Emerging global food safety challenges and how to address them

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Weaknesses triggered by zoonotic disease and m intensified due

change, a move to plant-based anc circular economies. Here, four experts explore the upcoming issues to be aware of and how we might forge c safe path forwards.

Zoonoses and extreme weather events in Europe compounded by the COVID-19 pandemic, have shone c spotlight on the underlying vulnerabilities of our globc food systems;[1] they are a wakeup call that must be heeded. Moreover, most of our food is not produced ir single production chains, but in a complex web of actors that trade on a global scale. Many influential sectors and drivers for improved food safety in these chains have already been identified; among them: climate change, growing global population, changing patterns of urbanisation, changing dietary patterns anc demographics, water scarcity, and reduced biodiversity (see Figure 1).[2]

These drivers can have direct and indirect effects on the emergence and spread of food safety hazards, and car also be connected or interrelated with each other Critically, these global stressors impact on regional anc often local food safety management procedures tha become incapable of maintaining safe food, resulting ir disturbance of the system and the emergence of c range of food safety hazards

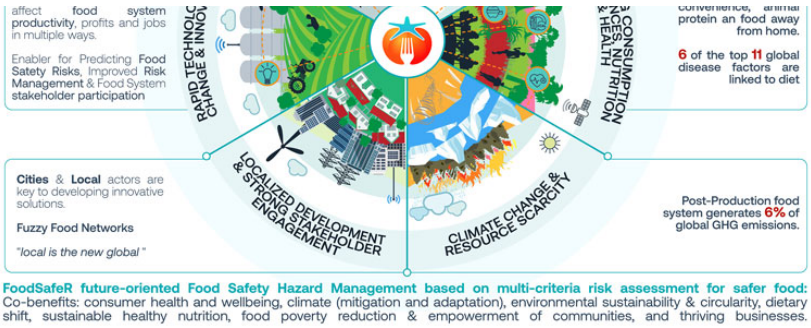

Figure 1

Weaknesses triggered by specific events such as a zoonotic agent or a (carcinogenic) mycotoxin will be heavily compounded in the years to come by climate change, a shift in our food system towards a more plant-based diet, and the need for a circular economy. The contamination of food by microbial agents is a worldwide public health concern as it causes dramatic loss of food due to raw food spoilage (most prevalent in developing countries), food waste and foodborne poisoning

Chemical contaminants in food remain an important public health concern in Europe especially if their concentrations cannot be kept at appropriately low levels as dictated by legislation Food safety management systems which have been established to tackle foodborne hazards including bacteria, parasites, toxins (chemical hazards) and allergens in farming and food businesses, must be further developed and adapted to make them more robust towards these global threats.

Microbial and c

In the EU-27, micro

count for over 95 percent of national food safety violations and 37 percent of Rapid Alert System for Food and Feed (RASFF) notifications. Microbial hazards endangering consumer health include infectious bacteria such as *Salmonella*, pathogenic *E.coli* and *Listeria monocytogenes*, which can lead to illnesses such as norovirus and hepatitis A and E.[3]

Historically, the focus of countermeasures has been on zoonotic pathogen transmission mitigation via animal-based foods. Meanwhile multiple crises have shown that food systems of non-animal origin also contribute their share to d leveraged risk emergence (the sprouts-associated STEC O104 outbreak in Germany and France is one example[4]).

On the one hand,

Plant toxins are expected to emerge in yet unknown areas and situations due to the globalisation of the food supply chain, climate change, online shopping and changing consumer behaviour

climate-based impacts, such as heavy rainfall lead to a higher contamination rate of plant food sources and extensively housed farm animals. Re- and cross-contamination scenarios, revealed by growing research on the persistence of microbiota highly adapted to conditions of modern food production triggered by microbiome studies, show an emerging risk fo processing level.[5] T

circular economy and reuse of water and other organic matter, eg, for fertilisation, adds more pressure on the contamination status of raw food sources and challenges the preharvest food safety management systems. On the other hand the consumption of minimally plant-based processed foods and the use of novel proteir sources has also put previously unsuspected food sources on the microbiological food safety radar Local food distributing systems and alternative, fuzzy food (delivery) networks, including a focus on small-scale artisanal foods, pose new challenges for controlling microbial food safety

Climate change-driven conditions like heavy rainfall lead to a higher contamination rate of plant food sources

The lack of monitoring for viruses remains a major weakness (particularly family-driven outbreaks and there has been very little progress in this area in recent decades. That said, a wide range of viruses were reported in 2019, with norovirus and hepatitis A and E being the most prevalent Overall, outbreak- led to many illnesse hepatitis E, are role

foodborne viruses,[6] with the prevalence of hepatitis E cases having increased 10- fold between 2005 and 2015.[7] The epidemiology of the infection is not fully elucidated and new sources of transmission have been identified in recent years.

Zoonotic microbes are not just critical in terms of pathogenicity, but may also be associated with dangerous genetic elements that confer resistance against antimicrobials and disinfectants, thus making them especially difficult to combat. This also seems to be true for aquaculture production since such production systems leverage the risk by virtue of experiencing enormous growth.

Chemical contaminants in food remain an important foodborne public health concern in Europe.[8] In particular, unintentionally present chemical contaminants in food, such as environmental and food process contaminants (eg, furans) and natural toxins (especially mycotoxins and plant toxins), can pose public health concerns if their concentrations are not kept at appropriately low levels as dictated by legislation. It is alarming to consider that each day the average European food consumer is exposed to a cocktail of (potentially) genotoxic· carcinogenic contaminants, such as mycotoxins at the potential risk levels[12,9]

Weaknesses triggered by specific events such as a zoonotic agent will be heavily intensified in the years to come as a result of climate change

There is also increasing evidence that unexpected biotoxin occurrence patterns due to climate change and combined health risks from exposure to a mixture of chemical contaminants, pose a greater potential risk to consumers[10] There is a high demand to advance existing prediction tools for mycotoxin (co-)occurrence through a big data and machine-learning approach for greater accuracy in forecasting these natural toxins in grains.

Emerging plant toxins, such as pyrrolizidine alkaloids, are a serious food quality and safety concern according to recent EFSA reports.[11,13] Plant toxins may act as genotoxic carcinogens in humans but too little data are available to say for certain, while tropane alkaloids may induce anticholinergic po[11,13,14] known to enter the seds, cereals, tea,

dietary supplements.[12,15] Plant toxins are expected to emerge in yet unknown areas and situations due to the globalisation of the food supply chain, climate change, online shopping and changing consumer behaviour. Currently, risk managers and policy makers are unable to rapidly respond and adapt to emerging plant toxin outbreaks or to assure food quality and safety and protect the consumer. These issues could be addressed by developing tools for the rapid screening of processed cereals and herbal teas

FoodSafeR – a joined up approach

The European Commission-funded FoodSafeR project, which launches in October 2022, will focus on the advancement of innovations to combat emerging microbial and chemical food safety hazards and associated risks of contaminants based on cutting edge science. It is an integrated effort that aims to design, develop and test the building blocks of an innovative proactive and holistic food safety management system with a key focus on emerging risks FoodSafeR embodies integrated approaches to food safety risk identification, assessment and management in a comprehensive suite of future-oriented frameworks, tools, methods, strategies models, guidance and training materials, which will be widely accessible via a digital hub as a key delivery platform for the project outputs FoodSafeR has brought together a world-class consortium of 18 or European countries

SMEs and policymakers.

Going beyond state-of-the-art, the FoodSafeF project will combine mathematical tools tc implement forecasting in food chain networl modelling, aided by classical predictive modellinc encompassing stochastic algorithms anc combining it with molecular analysis and fooc system information. Within microbiological case studies we will work on chain-derived impacts both from a food processing and food distributior point of view. In the field of chemical hazards FoodSafeR's mission is to advance the technology for early warning and monitoring of (emerging biotoxins by taking advantage of cutting-edge technology and expertise in the application o satellite images, machine learning, on-site testinc approaches, big data handling and management

FoodSafeR will also further develop the integrated immunodiagnostic-based 'food smartphone technology as an advancement of the highly successful H2020 FoodSmartphone ITN project. It will also carry out a horizon scanning exercise for the presence of emerging (toxic) secondary metabolites and agrochemicals both in a targetec and untargeted manner using tandem-mass spectrometry and high-resolution mass spectrometry-based metabolomics, respectively Moreover, a major goal is the design of a holistic and proactive framework, considering multiple criteria in risk management and real-time information on the hazards and associ

time data of the indicators)

Indeed, in the complex and evolving field of food safety decision-making, the risk analysis paradigm remains the cornerstone of safe food

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Rudolf Krska is full professor for (Bio-)Analytics and Organic Trace Analysis at the University of Natural Resources and Life Sciences, Vienna (BOKU). He is head of the Institute of Bioanalytics and Agro-Metabolomics at BOKU´s Department IFA-Tulln. Rudolf was the A/Chief of Health Canada's Food Research Division in Ottawa, and currently also works as the Head of Strategic Research at the Austrian Competence Centre for Feed and Food Quality, Safety and Innovation (FFoQAI). Rudolf has received 12 scientific awards and is (co)author of more than 460 SCI publications (h-index: 72, Scopus). In 2018, he became jointly appointed professor within the Institute for Global Food Security at Queen´s Universi
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Oonagh McNerney is the Co-founder and CEO of IRIS Technology Solutions, an advanced engineering company established in 2007 that specialises in photonics and Artificial Intelligence-based process monitoring solutions for Industry 4.0 and Digitalisation. Oonagh graduated from the University of Stirling in Scotland in 1992 with a Degree in International Marketing & Business. From 1993 until setting up IRIS, she worked in the innovation ecosystem in Barcelona with industry, universities and technology institutes, as well as business development agencies in the areas of technology transfer, innovation and business development, in addition to holding a foreign direct investment position with Malta Enterprise. A digital enthusiast, she is passionate about the power and opportunities of digital technology for driving smart industry, as well as for driving the data-driven workplace.

Martín Wagner studied veterinary medicine in Vienna, and is a research fellow at Würzburg University and Complutense University Madrid (1998-2000). He has been the Professor for Food Hygiene since 2000, and the Full Professor and Head of Institute for Milk Hygiene since 2008. He is now also head of the newl
Safety at Univers

In addition, Martín is the Scientific Director of the Austrian Competence Centre for Feed and Food Quality, Safety and Innovation and served as the head of the Christian Doppler Lab for Molecular Biological Food Analysis during 2006-2013. He is the principal investigator and coordinator of FP5, FP6, FP7 and H2020 projects, and has published 250 papers in food microbiology, H-factor of 45.

Chris Elliott is currently Professor of Food Safety and Founder of the Institute for Global Food Security at Queen's University Belfast. He served as Pro Vice Chancellor, responsible for the Medical and Life Sciences Faculty between 2015 and 2018. Protecting the integrity of the food supply chain from fraud is a key research topic and Chris led the independent review of Britain's food system following the 2013 horsemeat scandal. He has recently been elected to chair Foundation Earth's scientific advisory committee, an independent, non-profit organisation established to issue front-of-pack environmental scores on food products.

Chris Elliott AND Rudolf Krska will be speaking at The Food Safety Conference 2022 this October.

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