EEA Report | No 16/2017

Food in a green light

A systems approach to sustainable food

European Environment Agency

Cover design: Formato Verde
Layout: Formato Verde

Luxembourg: Publications Office of the European Union, 2017

ISBN: 978-92-9213-879-0
ISSN: 1977-8449
doi: 10.2800/884986

Environmental production
This publication is printed according to high environmental standards.

Printed by Rosendahls-Schultz Grafisk
— Environmental Management Certificate: DS/EN ISO 14001: 2004
— Quality Certificate: DS/EN ISO 9001: 2008
— EMAS Registration. Licence no. DK – 000235
— Ecolabelling with the Nordic Swan, licence no. 541-457
— FSC Certificate – licence code FSC C0688122

Paper
Cocoon Offset — 100 gsm.
Cocoon Offset — 250 gsm.

Printed in Denmark

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Acknowledgements

This report was prepared by Cathy Maguire, Constança Belchior, Ybele Hoogeveen (EEA), Henk Westhoek (PBL Netherlands Environmental Assessment Agency), Saskia Manshoven (VITO/European Topic Centre on Waste and Materials in a Green Economy). EEA colleagues, PBL colleagues, the European Commission and European Environment Information and Observation Network (Eionet) are thanked for their comments and support during preparation of this report.

PBL Netherlands Environmental Assessment Agency

SUSTAINABLE DEVELOPMENT GOALS

Contents

About this report

This report takes a food system approach to analyse European production, consumption and trade of food, and associated environmental and human health aspects. Understanding the patterns, processes and actors involved allows for more coherent and effective policy interventions to reduce environmental pressures along the value chain, with potential co-benefits to human health and well-being.

The report addresses both terrestrial and aquatic food production and goes beyond the environmental impact and economic performance of agriculture and fisheries. The focus is on long-term sustainability objectives, as laid down in the 2050 vision of the Seventh Environment Action Programme and the 2030 Sustainable Development Goals. It is a first effort to frame and analyse the issues rather than a comprehensive, integrated assessment.

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Food connects

The rise and spread of food production, trade and consumption has shaped human history, natural landscapes and people's relationships with the natural world. Food is also a crucial element in connecting communities, defining identities, expressing values and preserving cultural traditions. The food we grow, harvest, process, trade, transport, store, sell and consume is the essential connecting thread between people, prosperity and planet (UNEP, 2016).

Feeding a projected global population of 9.6 billion in 2050 in the face of global environmental changes and natural resource constraints is one of the main sustainability challenges of this century. For example, although food crops, dietary choices and production systems vary widely across the world, it is estimated that today only 30 crops provide 95 % of human food energy needs, which has adverse implications for soil quality, species diversity and ecosystem resilience. Just four of those crops — rice, wheat, maize and potatoes — provide more than 60 % (FAO, 2016b).

In its 5-yearly flagship report, *The European environment — State and outlook 2015* (SOER 2015), published in March 2015, the EEA concluded that Europe's progress in decoupling environmental pressures from economic growth has been incremental. Essential gains in resource efficiency have only partially translated into improved ecosystem resilience and human health. In SOER 2015 the EEA therefore argued that, if Europe is to achieve the Seventh Environment Action Programme 2050 sustainability vision of 'living well, within the limits of our planet' (EU, 2013), it must fundamentally transform its core societal systems, in particular those related to food, energy, mobility and the built environment. These sustainability transitions or transformations are understood to be long term, multidimensional and fundamental processes of change, based on profound changes in dominant practices, policies and thinking (EEA, 2015d).

This report is an initial attempt to articulate what a system transition for food might involve. It takes a European perspective, reflecting the transnational nature of the food system and the importance of food and agriculture in European policy. The report draws on the available information to provide a concise analysis of the different dimensions of the European food system. It also highlights some of the challenges and opportunities that currently exist to transform policy and practices in view of current EU policy objectives, the 2030 Sustainable Development Goals (SDGs) and the long-term 2050 vision. In doing so it aims to contribute to our understanding of the environmental, social and economic effects of the food system, how they are linked and the knowledge base that supports and informs policy and decision-making.

A systems approach to sustainable food

While an important criterion for judging whether or not the food system is sustainable is satisfaction of the world population's needs and wants for food and nutrition, it must also sustain livelihoods and ensure ecosystem health, otherwise its long-term viability is threatened. As such, a food system can be defined as 'all the elements (environment, people, inputs, processes, infrastructures, institutions etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socio-economic and environmental outcomes' (HLPE, 2014a).

Food systems have evolved greatly in recent centuries from predominantly local systems of exchange into complex global networks of production, consumption and trade. The global food system incorporates many regional, national and local food systems. These systems have multiple pros and cons for people and nature. For example, today billions of people are over-, under- or malnourished, which has consequent impacts on health and costs across the world. Moreover, an estimated 1.3 billion people depend on the agricultural sector for their livelihoods. Meanwhile, food systems are a major driver of environmental impacts. Globally, food systems are estimated to be responsible for 60 % of terrestrial biodiversity loss, around 24 % of greenhouse gas emissions, 33 % of degraded soils, full exploitation or overexploitation of around 91 % of commercial fish populations, and overexploitation of 20 % of the world's freshwater aquifers (UNEP, 2016).

The many dimensions of food systems create complex analytical and policy challenges. For example, the interdependence of dimensions implies that efforts to alter one (e.g. reducing environmental pressures) are very likely to produce impacts elsewhere (e.g. affecting employment, investments and earnings). This can also mean that interventions produce significant unexpected feedback and side-effects. In addition, food systems do not operate in isolation from other systems such as energy and mobility and wider society, which in turn shape the context in which the food system operates.

There are also diverse views on the problems with the food system and where and how to intervene to deliver more sustainable outcomes. From the perspective of the consumer, the primary function of the food system may be to supply food of the desired type, quantity, quality and price. From the perspective of the farmer or food processor, the food system's main function may be as a source of employment and earnings. For rural and coastal communities, the food system may play a key role in social cohesion, use of land and marine space, and cultural traditions (EEA, 2015d).

A systems approach to sustainable food addresses both terrestrial and marine food production in an integrated manner and analyses resource use and environmental impacts, as well as actors and governance. It expands the prevailing focus of attention from producers to include other actors such as food companies and retailers and, ultimately, consumers. This broader focus encompassing the range of actors and food chain activities has the potential to improve understanding of the food system, including interdependencies, and therefore to identify effective interventions that go beyond a sectoral approach.

Sustainable food system outcomes

The complexity of the food system requires a framework to better understand where and how to act. The framework used in this report interprets the EU 2050 vision of 'living well, within the limits of our planet' (Box 1.1) in terms of three overarching outcomes: food and nutrition security, ecosystem health and social (and economic) wellbeing (Figure 1.1) ([1]).

To 'live well' means that the food system is optimising outcomes in terms of food and nutrition security and social wellbeing in an equitable way and contributing to the provision of good livelihoods, healthy, safe and nutritious food, and communities and culture. To live 'within the limits of our planet' means that the food system is optimising outcomes in terms of ecosystem health, contributing to ecosystem resilience, rather than degrading biodiversity, ecosystem services and the natural resource base.

([1]) See Chapter 2 (EEA, 2016d) for further details on the conceptual framework.

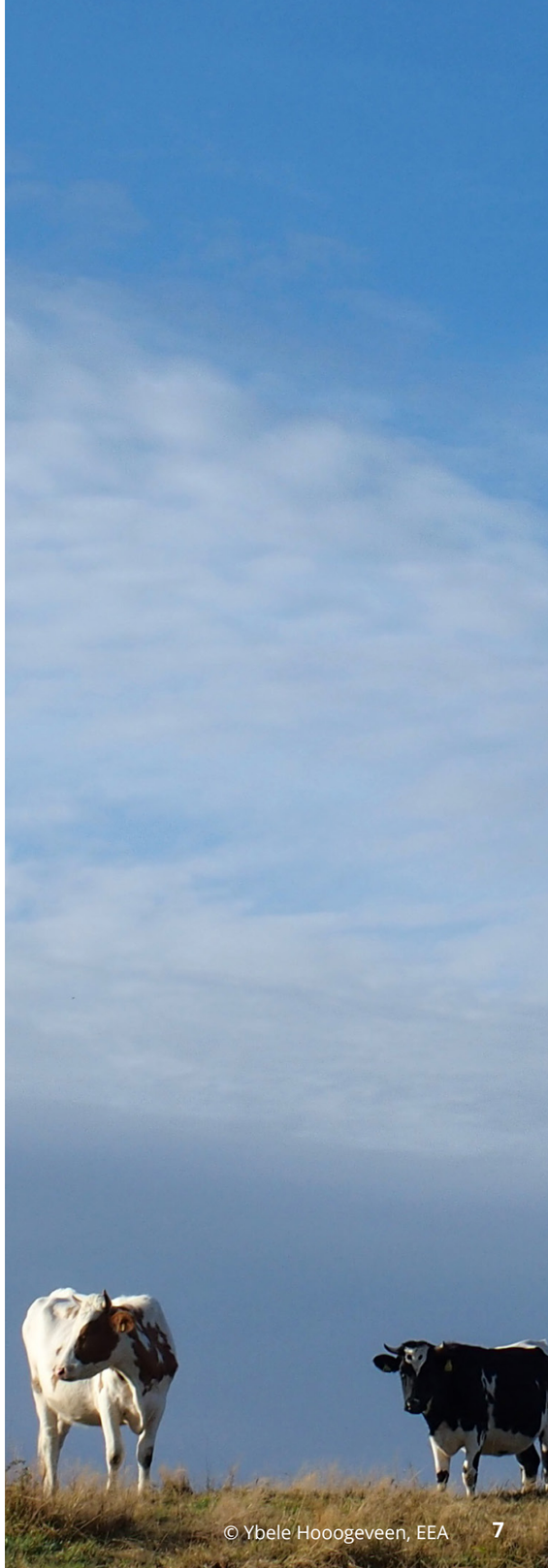

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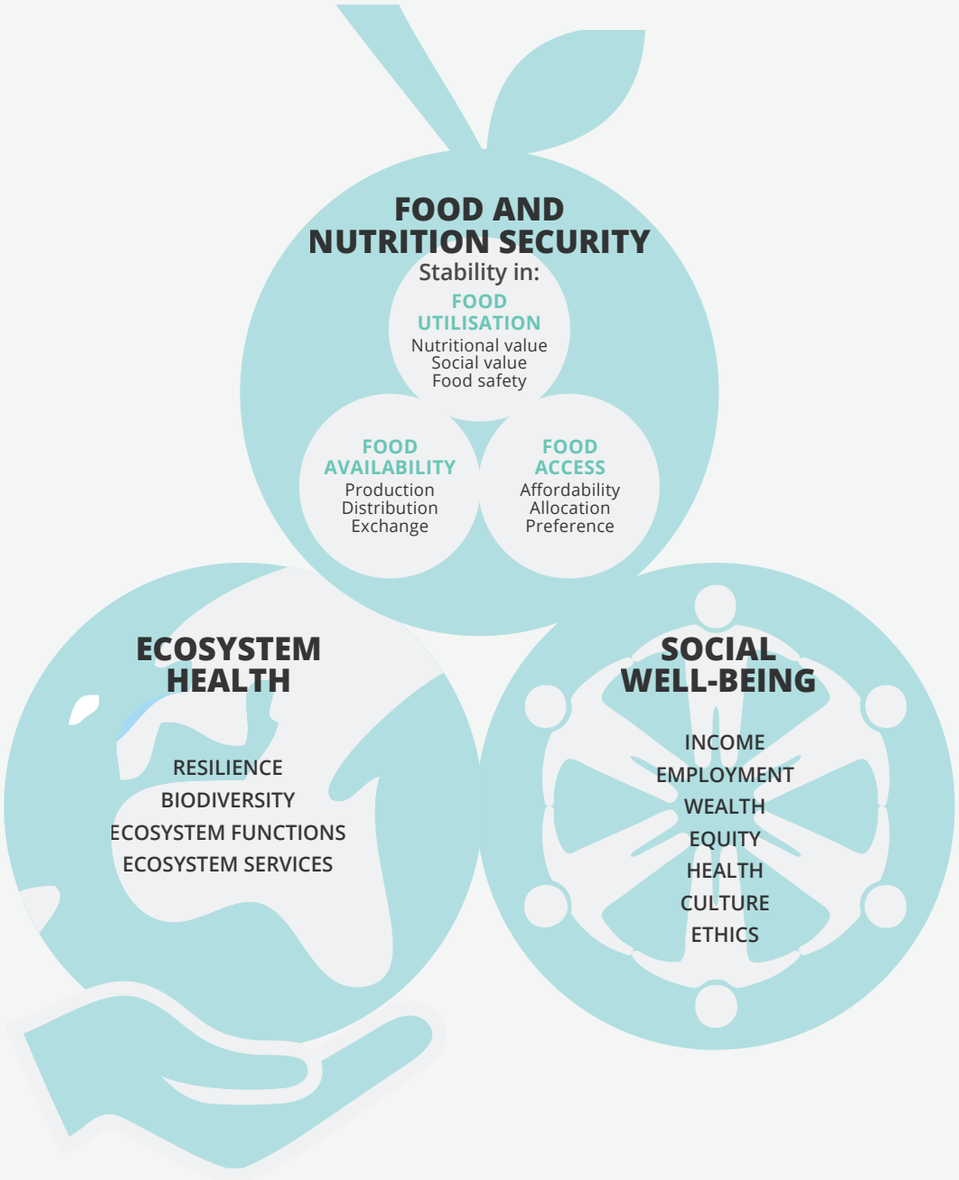
Figure 1.1

Food system outcomes



Source: EEA, based on Ingram, 2011 and UNEP, 2016.

Box 1.1

European and global sustainability goals

The EU has a long-term sustainability vision of 'living well, within the limits of our planet' by 2050. This vision, set out in the 7th EAP, recognises that Europe's economic prosperity and wellbeing is intrinsically linked to its natural environment — from fertile soils to clean air and water. Historically, countries have achieved a transition to high levels of human development by adopting production and consumption patterns that put a disproportionate burden on the environment. As a result, some countries today 'live well', while others live 'within the limits of our planet'.

Europe has recently adopted the targets set by the 2030 SDGs and has committed to be a frontrunner in implementing the 2030 agenda (EC, 2016c). This set of integrated goals is intended to stimulate action over the next 15 years in areas of critical importance for humanity and nature. It is a broad agenda, and food is a cross-cutting issue that connects the goals, as the 2030 agenda cannot be implemented effectively without eliminating hunger, achieving food and nutrition security and improving the health of the world's population. Four goals relate directly to food: Goal 2, 'end hunger, achieve food security and improved nutrition and promote sustainable agriculture'; Goal 12, 'ensure sustainable consumption and production patterns'; Goal 14, 'conserve and sustainably use the oceans, seas and marine resources for sustainable development'; and Goal 15, 'protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss'.

The ways in which food is produced and consumed also influences progress towards other important objectives and targets across a range of European policy areas such as climate change mitigation and adaptation, the circular economy, the bio-economy, biodiversity and nature protection.

Definitions of food security increasingly emphasise access to food and its nutritional value compared with the previous dominance of food production as the main goal (Ingram, 2011). One of the most widely accepted definitions of food security is one in which 'all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active life' (FAO, 2009). Food and nutrition security can be best understood as ensuring that everyone is able to access sufficient, affordable and nutritious food.

A sustainable food system is 'a food system that delivers food security and nutrition for all in such a way as the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised' (HLPE, 2014a). Therefore, to be sustainable, food and nutrition security must be delivered in a way that contributes to social wellbeing and maintains ecosystem health.

Goal 2 also specifies outcomes to be achieved that include 'by 2030 ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality'.

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What does the European food system look like?

There is not one uniform European food system. It has evolved over centuries and incorporates highly interlinked national and even local food systems. Yet the European dimension is crucial, as many important aspects such as regulation, financial support and trade are determined at EU level. The European food system is mainly characterised by high external inputs (such as fossil fuels, fertilisers and pesticides), lower labour inputs and long supply chains. However, there is also diversity with many small-scale family-based producers operating alongside large-scale globalised food companies and suppliers. In order to provide a concise overview, the analysis below focuses on four factors: food production, consumption, trade and actors.

Food production

Agriculture

Europe's farmers produce a wide range of food products due to the region's varied climatic and geographic conditions. While European agriculture provides other important functions, such as contributing to rural development and managing landscapes, the provision of food remains the primary function. European agricultural production has increased significantly since the 1950s as a result of a mix of European and national policy measures, production-related subsidies, technological innovations and market incentives. The most productive and specialised farming systems tend to be found in lowland western Europe, with some more extensive practices found in southern, eastern and mountainous regions.

Currently agriculture accounts for roughly 40 % of the land area in the EU. The EU is the world's largest producer of wine, olive oil and tomatoes. It is also a large producer of dairy products (more than 20 % of global production) and of cereals (13 % of global production) (Eurostat, 2016a). The EU is an important producer of livestock and, since the 1980s, there has been a shift towards larger-scale, specialised livestock holdings, with an increase in poultry, veal and pig production and a decrease in beef, sheep and goat production (Eurostat, 2016a).

The general pattern of development in the agricultural sector has been towards a greater concentration of agriculture within the hands of relatively few large, often corporately owned, farms (Eurostat, 2016b). So while overall agricultural production has increased, the number of farms and farmers has decreased and the average farm size is larger (Eurostat, 2016a). In 2013, very large farms (over 100 ha) comprised 3 % of all holdings but farmed half of the utilised agricultural area (UAA) in the EU-28 (Eurostat, 2016a). Just over 2 % of farms had a standard output greater than EUR 250 000 yet accounted for more than half (52 %) of the total agricultural economic output (Eurostat, 2016a). At the same time, small farms with a standard output up to

EUR 8 000 account for 69 % of all farms in the EU, reflecting the relatively large number of very small, subsistence farming households where over 50 % of the output is self-consumed (Eurostat, 2016b).

Growth in larger specialised production units has led to monocultures with considerable environmental impacts, reduced diversity and growing concerns among consumers about food quality (EPSC, 2016). This type of input-intensive and uniform production makes food systems increasingly reliant on chemical fertilisers, pesticides and the preventative use of antibiotics and leads systematically to negative impacts and vulnerabilities (IPES Food, 2016). However an increasing number of farmers are adopting alternative systems such as organic farming and agro-ecological practices. The total area under organic production grew by 21 % between 2010 and 2015 to 6.2 % of total UAA (11.1 million hectares) and is expected to grow further in coming years (Eurostat, 2016g).

Despite the dominant trend towards intensification, Europe still has substantial areas of high nature value farmland, characterised by a high proportion of semi-natural vegetation and low-intensity agriculture. These areas generate important ecosystem services and public goods while facing socio-economic pressures to intensify or abandon production. These changes have resulted in a significant decline in biodiversity across European farmland, including the genetic diversity of crops and livestock (EEA, 2015a, 2015c).

Nutrients (e.g. nitrogen, phosphorus and potassium) are essential for both crop production and animal and human nutrition. However, their overuse can lead to nutrient losses that affect soil, air and water quality and have a considerable negative impact on biodiversity and ecosystems. In 2013, the average nitrogen surplus on agricultural land in the EU was 51 kg/ha and, while still high, this had fallen by 12 kg/ha since 2000. The phosphorus surplus was 2 kg/ha and it had halved since 2004 (Eurostat, 2016e). While the average nutrient surplus provides a picture of overall trends in the EU, many regional and local nutrient surplus hotspots exist, often in areas of intensive agriculture and livestock production.

Nutrient emissions to air from agriculture have also decreased since 2000 and, while they are expected to decrease further, they will remain significant contributors to eutrophication in terrestrial ecosystems (EEA, 2016b). On average the EU still has an unacceptable surplus of nitrogen in view of losses to the environment, and further efforts are needed to manage the nitrogen cycle more sustainably (EEA, 2016b) (see Box 2.1).

Nutrient run-off is a particularly large source of diffuse pollution in water bodies, and agricultural pesticides have also been widely detected in both surface and groundwater bodies. Available data on pesticide use in Europe showed an overall decline between 2000 and 2009 (EEA, 2013). Pesticide sales slightly increased in the EU between 2011 and 2014; however, this cannot be directly equated to the risk to human health and the environment and provides no insight into whether or not the use of pesticides is sustainable (EEA, 2016b).

Agricultural production both contributes to climate change and is affected by climate change. It contributes to greenhouse gas emissions in many ways, including via methane produced by livestock, emissions from nitrous oxides from nitrogen fertilisers and manures, emissions from land use change and soil carbon loss, and emissions from the energy used by machinery and transport. Over 80 % of the greenhouse gas emissions from agriculture are related to the livestock sector (Leip et al., 2015). The agricultural sector was responsible for 11.3 % of EU greenhouse gas emissions in 2014 ([2]). In absolute terms those emissions included in the greenhouse gas inventory from the agricultural sector have decreased since 1990 (EEA, 2016e).

Agriculture is a significant user of water and, while by 2014 efficiency gains of 7 % had been achieved in agricultural water use since the 1990s, it remains the sector with the highest water demand and will continue to contribute to water stress in Europe (EEA, 2016b).

Over the last 50 years Europe's agriculture has received substantial support under the common agricultural policy (CAP), which currently has an annual budget of roughly EUR 59 billion, which includes funding for rural development programmes. The recent CAP reform for the 2014-2020 period aims to respond to the three main challenges facing agriculture: economic, environmental and territorial. An important feature of the new CAP is the recognition that farmers should be rewarded for the services they provide to the public even though they may not have a market value.

([2]) This does not include emissions from farm equipment or off-farm emissions related to fertiliser production.

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Box 2.1

Nutrient efficiency

How efficiently nutrients are used is a critical issue for a sustainable food system and the circular economy. The growth in nitrogen (N) and phosphorus (P) flows is having an impact on environmental and human health, as it overwhelms the capacity of natural nutrient cycles to absorb these flows. Over the last century humans have caused changes in the global nitrogen cycle, and current levels already exceed globally sustainable limits, as indicated by the planetary boundaries described by Rockström et al. (2009).

Nutrients leak into the environment across all food system activities, including crop and livestock production, processing food and waste management. Humans have converted atmospheric nitrogen into many reactive nitrogen forms (which are essential for life but occur in limited amounts in nature). In Europe the amount of reactive nitrogen coming into the environment has more than tripled since 1900, impacting on water quality, air quality, the greenhouse gas balance, ecosystems and biodiversity, and soil quality (Sutton et al., 2011). Europe is also dependent on imported P, a finite natural resource which is being depleted.

Recent studies have quantified the flows of N and P through the food system and show that a large proportion of the nutrient losses are related to the expansion of the livestock sector (Sutton et al., 2011; Leip et al., 2014; Buckwell and Nadeu, 2016). Analysis of the N and P flows through the agricultural food system shows major losses (80 % for N and 70 % for P) (Figure 2.1). Of the total input in the form of nitrogen and phosphorus fertilisers, only 20-30 % is actually embedded in the food that reaches consumers' plates.

The growth in nutrient flows is projected to continue in the coming decades; therefore, the scale of associated impacts will continue to grow. Three main levers to address this have been identified, namely, changing diets towards lower consumption of livestock products, improvements in nutrient use efficiency in all food chain activities, and reducing waste throughout the food chain (Buckwell and Nadeu, 2016). As well as reducing impacts, this would also reduce reliance on imported phosphorus and fossil fuels used to manufacture nitrogenous fertilisers.

There is substantial scope to reduce nutrient inputs in the food system, as well as increasing the recovery and reuse of nutrients from animal manures, sewage waste and food chain waste. Many of the necessary actions are already under way to some extent. The 7th EAP and Circular Economy Action Plan recognise the need for more integrated and resource-efficient management of the nutrient cycles. Existing policies related to nutrients are fragmented, and the European Nitrogen Assessment identified seven key actions for better management of the European nitrogen cycle that aim to provide an integrated package for developing and applying policy instruments (Sutton et al., 2011). Four actions relate directly to food production and consumption, for example improving nitrogen use efficiency in crop and animal production, and lowering human consumption of animal protein. The European Sustainable Phosphorus Platform was established in 2013 and includes stakeholders across the whole value chain of phosphorus management (see www.phosphorusplatform.eu for details).

Fisheries and aquaculture

In 2014 total production of fishery products was an estimated 6.7 million tonnes (live weight equivalent) (Eurostat, 2016b). There has been a steady decline in production since 2000 in both aquaculture (by 16 %) and capture fisheries (by 17 %) (Eurostat, 2016a).

European fishing has been managed under the common fisheries policy (CFP) since 1983. The latest CFP reform aims to respond to overfishing and ensure that fishing and aquaculture are environmentally, economically and socially sustainable. It introduced a legal obligation to manage fisheries with the objective of achieving maximum sustainable yield by 2015 where possible, and by 2020 at the latest for all stocks. In Europe's seas, overfishing levels (defined as fishing above maximum sustainable yield) remain high overall: 50 % in the EU's north-east Atlantic Ocean and Baltic waters, and over 90 % in the Mediterranean and Black Seas in 2014 (STECF, 2016).

Many stocks have been recovering since 2003, largely because of better management and progress towards fishing at maximum sustainable yield ([3]). The new CFP has still to overcome challenges to implementation if Europe is to reach the goal of fishing at maximum sustainable yield for all fish stocks by 2020. These challenges include fleet overcapacity, availability of scientific advice, adherence to scientific advice, the adequate uptake of management measures, and reducing adverse effects on ecosystems, particularly damage to the sea floor (EEA, 2015d). In addition, fish stocks are also affected by climate change and are responding to changing temperature and food supply by changing their distribution, which can have an impact on the local communities that depend on those fish stocks (EEA, 2017).

([3]) See Figure 2.4 (EEA, 2016c) for further details.

Socio-economic dimensions of agriculture and fisheries

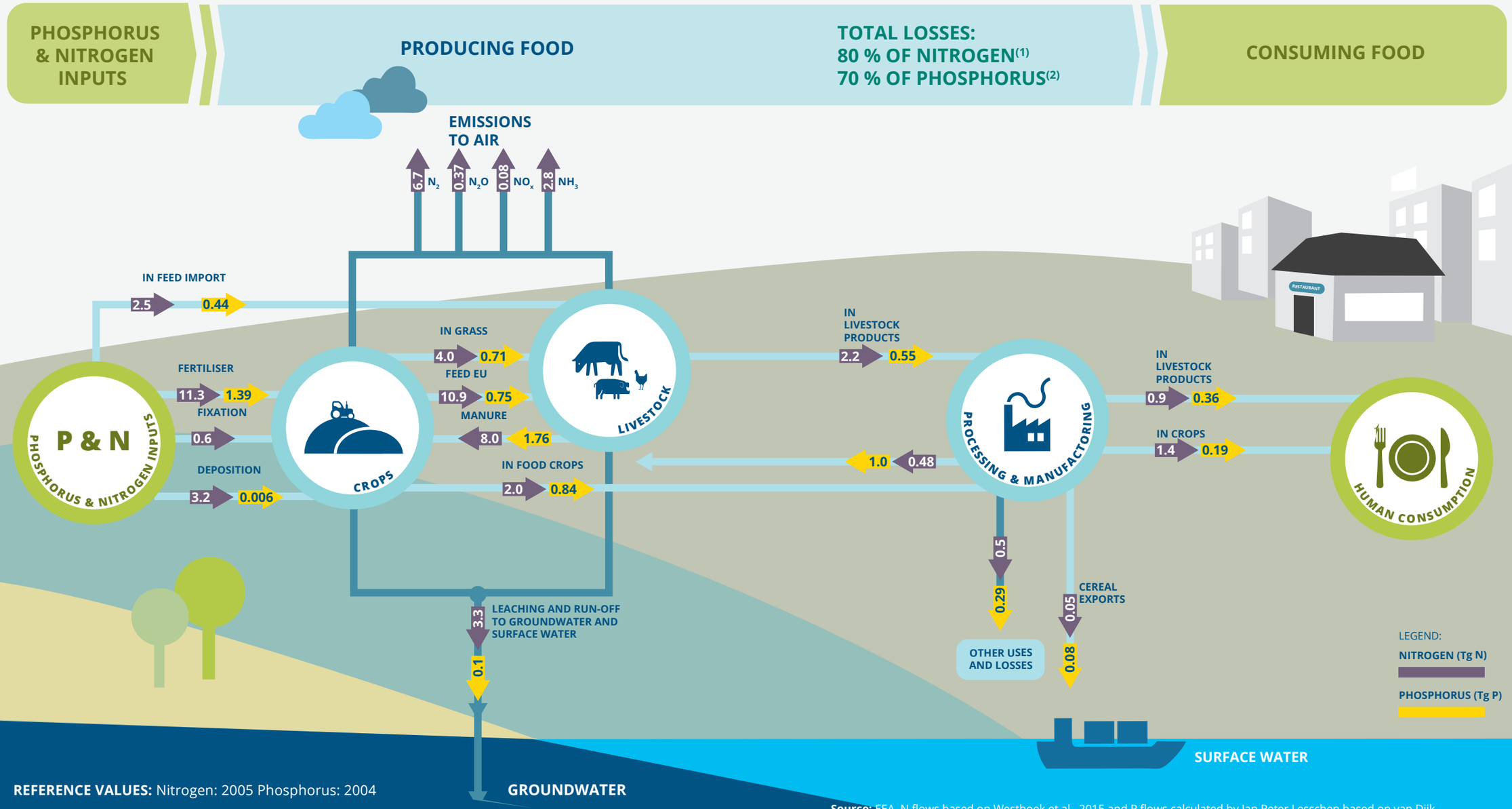
While the overall contribution of agriculture and fisheries to the EU gross domestic product is relatively modest, these sectors play important roles in supporting rural and coastal communities and contributing to balanced terrestrial development, social cohesion and management of natural resources. These aspects are addressed in the EU's regional policy and funding schemes under the CAP and the CFP.

The relative importance of agriculture and fisheries in the EU economy has been in decline over the last 50 years. The gross value added of the agricultural industry in 2014 was an estimated EUR 162.8 billion, while overall subsidies amounted to EUR 53.8 billion (Eurostat, 2016b). In 2013 around 22.2 million people worked regularly in agriculture. However, employment in agriculture is often characterised by seasonal labour peaks and part-time work, so this translates into 9.5 million full-time work equivalents. In the EU, fishing provided about 129 000 jobs in 2014 (STECF, 2015) while aquaculture accounted for about 80 000 jobs in 2012 (STECF, 2014).

Producing and processing fish as food in the EU is still largely dependent on small and medium-sized businesses. While relatively small, the fishing sector plays an important role in economic activity and employment in many coastal communities where it can provide over half of the local jobs (Natale et al., 2013).

Figure 2.1

Phosphorus and nitrogen flows and the EU food system



REFERENCE VALUES: Nitrogen: 2005 Phosphorus: 2004

Source: EEA. N flows based on Westhoek et al., 2015 and P flows calculated by Jan Peter Lesschen based on van Dijk et al., 2016; (1) Buckwell and Nadeu, 2016; (2) Van Dijk et al., 2016

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The wider food chain

Looking beyond agriculture, fisheries and aquaculture, the food and drink industry is one of the largest manufacturing sectors in the EU in terms of employment, turnover and value added. In 2014, it employed 4.25 million people with a total turnover of EUR 1 089 billion, and in 2013 it had a value added of EUR 212 billion (Food Drink Europe, 2016). In 2013, the wider food supply chain — from agriculture and the input industry to food and drink services — employed around 31 million people with a total turnover of €3.9 trillion and a value added of EUR 700 billion (Food Drink Europe, 2016).

The food system is a major consumer of energy and emitter of greenhouse gases and air pollution. The amount of energy necessary to cultivate, process, pack and bring food to European citizens' tables accounted for 17 % of the EU's gross energy consumption in 2013, equivalent to about 26 % of the EU's final energy consumption that same year (JRC, 2015a). Agriculture is the most energy intense phase of the food system, accounting for nearly one third of the total energy consumed in the food production chain (JRC, 2015a). While the EU has made important progress in incorporating renewable energy across the economy, renewables accounted for just 7 % of the energy used in food production and consumption in 2013 compared to 15 % in the overall energy mix (JRC, 2015a). This suggests scope for further use of renewables and reduced greenhouse gas and pollution emissions.

Food waste is generated along the entire food supply chain, although there is considerable uncertainty about estimates related to different stages, including production and processing. In 2012, it was estimated that 88 million tonnes of food waste was generated in the EU-28 (FUSIONS, 2016). Estimates of the environmental impacts of food waste at different stages along the food supply chain can depend on the approach used. In terms of climate change impacts, estimates based on the origin of the emissions allocate the majority of emissions to the production stage (72 %) (Cristobal Garcia et al., 2016).

In summary, improving the sustainability of food production in Europe implies a fundamental shift towards more ecological approaches by ensuring sustainable use of renewable resources, that is, by not overexploiting them and managing them effectively. It also implies an increase in overall resource efficiency in terms of external chemical inputs, water and energy use, land take and waste generation (EEA, 2013). Achieving sustainable food production will also need to reconcile low environmental impacts, food and nutrition security and the viability of rural and coastal communities.

Food consumption

Consumption patterns

Over the past 50 years, food consumption in Europe has undergone significant changes, influenced by factors such as demographics, availability of food products, economic change, price changes, cultural and personal preferences, technology, social values, education and health (EEA, 2014b). Per capita food consumption has increased and dietary preferences have changed. The average European per capita consumption of animal protein is now 50 % higher than in the early 1960s and double the global average (PBL Netherlands Environmental Assessment Agency, 2011). Economic, demographic and lifestyle changes have also led to an increase in the amount of food consumed outside the home and to a decrease in the amount of time devoted to cooking and eating food (Trichopoulou, 2009).

On average, food and drink products accounted for 14 % of household expenditure in 2015 but this varied among Member States, ranging from 10 % to 32 % (Eurostat, 2016d). The average yearly food intake by a European adult is shown in Figure 2.2. Food consumption patterns vary substantially across European countries. For example, meat consumption ranges between 109 and 159 g/day, fish and seafood between 9 and 63 g/day and milk and dairy product consumption between 171 and 522 g/day (EFSA, 2008; EC, 2009). Many factors influence differences in eating habitats between countries, such as culture and climate, household composition, education and income, and the degree of urbanisation (Eurostat, 2013).

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Health and environmental impacts

In the EU today, five of the seven biggest risk factors for premature death — high blood pressure, cholesterol and body mass index, inadequate fruit and vegetable intake, and alcohol abuse — are related to how we eat and drink. An unhealthy diet (e.g. too high in animal protein, sugar and fats) combined with a lack of physical activity leads to people becoming overweight or obese, increasing the risk of cardiovascular diseases, certain types of cancer, hypertension and type 2 diabetes. The proportion of the population that is overweight and obese is increasing in all European countries and among all age groups, including pre-school and primary school-aged children. In 2014, more than 50 % of the European population was overweight, with over 20 % classified as obese (WHO, 2015) (Figure 2.2). Up to 7 % of EU health budgets are spent each year directly on diseases linked to obesity, with additional indirect costs resulting from productivity losses associated with health problems and premature death (EC, 2014).

Dietary recommendations have been developed to support healthy eating habits in most European countries, although there is variation between countries in specific recommendations and definitions of portions and servings. In general, the average intake of fruit and vegetables is too low while intake of red meat, saturated fat, salt and sugar is too high compared with dietary recommendations. Increased consumption of processed foods and eating out also contribute to this. Research in the United Kingdom has revealed that food consumed outside the home is generally higher in fat, salt and protein (Defra, 2011; Remnant and Adams, 2015).

While dietary guidelines are based on nutrition and health considerations, they could also consider the impacts of food choices. Meat and dairy products contribute around 25 % of the environmental impacts caused by total final consumption of products in the EU (Weidema et al., 2008). The Swedish National Food Agency has developed dietary guidelines that focus on how to eat sustainably to benefit health and the environment (Livsmedelsverket, 2015). Currently these wider environmental concerns are not regularly considered during the development of dietary guidelines.

In the EU, many food waste studies and prevention measures are focused on consumption (Cristobal Garcia et al., 2016). Nearly all European countries include food/organic waste in their waste prevention programmes, and five countries and two regions have specific quantitative targets for food waste (EEA, 2015e). The prevailing type of policy instrument used to prevent food waste is providing information that is focused on cost savings or influencing consumer behaviour.

Trade

Europe is embedded in a dynamic global web of food producers, processers and markets that rely heavily on international trade in goods and services. International markets, technological developments and transport systems have made it possible to connect food production and consumption on a global scale. Global financial markets are increasingly influencing land transactions, agricultural production decisions, rural credit provision, risk insurance, commodity pricing, and food distribution and retail (HLPE, 2014b).

Europe is a net importer of commodities such as tropical fruits, coffee, tea, cocoa, soy products and palm oil. The EU is also the largest importer of seafood and fish products in the world. The EU had a market share of 20 % of total global imports of seafood and was responsible for around 6 % of total global exports between 2013 and 2015 (FAO, 2016c). The EU's capacity to meet the demand for fish and aquaculture products from its own waters has been around 45 % since 2008 (EUMOFA, 2015).

The largest proportion of food consumed in the EU is still produced within the EU and the majority of EU trade in food and drink products takes place between EU countries. Europe is a net exporter of many key agricultural products such as meat, dairy, cereals and wine, and EU food and drink exports have nearly doubled over the past decade in value. In 2016, Europe exported agri-food products with a value of nearly EUR 131 billion and imported products with a value of EUR 112 billion, giving a positive trade balance of EUR 19 billion (EC, 2016e). In terms of market share, Europe was the number one exporter (18 % market share of global exports) and number two importer (14 % share of global imports) of food and drink products in the world in 2015 (Food Drink Europe, 2016).

However, while Europe's exports have grown in volume over the last decade, in 2015, Europe had a negative trade balance in physical terms (kilograms) importing more food and drink from outside the EU than it exported (Eurostat, 2016c). This difference between trends in the volume and value of food and drink trade reflects the relatively low monetary value of some imported commodities such as soybeans and palm oil compared with the higher value of some exports such as processed foods, chocolate and wine.

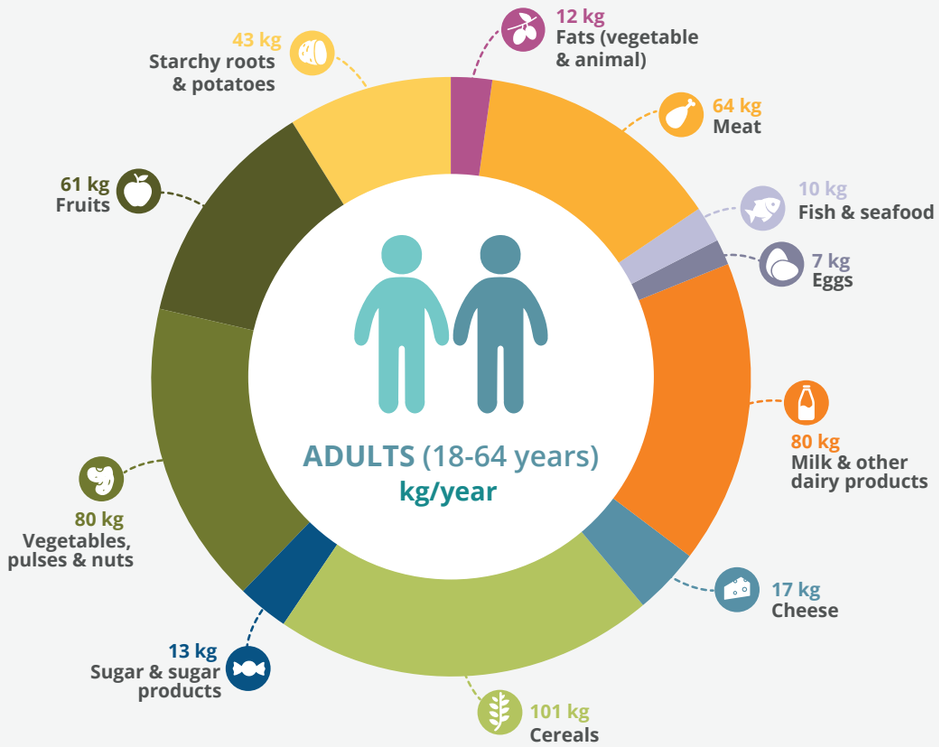
In a global food system, Europe's imports and their consumption have an environmental, social and economic impact beyond European borders. This wider impact is recognised in EU policy and the 7th EAP aims to ensure that by 2020 'the impact of consumption in the EU on the environment beyond EU borders is reduced' which requires 'assessing the environmental impact in a global context of EU consumption of food' (EU, 2013).

European production has an effect outside the EU through the import of feed that is used in both livestock and aquaculture production (Figure 2.3). In 2013, Europe had net imports of around 27 million tonnes of soybeans and soybean products for oil production and animal feed. This means that Europe is dependent on overseas land for its own production. In 2011, the land footprint of soybean imports was around 11 million hectares, of which 80 % was in South America. The vast majority of imported soybean is genetically modified, which is not permitted for cultivation in Europe. In Brazil and Argentina, expanding soybean cultivation has caused losses of habitat and biodiversity, while fodder production competes directly with Brazil's well-established bio-ethanol production sector, creating land use conflicts (EEA, 2014b).

Figure 2.2

Diets and malnutrition

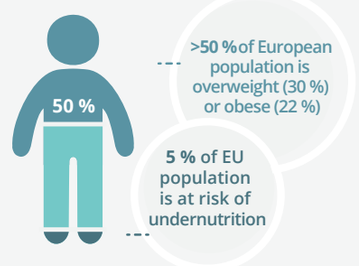
WHAT ARE WE EATING IN THE EU?



INCLUDING...

- 71 l/year **Alcoholic beverages**
- 190 l/year **Coffee, tea & cocoa**
- 54 l/year **Soft drinks**
- 28 l /year **Fruit & veg juices**
- 7.4 kg /year **Ice-cream & dessert**
- 14.8 kg /year **Ready-to-eat meals**
- 3.7 kg /year **Salt**

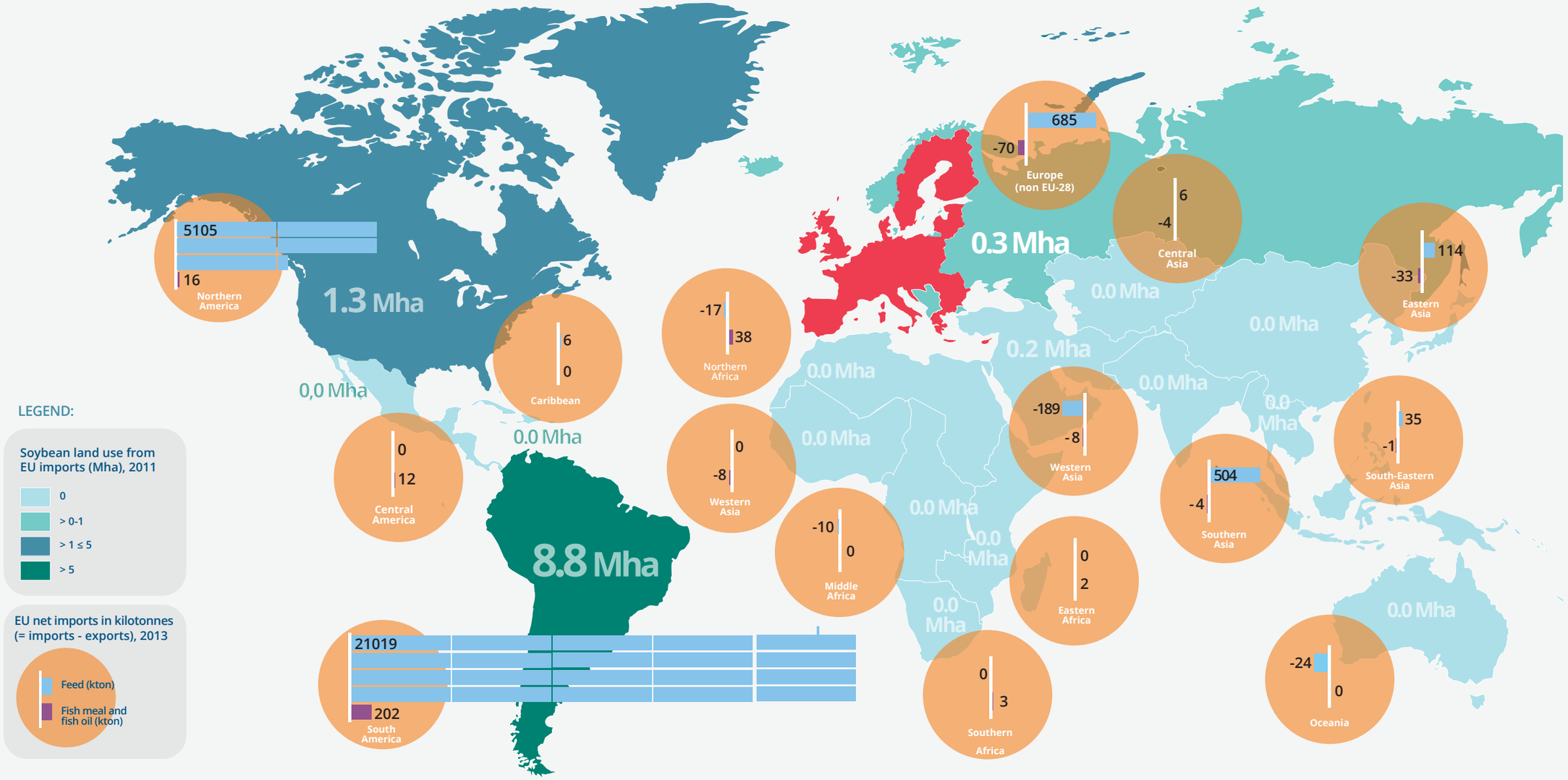
FACTS ABOUT MALNUTRITION



Source: EEA, compiled from EFSA, 2008; European Commission, 2009; WHO Europe, 2017.

Figure 2.3

EU animal feed imports and land dependency



Note: 100% of soycake imports were included as feed. Soybean imports for feed were calculated assuming that (1) 1.5% are used directly for human consumption; and (2) the remaining imports were split into oil for human consumption (20%) and soybean cake for feed (80%).

Source: EEA own calculations based on FAOSTAT 2013 data (soybean products), EUMOFA 2013 data (fish meal and fish oil) and Kastner et al., 2011 (overseas land use).

Food system actors

Food system actors represent the largest group of natural resource managers in the world, and consequently they are critical in both creating the problems and implementing the solutions (UNEP, 2016). In addition to those directly involved in food chain activities, governments and civil society are also important, as they set the wider policy and societal context.

Understanding the different roles of actors and the factors that influence their decision-making is important in identifying opportunities to support transition (Meadows, 2008). Identifying actors along the food chain (Figure 2.4), as well as where and how power is located, enables policymakers to develop management approaches targeted towards those actors with influence. Current policies and initiatives mainly target primary producers and consumers and, while these actors are the largest in numbers, they do not necessarily have the most power or influence to bring about change in the food system.

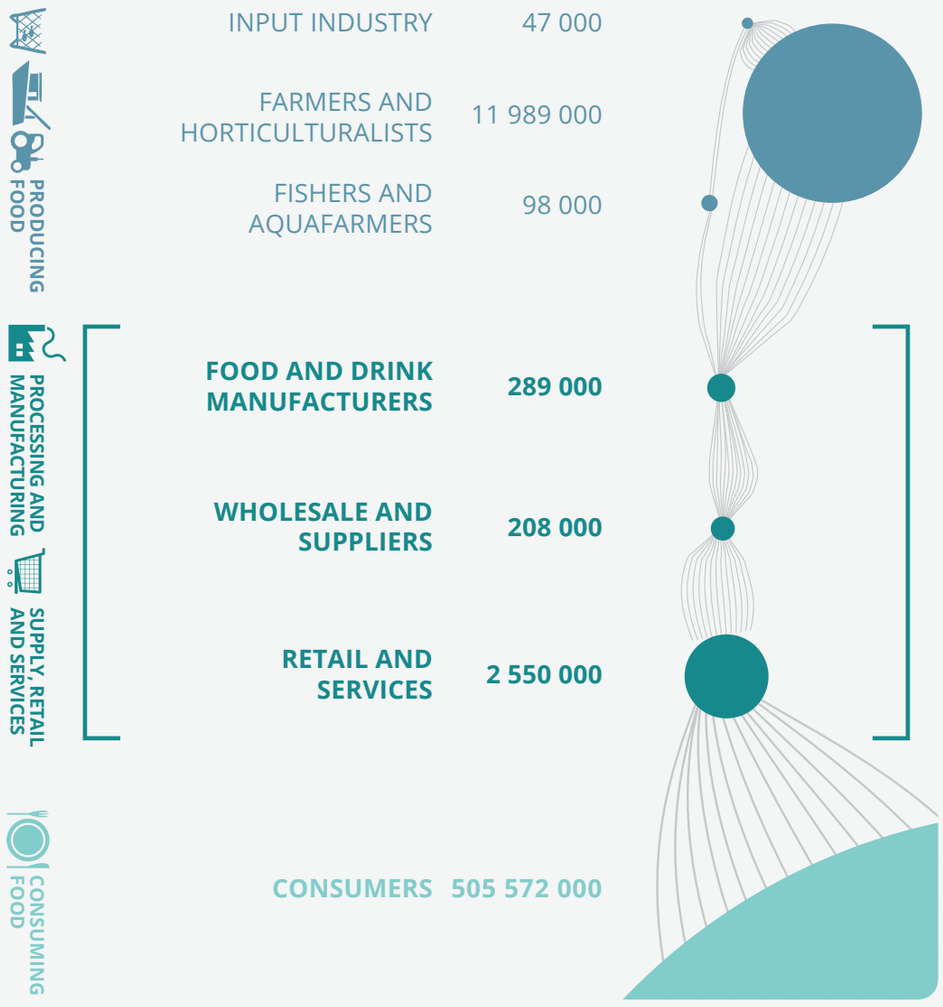
In the European food system, small and medium-sized enterprises are responsible for nearly 50 % of turnover (Food Drink Europe, 2016). However, many larger companies are vertically integrated, meaning that they operate at different steps of the value chain, and they are well connected to one another through subsidiaries. This consolidation has been accompanied by a shift in power from primary producers to actors downstream in supply chains (UNEP, 2016). Recent take-overs have further consolidated influence, for example the proposed Bayer and Monsanto merger, involving companies producing seeds and pesticides, would form an integrated and powerful global player (Heinrich Böll Stiftung et al., 2017).

The 10 biggest retail companies in the EU have a combined market share of over 50 % (Heinrich Böll Stiftung et al., 2017), exerting a large influence over both producers and consumers. The market share of the top three retailers per country ranges across Europe from 30 % to 50 %, reaching over 70 % in Ireland, Denmark and Sweden (Food Drink Europe, 2013).

When actors such as large retailers have disproportionate buying power they can increase their profit margins by depressing prices that food producers receive for their produce. This in turn means lower incomes for producers, impacting their ability to invest in product or production process innovations that can contribute to more sustainable outcomes. Analysis of companies in the seafood trade, for example, showed that corporate consolidation enhances the ability of companies to define production terms and set prices, while bringing a disproportionate ability to influence the dynamics of marine ecosystems worldwide (Österblom et al., 2015).

Figure 2.4

Actors in the food chain



Notes: 1. There may be some double counting as some actors operate across the value chain. 2. The input industry also includes some wholesale of grain. 3. Data used are the number of enterprises in 2012 (input industry, aquafarmers, manufacturers, wholesale and suppliers and retail and services), number of holdings in 2012 (farmers and horticulturalists), number of vessels in 2013 (fishers) and population in 2013 (consumers).

Source: EEA adapted from PBL and based on Eurostat [sbs_na_ind_r2] and [demo_pjan], European Commission, 2013; STECF, 2014, 2015.

This concentration of power brings challenges as well as opportunities. It can lead to negative outcomes, as these private actors prioritise efficiency of production and short-term profit over wider socio-economic and environmental considerations and are often active in setting policy for their sector. However the existence of globally networked and vertically integrated companies also means that collective action by relatively few has the potential to catalyse substantial change in the food system.

While consumers are critical actors in the food system, consumer choices are influenced by the 'food environment' — the physical, social and economic surroundings that influence what people eat. This plays a major role in determining food consumption patterns, particularly in urban areas (UNEP, 2016). Food system actors such as suppliers, retailers and services are increasingly operating on transnational scales and actively shaping the food environment to influence food choices through measures such as advertising and packaging. Influencing the food environment could be an important lever for change with regard to dietary composition, reducing food waste and supporting more environmentally sustainable production.

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What are the challenges ahead?

The main challenges for the food system can be better understood by considering both global and European perspectives. Environmental conditions and policies in Europe cannot be fully understood — or properly managed — in isolation from global dynamics (EEA, 2015d). For example, Europe's societal resilience is expected to be significantly affected in coming decades by a range of global megatrends, that is, large-scale, high impact and often interdependent social, technological, economic, environmental or political changes. There are additional challenges at European level in relation to the current impacts of the food system and the actions needed to achieve sustainable outcomes in terms of food and nutrition security, ecosystem health and social wellbeing.

A global perspective

Growing demand, limited resources

Based on United Nations population projections, the world will have to feed an extra 1.62 billion by 2030 and 2.38 billion by 2050. These figures may vary due to social, economic and political changes, but not very significantly, and the increase will largely occur in cities. The combination of population growth, urbanisation and rising incomes is expected to lead to an increase in global meat production of 60 % compared with current production levels, while crop production is projected to increase by 40 % (FAO, 2012).

While demand for food will grow, further expansion of agricultural land will be limited and the area of available arable land per person may decrease from the current 0.22 ha to 0.18 ha in 2050 in spite of a projected increase in cropland of almost 110 million hectares in developing countries and a decline of nearly 40 million hectares in developed countries (FAO, 2012). To put this into context, the total area of land used by European citizens to produce the food they consume each year has been estimated at around 185 million hectares of which around 20 % is located outside the EU (Figure 3.1). This is the equivalent of 0.4 ha per person, a little more than half a football field. Animal-based food products account for 72 % of this land use, with most land required for dairy farming and beef production. Nearly half of cropland is used for feed production.

Growing concerns about food, water and energy security have also fuelled transnational land acquisitions in the last 5-10 years, primarily in developing countries. Between 2005 and 2009 alone, global foreign land acquisitions totalled some 470 000 km^2, which is comparable to the size of Spain. In some countries (particularly in Africa) large parts of the agricultural area have been sold to foreign investors, mostly from Europe, North America, China and the Middle East (EEA, 2015d).

Climate change is also impacting on global food production. Changes in the global price for food and feed is of great importance for Europe, which relies on imports for direct consumption as well as livestock production.

Over the last decade there have been several periods of rapid food and cereal market price increases following extreme weather events in key producing regions. These events show that climatic change can have consequences beyond the regions in which they occur through the global food trade system (EEA, 2017).

The amount of fish supplied by capture fisheries is expected to remain stable, with the increased demand largely met through aquaculture. By 2030 it has been projected that over 60 % of fish for human consumption will be supplied by aquaculture (World Bank, 2013). How the aquaculture sector can fill the gap between demand and supply in a sustainable way is a challenge. The capacity of the marine environment to continue to provide the ecosystem services necessary for fish production is at risk, as the state of coastal and marine ecosystems is of concern globally and multiple uses of the ocean are growing (UN, 2016).

There are some parallels between the concerns around the expansion and intensification of aquaculture and those regarding intensive livestock production. The environmental impacts associated with finfish farming and management of sea lice in particular have significant costs and implications for the sustainable development of aquaculture. The use of feed resources in aquaculture raises a number of complex issues for sustainable use of both ocean and land resources. Analysis of the feed used in aquaculture reveals the dependency of finfish aquaculture on other species but also the connection to terrestrial food production (EEA, 2016d). Improved analysis and understanding of the interactions and dependencies between land and sea could enable aquaculture expansion plans to add resilience to the food system rather than undermining resilience through increasing environmental impacts.

Changing food preferences

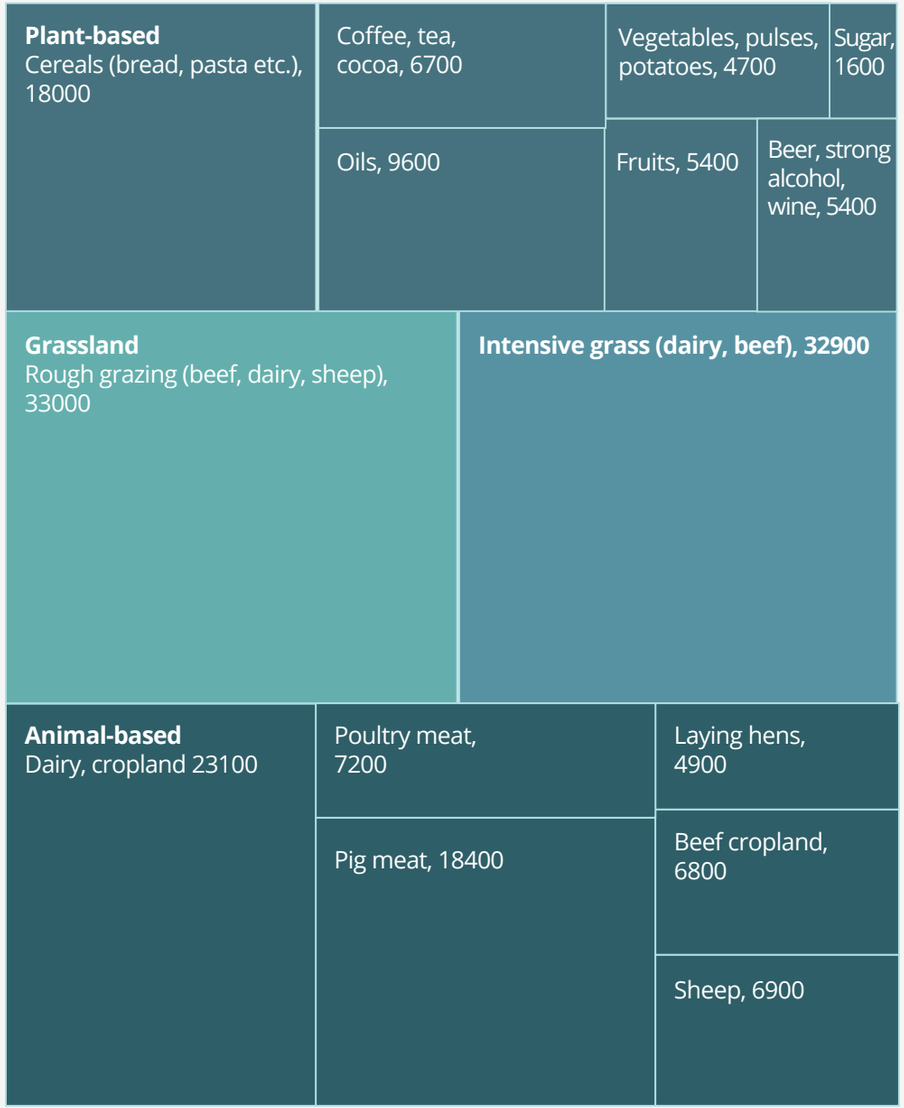
Food preferences are also projected to change driven by a growing number of middle class consumers and rising incomes leading to increasing demand for livestock-based products that require higher resource inputs than crop-based products and cause greater environmental impacts.

Livestock production is more than six times as inefficient as crop production in terms of protein output (Nijdam et al., 2012). It requires feed, and feed production requires large quantities of land, water and other inputs leading to significant emissions of greenhouse gases and nitrogen oxides (Leip et al., 2014). Different animals also have different conversion rates of feed into edible product, with beef production requiring much more feed than pork and poultry. Some estimates are presented below (Figure 3.2).

As a result, dietary shifts to consuming lower quantities of meat, dairy products and eggs would reduce environmental impacts as well as reduce health risks (Tukker et al., 2011; Westhoek et al., 2014).

Figure 3.1

Diets and land use — how much land is needed to produce Europe's food?

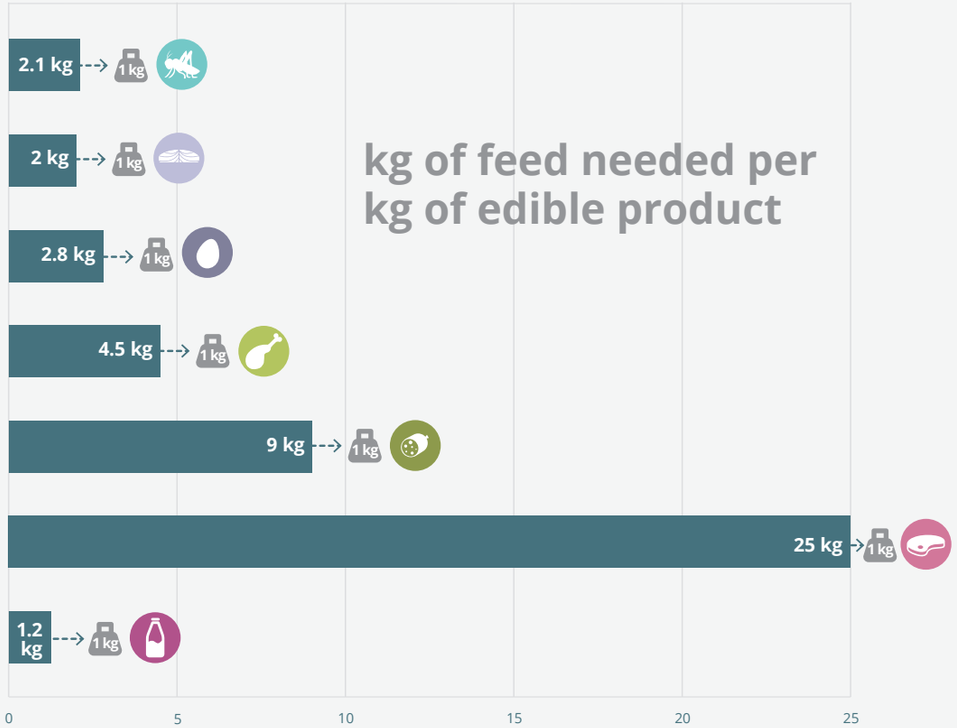


Note: Only land use for food products is included. Bio-energy, industrial uses and pet food have been excluded. Land use is in thousand hectares and both within and outside the EU. The data should be seen as illustrative, as a consistent data set was not available.

Source: PBL, compiled from Eurostat, 2016 (ef_oluft); Lesschen et al., 2011; FAOSTAT 2013 data (soybean products); Euromalt (www.euromalt.be) statistics; European Feed Manufacturers Federation (www.fefac.eu) data; and the European Vegetable Oil and Protein Meal Industry Federation (www.fediol.be) data.

Figure 3.2

From feed to food



Source: EEA, based on Smil, 2002; Welch et al., 2010; Lesschen et al., 2011; FAO, 2013a.

Global environmental change and planetary boundaries

The planetary boundaries framework proposes a safe operating space for humanity based on the biophysical processes that regulate the stability of the Earth's system (Rockström et al., 2009; Steffen et al., 2015). Nine planetary boundaries have been identified and the food system is directly linked to most including climate change, land system change, biogeochemical flows (nitrogen and phosphorus), freshwater use, biosphere integrity and novel entities. Both biosphere integrity and biogeochemical flows have been assessed as within the high risk zone (Steffen et al., 2015). These environmental boundaries have been complemented by social boundaries that are necessary to ensure that people are free from critical deprivations (Raworth, 2012). Food system activities are also directly linked to some social boundaries such as food security, income, jobs and social equity.

Global environmental and social change and the interactions between them will further influence food system outcomes in uncertain ways. Understanding these dynamics and their associated risk is a complex challenge. For example, climate change may adversely affect terrestrial food production and, in the marine environment, it is affecting the productivity of the oceans and creating shifts in species distributions that affect access to fish and fishing patterns (EEA, 2015b). Increasing demand for food is also expected to create significant threats to the availability of fresh water (Murray et al., 2012). Even if the efficiency of water use improves, the absolute agricultural intensification needed to meet the world's growing food and feed demand could lead to severe water stress in many world regions (Pfister et al., 2011). Achieving the 2030 SDGs requires an integrated approach to environmental, social and economic considerations and explicit consideration of trade-offs among objectives, winners and losers across society and emerging risks.

A European perspective

In addition to those outlined above, there are specific challenges ahead when considering the European food system. These are presented below in relation to how the food system can achieve more sustainable outcomes (see Figure 1.1) in terms of *living well* (food and nutrition security and social wellbeing), *within the limits of our planet* (ecosystem health).

Food and nutrition security

Food provision remains a major policy concern in Europe so as to ensure that nutritious food is available at affordable prices. While the amount of farmland has reduced, the trend does not appear to impact European food and nutrition security in terms of the stability and sufficiency of supply, as both domestic agricultural production capacity and purchasing power on the global market remain relatively high. However, European production and consumption patterns influence global food and nutrition security; therefore, maintaining European productive resources is vital to be able to respond to future challenges and food demand.

Climate change will affect future European food production. Climate change is projected to improve the suitability of northern Europe for growing crops and to reduce crop productivity in large parts of southern Europe,

although the effects will differ between different types of crops and livestock and also depend on adaptation measures ([4]). Further changes are also expected in the distribution of fish stocks (EEA, 2017). Droughts are also projected to increase in frequency, duration and severity for most of Europe. The demand for irrigation is also projected to increase, in particular in southern Europe where there is already considerable competition between different water users such as agriculture, industry, tourism and households (EEA, 2017). In addition, there could be increased competition between land and crop use for food and energy production.

In comparison with global trends, the increase in demand for food and changing preferences within Europe are likely to be modest. The EU-28 population was around 508 million in 2015 and is projected to peak at 526 million in 2050 before declining slightly (Eurostat, 2016h). European diets are already relatively high in animal-based products and, while consumption increased during the last two decades, this has stabilised in recent years, although it remains above dietary guidelines (EEA, 2016a). This means that the demand for food may remain relatively stable when viewed over this long-term perspective. Nonetheless, as European society ages and food preferences change over people's lifetimes, it could be interesting to analyse how demographic changes in Europe could influence the transition to sustainable food.

Current EU food security policies and initiatives are mainly directed towards developing countries, with an emphasis on hunger, malnutrition and humanitarian questions. While food security — in terms of sufficiency of supply — may not be a major concern for Europe, within many countries there are still issues regarding availability and access to food, particularly for low income groups. In 2015, some 8.5 % of the European population was not able to afford a regular good-quality meal every second day, although this varied across countries, ranging from 1.3 % in Sweden to 36.8 % in Bulgaria (Eurostat, 2016f).

Looking ahead, achieving more sustainable outcomes in terms of food and nutrition security in Europe involves complementing the current focus with improving access to food, its distribution, changing diets, reducing food losses and waste, ensuring effective climate change mitigation and adaptation and managing risks associated with change in the availability of food imports.

Social wellbeing

There are different definitions and approaches to measuring wellbeing, with a range of recent initiatives providing information for Europe (Stiglitz et al., 2009; OECD, 2011; Eurostat, 2015; JRC, 2015b; OECD, 2016). While approaches differ, they have common elements that link directly to food system activities and outcomes. These include objective measures of wellbeing such as material living conditions (income and employment), economic insecurity and health, and subjective measures of wellbeing and the contribution that food makes to this through identity and culture.

([4]) See Section 5.3 (EEA, 2017) for a more detailed assessment.

Ensuring that the food system contributes positively to social wellbeing in Europe means providing viable and just livelihoods for farmers, fishers and other workers involved in the food system. The majority of European citizens consider investing in rural areas to stimulate economic growth and job creation and strengthening farmers' role in the food chain to be very important priorities of the CAP (EC, 2016d). Currently many jobs are low paid and insecure and located in rural and peripheral regions where there are few alternative employment prospects (Eurostat, 2016b). Food production in some European countries is also dependent on seasonal labour and movement of workers, and the political and social acceptability of migration in Europe is an increasingly contentious issue.

Looking ahead, the diversity of European food production provides opportunities. A large majority of European citizens (87 %) is in favour of paying farmers for practicing a type of farming that is beneficial to the environment and climate (EC, 2016d). This provides scope for different production systems with different goals and approaches and with payment for delivery of ecosystem services. This can embed food production in a broader development perspective for rural and coastal communities, one that recognises the relationship between social benefits such as employment, cultural identity and traditions and the natural capital that food production depends on.

Delivering better outcomes in terms of nutrition and health is also a challenge. This involves reducing the impacts on health from pollution related to food production, as well as ensuring that food is safe and nutritious. A critical question is how do changes in food systems affect diets and therefore health and nutritional outcomes? (HLPE, 2014b). Issues such as the rising trend in obesity are complex and there are multiple genetic and environmental factors at play.

Ecosystem health

All food system activities have an impact on the environment, as explored throughout this report and summarised in Figure 3.3 below. It is possible to reduce those impacts, particularly through more efficient and sustainable use of natural resources, changes in production methods, food choices and diets, and reducing environmental risks by phasing out the use of harmful chemicals throughout the food chain.

Urbanisation is the dominant trend in European land use change and nearly half of land take (conversion to urban or other artificial land) has come at the expense of arable farmland and permanent crops, with nearly one third at the expense of permanent pastures and mixed farmland. This has not only reduced the amount of fertile land in Europe, it has also reduced space for species, habitats and ecosystems that provide important services such as pollination, water regulation and protection against floods, particularly if soil is highly sealed. Land take is a long-term change, which is difficult or costly to reverse.

Healthy fertile soils are at the heart of food and nutrition security. Soils can also offset greenhouse gas emissions by capturing and storing carbon, and soil's flood regulation function can help in the adaptation to climate change (EEA, 2017). A significant part of Europe's soils are affected by one or more types

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of land degradation such as soil sealing, erosion, depletion, contamination and compaction. Soils that are lost as a result of such degradation practices require very long periods to recover naturally. It is now becoming evident that there are complex trade-offs between land use patterns, the environmental pressures generated by that land use, and social and economic needs (EEA, 2013).

While implementation of current policies has resulted in decreasing pressures such as the reduction in nitrogen surplus in agricultural land, the dynamics of environmental systems can mean that there is a substantial time lag before this translates into improvements in ecosystem health.

Looking ahead, some environmental pressures resulting from food system activities are unlikely to decrease under current conditions. For example, while the EU is on track to achieve its target to reduce greenhouse gas emissions by 20 %, compared with 1990 levels, by 2020, countries have projected that agricultural greenhouse gas emissions are anticipated to increase between 2015 and 2030 (EEA, 2016f). In addition, in the long term the agricultural sector also has less potential to reduce greenhouse gas emissions than some other sectors. Future climate change will also interact with socio-economic developments, including increasing urbanisation and population change that could lead to emerging risks.

Analyses of water use by economic sectors illustrates that agriculture will continue to be a major pressure on renewable water resources compared with other sectors (EEA, 2016c). Nitrogen emissions to air

from agriculture will remain a significant contributor to eutrophication in terrestrial systems (EEA, 2016b).

The environmental impact of the food system is also influenced by economic factors. The full costs of preventing and cleaning up pollution or climate change mitigation (externalities) are not included in the prices of food. Instead these are borne by wider society. This lack of internalisation of external effects — the costs to society of environmental degradation — in the price of food represents a market failure that underpins high resource use and environmental impacts of the food system.

In summary, the overarching challenge for Europe is securing the health of the natural resource base, biodiversity and ecosystem services that the food system depends on, as these are essential to deliver other outcomes. Healthy ecosystems, in combination with human interventions, provide stability in food production and play a key role in sustaining wider social wellbeing.

European policy and governance

The EU has a single market for food products that must comply with food safety standards. Although there are differences in diets and culture within Europe, there are also common values such as the appreciation of traditional landscapes and regional products. Therefore, the EU has developed, in an implicit way, a broad policy framework for food. This includes policies related to agriculture, fisheries and aquaculture, product labelling and consumption, environment and climate protection, research and innovation, trade and development. Together these policies establish a common framework for governance and action, define incentives and direct research and innovation. In doing so they help shape the food system and influence how activities and actors interact with each other and use natural resources from land and sea.

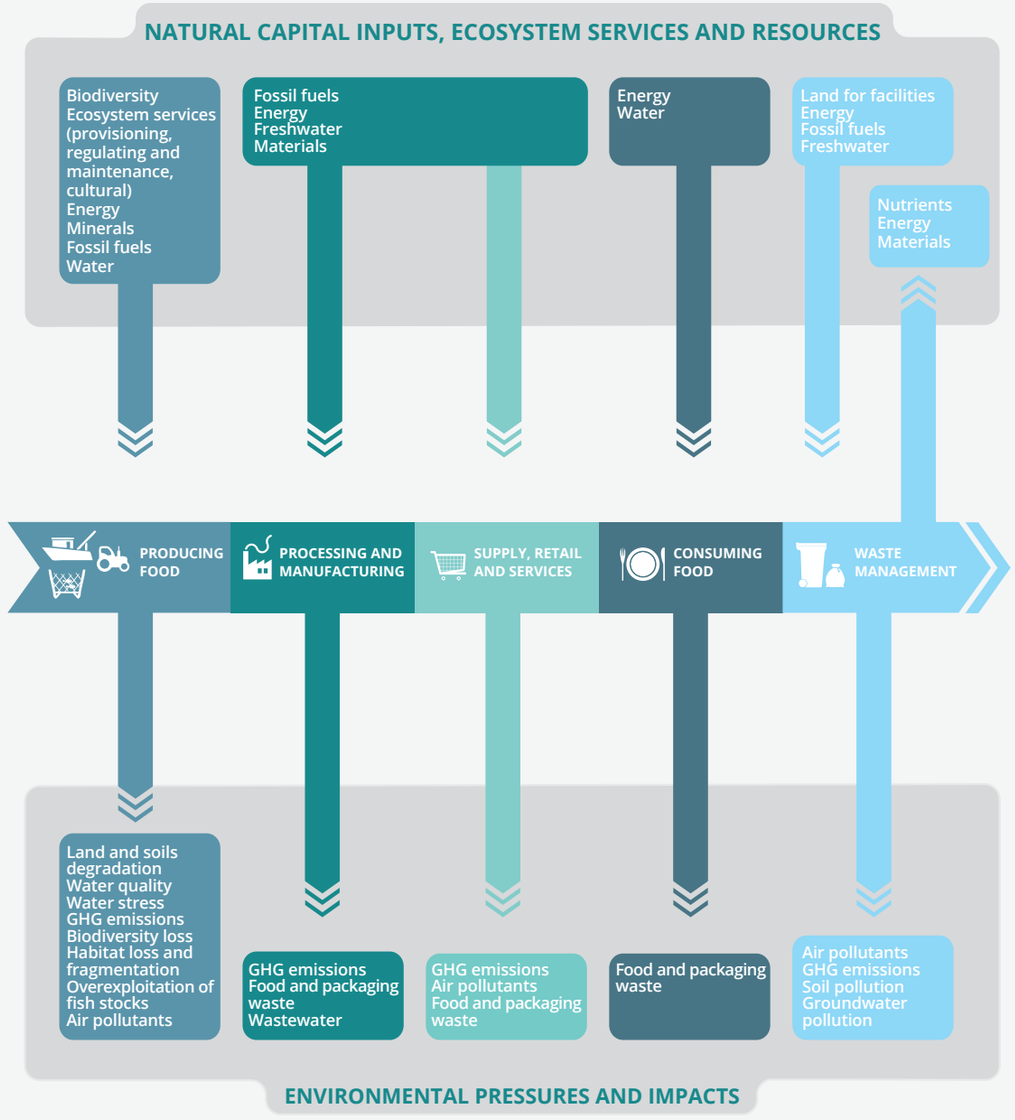
These are now increasingly embedded in longer term comprehensive policies and agendas for sustainable development (Figure 3.4). However while long-term ambitions have been translated into quantitative 2050 targets for the energy and transport sectors, the long-term perspective for agriculture, fisheries and food in general is not as clear.

The key challenges for European policy and governance in terms of achieving sustainable outcomes for the food system relate to: (1) the complex and global nature of the system; (2) policy coherence and coverage; (3) the need to deliver on and balance multiple objectives; (4) the ability to identify synergies and co-benefits; and (5) managing difficult trade-offs in a transparent way.

Governance of the food system has changed over the last 50 years, with a growing role for non-state actors that is also enhanced by ongoing consolidation within industry (UNEP, 2016). In combination with the global nature of the system and Europe's dependency on external imports, this raises challenges. European consumers and regulators alike have incomplete information about the resource use and related impacts associated with highly complex and diverse supply chains, and they have limited ability to influence them (EEA, 2015d).

Figure 3.3

An environmental perspective on food system activities



Source: EEA.

At an EU level, a variety of policies relating to food are not currently integrated leaving the relationships between several food-related policies implicit and with an emphasis on production and consumption. This means there is scope to strengthen policy coherence and coverage and target actors with influence. Moving to a food systems approach will require better policy coordination and coherence at EU level. This is not only a challenge, but an opportunity for the EU to play a role in innovation, trade, health, wealth generation and geopolitics (Maggio et al., 2015).

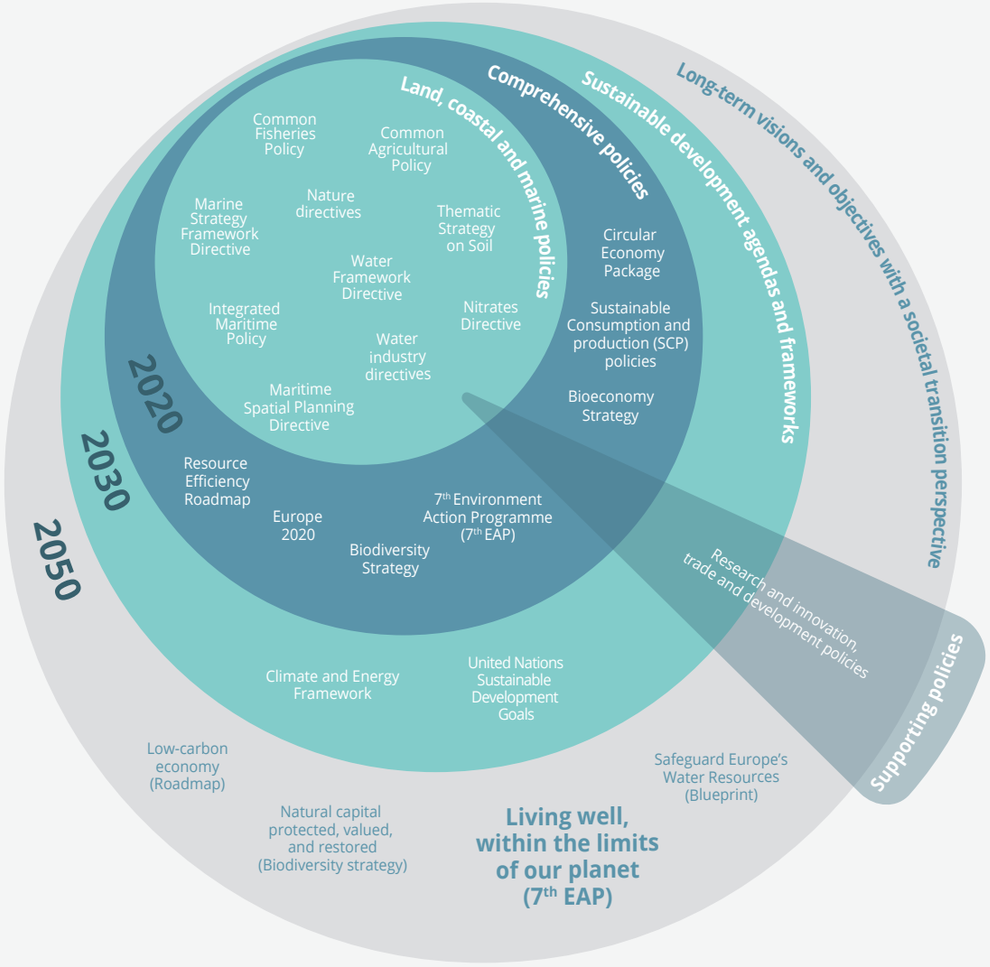
Governance mechanisms operate within specific policy areas (e.g. fisheries and aquaculture is governed by the CFP, agriculture by the CAP, and the protection of biodiversity by the Habitats and Birds Directives). This means that potential synergies, tensions and trade-offs are not always explicitly considered, such as the potential competition between crop production for food and for renewable energy. Another example is the intensification and concentration of food production in the most productive regions, which may appear to be the most efficient way to use available land, but this approach also has risks and limitations in view of pollution, losses of local biodiversity and resilience. Conversely, multifunctional and extensive farming systems would provide multiple benefits, but they imply greater agricultural land take.

Governance arrangements that can address this complexity and build a shared understanding and support for action are needed. Approaches are being tried that offer potential such as green infrastructure approaches to spatial planning and ecosystem-based management. In EU marine and maritime policies, ecosystem-based management has been incorporated as a key principle for securing the sustainable use of Europe's seas. It is a policy-driven process that aims to strike a balance between the ecological and social 'wants and needs' for the use of ecosystem services and natural resources (EEA, 2016d). There is a growing trend towards multiple uses of the marine environment to meet demand, not just for food but also for energy, raw materials and employment. Ecosystem-based management is also a science- and local knowledge-based process that involves stakeholders. As such it has the potential to help identify synergies and trade-offs across the multiple objectives of food and nutrition security, ecosystem health and social wellbeing. However, its current implementation is impeded by the broad nature and incompatibility of environmental, economic and social objectives and the lack of agreed guidance on prioritisation when trade-offs have to be made (Jennings and Rice, 2011).

Looking ahead, challenges lie not just in developing governance arrangements that address complexity but also in their practical application. Harmonisation of multiple objectives and goals may not always be possible, but governance arrangements that involve stakeholders and improve shared understanding of why and how food is produced, obtained and consumed can open up people's views to a wider array of responses and solutions.

Figure 3.4

EU policies for food and sustainability until 2050



Source: EEA.

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Greening the food system — food for thought

Europe's food system should deliver food and nutrition security in a way that contributes to social wellbeing and maintains ecosystem health. An interactive process between knowledge development and policymaking is needed to make this happen. Tensions and trade-offs, for example, between resource efficiency and maintaining ecosystem resilience, need to be considered explicitly, along with complementary measures to overcome lock-ins and unintended side-effects.

Three areas where opportunities exist to transform policy and practices in view of EU policy objectives are explored below. First, changing mindsets regarding the food system; second, seizing the current opportunities to secure the natural resource base, biodiversity and ecosystem services on which the food system depends; and, third, improving the knowledge base related to food systems in order to improve sustainability assessments and identify opportunities for meaningful European level interventions to support transition.

Changing mindsets

Places to intervene in a system to bring about change are known as leverage points. A leverage point with the potential to have one of the biggest impacts is changing mindsets, that is, the underpinning values, goals and views of the actors that shape the system (Meadows, 1999). Changing mindsets from the prevailing focus on food security and economic performance to a systems approach for sustainable food will require inputs and actions from a broad range of stakeholders. Actions are already ongoing in the EU that aim to develop a shared policy perspective on food ([5]). This includes work by the European Commission Joint Research Centre and the Directorate-General for International Cooperation and Development on a vision-building exercise to provide a holistic and future-proof EU position on sustainable food systems in the context of the SDGs.

The foresight work of the Standing Committee on Agricultural Research has provided input to longer term perspectives on development of the food system. The Directorate-General for Agriculture and Rural Development has recently developed a strategic approach to EU agricultural research and innovation that aims to support transition pathways towards resilient, sustainable and climate-friendly farming systems and value chains to secure the long-term supply of healthy and nutritious food (EC, 2016a). The Directorate-General for Research and Innovation's Food 2030 initiative will explore at EU level what is needed from a research and innovation perspective to transform and future-proof food systems to be sustainable, resilient,

([5]) See Box 4.2, EU-level initiatives for building a shared understanding of the food system (EEA, 2016d).

competitive, diverse, responsible and performing well in their provision of accessible, healthy and sustainable food and diets for all (EC, 2016b).

Other initiatives that aim to progress a food systems approach have been led by civil society, for example the 3-year process of research and reflection launched by the International Panel of Experts on Sustainable Food Systems (IPES Food) to identify what policy tools would be required to deliver sustainable food systems in Europe — or a common food policy vision. The European Economic and Social Committee has also called on the European Commission and Member States to develop a clear EU policy and implementation plan for building a sustainable, resilient, healthy, fair and climate-friendly food system (EESC, 2016). Many research, public sector and civil society organisations are also collaborating in initiatives aimed at changing mindsets and practices in relation to food. Examples at local level include, community-led urban food production, initiatives directly connecting producers and consumers, and partnerships to reduce food waste. Examples at sectoral level include development of standards and certification schemes (see EEA and Eionet, 2016 for case studies).

Private actors are also highly influential in the food system, and aligning private and public interests can be challenging but also offers opportunities. Partnerships between business, government and civil society have been effective in delivering change in other areas, addressing production and consumption simultaneously: for example improving the environmental performance of white goods through the introduction of product policy measures by government, 'choice editing' by retailers, and advocacy campaigns by non-governmental organisations to promote switching to more energy-efficient appliances.

Seizing current opportunities

Current EU policy processes, objectives and targets offer opportunities to support longer term transition of the food system, in particular the agreement and implementation of the SDGs and the Paris Agreement. While objectives and targets with a 2020 timeframe are not aimed at fundamentally altering the food system, they provide a foundation upon which to secure more sustainable outcomes. Improving the resource efficiency of food system activities will help move towards more sustainable use of renewable resources, reduce environmental impacts and lower depletion rates of non-renewable resources (UNEP, 2016). Therefore, effective implementation of current commitments in the areas of agriculture, fisheries and aquaculture, environmental protection, and research and innovation are essential steps. Circular economy, resource efficiency actions and climate mitigation and adaptation are also vital, given the close links between food, energy and climate change.

The planned mid-term reviews of relevant EU strategies with a 2020 timeframe offer a window of opportunity, as they will be instrumental in setting the EU's direction towards 2030 and thus determining pathways to 2050. Consideration of current policy commitments in a broader food systems perspective during such reviews could enable the identification of barriers to transition, contradictions, trade-offs, lock-ins and enabling actions. Of particular relevance are the CFP and the CAP; the next revision of the CAP, which is already under way for the post-2020 funding period, offers the opportunity to look at current commitments in this broader and longer term perspective and strengthen the environmental components.

The current policy mix of consumer and producer-orientated incentives is not anchored in an overarching, consistent intervention logic. An ambitious and longterm approach would explicitly address resource efficiency of the food system in terms of productivity, land take, carbon capture, water use and dependence on mineral fertilisers and pesticides. Interventions along the value chain would have to be geared to such an overarching perspective, in rationale and timing, optimising the synergy between them. Innovative production methods are called for, with sustainable use of natural resources such as land, soils and ecosystems and emission reduction measures at their core. Dietary shifts towards less resource-intensive products (more plant based, less refined), more effective distribution chains, and food waste prevention (see Box 4.1), could potentially compensate for the yield shortfalls that are often associated with more sustainable production methods (EEA, 2014a). This type of approach would help deliver the outcomes envisaged by the SDGs

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Box 4.1

Tackling food losses and waste

Food losses refer to food that gets lost, spilled or spoilt before it reaches its final product or retail stage. Food waste refers to food that is fit for human consumption but does not get consumed and is discarded. When food is wasted, the resources (e.g. water, land, nutrients, labour and energy) that were used throughout its value chain are also lost, leading to unnecessary environmental impacts and financial losses. The further down the value chain a food product is wasted, the greater the squandering of resources (FAO, 2013b). Reducing food losses and waste has great potential for reducing the resource use, environment and climate impacts and economic costs associated with the food system.

About one third of all food produced for human consumption (excluding fish and seafood) is discarded at the global level, amounting to about 1.3 billion tonnes per year (FAO, 2013b). Global food losses amount to 40-50 % for root crops, fruits and vegetables, 35 % for fish, 30 % for cereals, and 20 % for oilseeds, meat and dairy produce (FAO, 2016a). The amount of food waste that is generated in the EU is difficult to quantify, as there is no harmonised, reliable method to define and measure food waste along all stages of the value chain.

Often boundaries between food waste, by-products and production waste are difficult to draw (FUSIONS, 2016). As part of the Circular Economy Action Plan, the European Commission intends to elaborate a harmonised EU methodology to measure food waste and define indicators.

In 2012 it was estimated that 88 million tonnes of food waste was generated in the EU-28, which is about 173 kg/person. More than 50 % of food waste occurs at household level, although there is considerable uncertainty about waste estimates at different stages of the food chain. The costs associated with food waste in the EU-28 were estimated at around EUR 143 billion (FUSIONS, 2016).

The 2030 SDGs aim to reduce food losses in production and supply chains and halve per capita food waste at the retail and consumer level. Proposed actions include reforms to promote better understanding and use of date marking (including possible legislative reforms), to facilitate food donation to food banks and to support the use of unsold food and by-products as a resource in animal feed production without compromising food safety (EC, 2015). In 2016, the European Commission launched the EU Platform on Food Losses and Food Waste to support the achievement of the food waste reduction targets.

A recent report by the European Court of Auditors examined the question 'Does the EU contribute to a resource-efficient food supply chain by combating food waste effectively?' It found that currently it does not, but it also highlighted the ways in which current policies could be used more effectively. Many of the potential improvements do not require new initiatives or more public funding, but rather involve better alignment of existing policies, improved coordination and clearly identifying reducing food waste as a policy objective (European Court of Auditors, 2016).

While nearly all European countries include food/organic waste in their waste prevention programmes (EEA, 2015e), analysis of food waste prevention strategies being implemented by Member States seems to indicate that achieving a reduction in food waste is very complex in practice. The key reasons for this are the complexity of the food supply chain and the need to adopt a variety of integrated and well-coordinated measures that involve all stakeholders along the food supply chain to effectively tackle the problem (Cristobal Garcia et al., 2016). One of the important barriers is that policymakers are often not able to intervene efficiently, for instance on quality standards and contractual issues that are imposed by retailers on suppliers.

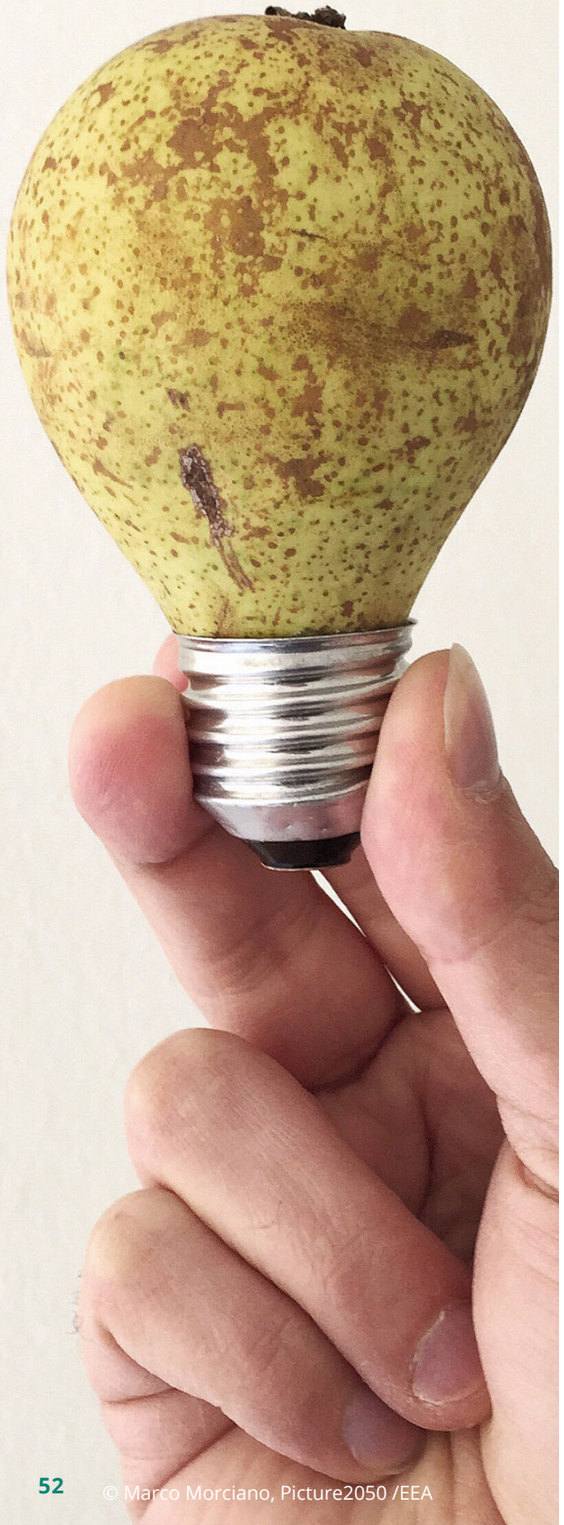
There are lessons to be drawn for food from how Europe is approaching the transition of the energy system. Long-term goals regarding energy have been established along with policy responses tackling different dimensions such as security of supply, efficiency of use and management of demand. For food this would entail a focus on managing demand in a way that delivers food and nutrition security but not at the continued expense of ecosystem health. Managing increasing demand could involve a range of approaches, including technological, but also addressing consumer preferences. This requires a focus not just on consumers but also on actors who influence and shape the food environment and consumer preferences such as manufacturers and retailers, caterers and the media.

While some actions need to be tailored to the specific location and context to maximise their potential, there are many current opportunities for a range of actors, a selection of which are presented in Table 4.1.

Table 4.1
Actors and opportunities

Dimension	Action	Key actors	Process
Improving resource efficiency of food systems	Sustainable intensification of crop production — higher yields and reduction in inputs without increasing overall environmental impacts	Farmers and horticulturalists; researchers	CAP; research and innovation policy; EIP-AGRI
	Better feed conversion (without reducing animal welfare)	Farmers; researchers	CAP; EIP-AGRI
	Higher nutrient efficiency and recycling along the food chain	Primary producers; processers and manufacturers; retail and services; consumers	7th EAP; Circular Economy Action Plan; research and innovation policy
	Reducing food losses and reducing food waste throughout the food system	Primary producers; processers and manufacturers; wholesalers and suppliers; retail and services; consumers; sewage treatment operators	Circular Economy Action Plan; CFP
Enhancing resilience	Increasing environment and climate-friendly food production	Farmers and horticulturalists; fishers and aquafarmers	CAP; CFP; EIP-AGRI
	Maintaining and using the diversity of food production and agricultural systems	Farmers and horticulturalists; fishers and aquafarmers	CAP; CFP; EIP-AGRI
	Ecosystem-based management approaches	Farmers and horticulturalists; fishers and aquafarmers	CAP; CFP; MSFD; Biodiversity Strategy; EIP-AGRI
	No degradation of ecosystems	Farmers and horticulturalists; fishers and aquafarmers	Biodiversity Strategy; EIP-AGRI; CFP
	More effective use of ecosystem services including carbon capture and storage	Farmers and horticulturalists; fishers and aquafarmers	Biodiversity Strategy; EIP-AGRI
Protecting and improving social wellbeing	Reducing overconsumption/ more nutritious food	Consumers	7th EAP
	Dietary shifts — from animal-based to more plant-based diets	Processers and manufacturers; wholesalers and suppliers; retail and services; consumers	7th EAP; research and innovation policy
	Rural development/ good livelihoods — more opportunities for labour-intensive integrated food production and diversifying employment	Farmers and horticulturalists	CAP; research and innovation policy; EIP-AGRI
Responsible and effective governance	Partnerships for change	All	
	Economic and fiscal reform — subsidy reform and payment for ecosystem services	Government	7th EAP
	Sustainable production and consumption — product policies	Government; civil society; business; consumers	Circular Economy Action Plan
	Improved consumer information on production methods and environmental impacts	Government; civil society; business; consumers	7th EAP; Circular Economy Action Plan
	Procurement policies	Government and civil society	7th EAP; Circular Economy Action Plan

EIP-AGRI, European Innovation Partnership for Agricultural Productivity and Sustainability; MSFD, Marine Strategy Framework Directive.



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Developing knowledge

Within the context of the 2050 vision of 'living well, within the limits of our planet', the European Commission is discussing the notion of a 'European brand' for a sustainable society in which economic growth is compatible with planetary boundaries and benefits are fairly distributed (EPSC, 2016). Such initiatives provide a vital framing for policies and actions across society, but there is a clear need to complement broad sustainability goals with concrete knowledge to inform system transition or transformation processes.

SOER 2015 highlighted the gap between established monitoring, data and indicators and the knowledge required to support transitions. As knowledge actors, the EEA and its partners, including PBL Netherlands Environmental Assessment Agency, are responding to this challenge by exploring what kinds of knowledge are needed to support transitions and how such knowledge can be co-created.

The research fields of sustainability transitions and transformations offer an increasing body of relevant knowledge. Common to both fields is the acknowledgement that achieving long-term goals such as the EU's 2050 vision will depend on enabling the emergence and upscaling of innovative technologies and practices (EEA and Eionet, 2016) (see Box 4.2).

Box 4.2

Innovation and transformation of the food system

There are different schools of thought on the way to transform the food system but all emphasise the importance of innovation as a catalyst for change (for further details, see EEA and Eionet, 2016). In reality no single innovation will hold the key, and transformation of the food system will involve many forms of innovation including technological, social, institutional, organisational and behavioural.

The 7th EAP has called for measures to foster innovation in order to stimulate green growth. Environmental policies have been shown to stimulate innovation and investment in innovation. The European countries with the most stringent environmental policies are generally characterised by high levels of eco-innovation and economic competitiveness (EEA, 2016b).

Environmental concerns are one of the drivers for recent investments by venture capital firms in Silicon Valley into food start-ups (The Economist, 2015). Their aim is to transform the traditional food industry by reinventing the entire system of transforming plants into meat and dairy products by creating new plant-based meat and dairy imitations that will be healthier, cheaper than animal-based products and have a lower environmental impact. They are applying the same philosophy as seen in the technology sector regarding the role of disruptive innovations in driving change. This is seen as an economic opportunity, as replacement of animal protein with plant protein reduces inputs in terms of energy, water, feed, etc., thereby reducing production costs. While there are scientific challenges in making plants taste like animal-based products, there are also cultural obstacles. For these innovations to contribute to transforming the food system, their reach would need to go beyond the small proportion of the population that already consumes meat and dairy substitutes and be taken up by those for whom meat is a regular and important part of their diet.

While the private sector has long been considered the source of economic dynamism and innovation, there is growing recognition that state funding and innovation policies have played a pivotal role in many important innovations. Governments can create space for innovation and experimentation by setting the direction via policy signals, investing in research and development and supporting the upscaling and diffusion of innovations through tools such as product standards, tax exemptions and subsidies (EEA and Eionet, 2016). Sometimes governments have supported innovation but then had to use environmental and social policy to mitigate or manage negative consequences. While it is not known what innovations will emerge in the coming decades, along with how producers and consumers will use them or how they will influence environmental pressures, an approach to innovation policy that has a greater focus on experimentation and learning can identify innovations that result in valuable co-benefits rather than trade-offs.

The important role of innovation in driving transitions also implies that information about innovation becomes a more central part of the knowledge base. Understanding innovation is also likely to entail an increased focus on solutions supported by case studies and qualitative evidence, drawing on a broader range of disciplines (EEA and Eionet, 2016). For example, the outcomes of food system activities at a local level or in terms of resilience or social wellbeing are less well captured by official statistics. This information tends to be captured in the form of case studies on more local and context-specific initiatives. This in turn creates difficulties in terms of drawing more general conclusions from individual case studies and bridging across scales from the local level where actions are taking place to how national and EU policy address the environmental sustainability challenges for the food system.

The EU has invested over EUR 5 billion in research and innovation in agriculture, food and fisheries since 1988. The European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) was launched in 2012 under the Europe 2020 strategy. It is implemented through both the EU's framework programme for research and innovation (Horizon 2020) at transnational level and the rural development pillar of the CAP at national and regional level (EC, 2016a). It tackles innovation in agriculture and rural areas through its interactive innovation models (e.g. multi-actor Horizon 2020 projects and EIP operational groups bringing together private and public interests).

A recent stocktaking exercise by the Directorate-General for Research and Innovation recognised that the current research and innovation policy landscape lacks a food system approach and is scattered across different sectors and stakeholders with weak policy coherence and coordination. There is a lack of data and knowledge regarding investment by Member States and on the impact of research and innovation policies on investment (EC, 2016c). The Food 2030 initiative seeks to address some of these challenges and work with stakeholders to identify how to best organise European research and innovation resources to future-proof European food systems to achieve food and nutrition security.

Knowledge investments also need to be oriented towards helping government optimise environmental, social and economic outcomes. The analysis in this report illustrates that there is already much data and information from EU policy implementation processes and EU research that can be used in an integrated assessment of the food system. However, different activities are currently monitored in isolation, which misses out important interactions. Environmental accounting has a bigger role to play here in providing information on the interlinkages between socio-economic activities and the use of natural resources and environmental pressures and by producing indicators for production, consumption and trade perspectives.

While some data are available, a more comprehensive assessment can be delivered only by bringing together different disciplines. Assessments that are just based on biophysical, economic or social data may lead to different conclusions. Factoring in an understanding of human behaviour is especially important in the context of food, as it is connected to so many aspects of people's lives. Foresight methods, such as horizon scanning, model-based projections and scenario development, can also enhance assessments, as they improve our understanding of future trends and uncertainties and so inform the development of policy options and responses. Such an integrated assessment could also explore the possible impacts of policy interventions and evaluate the impacts of changes in the food system in terms of food and nutrition security, social wellbeing and ecosystem health.

Finally, transition of the food system will be a long-term process of societal change involving many actors. Therefore taking a long-term view of knowledge developments is important, given the time lag between the initiation of research, the need for experimentation, uptake by users and translation into changes in policy and practice. Involving relevant actors in knowledge co-creation and exchange will help to ensure that knowledge reaches those with the capacity and opportunity to act to support the transition of the food system.

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For your notes

Food in a green light 2017

Ensuring the availability of nutritious food for all in a fair and environmentally sustainable way is a major societal, economic and policy challenge. The EU has a long-term sustainability vision of 'living well, within the limits of our planet' by 2050. If Europe is to achieve this vision it must transform its core societal systems, including the food system.

This report analyses the challenges ahead, places them in a global context and presents them in relation to how the food system can achieve more sustainable outcomes in terms of living well (food and nutrition security and social wellbeing), within the limits of our planet (ecosystem health). It identifies opportunities to respond to the challenges in the context of current policy objectives, the 2030 Sustainable Development Goals and the 2050 vision of the Seventh Environment Action Programme.

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TH-AL-17-010-EN-N
10.2800/884986