A systematic review of existing EU-wide scenarios related to the EU sustainable food and nutrition security, identification of most salient features, and resulting synthesis scenarios for exploring sustainable diets
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SUSFANS DELIVERABLES

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TEASER FOR SOCIAL MEDIA

Scenarios as a tool to reflect on future pathways to sustainable food and nutrition security. Building on existing foresight and scenario exercises and identifying their most salient features in order to be combined in SUSFANS scenarios able to assess the EU policy goals for food systems.

Twitter

#Scenarios as reflection tool for future pathways to #SFNS: building on and adapting earlier #foresight exercises for SUSFANS objectives.

ABSTRACT

SUSFANS aims to develop a toolbox that can aid policy-makers in making balanced and encompassing decisions on potential interventions to achieve food and nutrition security in the EU. An essential part of that is the use of scenarios/plausible futures, both quantitative and qualitative, to better understand the implications of decisions currently debated. Often, projects start the development of scenarios from scratch, which proves to be highly time-consuming, leaving little time for actual use of these scenarios.

Therefore, SUSFANS decided to use currently available scenarios and to adapt them to the SUSFANS needs. While there are plenty of available scenario exercises, not all of them have the right focus or epistemological basis. To ensure compatibility, selection criteria have been set, based on the SUSFANS conceptual framework. These criteria were: the use of a food systems approach; the elaboration on SFNS drivers; a focus on the EU food policy goals. Building on an earlier extensive scenario review done in TRANSMANGO (EU Horizon 2020 project), an initial selection was then thoroughly scanned for compatibility with these selection criteria. This assessment showed two projects that have developed scenario exercises that are compatible: FOODSECURE and TRANSMANGO. Combining these scenarios led to a good mix of qualitative scenarios that touched upon all the policy goals and applied a food systems thinking. Eight initial scenarios were developed, differing in their impact on FNS, agricultural systems, post-farm food system activities, interactions with global food security and environmental impacts of the food system.

A smaller number of these scenarios was then selected to be elaborated on quantitatively. Which exactly would be elaborated on, was based on their compatibility with the Shared Socioeconomic Pathways (SSPs), which are quantitative scenarios that are part of a new framework for the analysis of future climate impacts, vulnerabilities, adaptation, and mitigation. After this second selection process, four SUSFANS scenarios were identified as appropriate to be quantified as they were compatible with/similar to the Shared Socioeconomic Pathway scenarios (SSPs) used by the climate change community. This made the quantification process easier. These were scenarios 1, 4, 6 and 7. These four scenarios will become part of the SUSFANS toolbox and foresight work.

1. INTRODUCTION

The SUSFANS project focuses on exploring innovations and policy options for achieving sustainable food and nutrition security (SFNS) for Europe (Rutten et al. 2016). To do so, SUSFANS has developed a conceptual framework (Zurek et al. 2017), gathered the evidence base and developed analytical tools needed to assess the European food systems. Together these can be an insightful and holistic tool for policy makers to understand policy change options and their potential impacts. One of the major tasks involved in this, is the development of a set of concepts and metrics to help decision-makers get an understanding of the complexity of food systems, its actors, driving forces and outcomes, as has been highlighted in Rutten et al. 2016 (also see SUSFANS reports D1.1, D1.3 and D1.4). Another important component is the selection of future scenarios describing plausible futures of EU food system based on the conceptual framework that are then meant to test and develop food system innovation options based on stakeholder input. Scenarios analysis can provide a useful framework for thinking through the implications of various innovations to the EU food system by providing a structured approach to thinking about the driving forces and their interactions that will shape the future. WP5 has brought together various food system innovation options in D5.1, D5.2 and D5.3 that can be explored in the scenarios and foresight work for their impact on the four EU policy goals that the SUSFANS framework describes.

The future of SFNS in the EU will depend on the development of contextual variables such as economic growth and climatic change, and on the responses of the agro-food system through innovation and policies. SUSFANS explores these system drivers and system changes under its agenda for foresight (WP10). The foresight will rely on the SUSFANS modelling toolbox consisting of short-term and long-term economic models, and related biophysical and diet models, to provide quantitative projections of indicators defining the sustainability of the EU food system; the quantitative information will be complemented by qualitative narratives derived from the scenarios reviewed by SUSFANS stakeholders (Havlík et al. 2017).

Scenario development, especially in a combination of stakeholder-generated inputs and quantitative simulation, is a time-intensive process. In many cases, research projects in the realm of food security, rural development and sustainability spend most of their efforts on the development of new scenarios, with little time and resources being dedicated to the use of the scenarios for

policy development, where concrete impacts may be achieved. Because such strategies are the core concern of the project, we have chosen to avoid the common pitfall of focusing most efforts on the creation of new explorative/contextual scenarios by drawing on a combination of existing scenario results.

As such, SUSFANS decided to build on the currently available scenarios for the assessment of SFNS. This paper elaborates on the process of selection and combination of available scenarios in order to assess future trajectories of food in the EU. A structured process used for the review and use of existing scenario sets to avoid a mismatch between the scope of interest of the SUSFANS project and the scope used to design existing scenarios addressing food system issues. This compatibility of scope –what parts of the future are addressed or excluded- is arguably more fundamental than the specifics of each scenario in a scenario set. Compatibility of scenarios was checked based on correspondence with the SUSFANS conceptual framework. As outlined in the conceptual framework (D1.1) the outcomes of the EU food system result from activities by food system actors, grouped under the headings of consumers, primary producers and food chain actors. To be able to project future European SFNS the (direct and indirect) driving forces of these actors and their interactions need to be accounted for. The tools used within SUSFANS thus need to cover, to the extent possible, the metrics for measuring food system outcomes in terms of SFNS. But SUSFANS aims to move beyond the status-quo by navigating different innovation pathways towards a more sustainable and healthy future European diet. This requires an understanding of the behaviour of the actors shaping future food system outcomes (see the range of reports on drivers at the stage of food consumption (D2.1 to D2.5), food processing/transformation/distribution (D3.1 to D3.6) and primary production in agriculture and fisheries/aquaculture (D4.1 to D4.7)); and possibly leverage points for interventions towards a more desirable outcome (see case study reports on food system innovations (reports D5.1 to D5.3); as captured by changes in the SUSFANS performance metrics for the European food system (see the reports describing those metrics and quantification, i.e. D1.3 and D1.4, and forthcoming reports D1.5 and D6.3).

2. USE OF SCENARIOS IN THE SUSFANS PROJECT

2.1. What are scenarios and how have they been used

Increasingly the use of scenario exercises is considered useful for assessment of future trajectories within complex systems, as for example food systems. Scenarios can be described as "plausible and often simplified descriptions of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces and relationships" (Millenium Ecosystem Assessment 2005). Key in this is that scenarios are not intended as predictions or forecasts, but rather as a tool for future-oriented and resilient planning in complex systems with a high degree of uncertainty about how the system functions and/or how key emerging issues might develop in the future (see Figure 1). Scenario analysis allows, among other things, for reflection on and a way to think through potential impacts of a certain policy or alternative decision in a structured way. As Henrichs et al. (2010) describe, this is sometimes described as "wind tunnelling", as it allows for the testing of the 'performance' a certain decision under several conditions (i.e. scenarios).

Scenarios have been used for about half a century as a tool to reflect on future impacts of decision making and planning. The earliest recorded use has been for game analyses and military planning (See, for example Kahn 1960; Kahn and Wiener 1967). In the decades that followed business also increasingly took up scenario planning and the first foresight studies with regards to environmental concerns were undertaken (See, for example Meadows et al. 1972). Especially in the latter, the use of scenario exercise grew during the 1990s, as quantitative scenarios were used to explore technological and economic decisions and their

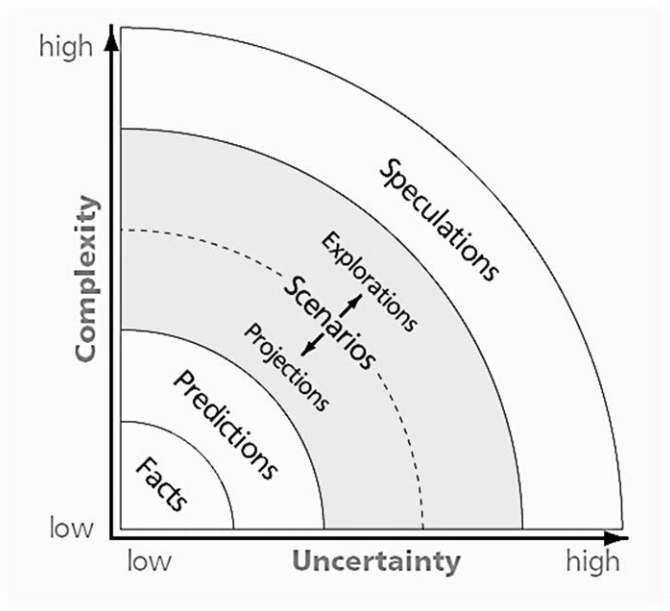

Figure 1. Scenarios can help address uncertainty in complex systems; note that scenarios differ from facts, forecasts, predictions, and speculations
Source: (M. B. Zurek and Henrichs 2007)

impact on environmental dynamics (IPCC 1992). And on the other, more qualitative scenarios were developed to describe alternative pathways of development (WBCSD 1997). Now, scenario exercises have become somewhat of a staple in the diet of environmental assessment exercises (For an overview see EEA 2001; Rothman 2008, van Vuuren et al. 2012).

While there are various reasons to use scenario exercises, the overall aim is to "attempt to anticipate possible consequences of current developments and options to either prevent, counter, prepare for, enhance, or benefit from future changes—and to better understand the implications of the uncertainties that surround assumptions about how the future may unfold" (Henrichs et al. 2010). Scenario exercises will prove especially useful for the raising of awareness, testing of strategies, stimulation of discussion and out-of-the-box thinking, process-engagement, challenging of established ideas, looking for common ground and a shared language, and supporting policy and decision-making.

There is a broad range of scenario exercises and several groups can be distinguished. Usually they are categorized based on their main characteristics, such as: format, main question, underlying epistemology or the scenario-development process (see Box 1 for examples). "Maybe the most straight-forward

Box 1. Example of scenario typologies excerpt taken from Henrichs et al. (2010)

A first example distinguishes scenarios according to the type of question about future developments that a scenario exercise sets out to address. Three principal types can be differentiated by these criteria.

- **Reference scenarios**
  Sometimes also referred to as "predictive scenarios." Generally set out to address the question "what is expected to happen?" and include forecasts as well as what-if analyses.
- **Explorative scenarios**
  Attempt to map "what can or might happen?" and explore what future developments may be triggered either by exogenous driving forces (developments that are external and cannot be influenced by the decision makers in question), by endogenous driving forces (developments that are internal and can be influenced by decision makers), or by both.
- **Normative scenarios**
  Sometimes referred to as "anticipatory scenarios." Aim to illustrate "how can a specific target be reached?" or "how might a specific threat be avoided?" and thus include both backcasting studies and planning exercises. Börjeson et al. (2006) offers a more detailed discussion of these types of scenarios.

A second example groups scenarios based on the epistemologies that underpin their exercises. Again, three principal types can be differentiated.

- **Problem-focused scenario exercises** centre on the factors shaping future developments and usually emphasize the product rather than the process.
- **Actor-centric exercises** focus on the relationship of specific actors to their environment and primarily see scenarios as a basis for strategic conversations (particularly in an organizational learning context).
- **Reflexive interventionist scenario processes** are developed around the interactions between various actors and their environment (and vice versa) with the aim to inform action learning (especially in a public policy context). Wilkinson and Eidinow (Wilkinson and Eidinow 2008) offer a more detailed discussion of these types of scenarios.

distinction between scenario types relates to the format of a set of scenarios—that is, the differentiation between qualitative and quantitative scenarios" (Henrichs et al. 2010). Most often, qualitative scenarios are descriptions of the future dynamics in the form of a narrative, through the use of phrases, images and/or storylines. Quantitative scenarios, on the other hand, are number-based estimations of future dynamics in the form of tables, graphs and maps (Alcamo

and Henrichs 2008). These are often results of simulation models, such as the models used in SUSFANS, such as GLOBIOM and SCAR (See e.g. D1.3 M. Zurek et al. 2017). However, many of the currently available scenarios combine both qualitative and quantitative descriptions, as the qualitative narrative might be underpinned by numerical scenario.

As Henrichs et al. (2010) describe, in current use of scenario exercises there has been "some convergence towards a set of 'stereotypical' scenario logics" (see box 2 for examples), in the sense that they have a similar perspective on "key uncertainties and assumptions about different driving forces". Van Dijk and Meijerink (2014) explore a similar set of scenario logics to characterise the available set of food security scenario exercises.

Box 2. Set of 'stereotypical' scenarios excerpt taken from Henrichs et al. (2010)

- **Economic optimism scenarios**, which have a strong focus on market dynamics and economic optimism usually associated with rapid technology development (e.g., the A1 (IPCC) or Markets First (UNEP) scenarios).
- **Reformed market scenarios**, which also focus on market dynamics but include some additional policy assumptions aimed at correcting market failures with respect to social development, poverty alleviation, or the environment (e.g., the Global Orchestration (MA) or Policy First (UNEP) scenarios).
- **Regional competition scenarios**, which assume that regions will focus more on their more immediate interests and regional identity, often assumed to result in rising tensions among regions and/or cultures (e.g., the A2 (IPCC), Security First (UNEP), or Order from Strength (MA) scenarios).
- **Global sustainable development scenarios**, which see a strong orientation toward environmental protection and reducing inequality, based on global cooperation, lifestyle change, and efficient technologies (e.g., the B1 (IPCC), Sustainability First (UNEP), or Technogarden (MA) scenarios).
- **Regional sustainable development scenarios**, which focus on finding regional solutions for current environmental and social problems, usually combining drastic lifestyle changes with decentralization of governance (e.g., the B2 (IPCC) or Adapting Mosaic (MA) scenarios).

2.2. What we are doing in the SUSFANS project with scenarios

As described in the previous section, there is a broad range of existing scenarios that have been developed over the past decades. More recently, the combining of both qualitative and quantitative scenarios has become common practice, also in the food and agriculture community. Building a set of scenarios that align both qualitatively and quantitatively is rather time-consuming. A common pitfall of projects is spending the majority of the available time and resources on the development of new scenarios (as this process can be quite resource demanding) while leaving little time and resources for the analysis and use of the developed scenarios and increasing the potential of having an impact.

Using a set of or a combination of existing scenarios in a project can have the advantage that the development process can be shortened and the analysis of scenario implications enlarged while the scenarios can nevertheless be used as a discussion tool for stakeholders and experts alike. The trade-off though when using existing scenarios, particularly for stakeholder engagement work, can be that the scenarios then do not quite fit the purpose of the overall scenarios exercise and they might lose relevance and buy-in from the scenario users. Thus, the process of scenario use needs to be carefully managed from the onset.

The SUSFANS project decided to experiment with building on and combining a set of currently available scenario exercises that have been recently meticulously developed in earlier food security, rural development, and food systems-related projects for developing a set of qualitative scenarios to be used in stakeholder discussion and as the basis for decisions about quantification in the foresight work of WP10.

Especially noteworthy is that explorative scenarios used in SUSFANS are not unchangeable contexts that the participants should accept and adapt to. In the contrary, these explorative scenarios serve as 'multiple baselines' that can be altered by a proposed interventions in order to change undesirable future pathways. Combining both normative intervention pathways and explorative scenarios has previously proved successful in planning contexts (Kok et al. 2011; Robinson et al. 2011). This also corresponds to the notion of *transformative scenarios* by Kahane (2012) and we believe this is key to the successful use of explorative scenarios as a tool to reflect and test interventions and to prevent broad-stroke visioning.

3. SELECTION CRITERIA FOR SCENARIO SCANNING

While there is an abundance of scenario exercises available, not all are suitable for what we aim to do in SUSFANS. As emphasised in the previous section, scenarios might have a certain focus or can be based on a certain epistemology. To make the scenario exercise useful to the project, the scenarios need to be compatible with the SUSFANS conceptual framework (D1.1: Zurek et al. 2017). This conceptual framework was developed by the SUSFANS research team and then discussed and revised with European food system actors. As is shown in more detail in D1.1, the conceptual framework includes food system actor activities, their direct and indirect drivers, policy goals formulated by various actors for the EU food system and food system outcomes.

We used this framework as a filter through which to review a range of European and Europe-relevant global food systems foresight processes, by indicating for each of the conceptual framework elements whether they are addressed. This was crucial as, the majority of currently available scenario exercises focus mostly on the production side of the food system and as such on agricultural dynamics. Secondly, the incorporation of environmental dynamics in food systems assessment is also a novelty and is something to select exercises on. We then selected scenario projects that overlap significantly with the SUSFANS scope, or offer elements that are complementary to other projects, as a basis for combined scenario inputs.

3.1. Food systems approach

Building on complex systems theory, a food systems approach considers the many interlinked actors, activities, drivers and outcomes associated with producing food and bringing it onto people's plates. As described in more detail the conceptual framework (D1.1), the food systems approach used in SUSFANS recognises food system activities, such as growing, harvesting, processing, packaging, transporting, marketing, consuming and disposing of food and food-related items. These activities then lead to outcomes, which are SFNS, environmental impacts, equity outcomes and sociocultural wellbeing, business performance, and global FNS.

Essential is also the acknowledgement of the role of diverse actors in food systems. As such, it not only looks inside the food system and its primary producers, food chain actors and consumers, but also at actors outside the food

system. Actors outside the food system are for example EU or national level policy-makers, NGO's and academia that are influencing the functioning and shape of the system in various ways (thus here also termed 'food system influencers'.)

Also essential to a food systems approach, is the acknowledgement of driving forces and their effect on food systems dynamics. However, we have taken these as a separate category (see paragraph below), as the scenario exercises were also scoped for interesting drivers that have not been associated with food research previously. As such, there are also several non-food systems exercises included in the considered exercises.

3.2. SFNS drivers

Crucial to systems dynamics is the role of direct and indirect driving forces. Direct driving forces have an immediate effect on food systems activities or outcomes (e.g. input and farm gate prices). Indirect driving forces are less obvious and operate more diffusely, by affecting one or more direct drivers. The influence of indirect drivers is as such less transparent and difficult to establish, but nevertheless existent.

Within the SUSFANS conceptual framework, six categories of indirect drivers have been incorporated: economic developments; population dynamics; technological change; agriculture and trade policies; environmental issues; and culture and lifestyle choices.

3.3. EU Policy Goals

The objective of the SUSFANS project is to develop a tool box useful for policy-makers influencing and deciding on food system change. To ensure this, the policy goals for the food system as expressed by various stakeholders inside and outside the food system have been incorporated in the conceptual framework. These goals express a complex mix of aims around achieving a healthy and sufficient diet for EU citizens, a reduction of the EU food system's environmental impacts, consideration on the competitiveness of the EU food sector as well a equity and social justice issues within the food system with respect to its outcomes in the EU and globally. The scenario exercises need to be able to assess and reflect on the effect of decisions around food system innovations on the status of these policy goals. Consequently, the currently available scenario exercises have been checked for compatibility with these following goals.

While in a later stage of SUSFANS, stakeholder consultation highlighted the importance of equity in the food system, this was not yet incorporated into the project when the potentially useful scenarios were selected. As such, one of the EU policy goals is formulated as “global contribution to FNS”, rather than Equity in the food system.

4. KEY FEATURES OF CONSIDERED SCENARIO EXERCISES

4.1. Considered exercises

The following section briefly highlights the existing scenario exercises that were considered as the foundation for the SUSFANS scenarios. Building on the Capstone review carried out by the TRANSMANGO project (under the EU 7th Framework Programme that author Joost Vervoort was a part of), which reviewed a large number of scenario exercises, this initial selection was made. These were then further assessed as to whether the exercises met the criteria of using a food systems approach, focussing on (one of) the EU policy goals used by SUSFANS, and describing drivers of SFNS.

TRANSMANGO

Combining both EU and local-level dynamics, the TRANSMANGO project (EU 7th framework programme) aims at exploring pathways to sustainable food and nutrition security and to provide insights on both EU and local level around policy-making and potential pathways to sustainability. On both levels, scenario exercises were used as a tool to think about future developments and their impact on food and nutrition security (J. Vervoort et al. 2016). Central to the conceptual framework of this project is that food systems' main outcome is food and nutrition security. The scenarios were developed based on both this conceptual framework and stakeholder input on drivers of food and nutrition security and priorities amongst them, which were then quantitatively given shape. These quantitative scenarios were then developed into four qualitative EU-level scenarios around the future of food and nutrition security. Within the project, the EU-level scenarios were downscaled to the local level. The EU-level scenarios have been considered as a basis for the SUSFANS scenarios.

FOODSECURE

FOODSECURE was an interdisciplinary research project (EU 7th framework programme) that aimed to explore the future of global food and nutrition security, by designing innovative assessment strategies of both long and short-term challenges. Using mostly quantitative scenarios, one of the main outcomes of the project were four scenarios on food and nutrition security on a global scale. The scenarios were developed via a participatory scenario approach involving a diverse group of stakeholders (van Dijk et al. 2016). The project takes a food

systems approach and as such describes both food production, consumption and processing activities related to food and nutrition security. Four quantitatively based scenarios describing global food and nutrition security drivers in 2050 were the result of the project, which have been made available for further use through a dedicated scenario chapter in the "FOODSECURE Navigator" website.

COST foresight 2030

A workshop, attended by an international and multidisciplinary group of experts in Belgium in 2009, resulted in "an optimistic scenario" around food security in 2030 (COST 2009). The workshop had three main objectives: to identify trend, drivers and challenges for food security; define potential scenarios for food security, and identify the role of ICTs in reaching food security. The exercise itself was focused on global food systems and used mostly qualitative data. While the report explicitly mentions a food systems analysis, the drivers and challenges for food security are still the main focus. In this, food security is divided into three categories: availability, accessibility and food safety. The exercise also describes drivers that impact food security and differentiates in the likelihood of them occurring. Lastly, key within the scenario is the role of ICT and its contribution in monitoring, analysing and communication information across the food chain.

SCAR: Sustainable food consumption and production in a resource-constrained world

Building on two earlier workshops, the third meeting of the SCAR-working group took place in 2011. Central to this exercise was a focus on the role of the 'knowledge-based bio-economy' in the realisation of a sustainable and green bio-economy in Europe, and to identify ingredients for and main challenges of a long-term vision (SCAR 2011). Central to the workshop was the notion of the global food supply, rather than food security and/or food systems. A systematic approach was used for the identification of opportunities and potential risks, and future developments for European agriculture. In the report, these are identified as key to a long-term vision, but no scenarios are developed within the exercise.

Scoping study – Delivering on EU food safety and nutrition in 2050

This study was initially commissioned by the Directorate General for Health and Consumers and its objective was to identify the major challenges for European food safety up to 2050. The aim of this study was to "provide insight and guidance for the development of future policy response scenarios" (FCEC, Agra CEAS

Consulting, and Arcadia International 2013). Building on, amongst others, earlier stakeholder workshops, a driver identification process, expert interviews, and consultation of stakeholders and experts, the study defines food safety and its main drivers, presents several qualitative scenarios and insights into safeguarding food safety and nutrition.

EURURALIS

The project EURURALIS intended to produce a support tool for discussions about the future of rural Europe. Based on a quantitative, model-based approach the objective was to simulate agriculture and land use in the EU. This included drivers varying from a global to a local scale and as such allowed for both top-down and bottom-up processes to be incorporated in one system (Vliet and Verburg 2012). In 2012, this resulted in four alternate scenarios that all had different combinations of global integration and market regulation. Central to the project were developments in land-use and agriculture, rather than food security or food system activities.

The Foresight expert group: Our world in 2025

The foresight expert group of the European Commission presented their vision of the world in 2050. The objective was to identify main trends, challenges and transitions the world would likely face by 2050 (The Foresight Expert Group 2009). Central to this vision are economic, research and development-focused dynamics and to a lesser extent ecological dynamics. As such, this vision contributes by presenting drivers and patterns in future dynamics.

Food security by 2050: Insight from the Agrimonde project

Aiming to build and analyse contrasting scenarios of the world's food and agricultural systems by 2050, the project Agrimonde was developed by two main French Agricultural research institutions. The project had three objectives to do so; "anticipate the key issues research will have to address", "initiative a process of debates and appropriation of the topics on a national scale" and "promote the participation of French experts in international debates on food security" (Paillard et al. 2011). The Agrimonde project used both qualitative storylines and quantitative modelling to develop global scenarios. The results were two scenarios, a business-as-usual scenario and a rupture scenario, that both describe future dynamics of food systems aspects such as nutrition security, access to food, trade and agro-ecological experimentation.

Foresight: Tackling obesities

Taking a "bold whole system approach" is critical according to the Foresight of the UK Government Office for Science and as such they consider food from production all the way down to people's health aspects (UK Government Office for Science 2007). Focussed on addressing the obesity challenge in the UK, the four developed scenarios concentrate on nutrition and health in 2050. In doing so the report describes drivers of obesity and ways to address these via policies and partnerships.

Foresight: The future of food and farming

Bringing together evidence and expertise from multiple disciplines, this project aimed to aid policy makers and other stakeholders in thinking about addressing challenges around the future of food and farming. As such it explored system pressures, or drivers of change, that could present challenges to food security and describes a vision for the future (UK Government Office for Science 2011b). The report outlines a number of key drivers that are considered as future challenges. In this it takes a food system approach and explores challenges in nutrition security, food supply and ecosystem degradation. The report emphasises the need for policy-makers to take a broader perspective and consider the global food system, from production to plate.

Foresight: Migration and Global Environmental Changes

This third foresight exercise of the UK Government Office for Science focusses on migration and environmental change. By taking a global perspective, the project aimed at developing a vision for how environmental changes, between now and 2060, affect mobility across the world. Highlighting especially the challenges and opportunities for migrants in both "originating and receiving countries" (UK Government Office for Science 2011a). The report shows a conceptual framework of migration both internal and international and the impact of environmental changes caused by climate change. The result of this study are four scenarios in a matrix showing global growth and governance. The scenarios differ in their levels of risk for certain geographical areas, conflict, displacement and ability to plan migration. While little is said about food systems, the environmental change assessment and trajectories to address these challenges are helpful.

Horizon Scan 2050

Rather than a scenarios exercise, the STT Horizon Scan is intended as food for thought and for creative thinking about our future. As such, it scans broadly across domains in order to feed into debates with academics, policy-makers, and the private sector. The study aims to provide inspiration around the future "grand challenges", vision of the world's society in 2050, an analysis of the risks and potential innovation points (Netherlands Study Centre for Technology Trends 2014). It highlights six "grand challenges" that span many domains and are interlinked; scarcity, climate change, demographic change, longer life, global power shifts, and new connectivity.

Land-use scenarios for Europe

Initiated by the European Environment Agency, several scenarios around the future of land-use in Europe were developed based on stakeholder input around key uncertainties, driving forces and storylines (EEA 2007). The scenarios are based on both qualitative and qualitative work, describing agriculture, land use, biodiversity and flooding. The report describes a number of key changes and their drivers, leading to five different scenarios that each has a different configuration of impacts on the key changes. While the report describes agriculture, it does not take into account other food system activities and aspects that are essential for a food systems perspective.

4.2. Selected exercises

As emphasised in the earlier chapter, a number of selection criteria were set for exercises to be useful for the objectives of the SUSFANS project. These criteria were the use of a food systems approach, the coverage of the EU policy goals, and the elaboration on drivers of SFNS. While all the considered approaches covered some aspects that were deemed interesting, only a limited number spoke to all selection criteria and were thus used for developing the SUSFANS scenario exercises. The FOODSECURE and TRANSMANGO approach aligned most with the objectives of SUSFANS and were as such the most applicable (Table 1).

Table 1. SUSFANS scenarios review table

Selection criteria	FOODSECURE	TRANSMANGO
EU policy goal: **Balanced and sufficient diets for EU citizens**	Global context for food and nutrition security is provided	Focused on livestock products consumption, sugar, elements of consumer awareness and food utilization
EU policy goal: **Reduced environmental impacts**	Global context	Several factors (resource use, environmental degradation) are core to the scenario structure.
EU policy goal: **Viable and socially balanced EU agri-food businesses**		One of the drivers focuses on market centrality in different configurations, the role of SMEs, and policy around market organization.
EU policy goal: **Contributions to global FNS**	Global food security is a focal point of this scenario exercise.	Quantification of the EU scenarios through GLOBIOM allows for an evaluation of global impacts.
Food system activities: **Producing**	A global perspective on this element is provided.	Different assumptions are made about the nature of agriculture and food production in the scenarios.
Food system activities: **Processing and Retailing**		Different market structures are at the basis of the scenarios, and food processing technology also plays a role.
Food system activities: **Consuming**	Food consumption is covered globally	Consumer behaviour is taken as a core element of the scenarios; income and inequality also contribute to this element.
Food system actors: **Primary producers**	Food production is covered globally	The scenarios describe farmers' actions and futures
Food system actors: **Food chain actors**		Other parts of the food system are also covered
Food system actors: **Consumers**	Food consumption is covered globally	Consumer behaviour is taken as a core element of the scenarios; income and inequality also contribute to this element.
EU and national **policymakers**	Global contexts for EU policy are provided	The role of EU and national policy is described, also in the local scenarios
Food system influencers (NGOs, academia etc.)		This comes up very differently across different scenarios depending on the dominant governance regime
Direct drivers for primary producers	Global contexts for EU drivers	European markets, CAP and other policy, climate change, European land use
Indirect drivers		Migration, global economic and political stability, global land use

(Status of **food and nutrition security)**	Global context for food and nutrition security is provided	Socio-economic drivers and behaviours leading to different FNS status for different societal groups are focused on in this scenario set.
(Status of **agri-food business performance)**		One of the drivers focuses on market centrality in different configurations, the role of SMEs, and policy around market organization.
(Status of **environmental impacts)**	Global context	Several factors (resource use, environmental degradation) are core to the scenario structure.
(Status of interactions with **global food security)**	Global context	Quantification of the EU scenarios through GLOBIOM allows for an evaluation of global impacts.
(Status of **sociocultural wellbeing)**	Focused on inequality at a global level	Socio-cultural wellbeing plays a large role in the scenarios, both at the EU level and in the local-level case study scenarios.

Both studies take an explicit food systems approach and even posit food and nutrition security as its main outcome. Considering none of the projects focus on SFNS in the manner SUSFANS aims to, the other studies that were considered proved useful in gathering both the drivers of and the evidence base of certain indicators around environmental change. The FOODSECURE scenarios offer a global context for the European TRANSMANGO scenarios. As a result, the SUSFANS scenarios are a careful mixture of the scenarios used in FOODSECURE and TRANSMANGO.

5. THE SUSFANS SCENARIOS

The following scenario narratives are a result of combining two highly SUSFANS-compatible scenario sets: those created for FP7 TRANSMANGO (providing EU scenarios) and those created for FP7 FOODSECURE (providing the global context). We have removed the original scenario names to let SUSFANS process participants characterize the scenarios themselves.

5.1. EU scenarios

Scenario 1

Europe by 2050:

Practices and business models leading to unhealthy diets and negative environmental impacts continue. The power of a crumbling EU and of national policy makers to change these trends decreases over time with a combination of decreasing funds and decreasing popular support. There is a lack of leadership in the face of climate and migration crises. Though inequality is high, consumers' incomes are enough to avoid extreme food insecurity, but many lack the knowledge, incentives or budgets for healthy life styles. Migrants providing cheap labour throughout Europe are an increasingly vulnerable group. In governments and in the private sector, there are minorities interested in changing the trend, but they are fighting an uphill battle.

Global context:

Several new financial crises have resulted in a sharp decrease in economic growth. This situation has sparked national political crises, which in turn have given room for opportunistic behaviour. Governance at the international level has also worsened: in 2050, there is no international cooperation and the whole UN system has dissolved. All of this has led to an unequal society, which consists of the "haves" and the "have nots", with the gap between the two groups widening over time. A select elite group ("the haves") holds the power and protects own interests, while the majority of people (the "have nots") is poor with limited access to food, health and education. There is monopolized access to knowledge and technology: the rich have access to modern technologies, while the poor do not. At the same time, the destructive effects of climate change, caused by uncontrolled depletion of fossil fuel reserves, have caused biodiversity loss, an increase in natural disasters, and disputes about water. Regarding food and nutrition security, only the small minority of the "haves" benefits from globally

unsustainable food production while the majority suffers from food and nutrition insecurity.

Table 2. SUSFANS scenario 1 narrative on particular food system dynamics

Food and nutrition security	Agricultural systems	Post-farm food system activities	Interactions with global food security	Environmental impacts food systems
Few people are undernourished in Europe, but other malnutrition and NCDs are common.	Large-scale industrial agriculture grows, with little innovation, among other reasons because cheap labour is available; smaller farmers fail.	Several companies control post-farm food system activities; locked into historic patterns	Europe struggles with competition from other global regions; but trade agreements remain open and free, offering market opportunities due to low European wages and lax regulations	Environmental policies are weakened; land and resource use becomes more indiscriminate and damaging.

Scenario 2

Europe by 2050:

Waves of immigration, terrorist threats and increasing impacts of climate change trigger social movements and policies that aim to keep global problems out of a Europe balancing between nationalism and xenophobic European exceptionalism, between fragmentation and collaboration. Nostalgia-fuelled politics create a brand of stronger environmental policies focusing on natural heritage and rural custodianship. Racism becomes more commonplace; migrants are kept out, creating employment problems in greying societies, which are partly solved by robotisation of work; fear of migration from Europe's south to northern countries due to climate change prompts European policy makers to use highly innovative technologies help make Mediterranean countries more climate-resilient. Environmental concerns drive down consumption of animal products; otherwise, the improvement of diets is not a priority amid concerns of European security and self-reliance.

Global context:

Globally, wealth is very unequally distributed. An elite group of 'new rich' – constituting around one per cent of the total population – controls companies dominating the majority of markets and owning most natural resources. The scarcity of resources in developing countries has increased considerably over the

past forty years. Authority and power have shifted from the government to the elite, especially in the developing world. Governments have cut budgets and reduced the expenditures on public services, which are mostly replaced by private services, mainly geared towards the needs of the elite. To protect their assets, they invest in research and development to create private solutions for global environmental problems. The results of the investments are a number of path-breaking technologies in later years to overcome the problems of climate change, reduce pollution and waste and protect the environment. Other technological advances have resulted in much higher crop yield to ensure the efficient and low-cost production of food. A lot of the advanced technology put in place requires minimum skill levels from employees handling the technology. Food and nutrition security is ensured for the elite; the rest are fed, with greater quantities of food being provided through high efficient and technologically advanced production systems. However, the nutritional quality of the staple food is insufficient, especially regarding micronutrients.

Table 3. SUSFANS scenario 2 narrative on particular food system dynamics

Food and nutrition security	Agricultural systems	Post-farm food system activities	Interactions with global food security	Environmental impacts food systems
Poverty and food insecurity are relatively low in Europe for its autochthonous populations; meat consumption has dropped; but NCDs are common as sugar consumption is high and not a policy priority	Mediterranean countries become a hub for climate-smart agriculture with Northern support; environmental policies have shifted Europe toward more sustainable agricultural practices.	Robotisation has increased in all food system activities with decreasing labour availability. This innovation has been facilitated by public policies.	Trade with the outside world has decreased; large food companies are increasingly focusing on other global regions. Food security in other regions is threatened by economic and climatic challenges, but Europe does little to help.	Strict policies ensure low environmental impacts of food system activities.

Scenario 3

Europe by 2050:

After a period of political crisis, the EU has reformed and reinforced its legitimacy. It has a strong and urgent mandate to respond to food system challenges – malnutrition and overconsumption the threat of climate change threatening food and feed production in Europe and elsewhere, and the global destruction of natural resources. Strategic action has been led by governments but supported by the private sector (large companies) and some in civil society (major health organizations), to the challenge of changing European diets and modes of production. The focus is on creating new sources of protein, including mainstreaming insect consumption and the production of artificial quasi-meats, supported by new, more integrated means of food production and processing based on a tech-driven sustainable intensification model. This is combined with strong action on reducing sugar in the years close to 2050, which nevertheless cannot avoid the legacy of unhealthier diets in earlier times. Europe seeks to export its sustainable FNS technologies and policies to other global regions. Even though basic food and nutrition security has improved, the top-down, command-and-control approach to food and nutrition security excludes many societal actors, leading to increasing dissent and attempts to create alternatives to the tech-focused, almost post-agricultural food system, which happens at the expense of the livelihoods of traditional farmers. The synthetic approach to food has also damaged local food cultures.

Global context:

Globally growth and development are seen as more important than sustainability. Rapid economic and employment growth, accompanied by more intensive multilateral international co-operation, has led to free movement of goods and people, better health and education systems, more democracy and a reduction of hunger. Wealth is more equally distributed and poverty has been reduced, since countries have adopted taxation systems to equalize incomes and property within societies. At the same time, the environment is on the brink of catastrophe. The climate change problem has worsened: over the last years, the global economy has been severely suffering from climate-induced disasters, such as hurricanes, floods and droughts. This happened as a consequence of the use of more and cheaper fossil fuels and less renewable resources, as well as due to the shift to intensive, but polluting agricultural systems. The overuse of pesticides and fertilizers has substantially decreased soil fertility on all continents across different

ecosystems. The rainforest has largely been destroyed and replaced by farm land. Food production systems have intensified to the point that pandemics have broken out in the livestock sector. Food and nutrition security is being achieved, but in an unsustainable way (i.e. over-intensification of food production systems). On global level, the problem of malnutrition is being solved, as well as micronutrient deficiencies (due to government interventions). However, the shift to synthetic food was a necessary measure resulting from the collapse of natural food production systems.

Table 4. SUSFANS scenario 3 narrative on particular food system dynamics

Food and nutrition security	Agricultural systems	Post-farm food system activities	Interactions with global food security	Environmental impacts food systems
People are not wealthy, but are able to meet basic needs. Innovations in meat and meat-like products ensure protein consumption; policies to control sugar consumption are in place, but rather late, and Europe struggles with a legacy of NCDs and obesity. Awareness raising policies have failed and nudge and restrictions are preferred policies.	Agricultural systems are increasingly industrialized, and integrated economically and technologically with the rest of the food system. Smaller farmers leave the market because of competitive pressures and food crises and scares.	Major companies work closely with governments to innovate and intensify in food systems, and integrate agricultural production with other aspects. Many societal actors are excluded from decision-making.	Strict policies on food products and processes, and a highly European focus limit market interactions with the rest of the world. However, European innovations are exported to other global regions.	Concerns about environmental impacts are driving the innovation into new modes of production and processing of meat and meat-like products. Over the longer term, this leads to a relative slowing of environmental decline.

Scenario 4

Europe by 2050:

Global economic downturns, social problems and increasingly non-competitive EU economies have increased the cost of living. These factors have combined to make many city dwellers financially insecure, and many responded to increasing food insecurity by moving back to the countryside where they can produce some of their basic foods themselves. Many Europeans have been returning to rural lives out of necessity due to these global pressures, but also because of changing social norms, and facilitated by technological advances in communication. These changes are supported by policies focusing on self-reliance and sustainability. The localization of supply has limited economies of scale, but cheap communication technologies have allowed people to be part-time farmers while maintaining aspects of other, productive career activities. For many, the notion of well-being is increasingly decoupled from financial wealth and overall consumption. Not everyone, however, is happy to be returning to the land – and the wealthiest do not have to follow suit.

Global context:

Several new financial crises have resulted in a sharp decrease in economic growth. This situation has sparked national political crises, which in turn have given room for opportunistic behaviour. Governance at the international level has also worsened: in 2050, there is no international cooperation and the whole UN system has dissolved. All of this has led to an unequal society, which consists of the "haves" and the "have nots", with the gap between the two groups widening over time. A select elite group ("the haves") holds the power and protects own interests, while the majority of people (the "have nots") is poor with limited access to food, health and education. There is monopolized access to knowledge and technology: the rich have access to modern technologies, while the poor do not. At the same time, the destructive effects of climate change, caused by uncontrolled depletion of fossil fuel reserves, caused biodiversity loss, an increase in natural disasters, and disputes about water. Regarding food and nutrition security, only the small minority of the "haves" benefits from food produced in a very unsustainable way, while the majority suffers from food and nutrition insecurity.

Table 5. SUSFANS scenario 4 narrative on particular food system dynamics

Food and nutrition security	Agricultural systems	Post-farm food system activities	Interactions with global food security	Environmental impacts food systems
Many are poor in terms of income, but rural lifestyles, smart and diverse agricultural, trade and distribution practices, combined with a shift in preferences and understanding of healthy supported by customized information technology results in good food and nutrition security for most. Cost and preferences have lowered the consumption of meat and animal products considerably.	Food produced by farmer cooperatives, and medium-sized farms, bolstered through flexible and climate-smart agricultural technologies, is integrated into short food chains, and supported by home-produced crops.	Post-farm food system activities are highly integrated with agricultural production, managed by small to medium-sized enterprises, supported by flexible agricultural, processing, transport and information technology. There are, however, some areas where such technologies are less available.	Europe has little capacity to help resolve food security issues elsewhere in the world.	Re-wilding trends due to the abandonment of rural areas are reversed, with people moving back to the land. The return to cultivated land is mostly done in a sustainable fashion; nevertheless, this leads to a stabilization, rather than a revival, of environmental conditions.

Scenario 5

Europe by 2050:

After years of economic instability, for which large companies and banks were primarily blamed, strong political action has been taken and economies have been re-organized to allow for much more local and regional diversity. Small and medium enterprises flourish; those with good ideas and entrepreneurial energy are much more likely to succeed. Inequality is high, since some manage to take their businesses very far, becoming the new elite. But standards of living for most of the population are good, at least in an economic sense. However, there is little political and economic interest in environmental conservation and sustainable business – after economically traumatic years, regaining prosperity is the focus. The prioritization of economic growth has also taken public attention away from

health concerns. Instead, standards of what is considered healthy and socially desirable have shifted.

Global context:

Globally growth and development are seen as more important than sustainability. Rapid economic and employment growth, accompanied by more intensive multilateral international co-operation, has led to free movement of goods and people, better health and education systems, more democracy and a reduction of hunger. Wealth is more equally distributed and poverty has been reduced, since countries have adopted taxation systems to equalize incomes and property within societies. At the same time, the environment is on the brink of catastrophe. The climate change problem has worsened: over the last years, the global economy has been severely suffering from climate-induced disasters, such as hurricanes, floods and droughts. This happened as a consequence of the use of more and cheaper fossil fuels and less renewable resources, as well as due to the shift to intensive, but polluting agricultural systems. The overuse of pesticides and fertilizers has substantially decreased soil fertility on all continents across different ecosystems. The rainforest has largely been destroyed and replaced by farm land. Food production systems have intensified to the point that pandemics have broken out in the livestock sector. Food security is being achieved, but in an unsustainable fashion (i.e. over-intensification of food production systems).

Table 6. SUSFANS scenario 5 narrative on particular food system dynamics

Food and nutrition security	Agricultural systems	Post-farm food system activities	Interactions with global food security	Environmental impacts food systems
Few are food insecure, but dietary concerns are otherwise not prioritized and NCDs are high.	Smaller and medium farmers manage to find economic viability through policy support, but care little for environmental or health impacts.	Europe is a flurry of companies experimenting with approaches to making food system activities economically successful. Little regard is given to environmental or health impacts.	Policies are focused on the economic health of the European region; there is little concern for the impacts of food or feed sourced elsewhere; nor is there funding for support of other global regions.	Economic concerns dominate, and environmental conditions continue to decline while everyone is focused on making a profit and creating economic resilience after global crises.

Scenario 6

Europe by 2050:

By 2050, relentless global and European economic instability, crises of migration and local conflicts at the edges of Europe, climate impacts affecting the southern countries, and a prolonged crisis of EU governance around these issues have taken their toll. The EU's power has been shattered. Economic shocks have led to high poverty and inequality. Natural environments decline, as they are exploited by international actors. Education and innovation have stagnated, due to lack of funds and optimism in politics. Many have moved back into the countryside in search of more stable livelihoods, but they are struggling because their transition is chaotic and is not being facilitated - with problems arising over issues like land tenure. Many more stay in urban poverty.

Global context:

Several new financial crises have resulted in a sharp decrease in economic growth. This situation has sparked national political crises, which in turn have given room for opportunistic behaviour. Governance at the international level has also worsened: in 2050, there is no international cooperation and the whole UN system has dissolved. All of this has led to an unequal society, which consists of the "haves" and the "have nots", with the gap between the two groups widening over time. A select elite group ("the haves") holds the power and protects own interests, while the majority of people (the "have nots") is poor with limited access to food, health and education. There is monopolized access to knowledge and technology: the rich have access to modern technologies, while the poor do not. At the same time, the destructive effects of climate change, caused by uncontrolled depletion of fossil fuel reserves, caused biodiversity loss, an increase in natural disasters, and disputes about water. Regarding food and nutrition security, only the small minority of the "haves" benefits from food produced in a very unsustainable way, while the majority suffers from food and nutrition insecurity.

Table 7. SUSFANS scenario 6 narrative on particular food system dynamics

Food and nutrition security	Agricultural systems	Post-farm food system activities	Interactions with global food security	Environmental impacts food systems
Poverty is widespread, and food insecurity reaches levels that are unprecedented for Europe. Many move back into the countryside but struggle to create effective sources of food under climate change. Many more stay in urban poverty.	A combination of conventional, large-scale farmers with little innovative capacity and a new and rather inexperienced generation of small-scale farmers producing for subsistence and marginal cash flow.	Many companies in food processing, distribution etc. have failed, resulting in less diverse food products – and a food system full of opportunism and a lack of reliability.	Global food demand affects price and stability, only adding to food insecurity in Europe.	Food production and other food system activities are in survival mode, and care little for environmental concerns; nor do policy makers.

Scenario 7

Europe by 2050:

By 2050, Europe is brimming with innovation. Facilitated by continued progress in communication technologies, local and regional initiatives and networks around energy, water, food and services have taken off, learning from innovations elsewhere in the world, and from each other. Governments are struggling to keep up with disruptive change in all sectors, and some individuals benefit far more than others. In terms of food consumption, environmental values are dominant. Meat consumption has become a social faux pas. However, Europeans have more trouble taking care of themselves – life is moving fast in these competitive economies, and local products from bakeries and breweries might be sustainable, but that does not mean they are low in calories.

Global context:

Globally, societies are more equal than ever, more and more people are well educated and wealth is more equally distributed. Free movement of people is guaranteed in many global regions. Local policies support the development of rural areas. New agricultural production technologies are developed that focus

on sustainability and zero waste. Urban agriculture is highly developed and aquaculture is sustainable. New and diversified renewable energy sources are applied, which replace conventional fossil fuel energy sources. Environmental and agricultural innovations are accessible for many due to their open source nature. Trade policies are aligned to food and nutrition security and stable ecosystems. The global population has access to sustainable diets. Water and food choices and basic needs are covered. Food is safer, and there are new sources of food available - socio-cultural aspects are respected in diets.

Table 8. SUSFANS scenario 7 narrative on particular food system dynamics

Food and nutrition security	Agricultural systems	Post-farm food system activities	Interactions with global food security	Environmental impacts food systems
There is an ethical shift away from the consumption of animal products; otherwise, though, people have a hard time maintaining healthy diets in a high-pressure society.	Agricultural production is diverse, innovative and thriving, focusing on sustainable forms of production and new ways to link to consumers.	The European food system is characterized by an extreme diversity of small-scale business models supported by strong communication networks.	Europe becomes a centre for food and agricultural innovations – eager to share its knowledge and technology with the world.	A strong dedication to environmentally sustainable agriculture and food system approaches among businesses across Europe leads to an environmental revival, and to positive global impacts where EU approaches are implemented.

Scenario 8

Europe by 2050:

Europe in 2050 is rather empty, apart from the sounds of birds and other wildlife. After worries of economic slowdown in the 2010s, the BRICs have taken off and outcompeted Europe in many ways. Accordingly, they have created such attractive economic opportunities for many that a minor but still significant amount of the European population has migrated, at least temporarily or intermittently, to other parts of the world. Europe is struggling with economic

growth because of this brain drain. Inequality is high. Pressure on land and natural resources has decreased, however, and natural environments have flourished.

Global context:

Globally, wealth is very unequally distributed. An elite group of 'new rich' – that constitutes around one per cent of total population – controls companies dominating the majority of markets and owning most natural resources. The scarcity of resources in developing countries has increased considerably over the past forty years. Authority and power have shifted from the government to the elite, especially in the developing world. Governments have cut budgets and reduced the expenditures on public services, which are mostly replaced by private services, mainly geared towards the needs of the elite. To protect their assets, they invest in research and development to create private solutions for global environmental problems. The results of the investments are a number of path-breaking technologies in later years to overcome the problems of climate change, reduce pollution and waste and protect the environment. Other technological advances have resulted in much higher crop yield to ensure the efficient and low-cost production of food. A lot of the advanced technology put in place requires minimum skill levels from employees handling the technology. Food and nutrition security is ensured for the elite; the rest are fed, with greater quantities of food being provided through high efficient and technologically advanced production systems. However, the nutritional quality of the staple food is insufficient, especially regarding micronutrients.

Table 9. SUSFANS scenario 8 narrative on particular food system dynamics

Food and nutrition security	Agricultural systems	Post-farm food system activities	Interactions with global food security	Environmental impacts food systems
There is a divide in Europe – many who were worried about the threat of poverty, but had the ability to leave have done so; those remaining are the poor with few options for employment outside of Europe, and the wealthy. Meat becomes too expensive for the poor, and environmentally taboo for the rich; strict food policies have, in the meantime, ensured a decrease in harmful and sugar-rich processed foods.	Food production in Europe has decreased significantly with stringent environmental laws and cheaper production outside of Europe.	With decreased food production, other food system activities have also been reduced, mostly focusing on processing food commodities from elsewhere. The brain drain affects Europe's ability to recruit the expertise needed in various aspects of its food system.	Europe struggles with the growing demand of other global regions for food commodities.	A decreasing population, and a decrease of agricultural production have led to a rewilding in rural areas.

5.2. Using the SUSFANS qualitative scenarios

The SUSFANS project focuses on exploring strategies and policy options for sustainable food and nutrition security for Europe. Because such strategies are the core concern of the project, we have chosen to avoid the common pitfall of focusing most efforts on the creation of new explorative/contextual scenarios by drawing on a combination of existing scenario results.

The qualitative scenarios developed through the combination of two existing sets of scenarios described earlier are used in two different ways in the SUSFANS project: on the one side as a discussion tool with stakeholders about the future

EU FNS and on the other side as basis for developing a set of quantitative scenarios together with WP10.

First, the project discussed the key drivers for the EU food system in the future with stakeholders in the first Stakeholder Core Group meeting, held in October 2015. Stakeholders were given a list driving forces of food systems change in the future that resulted from a review of scenarios work done TRANSMANGO and FOODSECURE. Then participants were asked to discuss the following questions, using the conceptual framework:

- Which drivers are missing?
- Which are most important?
- What directions could they develop into?
- What are the key policy questions?

These discussions resulted in a set of additional drivers, both direct and indirect ones, to consider in the SUSFANS work as well as a ranking of the most important issues to consider in the foresight work. The stakeholders also formulated a variety of policy questions that they feel are important to address in order to determine how to achieve sustainable FNS in the EU. These questions set the scope for analysing existing scenarios and the foresight analysis in WP10 for new insights. The policy questions varied in detail and level, some addressed the whole food system while others focused on a particular food system actor or activity, such as consumers or agricultural production. The majority of the questions though focused on policies that could move the EU food system towards achieving sustainable FNS.

In the second Stakeholder Core Group meeting, held in October 2016, the SUSFANS scenarios developed by then through the combination of existing scenarios and the input from stakeholders received in the first workshop were used as a tool to explore various plausible futures for the EU food system and their implications. Once participants were familiarized with the scenario storylines they were asked to discuss a number of food system innovations to the livestock and fish and fruit and vegetable systems explored by WP5. To guide the discussion the following questions were used:

- What innovation pathways seem highly feasible in this particular scenario and how can they be built upon in this world?
- What innovation pathways seem particularly problematic in this scenario, and how can they be improved?

- What new innovation pathways can you think of that would respond particularly well to the challenges and opportunities of the scenario?

The results of the discussions then helped to guide the selection of innovations and innovation pathways investigated in more detail in WP5.

5.3. Combining qualitative scenarios with quantitative work

In the SUSFANS project the qualitative scenarios serve as an entry point to the quantitative foresight work in WP10. Here the project follows in the footsteps of various well-known global scenario efforts such as the IPCC, the Millennium Ecosystem Assessment and others (Henrichs et al. 2010). The scenario storylines are here used to first generate a wide range new plausible futures that the modelling community then uses for the parameterization of different simulation models.

In order to make the SUSFANS scenarios work comparable and compatible with other quantitative foresight work currently going on in the food and agriculture community the eight SUSFANS storylines were examined for their compatibility with the Shared Socioeconomic Pathways (SSPs). These are quantitative scenarios that are part of a new framework for the analysis of future climate impacts, vulnerabilities, adaptation, and mitigation (Riahi et al. 2017). In the moment, many modelling teams are working with the first three SSPs. Four SUSFANS scenarios were identified as being compatible with SSP 1, 2 and 3 and can thus be easily quantified. These were scenarios 1, 4, 6 and 7 of the SUSFANS set. Table 10 describes the key features of these four scenarios using the SUSFANS set of indirect drivers of the EU food system and also shows their SSP equivalent. Table 11 shows what these qualitative scenarios say about some of the main food systems elements identified in the SUSFANS conceptual framework. These four scenarios describe quite varied and thought provoking plausible futures and their implications for the EU food system so that they can be seen as a useful tool for foresight discussion and analysis. They will thus become part of the SUSFANS toolbox using combined qualitative and quantitative scenarios.

Table 10. SUSFANS scenarios and their SSP equivalents

SUSFANS scenario		Scenario 1	Scenario 4	Scenario 6	Scenario 7
SSP equivalent		**SSP 2**	**SSP 3**	**SSP 3**	**SSP 1**
Indirect drivers	**Economic development**	slow (financial crisis), have's & have-nots	Slow, inequality, little cooperation, UN system dissolved, non-competitive EU economies, global econ crisis	relentless global and European economic instability, EU's power has been shattered, economic shocks have led to high poverty and inequality, urban poverty	Europeans have more trouble taking care of themselves – life is moving fast in these competitive economies. Globally, societies are more equal than ever, more and more people are well educated and wealth is more equally distributed
	Population dynamics	Inequality	Inequality	Migration crisis	Free movement of people is guaranteed in many global regions
	Technological change	Monopolies of knowledge, elites hold knowledge	Good communication technology	Little attention to education, innovation stalled	Increased effort in communication technologies, EU brimming with innovation, local and regional initiatives and networks around energy, water, food and services have taken off, learning from innovations elsewhere in the world, and from each other.
	Agricultural & trade policies	Little global cooperation, trade blocks	Little cooperation, increased competition of the EU		New agricultural production technologies are developed that focus on sustainability and zero waste. Urban agriculture is highly developed and aquaculture is sustainable. Trade policies are aligned to food and nutrition security and stable ecosystems. The global population has access to sustainable diets. Water and food choices and basic needs are

					covered. Food is safer, and there are new sources of food available - socio-cultural aspects are respected in diets.
	Environmen-tal issues	Little attention, degradation		Climate change taking its toll on Southern EU countries, natural resources in decline, little protection	New and diversified renewable energy sources are applied, which replace conventional fossil fuel energy sources
	Culture & lifestyles		EU: return to the land out of financial insecurities, norms around self-reliance, the notion of well-being is increasingly decoupled from financial wealth and overall consumption	Move back to the land to in search of livelihoods and stability, but little facilitated transitions,	Meat consumption has become a social faux pas.

Table 11. Overview of the selected SUSFANS scenarios and their food system outcomes

Scenario	Food and nutrition security	Agricultural systems	Post-farm food system activities	Interactions with global food security	Environmental impacts of the food system
1	Few people are undernourished in Europe, but other malnutrition and NCDs are common.	Large-scale industrial agriculture grows, with little innovation, among other reasons because cheap labour is available; smaller farmers fail.	Several companies control post-farm food system activities; locked into historic patterns	Europe struggles with competition from other global regions; but trade agreements remain open and free, offering market opportunities due to low European wages and lax regulations	Environmental policies are weakened; land and resource use becomes more indiscriminate and damaging.
4	Many are poor in terms of income, but rural lifestyles, smart and diverse agricultural, trade and distribution practices, combined with a shift in preferences and understanding of	Food produced by farmer cooperatives, and medium-sized farms, bolstered through flexible and climate-smart agricultural technologies, is integrated into short food chains, and	Post-farm food system activities are highly integrated with agricultural production, managed by small to medium-sized enterprises, supported by flexible	Europe has little capacity to help resolve food security issues elsewhere in the world.	Re-wilding trends due to the abandonment of rural areas are reversed, with people moving back to the land. The return to cultivated land is mostly done in a sustainable fashion;

	healthy supported by customized information technology results in good food and nutrition security for most. Cost and preferences have lowered the consumption of meat and animal products considerably.	supported by home-produced crops.	agricultural, processing, transport and information technology. There are, however, some areas where such technologies are less available.		nevertheless, this leads to a stabilization, rather than a revival, of environmental conditions.
6	Poverty is widespread, and food insecurity reaches levels that are unprecedented for Europe. Many move back into the countryside but struggle to create effective sources of food under climate change. Many more stay in urban poverty.	A combination of conventional, large-scale farmers with little innovative capacity and a new and rather inexperienced generation of small-scale farmers producing for subsistence and marginal cash flow.	Many companies in food processing, distribution etc. have failed, resulting in less diverse food products – and a food system full of opportunism and a lack of reliability.	Global food demand affects price and stability, only adding to food insecurity in Europe.	Food production and other food system activities are in survival mode, and care little for environmental concerns; nor do policy makers.
7	There is an ethical shift away from the consumption of animal products; otherwise, though, people have a hard time maintaining healthy diets in a high-pressure society.	Agricultural production is diverse, innovative and thriving, focusing on sustainable forms of production and new ways to link to consumers.	The European food system is characterized by an extreme diversity of small-scale business models supported by strong communication networks.	Europe becomes a centre for food and agricultural innovations – eager to share its knowledge and technology with the world.	A strong dedication to environmentally sustainable agriculture and food system approaches among businesses across Europe leads to an environmental revival, and to positive global impacts where EU approaches are implemented.

6. CONCLUSION

The use of scenarios to reflect on future pathways in a multi-stakeholder setting is increasing. The SUSFANS project is therefore also using this tool to investigate the potential of various innovation options for the EU food system, to conduct policy analysis as well as to stimulate a wider debate with stakeholders about the direction of system change and its implications for food system actors and consumers alike.

As there are ample scenario exercises available that address agriculture, food system and food and nutrition security questions at different geographical scales and with different level of detail the SUSFANS project decided to experiment with the use of existing scenarios while not developing scenarios from scratch. This report describes both the selection of considered scenario exercises and what elements in particular have been used. Having selected potential exercises based on their compatibility with the SUSFANS conceptual framework that have then been extended on both qualitatively and quantitatively, resulted in a detailed set of scenarios that can be used at the EU level.

Combining and building on earlier developed exercises proved a useful approach for SUSFANS project in that it resulted in a set of varied plausible futures able to stimulate debate and serve the objectives for the project. In addition, a number of the SUSFANS scenarios also proved compatible with the Shared Socioeconomic Pathways (SSPS) used in the climate change community, which allowed an easy entry point for the quantification of the qualitative scenario narratives.

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