

ADVISORY COMMITTEE ON THE MICROBIOLOGICAL SAFETY OF FOOD

ACMSF horizon scanning workshop 2023 summary of discussions and outputs.

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Introduction

The ACMSF Committee held a horizon scanning workshop in London on the 22nd of June 2023. The focus of the workshop was to determine how climate change is likely to affect the microbiological safety of food in the UK. Members were asked to identify emerging issues around a series of specific questions relating to climate change.

The workshop followed a similar format to previous years with a mixture of breakout groups and plenary sessions and included guest speakers Pete Falloon and Matt Gilmore from the Met Office and The Quadram Institute respectively.

Key issues were identified by members during discussion in breakout groups and the plenary session was used for the Committee to agree a prioritized list of recommendations based on their potential for understanding and reducing foodborne illness. This paper summarizes the main outputs and discussions from the workshop including challenges and corresponding actions highlighted by the Committee.

Members were asked the following question:

How in your opinion is climate change likely to affect the microbiological safety of food in the UK via the following areas?

Please consider:

- Both trends (higher average temperatures) and increasing frequency of extreme weather events (flooding, drought, forest fires)
- Timescales (0-10 years, 10-20 years, 20+ years)
- Indicators: how will we know if the effect is happening?
- Likelihood and magnitude of effect
- New as well as existing hazards
- Key evidence gaps
- How CC might affect, and be affected by/mitigated by, other drivers
- Any recommended actions for the ACMSF, the FSA, other government departments and agencies, and external stakeholders.

Annex 1 includes the comments members provided before the workshop. The secretariat sent the questions to the Committee members before the workshop which members provided responses to. This document guided the discussions at the workshop.

Priority actions identified by Members.

General Actions

Specific actions to climate change associated challenges, highlighted by the Committee, are listed in the tables below. However, there are several actions which have widespread implications across multiple sectors, in tackling microbiology safety concerns in food as a result of climate change. These broadly fall into three categories: information gathering to predict and plan for specific risks, education of consumers and collaboration, particularly with other government departments.

For example, in order to prepare for the impacts on food safety the Committee highlighted the need to work with the Met Office to receive the greatest possible warning of extreme weather events and plan preparations ahead of time to develop a rapid response capability. Furthermore, a need to identify and collate information on imported foods and develop scope to source similar foods from other countries, or move to UK production, if supply issues arise, was emphasized. Any indicators of concern to be monitored need to be agreed between government departments; and discussions must be held on how to handle these collaboratively. Surveillance to identify emerging pathogens needs to be carried out and insight must be gained from other country's experience and approach to climate change mitigations with particular reference to food safety.

A range of risk factors identified by this information gathering process can be mitigated by proper education to consumers and manufacturers. These might include consumer awareness of safe food practices in a warmer climate or rising cold chain management awareness to industry.

Many of the actions discussed in this report, would benefit from cross government collaboration. This is particularly relevant where there could be agreement on key factors to monitor as surveillance priorities for specific aspects of climate change impact, and the data to capture for them, so that research and other work can then be easily collated or combined to increase the power of detection.

Priority emerging issues identified by Members and associated actions.

The emerging challenges highlighted by the Committee are summarised in the tables below and are focused around the five key areas put to the Committee:

- Challenges associated with disruption to food supply chains
- Changes in methods of food production and new food technologies
- Changes in consumer behaviour and preferences
- Challenges associated with changes in the sizes of vulnerable groups

- Anything else

The points raised have been split into *direct* challenges, which are a result of climate change, and *indirect*, which may be compounded by, but are not a direct result of, climate change.

Challenges associated with disruption to food supply chains.

Direct Challenges from climate change:

Challenge	Possible actions
<p><i>Drought</i></p> <ol style="list-style-type: none">1. During periods of drought the impact of water scarcity and microbiological quality of both irrigation and drinking water may drive consumers to less robust/secure sources. Water scarcity could also lead to loss of food production (e.g., almond production in California could be wiped out due to water shortage) or increase food contamination risk (e.g., STEC in leafy greens spread by desiccated sheep faeces from neighbouring fields).	<ol style="list-style-type: none">1.1 The FSA should establish and strengthen links (either directly or via e.g., Defra) with experts who have worked, or currently work, in countries already experiencing regular droughts, to share lessons learned. For example, what risks do they find are increased by drought and how, and what mitigations are most effective (or ineffective) at mitigating them?1.2 The FSA should commission a review of microbiological risks most likely to increase as a result of climate change risks in countries from which we import food.1.3 FSA to provide an update to the committee on sources of imported foods and identify alternative sources of key products from countries affected by climate change.1.4 FSA Incidents and Policy teams should review preparedness measures e.g., rapid response capability in the context of climate risks, for example considering the potential for multiple incidents to occur

Challenge	Possible actions
	<p>simultaneously as a result of single extreme weather events.</p>
<p><i>Flash Flooding</i></p> <p>2. More thundery downpour in summer could lead to animal/human waste runoff in rivers affecting water safety for consumption. Increased incidents of flooding require a better understanding of pathogens that are associated with sewage and flooding. The risks of increased flooding are compounded by lack a of resources in government agencies and lack of enforcement e.g., raw sewage.</p>	<p>2.1 The FSA should establish closer working relationships with water authorities & water research as well as other organisations able to provide insight into e.g., flooding risks in arable areas.</p> <p>Consumer education/advice</p> <p>2.2 The FSA should consider preparing consumer messaging about the food safety risks from products that may be affected by flooding/sewage.</p> <p>2.3 The FSA should consider commissioning research on the effectiveness of consumer washing of vegetables to increase confidence in current consumer advice (or update it, as appropriate).</p>
<p><i>Increasing Temperatures</i></p> <p>3. Increasing temperatures require better temperature control in the cold chain (domestic and industrial) to avoid impacting microbiological safety and quality of</p>	<p>3.1 Similarly, to the action under “drought”, the FSA should consider establishing and strengthening links (either directly or via OGDs) with experts who have worked, or currently work, in countries already experiencing warmer</p>

Challenge	Possible actions
<p>food. Small Medium Enterprises (SME) are likely to struggle the most with the challenges of maintaining the cold chain. Extreme climate events will also stress bacteria, leading to viable but non-culturable cells (VBNC) or adaptations that may affect virulence. Challenges in sharing whole genome sequencing (WGS) data, cross government communication and standardization of methods needs to be addressed.</p>	<p>climates, to share lessons learned. For example, what risks do they find are increased by increasing temperatures and how, and what mitigations are most effective (or ineffective) at mitigating them? For example, any effects on microbiological safety of efforts to reformulate certain foods for higher temperatures (e.g., chocolate)</p> <p>Risk assessment</p> <p>3.2 When performing risk assessments, the FSA should where appropriate consider how the assessed risk might be affected by higher ambient temperature in processing facilities.</p> <p>Disease/AMR surveillance</p> <p>3.3 The FSA should consider establishing sentinel sites to monitor emerging pathogens in different parts of the supply chain, as well as strengthening cross-government links to share surveillance data, and the use and interpretation of WGS, to determine the impact of</p>

Challenge	Possible actions
	<p>climate change on foodborne disease and antimicrobial resistance (AMR).</p> <p>3.4 The FSA and other relevant departments and agencies (APHA/Defra, UKHSA/DHSC) should continue collaborations and activities initiated under the PATH-SAFE programme to interconnect animal, human and environmental pathogen datasets and make them available as open data with defined metadata standards.</p> <p>3.5 The FSA should consider projects to identify and monitor trends in pathogens not previously associated (or associated rarely) with specific food products, which may be influenced directly or indirectly by climate change.</p> <p>Education</p> <p>3.6 The FSA should consider strengthening communication with, and providing guidance for, the food industry on molecular methods and sampling strategies they can use for their own monitoring programmes.</p>

Challenge	Possible actions
<p data-bbox="203 253 568 288"><i>Rising Sea Temperatures</i></p> <p data-bbox="253 309 1099 453">4. Increasing sea temperatures may have an impact on the microbiological safety of fish and/or shellfish or increase microalgae (phytoplankton blooms).</p>	<p data-bbox="1178 253 2007 453">4.1 The FSA should consider supporting sampling projects and/or industry activities to monitor for changes in emerging microbiological risks associated with fish and shellfish.</p> <p data-bbox="1178 477 2007 620">4.2 The FSA should work with UKHSA to identify opportunities to monitor levels of domestically acquired <i>Vibrio</i> infections in humans.</p> <p data-bbox="1178 644 2007 788">4.3 The FSA should consider commissioning research into the effects of sea temperature on the exposure of UK consumers to waterborne viruses (e.g., norovirus)</p>
<p data-bbox="203 863 488 898"><i>Fraud / Compliance</i></p> <p data-bbox="253 919 1099 1342">5. Increasing food fraud risks, for example, wilful disregard of the increasing need for hygiene and temperature controls impacting microbiological safety. Failure to meet with compliance standards may become more frequent due to disjointed actions taken by different agencies to deal with common problems affecting different parts of supply chains. Supply of peppers & tomatoes (crop shortages) affected UK availability of product earlier this</p>	<p data-bbox="1131 863 2029 1062">5.1 The Micro Risk Assessment team should consider reviewing the work the National Food Crime Unit (NFCU) does to ensure these controls are accurately represented in RAs. For example:</p> <ul data-bbox="1178 1086 1973 1342" style="list-style-type: none"> <li data-bbox="1178 1086 1805 1121">• Review of food ‘fraud’ risks and controls <li data-bbox="1178 1145 1946 1233">• Review current and future focus and/or controls on monitoring the chill chain. <li data-bbox="1178 1257 1973 1342">• Review regulatory and enforcement controls for new market entrants.

Challenge	Possible actions
<p>year. This may lead to acceptance of riskier products to the market.</p>	
<p><i>Food Import Disruption</i></p> <p>6. Countries outside UK will likely be similarly impacted by climate change so may not be able to supply the UK with same food types or quantities typically seen.</p>	<p>6.1 Identify possible food import disruption in advance and look at mitigating measures. For example, look for other sources for similar food types or look at moving to UK production.</p>

Indirect challenges from climate change:

Challenge	Possible actions
<p><i>Sustainability</i></p> <p>7. The tension between microbial food safety and food waste/sustainability issues have been increased by climate change and the cost-of-living crisis. This includes the balance between microbiological food safety and shelf-life and energy considerations during all stages of food chain and other steps towards sustainability such as reducing food packaging.</p>	<p>7.1 The FSA should continue consumer education about how home storage behaviours change the risk from food hazards.</p> <p>7.2 The FSA should strengthen the links between the ACMSF and the ACNFP to ensure that new and changing risks relating to new foods and processes are fully understood.</p> <p>7.3 The FSA should use its influence to ensure that food safety, particularly microbiological safety, is factored into</p>

Challenge	Possible actions
	<p>decisions about legislation changes for packaging and shelf life.</p>
<p><i>Labour Availability</i></p> <p>8. The Impact on labour availability, in UK from Brexit and possible labour shortages from exporting countries may also disrupt supply chains and lead to shortages of certain food types.</p>	<p>8.1 The FSA should consider collaboration with industry to identify challenges relating to labour shortages.</p>

Changes in methods of food production and new food technologies

Direct challenges from climate change:

Challenge	Possible actions
<p data-bbox="203 389 389 416"><i>Novel Foods</i></p> <p data-bbox="253 443 1106 1251">9. The novel foods sector is growing rapidly, which has in part been driven by a sustainability agenda triggered by increased awareness of climate change as well as, in the UK, by factors such as EU Exit. Novel foods such as alternative proteins may carry a lower risk of some hazards typically considered for meat, such as <i>Salmonella</i> or <i>Campylobacter</i>. However, it is not always clear what new or increased risk may be associated with such novel foods or novel processes. Robust processes for approval will mitigate this challenge, but novel foods approved in other regions by local competent authorities may be sold illegally and promoted via social media. Furthermore, new business entrants with less experience of safe food production may be less aware of safety measures they need to comply with.</p>	<p data-bbox="1131 389 2022 528">The FSA should consider the following areas for generating evidence through commissioned research or reviews, formal risk assessment and/or review of risk management processes:</p> <p data-bbox="1180 555 2033 751">9.1 Ways to generate evidence to support microbiological risk assessment and associated regulatory guidance relating to novel food production processes e.g., cultured meat, insect protein, plant-based foods.</p> <p data-bbox="1180 778 2022 975">9.2 Take action to maintain and improve coordination between ACMSF and ACNFP to identify concerns about the microbiological safety of dossiers submitted for review relating to novel foods and processes.</p> <p data-bbox="1180 1002 2022 1141">9.3 Ensure that exposure data and hazard identification for novel foods and processes is considered and establish data on pathogen growth.</p> <p data-bbox="1180 1168 2022 1307">9.4 Consider the potential microbiological risk from plant-based products that are produced using contaminated plants.</p>

Challenge	Possible actions
	<p data-bbox="1178 250 1989 344">9.5 Improve data capture during outbreaks to record food production processes, not just food type.</p> <p data-bbox="1131 416 1473 453">Manufacturer regulation</p> <p data-bbox="1131 472 1995 619">9.6 FSA should consider development of guidance for manufacturers on validation for new process, or reiteration of current guidance if already in place.</p> <p data-bbox="1131 692 2024 786">The FSA should consider supporting research and surveillance in the following areas:</p> <p data-bbox="1131 860 1955 954">9.7 Research into the survival and growth of pathogens on alternative proteins</p> <p data-bbox="1131 1027 2013 1281">9.8 Research into cooking times and consumer behaviour around cooking times, for example whether consumers will apply the same storage, preparation and cooking behaviours when using meat alternatives as they would for meat.</p>

Challenge	Possible actions
	9.9 Research/epidemiological studies to identify any changes or new trends in contamination of novel products.
<p data-bbox="206 426 703 453"><i>New Farming/Fertilisation Methods</i></p> <p data-bbox="206 480 1099 1174">10 Various changes in farming practices to cope with increasing challenges associated with climate change may affect the microbiological safety of food. For example, the increased use of biodigesters and resulting impact on microbiological safety of wastewater and fertilization. Similarly, the development of vertical farming may be of concern due to the closed loop nature of its operation and especially with the recycling of irrigation water (e.g., Listeria risk). Also, the impact on need, and availability, of artificial fertilizers is driving an increased use of natural fertilizers. This may result in more animal waste runoff on agricultural crops and water during flooding. The use of animal by-products for use in animal feeds is also a concern.</p>	<p data-bbox="1131 426 2036 624">10.1 FSA should consider establishing strategic connections with OGDs to learn about proposed changes to wastewater treatment and commission work necessary to assess their impact on food safety.</p> <p data-bbox="1131 647 1989 791">10.2 The FSA should consider commissioning a hazard profile for indoor and vertical farming systems to identify recommendations for proactive testing.</p> <p data-bbox="1131 815 2002 959">10.3 The FSA should consider organising or supporting a stakeholder exercise to map practices in new methods of farming</p>

Changes in consumer behaviour and preference

Direct challenges from climate change:

Challenges	Possible actions
<p data-bbox="203 432 927 464"><i>Customer Behaviours in Related to Warm Weather</i></p> <p data-bbox="203 488 1104 906">11 There is a lack of preparedness in consumer behaviours for changes in climate effects in relation to warm weather. For example, handling of leftovers, doorstep delivery and cold chain maintenance. Certain behaviours such as leaving chicken out to thaw should be addressed. Similarly, a change in food preferences in relation to warm weather needs to be addressed, for example, a move to consumption of more salads and barbecues.</p> <p data-bbox="203 930 241 962">12</p>	<p data-bbox="1131 432 1989 520">12.1 The FSA should consider consumer messaging and education around safe food practices in warmer climate.</p> <p data-bbox="1131 544 2011 683">12.2 The FSA should consider strengthening communication with, and providing guidance for, the food industry on cold chain management.</p> <p data-bbox="1131 707 1935 794">12.3 The FSA should consider a behavioural survey on consumer habits during summer barbecues.</p>
<p data-bbox="203 991 891 1023"><i>Industrial Practices in Related to Warm Weather</i></p> <p data-bbox="203 1046 1104 1241">13 There is also a potential lack of preparedness in industrial practices in relation to warm weather. For example, standard practice by direct delivery from 'local' suppliers (e.g., door to door milk delivery) may no longer be suitable.</p>	<p data-bbox="1131 991 2024 1129">13.1 FSA should consider contacting Defra labelling teams to identify opportunities for supporting industry in exploring the potential of temperature abuse packaging labels.</p> <p data-bbox="1131 1153 2002 1353">13.2 FSA to update committee on education, guidance, and legislation/enforcement currently in place for manufacturers, particularly for on-line sales or dark kitchens.</p>

Challenges	Possible actions
	<p>13.3 The FSA should consider educating food businesses on the importance of additional controls for products that weren't previously heat-treated (e.g., sale of raw milk)</p>

Indirect challenges from climate change:

Challenges	Possible actions
<p><i>Customer Behaviour Related to Rising Costs</i></p> <p>14 With the rising costs relating to the cost-of-living we may see an increase in home cooking and/or a move to more affordable cooking methods such as microwave cooking. Furthermore, there may be an increased use of dark kitchens to obtain food from more affordable sources.</p>	<p>14.1 FSA to update committee on current work on food safety practices in food banks.</p> <p>14.2 FSA to consider cross-government working to consider how to assess the impact of changes to domestic food storage and usage on food safety, particularly in relation to</p> <ul style="list-style-type: none"> • Efficacy of new cooking solutions (e.g., air fryers) • Consumer education on the risk of new processes of these risks.
<p><i>Social Media Influence</i></p> <p>15 Social media trends and influencers can cause changes to food consumption and preparation, including selling of foods on places like Facebook marketplace and dark</p>	<p>15.1 FSA to update committee on current consumer messaging around the potential risks of buying from unregulated supplier (e.g., Facebook marketplace)</p>

Challenges	Possible actions
<p>kitchens. The absence of legislation for these products is a cause for concern.</p>	<p>15.2 The FSA should consider a survey looking at surveillance of foods being sold via these platforms (e.g., study proposed by FSS looking at foods being sold on Facebook)</p>
<p><i>Pets</i></p> <p>16 Lack of consumer understanding of safe foods for pets/animals has safety concerns for both pets and owners (e.g., via cross contamination). For example, there has been an increase in the raw pet food market in recent years. The raw pet food industry has seen issues with compliance in regulation. Similarly, there may be safety concerns in relation to animals fed left-overs and a lack of understanding on interspecies feed (e.g., an incident of pancytopenia in cats fed dog food as cats are more sensitive to aflatoxins and these are likely to increase with climate change).</p>	<p>16.1 The FSA should consider consumer messaging around safe food practices in relation to pets, in particular:</p> <ul style="list-style-type: none"> • Raw foods • Leftovers • Interspecies feed
<p><i>Preparation of Food by Children</i></p> <p>17 A greater appreciation is needed that children or young adults may be preparing food in the home.</p>	<p>17.1 The FSA should consider collaboration with other government departments to ensure consumer messaging</p>

Challenges	Possible actions
	and education in schools are in place to establish safe cooking practices that may also influence parents.

Challenges associated with changes in the sizes of vulnerable groups.

Direct challenges from climate change:

Challenges	Possible actions
<p><i>Climate Related Stress</i></p> <p>18 Vulnerable populations may experience climate-related stresses (heat, dehydration) which make them more susceptible to infection.</p>	<p>18.1 The FSA should consider working with other government departments to help promote targeted consumer messaging to educate vulnerable groups or caregivers on the risk of climate related stresses, such as dehydration and heat stress.</p>
<p><i>Ageing Population</i></p> <p>19 There is risk of a disproportionate impact of climate change and food poverty on ageing and pregnant groups. In particular the ageing population is most at risk of not taking precautionary action to mitigate risks and least able to respond i.e., less likely to leave home in extreme weather conditions (heat) to shop and so buying more home delivery. This may lead to an increased purchase of ambient higher risk foods e.g., powdered milk.</p>	<p>19.1 The FSA should consider commissioning research into the effects of ageing on vulnerability to foodborne disease.</p> <p>19.2 The FSA should obtain, or commission research to generate, evidence to identify groups likely to be particularly vulnerable to increased risks as a result of climate change, and then identify approaches to targeting relevant advice to them.</p> <p>19.3 The FSA should consider reviewing the definition of vulnerable group as the associated mitigation will depend on why they are vulnerable.</p>

Challenges	Possible actions
<p>The increasing size of vulnerable populations combined with the potential increase in microbiological food contamination related to various climate change factors may result in a multiplication of risk. To best target vulnerable groups to circumvent risk and change behaviour there is a need to define what a vulnerable group is. For example, the link between nutritional status and vulnerability needs to be better understood.</p>	<p>19.4 The FSA is advised to review the food safety advice targeted at vulnerable groups and manufacturers/food service in preparation of foods for vulnerable groups.</p> <p>19.5 The FSA should work with the NHS to identify to develop consumer guidance and education.</p> <p>19.6 The FSA should look to develop a categorisation of vulnerabilities for consumers to refer to; provide advice on different food groups based on category.</p> <p>19.7 The FSA should consider supporting research projects looking at the immune response in different populations as well as the development of easy tests for immune status and research on vulnerability to different pathogens, not just <i>Listeria</i>.</p> <p>Regulation</p> <p>19.8 FSA should consider developing guidance for manufacturers on assessing risks for consumers, and awareness of vulnerable groups by manufacturers.</p>

Indirect challenges from climate change:

Challenges	Possible actions
<p><i>Obesity</i></p> <p>19. Increase in obesity may lead to more co-morbidities.</p>	<p>19.1 The FSA should work to develop consumer advice and guidance aimed at increasing healthiness of diet to reduce vulnerability of population.</p>
<p><i>Food Poverty</i></p> <p>20. Food poverty has increased and may increase in the short term too leading consumers to store food for longer and consume more leftovers.</p>	<p>20.1 The FSA should develop better consumer advice and education on safe food storage.</p> <p>20.2 FSA should look at carrying out a review on food storage to have a better understanding of what can safely be kept, though it is accepted this is unlikely to be changed by industry without validation.</p>
<p><i>Migration</i></p> <p>21 An increase in migration will see a larger population which needs to be fed, putting further strain on food shortages. Increased migration may also increase novel food consumption.</p>	<p>21.1 The FSA should consider supporting surveillance to monitor changes in population size and the effect on food supplies.</p> <p>21.2 FSA should consider future proofing new regulations on imported foods against any new and emerging threats from novel goods.</p>

<p><i>Alcoholism</i></p> <p>22 Alcoholism is on the rise after the pandemic. Both alcoholism & vaping have a possible impact on vulnerable groups</p>	<p>22.2 The FSA should consider surveillance obesity and use of vaping to monitor the rise in these levels across the population.</p>
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Anything else

Challenges	Possible actions
<p><i>Chemical use and AMR</i></p> <p>23 The impact of response to microbiological stability issues may drive increased chemical use and AMR.</p>	<p>23.1 The FSA should continue its regular surveillance of AMR on food a range of food products and consider supporting surveillance to monitor chemical use in food production.</p>
<p><i>Loss of Agricultural Land</i></p> <p>24 Loss of agricultural land (including to solar farms) may drive food production to less safe sources.</p>	<p>24.1 The FSA should work with other government departments to determine the likely extent of the loss.</p>
<p><i>Drinking Water Quality</i></p> <p>25 Increased flooding and/or drought raises concerns over drinking water quality for agricultural use. The use of contaminated water may lead to more animal disease and subsequently more antimicrobial usage. This has the potential to increase the use of antibiotics in livestock despite the recent trends in reduction antibiotic use.</p>	<p>25.1 The FSA should consider carrying out a systematic review to enable a better understanding of how heat stress will affect antibiotic use in livestock by looking at examples from other countries with higher temperatures.</p>
<p><i>Biofilm Prevention</i></p>	<p>26.1 The FSA should consider developing guidance for industry on preventing biofilm formation by reviewing</p>

Challenges	Possible actions
<p>26 There is an absence of guidance for industry about preventing and removing biofilms despite increasing microbiological challenge in food processing. There is also increased pressure to reduce chemical cleaner use, sending conflicting messaging to manufacturers.</p>	<p>guidance for manufacturers for biofilm control/removal from other sectors e.g., dentistry.</p>
<p><i>Emerging viruses</i></p> <p>27 There is a risk of emerging respiratory viruses such as Covid taking out whole factories due to stall illness. Though this is more HSE issue than a food issue, it could have implications for food shortages.</p>	<p>27.1 FSA should consider working with other government departments to consider preparedness measures for respiratory viruses spread via food.</p> <p>27.2 FSA should consider carrying out a systematic review to identify possible opportunistic pathogens across various food types.</p>
<p><i>Disease Spread by Wildlife</i></p> <p>28. Continued concern of transmission of disease from wildlife into commercial animals (e.g., avian influenza spread from wild bird populations into commercial poultry).</p>	<p>28.1 The FSA should consider commissioning research surveys for surveillance/monitoring, of migratory birds and changing flight / pathogens and rodent populations (rural and urban).</p>

Annex 1

How in your opinion is climate change likely to affect the microbiological safety of food in the UK via the following areas?

Please consider:

- Both trends (increasing temperature) and increasing frequency of extreme weather events (flooding, drought, forest fires)
- Timescales (0-10 years, 10-20 years, 20+ years)
- Indicators: how will we know if the effect is happening?
- Likelihood and magnitude of effect
- New as well as existing hazards
- Key evidence gaps
- How climate change might affect, and how its effects might be affected by/mitigated by, other drivers
- Any recommended actions for the ACMSF, the FSA, other government departments and agencies, and external stakeholders.
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- **Challenges associated with disruption to food supply chains**

Possible interacting drivers: animal and plant disease outbreaks, geopolitical issues, shortages of materials or resources.

Member A

1. Trends and increasing frequency of extreme weather events - Cold winters and flooding have already affected UK winter/spring food production, reducing yield and quality (and associated sewage contamination risk); similarly hot, drought weather has impacted on summer/autumn crops, reducing yield and/or quality – affecting use of poor-quality irrigation water (compounded by ongoing water companies' sewage overflows into streams and rivers used for water abstraction). Even worse for imported foods, particularly food produced in areas of southern Spain and Portugal.
2. Timescales - Happening now and will only get worse.

3. Indicators - Reduced yields (reports by NFU), poorer shelf life (reports by BRC), increased reports of animal disease and AMR (reports by APHA) and foodborne disease and AMR (reports by UKHSA).
4. Likelihood and magnitude of effect - Highly likely, particularly for immunocompromised patients or animals already stressed by drought and heat.
5. New as well as existing hazards - Changes in migratory patterns of birds and bats, increasing virus risk when they feed or defaecate on crops, as well as the usual bacterial zoonoses. Increasing arthropod-borne diseases moving to warmer northern climes affecting animal health.
6. Key evidence gaps include influence of Climate Change on increased AMR and One Health; and fungal blites stressing crops and reducing quality and shelf life, and susceptibility to bacterial pathogens.
7. How climate change might affect, and how its effects might be affected by/mitigated by, other drivers - Shortage of water for human and animal drinking as well as for crop irrigation will cause increasing civil and inter-government strife, animal deaths and human migratory patterns.
8. Any recommended actions - Urgent need for all Government departments and other agencies (including NFU, BRC and UKRI) to work together and coordinate activities and responses to Climate Change, AMR and One Health.

Member B

9. Recent political (Brexit), conflict (Ukraine war) and societal (COVID-19) issues have demonstrated the impact on the security of raw material supply for food production and the associated costs of raw materials and finished products. However, much of this is cyclical and will be un-wound as disputes become resolved and key drivers like energy costs subside in future decades. Climate change however will be a

structural change to the food supply system, some of which will lead to pressures i.e., reduced availability and increased cost and some will lead to opportunities i.e. new domestic farming and production opportunities with increased availability and reduced cost. This may result in new farming systems, new processors and new products being produced in new regions of the country and world that will require associated food safety controls for these new individuals or companies. The major operators in the food system in the UK have exceptionally robust processes that are likely to respond and mitigate any increased risk. The key vulnerability will be those parts of the food supply system that do not operate effective food safety management systems – in the most part this challenge exists now albeit not related to climate change, but it will require effective regulation and enforcement.

Member C

10. Climate change events such as increasing temperatures may favour distribution of intermediate hosts, bringing novel vectors or temperature-associated changes in contamination levels. There is evidence that increases in temperature may result in: increases in Salmonella associated with poultry (increase by 5 to 10% for each 1oC increase in weekly temperature) – more likely to impact broilers rather than egg-laying flocks (due to immunization used to prevent carriage); increases in Campylobacter infections; increases in vibrio's associated with seafood; increases in mastitis in dairy cattle. Milder winters may also lead to improved survival of vectors (e.g. flies) for campylobacters. In situations where vibrio outbreaks have occurred in non-endemic regions such as Spain, there is good evidence that unusually warm seawater temperatures have been recorded at the same time. Vibrios do not currently feature as significant pathogens in the UK but if seawater temperatures increase during the summer months, there is potential for these pathogens to become a real concern in the longer term.

11. A significant rise in temperature of 2-3oC, predicted in the longer term of >10 years will likely reduce the shelf-life of chilled foods and impact on the cold chain.

12. Climate change is likely to lead to modified bacterial, viral and pathogenic contamination of water and food by altering the features of survival and transmission patterns through changing weather characteristics, such as increasing humidity and rainfall. Climate-dependent temperature and moisture changes will alter the occurrence patterns of xerophilic fungal growth and formation of mycotoxins on crops at the preharvest stage. Increases in rainfall will likely lead to increases in contamination of seafood by faecal organisms due to water runoffs and sewage leaks into rivers and estuarine environments. Contaminated runoff water is also likely to impact fresh produce where crops are exposed to these sources of contamination.

Member D

13. Global conflicts will continue to challenge food supply chains, including those relevant to UK food supply. The war in Ukraine, for example, impacted the UK in terms of limiting and/or increasing costs for foods, feeds, and fertilisers necessary to support the UK food system. This was also exacerbated by rising energy costs, that put financial strain on UK food businesses.

14. The impact of climate change and emerging hazards remains, e.g., how this will impact the geographical distribution of mycotoxigenic species in food production systems, including those supplying the UK. In the longer term, this may become more relevant to food production systems within the UK.

Member E

15. Floods, droughts, forest fires affecting crops.

16. Insect habitats being destroyed and less pollinators.

17. Less diverse species having an impact on soil quality.

18. Lower yields of crops will push the price up and may lead to an increase in adulterated food.

19. The war in Ukraine may escalate and push up food/feed prices further.

Member F

20. Climate change is likely to cause higher temperatures and more extreme weather events including drought and flooding which will impact on both crop/food availability and quality including increased risk of pests/disease and microbiological spoilage.

21. Warmer crop storage conditions (and wetter) will also increase the risk of moulds and microbiological spoilage.

22. Crop failures will also reduce the availability of food and increase food costs to the consumer.

23. Efforts to tackle climate change including sustainability are also likely to increase food costs as yields may reduce with more sustainable agriculture. This includes environmental pressures on agriculture such as the UK 25-year Environmental Plan.

24. Some sustainability measures may further reduce the UK's food self-sufficiency.

25. Environmental measures may impact on fertiliser use and slurry disposal, increasing risks and cost.

26. Key disease factors including Avian Influenza and African Swine Fever will reduce availability of food and increase costs as livestock are slaughtered.

27. Political factors such as Ukraine will also reduce agricultural crop availability as well as impacting on the costs of energy e.g., gas from Russia which affects both gas costs and electricity cost due to UK electricity generation being mainly from gas)

28. Use of land for solar farms may reduce land available for agriculture and hence food, again driving costs up.

29. Shortages of water may lead to reduced hygiene standards both for people and for food preparation.

Member G

30. This is hard to predict, especially in ever changing global political landscape. The distribution chains are probably most complex and fragile than they have ever been. This can lead to greater chance of contamination and fraud. Sourcing food from non-reputable sources could lead to plethora of different outbreak scenarios. Increasing sustainability in food production, with reduced food waste is paramount.

Member H

31. Food safety challenges associated with food supply chain disruptions:

- Increase in attributable foodborne illness from foods that were previously not associated with a specific pathogen or geographical areas that are seeing pathogens not previously seen (e.g. seafood and aquatic condition changes). Indicators: increases in targeted pathogens. Evidence gap: baselines and surveillance is unknown for some areas of the food supply
- Increased spoilage potential, but also increased pathogen levels due to microbial communities on foods (e.g. biofilms as a protective environment for pathogen to survive). Storage and transit cold or hot chains inadequate to keep a controlled environment may be indicators.
- Contamination of the food supply chain due to extreme weather events, pest control. Indicators: changes in reproductive rates or life-cycles of pests as indicators of increased transmission.

32. Recommendations

- Setting up of sentinel sites to monitor key areas of the food supply and known/emerging and re-emerging pathogens with intervention or mitigation procedure in place if a threshold is observed
- Pre-emptively improving infrastructure to improve resilience of the food supply chain

Member I

33. **Immediate-1 year:** extreme weather events affect availability of commodities in established markets causing price increase and changes to the supply chain. This brings microbial issues to UK regarding new country of origin e.g. new AMR patterns, pathogen prevalence. Also, these new untested supply chains may have hygiene/storage problems which can also lead to microbiological events.

34. **1-10 years:** Conflict tends to be long term and as Ukraine has shown, hybrid, in nature. Disruption of supply chains as above but also increased risk of microbiological issues with distribution through 'damaged' supply chain infrastructure e.g. mould growth (mycotoxins) on crops due to inadequate drying infrastructure

35. **10-20 years:** Rising temperature, humidity and frequency of extreme weather events will lead to stress on cold chain distribution systems, ambient distribution systems and increased risk of microbiological contamination e.g. flooding, drought stress in plants.

Member J

36. Climate change issues that affect food production tend to be slow to develop (10 years+ time scale), and agricultural practices tend to change in response to this (for instance, although some areas become less productive, areas which were previously unsuitable for growing crops can become less challenging – take grape production in the UK as an example. Hence climate change in the longer term is less likely to disrupt the food supply chain but moving crop production to new areas make them vulnerable to new diseases. Likewise animal diseases – introducing a new population of naïve animals into an environment also raises the risk of

outbreaks of disease. *There is little chance of predicting what these might be, and therefore the only mitigation possible is to recognise this as risk and establish a watching brief and collate data so that the information can be used to (a) react quickly to new problems within the UK and (b) to use information about patterns emerging from other parts of the world to mitigate against these problems occurring in the future within the UK.*

37. As we have seen recently, geopolitical events can have a very sudden impacts on the food chain. Both disruption of agriculture and increased energy costs have resulted in escalating food prices. Sudden increases in food prices lead to a risk of the consumer seeking out cheaper food supplies, which run the risk of food fraud becoming more widespread. *Monitoring the quality of food sold within the UK by Govt agencies then becomes a key activity to ensure consumer safety.*

Member K

38. Disrupted supply chains due to flooding or environmental damage to roads, railways etc may delay deliveries of foodstuffs resulting in shorter shelf life and possibly higher risk of contamination. It would be useful to map our main geographical areas for food supply and use predictive modelling to identify what major food types and their supply chains may be affected by climate change, this could inform the risk of microbiological hazards in relevant foods in the event of disruption in those geographical areas. It would also be useful to monitor food poisoning events in such a way as the potential link to climate change impacts can be traced back.

• **Changes in methods of food production and new food technologies**

Possible interacting drivers: vertical farming, “blue food”, new food packaging technologies, pressure to shift to sustainable food practices, alternative proteins (insect- and plant-based, cultured meat).

Member A

1. Vertical farming will need massive increase in scale to cope with UK consumer demand, coupled with new technologies to continuously recycle the irrigation water (adding essential nutrients and removing by-products, and sterilising the water e.g., perhaps UV treatment). The infrastructure such as renewable electricity supply will also need to be installed. Consider increased mushroom production to replace meat as this becomes scarcer and more expensive? New algal growth technologies powered by solar energy to produce protein for animal and fish feed, or directly to human. We have discussed insect-based protein production in previous ACMSF meetings, and this is likely to continue.
2. Can fish farming be increased sustainably without harming the marine environment and relying on more antibiotic use driving AMR? Warmer sea temperatures might lead to increased *Vibrio* contamination of fish and shellfish, increasing the risk of foodborne disease (and sea bathing). Indeed, until sewage treatment companies make the massive investment necessary, the risk of faecal pathogens being actively expelled into rivers and coast lines, thereby contaminating fish and shellfish farming sites, remains high.

Member B

3. The threat and also direct impact of climate change on availability of raw materials and food and the potential effect on increased food prices will continue to drive the sustainability agenda. This may lead to reduced processing of food i.e. optimised production techniques, reduced preservation, etc, as well as pressures to increase shelf life of food and also reduced protection of food i.e. packaging. Such combinations can increase microbiological risk and tools to support informed, risk-based developments like these would be useful.
4. New production methods such as vertical farming are likely to increase dramatically especially in the provision of ready to eat fresh produce and also commodity crops. Similar novel processes such as cultured meat and dairy products all need clear industry or regulatory guidance to ensure these developments have the correct food safety frameworks applied to manage their risks.

Member C

5. Increasing changes in weather patterns and climate change will likely continue to result in farmers introducing adaptive measures such as crop diversification, mixed crop-livestock farming systems, changes in planting and harvesting dates, and use of resistant varieties. Although these measures will help to maintain food production, there are possibilities of introduction of unknown foodborne hazards through new crops and cultivation methods.
6. Technological advances (e.g. whole genome sequencing and PCR) will allow improved monitoring for presence of pathogens in waters, farm animals (such as poultry), fresh produce and results from attribution and epidemiological studies should allow more accurate identification of sources of contamination in the food chain. Predicting temperature increases in particular regions and understanding impact on disease and weather forecasting should allow for a more integrated approach to anticipate the impact of climate change – some good examples of these approaches being developed already.

Member D

7. Alternative proteins will present a new disruption to traditional food products/chains. This includes cultured meats, which is growing rapidly in terms of investment, presents new regulatory and safety considerations. Insect protein is also a growing sector in the UK, which presents knowledge gaps in relation to food safety (including the impact of rearing and processing approaches), and challenges in terms of regulation. Other small-scale businesses in the alternative protein space (e.g., the production of plant-based products such as tempeh), may present challenges in terms of food safety awareness.
8. There have been a number of recalls for plant based dairy alternative, such as plant-based drinks (e.g., oat) and plant-based cheeses. Understanding the food

safety risks of these products, including the behaviour of pathogens in these products, requires more research, as this is relatively limited currently.

Member E

9. Make us pay a fairer price to farmers or they'll go out of business.

10. Insect proteins can contain allergens, so we need to be careful.

Member F

11. Businesses may cut corners to reduce costs and energy consumption risking poor food preparation and hygiene.

12. Carbon Capture Scheme by-products may be used for food, but these are industrial by-products from non-food industry so will need careful monitoring and controls

13. Insect and algal foods /animal feeds may be produced by new entrants who don't understand legal food / feed and hygiene requirements increasing the risk of microbiological issues (e.g., insects reared for animal feed on meat-based substrates with associated risks including TSE)

14. Fewer larger livestock units may increase the risk of animal disease spread and failure of the unit.

15. Reduction in use of animal medication (for AMR) may increase risks of animal diseases.

Member G

16. Climate changes (floods/droughts) may lead to change in beef/sheep production and more intensified livestock rearing which in turn may lead to emergence of more virulent and AMR strains of main pathogens.

17. Minimising initial contamination and extending shelf-life is of utmost priority.

Member H

18. A balance is needed to provide certainty of microbiological food safety in times of changing packaging technologies (e.g. a move towards the decrease of plastics and sustainable glues may result in packaging that is more likely to leak).

19. Evidence gaps still exist in the ability of pathogen's to survive and grow on alternative proteins. Baseline surveys are needed as is evidence that changing conditions in the food production system of alternative proteins may create a niche for pathogen growth and survival (e.g. humidity levels may create opportunity in insect protein production systems to foster changing microbial communities, including pathogens). Indicators could include monitoring of environments while knowing what thresholds would be conducive to pathogen growth.

Member I

20. The growing sector of plant proteins will increase risk from toxin producing bacilli e.g. *B. cereus*, and issue with *B. thuringensis* may have to be resolved.

21. Microplastics associated with seafood have been reported to be a foundation for bacterial biofilms which may yet pose a pathogen risk.

22. Vertical farming will bring hygiene challenges already associated with hydroponic systems.

23. Increased use of vacuum packaging in the meat industry (longer shelf life) will require good challenge studies for safety with respect to anaerobic pathogens.

24. Packaging sensors for spoilage/pathogens will need to be independently validated and verified as effective.

Member J

25. The introduction of any species as a food source represents a risk on introducing new pathogens into the human food chain. We are very familiar with pathogens that arise from land-based agriculture due to the long history of usage, however since intensive farming in the aquatic environment is a relatively recent development, less is known about the potential risk of pathogens entering the food chain through this route. In addition, the move towards foods based on the cultivation of algae introduces another unknown source of risk. *As above, there is little chance of predicting what these might be, and therefore the only mitigation possible is to recognise this as risk and establish a watching brief and collate data so that the information can be used to (a) react quickly to new problems within the UK and (b) to use information about patterns emerging from other parts of the world to mitigate against these problems occurring in the future within the UK.*

26. Another area that might pose a challenge in terms of food safety are the recent increases in the cost of packaging materials. This is the result of (a) increase production costs due to global geopolitical events and (b) the introduction of taxes designed to reduce the usage of non-recyclable packaging. These drivers will inevitably lead to changes in food packaging, moving away from established methods to the use of new materials, which runs the risk of unforeseen consequences in terms of food preservation and food safety. *Again, difficult to predict what issues may arise, so monitoring the quality of food sold within the UK by Govt agencies then becomes a key activity to ensure consumer safety.*

Member K

27. The comments and recommendations on this from the June 2022 workshop remain relevant, in particular the need to understand the efficacy of packaging that is replacing plastic in preventing microbial contamination of food. Monitoring of sales of food in alternative packaging and recording of packaging details in food safety incidents would provide useful indicators.

- **Changes in consumer behaviour and preferences**

Possible interacting drivers: food poverty and inequality, changes in food storage/preparation practices, changes in consumer diets influenced by health or sustainability issues

Member A

1. Increases in food prices will inevitably drive food poverty, with consumers looking for “bargains” (poor attribution and adulteration mislabelling, and dubious quality; altered close to or exceeded “use by date”) and also storing food for longer if bought in bulk to reduce cost. Continuing high cost of electricity will lead to increasing the refrigeration temperature to save money, exacerbated by increasing global temperatures. More dried or canned food processing to increase shelf life but problems of scale up?

Member B

2. It is hard to see that the consumer behaviours seen in recent years will not continue such as online shopping, meal delivery, the desire to be more thrifty by reducing wastage through use of leftovers or consuming food beyond expiry dates.

Member C

3. Where food supplies are insecure, people may shift to less healthy diets and may consume more “unsafe foods” – in which chemical, microbiological and other hazards pose health risks. Increasing demand for fresh poultry, coupled with intensive production practices could continue to lead to transmission within and between poultry flocks and amplification of clones may be driven by limited use of antibiotics (e.g., tetracyclines) for disease outbreaks and individual cases. Increasing demand for fresh produce, coupled with increased risk for these foods due to contaminated irrigation water and absence of intervention methods in their

preparation prior to consumption may also lead to an increasing number of cases of illness linked to these foods.

Member D

4. The desire for less processed, 'fresh' foods will continue to challenge food safety, and the novel technologies being applied to meet this consumer demand (e.g., HP, PEF, UV, Cold Plasma, etc.) need to ensure foods maintain high safety standards.
5. In the face of inflation and increasing money demands, there has been increased media reporting on ways to save money through food purchasing/cooking (e.g., the use of microwaves over cookers). They could impact the burden of foodborne disease if this leads to inadequate cooking, or similarly, if people are cooking for shorter times to try to save on bills.
6. Newer trends in the preparation of foods at home may also impact food safety, for example, the preparation of plant-based milk alternative can involve steeping plant material overnight at room temperature. If financial pressures push consumers to rely more on home preparation such as this, it could impact associated food safety.
7. Financial pressure may also lead to more consumers using food's part their Use By date, increasing food safety risks.

Member E

8. Provide accurate information to consumers about whether it's better to buy soya beans from deforested land in south America or milk from a UK cow?
9. Make food tech/cooking part of the national curriculum in schools (nursery to 18) to educate and empower the consumers of tomorrow.
10. It may improve if we educated people to throw less food away.

11. People can't afford the energy prices so turn off fridge/freezer and/or don't cook things properly.

Member F

12. As cost pressures mount on consumers and businesses (particularly food and energy) there will be those who try to economise by increasing fridge and freezer temperatures and also using more food that is out of date, increasing microbiological risks.

13. Increased use of online food and delivered food both bring associated risks especially maintenance of correct storage temperatures during transport

14. Increased use of food banks

Member G

15. Society is becoming more driven by "social networks trending" and being influenced by dubious "health choices" that have not ground in proper science. "Natural" foods are becoming increasingly available, they are not regulated nor controlled.

Disruption of cold chain and temperature abuse in food preparation/storage may become more common due to poverty.

Member H

16. Climate changes will create food product scarcity and supply/demand economics may see prices further increase. This is continuing to have a significant impact on consumer behaviour (e.g. storing food longer, purchasing more affordable foods that may be less nutritionally dense and changing diets potentially for a more 'intermittent' consumption).

Member I

17. Microbiological issues associated with botanical preparations as consumers seek 'natural' remedies.

18. Specialist food preparation practices associated with migrant groups will need to be understood and risks evaluated as the UK population dynamics change.

19. Narrative on 'ultra-processed food' may drive consumers towards 'natural' minimally/no processed foods which may bring new pathogenic challenges.

20. A major issue is the amount of food safety and hygiene disinformation on the web and its influence on adoption of unsafe food handling practices e.g. microwave flour to kill STEC ???.

21. The issue of reduction of food waste has particular traction with younger people challenging adherence to use by dates and increasing drives for food sharing schemes both formal and informal which will stretch hygienic handling practices.

Member J

22. In the face of rising household costs, food poverty and inequality are predicted to increase there will be a shift to an emphasis on longer shelf-life products as consumers try and minimise food waste. This may also result in consumers deciding to ignore or stretch use by dates, which again may pose a safety risk. In households facing fuel poverty, there may be a temptation to store foods that should be chilled at higher temperatures as households try and save on electricity costs – indeed, there is already anecdotal evidence that turning off fridges is seen as a way of reducing energy bills. *The only real answer to this is consumer education, so that they are fully aware of the risks of ignoring food safety information. A key action for the FSA would be an information campaign, targeting this issue.*

Member K

23. The increasing concern about ultra processed food may lead to more people avoiding these and preparing their own food, with resultant risks in microbial contamination if they are not aware of kitchen hygiene principles, which FSA could widely share and promote to mitigate this risk.

28. Challenges associated with changes in the sizes of vulnerable groups

Potential examples to consider: ageing population, poor nutrition of displaced groups

Member A

1. Increased costs and reduced food quality will result in less consumption and poorer nutritional value, particularly affecting the ageing population and pregnant women with higher nutritional needs.

Member B

2. The key issue is whether climate change per se is likely to increase the vulnerability of groups and / or increase the number of individuals who are in vulnerable groups in the UK. It is possible that the impact on weather may prove to be a confounding factor in increasing vulnerability i.e., hot or cold weather stress factors that lead to greater vulnerability to foodborne disease, but this would need to be extreme to have such an effect.
3. Secondly, the question infers an anticipated increase in vulnerable groups presumably due to ageing, but it is not entirely clear whether this will materialise (clearly ageing will but will vulnerability to foodborne disease?) and this may need exploration in itself.

Member C

4. The increasing ageing population in the UK will likely lead to more cases of foodborne illness, due to lack of awareness of effective controls and individuals not following cooking/preparation instructions. Increases in the chilled food market would be one area to focus on here.

Member D

5. The ageing population will continue to put added pressure in relation to infections more severe in this risk group (e.g., *Listeria monocytogenes*).
6. Financial impacts to nutritional quality of diets may also be an issue, in relation to the nutritional quality of food consumer can afford, but also pressures around feeding families (e.g., parents focussing on feeding their children at the expense of their own diet, due to financial pressures).

Member E

Member F

7. Increased ageing population some of whom will have a poor attitude to microbiological safety of food or are not able to adequately prepare their food will increase risks beyond cost pressures above

Member G

8. It is clear that ageing population will increase the importance of foodborne diseases that are likely to become more prevalent, particularly in immunocompromised individuals. Food safety management systems will need adjusting to implement more stringent control for food products that may need to undergo changing in their characteristics to reflect this.

Member H

9. Climate change may significantly increase the size of vulnerable groups and new vulnerable groups may arise. Re-emergence of 'old' issues associated with nutrition and health may increase (e.g., macro and micronutrient deficiencies).
10. The effect of this new increased vulnerability to a lower infectious dose of pathogens, thereby creating new risk groups for foodborne pathogens.

Member I

11. Food inflation driving down food security will be a short-term feature 1-2 years potentially making diets and health worth which is a challenge with pathogen exposure.

12. The continuing aging of the UK population and the size of population on medical interventions will increase risks for foodborne microbiological disease.

Member J

13. The UK population is estimated to grow to 67.1 million in mid-2020 and to 69.2 million by mid-2030, with net migration contributing to about 3% of this number (ONS data). Immigration from particular areas is often associated with new food retailers becoming established, who specialise in importing traditional foods from various regions of the world, and in the past these have been identified as sources of food borne disease as there is less control over the conditions of production and a long transport chain. *Again, difficult to predict what issues may arise, so monitoring the quality of food sold within the UK by Govt agencies then becomes a key activity to ensure consumer safety.*

14. In terms of changes to vulnerable groups it is predicted that there will be an increasing number of older people; the number of people aged 85+ years estimated to be 1.7 million in 2020 (2.5% of the UK population) but is projected to increase to 3.1 million by 2045 (4.3% of the UK population). Hence it is clear that food safety risks for this group will become increasingly important. *The only real answer to this is consumer education, so that vulnerable groups are fully aware of high risks foods – as has been shown to be effective for reducing levels of listeriosis affecting pregnant women. A key action for the FSA would be an information campaign, targeting this issue.*

Member K

15. As the health of the nation is getting poorer, with increasing levels of obesity and long Covid, the number and proportion of people in vulnerable groups is increasing, particular in lower socio-economic groups. They will be particularly susceptible to illness from microbially contaminated food. FSA could work across its disciplines to improve the health of such people with nutritional advice etc, so reducing their risk from food poisoning.

• **Anything else?**

What are other important issues or challenges that the Committee may face in the next 10-20 years?

Member A

1. Increased temperature might force farmers to house animals and poultry inside more often to conserve water and food (if grass and silage become short), and reduce animal heat stress, leading to increased pathogen infection rates due to close stocking rates and changes in diet.
2. Changes from using antibiotics to treat animals and humans to other antimicrobial agents (previously nicin but antimicrobial peptides are now being proposed) poses a future risk of new resistance patterns emerging and entering the food chain.

Member B

3. Concerns have been raised that the recent COVID-19 pandemic could be dwarfed by pandemics from more virulent pathogens e.g., coronavirus or avian flu virus strains. The Committee may wish to consider the prospect of what would controls might be needed if future pandemic viruses could be more readily spread via food.

Member C

4. Covering areas such as algal blooms, impact of mycotoxins – will be overlap with remit of other committees so good coordination is key to dealing with these effectively.
5. Increasing pressure on public health resources (e.g., NHS etc) may result in less effective surveillance of foodborne disease in the UK and fewer food monitoring surveillance studies which reflect the current status of risks in the food chain – this is a concern. If we are not monitoring effectively, it will be more difficult to identify changes and then react to these in a timely manner.

Member D

6. The issue of emerging pathogens and issues which can impact food systems remains a concern. For example, the potential increase in AMR associated with food systems, and global transmission, remains an important issue. In particular, trends on the dissemination of ESBL/carbapenemase resistance could worsen. The emergence of new pathogens that may challenge microbial food safety (e.g., *Staphylococcus argenteus* now connected to foodborne illness, other pathogens such as *Aeromonas* species, LA-MRSA seems to be low risk, but will this change in the longer term?) is a constant potential threat for food safety into the longer term.

Member E

7. Less chilled food chain
8. Underfunded and under capacity water systems/rivers etc. that can't cope with excess rainfall causing flooding in the UK.
9. Develop a more robust UK based supply chain to reduce our dependence on imports.

Member F

10. Impact of biofilms on microbiological contamination

11. Increased international trade including imports from countries whose agriculture and food standards are not as high as the UK's.

12. Higher atmospheric CO₂ can reduce nutritional value of crops (protein and minerals) could mean people are more susceptible to microbiological disease etc.

13. As costs increase there is a greater risk of food fraud as the criminal's cost returns increase

Member G

14. Research is lacking in many areas, hence lack of data for proper risk assessment and evidence-based opinions.

15. Industry reluctance to put more efforts and resources in producing safe(r) food.

16. Education - everything starts from young age; school curriculums need to change and address food safety from early years.

Member H

17. Food scarcity due to climate change may and will require foods to contain be more nutrient dense.

Member I

18. Virology: what if Covid19 had been foodborne??? The story would have been much different. Will the next viral epidemic/pandemic have a foodborne component? An understanding of virus (enveloped and non-enveloped) infection pathways and the role of the digestive tract would help in this regard come the next virus problem, as

would the role of sewage treatment in reducing/eliminating the environmental burden that may pass to fresh produce or sea/freshwater food.

19. Vulnerability of the food industry to cyber-attack and role played by technology in meeting critical limits of CCPs. Could food safety be compromised via hijack of computerised production systems without a food production facility knowing? What is the fallback position?

Member J

20. There is increasing public interest in moving away from the use of chemical food preservation and towards the use of more “natural” (defined as meaning non-synthetic chemical) food preservatives. This has resulted in the introduction of food preservatives being manufactured by the process of fermentation; in essence producing mixtures of organic acids and other molecules by a biological route rather than through chemical manufacture. However, this is inevitably going to introduce more variability into the food preservatives, which may in turn pose a risk to the consumer, especially when these preservatives are added close to their MIC, both to reduce costs and to produce products that the consumer perceives as being “fresher” or “less processed”.

21. In addition, the drive towards reducing the use of traditional chemical preservatives has promoted the use of biological control agents, such as bacteriophage, to target specific pathogens or spoilage organisms.

22. It would be advisable for the FSA to anticipate any potential risks associated with the introduction of such novel preservatives.

Member K

23. Many of the issues raised in the Workshop in June 2022 and their associated actions remain relevant and should be reviewed and included with this year’s report as appropriate.

24. Flooding may lead to contamination of crops with foodborne organisms which together with delayed supply chains and potential food shortages from drought may increase the risk of food poisoning, particularly among vulnerable groups. It may be sensible to increase advice about washing fresh fruit and veg before consumption.