Stockholm Resilience Centre

Insight Paper #4

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Nordic food system transformation series

Summary

This fourth Insight Paper of the Nordic food system transformation series explores the uncertainties associated with different food system futures. These uncertainties are mapped in relation to the three priorities of the Nordic Council of Ministers' Vision 2030: a green, competitive and socially sustainable Nordic Region. This Insight Paper discusses a variety of tools that can be used to inform decision-making in uncertain situations.

Key insights

- Uncertainty is an inevitable part of food system dynamics.
- Participants identified environmental, economic and social uncertainties that would need to be addressed to achieve the sustainability priorities of the Nordic region.
- The uncertainties identified during the dialogues included
  1) inherent uncertainties arising from the unpredictable nature of food systems;
  2) scientific uncertainties for which we currently have limited information but could gather more evidence; and
  3) social uncertainties that are caused by differences in individuals' values and beliefs.
- There is a range of future-oriented tools that food system actors can use to make decisions in the face of uncertainty.

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Food system transformation in the face of uncertainty

Sources of uncertainty in food system transformation

Uncertainty will be an inevitable part of food system transformation. One source of uncertainty is the unpredictable nature of the people, activities, inputs and policies that make up food systems. For example, it is hard to predict how policies shaping food systems will develop in the future. Will policy-makers introduce stricter regulations limiting the environmental impacts of food systems? And will these regulations be accepted and implemented, or will they be repealed in the face of political and societal backlash?

A second source of uncertainty arises from the potential for non-linear change in food systems. That means a disturbance to the system can cause disproportionate impacts, both negative and positive. For example, the spread of one novel virus – the coronavirus – has had enormous consequences across the food system, and indeed across our environmental, political, health, economic and social systems as well.[1] With respect to food systems, the current pandemic has led to increased food insecurity, disruption of food supply chains, restriction of movement of migrant agricultural workers, and shifts in people's eating patterns.

A third source of uncertainty stems from the fact that food systems are not isolated systems. They are embedded within the social and ecological world at all scales, from local to global. It is particularly challenging to know how changes at a global level – such as climate change – will affect a local or regional food system. For example, how will rising global emissions impact food production capacity in the Nordics? And what impact will other countries' climate mitigation actions (or inactions) have on Nordic food systems?

Further, our world is rapidly changing. There are several meta- and megatrends influencing society at large. These omnipresent trends will, in turn, influence domestic and international food systems. As megatrends interact, they increase the complexity and uncertainty that we will need to learn to deal with. One such megatrend is the pervasiveness of technology.[2] We are experiencing the beginnings of a technological revolution that will see the distinction between the physical, digital and biological worlds fade.[3]

Technological advances in food systems have been critical to raising yields, developing preservation techniques, increasing food safety, and improving the efficiency of distribution, thus filling the empty plates of millions around the world. Nevertheless, innovation may also bring unintended consequences with undesirable consequences.[4] In the future, will technology be the saviour of food systems, the source of new challenges, or perhaps elements of both?

It is easy to fall into a state of "paralysis by analysis" by the high degrees of uncertainty we face, where defaulting to inaction may seem like the most comfortable option.[5] Yet uncertainty is not an excuse for business-as-usual action. Why? Keeping food systems on their current trajectory will certainly bring far-reaching negative impacts for social, economic and environmental sustainability. There is a substantial, growing body of evidence that clearly points to changes that need to be made within food systems. These changes include adopting sustainable diets, improving food production practices, minimising food loss and waste, and ensuring equitable outcomes across food systems.[6–8] We may not have the detailed roadmap for action; but then again, decisions about complex systems – like food systems, financial systems, or cities – are rarely made with perfect information.

This Insight Paper aims to explore the uncertainties surrounding Nordic food systems transformation. The paper ends with a discussion about tools that can be used when making food system decisions in the face of uncertainty.

How were uncertainties surrounding Nordic food system transformation identified?

Food system actors came together in all Nordic countries during a series of Nordic food system transformation dialogues. In short, these actors were tasked with envisioning four future food system scenarios:

1) Reductions in red meat consumption
2) Increased consumption of nuts and legumes
3) Moving towards local food systems, and
4) Embracing global food systems

These dialogues are part of the project *Towards sustainable Nordic food systems*, a project contributing to the Generation 2030 program of the Nordic Council of Ministers. The details about the project are described in Insight Paper #1.

Dialogue participants were asked about the benefits and undesirable impacts of each scenario, as well as the barriers and uncertainties standing in the way of each potential food system change. This Insight Paper focuses on the uncertainties identified by participants. During the dialogues, participants listed the uncertainties as questions, whereas the barriers, benefits and undesirable impacts were posed as statements. This Insight Paper keeps this format and presents the uncertainties identified by dialogue participants as questions.

The uncertainties surrounding the four future food systems scenarios are described below in terms of the three pillars of sustainability – environmental, social and economic (Figure 1). This reflects the instruction for dialogue participants to think broadly about sustainability in terms of these three pillars. These pillars also align with the three priorities of the Nordic Council of Ministers' 'Vision 2030':
1) a green Nordic region,
2) a competitive Nordic region, and
3) a socially sustainable Nordic region.[9]

Thus, presenting the uncertainties in these pillars helps us to better identify the uncertainties that need to be addressed when taking action to reach the Nordic region's sustainability goals. It also helps us to understand the interaction between different pillars of sustainability and the uncertainties that they encompass.

The presentation of uncertainties is followed by a short analysis of findings. It should be noted that through the analysis, it was clear that not all of the uncertainties identified by stakeholders were aligned with the most up-to-date scientific evidence. For example, stakeholders expressed uncertainties related to environmental, nutritional and health impacts of certain diets or foods, whereas the evidence base can provide us with answers to many of these questions. This misalignment between the uncertainties presented below and the evidence base is to be expected, given that dialogue participants were often experienced with one part of the food system yet were asked to judge impacts of change across the entire food system. This is also understandable considering the sheer amount of new knowledge produced about food systems in recent years. It would be unreasonable to expect all stakeholders to have detailed, up-to-date knowledge of all parts of the food system.

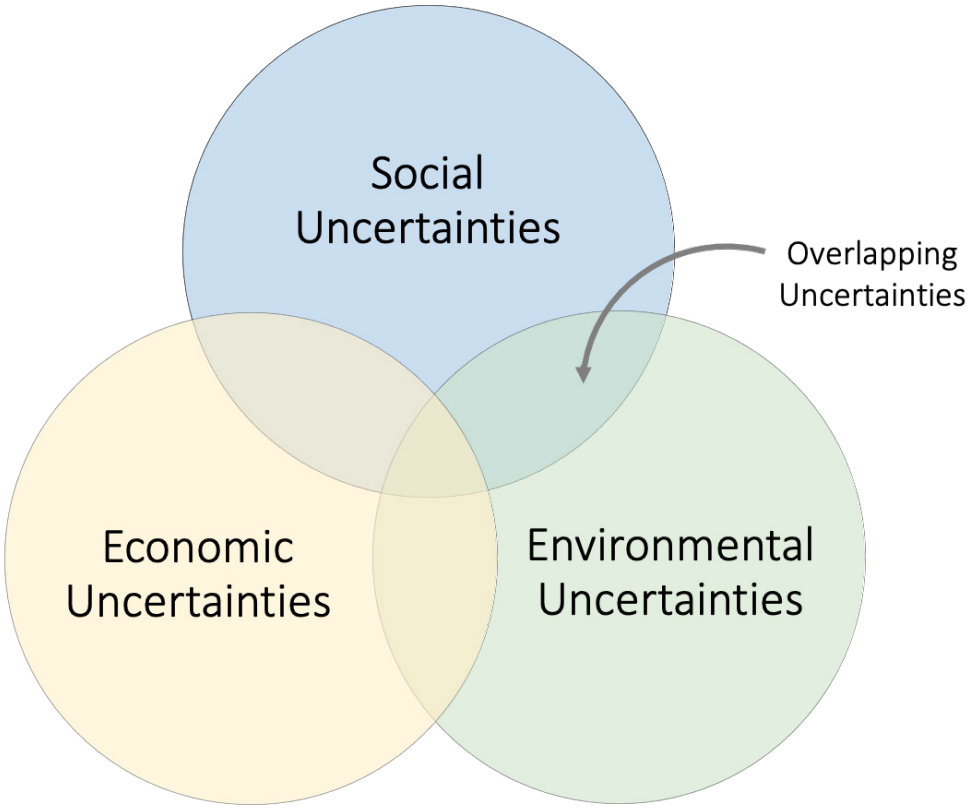

Figure 1. Mapping food system uncertainties onto the three pillars of sustainability can help us understand the interaction between the different pillars of sustainability.

Scenario 1: Reduction of red meat consumption

Throughout the dialogues, it became clear that participants perceived red meat consumption and production as a core part of Nordic culture and tradition.

One of the most significant uncertainties that arose from the discussions focused on questioning the alternatives to meat-heavy diets: *What would we eat instead? What would our food culture be without meat?* Another point of concern and discussion was the alternatives to red meat production in the region: *What would we produce instead?*

Another core uncertainty questioned the level of support available for different groups within society to adapt to this change. In particular, participants felt that individuals needed support to change their diets through increased knowledge and cooking skills. They also felt that farmers would need support to maintain their livelihoods or change their production methods or production systems.

Table 1 below summarises the various uncertainties expressed by participants about the scenario of reducing red meat consumption.

As the core questions in Table 1 make clear, the participants pointed out that the reduction of red meat consumption would also have direct and indirect impacts on meat production in the Nordic region. In addition, Table 1 illustrates that some participants saw legumes and other plant-based foods as the foods that would replace red meat in our diets. Scenario 1, however, did not specify what should be eaten in place of red meat, leaving it open to participants to decide if individuals would shift towards fish, poultry or plant-based foods, or reduce their overall food consumption.

Table 1. Uncertainties associated with the reduction of red meat consumption, as identified by dialogue participants.

Social uncertainties	Core questions
Food culture	– What would happen to food culture? – Would we lose part of our national identity? – Can we achieve the cultural shift required? How can we make the shift?
Individuals' ability to change	– Do people have the knowledge and cooking skills to make healthy, tasty meals without/with less meat?
Personal and political acceptance	– Would individuals accept this dietary change? – Would individuals accept legumes as a protein source? – Would policy-makers support this change?
Dietary shifts	– What would people eat instead of red meat? Would these foods be more or less healthy? – Are alternative foods safe? – How would this dietary shift impact milk consumption? – Would a shift to plant-based diets lead to nutritional deficiencies?
Food security	– How would food security be impacted?
Self-sufficiency	– What would happen to the self-sufficiency of food production in the Nordics?
Animal welfare	– Would we 'shift' animal welfare concerns? For example, if we replaced red meat in our diets with poultry, driving up poultry production, do we create new animal welfare concerns for chickens?

(continued)

Environmental uncertainties	**Core questions**
Impact of red meat production (general)	– Do we know the true environmental impact of meat production? – Is it possible for beef and dairy production to become more sustainable? – Don't livestock have a role to play in sustainable food production systems?
Impacts of reduced meat production on biodiversity, climate, land use and nutrient cycling	– If there are fewer grazing cows, how will this impact biodiversity and carbon sequestration? – Would a more limited manure supply mean fewer nutrient emissions in waterways? – How will land use change? Will this have positive or negative environmental impacts? – Would food transport emissions increase (e.g. more vegetables imported from around the world) or decrease?
Impact of red meat versus alternative food production	– Would plant-based production have fewer or more environmental impacts than red meat production? – How can we be sure that plant crops are better for the environment than meat production?
Grazing	– What is a necessary or sustainable level of grazing?
Demand for unsustainable inputs	– Would the lack of manure increase demand for other types of fertilisers? – Would the use of pesticides increase? *Note: this comment presumably referred to an increase production of crops in place of livestock production.*
Economic uncertainties	**Core questions**
Trade	– Would trade agreements and regulations change in light of this shift? – How would trade balances change? – Would the Nordics increase exports of meat to other countries? – If imports can't be regulated, such as the import of red meat products, how would this impact the Nordic's ability to reduce red meat consumption?
Nordic competitiveness	– Would the Nordics be able to produce plant-based foods competitively?
Economic impact	– Would the food production sector lose money? *Note: Presumably, this statement asks if the reduction in demand for red meat products would in turn have a negative economic impact on the livestock production sector.*
Overlapping uncertainties	**Core questions**
Knowledge and research gaps	– Do we have enough research on food systems as a whole to know what to do? – Do we know enough about local and regional food systems? – Do we know what our sustainability goals should be?
Systemic change	– How would we make this transformation at a global level? – How would we make systemic changes in the primary production sector?
Speed of transformation	– Considering the pace of policy processes, can the transformation required happen fast enough? – How quickly can economic and production systems change?
Pathways forward for Nordic farming	– How would national production systems change? – Should the Nordics continue to produce meat? If so, what kind, where and how? – Should we focus on fish and plant production instead of meat? – What would happen to milk production in scenarios of decreased meat production?
Farmers' livelihoods	– Can farmers adapt to these changes? – What is the profitability of new production systems for farmers? – Are there alternative livelihoods for farmers, or do they face unemployment? – Would farmers be made to feel guilty, or would they be supported to change?
Rural development	– What would happen to rural areas and rural livelihoods? – Would these areas depopulate and go 'out of business'?
Food prices and social inequality	– What would happen to the price of food? Would it rise? – If food prices rise, would this accentuate social inequalities? – Would only the elite be able to secure healthy diets?
Impacts of change in other countries	– What economic and environmental impacts would the reduction of red meat consumption bring to other countries? Are they positive or negative? – Would this lead to a re-nationalisation of food systems?

Scenario 2: Increased consumption of nuts and legumes

Many of the uncertainties discussed in the nuts and legumes scenario mirrored that of the red meat scenario. In terms of social uncertainties, participants asked if consumers would be willing and able to make the changes required and questioned how food culture might be impacted. Environmental uncertainties were also shared across the two scenarios, questioning the 'true' environmental impacts of different nut and legume production systems. Finally, regarding economic uncertainty, participants were unsure of the impact of either the red meat or nuts and legumes scenario on global trade and Nordic competitiveness.

There were, however, other uncertainties that were not shared across the nuts and legumes and red meat scenarios. For example, participants were concerned about the food quality and safety of new nut and legume products that would be imported and introduced to our diets. They also flagged the difficulty that individuals with nut allergies and legume intolerances would have in adopting this dietary shift. Participants were also unsure whether nuts and legumes would grow well in the Nordics, highlighting that many areas in the Nordics were suitable for livestock production. From an economic perspective, participants questioned whether nut and legume production would be profitable, whereas in the red meat scenario, they were mostly concerned with the loss of profit.

Table 2. Uncertainties associated with an increase in nut and legume consumption, as identified by dialogue participants.

Social uncertainties	Core questions
Food culture	– How do we integrate these foods into traditional Nordic food culture? – How would Nordic traditions and culture be impacted?
Achieving a just transition	– What are the working conditions in nut production systems around the world, and are these conditions aligned with human rights?
Food quality and safety	– Would this dietary shift have an impact on food safety, given these foods are associated with heavy metals and other harmful substances? – How to guarantee the quality and safety of these foods?
Food allergies and intolerances	– Is this dietary shift appropriate or possible for those with allergies or gastrointestinal issues?
Dietary shifts	– Is this dietary shift even necessary? – How can we change individuals' eating habits? – What are the nutritional risks (e.g. nutritional deficiencies, anti-nutrients) and trade-offs (e.g. healthy unsaturated fats versus risk of overconsumption)? – Should these foods replace meat?
Personal, business and political acceptance	– Would individuals accept this dietary change? – Would these new products appeal to individuals' preferences? – Would retailers encourage this shift through the promotion of nuts and legumes? – Would governments support this shift?
Food security	– What are the impacts on food security globally and in the Nordics?
Self-sufficiency	– Would production volumes be enough to satisfy the needs and demands of Nordic populations? – Would this create competition with other types of food production?
Individuals' ability to change	– Do individuals know how to cook with these foods?

(continued)

Social uncertainties	**Core questions**
Impact of climate change	– Would climate change lead to problems in farming, or would it make it easier to grow plant-based crops?
Environmental impact of nut and legume production	– Do we really know the environmental impacts associated with nut and legume production? – Do we know the potential impacts in different production regions? – Would biodiversity increase or decrease? – How would land use be affected, and will this increase land pressure? – Would the production of these foods cause water depletion and pollution? – Would more or less environmentally sustainable production methods be used to grow these foods? – What would the environmental impact be if everyone in the world starts eating more nuts? – Would increased nut and legume production create new environmental challenges?
Outsourced environmental impacts	– How would Nordic populations know/be able to control the environmental impacts of nut and legume production grown beyond Nordic borders? – Would the Nordics be 'outsourcing' the environmental impacts to countries already facing resource scarcity?
Food waste impacts	– Would there be less food waste due to, for example, the longer shelf life of these foods? – Would there be more food waste since food would be shipped long distances?
Demand for unsustainable production inputs	– Would farmers need to use more or less chemicals and fertilisers than currently are used for production? – Would the use of more pesticides encourage new pests and diseases to form?
Nordic climate and nut/legume production	– Which types of nuts and legumes could thrive in Nordic climates? – Where would nut and legume production take place in the Nordics?
Economic uncertainties	**Core questions**
Nordic competitiveness	– Would the Nordics be competitive in nut and legume production?
Added-value	– How can added-value plant-based products be created?
Profitability	– Would the production of nuts and legumes be profitable? More or less profitable than meat production? – Is there a good Nordic business case? – Would we lose profits from other big exports (e.g. vodka) due to land use competition?
Trade	– Would nut and legume production increase in the Nordics, or should these foods be imported from elsewhere? – What would happen to the trade balances of Nordic countries?
Overlapping uncertainties	**Core questions**
Impact on farmers	– Do farmers have the skills and knowledge needed to grow these foods? – Would farmers have the support they needed to make the shift? – How would farmers be compensated for their current investments? – Can farmers make a living producing legumes?
Food prices and social inequality	– What does a large-scale shift to nuts and legumes mean for food prices? – Would all individuals be able to afford nuts and legumes?
Existing policies and agreements	– Would it be difficult to develop breeds suited to Nordic growing conditions given EU regulations on GMO crops? – Would policies (e.g. agricultural subsidies, trade agreements) evolve to support this shift? – Would there be supportive policies from governments?

Scenario 3: Moving towards local food systems

For this dialogue, participants were asked to think of local food systems as either national or Nordic food systems. Despite this guidance, a key question in the discussion was what 'local' really means and how it should be measured. Many participants realised that there was a continuum of local-to-global food systems, and realistically, the right balance would be somewhere in the middle of that continuum.

Participants wondered how local food systems would 'work' in practice, given the current structure of Nordic and global food systems. For example, free trade agreements make it difficult to block imports in order to promote local markets. Also, consumers' expectation that foods will be available year-round does not align with local supply. Participants questioned what a local diet would look like here in the Nordics, and if that diet would provide the diversity and nutrients needed for a healthy diet. They also wondered if this scenario would be possible given the geographic and climatic conditions in the Nordics.

Social uncertainties	Core questions
Food security	– Would this shift lead to an increase in food security (e.g. less import reliance) or decrease (e.g. food shortages from extreme weather events)? – Would local food systems be more vulnerable to environmental changes? For example, what would happen if the Nordics could not produce food due to an environmental disaster
Self-sufficiency	– How long would it take to produce enough food locally? – Would there be enough farmers to fill these emerging positions? – Could the Nordics produce enough calories/nutrients for their populations (and for tourists)? – Could technology help us increase local production?
Rural populations	– Would rural areas become more populated? If so, what impact would this shift in demography have (e.g. a need for more hospitals in rural areas)?
Dietary shifts	– What dietary shifts would be needed to make to shift to local diets? And what would the nutrition and health impacts be? – Would this encourage people to eat more Nordic meat? – Would there be access to healthy foods (e.g. fruits, vegetables, legumes, nuts), and access to foods that many enjoy, such as chocolate? – Would diets become seasonal? – Would diets become less diverse?
Connections to other cultures	– Would local food systems limit our understanding of and interest in different cultures?
Social acceptance	– Would people accept a narrower food supply? – Would people get used to only eating local foods? – Would people resist this change, especially if it meant eating a more traditional diet?
Happiness and wellbeing	– What would happen to individuals' wellbeing and happiness if there was limited access to foods like chocolate, coffee and wine?
Individual knowledge and skills	– Do people have the knowledge and cooking skills needed to cook with local ingredients? – Would immigrants be able to cook with traditional Nordic ingredients?
Equity	– Would this shift enhance equity by allowing more people to be involved in food production?

Table 3. Uncertainties associated with moving towards local food systems, as identified by dialogue participants. *(continued)*

Environmental uncertainties	**Core questions**
Impact of climate change	– How would climate change affect food production conditions in the Nordics?
Food waste	– Would there be more or less food waste?
Environmental impacts of local production	– Would resources be used more or less efficiently in local production systems? – Would local production require further land use for agriculture in the Nordics? If so, would this impact important ecosystems, such as forests? – What production methods would be used? – Is local food production really better for the environment? – Would less food transport lower emissions, or would greater Nordic production increase emissions?
Nordic location and production	– What can be grown in the Nordics given the region's climate and natural resources? – Would there be enough raw materials for food production? – Could the ingredients for a varied diet be produced exclusively in the Nordics?
Production inputs	– Could the Nordics produce enough animal feed if it could no longer be imported? – Would the move to local systems stimulate the development of new animal feeds from local sources like insects and algae?
Economic uncertainties	**Core questions**
Trade	– If countries around the world stopped importing food (i.e. all countries adopted local food systems), would the Nordics have an excess supply of some foods (e.g. Norwegian fish)? – If the Nordics no longer imported food, would other countries buy Nordic exports? – Participants suggested that trade promotes 'dialogue, peace processes, and stable political systems' – what happens if trade dissolves? – Would this change our trade goals (e.g. export goals)?
Economic impacts	– What would the economic effect of local food systems be?
Local markets	– What would local markets look like? – How could small markets be expanded? – Would producers be able to react quickly enough to changes in local markets to deliver what consumers are expecting? – Would we produce what we need, or what makes money? – How can a country govern so that food producers only sell to local markets?
Unintended consequences	– Would this increase 'border sales' (also called cross-border trade), where individuals travel across national borders to buy foods not available in their own country? – Will black markets emerge to sell foods that can't be produced in the Nordics, such as coffee and bananas? – Would people travel to buy exotic foods?
Overlapping uncertainties	**Core questions**
Impacts on the rest of the world	– Would poorer countries suffer economically due to the inability to export goods? – Would those countries that cannot produce the inputs of sustainable diets suffer negative health impacts?
Research gaps	– Are there enough 'scientific facts' to move to local food systems?
Definition of 'local'	– What does a 'local' system mean? *Note: participants were asked to think about 'local' in this context as either national or Nordic level.* – Is it still a 'local' system if animal feed and fertilisers are imported?
Food prices	– What would happen to food prices? – Would small-scale, local farming result in high costs?
Impact on farmers	– Would this shift spur more small-scale farmers and cooperatives? – Would this bring more or less income to farmers? – Would some producers have all of the power due to little competition?
Existing international agreements	– What would happen to current political agreements? – Would re-nationalisation of Nordic food systems damage global relations?

Scenario 4: Embracing global food systems

During discussions of the global scenario, some participants wondered how different this scenario would be from the current reality of food systems. Despite this, many uncertainties about embracing global food systems were identified. In particular, participants questioned whether or not market forces and multi-national corporations could be used to improve sustainability. It should be noted that uncertainties such as these focus on the *economic and market structures* currently seen in global food systems, not necessarily the global scale of food systems.

Many concerns were raised by participants about the possibility of global food systems perpetuating the negative lock-ins associated with current food system challenges. For example, participants wondered if diets would suffer as the influx of cheap, unhealthy and unsustainable foods flowed into the Nordics. Participants were also uncertain whether further globalisation would bring additional environmental impacts.

Table 4. Uncertainties associated with increasingly globalised food systems, as identified by dialogue participants.

Social uncertainties	**Core questions**
Food security	– What impact would this have on short- and long-term food security?
Self-sufficiency	– Would this reduce the degree of self-sufficiency in the region?
Food culture	– If diets change, what would happen to Nordic food culture? – Would 'global fast-food culture' increase?
Dietary shifts	– How would global systems change our diets? – Would people eat more unhealthy foods? – Would individuals be adequately nourished by global diets? – How would these dietary shifts impact overall public health (both from a nutrition perspective and a plant/animal disease outbreak perspective)?
Animal welfare	– What impact would global systems have on animal welfare?
Food safety	– Is the safety and quality of food from global systems adequate? – Do global systems increase the risk of food fraud?
Personal acceptance	– Would people eat genetically modified foods? – Would individuals have enough information to make sustainable choices?
Social inequalities	– Would social inequalities increase or decrease?
Environmental uncertainties	**Core questions**
Impact of climate change	– How would climate change impact production around the world? And how would that impact imported goods to the Nordics? – Would climate change reduce global food production in the longer term?
Food waste	– Would food waste increase?
Environmental impacts of global food systems	– Do global food systems imply too many environmental impacts? – Would an increase in food transport negatively impact the environment? – How could environmental impacts be quantified or standardised? – Which is better for the environment – local or global systems? – Would environmental efforts be scattered due to lack of best-practice sharing? – Do global food systems promote efficient resource use? – What land use changes would occur, and how might these changes impact the climate?
Demand for unsustainable inputs	– Would producers use more pesticides in order to increase yields?

(continued)

Economic uncertainties	**Core questions**
Trade and economic impact	– What economic impact would an increase in global trade have? – Would there be export opportunities (presumably for Nordic producers)? – Would international crises restrict imports and exports?
Nordic competitiveness	– Are Nordic producers competitive in global markets? – How could the Nordics compete on something other than price?
Control of global markets	– How to govern and regulate this type of food system? – Who controls the global market? Would there be enough control throughout the value chain? – Who decides where different products are produced?
Overlapping uncertainties	**Core questions**
Markets and sustainability	– Would bodies such as the EU or WTO be able to develop tools to promote more sustainable products? – Could market mechanisms be used for 'good'? – Could big companies lead the way to a faster transition towards sustainable food systems? – Can we change a profit-driven economy? – How to regulate global markets to avoid environmental impacts?
Vulnerability of Nordic food systems	– Are global food systems more vulnerable due to, for example, trade dependency, potential international crises or pathogens?
Impact of global food systems on Nordic production	– Would there only be consumers in the Nordics, not producers? – Would there be more aquaculture and less farming? – Would local produce be replaced with non-native crops? – Would environmentally-intensive production sectors in the Nordics change for the better? – What would happen to the Nordic livestock sector?
Impact on farmers	– How would we ensure that farmers do not lose income or their livelihoods? – How would we ensure that producers are fairly treated and adequately paid?
Food price	– Would food be cheaper or more expensive? – Would food prices be more volatile or better reflect the 'true cost' of food? – If prices rise, who could afford varied and nutritious food?

Overview of findings

As the sections above illustrate, dialogue participants identified many social, environmental and economic uncertainties regarding the future of food systems, regardless of the scenario discussed. Across the scenarios, most uncertainties were generally associated with social sustainability. This could reflect the fact that social sustainability – including individual and population health, culture, well-functioning institutions and thriving communities – is influenced by a range of normative behaviours and decisions that are difficult to predict. It could also signal that this dialogue amplified an area that is relatively understudied. That is, the wide-ranging social impacts of food system transformation are not well researched. On the other hand, it could also reflect the dimension of sustainability (social) with which most participants were familiar.

The economic sustainability pillar was associated with the lowest number of uncertainties for each scenario. The absence of an in-depth discussion on this pillar might reflect the participants' expertise – economists and those working with the economic dimensions of food systems were largely missing from the dialogues.

Similar uncertainties highlighted across several scenarios

Several uncertainties were commonly highlighted across scenarios. For environmental uncertainties, participants questioned whether or not the actual environmental impacts of each scenario are known. They were also uncertain if the four scenarios would bring about changes to production inputs such as feed, fertilisers and pesticides, and whether those changes would have positive or negative environmental impacts. Other uncertainties, such as the environmental impact of food waste and the impact of climate change on food production, were discussed in three scenarios. Uncertainties focused on growing conditions in the Nordics were highlighted in the local and nuts and legumes scenarios.

For social sustainability, participants were unsure about the dietary shifts needed to achieve each scenario and the impacts of those dietary shifts on health and nutrition. Participants also questioned whether or not individuals would accept the dietary changes that would result from each scenario. Participants wondered how each scenario would impact food security and self-sufficiency. Finally, uncertainties about shifts in food culture were noted in all but the local scenario.

In terms of economic sustainability, the one uncertainty commonly held across the scenarios was the impact on trade. Participants also questioned the economic impact of each scenario, although this was phrased differently across scenarios (e.g. economic gain, profitability, economic impact). Nordic competitiveness was identified as an uncertainty in all but the local scenario.

Types of uncertainties identified

On closer analysis, it is clear that participants identified different types of uncertainties: inherent uncertainties, scientific uncertainties and social uncertainties.[10] Inherent uncertainties arise when we cannot know what will happen because of the inherent unpredictability of certain parts of a system. For example, participants indicated that it is difficult to know the impact of climate change on future food production due to a range of unpredictable variables such as future policy measures and social or technical innovations. Participants also felt that it can be challenging to know whether individuals will accept a particular dietary change or not, given that cultural and individual norms can change quite quickly in response to social movements or shock events.

Scientific uncertainties are those where we have limited information or incorrect information about a phenomenon.[10] These uncertainties could be reduced by gathering more scientific evidence. For example, we do not have perfect knowledge of the environmental impacts of every legume crop grown across geographical regions using a range of different production methods. However, significant research does already exist, as well as the tools to expand our knowledge where there are gaps. Further, new tools are being developed to expand the suite of environmental impacts that can be measured. Identifying scientific uncertainties can help us identify areas of future research (and research funding).

Social uncertainties are caused by differences in values and interpretations of individuals relating to a phenomenon.[10] For example, uncertainties about the level of self-sufficiency in Nordic food systems are caused partly by clashes of values. While some people value having a diverse food supply that can only be provided by importing foods not grown in the Nordics, others value local food systems' ability to meet the needs of the population. Thus, the uncertainty around self-sufficiency is in many ways normative, not technical.

It is also essential to distinguish between uncertainties that an individual has due to, for example, a lack of knowledge, and uncertainties that cannot currently be minimised with any existing knowledge. In this Insight Paper, several uncertainties presented by participants are individual in nature. For example, an individual may be uncertain about the environmental impacts of different food production systems, or whether certain dietary shifts will result in nutritional deficiencies due to lack of nutrient intake or anti-nutritional effects. However, research on these topics and tools to minimise this uncertainty already exists. As mentioned previously, the misalignment between perceived uncertainties and the evidence base is to be expected, since participants – often representing a single sector or 'part' of the food system – were asked to comment on the system-wide impacts of food system transformation.

A final reflection is a similarity between the uncertainties presented above and the barriers presented in Insight Paper #3. For example, individuals' resistance to change, the lack of citizens' knowledge and skills to adopt new diets, food culture, and lack of competitiveness were listed as barriers and uncertainties. This signals the close relationship between predicted barriers and uncertainty. In other words, some of the uncertainties noted by the participants could be reduced if the barriers were addressed. Alternatively, if an individual gained more knowledge to reduce one or more of their own uncertainties, this could lead her or him to perceive fewer barriers to change.

Tools for decision-making in the face of uncertainty

As this Insight Paper has illustrated, decisions about food systems will need to be made in the face of uncertainty. However, there is a range of future-oriented tools that can help manage, explore and even reduce food systems uncertainties. Five of these tools are discussed below. These tools were selected because they have either been piloted or implemented in the Nordic region. Again, this represents only a small sample of the potential tools that could be used to explore what the future holds – other tools not discussed here include the use of art, future role-playing and even serious gaming!

You will find a 'bookshelf' at the end of each section. Here, links are provided so that you can explore additional projects, tools or applications of the tools discussed here. While not a comprehensive library, each bookshelf will provide further resources to help you start using each tool.

1. Targeted research

As illustrated in the previous sections, uncertainties are best framed as questions. Scientific research ultimately comes down to finding ways to answer tough questions or contribute to the overall picture of what the answer might be in a given context. Further targeted research can help us reduce or eliminate 'knowable' uncertainties. While this isn't the most novel tool to help us manage uncertainties, it is an important one.

This tool makes sense in light of the research gaps identified in this project. For example, participants noted the lack of research about the environmental impacts of food production in specific regions. Many research tools have been established to capture these impacts. With proper resources, a broader range of food production systems could be analysed. Similarly, many participants questioned the nutritional and health impacts of specific dietary shifts – such as shifts away from high red meat consumption, or shifts towards increased nut and legume consumption. Research already exists on the nutritional impacts of certain dietary patterns and dietary shifts. With adequate resources, additional trials and studies could be developed.

Bookshelf (selected projects from the vast library!):

- Denmark: The DTU Centre for Food Technology and Nutrition, Sustainability and Health Promotion ; FOODSHIFT 2030 ; The Big Climate Database
- Finland: Leg4Life ; JUST-Food program
- Iceland: Sustainable Healthy Diets: Filling the gaps and paving the way for a sustainable future, a project led by the University of Iceland
- Norway: NOR-Eden project ; MEATigation ; Climate transitions in the Norwegian food system
- Sweden: Mistra Food Futures program ; Centres for food research and innovation ; SeaWin Sustainable Seafood project
- Nordic: Food System Transformation Dialogue Series ; Future Nordic Diets

2. Horizon scanning and megatrend analysis

How will food systems transform, and how will they be shaped by broader societal, environmental and economic trends over time? While these questions are impossible to answer with certainty, it is possible to systematically scan for the trends that will shape tomorrow's food systems. Horizon scanning is a technique that is used to explore "signals of change" that can disrupt a system.[11] The goal of these processes is to identify, collect and make sense of emerging issues and trends that might take shape.[11] In particular, this technique can provide the space to reflect on the challenges and opportunities that might accompany these future directions. In this way, horizon scanning can facilitate strategic planning and long-term decision-making.[12]

Horizon scanning can be used to look at the 'big picture', or it can be used to identify future trends and issues within a specific context, such as regional or national food system.[11] One such regional horizon scanning exercise took place in the Nordic-Baltic region in 2020. Students, food innovators, startup founders, researchers and industry experts were invited to scan for 'Megatrends' that might impact the future of Nordic-Baltic food systems.[2] The eight megatrends are illustrated below, Figure 2.

Horizon scanning can elicit the perspectives of a wide range of stakeholders, as in the Nordic-Baltic megatrends report introduced above. Other methods to pick up on emerging trends include using expert consultations, scanning teams (multi-disciplinary, specialised teams trained to identify and analyse emerging trends) and even artificial intelligence.[11,13]

Horizon scanning exercises can be the starting point for imagining more detailed stories of how the future will unfold. These stories, called scenarios, are described more in the next section.

Bookshelf:

- SITRA Megatrends List
- Eight Megatrends in Nordic-Baltic food systems

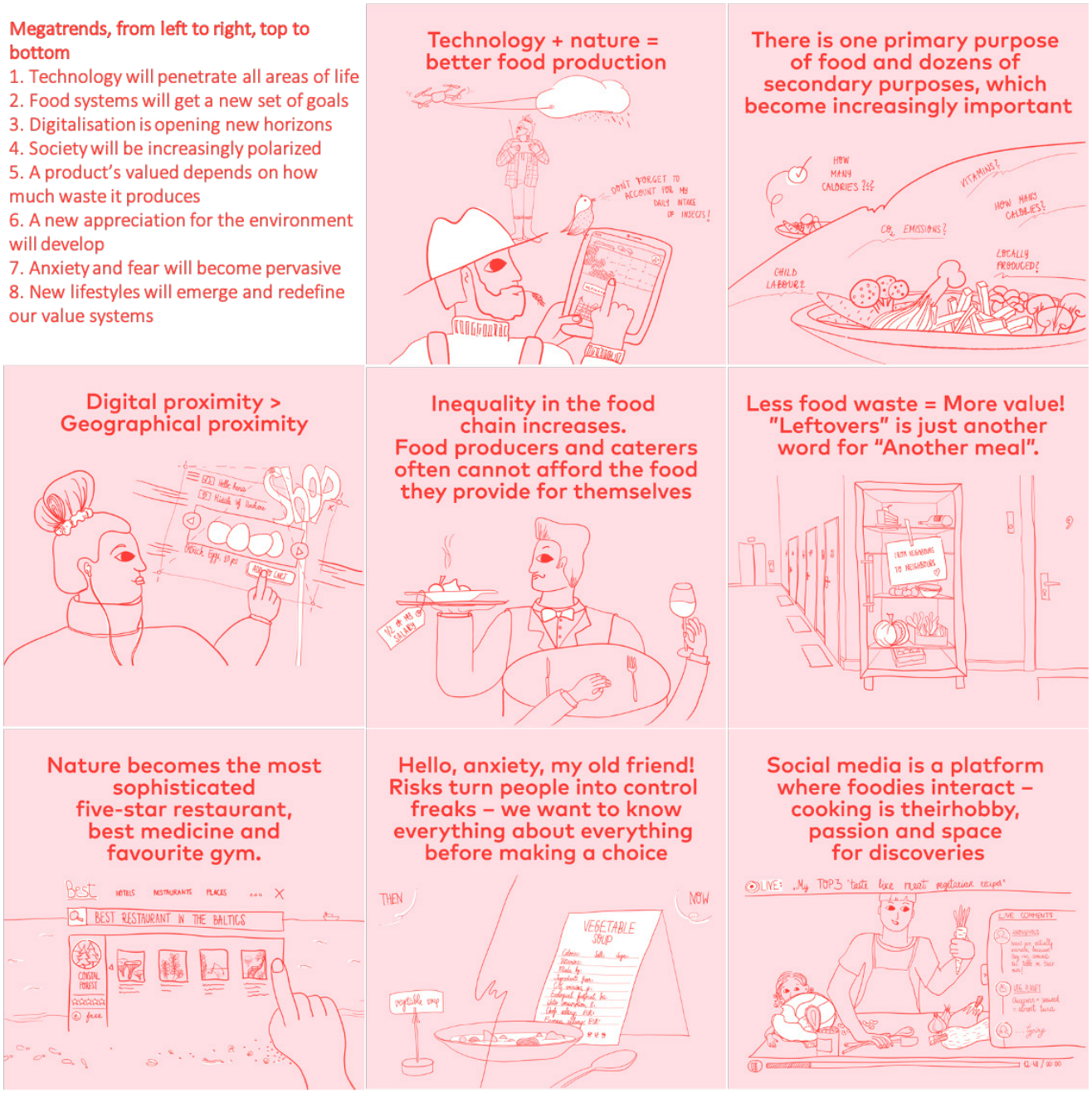

Figure 2. Eight megatrends that could impact the future of food systems in the Nordic Baltic region[2] Illustrations used from the open source media kit.

3. Scenario development and testing

A scenario is a story that aims to describe how the future could develop.[14] Scenarios are not predictions of the future,[14] and there is no one 'right' scenario that gives a picture of the future that will unfold. Rather, scenarios can be used to explore what possible futures might look like.[5] By thinking about the multiple ways that societies, food systems and ecological systems might develop, we can be better prepared for whatever the future might bring. In short, scenarios are a flexible tool that can be used to explore uncertainties in current and future food systems.

Scenarios come in many different forms. Exploratory scenario processes explore a range of possible futures. These scenarios can be a way to help stakeholders and decision-makers imagine the impact of multiple unpredictable drivers and set a policy agenda.[15] Other scenarios might aim for a particular end-point, known as 'target-seeking' scenarios. Figure 3 illustrates how different scenario types can be used to aid decision-making processes.

Scenarios can employ qualitative and/or quantitative methods in order to 'test' the impacts of a major change in a system. Qualitative techniques include the use of storytelling, imagination, metaphors and creativity.[16] For example, the current project used four qualitative scenarios, developed through stakeholder dialogue, as a basis for stakeholders to further imagine the social, environmental and economic impacts of those future food systems. However, scenarios can also be quantitatively tested using modeling approaches. For example, the EAT-Lancet Commission quantitatively assessed the health and environmental impacts of changes in diets, food loss and production practices.[6] Numerous research studies have modeled the environmental impacts of various shifts in diets at global and national scales.[17–19]

Different types of actors can be brought together to develop scenarios. Some scenario exercises are participatory in nature, engaging stakeholders to create scenarios that can then be tested in scientific models. The Future Nordic Diets project is one such example of a participatory scenario development process.[20] Further, the North Western Paths modeling project mentioned in Insight Paper #2 explores future food systems scenarios that stakeholders would like to see play out in the Nordic region. Other scenarios are developed by researchers and experts. There is no right or wrong group of people to develop scenarios. That said, some groups may be better at developing evidence-based scenarios, while others might produce more imaginative and creative scenarios.

Bookshelf:

- Shaping the Future of Global Food Systems: A Scenarios Analysis
- Future Nordic Diets: Exploring ways for sustainably feeding the Nordics
- Radical ocean futures-scenario development using science fiction prototyping

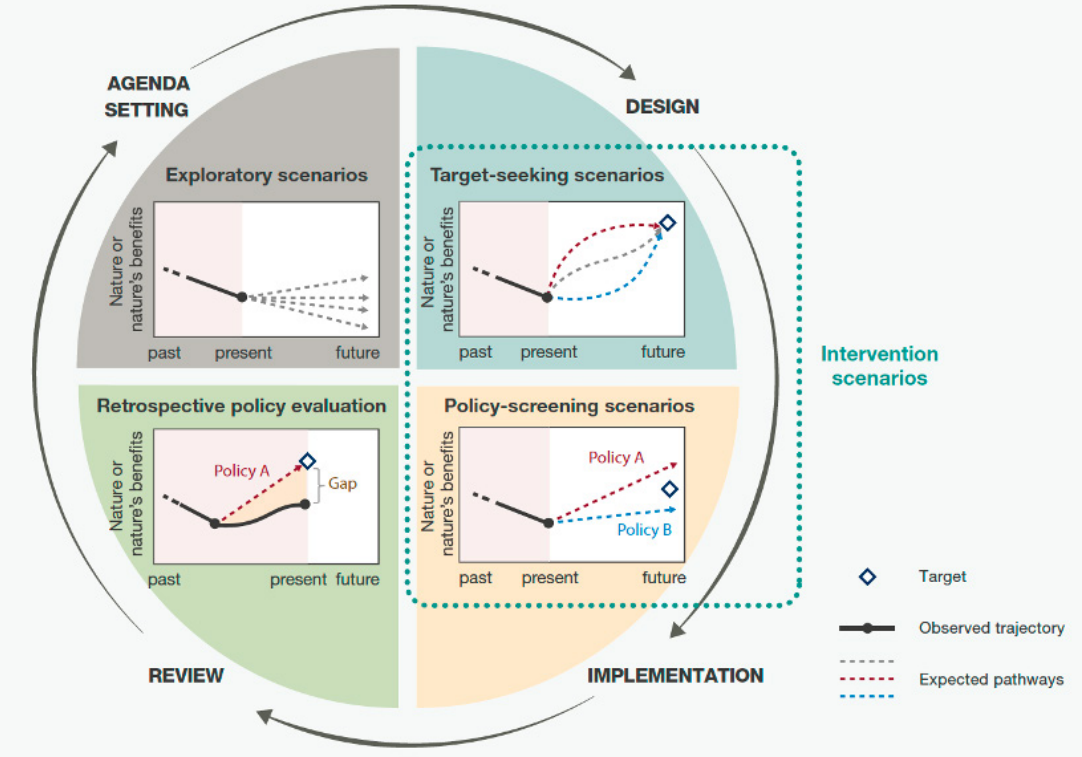

Figure 3. This figure illustrates the different types of scenarios (exploratory, target-seeking, policy-screening and retrospective policy evaluation scenarios) that could be useful in different parts of the policy-making process (simplified to agenda setting, design, implementation and review). This figure is reproduced from the 2016 IPBES report *The methodological assessment report on scenarios and models of biodiversity and ecosystem services*.[15]

4. Experimentation and living labs

Some uncertainties will persist until an event or phenomenon is actually experienced; just think back to the inherent uncertainties that were discussed above. In these situations, experimentation and living labs can be used to learn what would happen in a particular scenario.

Experimentation can come in many forms and can be undertaken by a range of food system actors. For example, a parent might experiment with new meals to see if her or his family will embrace dietary shifts. Businesses experiment with new products and ingredients, such as IKEA's veggie meatballs and Orkla's new line of climate-smart taco ingredients (Frankful brand). Retailers in Finland have experimented with 'happy hours' to sell food low-cost instead of sending it to the bin.[21] Policy makers experiment with innovative policies and targets, such as the city council in Helsinki that is adopting measures to halve the amount of meat and dairy products served in the city's public meals by 2025.[22]

Some experimental platforms are explicitly designed to bring food system actors together to co-create innovative solutions to food system challenges. For example, 'demonstrators' – most commonly discussed in the context of the mission-based approach – are experimentation testbeds designed to coordinate innovation across food systems actors towards a common goal.[23] Table 5 below outlines six essential qualities of successful demonstrators.

Table 5. The *Cookbook for systems change – Nordic innovation strategies for sustainable food systems* outlines the following six criteria for successful demonstrators, or experimentation testbeds.[23] Adapted with permission from the Cookbook authors.

Criteria	Description
Mission-oriented	Demonstrators translate the bold ambition and direction set by a societal mission into concrete, on-the-ground actions to provide proof that inclusive, fast and large-scale change is possible across a system.
Demand-led	Demonstrators start with a demand-led approach, working with organisations willing to take on responsibility for problems and become "problem owners" – city authorities, regional bodies, community organisations, government and industry leaders that are committed to the overall mission.
Place-based	Taking places as a starting point allows us to view the system through a local lens and understand what makes it unique, such as its culture, policy, law and economy. A clearly defined place creates boundaries within the system, allowing us to keep the local level in the foreground while also acknowledging all other levels in the background.
Iterative	Demonstrators progress in tightly designed, iterative processes. Demonstrators should mix innovation from the top down and the bottom up and combine mature projects with more experimental interventions.
Holistic	Demonstrators understand the parts of the system as being intimately interconnected and explicable only by reference to the whole. Experiments are not conducted in isolation from one another; multiple experiments are run in parallel to identify the types of interdependencies and synergies needed for transformation.
Grounded in citizen perspective	To successfully address social complexity, demonstrators are wise to acknowledge the perspectives and desired outcomes of citizens when designing experiments. Citizens should be framed as agents of change, not mere subjects of change.

Other experimental platforms aiming to achieve sustainable outcomes put citizens at the heart of the experimentation process, given that people are central to sustainable development. A living lab is one form of participatory experimentation that extends the traditional laboratory to the everyday settings where people live, make decisions and interact with each other (see www.enoll.org for examples). The idea behind living labs is to provide an environment for citizens to experiment and co-create innovation in a real-world setting.

All of these experimentation processes have one thing in common – they can reduce uncertainty by testing the impacts of interventions or decisions in real-world settings. Experiments don't aim to change the whole system. Rather, the focus on change within a sub-context within a system. This means that they are relatively low-risk and low-cost ways to explore various food system futures.

Bookshelf:

- Cookbook for systems change – Nordic innovation strategies for sustainable food systems
- FIT4FOOD2030 City Labs and Food Labs

5. Embedding resilience principles into food system development and policy

Resilience is the capacity of a system to deal with change and continue to develop.[24,25] In a food system, change comes in a lot of different forms. For example, change can result from deliberate decisions by individuals, such as a farmer who changes what she or he produces or an individual who changes her or his diet. Change can also be the result of large-scale shocks and disturbances, such as extreme weather events or foodborne disease outbreaks. Resilience enables systems to continue functioning and thriving, even in the face of uncertain changes.

But what really is resilience? And how do we know if our food systems are resilient? Researchers have developed seven principles of resilient systems,[26] and these principles have been applied to food systems. By embedding resilience principles into the way we develop and govern our food systems, our food systems will be better equipped to thrive in the face of uncertainty. Table 6 was developed by a researcher at the Stockholm Resilience Centre in order to demonstrate how the seven resilience principles could be applied to food systems in the Nordic region.[27]

Bookshelf of resources:

- What can the COVID-19 pandemic teach us about resilient Nordic food systems?
- Wayfinder tool for resilience assessments

Table 6. The seven resilience principles and applications in the Nordic food systems. Reprinted and adapted with permission from My Sellberg and co-authors.[27]

Principle	Description of the principle from resilience theory	Examples of potential applications in the Nordic food system
1. Maintain diversity and redundancy	Diversity in the components of a system, such as species, stakeholders or sources of knowledge, provides options for the future. Combined with redundancy, or overlap, in important functions, diversity allows components to compensate for the loss or failure of others.	Governments can ensure that policies, subsidies and rural development programs promote: – Different kinds of multi-cropping systems and polycultures, such as forest gardening, agroforestry etc. – Traditional crop varieties that are a source of genetic diversity. Some traditional grains varieties proved to be more tolerant in face of the 2018 drought, for example.[28]
2. Manage connectivity	Connectivity can be both god and bad. In a highly connected system, disturbances can spread faster, but connections can also facilitate recovery after a disturbance. Key is to be neither isolated from the outside world, nor completely dependent on it.	National governments can work at country and supranational levels (e.g. the EU) to ensure: – A higher degree of local-regional self-sufficiency, ***combined with*** access to global markets, which could provide preparedness both for distant and local shocks, e.g. disruptions in transport networks, as well as local crop failures.
3. Manage slow changes and feedbacks	A slow and gradual change in e.g. social trust, soil fertility, or environmental pollution, might go under the radar, but cause abrupt and irreversible damage if a so-called "tipping point" is reached. Understanding important feedbacks in a system helps to assess the effect of actions, since they can either reinforce or dampen change.	Researchers can develop and populate databases and governments can work to establish: – Environmental monitoring and understanding, e.g. of the state of the Baltic Sea, or levels of soil carbon and compaction in agricultural fields. – Transparency, certifications and traceability in food supply chains that help consumers assess the impact of consumer choices.

(continued)

Principle	Description of the principle from resilience theory	Examples of potential applications in the Nordic food system
4. Foster complexity and systems thinking	Often, we are trained to focus on the shorter-term interest of our respective sector or organisation and disregard future uncertainties. Building resilience means adopting an approach that acknowledges the inherent unpredictability of the systems we are working in and the interconnectedness of sustainability issues.	Research funders, research organisations, government agencies and ministries can: – Foster a systems perspective regarding food in governing bodies and in research, e.g. through funding for inter- and transdisciplinary research on sustainable food systems. – Develop cross-portfolio ministerial working groups on food systems. – Adopt a 'food in all policies' approach, similar to the better known 'health in all policies' approach.
5. Encourage learning	Through learning, experimentation and innovation we can adapt to new circumstances. This can be enhanced by drawing on different kinds of knowledge, learning from previous crises, and incorporating processes of continuous learning into our governance organisations.	Everyone can participate in: – Systems of monitoring, evaluation and learning in organisations, and a culture of learning - where there is space to reflect and learn, both from successes and mistakes. – Different kinds of "food labs" as spaces for experimentation.
6. Broaden participation	Broad and well-functioning participation has the potential to build trust and a shared understanding, which is fundamental for collaboration and collective action. It can also highlight important perspectives that might otherwise be overlooked.	All actors are needed for: – Broad participation and ownership in the development and implementation of food policies through citizens assemblies, collaborative governance structures, and public-private collaborations.
7. Promote polycentric governance	When several governing bodies on different levels work together, this provides an ability to coordinate actions in the face of change, and flexibility to deal with issues on the appropriate level.	Central and local governments, but also other quasi-governmental bodies, will be essential to: – Delegate power from national to local governments or districts to implement policies in a way that is adapted to their local context. – Draw on local "bridging organisations", such as Biosphere offices (UNESCO's Man and the Biosphere programme) or Leader organisations (EU rural development program) to link actors from local, to international levels, and enable collaborations across public and private sectors and civil society in a specific place.

Summary

This Insight Paper has explored some of the uncertainties on the road to food system transformation identified by dialogue participants. These uncertainties ranged from questions about how climate change and natural resource depletion will affect our ability to produce food in the future, to questions about how individuals would react to systemic shifts in food systems. It is no surprise then that nearly half of the dialogue participants felt that the pathways towards sustainable food systems are unclear (see Insight Paper #1).

One thing is certain: we need to put our food systems on a more sustainable trajectory. Navigating this pathway forward will not be easy. There will be trade-offs to balance, barriers to overcome and decisions to be made in the face of uncertainty. Yet if the Nordics want to deliver on their sustainability goals, food system transformation must be part of the solution.

References

1. Hawkes C. Five steps towards a global reset: lessons from COVID-19. *Global Sustainability*. 2020; 3.
2. Grivins M, Halloran A, Kale M. *Eight megatrends in Nordic-Baltic food systems*. Copenhagen: Nordic Council of Ministers; 2020.
3. WEF. The Fourth Industrial Revolution: what it means, how to respond, 2016. https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/
4. Herrero M, Thornton PK, Mason-D'Croz D, et al. Articulating the effect of food systems innovation on the Sustainable Development Goals. *Lancet Planetary Health*. 2020; 5(1):e50-e62.
5. Peterson GD, Cumming GS, Carpenter SR. Scenario planning: a tool for conservation in an uncertain world. *Conservation Biology*. 2003; 17:358–366.
6. Willett W, Rockström J, Loken B, et al. Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. *Lancet*. 2019; 393:447–492.
7. Swinburn B, Kraak V, Allender S, et al. The global syndemic of obesity, undernutrition, and climate change: the Lancet Commission report. *Lancet*. 2019; 393:791–846.
8. Micha R, Mannar V, Afshin A, et al. *Global nutrition report: action on equity to end malnutrition*. Bristol, UK: Development Initiatives; 2020.
9. Nordic Co-operation. Our Vision 2030, 2019. https://www.norden.org/en/declaration/our-vision-2030
10. Bodde M, Van der Wel K, Driessen P, et al. Strategies for dealing with uncertainties in strategic environmental assessment: An analytical framework illustrated with case studies from The Netherlands. *Sustainability* 2018; 10:2463.
11. Bengston, DN. Futures research methods and applications in natural resources. *Society and Natural Resources*. 2019; 32:1099–1113.
12. Sutherland WJ, Bailey MJ, Bainbridge IP, et al. Future novel threats and opportunities facing UK biodiversity identified by horizon scanning. *Journal of Applied Ecology*. 2008; 45:821-833.
13. Garnett K, Lickorish FA, Rocks SA, et al. Integrating horizon scanning and strategic risk prioritisation using a weight of evidence framework to inform policy decisions. *Science of the Total Environment*. 2016; 560:82–91.
14. Curry A, Schultz W. Roads less travelled: different methods, different futures. *Journal of Futures Studies*. 2009; 13:35–60.
15. IPBES. *The methodological assessment report on scenarios and models of biodiversity and ecosystem services*. Bon, Germany: Secretariat of the intergovernmental science-policy platform on biodiversity and ecosystem services; 2016.
16. Merrie A, Keys P, Metian M, et al. Radical ocean futures-scenario development using science fiction prototyping. *Futures*. 2018; 95:22–32.
17. Springmann M, Clark M, Mason-D'Croz D, et al. Options for keeping the food system within environmental limits. *Nature*. 2018; 562(7728):519-525.
18. Röös E, Patel M, Spångberg J, et al. Limiting livestock production to pasture and by-products in a search for sustainable diets. *Food Policy*. 2016; 58:1–13.
19. Moberg E, Karlsson Potter H, Wood A, et al. Benchmarking the Swedish Diet Relative to Global and National Environmental Targets – Identification of Indicator Limitations and Data Gaps. *Sustainability*. 2020; 12:1407.
20. Karlsson JO, Carlsson G, Lindberg M, et al. Designing a future food vision for the Nordics through a participatory modeling approach. *Agronomy for Sustainable Development*. 2018; 38:1-10.
21. Broom D. 900 Finnish supermarkets are redefining 'happy hour' to reduce wastage, 2019. https://www.weforum.org/agenda/2019/10/these-finnish-supermarkets-have-a-happy-hour-to-stop-food-waste/#:~:text=But%20for%20one%20hour%20every,are%20sold%20at%20big%20discounts.
22. City of Helsinki. Valtuutettu Atte Harjanteen aloite liha- ja maitotuotteiden kulutuksen puolittamiseksi vuoteen 2025 mennessä, 2018. https://dev.hel.fi/paatokset/asia/hel-2018-006850/khs-2019-3/
23. Halloran A, Wood A, Aguirre F, et al. Cookbook for systems change–Nordic innovation strategies for sustainable food systems. Copenhagen: Nordic Council of Ministers; 2020.
24. Holling CS. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*. 1973; 4(1):1–23.
25. Folke C, Carpenter SR, Walker B, et al. Resilience thinking: integrating resilience, adaptability and transformability. E*cology and Society*. 2010; 15(4).
26. Biggs R, Schlüter M, Schoon ML. *Principles for building resilience: sustaining ecosystem services in social-ecological systems*. Cambridge University Press; 2015.
27. Halloran A, Wood A, Sellberg M. *What can the COVID-19 pandemic teach us about resilient Nordic food systems?* Copenhagen: Nordic Council of Ministers; 2020.
28. Gerhardt K, Wallman D, Axelsson Linkowski W. Äldre sorters spannmål och extremvädret 2018 – hur gick det? Uppsala: SLU Future Food; 2019.

About this Series

The Stockholm Resilience Centre will release a multi-part series of Insight Papers related to Nordic food system transformation dialogues. Each Insight Paper focuses on a central theme or finding that emerged from the dialogues. All Insight Papers can be found on the Stockholm Resilience website: www.stockholmresilience.org.

CONTACT US: The Stockholm Resilience Centre at Stockholm University coordinated and executed this project, with Dr. Line Gordon as the Lead Investigator and Dr. Amanda Wood as the Project Manager. Dr. Afton Halloran facilitated the dialogues. Please reach out to Amanda with any questions or comments – amanda.wood@su.se, +46 73 460 4657.

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