DIGITALIZATION, FOOD SAFETY AND TRADE

INTRODUCTION

Information is required for food safety decision-making by all stakeholders in the food system continuum— from primary producers through to the consumer and all the actors in between, including risk assessors, policy-makers and communicators. Despite the increasing complexity of food systems, digital technologies are permitting the collection of an unprecedented amount of data from a virtually unlimited number of points along and around the food chain. The synthesis of these massive amounts of data requires considerable investment but can yield unparalleled insights and information applicable to food safety, public health and trade never before possible following the analysis of smaller isolated datasets.

The enhanced understanding of factors contributing to the occurrence, survival, and transmission of foodborne hazards allows for the development of new, more effective, risk mitigation interventions. Artificial intelligence and machine learning programs are also finding expanding application in food production systems and specifically in the assessment and management of food safety risk.

Perhaps the most visible impact of digitalization on society in general and food systems in particular, lies in the way information is exchanged. There is growing attention globally to e-certification as a means of increasing the efficiency of cross-border movement of food and agricultural products while also reducing opportunities for fraud. Distributed ledger technologies are expected to enhance the transmission of information of food and food ingredients throughout supply chains and e-commerce is changing the way in which food is marketed. Additionally, the communication revolution impacts directly on consumers' attitudes through the ready availability of real-time information and, in some cases, mis-information about the safety and quality of foods.

The sharing of digital information will introduce a new level accountability among actors at all stages of the food chain and enhance confidence and trust among trading partners and consumers alike. However, the adoption of digital technologies also raises questions about data ownership, use, privacy, sharing and transparency that must be addressed.
The session will provide an overview of key aspects of digital transformation of food systems that impact on food safety and their direct and indirect consequences on trade. Both opportunities and challenges will be discussed, with particular consideration of the perspective of developing countries.

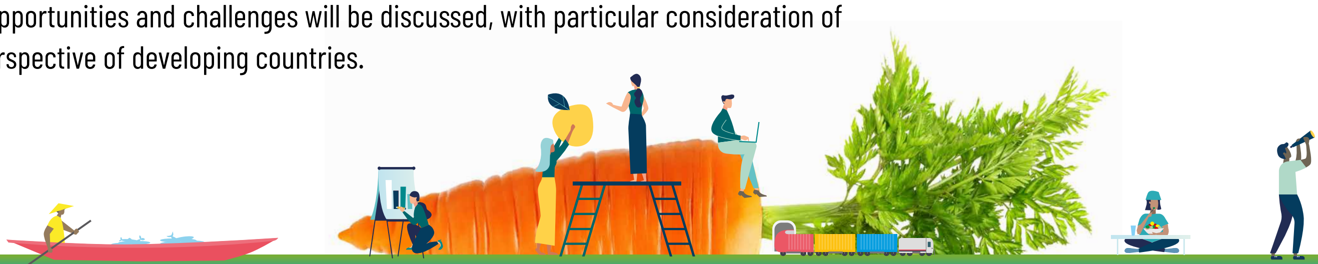
KEY MESSAGES

There are considerable opportunities for gathering, integrating and analyzing data to predict, assess and manage food safety risks.

Availability of information with increased transparency can spur innovation and build trust, leading to stronger economies and new trade opportunities.

Platforms for diverse activities such as e-certification or e-commerce can streamline and expedite cross-border flow of foods and agricultural products but will also require new governance approaches to ensure safety.

Digital divide requires attention as the opportunities for digital transformation of food systems continue to outpace preparedness for the transformation.



BIG DATA IN FOOD SAFETY

Worldwide, over 25 billion devices are currently connected to the internet. Around the globe, the total number of sensors, monitors, computers, smartphones and other devices communicating with each other—through the Internet of Things (IoT)—is expected to exceed 75 billion by 2025. When applied to food safety, it is important to recognize that data may be collected from a very wide variety of sources and sectors (e.g. precision agriculture fertilization history, transport temperatures, geo-spatial, environmental and temporal metadata, hospitals records, ports of entry for imported foods, or sensors on individuals refrigerators or attached to personal smart phones). Such data complexity mirrors the increasing complexity of food supply chains and requires enormous (zettabytes[1]) amounts of storage. Data mining tools such as web crawling, web scraping, data-mining and text extraction from scientific, industry and government databases can yield valuable information to better understand food safety hazards, and control measures and their implications for trade.

The types and kinds of data available for collection in the food chain are diverse, often highly unique for each specific food commodity and extremely interrelated. Because of the cost of data collection, validation and storage, consideration should be given to determining the purpose of the data collection, who will shoulder the cost burden, what are the real and perceived returns on investment in each sector, and who benefits from the investment in data collection. Importantly, priorities for data collection by agro-enterprises may be different from those desired or required by regulators, trading partners, or other stakeholders, such as the public. Stakeholders are accessing and leveraging the opportunities of big data at different rates. Many private companies, in order to promote their business interests, are already exploiting digital information in the food industry. One example is the tracking of customer food purchases using frequent shopper cards, information that can also be useful in food recalls. However other businesses, especially those in developing countries or small- and medium-sized enterprises, may lag behind in leveraging this technology because of lack of information, access, or resources. Governments, too, are taking advantage of big data for food safety purposes, for instance in the use of whole genome sequencing to aide in outbreak investigations. Regrettably, many regulatory agencies are often slower to keep pace with these advances.

Use of big data in food safety is not without potential pitfalls. Bias is of concern. Data that is collected by convenience may not be representative. For example, using food safety and food system data collected in mature economies or from large-scale food systems may not represent the situation in low- and middle-income countries or from small and medium-sized agro-enterprises. Thus, regardless of the thousands or millions of data points that are subsequently used to develop models, these models, albeit perhaps extremely precise, may not be appropriate for use in all regions or economies of scale. Data ownership, equitable contributions and access by individuals, organizations and countries with different levels of IoT connectivity, and assurances of privacy are also issues of potential controversy that are best addressed prior to data collection.

ARTIFICIAL INTELLIGENCE IN SUPPORT OF FOOD SAFETY RISK ASSESSMENT

Some practical uses of Artificial Intelligence (AI) applications have already been successfully integrated into food supply chain management to improve the sorting of foods, monitoring personal hygiene of workers, and assessment of equipment cleaning. More advanced applications of AI lie in the potential of synthesizing scientific studies and data to develop of models to inform food safety decision-making which are quicker and less prone to human error and bias introduced by humans. For example, artificial neural networks have been the basis for the development of early warning systems for food safety monitoring. Other applications of AI with direct application to trade can be found in the area of prevention of food fraud and adulteration to identify foods in commerce that may violate trade rules and/or present a threat to public health. Self-updating risk models that recalculate risk associated with changing of food ingredients/supplies have been proposed.

Importantly, AI applications are being applied in the field of food safety risk assessment. Chemical risk assessments have traditionally relied on costly and time-consuming modelling based on animal testing, limiting throughput and raising animal welfare concerns and applicability to humans. With the current ability of computational and mathematical approaches using large quantities of data, predictive models are being generated that are based on high throughput cellular and *in vitro* assays, structural homology of chemicals and shared biochemical pathways, with the goal of facilitating a more inclusive risk assessment that ultimately is expected to aid in the faster and cheaper development of international food safety standards. The potential for machine learning to inform microbial risk assessments is still less developed, yet progressing quickly. Machine learning is being employed to harness the wealth of foodborne pathogen genomic sequence data to predict health outcomes and improve hazard characterization of specific pathogens in risk assessment models.

Robust risk assessments are the basis for standard setting and fair trade and can be enhanced with AI as described above. On the other hand, recognizing patterns with artificial neural networks deep learning and other AI and machine learning tools, often involves such complexity it is not always possible to interpret or explain the models that underpin the output. Use of such "black-box" techniques is problematic from both scientific and regulatory transparency perspectives; presents challenges for legal enforcement and communication and represents a potential barrier for adoption of the use of this technology.

E- CERTIFICATION: A TOOL SUPPORTING THE FACILITATION OF "SAFE" TRADE

International trade in food and agricultural products has grown from 63.8 billion USD in 1970 to 1.6 trillion in 2016. Greater efficiencies in the way border transactions are carried out – without

[1] One zettabyte is 10^{21} bytes; equivalent to 10 billion semi-trailer loads of books.

compromising effectiveness of control – are necessary to lower the cost of doing business. Governments around the globe have been reviewing and adjusting their systems of control and their approaches to enforcement to deal as best they can with this reality. One of the tools for achieving this is e-certification.

For over two decades several countries have been engaged in the promotion of e-certification but there has been limited uptake. Early adopters were Australia, New Zealand, Japan and the Netherlands: these early efforts by leading countries evolved towards the development of international reference standards such as the UN/CEFACT standards for the electronic transmission of (Sanitary and Phytosanitary) SPS certification data. According to a 2017 survey by The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), globally, around 50 countries have e-certification capability regarding exports. Fewer have the capacity to clear imports effectively using e-certification most countries still require paper SPS certificates to accompany electronic versions and there would be less than 5 economies that are fully paperless with regard to SPS certificates.

Since the ratification of the Trade Facilitation Agreement, activities have gained pace across SPS domains. The International Plant Protection Convention (IPPC) developed an e-certification hub for phytosanitary certification and is currently winding up implementation of a global pilot with funding from the Standards and Trade Development Facility. To date, 31 countries are registered with the hub and at least 5 are actively exchanging e-certificates. The World Organisation for Animal Health (OIE) is carrying out a consultation with stakeholders as a basis for developing guidance for member states on e-certification for animal health. The Codex Committee on Food Inspection and Certification Systems (CCFICS) has been discussing the use of electronic certificates, in lieu of paper, since 2014 with a view to developing international guidance.

Success in terms of a global push for e-certification to facilitate efficiencies in trade depend on three major factors:

- there is sustained effort to build capacities of increasing numbers of developing countries to establish the necessary regulatory frameworks and to effectively implement the monitoring and verification activities that underlie certification processes;
- there is international agreement on precisely what information needs to be transmitted (through a precise data table of fields and characters), access and exchange rules; security, etc;
- that the digital divide is overcome, and lower income and least developed countries will be able to benefit from paperless trade.

TRACEABILITY, THE INTERNET OF THINGS AND DISTRIBUTED LEDGER TECHNOLOGIES

Blockchain technology is a form of distributed ledger technology (DLT) that acts as an open and trusted record of transactions among parties that is not stored by a central authority. Instead, a copy is stored by each user running Blockchain software and connected to a Blockchain network—also known as a *node*[2]. This technology introduces the possibility to manage information and trust in completely new ways that need to be understood in order for food supply-chain to seize the new opportunities that they present. Blockchain solutions represent a technology capable of responding to the food supply-chain challenges connected to security and portability of data able to guarantee a distributed and trustable traceability of food products.

When linked to smart contracts and with the support of data-mining/artificial intelligence (AI), DLT solutions can expedite trade and enhance food control systems. For example, remote data collected on food safety parameters can be analyzed and be used to develop risk-based priorities for inspection in the food chain. DLT has its limitations which may render the technology unsuitable for certain use cases. Currently public blockchains still impose high-energy consumption for their consensus mechanisms, even if new solutions are being implemented to address this challenge. Likewise, the costs related to the digitalization of detailed-traceability should be balanced against correlated advantages and disadvantages. Other challenges include, but are not limited to, data protection, governance, or confidentiality of information.

Without a common ontology of the data and a shared governance model able to respond to the needs of standardization and the openness of blockchain, the advantages of the technology might not be fully exploited. There are also other inherent limitations for blockchain food traceability adoption. For blockchain to be effective, there must be participation from all parties and points of contact involved, assuring an integrated use of the technology.

The food supply-chain DLT will certainly need to be complemented by IoT and AI solutions to better guarantee its operability. Practical and low-cost solutions might bridge the gap of the digital competence barriers that currently exist; access to simple and accessible user-interfaces might also empower the diffusion of the technology.

Public institutions have a role in the standardization of DLT solutions to be able to respond to the challenges imposed by the adoption of DLT technology and assure inclusivity, transparency and minimum standards able to assure adequate security and use of data.

E-COMMERCE

The value of e-commerce was estimated at 27.7 trillion in 2016. The power of e-commerce to open access to markets is seen as an important development opportunity, however, according to the e-Trade Readiness Index, most least developed countries (LDC) are poorly prepared to compete in this space. E-commerce in food represents a small (1.5 percent) proportion of food commerce but is expected to grow to 8 percent by 2025. For example, between 2016 and 2017 the value of e-traded foods increased 52 percent. Food is not a commodity like any other: not only must countries be prepared in terms of the infrastructure and laws governing e-trade, there must also be assurance that food safety regulatory frameworks protect consumers equally from food purchased through e-commerce as through traditional marketing systems.

Situational awareness is one of the characteristics of sound national food control systems[3]. With increasing

[2] Berryhill, J., T. Bourgery and A. Hanson (2018), "Blockchains Unchained: Blockchain Technology and its Use in the Public Sector", *OECD Working Papers on Public Governance*, No. 28, OECD Publishing, Paris.

[3] http://www.fao.org/fao-who-codexalimentarius/codex-texts/guidelines/en

volumes of food being traded through e-commerce, regulators must consider how and if the evolving system of marketing poses food safety risks to consumers. While existing food safety legislation, including rules on the hygienic handling of food apply to those marketed through e-commerce, further regulatory attention must be paid to: (i) ensure that all actors in the food e-commerce chain, including internet platforms, have well defined responsibilities and that there is adequate surveillance and enforcement; (ii) review specificities of record-keeping and transparency requirements; (iii) consider the impact of e-commerce on cross-border controls and import formalities (the differences in terms of food certification, documentary and other food safety controls, between normal importations and internet-based purchases for self-consumption); (iv) ensure adequacy of information provided to the consumer at the point of purchase; (iv) assure the protection of consumers' rights related to distant sales.

Discussions with managers of e-commerce platforms dealing in food products suggest that there is considerable variability in the extent to which they exercise control of the safety and authenticity of the products sold on their platforms. Most often, these platforms act as agents and not as direct sellers, so some jurisdictions would not consider them as food operators, and they would not be bound by the same responsibilities as food operators. The lessons learned by the food industry and regulators in the wake of the horse-meat scandal in 2013 point to the need for adequate control of brokers and agents.

Unfortunately, there is no explicit international guidance available to assist national regulators regarding e-commerce and the trade of food, and consumer protection. Discussions are planned within the Codex Committee on Food Labelling (CCFL) on providing guidance on the labelling of foods sold through internet/e-commerce. A questionnaire to understand current practices was sent to Codex members and the results of this will be the basis for CCFL discussions at its next session in May 2019.

THE DIGITAL COMMUNICATION REVOLUTION

It is also generally recognized that consumers are a key partner in national food safety systems and that constructive engagement between regulators and consumers is not only good, but necessary. The dynamism and related technologies of the systems is rapidly evolving and becoming ever more complex. For instance, new analytical techniques that reveal minute traces of previously undetected contaminants are available, even to the consumer; novel foods and formulations are being introduced, many of which are produced far away from the consumer, at multiple locations and through innovative means (eg 3D printing) and with new ingredients. There is global agreement that food safety standards should be based on science. This is especially true in a multi-lateral trading environment where harmonized standards and agreed approaches to regulation are critical to achieving efficient and safe trade. Unfortunately, experts often have difficulties communicating food safety risks to the public, a problem that is further complicated by the differing perceptions of risks held by experts and consumers.

The challenge of building trust, and hence confidence in the safety of the food supply and an enabler of trade, is directly related to recent changes in how food safety information is exchanged in the digital age. Paralleling the changes in the food system is the advent of a plethora of new pathways for communication, notably the internet and social media platforms. These digital platforms may provide powerful complements to traditional communication tools to increase transparency, accountability, and permit real-time tracking of food safety issues for large numbers of people. Food safety authorities should evaluate the best ways to harness new information and communication technologies to enhance consumer awareness and build trust, keeping in mind it is often difficult for consumers to differentiate between fact-based stories and unverified and false information. Additionally, it is important to recall that access to information via the internet is biased by wealth status, level of education, location (urban vs rural) and gender. A focus on digital communication strategies could disadvantage segments of the society in need of particular attention with respect to food safety information.

THE FUTURE OF **FOOD SAFETY**

Transforming knowledge into action for people, economies and the environment

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International Forum on Food Safety and Trade