Food and Agriculture Organization of the United Nations

FOOD SAFETY AND QUALITY PROGRAMME

Horizon Scanning and Foresight

An overview of approaches and possible applications in Food Safety

(emphasis on possible applications by FAO's Food Safety Program)

Background paper 2

FAO Early Warning/Rapid Alert and Horizon Scanning

Food Safety Technical Workshop

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Rome, 22-25 October, 2013

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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***For brevity reasons: all references including list of references are removed from this version of the report.**

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Glossary

Term	Definition
Driver	A driver references the underlying cause of change. These may or may not be directly related to the issue at hand. Some examples of key drivers specific to food safety include globalization, changing demographics, farming intensification etc.
Early Warning Rapid Alert Systems	EWRA systems are systems that predict or detect issues (often outbreaks of disease) of potential serious consequence early on in the epidemiologic curve. The rapid alert portion to the system provides information to the public or key stakeholders in a quick fashion to allow for timely response to the issue identified. These are generally associated with ongoing and known hazards and do not predict potential emerging risks.
Emerging Risk	EFSA defines an emerging risk as a "…risk resulting from a newly identified hazard to which a significant exposure may occur or from an unexpected new or increased significant exposure and/or susceptibility to a known hazard." [1]
Food Safety	Defined by Codex Alimentarius as "… assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use." [2]
Foresight	A collection of forward-thinking methodologies that are generally applied to improve institutional planning or policy making for potential future situations, hazards or opportunities.
Futures Methodology	A set of methodologies that can be used singly or in combination to provide insights about potential futures and trends. Also known as Foresight methodologies.
Hazard (related to food safety)	As defined by Codex Alimentarius, a Hazard is a "…biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect."[3]
Horizon Scanning (HS)	A specific foresight methodology that utilizes various steps to identify issues at the edge of current thinking that may have significant impact in the medium to long term future.
Indicator	EFSA defines an indicator as a "…measurement and / or observation that is reliable, sensitive, quantifiable and provides information on the nature of a hazard and a source of a risk." [4]

[1] European Food Safety Agency. *Definition and Description of "Emerging Risks" within the EFSA Mandate*.Parma: n.p., 10 July 2007. Print.

[2] Codex Alimentarius. "General Principles of Food Hygiene." 1969. http://www.codexalimentarius.org/download/standards/23/CXP_001e.pdf

3 "Codex Alimentarius Commission Procedural Manual" Definitions of Risk Analysis Terms related to Food Safety. Pg 114 Joint FAO/WHO Food Standards Program. Web. 8 Oct. 2013. <ftp://ftp.fao.org/codex/Publications/ProcManuals/Manual_21e.pdf>.

Risk (related to food safety)	Codex Alimentarius defines Risk as a "…function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard in food."[5]
Risk Analysis	Codex Alimentarius defines Risk Analysis as "A process consisting of three components: Risk Assessment, Risk Management and Risk Communication" [4]
Risk Assessment	Codex Alimentarius defines Risk Assessment as "A scientifically based process consisting of the following steps: (i) hazard identification, (ii) hazard characterization, (iii) exposure assessment, and (iv) risk characterization"[4]
Risk Management	Codex Alimentarius defines risk management as "…the process, distinct from risk assessment, of weighing policy alternatives, in consultation with all interested parties, considering risk assessment and other factors relevant for the health protection of consumers and for the promotion of fair trade practices, and, if needed, selecting appropriate prevention and control options."[4]
Risk Communication	Codex Alimentarius defines risk communication as "…the interactive exchange of information and opinions throughout the risk analysis process concerning risk, risk-related factors and risk perceptions, among risk assessors, risk managers, consumers, industry, the academic community and other interested parties, including the explanation of risk assessment findings and the basis of risk management decisions." [4]
Trend	A directional assessment of something that is changing or developing over time. Often this is a result of specific drivers. For example, as a result of the driver "globalization," there is increasing demand for ethnic or specialty foods across the globe.
Wild Card	This is a term used specifically related to foresight work and can be described as an event that has a very low probability of occurring, but a very high impact. These could include things like natural disasters, world wars, emergence of new deadly viruses etc. While these are low probability, it is important for them to be considered in foresight work as they do have a high impact on future scenarios.
Weak Signal	These are generally understood as current or past developments with unclear implications to future developments. These may or may not be relevant and are generally difficult to identify. For example, changing public attitudes towards an issue could be considered a weak signal that may change slowly over time. Relevant weak signals are essential to foresight work.

[4] European Food Safety Agency. *Definition and Description of "Emerging Risks" within the EFSA Mandate*.Parma: n.p., 10 July 2007. Print.

Definitions of Foresight, Futures, and Horizon Scanning within the context of this paper:

There is much overlap between the terms futures, foresight and horizon scanning within the literature. Our main goal for this background document was to better understand Horizon Scanning (HS) within the context of food safety. When performing the review, we noted that additional Foresight methodologies (which includes horizon scanning) were highly pertinent and expanded the rapid literature review to include basic understanding of the broader foresight methodologies. For this reason, much of the document discusses Horizon Scanning and Foresight (HSF) together but it is important to note that HS is actually a method of Foresight. Within the document, HS generally refers to methodological approaches that scan or review various data sources, while Foresight generally refers to the wider group of more participatory methods.

"Future methodology" is another term used interchangeably with foresight, and for this reason is used at times within the document to denote foresight methodologies.

Executive summary

Background and objectives: Many factors inside and outside the food production system(s) could directly and/or indirectly drive the emergence of important food safety hazards, risks and issues. It is important to identify these events at an early stage of the system or preferably prevent their occurrence. To improve food control systems at any level, the food control paradigm has shifted from reactionary to preventative (predictive) approaches. Effective monitoring of important drivers of change that could contribute to the emergence of important hazards or issues is necessary at the global, regional, and/or country-level. Traditionally, various surveillance approaches and tools are used to identify and assess potential hazards, risks and issues and to provide recommendations for potential actions. While these traditional approaches are reasonably effective to identify immediate hazards and issues, there is a need to also predict important medium to long-term issues to allow for effective preventative actions. Horizon scanning/foresight/future scenario methodologies or approaches have been widely used across different sectors for many years, and more recently in food safety to identify potential medium and long-term hazards and opportunities.

The main aim of this background paper is to provide:

- a brief overview of horizon scanning/foresight (HSF) methods and reported knowledge on their use in food safety
- a brief overview of the current use of HSF and similar/related activities across FAO technical units
- To stimulate discussion on aspects of HSF at the upcoming FAO technical workshop (Rome, October 22nd -25th, 2013).

Methods: We conducted a rapid structured review of publicly available knowledge to better understand HSF approaches and methods in general, their specific use in food safety and related "one health" fields. Concurrently, we administered a questionnaire and performed semi-structured interviews to 24respondents from 9 technical units to understand HSF use within FAO and learn from their experience.

Key findings

Review highlights: The most commonly used definition of **Horizon scanning (HS)** is the United Kingdom's Department for Environment, Food and Rural Affairs (DEFRA). DEFRA defines HS as "*…the systematic examination of potential hazards, opportunities and likely future developments which are at the margins of current thinking and planning. Horizon scanning may explore novel and unexpected issues as well as persistent problems or trends*"

Foresight is often defined as *"…an approach and a process which requires broad thinking and results in the generation of multiple scenarios and ideas. Some of these ideas must then be further developed and implemented into policy and subsequent action."* The European Foresight Platform further describes futures work as *"…a conceptual framework for a number of forward looking approaches to informed decision making that includes long term considerations".* Popper defines foresight within the food sector as "*Systematic, participatory, prospective and policy oriented process which, with the support of environmental and horizon scanning approaches is aimed to actively engage key* stakeholders into a wide range of activities..." A list of frequently reported definitions is shown in Appendix 1.

HSF methodologies include a wide range of qualitative and quantitative methods and are generally applied to identify plausible futures to allow governmental organizations to be better prepared for future changes, identify key drivers of change and trends, evaluate the need for action in support of policy changes and identify key questions for targeted research. Horizon scanning can be conceptualized as a very early warning or early identification system that identifies trends, opportunities or hazards significantly early in their development, 5-10-20 years before the issues become mainstream. HS is generally understood as a particular method of Foresight. It is import to distinguish between HS and surveillance-based early warning systems. HS is generally envisioned as a continuous or periodic structured activity aimed at identifying medium to longer-term key important risks and issues. HS typically includes identification of drivers, screening of selected data sources, and evaluation of risks and communication of risks with those that should consider/take potential action.

HSF have been relatively rarely and more recently used in food safety, mostly in some developed regions and countries, to identify potential emerging risks and issues in food safety and future policy development. Foresight methodologies have been utilized to identify the most promising emerging technologies in food safety such as smart packaging and nanotechnology to improve traceability. A summary description of organizations with reported HSF activities in food safety is shown in Appendix 4. Based on reported knowledge, there is still a lack of clarity on how screening of different sources is linked with analysis for important food safety drivers and translated into transparent risk assessment and effective communication with end-users. It should be clarified whether HSF is effective for identifying medium-to-long term issues and opportunities in food safety. It is not clear whether overall effectiveness evaluations have not been performed or whether they have not been reported publicly. Significant resources are required to apply systematic and continuous HS in food safety, and other foresight methodologies can be both time and resource intensive.

Questionnaire-interviews highlights: The majority of the FAO's technical divisions use some form of mixed-HSF activities to identify short and medium term emerging issues and opportunities at the global, regional and/or country levels. Some divisions are also monitoring longer term emerging issues such as changes in population and income, climate change impact and wood supply. Data are collected either in semi-structured or ad hoc manners. Issues are frequently prioritized at the technical division level and discussed/verified through consensus expert meetings. General approach applied across almost all technical divisions is a mixed approach that includes some form of scanning of web based sources (structured and/or unstructured), periodic survey administration, periodic reporting based on on-going project results, and different ranges of consultations through regular or ad-hoc expert/people networks. The respondents indicated that the main benefits of this approach are access to multiple sources of data; flexibility of approach to adapt to innovations and urgent needs, and regular interactions with and between the countries, regions and the scientific community. Important challenges are lack of resources (human and financial) to conduct HSF in a more structured way and on a more regular basis; difficulty to evaluate impact of HSF and lack of sound prioritization process. Many respondents indicated that FAO would benefit from/should invest in broader cross divisional and multi-disciplinary HS activities at organizational level.

Looking forward

Early identification, evaluation and prioritization of short and medium-long term issues are critical in the food safety decision making process. HSF has the potential to support this process by

improving strategic planning, identifying specific emerging risk and opportunities, and keeping a handle on how the food safety context is changing over the course of time.

In order to move towards a more systematic approach to identify short and medium term risks and opportunities, the Food Safety Unit will greatly benefit from experts' advice to identify the most promising and applicable methodologies for HSF. In doing this some issues will need to be considered:

Identify and address the challenges surrounding HSF application in Food Safety:

- Discussing and clarifying whether transparent methodological frameworks (or simply procedures) exist, and how they could be adopted or modified to establish effective and pragmatic horizon scanning process in food safety.
- Gaining knowledge and evidence of any clear benefits or success related to the use of HSF in food safety

Consider the needs of end-users

- FAO member countries: ensuring that information and intelligence generated by the HSF can effectively inform relevant national authorities - particularly in developing countries - on how to be more prepared to face emerging risks as well as to optimize benefits from new opportunities.
- FAO Food Safety Program: considering how HSF could support our Unit in improving strategic planning, and prioritizing potential future global work in the area of food safety.
- Collaborators: ensuring that synergies with partners are optimized by gaining insights form leading players in HSF, and at the same time contributing to HSF global intelligence through the long FAO food safety experience at global, regional and national level as well as through complementary data sources.

Identify ways to overcome the challenges

- Exploring opportunities offered by a mixed HSF approach – i.e. combining more than one method and different approaches. Selection of the most appropriate methods for food safety will need to be made pragmatically on the basis of efficacy as well as time and resources requirements.
- Establishing strategic partnerships with key national and regional organizations currently involved in HSF.
- Exploring opportunities for implementing HSF pilot's studies in collaboration with selected partners, to develop, implement and evaluate an operational FAO framework for HSF in Food Safety.

Purpose and scope

The purpose of this background paper is to stimulate discussion among the participants of the upcoming FAO technical workshop (Rome, October 22nd -25th, 2013).
This report provides brief:

- overview of reported knowledge on Horizon Scanning and Foresight (HSF) approaches and methodologies and specifically on their use in food safety **(Part I)**
- overview of the current use of these approaches and methodologies within FAO **(not food safety specific) Part II)**

The report coupled with captured insights and feedback from the workshop participants will be used to inform decisions on whether and how HSF approaches could be undertaken to better meet the needs of the FAO Food Safety Program target audience or beneficiaries, collaborators and itself.

Background and rationale

Many factors inside and outside the food production system(s) could directly and/or indirectly drive the emergence of important food safety hazards, risks and issues. It is important to identify these at an early stage or preferably to prevent their occurrence. The food control paradigm has rapidly evolved from typical reactionary to preventative approaches to ensure safe food production and consumer protection. The performance of such preventative systems should be monitored at every level. This includes monitoring of drivers of change or signals, not only short, but also medium and longer term, which could contribute to the emergence of important hazards and issues at the global, regional, or country-level. Traditionally, various surveillance approaches and tools are used to identify and assess potential hazards, risks and issues and to provide recommendations for potential actions. While these traditional approaches are reasonably effective to identify immediate hazards and issues, there is a need to also predict important medium to long-term issues to allow for effective preventative actions.
HSF methodologies or approaches include a wide range of qualitative and quantitative methods. These have been used across different sectors for many years, and more recently in food safety to monitor and evaluate important drivers of change and identify potential medium and long-term hazards and opportunities.

Below we briefly describe **some** of "drivers of change" that could be relevant to food safety.

1. ***Globalization of trade****:* Food safety must be considered within a global context that is dynamic and evolving as part of the globalization process: increased international trade, more integrated markets, more rapid adoption of new technologies, increased market concentration and information transfer, can all have important implications, both positive and negative, in food safety. Globalization of food trade requires the development of a more integrated and preventive approach within food safety systems. As international trade in food and farm products increases, it will become increasingly difficult to resolve food safety problems of any one country without collaborative international efforts to develop integrated, preventive strategies.

2. ***Climate change:*** Climate change, perhaps the most compelling environmental issue of our time, is affecting patterns of occurrence of food safety hazards. For example: increased frequency of inland flood leading to higher chemical contamination of agricultural and pastureland soil; ocean warming

contributing to harmful algal blooms; residues of pesticides in plant products affected by changes in pest pressure; and increased mycotoxin contamination of crops pre- and post-harvest.

In order to identify, and proactively address the challenges posed by climate change to food safety, it will be important to strengthen systems of integrated disease surveillance and to develop models that allow better understanding of the direct and indirect impacts on food safety hazards of selected environmental factors that are affected by climate change.

3. ***New technologies:*** The increasing role of new and emerging technologies in food production, post-harvest treatment, processing, packaging and sanitary treatment is also significant in the context of food safety and more globalised food trade. New technologies like nanotechnologies for example are expected to play a big role in addressing food safety challenges but at the same time may also bring potential new risks to both human and environmental health.

4. ***Scientific progress:*** Technical and scientific innovation has multiple impacts on food safety and its management. More sensitive detection methods are providing new tools for investigating and indeed discovering new food safety hazards. Recent advances in food safety related sciences give us a better understanding of food-borne disease, and the role played by some so-called emerging food contaminants (including pharmaceuticals, veterinary medicines, degradates and personal care products) in the etiology of some pathologies and disorders.

5. ***Urbanization:*** With the global population growing there is a sustained trend of migration from rural to urban areas. Cities (and surrounding areas) are increasingly becoming places where food is produced (i.e. urban and peri-urban agriculture). This plays an important role in how people procure food, what people eat, the nature of food traded and the interactions among food systems, people and the environment.

6. ***Public attention to food safety:*** Increasing public awareness of food safety hazards, concern over hazards to health attributable to food hazards and reduced confidence in the ability of current food supply systems to manage food safety risks are additional factors to be considered in the food safety evolving context.

Why consider doing Horizon Scanning and Foresight in Food Safety?

Food safety is frequently indicated as important national and global priority. Still, food safety incidents and emergencies continue to frequently occur resulting in devastating public health and trade impacts both in developed and developing countries. There is clearly a need to ensure early identification of emerging and important food safety issues before they become real risks. This will ensure development and implementation of effective preventative and/or corrective actions.

HSF methodologies or approaches have been used in some sectors (i.e., business planning and health technology assessments) for a while and relatively rarely and more recently in food safety. Agencies and institutions like Canadian Food Inspection Agency, the European Food Safety Authority (EFSA), the UK Department for Environment, Food and Rural Affairs (DEFRA) in collaboration with the Cranfield University, and the UK Food Standards Agency (FSA) have been using different aspects of HSF approaches over the past 5-10 years. It is good timing to gather these organizations at the forthcoming workshop and to learn from their experience.

Methods

We conducted: 1) rapid structured review of publicly available information to better understand HSF approaches and methods in general, and their specific use in food safety and related "one health" field and 2) we administered the questionnaire and semi-structured interviews to 24respondents from 9 technical units to understand the current HSF use within FAO and to learn from their experience.

Part I: A rapid, structured review of publicly available literature reporting the use of HSF methodologies in food safety/one health related sector was conducted to answer the following questions:

- *What is meant by horizon scanning, foresight and related terms (e.g. environmental scanning), with specific focus on Food Safety?*
- *What is the current state of knowledge and application of these methodologies and approaches in different sectors?*
- *What is their potential applicability to food safety or closely related 'one health' fields?*

A priori, due to short project timelines (one month) and limited available manpower, it was decided to not use a full scope robust systematic review, but to apply the principles of rapid structured review. A total of 83 relevant articles were reviewed, including 23 more relevant to food safety. These included reports, articles (peer-reviewed and grey) and power point presentations. The reported data and information were systematically evaluated, extracted and summarized by one reviewer.

Part II: We:

- Identified FAO technical departments/ divisions/units that might be doing HSF in areas related or potentially relevant to food safety, and confirmed respondents on behalf of those groups
- Administered questionnaire-interviews to 24 respondents from 9 FAO technical divisions (response frequency = 81%).
- Analyzed data using descriptive/thematic analysis.

Key findings

For brevity reasons we report only key findings of this study.

Part I: Rapid structured review

Definitions and use of HSF

The main HS definitions identified across the sectors are shown in **Appendix 1**. The most commonly used definition of HS applicable to food safety is the definition coined by the United Kingdom's Department for Environment, Food and Rural Affairs (DEFRA). DEFRA defines horizon scanning as "*…the systematic examination of potential hazards, opportunities and likely future developments which are at the margins of current thinking and planning. Horizon scanning may explore novel and unexpected issues as well as persistent problems or trends*".

HS is most frequently applied in business, health technology assessment and environmental sectors and there is variability between definitions used across the sectors, and in some cases the term "environmental scanning" and "identification of emerging risks" is used interchangeably with "horizon scanning." Horizon scanning can be conceptualized as a very early warning or early identification system that identifies trends, opportunities or hazards significantly early in their development, 5-10-20 years before the issues become mainstream. Horizon scanning is generally understood as a particular method of Foresight (see below).

Foresight is often defined as *"…an approach and a process which requires broad thinking and results in the generation of multiple scenarios and ideas. Some of these ideas must then be further developed and implemented into policy and subsequent action".* The European Foresight Platform further describes futures work as *"…a conceptual framework for a number of forward looking approaches to informed decision making that includes long term considerations"* Popper defines foresight within the food sector as "*Systematic, participatory, prospective and policy oriented process which, with the support of environmental and horizon scanning approaches is aimed to actively engage key stakeholders into a wide range of activities…*"

Foresight challenges governments and organizations to think about multiple probable (and some improbable) futures to improve preparedness, policy making and decision making across a wide range of potential outcomes. For additional definitions of foresight, please refer to **Appendix 1**.

Brief overview of HS methodologies

An overview of methodologies utilized related to horizon scanning across all disciplines is shown in **Appendix 2**. HS's objective is not to predict the future but to assist current decision-makers to produce strategies and plans that are sufficiently flexible and adaptable to remain robust in a range of possible plausible futures that have been identified within the exercise. Its major purpose is therefore to inform and direct future policy initiatives and identify longer term hazards or opportunities. The most commonly identified use for HS was ***to support improved policy making that is sensitive to multiple potential futures***. HS applications include: intelligence gathering, priority setting for science and technology research and innovation investments, benchmarking and organizational learning. It is generally agreed that focused HS is best utilized as a continuous activity that takes up a considerable amount of time to identify trends over time.

HS can be divided into two different types based on the goals of the horizon scan:

- ***Issue Centered*** HS identifies signals that support future narratives for policies. These are generally quite focused processes that highlight an issue that shows potential great impact with a need to act in present day.

- ***Exploratory Scanning*** which identifies various types of signals with an open search profile. The results of an exploratory scanning profile are much broader than Issue Centered HS, and more likely applicable to a wide range of future food safety hazards and opportunities.

HS should utilize inputs from key reliable sources and be checked on a regular basis to identify those issues at the margins of current thinking. This can be done through literature reviews of previous work, expert input, reviewing of conference materials, etc. and can be time and cost intensive. While some of the procedures for identification of emerging issues can be automated (i.e. with IT tools and software), expert advice still plays an essential role in the formulation of search criteria, the subsequent interpretation of search outcomes and the selection of those signals that require further assessment and consideration by food safety professionals.

Brief overview of Foresight methodologies

Foresight methodologies differ from general "early warning" methods which seek to identify an issue that will most likely occur, or is already occurring. Early warning systems are often geared at responding rapidly to outbreaks of disease, or even going so far as to predict when or where outbreaks might occur based on climatic conditions, weather patterns, or known vector habitat distribution among other things generally on a seasonal or annual basis. Foresight depends on identifying multiple potential futures before they have occurred, often 5-10 years in advance, and is not necessarily a prediction for something that will occur.

The main uses or goals of foresight as described by Damrongchai include strategic planning, improved decision-making and evaluation, establishment of technological targets when utilized for technology assessments, team-building, influencing public attitudes, agenda-setting, generating policy options, formulating a vision for the future, form coalitions across stakeholder groups, and mapping policy effects in advance. The use of foresight methodologies is quite wide, and the utilization of particular methodologies will vary based on the desired outcome of the exercise.

Commonly used methodologies for Foresight includes Horizon scanning and vary from highly qualitative to highly quantitative. These methods are listed in **Table 1** below. A more in depth description of these methods is in **Appendix 3**.

Table 1: Commonly used foresight methods based on a classification modified and extended from Rafael Popper (2008)[6].

Qualitative	Quantitative	Semi-quantitative
Methods providing meaning to events and perceptions. Such interpretations tend to be based on subjectivity or creativity often difficult to corroborate (e.g. brainstorming, interviews)	Methods measuring variables and apply statistical analyses, using or generating reliable and valid data (e.g. economic indicators)	Methods which apply mathematical principles to quantify subjectivity, rational judgments and viewpoints of experts and commentators (i.e. weighting opinions)
1. Backcasting 2. Brainstorming 3. Citizens panels	1. Agent based modeling 2. Benchmarking 3. Indicators	1. Cross-impact / structural analysis 2. Delphi

[6] Popper, R. 2008. Foresight Methodology, in Georghiou, L., Cassingena, J., Keenan, M., Miles, I. and Popper, R. (eds.), The Handbook of Technology Foresight, Edward Elgar, Cheltenham, pp. 44-88.

4. Conferences/workshops 5. Essays /Scenario writing 6. Expert panels 7. Genius forecasting 8. Interviews 9. Literature review 10. Morphological analysis 11. Relevance trees /logic charts 12. Role play / Acting 13. Horizon Scanning 14. Scenario workshops 15. Science fictioning (SF) 16. Simulation gaming 17. Surveys 18. SWOT analysis 19. Weak signals /Wildcards	4. Bibliometrics 5. Patent analysis (e.g. technology forecasting) 6. Time series analysis (e.g. trends) 7. Econometrics 8. Simulation models	3. Key / Critical technologies 4. Multi-criteria analysis 5. Polling / Voting 6. Quantitative scenarios / SMIC* 7. Road mapping 8. Stakeholder analysis 9. Mixing econometrics, simulation models and qualitative methods *SMIC = Cross Impact Systems and Matrices

Horizon Scanning and Foresight in Food Safety/Related fields

HS methodologies have been applied to emerging food safety risks mainly in the EU by UK DEFRA, UK FSA, EFSA, and Cranfield University. A list of main institutions/organizations involved in HSF activities with a focus on food safety or closely related field can be found in **Appendix 4.**

EFSA has been identifying emerging food safety risks through a combination of expert input and desk review (i.e. literature review). EFSA EMRISK refers to a "pre-early warning system" that utilizes all the facets of HS and utilizes information both inside and outside the food chain to identify the most influential sectors related to food safety.

The Food Standards Agency (FSA) in the UK is apparently using a mix of different approaches. HS, based on monitoring specific drivers of change, specifically for issues related to food safety has been implemented by Cranfield University on behalf of the UK Food Standards Agency **Table 2**).

Table 2: Key trends in food safety as identified by Cranfield University

Key foresight trends related to food safety
1. Global meat production has tripled and will continue to grow to double the present level by 2050
2. Consumption of livestock in emerging economies is growing significantly.
3. Increased production of livestock markets
4. Growing demand for locally produced product in developed countries
5. Increased amount of animal and plant production at the household level
6. Increased requests for special products (i.e. halal, kosher, vegetarian etc.).
7. Advancements in technology

FSA's National Intelligence Model (NIM) is a proactive HS approach utilized by the agency to identify patterns and trends related to food safety intelligence. At this stage it appears that the NIM, when applied to food safety, is associated with identifying food fraud. While this tool has the potential to be useful for issues in the long term, it does appear to be focused on emerging risks in the short term.

Food safety programs have generally utilized foresight methodologies to identify emerging risks to food safety and for future policy development. In some circumstances, foresight methodologies have been utilized to identify the most promising emerging technologies in food safety such as smart packaging and nanotechnology to improve traceability.

Leatherhead Food Research is a company which provides targeted food and beverage research to members in addition to regular tools for food research. One of the tools offered by the company is known as the Foodline Web-FERA Horizon Scan which is a global food safety monitoring tool. This tool provides users with hazard and risk assessments for specific commodities, and countries can be checked for known problems. Specifically related to HS, the company performs scans for emerging issues over the past 14-31 days. While this will not provide information for long term issues, this does provide useful information for issues in the short term. Costs for utilizing these tools vary, but can go up to USD 20,350 for unlimited use for one year.

Of interest to food safety is the project entitled "Promoting Food Safety through a New Integrated Risk Analysis Approach for Foods" (SAFEFOODS), a four year project that ended in 2008. While the work was global and included institutions from 21 nations, the focus of the project was not on methodologies of foresight but identifying how specific methodologies of risk analysis or early warning systems could be applied to improving food safety. One of the reports supported through the SAFEFOODS project could be classified as foresight as it looks at trends related to climate change and the possible effect those changes may have in the future. SAFEFOODS work could be a strong link or basis for applying foresight methodologies to identify food safety issues in the long term.

Canadians have reported the use of foresight within the context of animal health emergency management. This occurred through the Fore-CAN project, or Foresight in Canadian Animal Health. This project occurred from 2008-2011 and worked to identify potential futures that would have a

significant impact in animal health and production. The project included input from a wide variety of stakeholders representing government, industry and educational institutions encompassing 40 organizations and over 300 participants. The outputs of the nearly three year project included 5 key areas for further support and development and a specific road map for reaching a future that safeguarded human and animal health up to the year 2025.

Additionally in Canada a study entitled "Global Realities Scenario Project" was implemented presenting plausible futures and results of a specific scenario analysis. The main purpose of this project was to provide longer term thinking about global drivers of change and the emergence of health risks and opportunities to populations in Canada. Steps to this exercise in foresight included a horizon scan (although called an environmental scan in this project), literature review, expert interviews and final driver analysis. Scenarios were built using morphological analyses which created three plausible futures for presentation and discussion by policy makers.

The European Cooperation in Science and Technology (COST) Foresight 2030 workshop is a good example of scenario building with an emphasis on food safety. The workshop occurred in 2009 with a goal of identifying key future technology developments with an impact on food security. The three pillars of food security were defined as food availability, food accessibility and *food safety*. The workshop brought together a wide range of professionals to discuss in detail matrix scenarios created by the contrast of two issues: 1) the integration of European food systems with the global market and 2) access to Information and Communication Technologies (ICT) solutions. The best case scenario (high integration of the European food system with the global market and high access to ICT solutions) was further discussed in working groups to identify potential future technologies and the impact these will have on food security. The workshop identified key high level recommendations for ICT development including: ubiquitous access to technology, education and skill development across agricultural sectors, cross-cultural content development for ICT learning solutions and multidisciplinary research into technology applied to the three pillars of food security.

Effectiveness and limitations of FHS

Little publicly accessible information is available on the performance of HSF. It is not clear whether such evaluations have not been performed or whether they have not been published. Part of the explanation could be that as HSF methodologies are used to identify potential futures in the medium to long term, it is difficult to evaluate the effectiveness of a foresight program. Additionally, as these methods have only recently been adopted into government strategic planning, and specifically into food safety and public health fields, there has not been enough time to evaluate their performance. Nevertheless, defining sets of criteria to evaluate the performance of HSF is a prerequisite to justify the investments made.

There have been limited studies reviewing specific effectiveness or benefits gained by the use of these methods, and the results have been contradictory. Generally speaking, foresight work with the goal of improving strategic planning and policies has been successful, while success of foresight work for health technology assessments has been highly variable.

One of the challenges of HSF is that as they might be quite time and resource consuming, effort could be diverted from current true concerns to false alarms, and while the process can be made as comprehensive and rigorous as possible, there will always be a subjective element. The challenges of Foresight and horizon scanning also include obtaining relevant and credible evidence, and using it to priorities the response

O'Malley and Jordan (2009) reviewed the effectiveness of HS of new and emerging technologies as compared to other technology identification methods that were used concurrently in Australia. The results showed that HS did *not* perform better than the previous methods for technology identification. This could be due to the fact that the alternative method for identifying technologies generally identified those technologies close to research implementation, whereas HS may be more likely to identify technologies that are still a ways off from implementation. This can be contrasted with empirical or anecdotal evidence that may be available through organizations implementing foresight work. It will be important to utilize expert input to identify the effectiveness and limitations of foresight work within the field of food safety, as there does not appear to be clear examples of structured monitoring or evaluation of foresight exercises implemented at this time.

Part II: Horizon Scanning activities (not specific to Food safety) within FAO

Key findings

What are others doing?
Generally the approach applied across all the technical divisions to conduct their HSF activities is a mixed approach between a scanning of web based sources (structured and/or unstructured) and a consultation with people network based sources (regular and/or irregular). The list of divisions interviewed in this project is listed in Table 3 (below).

The majority of technical divisions focus on identification and evaluation of **short and medium term** important (emerging) issues and within their technical areas of work. Respondents from only

Department	Technical Division
Agriculture and Consumer Protection Department (AG)	Animal Production and Health Division (AGA) (6 animal health officers)
	Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (AGE) (1 officer, head of Laboratory in Food and Environmental Protection (IAEA))
	Rural Infrastructure and Agro-Industries Division (AGS) (1 technical officer)
Economic and social development department (ES)	Agricultural Development Economics Division (ESA), 1 senior officer, Deputy Director
	Trade and Markets Division (EST), 3 economist officers
Fisheries and Aquaculture Department (FI)	Fisheries and Aquaculture Economics and Policy Division (FIP) , 5 fishery officers
Forestry Department (FO)	Forest Economics, Policy and Products Division (FOE), 1 forestry officer
Natural Resources Management and Environment Department (NR)	Climate, Energy and Tenure Division (NRC), 3 natural resource officers

five divisions indicated importance of **longer term emerging** issues and topics of interest, for example, changes in population and income, climate change impact and wood supply.

Over 40 **emerging issues/topics** could be categorized under 4 themes: surveillance related important/emerging issues (animal, plant and food health; climate change monitoring) (11); production related important/emerging issues (12); socio-economical related emerging issues (14) and environment related emerging issues (7). These are shown in **Appendix 5.**

Almost 30 drivers of change related to the above mentioned emerging issues were identified and could be categorized into 4 themes: market related drivers (9); production related drivers (4); environment related drivers (8) and sociological aspect related drivers (8). These are shown in **Appendix 6.**

Reported **data sources** included web based sources such as FAO in house databases (i.e. FAOstat and FPMIS), official governmental databases (i.e. USDA) or intergovernmental databases (i.e. RASFF, NASA), nongovernmental databases (i.e. VITO) and scientific literature. The network based sources included various FAO sources (field officers, survey based) to expert panels, scientific conferences, workshops to member country's sources (regular monitoring data from government, ad hoc project based data, academia, private sector and NGO). **Data collection processes ranged from unstructured and ad-hoc to semi-structured procedures** varying in collection frequency from daily (i.e. disease event occurrence and tracking data), weekly (i.e. prize data), monthly (i.e. market trend and flow data) and yearly (i.e. production data, consumption data, laboratory data, food chemical occurrence data) up to a 5 year basis (climate change related data). It remains somewhat unclear which concrete data and related drivers are collected in either way. **No formal prioritization process** was reported by any technical division; common practice is to prioritize issues at technical divisional level and then further validate the list at expert meetings. Data collected were **analyzed** using a variety of **statistical qualitative and/or quantitative methods** and simulation models.

Data from the analysis are used for **different purposes** across the divisions: future scenario building studies for forecasting and identification of possible at risk areas; impact modeling (to understand what drivers are influencing the identified emerging issue and how), vulnerability and risk assessments; future research and expert meeting planning; adjusting and /or validating monitoring plans at country level; to raise awareness, develop policy recommendations and empower regulators to amend the legislation; to develop FAO technical papers; to steer FAO future work plan; to develop strategic frameworks. Target audience for the HSF study findings were **mainly FAO member countries** (competent authorities and related **technical services** including laboratories; **policy makers**) and **FAO management**.

The benefits and challenges of the current approaches used by various FAO's technical divisions are shown in **Appendix 6** and **Appendix 7**.

Proposed changes in the approaches applied within FAO technical divisions to conduct HS

Survey participants proposed changes to enhance their current approach in conducting HS which included: more resources and technical staff in order to enable a broader and more complete horizon scanning; more time should be dedicated to data analysis and the outputs of the analysis should feed into the strategic thinking and work planning; conduct HS on a multi-disciplinary basis and integrate it into the One Health initiative; increased participation to international scientific meetings as an important source of information for identifying emerging issues; enhance countries engagement by stimulating exchange programs.

Information collected by other FAO technical divisions potentially relevant to food safety

The technical divisions in the Agriculture, Fisheries, and Natural Resources departments are currently collecting data and information which are of clear relevance to food safety and they expressed their interest in planning joint activities in the future. Statistics units and Forestry department have considerable methodological expertise and experience from which the Food Safety unit can learn.

It was stressed by all the divisions that the most important condition for collaboration was to have joint funds to do joint activities and consequently it will be important to do joint resource mobilization.

Envisioning a broader systematic HS in FAO?

All 24 participants from the technical divisions interviewed in this survey agreed that FAO would benefit from and should invest in broader cross divisional and multi disciplinary horizon scanning activities at organizational level. Comments/suggestions for broader systematic HS implementation at organizational level were provided and included: there is growing attention at the international level on HS, so it could be the right moment for FAO to better engage in this; HS is not the mandate of one technical division but one central unit in FAO should coordinate; the focus of HS should be on medium and long-term broader scanning; broader HS should be implemented with gradual improvements in moving towards broader horizon scanning with right partnerships within/outside FAO; an annual forecasting meeting with external partners could be envisioned and every division would present short and long term issues identified.

Some challenges were also brought forward, including: being aware of how HS can be highly time and resource consuming; the validity of the approaches and related benefits are still unknown; the data availability is a problem; there is a need to do obtain more country-level data in order to better understand what is going on the ground, etc.

Looking forward

Early identification, evaluation and prioritization of short and medium-long term issues are critical in the food safety decision making process. HSF has the potential to support this process by improving strategic planning, identifying specific emerging risk and opportunities, and keeping a handle on how the food safety context is changing over the course of time.

Currently the FAO Food Safety Unit conducts HS on ad hoc basis and not systematically: this is done primarily through web scanning, periodic reporting based on on-going project results, and different range of consultations through regular or ad-hoc expert/people networks. In order to move towards a more systematic approach to identify short and medium term risks and opportunities, the Food Safety Unit will greatly benefit from experts' advice to identify the most promising and applicable methodologies for HSF.

In doing this some issues will need to be considered:

Identify and address the challenges surrounding HSF application in Food Safety:

- Discussing and clarifying whether transparent methodological frameworks (or simply procedures) exist in HSF, and how they could be adopted or modified to establish an effective and pragmatic horizon scanning process in food safety.
- Gaining knowledge and evidence of any clear benefits or success related to the use of HSF in food safety

- Having indications on the resource implications (human and financial) associated with implementation of HSF - both within an organization undertaking the exercise, and the cost of contracting another party to complete the work.
- **Gathering feedback and insights on how HSF could be linked to EWRA in a structured way, and in particular how HSF outcomes could feed into the EWRA system**

Consider the needs of end-users

- FAO member countries: ensuring that information and intelligence generated by the HSF can effectively inform relevant national authorities - particularly in developing countries - on how to be more prepared to face emerging risks as well as to optimize benefits from new opportunities. An important aspect in this regard will also be the information/data from member countries channelled through the FAO regional offices to feed the HSF process.
- FAO Food Safety Program: considering how HSF could support our Unit in improving strategic planning, and prioritizing potential future global work in the area of food safety.
- Collaborators: ensuring that synergies with partners are optimized by gaining insights form leading players in HSF, and at the same time contributing to HSF global intelligence through the long FAO food safety experience at global, regional and national level as well as through complementary data sources.

Identify ways to overcome the challenges

- Taking advantages of other ongoing HS initiatives within FAO: the majority of the FAO's technical divisions use some form of activities to identify short and medium term emerging issues and opportunities and many of their collected data could be relevant to Food safety. Furthermore mechanisms could be considered for establishing a broader cross divisional and multi disciplinary HS activity at organizational level.
- Exploring opportunities offered by a mixed HSF approach – i.e. combining more than one method and different approaches. Selection of the most appropriate methods for food safety will need to be made pragmatically on the basis of efficacy as well as time and resources requirements.
- Establishing strategic partnerships with key national and regional organizations currently involved in HSF.
- Exploring opportunities for implementing HSF pilots studies in collaboration with selected partners (external and internal), to develop, implement and evaluate an operational FAO framework for HSF in Food Safety.

Appendix 1: List of key definitions of Horizon Scanning and Foresight

Main Definitions of Horizon Scanning	Key Organizations using this definition
"…the systematic examination of potential hazards, opportunities and likely future developments which are at the margins of current thinking and planning. Horizon scanning may explore novel and unexpected issues as well as persistent problems or trends." (7), (16), (19), (37), (38), (39), (40)	United Kingdom Department for Environment, Food and Rural Affairs, Cranfield University
"…the systematic search for potential hazards and opportunities that are currently poorly recognized" (13), (41), (42), (43)	
"…the practice of monitoring the business environment and tracking the changes in the environment that could have an impact on individual businesses." -Brown (35)	Generally within for-profit companies (i.e. Shell Oil Company)
"…aim is to assist control and rationalize the adoption and diffusion of new technologies in healthcare practice" - Douw (44), (45)	Generally used related to emerging health technologies.
"…a search process which is extended at the margins of the known environment and potentially beyond." – Loveridge (45)	
"…a system to identify, filter and prioritize new and emerging health technologies to assess or predict their impact on health, costs, society and the healthcare system" – Nachtnebel (10),	Generally used related to emerging health technologies.
"The systematic search for incipient trends, opportunities and risks that may affect the probability of achieving management goals and objectives. Used by businesses, military and medicine" –Sutherland (45)	
"A foresight tool that is created to think, debate and shape the future in the direction of societal desires in a systematic way" – Van Rijj (38)	
"Horizon Scanning is a structured and continuous activity aimed to "monitor, analyse and position" (MAP) "frontier issues" that are relevant for policy, research and strategic agendas." – Popper (12)	
Main Definitions of Foresight	**Key Organizations using this definition**
"Foresight is a systematic, participatory, prospective and policy-oriented process which, with the support of environmental and horizon scanning approaches, is aimed to actively engage key stakeholders into a wide range of activities "anticipating, recommending and transforming" (ART) "technological, economic, environmental, political, social and ethical" (TEEPSE) futures" (12)	
"Foresight is an approach and a process which requires broad thinking and results in the generation of multiple scenarios and ideas. Some of these ideas must be further developed and implemented into policy and subsequent action." (2)	
"…a conceptual framework for a number of forward looking approaches to informed decision-making that includes long term considerations" (11)	European Foresight Platform

Appendix 2: Main characteristics of all Horizon Scanning methodologies reported in reviewed literature (alphabetical order)

Horizon Scanning method	Definition	Use	Pro / Con of Methodology
Best-Worst Scanning	Horizon scanning method that allows prioritization of key issues (generally technologies) by certain pre-identified criteria. Utilizes expert opinion via questionnaires.	Generally applied to health technology, this methodology is often used to rank or prioritize issues or new technologies for funding support.	PRO: Fairly quantitative analysis with clear expert support for outputs. CON: Requires substantial time commitment and commitment of experts to obtain good results.
Delta Scan	A selection of key foresight papers and reflection from global foresight experts. This is freely available through the internet and supported by the UK government.	Generally used as a source of information relating to drivers, trends and general foresight knowledge. The methodology of this incorporates structured input from more than 250 foresight experts.	PRO: Freely available, contains large amounts of highly relevant data. CON: Methodology for collecting data is not entirely clear, and may not address specific issues related to food safety.
Expert Consultation	Highly variable between organizations, but generally includes obtaining expert opinions through questionnaires or face-to-face meetings on potential drivers and trends relating to a particular topic.	Most common use is to identify or prioritize emerging issues identified by experts within a specific field, or to identify potential trends and drivers to feed into a larger foresight exercise.	PRO: Flexible methodological approach to obtain broad information CON: Not clearly outlined how to utilize the methodology and may not be able to apply quantitative analysis. Is fairly costly to implement.
Manual Scanning	The most commonly utilized method of horizon scanning. Includes scanning a variety of sources in a structured way, and may or may not include the use of text-mining software. Can be exploratory or issue-centered in nature.	Applied to track and identify drivers and trends either generally or specific to a particular issue. Tracking these over time gives a good picture of potential future issues that can then be validated through expert consultation etc.	PRO: Fairly low resource requirement for weekly scanning activities. CON: Requires additional foresight methodologies or expert input to obtain robust results.

Appendix 3: Main characteristics of Foresight methodologies reported in reviewed literature

Foresight method	Definition	Use	Pro / Con of Methodology
Assumption-Based Planning	A method used to think through long term planning by identifying and challenging main business assumptions.	Mainly used in business planning or military foresight. Identifies load bearing or vulnerable assumptions to an organization to find shaping actions to protect vulnerable assumptions and thresholds that indicate important changes.	PRO: Challenges users to identify assumptions in a business or organization that may otherwise be unclear. CON: Becomes complicated if too many assumptions are identified.
Backcasting	A method to determine normative scenarios and explore their feasibility and implications.	This method is generally following the identification of ideal future scenarios which are then "back cast" to identify the necessary steps to reach that preferred future goal.	PRO: Removes barriers to discussion between stakeholders CON: Long project time is required.
Creativity Methods (Brainstorming and Mind-Mapping)	Brainstorming is the method of "eliciting ideas without judgment or filtering" Mind-mapping seeks to map out the relationship between various issues or ideas.	These methods should never be stand-alone and the outputs of which should always feed into a larger wider foresight process. These activities should occur early on in the foresight work.	PRO: Encourage team building and allow for easy sharing of ideas CON: Not a useful exercise by itself.
Critical and Key Technology Study	Method utilizing interviews with key experts to obtain in depth knowledge about a specific issue, generally a technological advancement.	Usually focused on short term issues within the frame of new technologies. Can also be used to define key actions.	PRO: Results taken seriously by policy makers. CON: Does not take into account societal concerns or variety in potential futures.
Cross-Impact Analysis	A cluster of methods that evaluate changes in the probability of the occurrence of an event or set of events given the actual occurrence of something related.	Mainly used with technological forecasting instead of as a specific foresight method.	PRO: simple to implement, computer software supported, estimates dependency, increases knowledge CON: limitations in number of events that can be included in the evaluation, difficult to validate, not useful in complex issues.
Delphi Survey	A structured method of surveys that utilizes experts in the relevant fields and generally seeks to create consensus.	Used when long term issues (30+ years) are being debated to come to a general consensus. Especially useful in science, technology or education fields.	PRO: Formalized approach, identifies consensus, outputs are generally operational CON: Time-consuming, consensus in second round is artificial, loss of single opinions, dropout rate with multiple surveys.

Expert Panels	Method that utilizes experts in a particular field to review or deliberate on the future of a specific matter.	One of the most commonly utilized foresight methods. Usually consists of 12-20 people who are given 3-18 months to deliberate on futures of specific aspects related to their area of expertise.	PRO: Simple to set up CON: Results are only as good as the work the experts are willing to put into it.
Forecasting	A method to predict a future event or trend	Relies on past data to identify the most likely future scenario. Often used in business environments or when previous data is easily available.	PRO: Uses distinct data sets to predict most likely future. CON: Does not take into account wild card or other unforeseen events.
Gaming	A method used for dealing with human-related issues and created to mirror real life in a stimulating way.	Mainly utilized to aid decision-making, planning and policy implementation to better understand the viewpoints of other people involved.	PRO: provides practical insights into human behavior. CON: Success is limited if not all stakeholders are players.
Horizon Scanning/ Environmental Scanning	"…the systematic examination of potential hazardshazards, opportunities and likely future developments which are at the margins of current thinking and planning. Horizon scanning may explore novel and unexpected issues as well as persistent problems or trends." –DEFRA	This method is used to identify long term issues or trends that could be important for decision making, agenda setting, or articulating credible observations.	PRO: Varied methodology to fit needs of organization, low time investment necessary. CON: Must be combined with other foresight methodologies to be useful
Mass Collaboration	A generic name for a group of methods by which a large group of people either general public or experts are engaged to provide opinions.	This method is used when there is necessity to obtain a large amount of opinions to feed into a larger foresight study.	PRO: Obtain large amounts of data fairly quickly. CON: Many of the data will not be useful, must be used in conjunction with more targeted foresight studies.
Modeling	A method utilizing computer derived simulations to determine answers to futures questions.	Method is used when the goal is to: get insights into complex system, test new policies or identify appropriate new policies.	PRO: allows experimentation in a virtual setting, reduces requirements for analysis CON: Expensive, and results are only as good as input data.
Morphological Analysis and Relevance Trees	A normative foresight method that is similar to Backcasting, but seeks to identify paths to reach an ideal future through identifying subtopics.	Use this method when the perceived ideal future is complex and there are many potential influences or drivers on the system.	PRO: ensures topic is reviewed in comprehensive way CON: Requires thoughtful insights to be useful.
Multi Criterion Analysis	A quantitative methodology to rank and compare potential decisions.	Not only used in foresight, but this method has application to foresight.	PRO: simple method to test robustness of various policy options,

		Used during strategy phase to prioritize potential responses.	CON: can create difficulties if multiple high rated options are incompatible.
Scenario Planning	A method that creates storylines that envisions possible futures based on previously identified drivers/issues	Generally used as a tool for decision making, identify strategies, reveal choices available and highlight potential consequences. One of the most recognized and used methods of foresight used by both public and private organizations.	PRO: stimulates critical thinking, useful tool to use when uncertainty is high, allows creativity in creating possible futures. CON: Hard to identify credible scenarios, need to include wild card futures for best results.
Science and Technology Road mapping	This method creates detailed projections of possible technology advancements or future environments.	This has occurred since the 1980s and is not always grouped in with other foresight methodologies. **Never** uses a strict methodology, but instead uses a variety of tools to identify innovation.	PRO: allows for wide range of possibilities. CON: method is not easily applied to generally foresight work.
Structural Analysis	A method that works to identify all key variables affecting a certain system.	Used in coordination with cross-impact matrices and best when problem is highly complex.	PRO: generates thoughts and stimulates ideas. CON: list of variables is highly subjective, time consuming.
SWOT Analysis	An analytical method for organizations to identify important internal and external factors as strengths, weaknesses, opportunities or hazardshazards.	Not strictly a method of foresight. Best used when attempting to identify what the most appropriate tools are to be used in the implementation of a foresight exercise.	PRO: Fairly simplistic and does not require special training. CON: Lacks prioritization of factors, no suggestions for resolving disagreements, generation of factors is subjective.
System Dynamics	This method models complex issues through “stocks” (accumulation of things), “flows” (movement of things) and feedback loops within the system.	Useful in complex problems and may help anticipate patterns and sources of dysfunction within a system.	PRO: good for predicting changes in highly complex issues. CON: Difficult to analyze with multiple variables, requires considerable expertise, appears objective but all variables are user-defined.
Trend Intra/Extrapolation	This method identifies ongoing trends and projects them over the short to medium term.	Useful for identifying potential changes in major issues over the short to medium term.	PRO: Descriptive outputs that are generally relevant in the short term. CON: Requires strong understanding of driving forces affecting the trend or system.

APPENDIX 4: Global organizations involved in Foresight and Horizon Scanning (listed in alphabetical order) related to Food Safety

Organization (Country)	Brief Description	Contact
Canadian Food Inspection Agency (Canada)	Governmental organization responsible for safeguarding food in Canada, this organization also performs foresight exercises on a semi-regular basis.	http://www.inspection.gc.ca/eng/1297964599443/1297965645317
Centre for Environmental Risks and Futures, Cranfield University (United Kingdom)	Founded in January 2011, this organization conducts regular research into foresight methodologies and is considered a leader for horizon scanning work. They have been contracted previously by UK DEFRA to perform foresight work.	http://www.cranfield.ac.uk/sas/cerf/
DEFRA Horizon Scanning and Futures Team, Department of Environment, Food and Rural Areas (United Kingdom)	A leader in horizon scanning work at a global level, this group provides policy advice, identifies future risks and opportunities, and topic specific workshops.	http://horizonscanning.defra.gov.uk/
European Food Safety Authority	Responsible for a wide range of food safety issues in the EU, but does support and perform "emerging risk assessments" that utilize aspects of foresight methodologies.	http://www.efsa.europa.eu/
European Foresight Platform (online, mainly EU)	Supported by the European FP7 initiative, this is a network building platform to bring together global leaders in foresight. Provides briefs for specific topics on a regular basis.	http://www.foresight-platform.eu/
Food Standards Agency (United Kingdom)	Government agency in the UK responsible for food safety and hygiene. Organization creates food policies and ensures enforcement of food safety regulations. Has been recently exploring use of foresight methodologies within food safety.	http://www.food.gov.uk/
Foresight Horizon Scanning Centre, Department for Business, Innovation and Skills (United Kingdom)	Set up in 2005, this is one of the main groups within the UK system working on foresight issues. Major outputs include various futures projects, capacity development tools, and the "Sigma Scan."	http://www.bis.gov.uk/foresight/our-work/horizon-scanning-centre
Strategic Foresight, Department of Agriculture, Fisheries and Forestry (Australia)	Focused on environmental scanning and foresight techniques to identify future issues, this government organization works with local and international partners to identify and respond to critical future issues early.	http://www.daff.gov.au/animal-plant-health/animal/strategy

APPENDIX 5: Main Issues identified through key interviews and internal questionnaire

N	Emerging issues/ topics	AG	ES	FI	FO	NR	Themes
1	Weed resistance to herbicide	X					surveillance related emerging issues (animal, plant and food health ; climate change monitoring)
2	Invasive alien plants	X					
3	Increased pest movement	X					
4	Newly detected residues of chemical contaminants like i.e. pesticides, veterinary drug residues	X					
5	Emergence of new infectious diseases in animals (fish included)	X		X			
6	Increasing demand for integrated surveillance	X					
7	New lab testing and diagnostic technologies	X					
8	New approaches to risk assessment	X					
9	Nanotechnologies	X					
10	Automatization of data analysis					X	
11	New sensors with high resolution for remote control					X	
12	Food traceability (food scares, scandals)	X					production related emerging issues
13	Food authenticity/adulteration	X					
14	Bioinformatics	X					
15	Food production sustainability	X	X				
16	Food security		X				
17	Increase in anti biotic residues in aquaculture products			X			
18	Illegal, Unreported, Unregulated (IUU) fishing and its impact on marine resources			X			
19	Impact of rules for responsible fisheries			X			
20	Eradication of certain fish species			X			
21	Small scale fishery			X			
22	Sustainability of forest management				X		
23	Impact of demands for more forest conservation (taking areas out of production)				X		
24	Globalization and related increased trade	X					socio-economical related emerging issues
25	Increasing rural poverty	X					
26	Better use of information technology	X					

27	Increasing urbanization	X					
28	Prize volatility		X				
29	Impact of policy drivers on prevailing markets (e.g. oil-biofuel-maize prices		X				
30	Impact of food safety on food security		X				
31	Impact of food safety on food trade		X				
32	Influence of novel technologies (like GMOs) on trade flow		X	X			
33	TRIPS agreement :trade related IPs (intellectual property)		X				
34	Parasites prevalence increase due to change in consumption pattern (increase in raw fish consumption)			X			
35	Vibrio prevalence increase due to change in consumption pattern (increase in bivalves consumption)			X			
36	Wood supply sustainability				X		
37	Socioeconomic contributions of forests and related change				X		
38	Impact of climate change on household revenue		X				**environment related emerging issues**
39	Renewable energy		X				
40	Climate change impact on crop production		X				
41	Impact of climate change on food safety: i.e. increase of biotoxins			X			
42	Vulnerable marine eco-systems			X			
43	Ecological disasters			X			
44	Identification of Climate Change adaptation and mitigation strategies to increase agri-production					X	

APPENDIX 6: Drivers of Change identified through key interviews and internal questionnaire

N	Drivers	AG	ES	FI	FO	NR	Themes
1	Import /export trends (commodities, species) ;trade flow	X	X	X	X		market related drivers (economical)
2	Trade interruptions	X					
3	Market trends		X		X	X	
4	Consignment rejection figures	X					
5	Prize of crops	X	X				
6	Oil price trends		X				
7	Consumer preferences	X		X			
8	Market requirement	X					
9	Household revenues (income)		X				
10	Technology development and innovation -biotechnology	X					production related drivers
11	Agro-ecosystem changes-change in land use	X			X	X	
12	Changes in production systems (food &feed) and market or value chains, change in productivity	X		X	X	X	
13	Change in product development and processing			X			
14	Climate variations (wind, humidity, temperature, precipitation)	X					environment related drivers
15	Climate change	X	X	X	X		
16	Climate change land environment related drivers (carbon emissions, greenhouse gas inventory, land surface temperature, and meteorological information i.e. rainfall, drought, solar energy etc.)					X	
17	Climate change aquatic environment related drivers (rainfall, water surface T, lake level rise, acidification of ocean etc.)			X		X	
18	Deforestation				X	X	
19	Natural catastrophe	X					
20	Forest/ environmental encroachment (and hot spots)	X			X		
21	Biodiversity					X	
22	Peri-urban dynamics,	X					sociological related drivers
23	Human demographics	X	X		X	X	
24	Animal demographics -population densities	X					
25	Political conflicts-civil unrest	X	X				
26	Poverty	X					
27	Policy frameworks and drivers	X	X		X	X	
28	Regulatory frameworks	X				X	
29	Institutional frameworks	X				X	

APPENDIX 7: Benefits of the approaches applied within FAO technical divisions to conduct HS categorized by theme

(1) **Methodology related**	(2) **FAO related**	(3) **Stakeholder engagement related**
• provides access to multiple sources of data • flexibility of approach to adapt to innovations • transparent and consensus based • pragmatic	• enables the design of prevention programs • provides the element for the development of new project proposals (capacity building and research projects)	• the communication and information sharing among the various networks seems to work very efficiently • enables the facilitation of the interactions between the developing world and the scientific community • provides quick access to externally available expertise • the embedded inclusiveness ensures a better buy in and implementation and impact on the field • the engagement with member countries at an early stage is ensuring that key issues (including emerging issues) of interest to member countries are considered • allows to bridge the gaps between understanding the problems on one hand and meeting the needs on the other hand of policy makers

APPENDIX 8: Challenges of the approaches applied within FAO technical divisions to conduct HS categorized by theme and subtheme

(1) FAO and institutional related	(2) Data collection and analysis	(3) Stakeholder engagement
(1.1) resource related:	**(2.1) data collection related**	**(3.1) stakeholder identification and mapping related**
• very little is known about the impacts of the applied approach in the field once the issue has been identified • difficult to monitor at country level from HQ • lack of FAO technical resources in the field and in HQ in order to maintain the current heavy workload • funding is a big issue as emerging issues once they are identified are not necessarily reflected in the work plan and budget • no adequate access in FAO to relevant scientific journals	• the sustainability of web scanning tools • the lack of data in general and quantitative data and non conventional data in particular • intelligence gathering is very time consuming due to background noise • the language coverage is an issue(in particular loss of local languages) • culture differences can hamper data collection • copyrights issues.	• difficulties in assembling and communicating with all relevant stakeholders, in particular public - private partnerships • deficiency in participatory methodologies • very time consuming and the various interactions can be complicated
(1.2) work program related:	**(2.2) data analysis related:**	**(3.2) stakeholder engagement related**
• the risk of duplication of work across FAO technical units due to silos mentality • lack of formal prioritisation process and the reality of political influence on prioritisation process • in most divisions the data analysis is not feeding back yet into the strategic planning • the constraint to tailor the activities to multiple organisational mandates in case of partnerships between FAO and other intergovernmental organizations	• the heavy workload of data entry • the need for more structured and formal data analysis • the need for use of RSS feeds as current approach is very time consuming • method could be biased as trend analysis are based on retroactive data.	• no common language between technical and policy communities • issues in identifying comparative advantages • sustainability of built capacity in the field • how to influence a change in behaviour • to convince people (within and outside FAO) of the importance of this work and the benefit it could bring