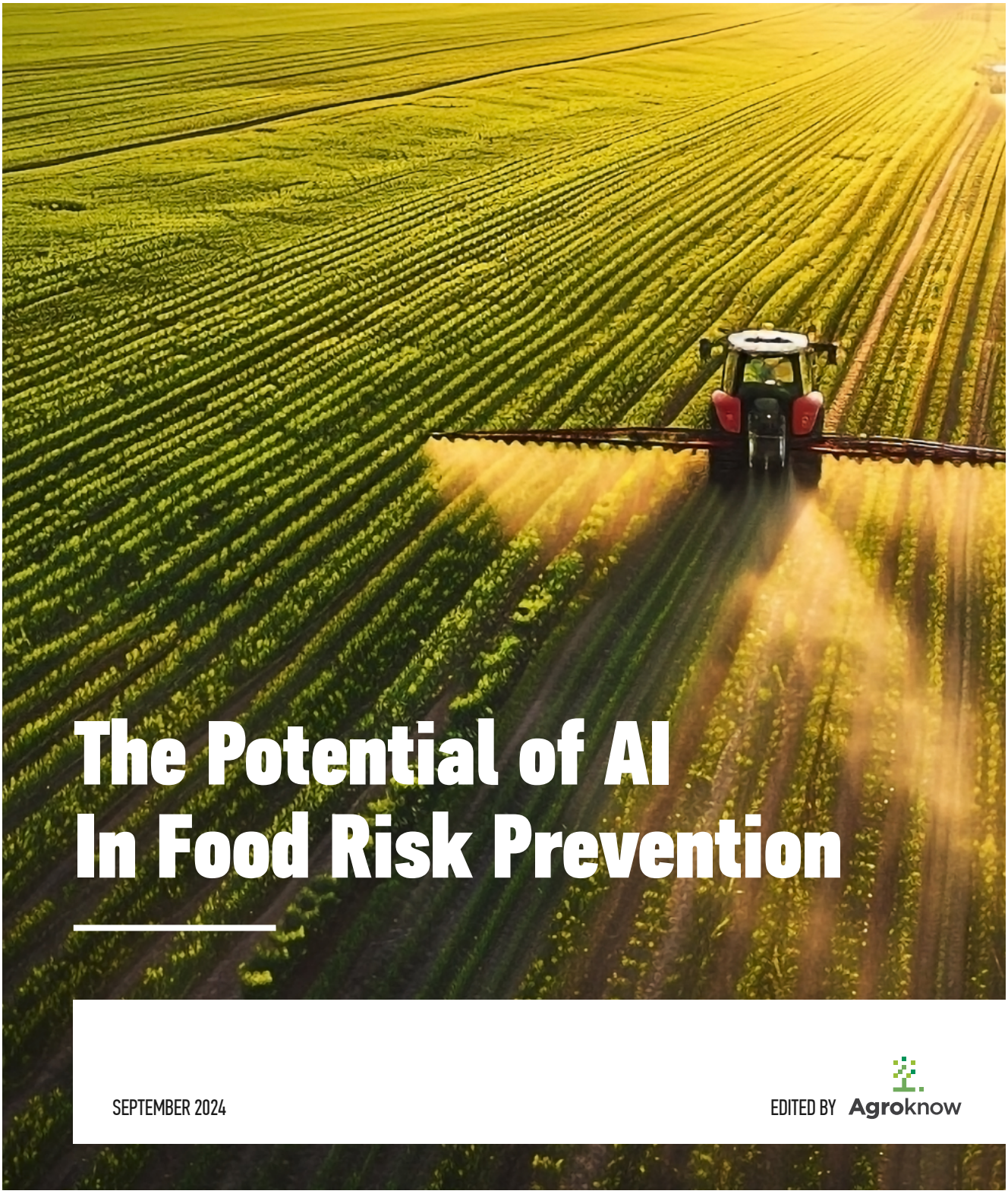
EFRA
EXTREME FOOD RISK ANALYTICS



The Potential of AI In Food Risk Prevention

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EDITED BY Agroknow

This discussion paper was funded by the EFRA EU project, aimed at enhancing food risk prevention through innovative approaches and coordinated by Manos Karvounis, the leader of the Innovation department at Agroknow.

Note: For the above image, we used a word cloud that depicts the frequency of words found throughout the discussion paper. The bigger the word in the image, the more times it was mentioned.

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Foreword

Ákos Józwiak
Chair of EFSA Advisory Group on Data

The intersection of artificial intelligence (AI) and food safety marks a critical juncture in our efforts to enhance public health, food security and sustainable food systems. The profound implications of AI on food risk prevention cannot be overstated, as these technologies promise to revolutionize our ability to predict, detect, and mitigate food safety hazards across the entire supply chain. This discussion paper presents a comprehensive exploration of AI's role in transforming food safety, drawing insights from a diverse array of experts and practitioners in the field.

Artificial Intelligence (AI) stands as a powerful tool, it holds the potential to be harnessed wisely and effectively for profound advancements in food safety. However, like any tool, AI's efficacy and ethicality hinge on its application. Used improperly, AI can lead to misinformed decisions and unintended consequences. Therefore, it is imperative to understand that AI must be guided and complemented by human intelligence to achieve its full potential in the realm of food safety.

Human oversight is essential at every stage of AI deployment. Identifying the right problems, setting the appropriate context, and selecting suitable AI tools are tasks that require human insight. Experts must ensure that data used by AI systems is not only available but also representative and ready for analysis. Once AI systems have processed the data, it falls upon human experts to interpret and contextualize the results accurately and to take appropriate actions based on those insights. This symbiotic relationship between AI and human intelligence underscores the need for a significant enhancement in data literacy across all stakeholders involved in food safety. Without a profound understanding of data principles, the risk of AI being used incorrectly or ineffectively increases, potentially undermining the benefits it promises.

As one of the authors of this paper mentions, AI can be likened to the advent of calculators. When calculators were first introduced, there was widespread fear that they would render mathematical skills obsolete. And they didn't. Instead, calculators became indispensable tools, enhancing the capabilities of those who used them. Similarly, AI is set to become a transformative tool in the hands of skilled professionals. What sets AI apart, however, is its capability to perform tasks beyond human imagination. According to the laws of nature, it is theoretical possible to create an artificial general intelligence that surpasses human intelligence, highlighting the profound potential of AI.

Adapting to the capabilities of AI involves more than just leveraging its ability to perform tasks faster and more effectively. It necessitates

a paradigm shift in our processes and methodologies. AI provides an opportunity to rethink and redesign our approaches to food production, risk assessment, and risk management. Rather than merely replicating existing processes with AI, we need to evolve these processes to fully integrate AI's strengths and accommodate its needs. This transformation also demands a reevaluation of our roles as experts. By delegating repetitive, high-volume tasks that require precision to machines, humans can focus on areas that require creativity, interdisciplinary collaboration, and social understanding.

Such a shift calls for deep discussions on ethics, morals, and the philosophical and policy implications of AI. The integration of AI into food safety is not just a technical challenge but a multidisciplinary one, requiring collaboration across various scientific domains. Ensuring that AI applications are ethical and beneficial involves creating frameworks that address the moral complexities of AI decisions and their impact on society. This collaborative approach will ensure that AI not only enhances food safety but also aligns with broader societal values and expectations.

In conclusion, the introduction of AI into food safety represents both an opportunity and a challenge. While AI has the potential to revolutionize the field, its success depends on wise and ethical usage, guided by human intelligence. By enhancing data literacy, fostering interdisciplinary collaboration, and engaging in deep ethical discussions, we can harness AI's full potential, ensuring a safer and more secure food supply for all.

Note from the Editor

Maria-Eleni Dimitrakopoulou
Research Project Manager

The landscape of food safety is poised for transformation as artificial intelligence (AI) integrates more deeply into the industry. This discussion paper, "AI Potential in Food Risk Prevention," presents a comprehensive analysis of how AI technologies can be harnessed to enhance food safety, mitigate risks, and improve the overall food supply chain. The contributions from leading experts provide invaluable insights into the practical applications, challenges, and future visions of AI in this critical sector.

From the perspectives shared by researchers and industry professionals, it is clear that AI's ability to gather, process, and analyze vast amounts of unstructured data holds great promise. The potential to improve risk assessment models, ensure regulatory compliance, and enhance outbreak detection and response mechanisms are just a few of the exciting possibilities discussed. However, the implementation of AI in food safety is not without its challenges. Issues such as data sensitivity, resource constraints, and the need for ethical considerations and regulatory frameworks are highlighted as significant hurdles that need to be addressed.

The discussion also emphasizes the importance of building trust in AI systems. Transparency, explainability, and continuous improvement are crucial factors that will determine the success and acceptance of AI-based recommendations within the food safety sector. The collaborative efforts of researchers, regulatory agencies, food industries, and consumer associations are essential in creating a robust framework for the safe and effective use of AI technologies.

Looking ahead to 2035, the vision for AI in food safety is both ambitious and inspiring. AI is expected to play a central role in enhancing food safety monitoring, improving traceability, and providing real-time data integration and predictive analytics. These advancements could lead to significant breakthroughs in risk prevention and consumer protection, ultimately contributing to a safer and more sustainable food supply chain.

This discussion paper serves as a vital resource for anyone interested in the intersection of AI and food safety. The insights and recommendations provided by the contributors offer a roadmap for leveraging AI to address the complex challenges of food risk prevention. As we move forward, the collaborative and interdisciplinary efforts of all stakeholders will be key to realizing the full potential of AI in safeguarding our food systems.

Editor: Maria-Eleni Dimitrakopoulou

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Food Risk Prevention Towards the AI Era

The food industry is undergoing a significant transformation, with artificial intelligence (AI) emerging as a driving force behind innovations across the entire supply chain. As the complexities of global food production, processing, and distribution increase, AI offers powerful tools to enhance efficiency, sustainability, and, most critically, food safety. The integration of AI is not just reshaping how food is grown, manufactured, and delivered but is also setting new standards for ensuring that food is safe, reliable, and of high quality.

At the forefront of AI's impact is its role in enhancing food safety. AI technologies are revolutionizing the detection, prevention, and management of foodborne risks. Advanced algorithms are used to analyze vast amounts of data from multiple sources, such as IoT devices, sensors, and scientific publications, to predict and identify potential hazards before they can compromise public health. In food processing, AI-driven systems are automating quality control, ensuring that products meet safety standards by detecting contaminants, monitoring production environments, and minimizing the risk of human error.However, the integration of AI into food safety protocols is not without challenges. Issues such as data quality, privacy, and the ethical use of AI technologies must be carefully managed. Moreover, building trust in AI systems is essential, requiring transparent and explainable models that can be trusted by both regulators and consumers.

This discussion paper explores the transformative potential of AI in food safety, drawing on insights from industry experts, academics, and regulatory bodies. It examines how AI is being deployed to safeguard the food supply chain, prevent risks, and enhance public health. The paper also addresses the challenges that must be overcome to fully harness AI's capabilities in ensuring food safety and outlines the steps needed to create a secure and reliable food system for the future.

Position Statements from Academic & Research Institutes

EFRA
EXTREME FOOD RISK ANALYTICS

Position Statement from WFSR

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In your experience, what are some key decisions in food safety that you have to make where you feel that AI could assist you?

I consider AI as an assistant that facilitates the work of experts in making all sorts of decisions. AI is a pattern and relationship detector that can process "unlimited" data and highlight where to look and when to look. This tool enhances the capacity of a farmer in observing his fields for pests or measuring crop land for forecasting crop amount. Frequent and high-resolution results yielded by AI tools enable us to be proactive against food safety risks.

AI recently assisted me in filtering text documents, translating these documents, detecting weather conditions that yield pest alarms, and identifying crop fields in satellite images.

Are there any specific examples where AI is currently being used in food safety prevention within your organization or industry?

Currently, in my organization AI is mainly utilized in research projects to assess the utility of this technology for food safety. Some of my research is about i) improving pest alarms to limit unnecessary pesticide use, ii) identifying chemicals with minimal number of tests, and iii) forecasting the effect of climate change on food safety. Results of these studies will generate knowledge that will help us to decrease chances of food safety events and take preventive measures. We will also learn under which conditions these AI approaches can fulfil these tasks.

What are the main challenges you foresee in implementing AI for food safety, and what strategies could be employed to overcome these hurdles?

Currently machine learning and deep learning are the most prevalent methods of AI models in food safety. A prerequisite

for these methods is good data. Therefore, potential limitations of data such data originating from the past (i.e., retrospective data) can cause errors when these methods are used to process new data. AI needs big and diverse data. Therefore, data sharing among stakeholders is essential to create high quality models. Moreover, there should be checks and balances in place – human or automated – to assess whether the model created is still valid on new data. When this is no longer the case, for example due to a changing climate, the model should be retrained.

Moreover, it is very important to always collaborate with domain experts when developing such models.

What factors, in your opinion, are crucial for building trust in AI-based recommendations or predictions within the food safety sector?

AI-based recommendations should be accompanied by an explanation. These can be generated automatically. I consider explainable AI as the first step of building trust in AI systems. Next, a model should – in addition to its prediction – provide a score on how reliable this prediction actually is. This is critical when the data on which a model is trained differs from the data the model uses to generate a prediction. Lastly, the possibility to perform a regular manual check to some of the results is an essential component of AI models. I believe these features of an AI model eco-system will increase trust and utility of AI tools.

Looking ahead to 2035, what is your vision for the role of AI in food safety and risk prevention?

We will have significantly more experience in using AI models in 2035. This experience will include when AI was successful and when applying AI does not work. The knowledge gained will help us to utilize AI more effectively. The tools for tracking AI model quality on new data will be much more robust than the initial versions we currently develop. Consequently, AI will be our essential and reliable partner in ensuring food safety.

From your perspective, what would be the ultimate achievement or breakthrough in the use of AI for food safety that we should strive for?

An AI method that integrates data with domain knowledge and understands causal relations will provide us the possibility to utilize AI much more effectively. Integration of multimodality, multilinguality, and explainability to such an AI system will lead to an AI system that is useful for anyone around the world.

I would consider it a breakthrough if an AI system detects the limits of its capacity and explicitly abstains from generating a result under conditions it is not equipped for.

Position Statement from Polytechnic University of Cartagena

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In your experience, what are some key decisions in food safety that you have to make, where you feel that AI could assist you?

I am a researcher in the field of food safety who also eventually collaborates with the Scientific Pannel of national and European food safety agencies. One of the principal challenges we face is gathering information to support risk decisions. This data we need is spread in an unstructured manner among diverse sources, such as scientific publications, reports by food safety authorities, industry data or social media. Gathering and processing this information is often the main bottleneck of the assessment, as this must be done by hand. I firmly believe that AI-based systems show great promise for tackling this type of challenge, as they excel at acquiring, sorting and processing unstructured information.

A second aspect where AI can be of great value is the improvement of risk assessment models. The methods we use nowadays cannot consider the high degree of complexity of the food supply chain. Instead, they require strong simplifications. AI-based models have the potential to increase the number of variables and interactions considered in risk models. They could even incorporate real-time data in the risk estimation, so risk models would naturally improve over time. Both aspects could improve our risk assessment models, ultimately improving consumer protection.

What are the main challenges you foresee in implementing AI for food safety, and what strategies could be employed to overcome these hurdles?

Food safety information is highly sensitive, as any data leak could compromise the public image of a food industry. For this reason, industries are very protective with their data. This is a challenge for the implementation of AI-based solutions, as they need a direct connection to those database. Consequently, I believe that it is extremely important that

AI-systems for the field of food safety follow a “Safety by Design” approach. For instance, architectures based on Federated learning put data protection as a core principle, so they are very suitable for food safety applications.

Another important challenge is cost and resource constraints. Training AI-systems requires considerable investment. On top of that, implementing and maintaining these systems also requires resources and dedicated personnel with profiles not commonly found in most food industries, especially SMEs. In this sense, I believe that advances in decentralized AI-architectures are of high interest for the food industry, as the costs for model development and maintenance can be shared among actors.

What factors, in your opinion, are crucial for building trust in AI-based recommendations or predictions within the food safety sector?

I consider that ethical considerations are essential for AI-based systems to be incorporated into food safety decisions. These systems will be a part of ensuring consumer protection, so it they should ensure fairness and accountability. For this, we require the development of food safety regulation adapted for AI-based systems agreed by regulatory agencies, food industries, consumer associations and researchers. Such regulation would provide the required framework to build trust between AI-based systems and decision makers.

Looking ahead to 2035, what is your vision for the role of AI in food safety and risk prevention?

As mentioned above, accessing and processing information is a principal bottleneck we nowadays face for risk assessment. I believe that advances in AI will rationalize this process during the next decade, enhancing our ability to use that information. This would ultimately foster global collaboration through knowledge sharing, a topic of great importance considering that most food safety (and food security) issues are global challenges.

A second aspect where AI could enable great developments during the next decade is food safety monitoring. Current systems use very limited data: mostly a combination of HACCP, risk assessment and microbiological testing. AI-based monitoring could augment current systems by incorporating other data sources, such as trade patterns, environmental factors, detailed traceability data or image analysis. This could improve food safety assessments at every step of the Food Supply Chain, providing personalized recommendations to improve consumer protection and reduce food waste.

From your perspective, what would be the ultimate achievement or breakthrough in the use of AI for food safety that we should strive for?

Nowadays, food supply is a global endeavour, with ingredients often travelling thousands of kilometers from farm to mouth. Current food safety systems are not able to account for the complexity of this globalized food supply network. Furthermore, these systems are also unable to account for the multifaceted nature of food production, as any food safety intervention also has social and environmental implications.

AI-based systems show great promise for food safety, due to their ability to account for the complexity of the food supply chain. This could bring tangible breakthroughs in our risk assessment, including a better ability to detect emergent hazards, a more rapid response to outbreaks, or surgical food safety interventions that would reduce food waste.

Position Statement from the FoodSafety4EU Platform

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The power of AI in Food Risk Prevention

The role of AI in unravelling and managing food safety risks in the next future has been explored in the Strategic Research and Innovation Agenda for Food Safety in Europe (FS4EU SRIA), recently released by the FoodSafety4EU project, actually evolved into the EU Food Safety Platform. This agenda, focused on priority challenges in emerging food hazards and risks, is the result of a multi-stakeholder co-creation workshop series. The group, involving more than 30 high level experts (from science/academia, industry, consumer associations, food safety authorities) co-designed the topics in the agenda and prioritized challenges and relevant actions, that were then validated through an online open consultation for large public.

The vision for the role of implementing AI in food safety, main challenges and recommendation for future research, reported herein are based on this experts' analysis.

The FS4EU SRIA envisages a key and cross-cutting role of AI in the future EU food safety systems, that can be unfolded in several domains:

- improving integrated risk assessment, including the shift towards non animal methods;
- fostering the integration of emerging technologies for traceability and rapid/ early risk monitoring along the food supply chain;
- identifying, predicting, managing (re) emerging food safety risks in relation to big drivers such as climate change, circularity of resources and transition towards sustainable food productions.

Supporting robust food safety regulatory frameworks, including those addressing new and emerging food safety risks, calls for big data generation and processing to feed predictive modelling tools. The access to this data could facilitate food safety authorities in defining the scenarios, refine risk assessments or measure the impact of emerging risks or new control methods.

One of biggest challenge in this area is to deal with unstructured data (estimated to account for around 75% of the data available in the world today according to EFSA Strategy 2027) and with the huge amount of data from different sources (surveillance and controls, and biomonitoring) that remains under-exploited due to a lack of connectivity or interoperability. In this respect AI implementation in risk assessment is expected to increase exponentially also since it facilitates the integration of data from different sources and automatic processing.

When thinking about future developments of predictive and modelling tools (e.g. predictive toxicology, molecular modelling for in silico-testing), the integration of AI based approaches is expected to significantly contribute to the advancement and implementation a number of innovative methodologies such as alternative approaches to animal testing (NAMs), next generation risk assessment (NGRA) as well as physiologically-based pharmacokinetic

modelling (PBPK) and first-in-human (FIH) pharmacokinetic prediction approaches.

The use of artificial-Intelligence machine learning techniques is advocated by risk assessors to undertake complex issues such as antimicrobial resistance (AMR). The integration of AI, especially deep learning/ machine learning, is playing a key role in understanding how climate change, environmental factors and current practices in food production contribute to the selection and spread of AMR. The huge amounts of data from multiple sources such as data on new AMR genes, mutations, drug identification, conditions favourable to spread, etc, will offer multiple chances to fully exploit the potential of AI in data processing and modelling.

A further contribution to boost safer food chains towards innovation is expected to be the integration of AI in the numerous rapid detection systems at critical control points along the supply chain, generating real-time and diverse data on (re)emerging food safety risks. Some examples of digital devices that can work with AI are wireless sensor networks for monitoring of safety and quality data, biosensors for the detection of food safety hazards (pathogens, chemical contaminants...), lateral flow devices attached to smartphones, biosensors incorporated in packaging materials (intelligent packaging), all allowing the real time generation of food safety data. AI modelling of the above data will improve food chain preparedness for food shortages by decreasing or minimizing food waste (f.i. by improving inventory management, demand forecasting, and expiration date management), and improving logistics. While ensuring its safety, AI could increase also efficiency and productivity of the chain (i.e. it could make automatic some control processes as food safety inspections, contamination tests, equipment monitoring), saving time and resources. A major challenge for implementation can be the cost of these different devices, that can vary widely.

A better implementation and integration of AI in the new technologies, that are being or are expected to be explored, to address traceability and food safety challenges along the food supply chain is advocated, especially when considering food and feed flows

across different countries and continents where different regulations are in place. The integration of blockchain technology with other digital solutions (e.g. codes and smart tags) continues to be regarded as powerful tool to address authenticity vs food fraud issues. Next to sustainability issues (e.g. high energy costs to be considered in applying blockchain-based food chains at large scale), main challenges to be overcome for a blockchain wider implementation are those associated to scalability, security, privacy, and storage capacity.

Another relevant role envisaged for AI to improve the food safety along the chain deals with identification, prevention and monitoring of hazards whose distribution patterns is related to the climate change. This responds to the emerging and future need to elucidate the complex interactions between climate change and food safety. Scientific evidence shows that climate change leads to complex associations with a number of food safety hazards, potentially leading to increased risks of foodborne illnesses and affecting access to safe and nutritious food for people. AI is playing a relevant role in facilitating the exploitation of the available knowledge and big data (relevant to surveillance of environmental health parameters, food safety, human and animal disease). Such data can feed and train AI-based models to understand microbial population dynamics and growth and predict or detect infections at early stages, as for example in the case of toxigenic fungi.

A specific case comes from toxigenic fungi that produce mycotoxins on various crops, when favorable conditions for their production exist, often under warm and humid conditions. Mycotoxins are therefore naturally occurring compounds, whose distribution patterns are highly influenced by climate conditions. Even though representing a well-known hazard, due to climate change influence leading to “unexpected new or increased significant exposure risk”, some mycotoxins are considered as emerging hazards and are still of high priority for EU food safety authorities, as highlighted in a mapping study carried out within the FoodSafety4EU project. Next to enhancing food safety, avoiding fungal contamination has a positive impact on quality, crop yields and therefore on food costs.

Position Statement from FoodSafety4EU Platform

The development and use of predictive models for fungal infection and mycotoxin contamination of crops is a research topic particularly prone to AI developments. In our organization (CNR-ISPA) we are exploring the implementation of artificial intelligence (AI) in metabolomics to obtain a comprehensive study of metabolite changes caused by host(cereals)/pathogen(fungi) interactions, with the final objective of identifying reliable biomarkers for early monitoring of fungal infections. The high-throughput nature of metabolomics experiments and the wide range of analytes covered by liquid chromatography coupled to high-resolution mass spectrometry to be evaluated alone or in combination with data from other sources, result in enormous and heterogeneous data sets. To deal with these data we are building a machine learning algorithm that can recognize patterns in large data environments from untargeted metabolomic analysis. This can be demanding at first stage, since requires the generation of data in standardized conditions to properly train a machine learning algorithm. The result will be an algorithm able to detect markers like plant or fungal metabolites that are produced at early stages of the fungal infection. In addition to implementation of the identified markers for the early detection of fungal diseases (hopefully before mycotoxin production), the ambition of this research is to foster better understanding and trust amongst farmers, and other stakeholders of the utility and reliability of the AI models and the importance of data gathering, sharing and disclosure.

To build or reinforce trust in AI-based recommendations we first need to cope with poor data quality (including unstructured data), and to better inform the end users (policy makers, food chain operators as well as consumers) and civil society about the data curation approaches already in place. Knowing that expert or certified knowledge (generated through brainstorming or other elicitation events) can be incorporated in algorithms at the basis of AI modelling would increase trust by end users. On the other side, involving consumers as source of self-

measured or reported data on healthiness, safety and sustainability of foods, employing AI for the analysis of their input while respecting their privacy, would increase their trust in AI-based recommendations. From food chain/industry perspective, key enabling factors for a trusted AI would be the establishment of AI expert groups and on-site training, complemented appropriate infrastructures for data processing and storage. More "user friendly" AI, using simplified and more intuitive interfaces hiding the technical complexities of machine learning, would empower a wider range of users.

Indeed, in all domains, privacy concerns and data security will remain issues to be constantly addressed in the evolving scenario. Here a major challenge is represented by the lack of standardized communication protocols for the food supply chain, also across countries, that would also facilitate information and data sharing especially with low- and medium-income countries. This latter aspect is particularly relevant since, when thinking to a more trusted AI, we cannot overlook the concept of "inclusiveness of AI". A major ethical responsibility in AI development in the food safety domain is to ensure inclusiveness towards subpopulations at risks.

As science-policy-society interface, from the EU Food Safety Platform perspective the ultimate achievement we should strive for us the integration of artificial intelligence (AI) in the interface between scientific advice and food risk management. AI based modelling and computational tools enable faster information gathering, synthesis, and analysis. Such tools will therefore facilitate evidence-based decision-making, also during food safety incidents, leading to improved crisis management, resource allocation, and response strategies.

AI tools enabling to merge traditional and alternative source of data, such as social media data, to explore consumer opinions, attitudes, and choices, that drive changes in dietary patterns, would support risk assessors in timely identification of consumer insights and trends that can potentially lead to food safety risks, by providing real-time decision-making and recommendation systems.

In the next future, AI will increasingly serve the implementation of the One Health principle in approaching food safety issues. The prediction of future food safety risks will be based on a more comprehensive approach that will model monitoring data on plant, environment, human and animal health, and foster sustainability.

The enabling environment to achieve these goals would include an adequate, and where possible, harmonized legislation on data sharing and data protection, complemented by harmonized and simplified data formats and collection methods. AI can in turn help food business operators to adhere to strict regulatory standards and frameworks, such as ensuring labelling accuracy and other critical quality standards (f.i. Regulation (EU) 2024/1143). Along with a framework for safe and transparent data collection, it is of utmost importance to boost a "data sharing culture" encouraging industries to allow openness of data for use for the public good in collaboration with national agencies and research organization. Finally, for a better AI inclusiveness, national and international policies should foresee means to ensure appropriate infrastructures (connectivity, high performance computing capability, clouds...) including collaborative platforms for knowledge and data sharing, across countries including low- and medium-income countries and rural areas.

Position Statement from Università Cattolica Del Sacro Cuore (UCSC)

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Industry 4.0 is the integration of intelligent digital technologies into manufacturing and industrial processes. Industry 4.0 is not characterized by a single technology. It is defined by the seamless integration of a number of systems, tools, and innovations: industrial IoT networks, AI, Big Data, bio and nanotechnologies, robotics, automation. The Food Industry, in order to respond to the challenge of feeding an increasing population expected to peak at 10 billion around 2080, along with climate change, does require a major transformation of the global food systems. Business as usual is not an option, and the food industry stakeholders will have to make the most of the new information and increase their competitiveness.

The issue remains that data generation is scattered, not standardized and for now not so easily accessible. Specifically, when it comes to quality and food safety data, it is becoming a major challenge to take the most relevant decision, if not the “less bad”. Time to decision is getting shorter and shorter due to (understandable) business pressure, and one does not to ensure prior to this the compliance and relevance of the data available. It is very easy unfortunately to get “drown” in the sea of information and eventually occasionally take a poor decision.

Artificial intelligence in Food Safety has gained a lot of interest in the very recent years, promising to support decision makers

to react fast and accurate to the numerous challenges they will face. It has proven to be definitely a relevant support, but the use of the term intelligence is perhaps overrated. There is still, and probably will always need (scientifically and in terms of liability) a human brain to take the decision.

"A little human choice is demanded by a technology that is non-repeating" (Jaron Lanier, New Yorker, April 20, 2023)

This is precisely where the Food Industry shall not naively jump into "AI" without maintaining capability of analysing data for decision making. These new technologies are a jump forward in terms of capacity, to analyse and decipher massive amounts of data in a short time not achievable by the human capacity. But it is a tool for decision making, not a living entity able to make its own choices. The best example of this remains in the capacity of AI to always predict... the past! but anticipating the future as showcased by marketing campaign, most definitively not. Providing plausible scenarios with a probability of realisation, most definitively. But there will be for long time still someone to be able to step back, reflect and prioritize. An expert, food safety presently. Investing in AI is definitely relevant and there are numerous case studies that show how to gain a return of investment. But it is still needed to invest in people: those who provide the "AI" models, and those who can understand the outcome and have the capability to decide. It starts by working with the relevant partners who do have the knowledge and skills in AI to develop and/or implement models for internal use.

In terms of risk analysis, the concept as proposed by the FAO in 2007 still does apply:

- The risk assessment, science based, can be undertaken partially if not entirely by artificial intelligence;
- The risk management, policy based, in terms of liability and decision making, will still require human intervention.

Artificial Intelligence will most definitively have a major positive impact in the transformation of the food system. How it will be accepted depends on the education and communication that still need to be done to facilitate implementation. Everyone

A little human choice is demanded by a technology that is non-repeating

Jaron Lanier, New Yorker, April 20, 2023

has an opinion about AI, bit how many really understand what it is, and what is the potential (and limits).

As we consider the stakeholder dimensions as enablers of innovation in food safety, the liaison is needed between Science, Society and Policy. The working model along stakeholders is to collect the science, translate it in simple words and educate in an accessible manner to facilitate implementation. Università Cattolica del Sacro Cuore, the most important Catholic University in Europe, has started early 2024 with 17 partners the coordinated supported action CATALYSE Project in the framework of Horizon Europe, to foster innovation in Food Safety: continuous advances in the industrial processes and control measures, pose new challenges in sharing knowledge on innovations among all food system actors. Research in recent years has driven immense advances, but barriers exist that can impede knowledge sharing among food system actors, hindering innovation in food safety. Overcoming these barriers requires a concerted and interdisciplinary effort involving industry, regulators and researchers to discuss and identify food safety priorities and how these can be translated into applying innovative solutions. Some of the primary barriers to innovation in food safety and their impact can be listed as follows:

- Lack of collaboration and Information sharing;
- Regulations, while they are necessary to ensure safe food, they can also stifle innovation, particularly if not well understood by practitioners;
- Costs of innovation;
- Lack of Awareness;
- Lack of Dissemination to Small/Traditional Producers;
- Resistance to Change.

CATALYSE project aims to address these key challenges creating tools to enable new knowledge for safe food productions. Innovative solutions and research approaches generated by the scientific and entrepreneurial community need to be available, applied and fully exploited by the food system. CATALYSE will create effective channels to connect knowledge, making innovation in food safety applicable by all stakeholders and fostering continuous improvements in the European food system.

Position Statement from University of Guelph

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What role does AI have in academia about food risk prevention?

In the academic field we contribute to risk prevention by undertaking research and teaching the next generation of food safety contributors. As with academia in general, the use of AI has not been without controversy in teaching, research, and scholarship. However, AI, a relatively recent innovation in the classroom, has shown promising potential. Within the classroom, AI enabled students to generate assignments within seconds, a task that used to take hours of manual research. There are even cases where instructors use AI to mark scripts – machines marking machines. Beyond the classroom, AI can write papers, proposals, thesis, and lecture material, and perform literature searches within seconds. This has led to debate about the use of AI as a form of plagiarism and, in extreme cases, fabricating whole papers, including results, at the press of a button. On one side of the argument, one could view AI as we once did the calculator with attempts to limit use because it bypasses the intellectual part of deriving the answer. This is correct to some extent, given that AI reduces the creativity and the art of deriving novel ideas and connections. Yet, one can envisage that, like the calculator, AI will become acceptable and invaluable for shifting through the sea of paper publications and "weeding" out invalid ones thereby saving time. Moreover, generating experimental approaches could benefit research by ensuring that the

appropriate tests have been performed. We believe that a balanced approach is necessary, one that respects the intellectual element of research while taking advantage of the new tools available.

What are the main challenges you foresee in implementing AI for food safety, and what strategies could be employed to overcome these hurdles?

Currently, the major challenge of AI within the food industry is that it represents a technology looking for a problem. In a recent conference that had a combination of industry and government attendees, the organizers had an interactive exercise in which groups had to collectively identify applications of AI in food safety. After 30 minutes of collective thinking, the majority of suggestions were more related to data management. For example, retrieving data from environmental sampling or tracing products through the chain. It was also interesting to find that the experts fronting the session were unclear about the industry's and regulators' needs. The same was experienced with the introduction of next generation sequencing (NGS) with projects such as the 100k genome initiative that didn't have a clear purpose. However, through refinement and more clear potential of the technology, NGS has become a routine tool for the early detection of outbreaks and linking cases thereby increasing the likelihood of source attribution.

A further challenge with AI is collecting sufficient volume and quality data from diverse sources to facilitate machine learning. Data can be standardized in large organizations but can be inconsistent and/or not collected by small and medium-sized organizations. All data incurs costs in some form, and the question arises if this should reside with the company or those who utilize the AI output (e.g., verification records for regulator review). Beyond the cost of data collection, privacy issues remain a significant challenge, given the sensitivity of the information being collected. This remains a challenge to most AI applications and is being addressed by encryption, minimal information collected, and indirect

transferring of data to decentralized storage servers, amongst other strategies. Finally, there are concerns if the outputs of AI can be trusted especially when making key decisions based on the generated results. Therefore, rather than blindly trusting the outputs of AI there is the need for a human element to verify accuracy.

What factors are crucial for building trust in AI-based technology in risk prevention and what is the vision the area will be in 2035?

As with all technologies, there is mistrust regarding the privacy of collected data and unknowns relating to AI's capabilities and applications. For finance, marketing, and entertainment, the use of AI is relatively well understood, but in food safety, the benefits are less clear and, in some cases, considered unnecessary. Consider the early introduction of Hazard Analysis of Critical Control Points (HACCP) in the 1970s. There was significant pushback from the industry due to the lack of knowledge about hazards, implementation, and a general consideration that there was no food safety crisis. However, as history illustrated, food safety became a crisis point in the 1980s with Listeria monocytogenes and Salmonella outbreaks and BSE's emergence. HACCP was revisited, and Codex Alimentarius established standards for introducing the food safety management system. Within a decade, HACCP principles were introduced across the globe. One can envisage a similar evolution in the application of AI.

In relation to food safety systems, AI is already being considered for inspection oversight of Food Business Owners (FBO) to identify high risk facilities. This would ease inspection for regulators and enable allocation of resources within a risk-based inspection system. Yet, with the power of AI it will be possible for food processing facilities to generate custom food safety plans. Since the inception of food safety management systems, a key challenge is how to translate regulations (for example, those regulations under Safe Foods for Canadians Act) into practice. The current approach is to provide descriptive guidelines in which the Food Business Owner is required to interpret. This can be challenging especially in relation to identifying foreseeable hazards and preventative control measures. It can be envisaged that AI could take information of the facility and product to generate a custom preventive control plan/Hazards Analysis Critical Control Points plan along with how to monitor, respond to deviations and compiling reports. In effect, each FBO will have a prescriptive plan that can be verified by the AI of regulators – again machine monitoring machines but in a positive way. This is one

example of a range of AI applications that deliver positives in the field of food safety.

A further application of AI would be the prevention of foodborne illness outbreaks before they begin. A study of foodborne illness outbreak investigations frequently identifies a "perfect storm" of incidents leading to contaminated products arriving on the consumer's plate. For example, an Escherichia coli O157:H7 outbreak linked to contaminated lettuce was linked to several events. Specifically, manure runoff from an upstream cattle feedlot contaminated irrigation water that was subsequently used on a romaine lettuce crop. There was a snap frost prior to harvesting the crop that enabled E. coli O157:H7 to infiltrate into the damaged lettuce tissue. The crop was harvested and underwent a post-harvest wash in which the free-chlorine concentration had depleted due to sequestering by organic loading. In effect, the wash process caused the dissemination of contamination across the lettuce batches. In hindsight, the outbreak could have been prevented if the sequence of events had been identified, which was not the case at the time. However, AI could have collected data by sensing the water quality and monitoring weather patterns, and the wash process could have broken the chain, thereby preventing the lettuce from reaching the market. Moreover, AI could be applied for more effective targeting of risk management practices and predicting the impact of extreme weather events.

The power of AI is currently used to detect foodborne illness outbreaks but could also be applied in the response. For example, AI could assist in generating and disseminating surveys to those who have been caught in the outbreak. Here, purchasing records could be collected, and then surveys could be sent automatically to enable more complete data sets to be collected. As an extension of public outreach, AI could strategically release social media posts to inform food safety practices in the event of outbreaks and in general. The use of AI to detect outbreaks through monitoring social media posts relating to illness has been researched for several years. However, such approaches have been challenging due to unreliable posts that may not be related foodborne illness. Interesting correlations have been made with respect to outbreaks and sales of medications (for example, anti-diarrhea medicines). It can be assumed that

as the power of AI increases, the data mining and refinement would increase the accuracy of models generated.

Today, technology exists to apply AI to prevent foodborne illness outbreaks, and this could potentially become routine by 2035.

What would be the ultimate achievement or breakthrough in using AI for food safety that we should strive for?

The concept of AI can be traced to the 19th century and emerged as a science in the 1950s. It was the coming together of enabling technologies of Big Data, and AI that has moved beyond playing chess to practical utility in banking, marketing, and, more recently, entertainment. As with many technologies, AI has filtered down to the food industry, which includes food safety. The key is to take the language of AI with that of food safety to facilitate practical application. One could say that the breakthrough event has already occurred with predictive modeling of pathogen behavior within food systems along with increasing the power of analytical techniques. The key event will be the application of AI in the routine implementation in managing Food Safety Systems, thereby removing the human element. Yet, there will always be a need for a human element, given machines can learn from the past but struggle to predict the future of emerging food safety issues.

Position Statement from University of Veterinary Medicine Budapest

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Applying AI methodologies could influence food safety in numerous areas, from leveraging AI capabilities in everyday work (e.g., screening huge amount of literature), through the capacity to connect and analyse vast amount of data (e.g., IoT and remote sensing), to discovery of patterns and new insights. In this short summary, I would like to concentrate on the disruptive and game-changing nature of AI in food safety. Our current understanding of the direction and the dose-response relationship of risks relies mainly on knowledge inferred from animal studies. Nevertheless, these are inherently biased, uncertain, and also challenged on ethical-moral dimensions. Enabling the widespread application of computational toxicology, in silico modelling, or in general: data-driven approaches, we could have a deeper, more reliable and more extensive understanding of how chemical contaminants affect our health. Moreover, an AI-assisted approach would enable 'live evidence mapping', i.e., a continuously (and automatically) updated, interoperable knowledge corpus on a particular chemical.

Discovering emerging risks and evaluating the effect of drivers (e.g., climate change) is a central question for food safety. Nevertheless, this is a question of high complexity in a (complexity) scientific meaning: food system components interact in multiple ways, leading to "non-linearity, randomness, collective dynamics, hierarchy, and emergence"[1]. For finding the 'unknown

knowns' and 'unknown unknowns', we need to leverage the ability of AI to collect and filter large amount of information, in order to help in knowledge mapping and detecting emerging patterns. Beyond that, in this complex system, to derive insights and predictions leading to better preparedness, we need the tools of computational science, including AI methodologies.

This ability of AI methodologies to capture system complexity could be used in other areas of food safety from supply chain monitoring and predictive analytics, through improving food inspection procedures, to food fraud detection (where also other, socio-economic drivers come into picture). Nevertheless, we need to re-think the current food safety processes. The power of AI is not in replicating human thinking and doing conventional processes more efficiently. It is more about changing the current paradigms (and adapting processes to AI needs) to leverage the power of AI. This needs an adaptation from food safety professionals and institutions, and for this, we need to overcome a few challenges.

Besides regulatory, ethical, privacy and trust questions, the most pressing constraints are related to data quality and availability. Accurate AI models require large amounts of high-quality data. In food systems, data very often are fragmented, inconsistent, biased, not granular enough or simply not available. In most cases, we are very far away from having representative, standardised data, let alone FAIR (findable, accessible, interoperable, reusable) datasets. To overcome this issue, we need to invest in data generation, and in improving data infrastructure to ensure the collection of consistent, high-quality data. Promotion of standards for data (and metadata!) collection and sharing across the industry is vital to improve the interoperability and enable the use of AI systems[2]. Taking a long-term perspective, improving data literacy across all stakeholders of the food systems is a prerequisite for future food safety.

If we will be successful in providing good quality data in a standardised, interoperable way, this would enable better (more detailed, stronger evidence-based) risk assessment, near-real time tracking, monitoring and prediction, allowing for better preparedness, prevention and intervention, consequently saving lives and improving quality of life and sustainability. Nevertheless, the ultimate breakthrough in the use of AI for food safety would be a deeper (mechanistic) understanding of the role of food and diet on our health, and precisely describing the factors influencing this. The vision which we need to strive for is to finally connect food composition, contamination and consumption data to health and nutrition data. Currently, we lack even the basic prerequisites for this (i.e., we don't have a molecular level compendium of food composition), but utilising the powerful abilities of AI methodologies in evidence generation and handling large amount of interconnected data, food exposome (foodome) research could finally lead to useful insights. This could revolutionize nutrition science – also exploring the role of food processing on health –, and change how we produce food: designing functional, healthy, wholesome, sustainable foods could be boosted, and personalised nutrition, safety and health advice would be possible.

[1]Worlds Hidden in Plain Sight: The Evolving Idea of Complexity at the Santa Fe Instituite. Santa Fe Institute, 2019

[2]EFSA (European Food Safety Authority), Abbinante, F., Basic,S., Foster, D., Fuchs, K.,Georgieva, N.,Jozwiak, Á., Nellemann, Ch., Maldonado, A., De Martino, M., O'Dea, E., Scharfenberg, E., Stack, M., Tuominnen, M., Volatier, J.-L., Wienk, K., 2024.2023 Annual Re-port of the Advisory Group on Data. EFSA supporting publication 2024:EN-8760. 13pp. doi:10.2903/sp.efsa.2024.EN-8760

Position Statements from Industry Professionals

EFRA
EXTREME FOOD RISK ANALYTICS

Position Statement from Crème Global

Creme Global

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In your experience, what are some key decisions in food safety that you have to make where you feel that AI could assist you?

Whilst we do not make decisions on behalf of our clients, the AI we design and implement offers our clients the ability to make better decisions surrounding their quality or regulatory policies and practices. This has the associated effect of making risk identification and management easier, as real-time intelligence facilitates a real-time response.

Are there any specific examples where AI is currently being used in food safety prevention within your organization or industry?

AI is currently being used in our predictive analytics projects for identifying potential food safety breaches before they occur, based on machine learning models that analyze historical data to predict future outbreaks. Looking at all manner of contaminants, our models aim to provide our customers with the ability to uncover geo-temporal patterns in contaminant proliferation in order to inform mitigation strategies, as well as to provide early detection for emerging contamination trends.

What are the main challenges you foresee in implementing AI for food safety, and what strategies could be employed to overcome these hurdles?

So much food safety is locked in unstructured data sources, but even more data is locked behind closed doors outright. Building out both better data harvesting capabilities and building connections with those who hold the keys to accessing crucial data are challenges that can both be overcome at the technological and inter-organisational levels. This way we can work towards complete transparency between industry and regulators. Building trust is crucial for any

long-term plan to build out an AI framework in the context of food safety. We are acutely aware that we need to have total confidence in the outcomes we produce - when it comes to Food Safety, lives are on the line.

What factors, in your opinion, are crucial for building trust in AI-based recommendations or predictions within the food safety sector?

Even though so much of our day-to-day life is guided by unseen algorithms, to convince people to place their trust in AI takes special effort. We have seen in the last few months just how much consumers care about transparency in training data, so ensuring that the use of data is transparent to all stakeholders is a top priority. Naturally, it's also important to be able to demonstrate that the models you are using are providing accurate information also. Additionally, with AI becoming increasingly regulated, it's important to be able to navigate a brand-new legislative environment with poise and confidence. Providing as much transparency on the data via dashboards and visualisations as possible instils more confidence in the users of the model.

Looking ahead to 2035, what is your vision for the role of AI in food safety and risk prevention?

The global food supply chain is under the most intense pressure it has ever experienced right now, and this may only get worse. Accordingly, we need disruptive change to ensure the ever-growing global population is fed with nourishing, safe food. By 2035 the people of the world will need to be the beneficiaries of a completely new and harmonised framework of food safety practices across the whole supply chain, with data and AI at the core. Not only would this cause foodborne illness to plummet, but also enable the right nutrients to get to people in need.

From your perspective, what would be the ultimate achievement or breakthrough in the use of AI for food safety that we should strive for?

The ultimate achievement would be to reduce foodborne-illness related deaths to 0 by creating a global, AI-powered network that provides real-time monitoring and risk assessment for the entire food supply chain. This system would predict potential outbreaks before they happen, recommend preventive measures, and facilitate rapid response to emerging threats, thereby ensuring the highest standards of food safety worldwide.

Position Statement from Food Fortress

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In your experience, what are some key decisions in food safety that you have to make where you feel that AI could assist you?

As a network of businesses monitoring contaminations in feeds and feed materials we are regularly detecting levels of mycotoxins which have the potential to impact on animal welfare and performance. The ability to manage and effectively mitigate the effect of these events can be improved by a more detailed understanding of the patterns of contamination in terms of seasonal variations, the effect of weather and the level of risk associated with materials from different origins. Detailed analysis of historic data can help us identify the trends in contamination occurrences and can help predict periods of high risk. AI can assist in the processing of this data and in the production of predictive models.

Are there any specific examples where AI is currently being used in food safety prevention within your organization or industry?

Preliminary work on the application of AI analysis to test results from feed materials - specifically maize from various regions of the world would suggest that predictable patterns of mycotoxin presence can be identified which can inform risk management strategies. Testing priorities can be adapted in light of the calculated risk in a particular season or origin of material.

What are the main challenges you foresee in implementing AI for food safety, and what strategies could be employed to overcome these hurdles?

The successful implementation of AI principles to the challenge of managing food safety will depend on a sufficient volume of reliable data – in the form of historic test results – on which to base the calculated predictions. The Food Fortress results database comprises 10 years of results from the mycotoxin testing

program covering approximately 3,000 samples of compound feedstuff supplied by feed manufacturers and over 2,000 samples of feed ingredients from the importers and suppliers of raw materials. We believe that this will provide a sufficient basis for the AI analysis and for trends to be identified and valid predictions to be derived from them.

What factors, in your opinion, are crucial for building trust in AI-based recommendations or predictions within the food safety sector?

The ability to identify and quantify the key variables which influence the occurrence and severity of the mycotoxin threat from key feed materials will be essential to meaningful outcomes from this work. Accurate prediction of contamination patterns which allow focused testing programs and effective mitigation strategies to be developed will be welcomed by the food and feed sectors.

Looking ahead to 2035, what is your vision for the role of AI in food safety and risk prevention?

In the future I would expect to see the food industry adopting surveillance programs based on robust AI generated risk predictions. These programs will reflect a wide range of potential contaminants, including new and emerging risks, and they will be cost effective in delivering a high degree of security and confidence to an industry which will put an increased emphasis on food safety.

Position Statement from Maize

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A JAKALA COMPANY

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In your experience, what are some key decisions in food safety that you have to make where you feel that AI could assist you?

AI offers huge opportunities to improve food safety in different scenarios, by coupling pattern recognition and predictive capabilities of AI models with the richness of data available on the internet and from IoT sensors. In our company, MAIZE, we provide knowledge, strategies and solutions to enhance businesses through the transformative capabilities of AI; our expertise lies particularly in transforming unstructured multilingual contents into knowledge. Therefore, we will focus on scenarios involving the analysis of multilingual textual contents.

Within this context, in our opinion, 3 key decisions where AI could assist business decision are:

- **Regulatory Compliance:** AI can assist in ensuring compliance with food safety regulations by analyzing regulatory documents, monitoring practices and food safety authorities reports.
- **Outbreak Detection and Response:** AI can analyze data from various sources, such as social media, healthcare records, and consumer complaints, to detect potential foodborne illness outbreaks in real-time. This early detection can facilitate rapid response efforts in order to mitigate the impact of outbreaks.

- **Risk Communication:** AI can analyze consumer data and sentiment to understand public perceptions and concerns about food safety issues. This information can help authorities and food industry stakeholders (e.g. to communicate effectively with the public, address concerns, and build trust in the safety of the food supply).

What are the main challenges you foresee in implementing AI for food safety, and what strategies could be employed to overcome these hurdles?

One of the primary challenges in implementing AI for food safety is the inherent tradeoff between the interpretability and accuracy of AI models. On one hand, simpler models such as linear regression or decision trees (because of their internal logic and decision-making processes) tend to be more interpretable; however, these simpler models often lack complexity and flexibility. On the other hand, more complex models like deep neural networks have demonstrated remarkable accuracy and predictive power, but they are "black boxes" due to their opaque internal workings.

While techniques like LIME and SHAP have been developed to shed light on these models, they have their own limitations and may struggle to provide clear and reliable explanations for highly complex models. Another significant obstacle in explainable AI (XAI) is the lack of standardization and consistency among techniques, because for the same AI model, different XAI methods may produce varying or even contradictory explanations, leading to confusion and undermining trust in the explanations themselves. This lack of standardization can be particularly problematic in domains like food safety, where accurate and reliable explanations are crucial for ensuring accountability, ethical decision-making, and regulatory compliance. To address these challenges, ongoing research into improved XAI techniques is crucial. Recent advancements, like large language models providing human-readable explanations, show promise, but maintaining accuracy is essential. Establishing guidelines and frameworks for XAI could also enhance consistency and reliability across different methods, mitigating confusion and inconsistencies.

What factors, in your opinion, are crucial for building trust in AI-based recommendations or predictions within the food safety sector?

Building trust in AI-based recommendations or predictions within the food safety sector is a critical issue, given the potential consequences of errors or biases in this domain. Several key factors are crucial for fostering trust:

1. **Transparency and explainability:** the ability of AI systems and Explainable AI (XAI) techniques to provide clear and understandable explanations for their decisions is essential for building trust, particularly in critical areas like food safety.
2. **Accuracy and reliability:** while explainability is important, it cannot come at the expense of accuracy and reliability. Rigorous testing, validation, and continuous monitoring of these AI systems are crucial to ensure their accuracy and reliability over time.
3. **Accountability and oversight:** trust in AI-based food safety recommendations requires a clear framework for accountability and oversight. There must be mechanisms in place to identify and address mistakes, biases, or unintended consequences of these AI systems.
4. **Ethical and unbiased decision-making:** explainability can help detect and mitigate biases, but it is also essential to incorporate ethical principles and fairness considerations into the design and training of these AI models from the outset.
5. **Involvement of domain experts and stakeholders:** building trust in AI-based food safety recommendations requires close collaboration and involvement of domain experts, such as food scientists, safety inspectors, and public health officials to provide valuable insights, validate the recommendations, and ensure that the AI systems are aligned with industry best practices and regulatory frameworks.
6. **Continuous improvement and adaptation:** as new data, regulations, and challenges emerge in the food safety sector, AI systems must be capable of adapting and improving over time.

Position Statement from Maize

Looking ahead to 2035, what is your vision for the role of AI in food safety and risk prevention?

Looking ahead to 2035, AI will play a central role in enhancing food safety and risk prevention across the entire food supply chain. Here's some examples of how AI could be transformative in this domain:

Data integration and predictive analytics: the ability to integrate various data sources (IoT sensors, supply chain logistics, consumer feedback and more) and analyze in real-time to detect anomalies, identify emerging risks and provide predictive analytics on potential food safety issues before they occur.

Intelligent processing optimization: optimization of processing parameters like temperature, humidity and equipment settings to minimize risks and maximize quality.

Traceability and root cause analysis: provide comprehensive food traceability from farm-to-fork: if any safety issues arise, it can rapidly trace back through supply chains to pinpoint root causes.

Regulatory compliance and standards uniformation: interpret and uniform fragmented food safety regulations across regions; AI can assist companies in maintaining compliance through automated document analysis, standards mapping, and real-time monitoring of operations against requirements.

While exciting, this AI-driven future for food safety is not without challenges; ensuring AI systems remain transparent, unbiased, secure, and aligned with ethical principles will be critical.

From your perspective, what would be the ultimate achievement or breakthrough in the use of AI for food safety that we should strive for?

The ultimate achievement or breakthrough in the use of AI for food safety that we should strive for is the development of a food safety management system that would leverage the full power of AI to proactively identify, mitigate and prevent food safety risks across the entire farm-to-fork supply chain. At its core, this system would employ advanced machine learning models capable of continuously learning and adapting to detect even the most subtle patterns and anomalies that could signify potential food safety hazards. The system would utilize XAI techniques to ensure transparency and interpretability, allowing human experts to understand and validate the AI's decision-making processes. Additionally, this system would incorporate advanced natural language processing capabilities, enabling it to communicate food safety guidance and recommendations in a clear, personalized manner to consumers, taking into account individual dietary needs, risk profiles, and cultural contexts.

Contributing Organizations

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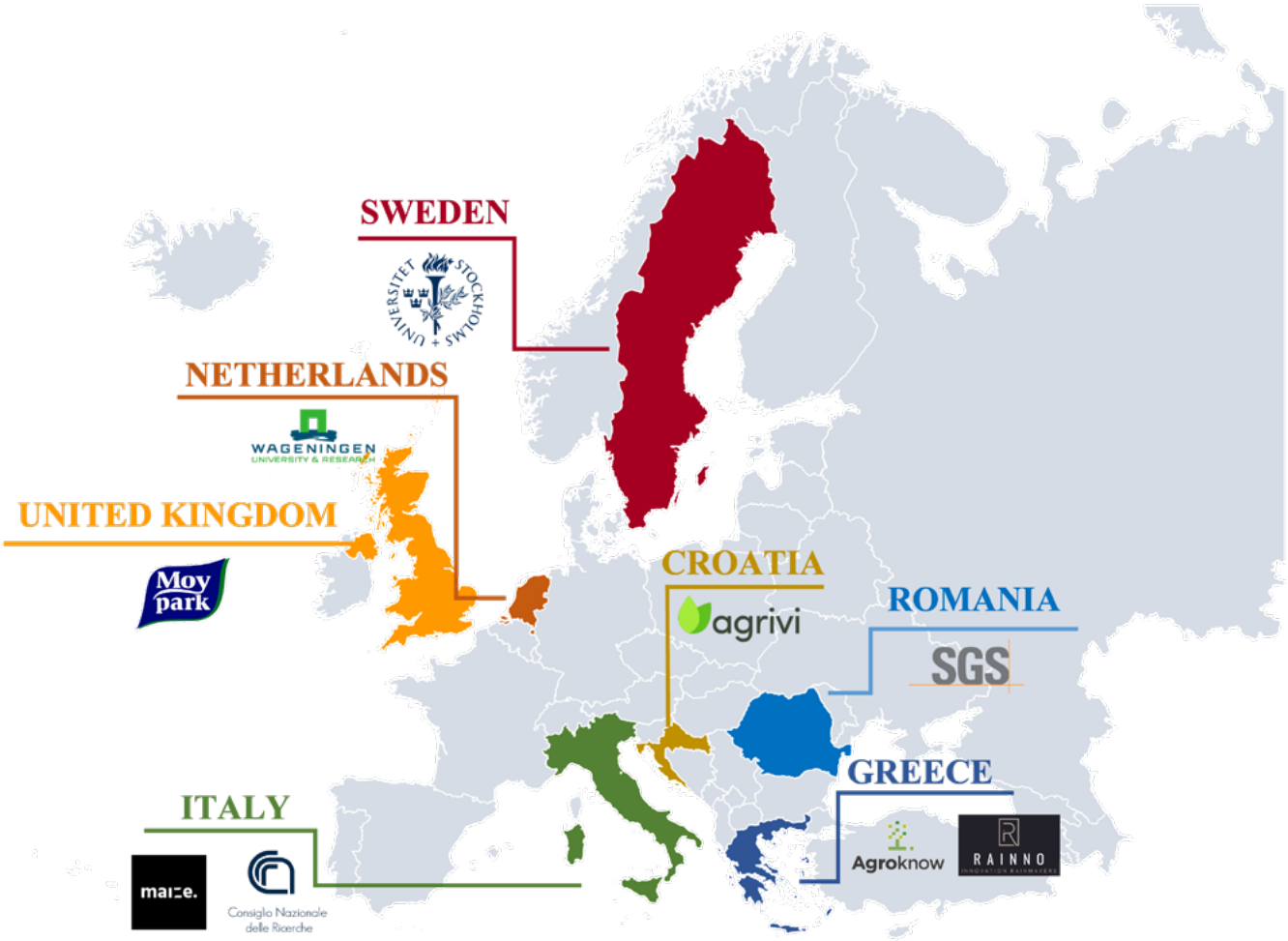
EXTREME FOOD RISK ANALYTICS

Let's Ensure Safer Food For All



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