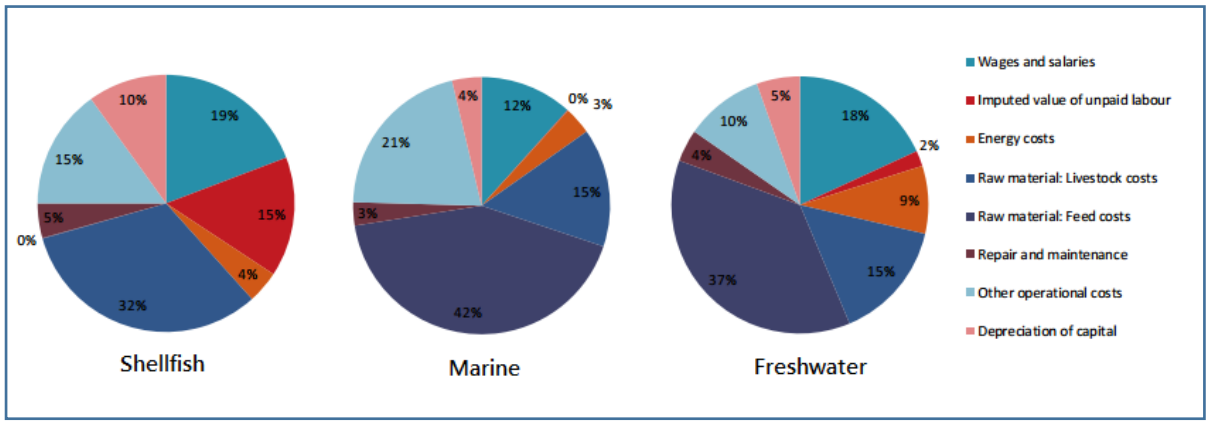


Figure *30: Prices at landing stage of most important commercial species for the EU market (EUR/kg), 2010-2013, EUMOFA, 2016*

30 shows the price developments at landing stage of the most important commercial fish species in the EU market from 2010 to 2013.

Figure 30: Prices at landing stage of most important commercial species for the EU market (EUR/kg), 2010-2013, EUMOFA, 2016

Main commercial species	2010	2011	2012	2013	variation 2013/2012
Anchovy	1,70	1,87	1,94	1,91	↓
Blue whiting	0,54	1,13	0,58	0,42	↓
Cod	2,30	2,32	2,16	2,25	↑
Gilt-head seabream	9,19	8,78	8,46	8,54	↑
Hake	3,48	3,58	3,33	3,36	↑
Herring	0,32	0,44	0,56	0,46	↓
Mackerel	0,88	1,11	1,01	0,97	↓
Monk	5,26	4,79	5,16	5,13	↓
Mussel	0,15	0,24	0,45	0,45	=
Red mullet	7,92	7,42	7,35	6,93	↓
Sardine	0,81	0,87	1,06	0,92	↓
Seabass	9,31	9,92	9,89	9,93	↑
Skipjack tuna	1,23	1,24	1,08	1,17	↑
Sole	9,26	9,38	9,06	8,24	↓
Sprat (=Brisling)	0,18	0,22	0,27	0,28	↑
Squid	4,38	4,99	4,56	4,03	↓
Yellowfin tuna	1,65	1,74	2,37	2,26	↓

Producer prices are endogenous in the economic large-scale models reflecting the interplay between supply and demand. Input prices are partly endogenous, partly exogenous depending on type of input and type of model in the SUSFANS toolbox.

3.3.1.1.3 Contract opportunities

"Contract farming can be defined as agricultural production carried out according to an agreement between a buyer and farmers, which establishes conditions for the production and marketing of a farm product or products. Typically, the farmer agrees to provide agreed quantities of a specific agricultural product. These should meet the quality standards of the purchaser and be supplied at the time determined by the purchaser. In turn, the buyer commits to purchase the product and, in some cases, to support production through, for example, the supply of farm inputs, land preparation and the provision of technical advice" (FAO, n.d.). Contracts can be negotiated between input suppliers (e.g. seed and feeding stuff companies) and farmers as well as between farmers and upstream supply chain companies (e.g. slaughterhouses, wholesalers, supermarkets).

Contract farming is often defined as a weaker form of vertical integration between spot market exchanges and full vertical integration (Rehber, 1998; Schulze et al., 2007). Marketing and production contracts, as well as contract farming or informal long-term relationships are referred to as "vertical cooperation" aiming at adding higher value to the products. In spot market exchanges, only short-term contracts between seller and buyer are negotiated, though many farmers actually

prefer long-term relationships since stable business connections allow more reliability and lower search costs (Schulze et al., 2007). The advantages of contract opportunities for farmers are often seen in a more formal establishment of these relationships lowering transaction costs and providing more security for farmers and their contractors. One distinguishes between several forms of contracts, for example, marketing contracts, production contracts, cultivation, sales or delivery contracts (Lipinska, 2013; Schulze et al., 2007).

A vast literature exists on the impacts of contract farming in developing countries and at smallholder farming (e.g. Chakraborty, 2009; Key and Runsten, 1999; Oya, 2012), but considerably less information on contract farming in the EU exists. According to Rehber (1998), contract farming became an integral part of the food and fiber industry in Western Europe, North America and Japan at the end of the 20th century. It was particularly widely used by the vegetable canning industry in North America and the seed industry in Western Europe in the 1930s and 1940s. For the example of pork production in Germany Schulze et al., (2007) express doubts about ongoing trends towards more contracts. They find that many farmers reject contracts since they prefer to stay independent. Sugar producers in the EU usually sign pre-sowing delivery contracts with the sugar companies to make sure that the sugar quota will be filled.[15] In 2003, the possibility to sign a delivery contract along with a cultivation contract existed also for the fruit and vegetable market, the hop, tobacco and dried fodder markets (Lipinska, 2013). Marketing contracts are often signed in the grain sector. Balmann et al. (2006) suggest that it will be more and more important for crop producers to make use of cooperation opportunities along the value chain in the future.

Also in fisheries, production based on contracts between fishing companies and processors is common, both involving large and small vessels. Other processors decide to buy their raw material on the spot market, but are then dependent on the supply, which can be highly variable both in terms of quantity and quality and hard to forecast. This is due to fish being a wild natural resource, a unique characteristic of capture fisheries compared to any other industrial scale food production systems.

Contract opportunities are not explicitly considered in the economic agricultural sector models in the SUSFANS toolbox.

3.3.1.1.4 Natural resource availability

Natural resource availability is the most important driver of agriculture. It determines agriculture in terms of which farming activities can pursued at all (e.g. olive production in Finland not possible) and which results, i.e. yields can be achieved (e.g. lower crop yields on poorer soils).

Natural resource availability includes mainly land, climate, soils and water (van Ittersum and Rabbinge, 1997). Seafood production and agricultural production like chicken and pig production that uses feed inputs of marine origin is also dependent on the availability of wild fish stocks. Natural and especially climatic conditions vary a lot between different regions and countries within the EU. While the growing season in the northern countries is limited by the occurrence of snow and frost, farmers along the Atlantic coast or in mountainous regions face wet conditions that can have negative effects on soils, yield and crop quality. Extreme weather events, heat and water scarcity

[15] Please note that the sugar quota expires in 2017.

affect particularly crop producers in Mediterranean countries, whereas the range of cultivated crops is limited in Eastern Europe by dry climatic conditions and a greater temperature amplitude than in the other regions (Olesen and Bindi, 2002).

Almost all arable land in the EU is already under cultivation. In fact, land in the EU is even a shrinking resource. Almost 1000 km^2 of agriculture or natural land in the EU is converted into artificial areas. More EU land is affected by degradation (European Commission, 2016c).

Climate change is predicted to affect EU countries very differently, with largely increasing crop yields in the north and decreasing yields in the south and a general increasing probability for extreme weather events (e.g. floods, droughts). Climate change will lead to considerable adaptation effects throughout the EU and heavily influence agricultural production (Ewert et al., 2005; Leclère et al., 2013; Nelson et al., 2014; Wolf et al., 2012). Climate change will also lead to changed migration patterns, dispersal of fish stocks and the food webs the rely on, which will influence both seafood production and economic performance (Cheung et al. 2013; Branch et al. 2013).

Regarding soils as a driver for agricultural production and expected changes, soil degradation plays a major role. The main problems for soils in the EU are irreversible losses due to soil sealing and erosion and continuing deterioration due to local and diffused contamination (acidification and heavy metals). Soil degradation is mainly caused by urbanization and infrastructure development in western and northern Europe and erosion in the Mediterranean region. A risk of erosion from water exists in southern and central Europe (European Environment Agency, 1999).

Around 40 % of total water abstraction in Europe is used for agriculture. The largest share of abstracted water is used by southern European countries, whereas levels of water use in agriculture are much lower in northern Member States (European Commission, 2016d). Europe is generally not considered to be water scarce. However, the frequency and spread of water scarcity and droughts have increased in the EU. By 2007, at least 17% of the EU's territory was estimated to be affected by water scarcity. Further deterioration of the water situation is expected due to climate change that is associated with generally increasing temperatures and more droughts (European Commission, 2016e).

In 2015, 93% of the assessed stocks in the Mediterranean were overfished whereas approximately 50% in the North-East Atlantic and adjacent waters (EU 2016). Except for the Mediterranean and Black Seas, the proportion of overexploited stocks is slowly decreasing in the EU. The stocks that are overexploited require lessened fishing pressure, i.e. less immediate landings, and those that are sustainably fished has no room for expansion. Most of the seafood consumed in the EU is imported. However, also at a global scale, nearly 29 % of the stocks were fished at unsustainable exploitation levels; roughly 63% were fully fished whereas 10 % under-utilized (based on the latest estimates, 2011; FAO 2014). To this end, there is no or little room for expansion of seafood production and consumption of seafood from capture fisheries in the EU.

Natural resource availability enters the economic models in SUSFANS partly in terms of path dependence in the data base, partly it is modelled endogenously (e.g. land use), and partly it is reflected in the scenarios and/or exogenously provided by other models (e.g. climate change).

3.3.1.1.5 Available technology

'New and improved technology has proven to be the most important driver of agricultural productivity growth' globally and in the EU (Hazell and Wood, 2008; Benton et al., 2003). Consequently, the development and dissemination of new technology is an important factor determining agriculture (FAO, n.d.). Whereas technology development is rather an indirect driver (see below), technology adoption and usage are direct drivers of agricultural production at farm level. Technology adoption and diffusion depend on the available technology. There is often a significant interval between the time an innovation is developed and available in the market, and the time it is widely used by producers. Adoption and diffusion are the processes governing the utilization of innovations. Adoption describes the process if and when producers start using an innovation, diffusion is interpreted as aggregate adoption (Sunding and Zilberman, 2001). The social science literature on technology adoption often emphasizes the role of distance and geography in the process. Producers located farer away from regional centers are likely to adopt technologies later (Sunding and Zilberman, 2001). Other drivers of technology adoption are producer characteristics such as risk perception and knowledge, subsidies, credit and other financial resources (van Ittersum and Rabbinge, 1997).

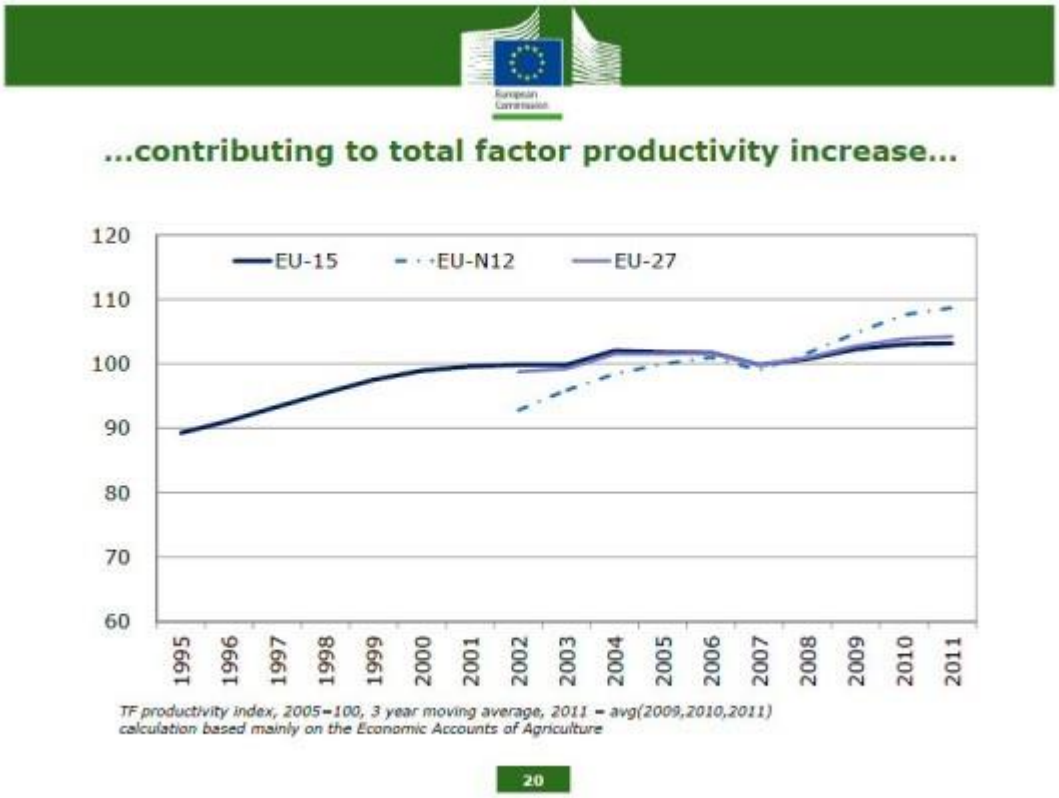
Current important technological improvements and adoption processes include 'big data' based applications, robotics, precision/smart farming, biobased economy, aquaculture, and biotechnology in crop and animal sciences. The new landing obligation in the CFP is intended to stimulate technological development of fishing gear towards increased selectivity to avoid unwanted catches (catches of species and sizes of low market value). Furthermore, seafood production is at present increasingly dominated by aquaculture which can be seen as a technological innovation to address the problems with capture fisheries: aquaculture, predominantly inland systems, now stands for half of the global seafood production in volume (FAO 2014). In the EU, however, aquaculture production has not increased since 1999 (EU 2016).

Technology development, availability and adoption lead to productivity growth. Productivity growth is measured by Total Factor Productivity (TFP) growth, which is the aggregate quantity of outputs produced by the agricultural sector divided by the aggregate quantity of inputs used to produce those outputs.

According to Matthews (2014), an approximate rule of thumb is a normal TFP growth in agriculture around 2% per annum. Matthews (2014) compares two statistics of TFP growth in the EU, one by DG AGRI and the other one according to USDA data. DG AGRI finds a TFP growth in the EU15 from 1995 to 2002 of about 1.6% per annum and a stagnation of TFP growth in the EU15 after 2002 to 2001 (growth rate around 0.3% per annum). TFP growth in the new member states averaged around 1.6% per annum from 2002 to 2011. Since the new member state account for a relatively small share of total agricultural output in the EU, TFP growth in the EU27 was about 0.6% over the past decade (**Fout! Verwijzingsbron niet gevonden.**31) (Matthews, 2014).

TFP growth by individual country is shown in **Fout! Verwijzingsbron niet gevonden.**32. The highest productivity growth was achieved by some of the new member states (yellow bars), whereas negative productivity growth rates are reported for Spain, Ireland and Italy.

Figure 31: Total Factor Productivity growth in the EU, cited from Matthews, 2014



According to Matthews (2014), the TFP growth rated according to USDA data describe exactly the opposite. TFP growth has accelerated in the EU23 (Baltic EU countries, Slovenia and Croatia omitted, Czech Republic and Slovakia grouped together) in the past decade and this acceleration has been particularly pronounced in the EU15, while TFP growth in the new member states has slowed down more recently. Thus, according to the USDA figures, productivity growth in the new member states has been consistently lower than in the old member states, and the gap has grown much bigger in the most recent period (Figure 33).

Matthews (2014) states that without a more detailed analysis, the reasons for the difference between the DG AGRI and the USDA estimates are not identifiable.

For the modelling toolbox in the SUSFANS project, technical progress will be explicitly considered in the scenarios affecting agricultural productivity in an aggregate way. However, the process of technology adoption is not explicitly modelled.

Figure 32: Total factor productivity growth in the EU per country, cited from Matthews, 2014

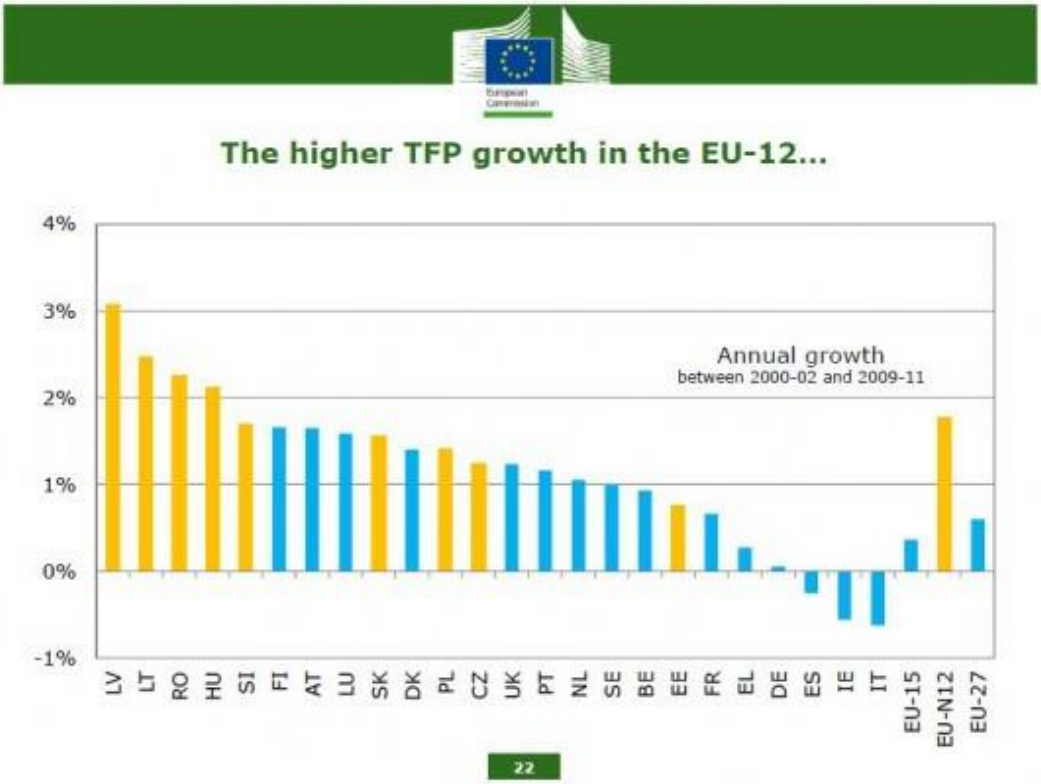
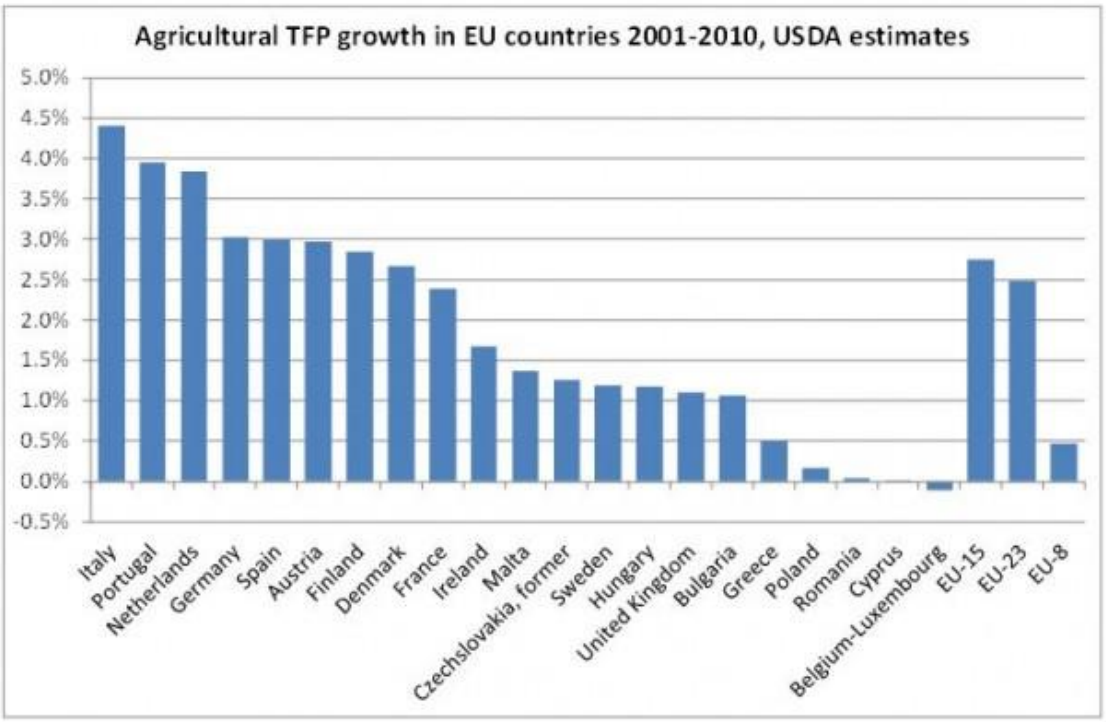


Figure 33: TFP growth in the EU according to USDA estimates, cited from (Matthews, 2014)



3.3.1.1.6 Producer and farm characteristics

Besides direct production factors, personal attitudes, values and goals, experiences as well as social influences drive producers' decisions (Öhlmér et al., 1998). Agricultural production is also heavily influenced by path dependencies through existing farm characteristics and farm structure (e.g. (Balmann et al., 1996; Zimmermann and Heckelei, 2012). In fisheries, the corresponding characteristics with a large influence on fisheries production are vessel characteristics and fleet structure. While there is considerable room for individual differences between fishers depending on their choices and skills (Ruttan & Tyedmers 2007), the management system also locks certain structures by e.g. not allowing transfer of fishing quotas between different fleet segments or gear types.

Schneeberger et al. (2002) for example find a significant relation between a farmer's opinion on the adoption of organic agriculture and the general evaluation of this type of farm management. Also other management decisions such as the participation in agri-environmental schemes or switching to organic farming are heavily influenced by farmers' characteristics (Wilson and Hart, 2000). Several socio-economic characteristics influence farmers' risk aversion (e.g. Ayinde, 2008), which in turn affects their management decisions (e.g. Pennings et al., 2005; Zulauf and Irwin, 1998, Coble et al., 2000, Fackler and Livingston, 2002).

In large-scale economic agricultural sector models, individual producer and farm characteristics are typically not considered due to their complexity. However, producers are also consumers and affected by general lifestyle changes as considered in SUSFANS, which in turn might affect their production decisions in line with price changes transmitting signals of changes lifestyles and diets.

3.3.1.2 Direct drivers for food chain actors

3.3.1.2.1 Food Prices

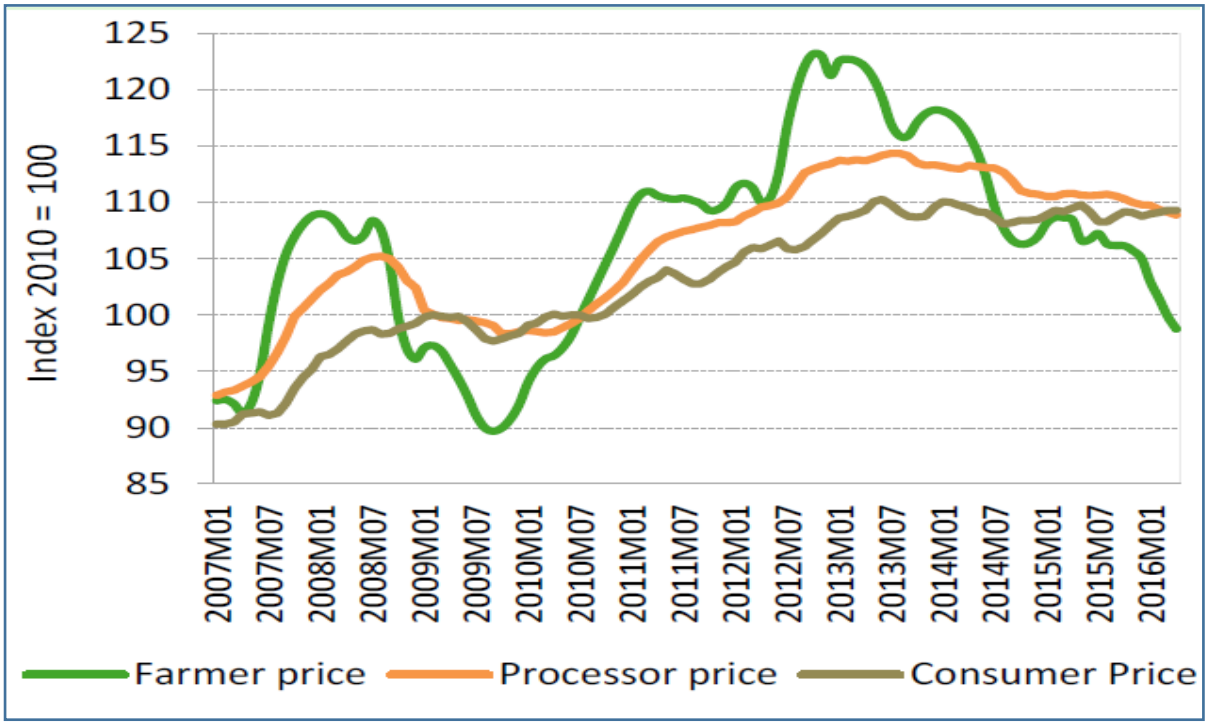
This section offers an overview of the aggregated price developments along the food supply chain over the last decades, i.e. commodity price or farm-gate price index (the agricultural sector) (commodity price, farm-gate price), producer price index or factory-gate price index (food processors) and the food consumer price (retail sector). An analysis of the prices linkages along the supply chain is necessary for understanding drivers of its functioning of the supply chain. For example, food manufacturers are affected on the one hand by agricultural commodity prices in terms of production costs (i.e. input prices) and on the other hand by consumer prices in that they influence their turnover (European Commission, 2016b).

A very recent publication from European Commission (2016c) presents price evolution along the food supply chain from 2007 to 2016. A decline in agricultural prices paid to farmers has been documented since 2014- around 15% between April 2014 and April 2016. Over the same period processor prices also reported a decrease by 4% while consumer prices remained more or less stable (European Commission 2016c) (Figure 34).

One of the major aspects of price transmission along the food supply chain is the persistent discrepancy between the high price volatility in the agricultural sector compared the price stability in the food processing and distribution sectors, with agricultural price fluctuations passed asymmetrically and with some lags to producers or consumer price (European Commission, 2009 and 2015). As the recent 2016 EC publication reports: "*The sharp recent decrease in prices paid to*

farmers was not fully transmitted along the food chain agricultural prices are indeed more volatile. The index (2010=100) of farmer prices moved from 90 mid-2009 to 123 at the beginning of 2013 back to 98 in April 2016. In 2009 and 2016, processor and consumer prices decreased less and similarly the increase in 2013 was significantly lower" (European Commission 2016l).

Figure 34: Evolution of food prices along the supply chain (European Commission 2016l)



3.3.1.2.2 Regulatory Environment

The regulatory framework affects the food supply chain at all levels from the agricultural sector down to retail. In particular, an effective competition policy is essential to ensure that the on-going consolidation of the food supply chain does not negatively affect a competitive environment where firms operate (European Commission, 2009a). Recently, a policy debate has been opened at both EU and Member States level on the trend towards of larger retail chains reinforcing their bargaining power at the expense of upstream partners (farmers and food processors). Unfair Trading Practices[16] (UTPs) in the food supply chain have received the attention of policy makers and of stakeholders, with the on-going discussion is on whether and how to act against UTPs through EU-legislation initiative.

[16] "UTPS can broadly be defined as practices that grossly deviate from good commercial conduct, are contrary to good faith and fair dealing and are unilaterally imposed by one trading partner on another." (*Green Paper on unfair trading practices in the business-to-business food and non-food supply chain in Europe* (COM/2013/037 final).

Figure 35: Regulation of retail sector 2008-2013, (scale of 0 to 6, with a higher score indicating tighter regulation), OECD 2016

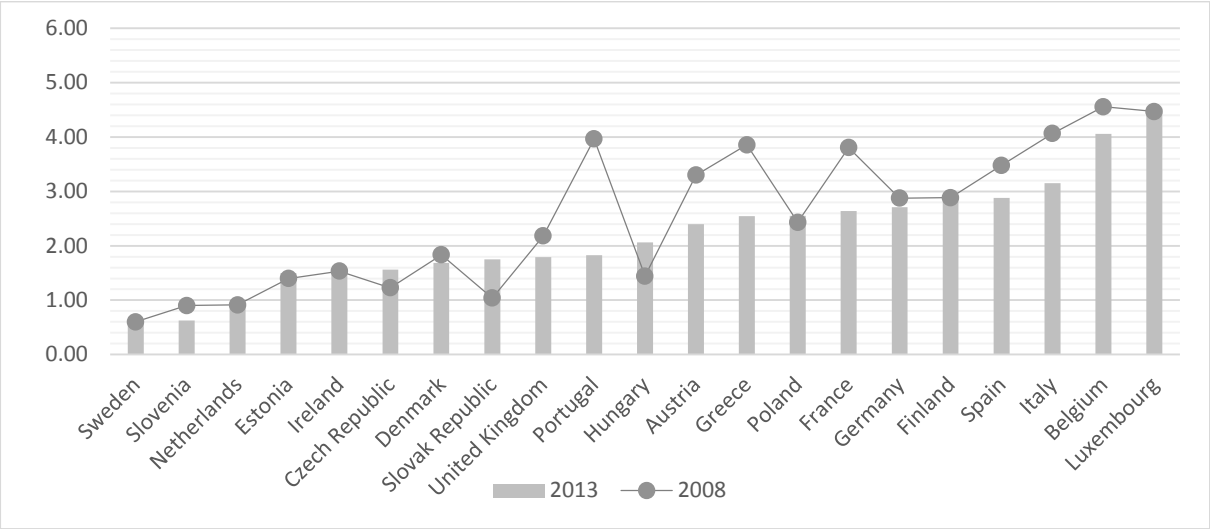


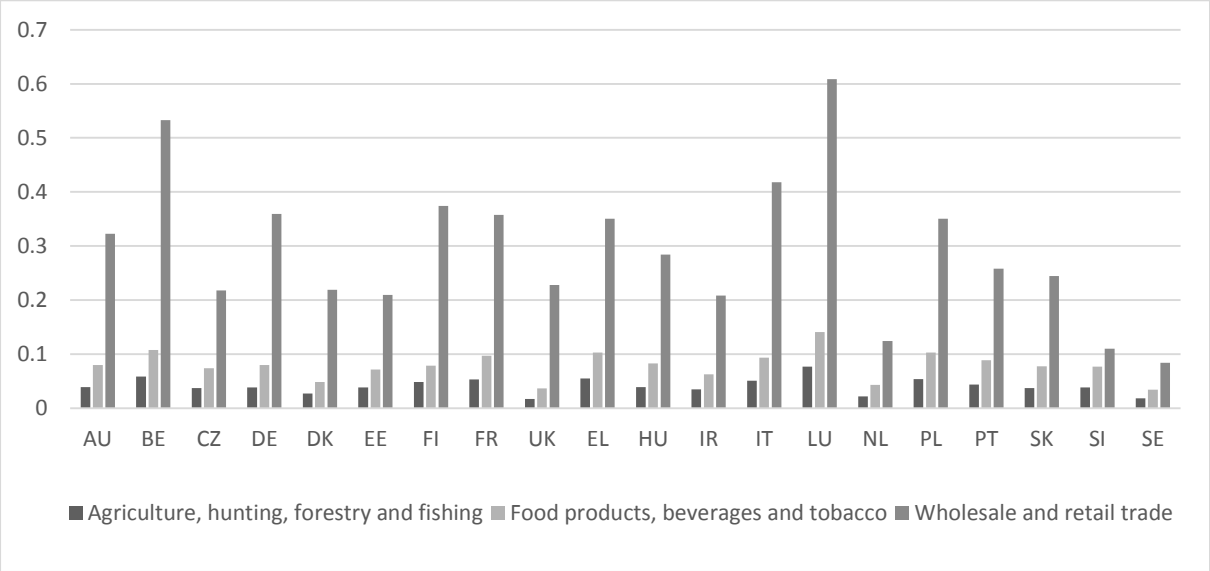
Table 7: Regulation in the retail trade (2013), OECD 2016

Member State	Licenses or permits system	Specific regulation of large outlet	Protection of existing firms	Regulation of shop opening hours	Price controls	Promotions & discounts
Austria	5.40	0.00	0.00	5.00	2.00	2.00
Belgium	4.20	6.00	6.00	3.43	1.71	3.00
Czech Republic	4.80	0.00	0.00	0.00	2.57	2.00
Denmark	2.40	3.00	3.00	0.86	0.86	0.00
Estonia	6.00	0.00	0.00	0.00	3.00	0.00
Finland	3.60	3.00	6.00	3.71	0.86	0.00
France	2.40	4.00	3.00	0.43	2.00	4.00
Germany	2.40	5.00	3.00	2.14	1.71	2.00
Greece	5.70	4.00	0.00	2.71	0.86	2.00
Hungary	4.50	6.00	0.00	0.14	1.71	0.00
Ireland	1.20	2.00	6.00	0.00	0.00	0.00
Italy	4.20	4.00	3.00	0.00	1.71	6.00
Luxembourg	5.25	6.00	3.00	3.57	3.43	6.00
Netherlands	1.20	0.00	0.00	2.57	1.71	0.00
Poland	3.30	6.00	3.00	0.14	0.86	2.00
Portugal	2.40	3.00	0.00	1.00	2.57	2.00
Slovak Republic	3.00	0.00	0.00	2.64	0.86	4.00
Slovenia	1.20	0.00	0.00	0.00	2.57	0.00
Spain	3.00	3.00	3.00	3.43	0.86	4.00
Sweden	0.60	0.00	3.00	0.00	0.00	0.00
United Kingdom	3.90	6.00	0.00	0.00	0.86	0.00

An OECD study reports the regulatory indicators for the retail sector17 across EU. Member States with the highest regulated policy settings are Luxembourg, Belgium and Italy (The regulatory framework affects the food supply chain at all levels from the agricultural sector down to retail. In particular, an effective competition policy is essential to ensure that the on-going consolidation of the food supply chain does not negatively affect a competitive environment where firms operate (European Commission, 2009a). Recently, a policy debate has been opened at both EU and Member States level on the trend towards of larger retail chains reinforcing their bargaining power at the expense of upstream partners (farmers and food processors). Unfair Trading Practices (UTPs) in the food supply chain have received the attention of policy makers and of stakeholders, with the on-going discussion is on whether and how to act against UTPs through EU-legislation initiative.

Figure 35: Regulation of retail sector 2008-201335). The analysis of six low-level indicators (Table 7) composing the overall OECD regulatory indicators suggests that license and permits systems and specific regulation of large outlet are found to have stricter regulatory stance. **Fout! Verwijzingsbron niet gevonden.** 36 presents the 2013 OECD regulatory impact indicators across EU Member States, reporting how important anti-competitive regulation is for food supply players in the Member States economies. The impact of a regulation might indeed affects sectors differently depending on the extent to which they use products of the regulated sectors as intermediate inputs (OECD 2016; Egert and Wanner, 2016; Koske et al., 2015).

Figure 36: Regulatory Impact indicators for the EU food supply sectors 2013, OECD 2016



3.3.1.3 Direct drivers for consumers

Consumer food choices, including sustainable and healthy food choices, are determined by consumer characteristics. These determinants include demographics (e.g. age) and psychographics. More specific, determinants of (sustainable) food choice include sustainable food knowledge,

[17] The OECD indicators used in this study refer to the whole retail sector and not food retailing as such.

several food-related motives such as the importance of price, taste, and health, involvement with (sustainable) food, positive attitudes toward sustainable food, social and personal norms, perceived effectiveness, food neophobia and demographics (Aertsens, Verbeke, Mondelaers, & van Huylenbroeck, 2009; Arvola et al., 2008; Bezencon & Blili, 2011; de Boer, Hoogland, & Boersema, 2007; Dowd & Burke, 2013; Lindeman and Vaananen, 2000;in Tanner & Kast, 2003; Toma, McVittie, Hubbard, & Stotta, 2011; Vermeir & Verbeke, 2006). In the following the factors driving consumer choices are presented in more detail.

3.3.1.3.1 Objective and subjective knowledge

Someone's knowledge is an important predictor of food choices. For example, consumers with less knowledge are more likely to panic due to mass media reports regarding a food hazard issue. More informed consumers have less dramatic responses to food safety issues compared to less informed people. Knowledge also relates to the amount of choice options someone prefers. Paradoxically, people who feel unknowledgeable in a certain domain are especially willing to purchase when more choice options are available, which is consistent with the notion of "more is better." This pattern is reversed for people who feel knowledgeable, which is consistent with prior evidence for choice overload (Hadar & Sanjay, 2014). Also a lack of (perceived) knowledge has been identified in the literature as a barrier for the consumption of vegetarian diets (Lea & Worsley, 2001) as well as for choosing climate-friendly foods (Mäkiniemi & Vainio, 2014). Generally "green" consumers have higher environmental knowledge than "non-green" consumers.

Two types of knowledge can be distinguished, namely subjective and objective knowledge. Subjective knowledge is the perception that a person has about his/her level of knowledge on a specific topic. Objective knowledge is accurate stored information that consumers possess. Subjective knowledge has been related to acceptation and evaluation of products (Flynn and Goldsmith, 1999; Thøgersen, Haugaard & Olesen, 2010). In contrast, consumers' objective knowledge rather than subjective knowledge plays an important role in the formation of consumer's attitudes to GM foods in urban China (Zhang et al., 2015). A meta-analysis looked at how subjective and objective knowledge relate to each other. Their results shows that the relationship between objective and subjective knowledge was stronger for products than for non-products and also stronger for public goods than for private goods (Carlson, Vincent, Hardesty & Bearden, 2009).

3.3.1.3.2 Food choice motives

Consumers' food choices are influenced by a range of motives. Food choice motives have an added value in explaining sustainable food choices beyond psychological factors such as attitudes or norms (Dowd & Burke, 2013; Verain et al., 2015). Studies show that food choice motives concerning health, environment, naturalness and taste can contribute to the purchase of sustainable products, whereas the motive price can be a barrier to purchasing sustainable foods (Dowd & Burke, 2013; Lea & Worsley, 2005; Mäkiniemi & Vainio, 2014; Tanner & Kast, 2003; Tobler, Visschers, & Siegrist, 2011; Vanhonacker & Verbeke, 2009). The importance of naturalness, fair trade and environment is also found to be related to a stronger preference for organic food products (Lusk & Briggeman, 2009). Motives that play a role in meat avoidance include health, ethical concerns, concerns about animal welfare, environmental impact and sensory aspects (De Backer & Hudders, 2015; Fox & Ward, 2008; Janda & Trocchia, 2001; Lea & Worsley, 2001; Hoffman, Stallings, Bessinger, & Brooks, 2013; Ruby, 2012; Zur & Klöckner, 2014). Whereas ethical motives are the main reason for complete meat

avoidance (vegetarianism), a reduction in meat consumption (curtailment) is mainly motivated by health concerns (Tobler et al., 2011).

Steptoe and colleagues (1995) developed the Food Choice Questionnaire (FCQ), to measure food choice motives. The FCQ has been tested for reliability and convergent validity. The FCQ was developed in the UK, but is validated in many countries (e.g. Januszewska et al., 2011; Markovina et al., 2015). The FCQ is often used for measuring food choice motives and consists of 36 items to measure 9 underlying motivations: health, mood, convenience, sensory appeal, natural content, price, weight control, familiarity and ethical concern. Sensory appeal, health, convenience and price are the most important factors on average (e.g. Insch & Jackson, 2014; Markovina et al., 2015; Onwezen & Bartels, 2011; Sautron et al., 2015; Steptoe et al., 1995, Verain et al., 2015). Familiarity and ethical concern are often ranked as least important (Januszewska et al., 2011; Markovina et al., 2015). But differences in importance ratings exist across consumer groups, across situations and across product categories (Bond, Thilmany, & Keeling Bond, 2008; Lindeman and Vaananen, 2000; Verain et al., 2016).

Sustainability has become an increasingly important consideration in food choices, but a validated questionnaire that includes these considerations is lacking. The ethical concern factor in de FCQ is performing badly. Therefore, several researchers have tried to develop such a scale. Lindeman and Väanänen (2000) for example, developed an extension to the FCQ, by including a range of environmental and ethical motives. They developed three complementary scales: Ecological Welfare (including subscales for animal welfare and environmental protection), political value and religion. The subscales appeared to be valid and reliable. The items on animal welfare and environmental protection loaded on a single factor (labelled as ecological welfare), but the reliabilities of the subscales indicate that the scales can be used as separate subscales. Also Sautron and colleagues (2015) developed a questionnaire that measures food choice motives with a special focus on sustainability. Nine dimensions were identified, labelled ethics and environment, local and traditional production, taste, price, environmental limitations, health, convenience, innovation and absence of contaminants. The scale performed good on validity and reliability.

3.3.1.3.3 Food involvement/interest

Food involvement or an interest in food influences our food choices. In a review on food involvement Bell and Marshall (2003) investigated existing research on this topic and developed a valid scale to measure food involvement. They found that involvement is linked to brand loyalty, search processing of product information, and responses to advertising and product choice decisions. Food involvement can be defined as “the level of importance of foods in a person’s life” (Bell and Marshall, 2003, p.236). It refers to the level of attachment, enjoyment, the amount of thinking and talking about food.

According to Bell & Marshall (2003) food involvement differs between individuals. For example, someone with a high food involvement, is better able to discriminate and identify between different food products than someone with a low food involvement. Food involvement also has a positive effect on sustainable food choices (Verain et al., 2015). High levels of food involvement seem to be related to meat curtailment and the consumption of sustainable meat options (De Boer et al., 2007). Consumers with low food involvement buy less free-range meat (de Boer et al., 2007).

3.3.1.3.4 Attitudes and subjective norms

Attitude is an important predictor of intentions according to the theory of planned behaviour (TPB; Ajzen, 1991). Attitude is defined as ‘the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behaviour in question’ (Ajzen, 1991, p. 188) and are assumed to be

influenced by behavioural beliefs. Several studies show that attitudes should also be considered in relation to sustainable food consumption. In general "green" consumers have more positive attitudes towards the environment than non-green consumers (see Verain et al., 2012 for a literature overview). Interestingly, some "green" consumers don't necessarily have a positive attitude towards the environment, but believe that organic food is healthier. They seem more concerned with their health, chemicals in food, natural food than the environment.

Zur and Klöckner (2014) show that attitudes also determine intentions to reduce meat consumption. In this study attitudes were operationalized as the pleasantness of the introduction of more vegetarian dishes in one's diet. Povey and colleagues (2001) also show that attitudes influence the intention to the amount of meat one's diet contains. Attitudinal ambivalence was found to be a moderator of the attitude-intention relationship, were attitudes are stronger predictors under low ambivalence.

Subjective norm is an important predictor of intentions according to the theory of planned behaviour (TPB; Ajzen, 1991). Subjective norm is defined as 'the perceived social pressure to perform or not to perform the behaviour' (Ajzen, 1991, p. 188) and is assumed to be influenced by normative beliefs. Normative beliefs are the likelihood that important individuals or groups (dis)approve of performing a given behaviour. Cialdini, Kallgren and Reno (1991) argue that norms can refer to different things. It can refer to what is commonly done (what is normal) and to what is commonly approved (what is socially accepted). Thus, they make a distinction between descriptive norms (norms that characterize the perception of what most people do) and injunctive norms (norms that characterize the perception of what most people approve or disapprove).

Verain et al. (2015) shows that the subjective norm is a predictor of sustainable food consumption. Subjective norms are significant predictors of the intention to avoid meat (Povey et al., 2001) and injunctive and descriptive norms determine the intention to reduce one's meat consumption through moral beliefs (Zur & Klöckner, 2014).

3.3.1.3.5 Perceived effectiveness and behaviour

Perceived effectiveness or perceived behavioural control is an important predictor of intentions according to the theory of planned behaviour (TPB; Ajzen, 1991). Ajzen (1991) defines perceived behavioural control as 'the perceived ease or difficulty of performing the behaviour' (Ajzen, 1991, p. 188) and are assumed to be influenced by control beliefs. Bandura (1977) calls perceived behavioural control 'self-efficacy' and defines it as the conviction that one can successfully execute the behavior required to produce the outcomes. Self-efficacy seems to play an important role in dietary behaviours (Grembowski et al. 1993; Shannon et al., 1997; Gutiérrez-Dona et al., 2009). Self-efficacy is a consistent factor in explaining fruit and vegetable intake (Guillaumi, Godin & Vezina Im, 2010; Annesi, 2011; Kreausukon, Gellert, Lipke & Schwarzer, 2011) and considered one of the main determinants of behaviour adoption (Bandura, 1997). Perceived behavioural control also seems to influence the intention to consume low levels of meat (Povey et al., 2001; Zur & Klöckner, 2014).

3.3.1.3.6 Food neo-phobia

Individuals differ in how open they are to trying new foods. This has to do with the level of food neo-phobia. Individuals with high food neophobia can be wary of novel foods and individuals with low food neophobia have no problems with trying new and unknown foods (Ronteltap, van Trijp, Renes, & Frewer, 2007). Level of neophobia can influence someone's sustainable food choices. Generally, consumers with high food neo-phobia become more conscious about what they eat (Lindeman & Vaananen, 2000; von Alvensleben, 2001) and prefer natural products over processed products

(Rozin, 2005; Rozin et al., 2004). High neophobia can thus result in higher preference for natural and organic foods.

3.3.1.3.7 Demographics

Demographic consumer characteristics can influence food choices. A review done by Verain et al. (2012) found that gender is an important predictor of sustainable food choice. In most studies women seem to be more concerned with the environment and are more often found in "green" consumer segments compared to men. Krystallis et al. (2012) also find that women are more concerned with the environment. In 2015 Verain et al. found that gender is also an important predictor of curtailment behaviour, with women involving more in curtailment behaviour than men (De Boer et al., 2014; Hayley, Zinkiewicz & Hardiman, 2015; Schösler et al., 2012; Tobler et al., 2011). In addition, higher education, higher socio-economic status, smaller household sizes and higher age levels appear to be related to a higher level of meat curtailment (De Boer et al., 2014; Hoek, Luning, Stafleu, & de Graaf, 2004; Schösler et al., 2012). Krystallis et al. (2012) also found that individuals with a high income and a good education generally belonged to clusters that are more concerned with animal welfare and sustainability. They also found that individuals in sustainable clusters are more urban than the 'animal welfare conscious' citizens. Kennedy et al. (2013) found that sustainable consumers have slightly more years of education and that mainstream consumers are typically younger.

3.3.1.3.8 Information on nutrition, health and the environmental impacts

Providing information for consumers about food products can help them to make informed choices. The main goal of informed choice is to increase transparency and trust and inform the consumer (Altintzoglou, 2010; Brambila-Macias et al., 2011; Grunert, Hieke & Wills, 2014). It is hoped to empower people to consume more sustainably and healthier (Grunert, Hieke & Wills, 2014). A review of European research on consumer response to nutrition information on food labels found that consumers indicate an interest in nutrition and are also interested in getting information about the nutritional properties of the food they eat (Grunert & Wills, 2007). Many consumers also report that they use nutrition information on packages to buy the product (Brambila-Macias et al., 2011; Miller & Cassady, 2015). Product information obtained via label claims seems to influence consumers' product perceptions and there is some empirical evidence that providing label information about nutritional qualities leads to higher repurchasing intentions (Samant & Seo, 2016). There are roughly two ways to communicate information about food, namely via the product environment (e.g. labels) and through communication campaigns (websites, pamphlets, etc.).

Labeling seems to contribute to informed choice (Brambila-Macias et al., 2011). But changing eating patterns by providing information has been found to be difficult (Grunert & Wills, 2007). First, overload and gaps in understanding may result in consumer confusion and limit the use of labels (Grunert, Hieke & Wills, 2014; Grunert & Wills, 2007; Miller & Cassady, 2015). Consumers who say that they use nutrition labels, may not really use them (Grunert & Wills, 2007; Miller & Cassady, 2015). Second, informed choice doesn't necessarily translate into better dietary choices (Brambila-Macias et al., 2011). Labeling can help people to avoid bad nutrients, but it doesn't necessarily encourage people to buy products rich in nutrients. Third, studies have shown that there is a gap between consumers' environmental concerns and their actual purchases of sustainable products (Grunert, Hieke, & Wills, 2014). Which means that in general providing information doesn't necessarily lead to behavior change. There are different factors that mediate the effect of information on behavior that have to be taken into account.

3.3.2 Indirect drivers of change to the EU food system

Given that the EU food system, and for that matter food systems in general, operate in a broader context of that offered by the real world, several indirect drivers of change operating at the national and global level affect its functioning. In the scenario literature (van Dijk and Meijerink, 2014) three key drivers are distinguished, including economic development, population dynamics and technological change (affecting agricultural productivity in terms of yields). Other drivers also playing a role include policies (in the area of agriculture, food and trade) and environmental issues (climate change and biofuels). Each of these will be discussed below.

3.3.2.1 Economic development

Economic development, usually summarised by growth in GDP, affects food systems by influencing incomes earned and so expenditures on food consumption, prices food producers receive for their commodities (and paid for by consumers), and wages earned by workers employed in agriculture and food sectors. A recent example is the global financial crisis of 2008 which hit EU economies hard and prompted many EU governments to adopt austerity measures. The negative impacts on incomes, in combination with the high and rising food and energy prices, meant that many EU citizens were not able to buy the food they need. This has led to a rise in food insecurity in Europe, with an additional 13.5 million people living with food insecurity since 2010 compared to what would have been expected on the basis of previous trends (Loopstra et al., 2015). This trend has been accompanied by a steady rise in the use of food banks across the EU, increasing from 5 million in 2010 to close to 6 million in 2014 (http://www.eurofoodbank.eu/about-us/social-impact-indicators). In the long term it is estimated that world economic growth will be around 3%, while the average annual growth for developing countries will be around 5%. This will be a major driving force of future food demand (Maggio et al., 2015).

Studies reflecting on market power in the agricultural sector are conducted by Flaig et al. (2013) for a case study on Israel and Soregaroli et al. (2010) for a case study on Italy. Both studies apply single country CGE models and focus on imperfect competition in the dairy sector. Flaig et al. find significant welfare losses associated with market power and report that an elimination of the oligopoly's mark-up would lead to declining prices for consumers.

3.3.2.2 Population dynamics

Population growth and the associated demographic changes that can be observed over time affect the demand for food. Specifically, by 2050, the world's population will have risen to a level of 9.1 billion (FAO, 2009). Most of this increase will be realised in developing countries, which will urbanise rapidly and realise substantial income growth. This not only means that food demand will increase – an estimated 60-70% net increase in food production is estimated to be needed to feed the world's population in 2050 – but also its composition in terms of diets. Specifically, diets over time are observed to change from traditional diets high in cereal and fibre to more Western pattern diets high in sugars, fats, and salt relating to the increased consumption of meat and processed foods (Kearny, 2010). This nutrition transition from a situation of undernutrition to a situation of increased consumption of unhealthy foods leading to overweight and obesity, is accompanied by a health or epidemiological transition from infectious to chronic diseases, including heart and cardiovascular diseases, stroke and hypertension (Popkin et al., 2012). What this implies for the EU food system is unclear. The increase in the worldwide demand for food will provide opportunities for the EU food system, but at the same time, its ageing and - if current trends continue - increasingly unhealthy

population will also imply challenges in terms of the provision OECD (2013). Research so far has focused more on specific food needs of an ageing population, concluding that dietary recommendations for specific groups of older adults who are no longer in good health may be warranted (Caldeira and Mussio, 2015). An ageing workforce in the agri-food sector of the EU will undoubtedly put pressure on the provision of food, part of which may be mitigated by migration.

Education, demographics, and population dynamics can be assessed within a macro-micro framework. Bussolo et al. (2010) for example present a macro-micro framework for a global ex-ante analysis of income distribution. The long-term focus of the model system captures the impacts of aging and other demographic changes, such as the education level of different population groups in an exogenous way. Labour supply in the CGE model is adapted in accordance to changes in the population structure. In their paper, Bussolo et al. (2010) analyse impacts of free trade and climate change on global poverty and income distribution.

3.3.2.3 Technological change

The importance of technological change and particularly the available technology for the agricultural sector has been emphasised under **Fout! Verwijzingsbron niet gevonden.** as a direct driver. Several studies address the potential impacts and benefits of new technologies on agricultural markets and food security. An example is a study by Rosegrant et al. (2014), who apply a combination of a process-based crop model and the agricultural sector model IMPACT to evaluate the potentials of a broad range of agricultural technologies for maize, rice and wheat, under different assumptions on future climate change. Eleven alternative technologies (no-till, integrated soil fertility management, precision agriculture, organic agriculture, water harvesting, drip irrigation, sprinkler irrigation, heat tolerance, drought tolerance, improved nitrogen use efficiency, crop protection) are characterized by the crop model. The effects on yields and input requirements are calculated for two different climate change scenarios and then implemented in the economic model IMPACT, which in turn estimates effects on production, trade, prices, resource use as well as availability of kilocalories and poverty indicators.

Besides the development of new technologies in the agricultural sector itself, developments in other sectors may lead to increased competition for land. In particular the demand for bio-based products in chemical, biotechnological and energy industries is rising fast. According to Smeets et al. (2013), the technological advancements in biotechnology will be an important driver for the growth of the bioeconomy. Applications of the anticipated developments are mainly met in four sectors: agriculture (non-food), pharmaceutical, energy (e.g. second generation biofuel production or heat and power production based on forest biomass) and chemicals. In addition, emerging systems such as bio-refineries are considered as an efficient approach of valorising biomass to a spectrum of bio-based products and are expected to develop further.

3.3.2.4 Agriculture and trade policies

Agricultural and trade policies indirectly affect the EU food system and its actors through their impact on prices, and so diets. Mazzocchi et al. (2012) find that agricultural support policies in the OECD according to some studies have led to a deterioration of diets because of subsidised production of dairy (leading to excessive consumption of fats), but according to other, more convincing evidence has led to dietary improvements since support policies have increased domestic

prices, acting as a food tax, and relatively more so for energy-dense commodities (sugar, beef and milk) than for vegetables and fruits. Undoing this would therefore worsen diets, though it is found that the effects will have been small due to the weak price transmission between agricultural policies and consumer food prices. Elsewhere, in non-OECD countries, support levels have been much less and evidence on dietary impacts is very limited, though price transmission effects may be stronger due to lower levels of processing and value addition along the food supply chain. According to Mazzocchi et al. (2012), the weak evidence-base suggests that socio-demographic and agricultural productivity changes are relatively more important levers.

Trade policies, like domestic support policies, have also been liberalised since the Uruguay Round in 1994 leading to reductions in tariffs and export subsidies and agreements on non-tariff barriers. With the Doha round, so far, failing no further progress has been made. Mazzocchi et al. (2012) conclude that, since price impacts for agri-food commodities are found to be limited in economic simulation models, the expansion of non-agricultural trade and accompanying worldwide economic growth has had much more impact on diets by increasing the availability and consumption of processed foods (notably oils and meats) than traditional trade policy reform.

Trade policies in turn are influenced by the distribution of welfare changes in industrialized countries. Keeney and Beckman (2009), for example, assess distributional impacts of WTO reforms on rice producers in the US. To this end, they apply a CGE model which is refined to distinguish between market clearing wages and capital rents for agriculture and non-agriculture and combine model results with a large-scale farm household survey to estimate welfare changes of individual farm households. They argue that the wealthiest US producers bear the largest losses of market liberalization and thus, that reforms would face strong political opposition.

Different trade policies are affecting price volatility and thus indirectly calorie consumption, as well. Price volatility affects individual consumption directly via price changes for the consumer, but also indirectly via income changes for the producer. A specific focus on volatility is presented by Verma and Hertel (2009). They analyse the interplay between trade policies and calorie consumption in the presence of commodity price volatility. To this end, a stochastic simulation approach is applied to simulate endogenous price reactions on output volatility. Furthermore, impacts on the nutrition status of poor people are estimated by accounting for behavioural responses of low income households to changing prices and incomes.

The impacts of European agricultural policy on food prices, intensification and land use effects in other parts of the world is analysed by Pelikan et al. (2015). They assess a recent reform of the European Common Agricultural Policy with a modelling system consisting of a partial agricultural sector model and a CGE model. They report that an introduction of biodiversity-targeted ecological focus areas within the EU leads to higher output prices and intensification of agricultural production in the more marginal areas of the EU. A decline of arable land in the EU is partly compensated be increasing land use for agricultural production as well as increased fertilizer use outside of the EU.

A related question refers to the effects of sanitary and phytosanitary regulations on international trade. This aspect has been analysed, for example, by Trewin et al. (2016) in a case study for Vietnamese pork within a CGE framework.

3.3.2.5 Environmental issues

The climate change impacts on crop growth and the related commodity markets have been extensively studied (Rosenzweig et al. 2014, Nelson et al. 2014) and some attention have been also devoted to the livestock sector (Havlik et al. 2015, Weidl et al 2015), for an overview see IPCC AR5 WGII. Most studies have focused on impacts due to changes in climate trends (Dumollard et al., 2012), while less studies addressed the occurrence of extreme weather events (Thornton et al., 2014). One study is presented by Willenbockel (2012), in which a CGE model is used to simulate impacts of idiosyncratic adverse temporary shocks to crop productivity in main exporting regions for rice, maize and wheat on prices and consumption in 2030.

Less attention has also been paid to the effects of climate change mitigation on the food system although they may be even stronger than those of the climate change impacts themselves (Havlik et al. 2015). The COP21 Paris Agreement set an ambitious target to stabilize the global temperature rise well below 2 degrees. Already in October 2014, EU leaders set a binding economy-wide domestic emission reductions target of at least 40% by 2030 compared to 1990. Besides the direct effects on agricultural production through incentives to reduce the non-CO_2 emissions of the sector which currently represent about 12% of global anthropogenic emissions (Wollenberg et al. 2016), there are at least four indirect ways through which agricultural production will potentially be affected.

Soil carbon sequestration in agricultural soils: Soil organic carbon has been depleted in large areas as a result of intensive farming leading to land degradation. The "4 per 1000" initiative launched at the COP21 attracts attention to the potential for carbon sequestration in soils as a way to slow down the climate change, help to buffer the residual climate change impacts and through improved soil fertility contribute to food security (http://4p1000.org). In the short term, however, restoring the soil organic carbon may require extensification of production and hence could compete with agricultural production. Frank et al. (2015) apply an EU version of the GLOBIOM model to assess the dynamic soil organic carbon mitigation potential of European cropland. For the study, three alternative tillage production systems are integrated in the model structure and the dynamics of soli organic carbon emissions is explicitly addressed.

Reduction of emissions from land use change and carbon sequestration in biomass: Reducing Emissions from Deforestation and Forest Degradation (REDD) has been advocated as a cheap and effective instrument for climate change mitigation since many years (Kindermann *et al.*, 2008). However, stabilisation of global temperatures would require in addition the afforestation of hundreds of millions of hectares (Fricko *et al.*). This land would either come from natural areas being potentially in conflict with biodiversity protection and other ecosystems services provided by the natural vegetation, or from currently cultivated land and thus would conflict with agricultural production.

Biomass production for energy uses: Afforestation and massive expansion of plantations would be promoted also through the demand for biomass for energy production, which in particular if linked with carbon capture and storage (CCS), would be able to provide negative emissions which seem necessary for achieving of any ambitious stabilization targets at reasonable cost (Kriegler *et al.*, 2014).

Energy prices: Agricultural and energy markets are increasingly interconnected (Tadesse *et al.*, 2014). This is on the one hand because of the growing reliance of agricultural production on energy

e.g. for traction but also the reliance of energy intensive inputs such as synthetic fertilizers. On the other hand, the development of biofuels triggers increases in demand for the biofuels feedstocks, such as corn, which in turn leads to higher agricultural prices. We can expect that because of the growing demand, decreasing conventional reserves, as well as policies to limit climate change, the price of energy will substantially increase. Energy prices will have a negative impact also on irrigation water availability because energy is necessary for pumping. The water availability will be further constrained by climate change (Elliott *et al.*, 2014; Schewe *et al.*, 2014) and by the rising demands from the non-agricultural sectors (Wada *et al.*, 2016).

3.3.2.6 Culture and lifestyles

A study focusing explicitly on nutrition intake and changing dietary behaviour is presented by Lock et al. (2010). They apply a CGE model to estimate the effects of changes in dietary behaviour in the UK and Brazil. The model is shocked by different scenarios on reducing livestock products in human food consumption. Their results suggest that the benefits of a healthy diet policy will vary substantially between different populations.

The impacts of different global drivers of change (climate change, socio-economic developments) on food consumption, undernourishment, the risk of hunger and impacts on human health have been analysed in a couple of articles applying the AIM/CGE model (Ishida et al., 2014; Hasegawa et al., 2014, 2015, 2016). In these studies CGE model projections are utilized in combination with other data sources or regression models. Ishida et al. (2014), for example, applies CGE projected consumption levels in a function estimated from historical data to calculate the proportion of people undernourishment until 2050. Based on this, children stunting levels are estimated and subsequently, disability-adjusted life years.

In a similar attempt, Rosegrant et al. (2014) apply IMPACT model results on per capita kilocalorie availability together with other data to estimate the percentage of malnourished children and the share of people in a population at risk of hunger. Recently, IMPACT also was coupled to a risk assessment framework for the analysis of climate change on dietary and weight-related health risks (Springmann et al., 2016).

4 Using the conceptual framework: Devising strategic interventions to achieve EU Food and Nutrition Security

This section briefly describes possible uses of the conceptual framework for guiding the analysis within the SUSFANS project as well as for external use. First, the main internal uses are explored, such as for guiding the development of a modelling toolbox for assessing the EU food system. Then some external uses are described, such as the utilization by decision makers thinking through an EU food policy or developing future scenarios on climate change and food systems in developing countries (part of the CGIAR/CCAFS work).

4.1 Internal use of the SUSFANS conceptual framework

The SUSFANS conceptual framework was created to document the project's understanding of the key components the EU food system building on the expertise of the various scientific groups constituting the project. Building on this shared understanding, the framework provides the background for the selection of performance metrics and indicators to assess the EU food system with respect to food and nutrition security outcomes. Furthermore, the framework allows the setup of a modelling framework to couple different available and under-development models for describing the relationships within the EU food system and building a comprehensive toolbox for assessment. The conceptual framework also aids in the identification of relevant future contextual factors that should be incorporated into explorative scenarios used as modelling inputs into the toolbox.

Based on the quantitative linking of different models, the toolbox will allow for quantitative projections of diverse future scenarios to help explore the potential future developments and behaviours of the EU food system, its sources of vulnerability and resilience under different conditions, and how it might respond do different interventions. The system's perspective ultimately allows for the identification of a wide set of policy and technical recommendations which have been assessed not just against a number of specific objectives or for specific actors but which can also be examined against their ripple effects through the whole system and the potential unintended consequences/trade-off effects they might have.

4.2 Use for decision-makers

The use of the SUSFANS conceptual framework to gain greater understanding of the present and futures of the EU food system is ultimately aimed at providing insights for decision-makers – whether at the EU level, in national governments, in the private sector, in civil society or in academia.

In decision-making contexts, the SUSFANS conceptual framework and the toolbox built on this foundation can be seen to have two main objectives: 1) providing a tool for decision-makers involved in planning for sustainable food and nutrition security that aims to take all relevant dimensions into account, as many of the public and private SUSFANS stakeholders have requested; and 2) providing an integrated, quantitative means to demonstrate the need for a food systems perspective in the first place in planning processes that have so far been limited in scope – for instance, planning processes that have focused mainly on production or on consumer behaviour.

In the first SUSFANS stakeholder workshop (carried out in October 2015), participants from governments, the European Commission and private sector groups suggested that the conceptual framework could, for instance, be used for the following questions:

- How can the power relationship along the food chain be managed to avoid market concentration?
- How can legislations for fair governance of the food system be developed and tested?
- Is a Food System Policy possible?
- How can policy makers reflect and formulate environmental policies and their impacts on the food system?

- How can policy makers better respect and incorporate values and perceptions held by food consumers?
- How can Big Data be used?
- How can agrifood and trade policies be considered together?
- How can the use of inputs in production change?
- How can the use of sugars, fats, etc. in food products change?
- Will the increasing number of NCDs lead to policy measures influencing food production?
- Will food reformulation (including less salt) influence shelf life, waste etc.?
- What is the role of regulation versus awareness/education?
- How can behavioural changes be promoted?
- Where is policy needed? Where is the market failure?
- Should a 'stick' or 'carrot' be used in the design of legislation?
- How can FNS policy coherence be achieved?
- Can we design a SFNS stress test for all policies?

4.2.1 Example of an application in policy: an EU Common Food Policy

As the need for food policy integration grows, more and more European stakeholders, including SUSFANS stakeholders and the SUSFANS sister project FP7 TRANSMANGO, are advocating for the need to move beyond the Common Agricultural Policy and toward the development of a form of 'EU Common Food Policy' (IPBES-Food, 2016; Marsden, 2015) based on food systems thinking. The SUSFANS conceptual framework and the resulting SUSFANS toolbox could 1) provide a framework to understand the domains and interactions that this Common Food Policy would have to cover; 2) an insight into future challenges and food system vulnerabilities such a policy would have to engage with; and 3) a way to experiment with and project the impacts of different forms and elements of a Common Food Policy.

4.2.2 Example of an application in non-EU regions: policy guidance in the CCAFS Scenarios Project

Though the SUSFANS conceptual framework and resulting modelling toolbox has been developed with a primary focus on the EU food system, it can be adapted and extended to be used in non-EU policy guidance as well, and in fact, it has already been used for this purpose.

The CGIAR's Climate Change, Agriculture and Food Security programme has a high-impact Scenarios Project led by Oxford University which has, in recent years, successfully used future scenarios to guide the development of major policies across seven global regions (Vervoort et al. 2014). The SUSFANS conceptual framework has been adapted and used as a framing device to design new regional scenarios in the Pacific (Vervoort, 2015) and to help frame policy processes in other regions as well (Vervoort and Balinga, 2015). In these cases, the conceptual framework was used to structure available knowledge about a focus region or country, to identify blind spots and to enable investigations of trade-offs and connections that had heretofore not been discussed. Public and private sector participants in these processes reported that the use of the adapted framework was highly welcome, because though they increasingly see the use of 'food systems' in policy and academic discourse, their encounter with the SUSFANS framework was the first time this notion of food system was disentangled and clarified.

In the next phase of the CCAFS programme, the use of the SUSFANS toolbox which is built on the conceptual framework will be used to further strengthen the program's capacity in successful

foresight-guided planning support for national and regional public and private actors in its seven global regions (CCAFS, 2016). Here, the SUSFANS toolbox will provide a toolbox of state-of-the art micro-level models of nutrition behaviour of individual consumers and macro-level models of natural resource use, food system activity, consumption and nutrition, with long-term time horizons and opportunities, for the quantification of future scenarios and the exploration of levers for innovation and policy reform.

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