Food and Agriculture Organization of the United Nations

Layman's guide to food safety in Asia and the Pacific

1

Introduction to the food safety toolkit

FOOD SAFETY
TECHNICAL TOOLKIT FOR ASIA AND THE PACIFIC

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1

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TECHNICAL TOOLKIT FOR ASIA AND THE PACIFIC

Food and Agriculture Organization of the United Nations
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Abstract

Food safety is a fundamental element of food security. To provide safe foods, food safety has to be connected to all the other elements that touch it and surround it. In our ever-changing world, these elements may remain scattered, neglected or unclear. This document provides a layman's introduction to many food safety topics that are currently observed in the area, providing a list of possible documentation to rely on and asking to the readers some questions that cannot have one unique answer, but that rather invite for reflection on what can be done at the national level. This guide also serves as an index to the entire food safety toolkit, a collection of written materials on the less mainstream topics of food safety, but on which the readers are invited to read more detail and reflect. The contents are reported in the form of a small and unconventional handbook that aims at being referred to regularly by, and within easy of access of, those who interact daily with food safety.

Contents

Acknowledgements

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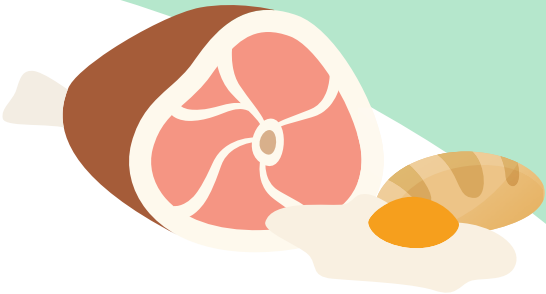
Acronyms

AMR	antimicrobial resistance
FAO	Food and Agriculture Organization of the United Nations
FSANZ	Food Standards Australia New Zealand
GM	genetically modified
GMO	genetically modified organism
OIE	World Organisation for Animal Health
UN	United Nations
WGS	whole genome sequencing
WHO	World Health Organization

1 Introduction

Food safety in Asia and the Pacific

Across Asia and the Pacific, news on food safety issues and incidents frequently hit the headlines. Reports of food contamination and foodborne illnesses regularly cause alarm among the public and impact local businesses. This, in turn, has wider negative economic consequences as trade and tourism are adversely affected and the image of a country is associated with unsafe food. The concern among consumers reflects a lack of confidence in the way food safety is enforced and practiced. It also echoes the necessity for greater investment in infrastructure and technical capacity to assure that all foods available in the marketplace are safe for human consumption, by default. It is now well-recognized that food security, food safety and nutrition go hand-in-hand, and achieving zero hunger within the framework of Sustainable Development Goal 2 (SDG2), entitled "Zero Hunger" is not simply about providing adequate food for everyone, but ensuring safe and nutritious diets for all.



Microbes are the number one killer in food safety

Food safety is a complex issue that requires the attention of many different sectors and stakeholders. While many people may think primarily of it from the point of view of chemical contamination, the biggest problem for food safety are microbiological contaminations, including viruses, bacteria and parasites. These microscopic living things have the power of making our food unsafe, causing thousands of deaths every year. According to global estimates of the burden of foodborne diseases, the Southeast Asia region has the second highest burden of foodborne diseases after the African region, with more than 150 million cases and 175 000 deaths annually.[1] Also, every year, as many as 125 million people in the Western Pacific region fall ill from contaminated food resulting in more than 50 000 deaths. Foodborne diseases kill 7 000 children under age five in the Western Pacific region alone. Out of 50 000 deaths in the region each year, 7 000 (14 percent) are children under age five. Of the 125 million people who become sick from contaminated food, 40 million (32 percent) are children under age five.[2] While these numbers are shockingly huge, the public perception of the risk of microbiological contamination in food is surprisingly low. This is one of the reasons why the Food and Agriculture Organization of the United Nations (FAO) and its partner agencies and bodies, including Codex Alimentarius, often focus on the topic of microbiological risks in food, and develop various materials and tools for countries to effectively manage the relevant risks.[3]

[1] More information is available at https://apps.who.int/iris/bitstream/handle/10665/327655/WHO-FOS-15.8-eng.pdf?sequence=1&isAllowed=y

[2] More information is available at http://mobile.wpro.who.int/mediacentre/releases/2015/20151203/

[3] Visit the resources that the Joint FAO/WHO Expert Meetings on Microbiological Risk Assessment (JEMRA) for more information on this important topic http://www.fao.org/food/food-safety-quality/scientific-advice/jemra/

Chemical additives, residues and contaminants

Following the risk of microbiological contamination is potential chemical risks, which do receive public attention. Codex Alimentarius has multiple standing committees to deal with potential chemical risks such as food additives, chemical contaminants, pesticide residues and residues from veterinary drugs.[4]

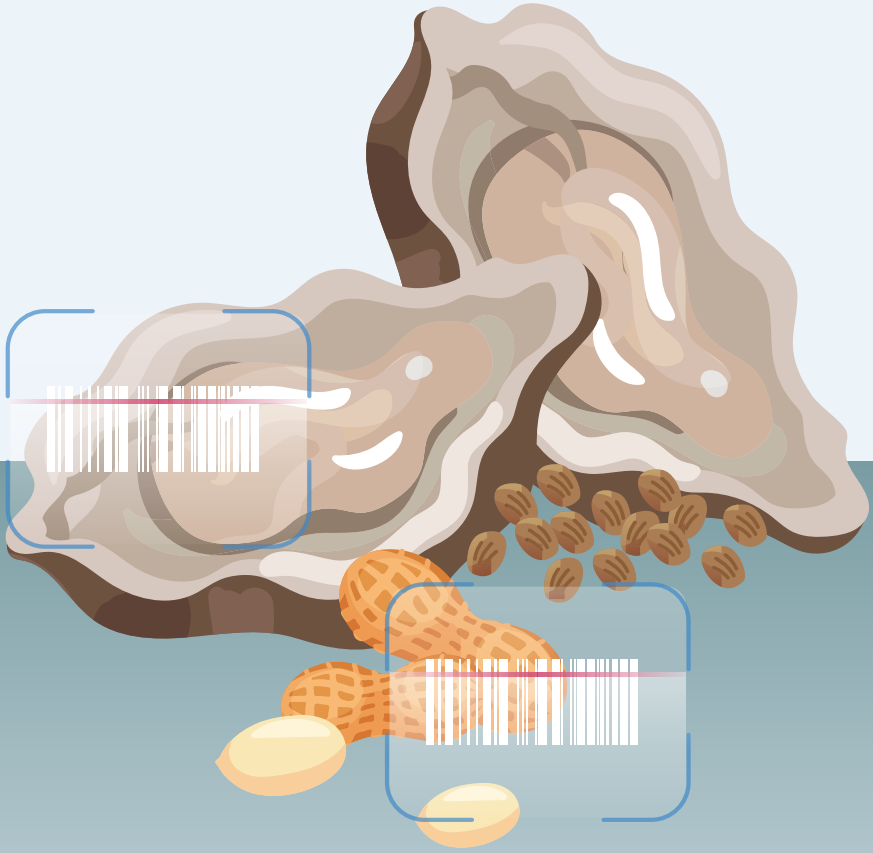
Bringing the spotlight on "non-mainstream" food safety issues

The aim of the present toolkit as a whole is to highlight some of the very important, but not-so-mainstream food safety issues for technical officials working in food safety competent authorities in Asia and the Pacific. Complementing the already existing, valuable documents on both microbiological and chemical risks to food safety, this set of booklets touches on issues that might have been neglected, or issues that people might not consider as food safety issues but which have significant impact on food safety.

Layman's guide to food safety in Asia and the Pacific

As the first booklet of the toolkit, the present document entitled "Layman's guide to food safety in Asia and the Pacific" introduces some "hot" and "classic" topics in the area of food safety in the region, and serves as an index guide for the rest of the toolkit. It is not an extensive or comprehensive guide, but it can be used as an entry point for each topic of food safety.

[4] Visit the resources that the Joint FAO/WHO Expert Committee on Food Additives (JECFA) for more information on the work of FAO for provision of scientific advice to Codex Alimentarius http://www.fao.org/food/food-safety-quality/scientific-advice/jecfa/



2 A to Z regional food safety issues

A

Allergies

See booklet 4: "Food allergies – Leaving no one behind".

Did you know that shellfish allergy is the most common food allergy in Asia (Lee *et al.,* 2013)? And that compared to other countries in the world, the Asian population is less allergic to peanuts (Lee *et al.,* 2013)?

In line with a global trend, food allergies are likely to increase in our region (Shek and Lee, 2006). Researchers worldwide are studying the reasons why people are becoming more allergic to foods. Even though some theories have been formulated to explain this phenomenon, no concrete reason has been identified yet. Epidemiological data and research may help our understanding of what the environmental and genetic factors can enter into the risk equation.

Selected data on food allergies in Asia

Shellfish is a very common food allergen in Asia, and is a leading cause of food-induced anaphylaxis in South East Asia, although not in the Republic of Korea or Japan.

Wheat allergy is the most common cause of anaphylaxis in Japan and the Republic of Korea, and is increasing in Thailand.

Bird's nest is a common cause of anaphylaxis in Singapore.

In India, legumes – particularly chickpeas – are a major allergen due to their high consumption.

Anaphylaxis, due to the ingestion of wheat flour contaminated with dust mite, was often reported in regions where warm and humid climate promotes the growth of dust mites, especially in stored wheat flours.

Reports of allergies to galacto-oligosacharide-containing formulas are also common in Southeast Asian countries.

Reports of allergy to peanuts is substantially lower compared to other regions.

Source: Lee *et al.*, 2013

Diagnosing food allergies for a large population can be an exhausting and complex procedure, but knowing personal allergies is a fundamental step towards improved conditions and food safety. Food allergies affect human health, social life and financial resources of people, and efforts to identify effective diagnostic tools and improve the quality of people's lives can begin with good communication and clear instructions.

Consideration points

- The number of reported food allergies is increasing throughout the world.
- Awareness raising and education on food allergies for the food industry and consumers is essential.
- Food labelling is one of the most effective ways to inform consumers with allergies.
- Diagnosis of food allergies is often difficult, but continuous efforts to develop effective diagnostic tools are being made. Supporting research and development of diagnostic tools facilitates the detection of food allergies in humans.

While looking into your national context, be aware that Codex Alimentarius established a list of the most common allergenic foods associated with immune reactions through the Codex Committee on Food Labelling. This list was established on a worldwide basis, and includes peanuts, soybeans, milk, eggs, fish, crustacea, wheat, and tree nuts. The list established by the Codex Committee on Food Labelling also includes gluten-containing cereals (wheat, rye, barley, oats and spelt) that are implicated in the aetiology of gluten-sensitive enteropathy (FAO & WHO, 2001).

Further readings

- **FAO.** 2001a. Overview on food allergies. http://www.fao.org/3/y0820e/y0820e04.htm#bm04
- **FAO and WHO.** 2001a. Evaluation of allergenicity of genetically modified foods. http://www.fao.org/3/y0820e/y0820e00.htm#Contents
- **Taylor, S.L.** 2017. Food allergies – An increasing public health concern. http://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FMeetings%252FCX-712-49%252FPresentations%252FTaylorCCFHChicago2017.pdf

A

Antimicrobial resistance

See booklet 8: "Slowing down superbugs – Legislations and antimicrobial resistance (AMR)".

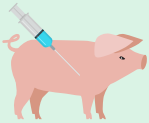
How do you track down antimicrobial resistance (AMR)? In 2015, a group of scientists tried using toilet waste from international aircrafts to determine whether AMR bacteria was present (Petersen, 2015). Toilet waste is a much-underestimated source of information, if you know what to look for. In fact, AMR pathogens may use toilet waste as a route to spread themselves, just as much as drinking and eating contaminated water and food products.

AMR data and facts

If no action is taken, antimicrobial use is predicted to rise by more than 50 percent by 2030 (Van Boeckel *et al.,* 2015).

There is a correlation between AMR levels and poor sanitation conditions (Collignon *et al.,* 2018).

The Asia-Pacific region has no surveillance network for AMR, and much data are missing (Yam *et al.,* 2019).



73 percent of all antimicrobials sold in the world are used for animals that are raised for food production (Van Boeckel *et al.,* 2019).

The largest hotspot of AMR in animals is in Asia, which is home to 56 percent of the world's pigs and 54 percent of the chickens (Van Boeckel *et al.,* 2019).

The majority of low- and middle-income countries have minimal or zero programmes to monitor the use of antimicrobials in food animals, food products and humans (Founou *et al.,* 2016).

It has been reported that, if left unchecked, drug-resistant diseases could cause 10 million deaths per year by 2050, with a catastrophic effect on the global economy, costing more than USD 100 trillion (O'Neill, 2014). The spreading of these superbugs creates the potential for future pandemics, but at the same time, in the last 30 years, no new class of antibiotics was launched. Key global efforts to address the rising spread of AMR was dedicated to preventing the spread, particularly through a tripartite collaboration among FAO, the World Organisation for Animal Health (OIE) and the World Health Organization (WHO) (see FAO, OIE and WHO, 2010g).

Consideration points

- DNA sequences of superbugs could provide more details and precise information that can be useful to fight them.
- Reducing antimicrobial usage to the minimum necessary is important, not only for the health-care situations, but also for the food, agriculture and aquaculture fields.
- Collaborations among health professionals, veterinarians, primary producers, food safety authorities, educational institutes and media is important to address AMR.
- Reviewing the legal food safety frameworks through the lens of AMR is effective to identify and address potential weaknesses in providing a comprehensive regulatory response to AMR.

Superbugs have become globalized, and as such, they are a global problem. This is why the Codex Alimentarius recently established a taskforce dedicated to AMR to provide internationally recognized standards to guide national food safety authorities with managing AMR. Meanwhile, FAO is helping countries assess their national surveillance and laboratory capacities, and together with WHO and OIE, it has signed a tripartite agreement to share responsibilities and coordinate global activities to address health risks at the animal-human-ecosystem interfaces.

Further readings

- **FAO.** 2020a. Antimicrobial resistance. http://www.fao.org/antimicrobial-resistance/
- **FAO.** 2020b. Antimicrobial resistance: Background. http://www.fao.org/antimicrobial-resistance/background/fao-role/
- **FAO.** 2020c. Antimicrobial resistance: Key issues. http://www.fao.org/antimicrobial-resistance/key-sectors/food-safety/

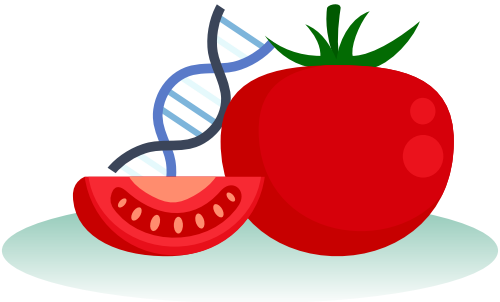
B

Biotechnology

Were you aware that Asia is one of the leading regions in the world that is conducting scientific assessments on genetically modified foods (GM foods)?

There are many kinds of biotechnologies. As the term indicates, biotechnology is the use of technology related to living organisms ("bio" in ancient Greek means "life"). One of them allows cutting and pasting of the DNA of a living cell into the cell of a different species. This is referred to as recombinant DNA technology, and it is the technology that stands behind genetically modified organisms (GMOs).

One-third of the countries in Asia and the Pacific conduct regular work to ensure that GM foods are safe, and another one-third is planning to implement some measures soon (FAO, 2019a).



Selected data on GMOs in Asia and the Pacific

Australia, China, India, Indonesia, Japan, the Republic of Korea, Malaysia, New Zealand, Philippines, Singapore, Thailand and Viet Nam regularly conduct GM food safety assessments (FAO, 2019a).

Bangladesh, Bhutan, Cambodia, Fiji, Kiribati, Mongolia, Nepal, Papua New Guinea, Samoa, Sri Lanka, Timor Leste and Tonga are planning to conduct GM food safety assessments soon (FAO, 2019a).

Soybean represents 50 percent of all global biotech crops, followed by corn at 30.7 percent, cotton at 13 percent and canola at 5.3 percent (Statista, 2020a). Cotton GM crops are particularly important in the region (ISAAA, 2017).

Afghanistan, Brunei Darussalam, Maldives, Micronesia and Myanmar do not foresee any possibility of conducting a GM food safety assessment in the near future (FAO, 2019a).

No matter how a food item is produced, ensuring its safety remains the top priority. The safety of GM foods is assessed through a whole food safety assessment, in contrast to a single substance safety assessment. The capacity requirement for such a comprehensive assessment may pose a significant challenge to many countries in the region.

In collaboration with some partner organizations, FAO provides technical guidance to conduct GM food safety assessments. This guidance is in line with the internationally harmonized Codex guidelines.

Consideration points

- International, bi-lateral and multi-lateral collaborations can be sought when in-country capacities are limited to manage biotechnology issues.
- A targeted communication strategy on GMOs with clear messages that convey the science-based information through appropriate channels is effective.
- Constant open-dialogues among stakeholders and having easy-to-access science-based information are the fundamental starting point to reaching out to the general public.
- Timely data sharing is important for avoiding time gaps in the authorization of GM crops between importing and exporting countries is effective to manage low-level presence (LLP) situations.

Further readings

- **FAO.** 2020d. Biotechnology and food safety. http://www.fao.org/food-safety/scientific-advice/crosscutting-and-emerging-issues/biotechnology/
- **FAO.** 2019a. Global community meeting of the FAO GM Foods Platform, Towards effective risk-based food safety assessment and regulatory management. http://www.fao.org/3/ca8945en/CA8945EN.pdf
- **FAO.** 2019b. FAO GM Foods Platform: Are we effectively evaluating food safety? http://www.fao.org/3/ca7770en/ca7770en.pdf
- **FAO.** 2013a. FAO GM Foods Platform. http://www.fao.org/gm-platform/
- **FAO.** 2000. FAO statement on biotechnology. http://www.fao.org/biotech/fao-statement-on-biotechnology/

C

Crimes and food safety

Did you know that the use of biological weapons has a long history? For example, in 1495, Spanish forces supplied their French adversaries with wine contaminated with the blood of leprosy patients during battles in southern Italy (Barras and Greub, 2014).

Crimes involving food poisoning have a long history: the ancient Romans used to contaminate the water wells of their enemies using carcasses. More recently, some nations have biological warfare programs where water and foodborne pathogens are used as biological weapons and unfortunately, criminals and terrorist groups do the same (Barras and Greub, 2014).

It may look like a remote possibility that is even unrelated to food safety authorities, but the truth is, even if the possibility of a bioterrorist attack is very low, its effects would be devastating and, as such, it cannot be denied. For this reason, it is important to strengthen the surveillance, preparedness and response systems already in place with a set of improvements.

Consideration points

- Preparedness is key in minimizing the negative impacts of crimes that involve food safety.
- A management plan for unintentional food incidents, such as counterfeiting and fraud, can be used as a good basis for a defence plan against crimes that involve food safety.
- Clarifying the roles and responsibilities among stakeholders in the preparedness plan is a useful awareness-raising exercise, as it will generate a relevant network.

FAO works in the field of emergency readiness and preparedness on a variety of different levels, and has developed several documents, tools and guidance materials that can be used as a reference to update and strengthen national plans.

Further readings

- **FAO.** 2011. Good emergency management practice: The essentials. http://www.fao.org/3/a-ba0137e.pdf
- **FAO.** 2016a. Strengthening veterinary diagnostic capacities: The FAO laboratory mapping tool. http://www.fao.org/3/a-i5439e.pdf
- **FAO and WHO.** 2012. FAO/WHO guide for developing and improving national food recall systems. http://www.fao.org/3/i3006e/i3006e.pdf
- **FAO and WHO.** 2011. FAO/WHO guide for application of risk analysis during food safety emergencies. http://www.fao.org/3/ba0092e/ba0092e00.pdf
- **FAO and WHO.** 2010b. FAO/WHO Framework for developing national food safety emergency response plans. http://www.fao.org/3/i1686e/i1686e00.pdf
- **FAO and WHO.** 2007. FAO biosecurity toolkit. http://www.fao.org/3/a1140e/a1140e.pdf

C

Culture of food safety

Close your eyes, and picture a world where everyone acts responsibly to make sure that all food is safe for everyone. Isn't that a great vision? Now you can open your eyes. Yes, it was a vision, but that does not mean it could not become true. And believe it or not, someone like you in the food safety authority, or anyone in any organization, group, company or household can initiate some concrete actions to make it possible.

Many consumers consider that it is a food industry's or government's role to make sure that foods are safe to eat, but food safety is really everyone's business. Regulations only go so far; therefore, it is important to support food industries and consumers and delegate responsibilities. Good guidelines and correct and timely information could lead you to the point where everyone actively participates in food safety.

The Food Standards Australia New Zealand (FSANZ) agency is a great example of how government authorities can support food businesses to create a food safety culture, and has created an online hub for food businesses with some very useful materials. The idea behind this initiative is to help everyone in a food-related business to understand the importance of food safety and to become proud in producing safe food. Food safety is more than just processes and procedures.

A food safety culture can start at the top to be effective, and the consistent commitment of all the stakeholders is essential. A food safety culture starts at the top, and the commitment of authorities is essential. Such approach goes beyond traditional training, testing, inspectional approaches and managing risks; it involves trust in all people handling foods, and from this recognition comes the need that their responsibility cannot be ignored. It cannot be taken for granted either, so education must be ensured.

Consideration points

- A food safety culture is when everyone in the food supply chains thinks and acts in their daily job to make sure the food they make or serve is safe.
- Public-private partnerships between food safety authorities and food businesses help promote a food safety culture where food safety is perceived as a shared responsibility.
- Various government agencies, including the ones in Australia and Canada, provide a series of guidelines and tools for food businesses to implement food safety culture.
- Food safety authorities can provide various templates of food safety self-check lists to food businesses so that they can improve food safety culture within the system.

While you think about it, you can look at some links about a project in Bhutan to create a food safety culture. Bhutan believes that a strong food safety culture would create responsibility among everyone involved in the food supply chain and, hand-in-hand with capacity improvements, this may lead those individuals to achieve optimal outcomes.

Creating a food safety culture in Bhutan

https://youtu.be/E88Mnh0MVxE

Further readings

- **FAO.** 2020e. FAO- Bhutan Agriculture and Food Regulatory Authority (BAFRA) national seminar and workshop on food safety culture and food safety indicators pilot project in Bhutan. http://www.fao.org/3/ca7021en/ca7021en.pdf
- **FAO.** 2019c. Creating a Food Safety Culture in Bhutan [video]. https://youtu.be/E88Mnh0MVxE

D

Diarrhoea

Did you know that people with diarrhoea caused by certain infections can lose up to 20 litres of fluids per day? Dehydration is a major result of diarrhoea which can lead severe consequences such as kidneys shut down.

Determining the exact cause of diarrhoea is hard: for the symptoms to appear, the time after ingestion can vary from eight hours to up to six weeks (USFDA, 2020). Diarrhoea remains a major killer in many developing countries, and most cases are due to microbial contamination of food or water. Furthermore, cases of diarrhoea are likely underestimated because many data related to food poisoning are not reported to institutes or authorities.

Data on diarrhoeal diseases

Diarrhoea kills 2 195 children every day and accounts for 1 in 9 deaths of children worldwide, which is more than AIDS, malaria and measles combined (CDC, 2020).

Globally, there are nearly 1.7 billion cases of childhood diarrhoeal disease every year (WHO, 2020).

Afghanistan, Bangladesh, Lao People's Democratic Republic, Malaysia, Maldives, Myanmar, Nepal, Pakistan, and the Philippines have been reporting that more than 35 percent of children under age five years has sought care or treatment for diarrhoea in the period 2015–2020 (UNICEF, 2020).

The highest mortality from diarrhoeal diseases is in Sub-Saharan Africa and South Asia, where the rates typically range from 50 to 150 per 100 000. (Dadonaite and Ritchie, 2018).

The highest risk factors for development of diarrhoeal diseases are unsafe drinking water and poor sanitation. In children, child growth failure and vitamin A deficiency are also important (Dadonaite and Ritchie, 2018).

In 2016, diarrhoea was the eighth leading cause of death among all ages, with rotavirus being the leading aetiology (GBD, 2016).

Food safety education across the population can be an effective measure to reduce food safety incidents, as the key hygienic measures could be consciously implemented. However, while ensuring food safety is everyone's responsibility, food safety authorities may create enabling environments that encourage food safety measures that can be implemented by everyone.

Consideration points

- The highest risk factor for developing diarrhoeal diseases is unsafe food and drinking water, and poor sanitation.
- Foodborne diseases are heavily underreported in many countries, and even when the cases are reported, they may not necessarily reflect the reality of food safety situations in the country.
- Establishing good statistics on diarrhoeal diseases in the national context could help raise awareness and prioritize food safety at the national level.
- Communication campaigns for the public have an important role in helping consumers apply prevention measures that mitigate the risks of foodborne diseases.
- Access to clean water and sanitary infrastructure where the food is produced, handled, stored, sold, and consumed, can lead to significant improvements.

Diarrhoea is the result of poor hygiene practices or consumption behaviours, and FAO is deeply committed to supporting its member countries in improving food safety systems and to providing scientific advice. FAO also provides regularly updated handbooks and manuals that can be used as a reference on the different topics surrounding food safety.

Further readings

- **FAO.** 2020f. Microbiological risks and JEMRA. http://www.fao.org/food/food-safety-quality/scientific-advice/jemra/
- **FAO.** 2016b. Risk communication applied to food safety handbook. http://www.fao.org/3/a-i5863e.pdf
- **FAO and WHO.** 2001b. Codex Alimentarius food hygiene basic texts. http://www.fao.org/3/y1579e/y1579e00.htm#Contents

E

E-commerce

Did you know that three of the top ten online grocery markets in the world are in Asia (China, Japan and the Republic of Korea)? The online grocery channel is expected to grow to USD 267 billion by 2022, making it the fastest growing channel in the region (Food Industry Asia, 2018).

Food e-commerce is a trend, but little is known regarding the conditions under which the foods are stored and transported. Several factors could intervene to threaten the safety of foods. While some details are yet unknown regarding food e-commerce, new technologies and guidance for the private sector can widely improve food safety of this retail modality.

Selected data on food e-commerce

In 2020, in Asia, the online food delivery segment amounted to USD 57 380 million, and is expected to reach a market value of USD 101 883 million in 2024 (Statista, 2020b).

By 2024, the number of users of platform-to-consumer deliveries is expected to be 691.2 million and that of restaurant-to consumer to 536.2 million (Statista, 2020b).

In 2019, 37.6 percent of the users were 25–34 years old and 41.6 percent of them belonged to low-income households (Statista, 2020b).

Technologies such as artificial intelligence, machine learning or delivery robots are likely to be implemented in the future of food e-commerce. These technologies may, for example, be used to help analyse factors such as weather, traffic, and destination addresses that may help deliver orders faster, and play a role in ensuring food safety (Sichao and Xifu, 2016).

Individual responsibilities, timely communications and real-time data are the key to food safety in food deliveries. To accomplish all of these, consumer awareness, investments in new technologies, and regular dialogues with stakeholders are important starting points. Furthermore, clear guidelines that are easy to implement rather than strict regulations can support the food industry in implementing food safety measures. Government authorities could also play a supporting role in food safety education, thus promoting a participatory approach to food safety.

Consideration points

- In Asia, the online food delivery segment has a value of hundreds of million dollars, and it is expected to continue to grow. New technologies such as artificial intelligence are likely to be implemented in the future of e-commerce.
- Ensuring application of adequate food safety measures such as storing and transporting foods at the right temperatures during e-commerce deliveries is a challenge many low and low-middle income countries are facing.
- Guidelines, assistance and advices rather than punishments are often effective for the private e-commerce sector to follow the food safety rules and regulations.

Food e-commerce is a relatively new trend. FAO is committed to keeping pace with the continuous transformation of food systems. Part of this consists of empowering consumers' choices through an increased awareness of food safety.

Further readings

- **FAO.** 2020g. Food safety in the new normal. http://www.fao.org/3/cb0481en/CB0481EN.pdf
- **FAO.** 2019d. Digital transformation of the food system. http://www.fao.org/3/CA2965EN/ca2965en.pdf
- **FAO.** 2019e. Science, innovation and digital transformation at the service of food safety. http://www.fao.org/3/CA2790EN/ca2790en.pdf
- **FAO.** 2019f. Sharing responsibility for consumer empowerment. http://www.fao.org/3/CA3542EN/ca3542en.pdf

F

Fake news

Fake news is not a new phenomenon: in fact, it is as old as print media, if not older. Fake news is sensationalist and extreme and purposefully designed to make people passionate about a subject. It often has a root in popular prejudice (Soll, 2016).

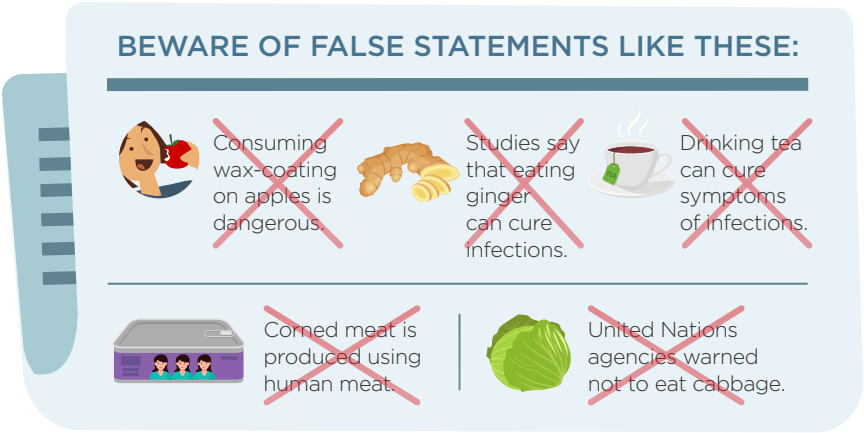
Fake news relies on the phenomenon known as confirmation bias. As philosopher Francis Bacon stated in his *Novum Organum* (1620):

> The human understanding when it has once adopted an opinion draws all things else to support and agree with it. And though there be a greater number and weight of instances to be found on the other side, yet these it either neglects and despises, or else by some distinction sets aside and rejects, in order that by this great and pernicious predetermination the authority of its former conclusions may remain inviolate.

Throughout history, objective journalism made the contrast with fake news quite effectively. Until the rise of web-generated news, algorithms that create news feeds on social media have no regard for accuracy and objectivity, and the spread of digital news, objective or

not, is no longer subject to the traditional methods of journalism that guaranteed a trustworthy information. Thus, we are now in the age that some define as “post-truth”, fake news and scientific misinformation.

Selected fake news on food safety



Adapted from: AFP, 2021.

In recent history, the term fake news became a catch-all term for many different things: misinformation, conspiracy theories, pranks, political spins. Fake news is thrown around with abandon, and experts now believe that the term has outlived its usefulness and that the focus should be given to the differences between facts, opinions, speculation, and outright fiction (BBC, 2018). If it is news, then it cannot be fake: news is a verifiable information shared in the public interest, and it would be an oxymoron for it to be fake. Today, fake news would should be called “information disorder”, and the United Nations Educational, Scientific and Cultural Organization (UNESCO) is now categorizing three different forms of it (UNESCO, 2018):

1. disinformation: Information that is false and deliberately created to harm a person, social group, organisation or country;
2. misinformation: Information that is false but not created with the intention of causing harm; and
3. mal-information: Information that is based on reality, used to inflict harm on a person, social group, organisation or country.

Consideration points

- Internet users increasingly use social media as a way to gain knowledge on health-related matters, including food safety.
- Web-generated news does not necessarily go through the process of fact-checking like traditional journalism, which often values to report trustworthy information.
- It is important for the competent authorities to regularly monitor social media to identify incorrect or misleading information on food safety, so that timely counter-provision of accurate information can be done.
- Valuing and maintaining the transparency and credibility of the government authorities are crucial to protect consumers from fake news.

F

Food fraud

See booklet 5: "Food fraud – Intention, detection and management".

The majority of consumers would pay more for food that has "a zero food fraud certificate", a survey in Canada showed (Statista, 2020c). This can be related to the fact that people often perceive food fraud as a risk to their health.

Some famous food fraud cases in recent history have illustrated how food fraud is not only an economic crime, but also a food safety issue. As examples, the case of melamine in milk led to over 300 000 people becoming ill (BCC, 2010), and the toxic olive oil syndrome – resulting from aniline in olive oil – led to approximately 300 deaths shortly after the onset of the disease and to a larger number who developed chronic disease (Gelpi *et al.,* 2002). Food fraud is not a new issue: efforts to regulate agri-food fraud have been already documented in the Hammurabi code of laws around 1 760 BC (CAFIA, 2015)

Food fraud is committed when a food business operator intentionally decides to deceive customers about the quality and/or content of the food they are purchasing in order to gain an undue advantage, usually economic, for themselves. Three elements identify food fraud: 1) intentionality, 2) deception and the motivation behind it, and 3) undue advantage. However, food fraud is not a new issue: efforts to regulate agri-food fraud have been already documented in the Hammurabi code of laws around 1 760 BC (CAFIA, 2015).

Examples of commonly adulterated foods


Olive oil

Milk


Honey


Saffron


Orange juice


Coffee


Apple juice


Grape wine

Maple syrup


Vanilla extract

Because of rapidly rising living standards and the related demand for premium quality food, and the explosive growth of food e-commerce, the Asia-Pacific region is considered to be at particular risk for food fraud. Both legal and technological interventions can address the problem, and the two together can be an asset in preventing food fraud.

Consideration points

- Three elements underlie all cases of food frauds: intentionality, deception, and the motivation of having an undue advantage.
- Some forms of food frauds pose a risk to human health, for example when foods are adulterated by adding some toxic or allergenic substances.
- Setting a clear definition of food fraud in national jurisdictions can help governments offer more targeted solutions to the problem.
- Keeping up-to-date with new technologies, such as artificial intelligence and blockchain technologies, may help detecting sophisticated food fraudsters.

FAO has been looking into food fraud and in 2019 it convened an expert meeting to discuss the topic. Generally speaking, any act that would be categorized as food fraud would already most likely be prohibited in the national legal frameworks of jurisdictions in the Asia-Pacific region. This should not lead to a sense of security, however, as the rising number of food fraud cases in the region, and in the world in general, suggest that a generic approach is not necessarily enough. The question then is, what would be the legal interventions, as well as potential technical innovations, needed to reduce food fraud?

Further readings

- **FAO.** 2020g. Food for thought on food fraud. http://www.fao.org/legal/development-law/magazine-1-2020/
- **FAO.** 2016c. Handbook on food labelling to protect consumers. http://www.fao.org/3/a-i6575e.pdf
- **FAO and ITU.** 2019. E-agriculture in action: Blockchain for agriculture. http://www.fao.org/3/CA2906EN/ca2906en.pdf
- **FAO and WHO.** 2020a. Codex Alimentarius standards and related texts. http://www.fao.org/fao-who-codexalimentarius/codex-texts/en/
- **FAO and WHO.** 2018a. Discussion Paper on "Food Integrity and Food Authenticity", CX/FICS 18/24/7. https://bit.ly/35SKZJp
- **FAO and WHO.** 2017. Discussion Paper on "Food Integrity and Food Authenticity". Prepared by Iran with assistance from Canada and the Netherlands. https://bit.ly/3frRSol

F

Food and Agriculture Organization of the United Nations (FAO), Regional Office for Asia and the Pacific

Did you know that FAO has 38 offices across Asia and the Pacific? A regional office in Asia and the Pacific is in Bangkok, Thailand. A subregional office for the Pacific is in Apia, Samoa, and a liaison office is in Yokohama, Japan.

Food safety across Asia and the Pacific frequently hits the news. Highly diverse food culture in Asia and the Pacific lead to various food safety issues that require solutions with country- and region-specific approaches. Every year, more than 275 million people fall ill and 225 000 people die due to foodborne diseases in Asia and the Pacific.

Increased urbanization, rapid population growth, new technologies in production, and changing environmental conditions trigger the emergence of new food safety threats. FAO's regional office for Asia and the Pacific works closely with government authorities, local industry and other relevant stakeholders from the region to address these issues and achieve better food safety management systems. Specific activities include, among others, support for development and improvement of food legislation and regulation, enhancing the participation in Codex activities and adapting international standards for trade, and assessment of national food control systems.

FAO food safety areas of support in Asia and the Pacific

Food safety institutional capacities;

technical capacities in GM food safety assessment and biosecurity;

standards development for good agricultural practice implementation and certification;

food control systems capacities for future capacity developments;

food safety and quality controls of livestock products;

capacities on effective participation on Codex Alimentarius activities and standard setting;

improvement of imported food controls within the one health framework;

food safety risk communication;

development and implementation of food safety indicators;

food safety in food systems;

strengthening international food safety networks;

antimicrobial resistance and food safety; and

policy advice in managing street food and the informal sector.

FAO supports the strengthening of systems of food safety and quality control at the national, regional and international levels. This involves:

1. Strengthening national food control regulatory capacities and global trade facilitation by providing leadership in supporting countries in the assessment and progressive development of food control systems, including food safety policy and food control regulatory frameworks.

2. Supporting development of institutional and individual capacities for food control and food safety management, including the management of food safety emergencies.
3. Supporting science-based food safety governance and decisions by providing sound scientific advice (through the Joint FAO/WHO Expert Committee on Food Additives and the Joint FAO/WHO Expert Meetings on Microbiological Risk Assessment expert bodies) to underpin food safety standards at national, regional and international levels.
4. Enhancing food safety management along food chains to prevent diseases and trade disruptions by supporting developing countries to apply risk-based food safety management along food chains that are appropriate for national and local production systems and in compliance with Codex texts.
5. Providing food safety platforms, databases and mechanisms which support networking, dialogue and global access to information and facilitating effective communication internationally on key food safety issues.
6. Developing food safety intelligence and foresight by becoming a major actor in the collection, analysis and communication of food chain intelligence.
7. Addressing the issues around new technologies to improve food safety and protect public health.

Consideration points

- FAO is a specialized agency of the United Nations that leads international efforts to defeat hunger. Its goal is to achieve food security for all and to make sure that people have regular access to enough high-quality food to lead active, healthy lives.
- FAO provides policy support and technical assistance, including scientific advice on food safety, capacity development, emergency preparedness and resilience development.

- FAO, in collaboration with WHO, hosts Codex Alimentarius, the international food standard-setting body, and it promotes collaborative activities on food safety among countries to protect consumer health and to facilitate fair food trade.
- FAO takes a food chain approach for the agri-food systems, providing a 360° vision on food safety.
- FAO Members can submit an official request through their respective country offices or regional offices for FAO technical assistance on food safety.

Keeping food safe is a complex process that starts on the farm and ends with the consumer. FAO is the only international organization overseeing all aspects of the food chain, thereby providing a unique, 360° vision on food safety, and a longstanding partnership with the World Health Organization (WHO) enhances this perspective. Through complementary mandates, FAO and WHO cover a range of issues and support global food safety and protect consumers' health. WHO typically oversees and maintains strong relationships with the public health sector in countries, and FAO generally addresses food safety issues along the food production chain.

Further readings

- **FAO.** 2020i. FAO food safety and quality. http://www.fao.org/food-safety/background/en/
- **FAO.** 2020j. Food safety activities. http://www.fao.org/asiapacific/perspectives/one-health/food-safety/
- **FAO.** 2020k. FAO offices in Asia and the Pacific. http://www.fao.org/asiapacific/our-offices/
- **FAO.** 2020l. FAO offices worldwide. http://www.fao.org/about/who-we-are/worldwide-offices/en/
- **FAO. 2020ac.** Food safety and quality: Scientific advice. http://www.fao.org/food-safety/scientific-advice/

See booklet 9: "Measuring food safety - Indicators to achieve sustainable development goals (SDGs)"

One of the projects of FAO consists in the development of scalable indicators that could be used to make food safety improvements that are specifically tailored on national contexts.

G

Gene/genome-editing

Is "gene-edited" food different from GMO food? What is that difference? In gene-edited organisms, the genetic modification occurs by using the DNA of the same organism, and thus, there is no introduction of new genetic materials, whereas for GMOs genetic materials come from different organisms.

This is made possible by new molecular techniques such as clustered regularly interspaced short palindromic repeats (better known as CRISPR-Cas 9), transcription activator-like effector nucleases (TALENs), and zinc-finger nucleases (Gaj, 2016). These are very precise technologies that ensure a good level of confidence in the manipulation of genetic materials, and they are used in a variety of sectors, including food and agriculture.

Various regulations around gene-editing

Process-driven regulations focus on the process used in food production. They have been adopted in Australia, New Zealand, Europe, and India.

Product-triggered regulations focus on the final product resulting from the modification. The novel traits inserted are regulated. These regulations have been adopted in Canada and the United States of America.

Specific regulatory approaches focus on all new breeding techniques, which mostly follow a case-by-case approach (adopted in Argentina) (Friedrichs, 2019).

The application of CRISPR technology in crop improvement has so far been focused on improving crop yields, quality and stress resistance. This can be done by making the genes that confer undesirable traits "silent", while expressing the ones with the desired traits (Zhang *et al.,* 2020). Some of the possibilities provided by gene editing include the production of crops that are resistant to environment stresses (poor weather, drought, pests), the improvement of produce's longevity and nutrition, and the production of hypoallergenic nuts or gluten-free wheat. Gene-editing with this technique has the advantage of being highly precise.

Consideration points

- Gene-edited foods are appearing on the food market in several countries.
- Based on the existing regulatory framework, countries assess the safety of gene-edited foods. Some countries require pre-market approvals and some countries do not.
- Consumer perception and acceptance can vary among countries and cultures, thus providing evidence-based information and facilitating open dialogue are good practices.

FAO dedicates its efforts to ensure safe foods for all: independently of the mean of production and on the opinion regarding the implementation of new technologies, the key requirement for all foods is safety. While FAO develops new documents on new biotechnologies, manuals for food safety assessments still remain valid.

Further readings

- **FAO.** 2020m. Stock-taking report: food biotechnology communication materials in the world. http://www.fao.org/3/cb1394en/cb1394en.pdf
- **FAO.** 2020n. Biotechnology http://www.fao.org/biotechnology/en/
- **FAO.** 2020o. The status of application, capacities and the enabling environment for agricultural biotechnologies in the Asia-Pacific region. http://www.fao.org/3/ca4438en/ca4438en.pdf

H

Home slaughtering and backyard farming

See booklet 2: "Backyard farming and slaughtering – Keeping tradition safe".

Did you know that there is a strong connection between subregional religious and cultural beliefs, and practices and trends in animal production?

For example, during the cultural festival of *Nekowiar* (also referred to as the *Toka*), in Vanuatu in the Pacific islands, thousands of people converge to dance, determine tribal authority, arrange marriages, and ceremonially feast. The celebration culminates in kava drinking and the slaughter of up to 100 pigs. The spilling of blood and animal sacrifice symbolizes a cleansing of the sins committed earlier during the festival (Bonnemaison, 1986).

Beyond differences relating to religious, cultural and regional factors, slaughter practices vary greatly within the region of Asia and the Pacific. Smallholder animal production has vital economic, practical

and cultural value to communities, particularly within rural and low- to middle-income population groups.

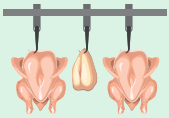
Main categories of slaughter premises

Newer, well-designed and equipped abattoirs that promote hygienic meat production destined for the export market or high value domestic markets.

Large-scale, older abattoirs, usually government-owned and typically located in urban areas.

Small to medium sized private or municipal abattoirs can be urban or rurally based.

Family or village level slaughter "slabs" used for smallholder and/or religious and cultural slaughter.



In developing countries, slaughter tends to occur across numerous smaller abattoirs, which contrast with industrialized countries that have a more integrated and centralized approach to slaughter.

Source: (FAO, 2008a)

These practices, of course, come with risks linked to zoonotic diseases and food safety. These risks can, however, be managed, thereby making household or village-level slaughter and animal-derived food production sustainable, safe, and continually rewarding for the communities for whom such practices are so ingrained in their culture. There are a number of relatively simple interventions that can be introduced or maintained at the level of home farming and slaughter that can improve food safety outcomes. Evidence-based leadership towards improvements

in smallholder farming and slaughter practices from local competent authorities is a critical pathway to success in minimising the risks from foodborne disease.

Consideration points

- The region of Asia and the Pacific has a long history in farming livestock at the household level. Risks of foodborne pathogens contaminating animal-derived foods, or of animal-to-human disease transmission are not low in backyard farming and home-slaughtering.
- It is important to follow good animal management, to implement hygienic measures after slaughtering, and to conduct proper inspections and waste management in the slaughtering environment.
- Awareness raising of the basic hygiene practices for the general public is an effective measure to prevent foodborne diseases linked to backyard farming and home-slaughtering.

Many resources are available to competent authorities to assist with local disease intelligence and risk management, including from FAO and other international organisations (e.g. WHO, OIE) as well as through engagement with similar authorities in other jurisdictions.

Further readings

- **FAO.** 2019g. Technical guidance principles of risk-based meat inspection and their application. http://www.fao.org/3/ca5465en/CA5465EN.pdf
- **FAO.** 2018a. World Livestock: Transforming the livestock sector through the Sustainable Development Goals.
- **FAO.** 2018b. Family farming in the Pacific Islands countries – Challenges and opportunities. http://www.fao.org/3/ca0305en/CA0305EN.pdf
- **FAO.** 2008a. Abattoir development: Options and designs for hygienic basic and mediums-sized abattoirs. http://www.fao.org/tempref/docrep/fao/010/ai410e/ai410e00.pdf

I

Imported food controls

See booklet 3: "Investing in food safety for global benefits – A concrete case in the Association of Southeast Asian Nations (ASEAN) countries".

Did you know that it is impossible to import Kinder eggs into the United States of America? Or that import of chewing gum ceased in 1992 in Singapore? In Malawi, authorities have banned the import of any and all aphrodisiacs, and milk powder and baby formula can only be brought in China as a personal effect.

Every country has its own way of dealing with food imports, and it is not always easy to trade foods internationally. Food products are the third most valuable commodity group traded internationally, and imports constitute a significant proportion of the food supplies of developing countries.

Key data on food imports

The value of global food imports in 2018 was USD 125 599 079.44 (World Bank, 2018).

The Asia-Pacific region accounts for 48 percent of global food imports (World Bank, 2018).

According to the World Bank (2017), China's food imports in 2017 accounted for 6.7 percent of its total merchandise.

Various good practices to perform controls on imported foods are commonly used in countries despite the differences in their capacities and food import priorities. Common approaches consist of subjecting imported foods equally to the same legal requirements for domestic foods; keeping records of importer profiles and imported foods; making testing and sampling methodology and frequency decisions based on the risk level of the food; and having risk-based management actions at border control points.

Consideration points

- The use of risk categorization to prioritize commodity and hazard combinations creates a concise and easy reference for border control officials, so that high-risk and high-interest food items will receive more attention than other food items.
- The nationwide dissemination and use of standard operating procedures for risk-based inspections for imported foods maintains consistency and transparency.
- The systematic written communication among food safety competent authorities and relevant border control officials on the information of importer profiles, risk categorization results, and required documents, helps achieving effective risk-based management for imported food safety.

Source: FAO, 2018c.

Further readings

- **FAO.** 2016d. Risk Based Imported Food Control Manual. http://www.fao.org/3/a-i5381e.pdf
- **FAO.** 2018c. Ensuring the safety of imported food. http://www.fao.org/3/ca0286en/CA0286EN.pdf

J

Juice stands and food safety

Were you aware that in Asia, the market for fresh juices is expected to grow annually by 5.8 percent (Statista, 2020e)?

Fresh juices provide excellent tastes and nutrients, and fresh juice stands on the streets are part of the traditional culture of the region which helps provide both hydration and a touch of tropical flavour to the people walking under the strong sun in many Asian countries. However, fresh juices, just like raw foods, present some significant food safety risks due to their high exposure to microorganisms. Proper pasteurization and hygienic measures are, thus, needed and competent authorities need to ensure that this is possible everywhere.

Selected data on juice stands in Asia and the Pacific

Revenue from the sale of juice segments amounted to USD 23 270 million in 2020 (Statista, 2020d).

The global juice market is expected to grow annually by 6.3 percent (Statista, 2020d).

During the marketing year 2019/2020, global orange juice production amounted to about 1.62 million metric tonnes. In that year, the global production (in volume) of fresh oranges amounted to about 46.06 million metric tonnes (Statista, 2020d).

Juice mixtures and ready-made smoothies, which are consumed for perceived nutritional benefits, are non-alcoholic drinks that have generated the highest growth (Statista, 2020e).

As with other food vendors, it is important that proper hygiene measures are implemented in juice stands. Some of these include:

1. The use of clean water and sanitary facilities;
2. Hand-washing and regular cleaning of utensils and surfaces;
3. Appropriate temperature storage.

(WHO, 2006)

Consideration points

- Street-vended fresh juices may present significant food safety risks, if combined with poor hygiene.
- Access to safe water and sanitary facilities for street juice vendors is a great starting point for ensuring safety of their products.
- Informed consumers and juice vendors that are trained on good hygiene practice play an active role in ensuring safety of fresh juices sold on the street.

FAO has developed a book entitled “Principles and Practices of Small- and Medium-scale Fruit Juice Processing” (2001b), which presents both theoretical and practical information on the processing of fruit and vegetable juices, and provides the reader with both the principles and the practices of small- and medium-scale fruit juice processing. The book is available online at http://www.fao.org/3/y2515e/y2515e00.htm#toc.

K

Knowledge assessment

Can you imagine a world where people are perfectly able to make safe food choices? It is often said that food safety awareness needs to be increased, but how?

Knowledge assessments usually reveal the level of knowledge about a particular topic. In the case of food safety, that would be the knowledge of consumers. It is often said that "big data" is the new gold. Indeed, to learn about knowledge levels, data need to be collected and fortunately, there are more tools than ever before to collect such data. Traditional methods from the social sciences can be enhanced by using IT technology and social media, which make it possible to investigate consumers' opinions. Data collection can, therefore, be designed for larger purposes and with faster results.

Selected data collection methods from the social sciences

Interviews

Questionnaires and surveys

Observations

Documents and records

Focus groups

Oral histories

Consideration points

- It is a good practice to conduct food safety knowledge assessments for food handlers and the general public. Food safety knowledge empowers consumers who can demand safe food.
- Food safety knowledge assessments targeted to specific consumer groups may be necessary. For example, vulnerable populations such as young, elderly, pregnant women and immuno-compromised individuals benefit from knowledge of high-risk food for them. Rural community with specific high-risk food preparation patterns can also receive a tailored intervention depending on their level of food safety knowledge.
- It is important to note that knowledge and behaviour change may not correlate. Consistent and effective interventions may need to be sought to have the relevant behaviours to be changed.

FAO has developed a set of knowledge, attitudes and practices model questionnaires that can be adapted to specific country or situational contexts, and to the requirements of the specific project or intervention in which they will be used. These models are available at: http://www.fao.org/economic/kap/.

L

Livestock and feed safety

Did you know that bovine spongiform encephalopathy, foot-and-mouth disease, dioxin, mycotoxin, *Escherichia coli* O157:H7 contaminations, and the development of antimicrobial resistance, are all related to animal feeding?

Feed safety is a prerequisite for food safety and human health, and is a necessity for animal health and welfare. Feed safety is a component of access to trade, income generation and economic sustainability. Animal feed plays a leading role in the global food industry and it is

the largest and most important component to ensure the sustainable production of safe and affordable animal proteins.

Key facts on animal feeds

World compound feed production is fast approaching 1 billion tonnes annually.

Global commercial feed manufacturing generates an annual turnover of over USD 370 billion.

Commercial production or use of manufactured feed takes place in over 130 countries.

The feed sector employs over 250 000 skilled workers, technicians, managers and professionals.

Around 300 million tonnes of feed are produced directly by on-farm mixing of feed ingredients and pre-mixes.

Source: FAO and WHO, 2020e.

In many countries, adequate know-how and sufficient awareness to ensure feed safety among all operators along the whole value chain are lacking. Even where more knowledge is available and control systems are in place, new and unconventional feed ingredients are entering the production chain.

Consideration points

- Hazards in feed may pose a risk for human health as a result of transfer from feed to food of animal origin.
- Development and implementation of standards, guidelines and practical measures to ensure feed safety are important for food safety.
- Data generation, collection and sharing of possible feed contaminants can contribute to minimizing the risks of them transferred into food.
- In many countries, increased awareness and practical know-hows are effective to ensure feed safety among all operators along the whole value chain.
- It is useful for food safety competent authorities to monitor the trend on any new or unconventional feed ingredients entering the production chain.
- Implementation of feed regulations harmonized with the Codex Alimentarius is effective to ensure food safety.

Codex Alimentarius has established guidance to governments on good animal feeding practices and on the conduct of risk assessment and prioritization of hazards in feed. A webpage on animal feeds exist that collects the different documents that were produced by Codex Alimentarius on the topic (FAO and WHO, 2020a). The Codex code of practice on good animal feeding is also available online (FAO, 2008b).

M

Modernization of food systems

Can you name all the traditional fresh food markets in your city? Can you locate all the food vendors in your neighbourhood?

The answer to the previous questions is most likely, "not perfectly", and this can be a food safety problem. While it is undeniable that fresh food markets or street food systems carry the beauty of history, culture and traditions, there are often concerns linked to their hygiene and biosecurity. Furthermore, as with other food systems, there is an informal economy behind fresh food markets that is hard for regulators to monitor.

Examples of informal economy

More than 68 percent of the employed population in Asia and the Pacific are in the informal economy (ILO, 2020a).

Two billion people work in the informal economy, and 1.3 billion of these are in the Asia-Pacific region (ILO, 2020a).

Almost all agricultural employment (94.7 percent) is informal in the region, and reaches a high of 99.3 percent in South Asia. Informal employment represents a higher share in the industrial sector (68.8 percent) than in the services sector (54.1 percent) (ILO, 2020a).

The freshness of food is the most searched for requirement when buying food in a fresh food market (Zhong, 2019).

The market value of street food stalls in Thailand was forecasted to reach around 286 million Thai baht (approximately USD 10 million) in 2019 (Statista, 2020f).

The key principle to effectively improving food safety within the informal and traditional food systems is that food safety is a shared responsibility where everyone has a role to play. It is unlikely that regulatory authorities can manage this all on their own, but through dialogue with key stakeholders and education of consumers, they can actively help to ensure food safety.

Consideration points

- Traditional fresh food markets and street food vendors are a fact of life, but they often raise food hygiene and biosecurity concerns that are linked to their operation and management mechanisms.
- Securing frequent access to safe water and sanitaries is essential to ensure food safety in food markets and services. In many low and middle income countries, improving this aspect will drastically increase the levels of hygiene and safety of traditional markets and street food.
- Providing an enabling environment for the private sector to implement hygienic measures can efficiently help improving food safety.
- Food safety competent authorities can be advisors of market managers and vendors. Providing useful templates and check lists on food safety measures is one way to promote effective self-checking systems, and discussing with the market managers and vendors to understand their needs and challenges helps them to find solutions.

FAO is focusing on transforming food systems into sustainable systems that deliver food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised. Within this scope, FAO has created a “dashboard” in partnership with Johns Hopkins University, which collects various information on the topic (John Hopkins University, 2020).

N

Nanotechnologies

Did you know that if you take a gold object and you see it at the nano scale, it appears red or purple? Nanotechnologies deal with materials that are as small as a water molecule, and that have properties that do not follow traditional physics.

The fact that different rules apply at the nanoscale and the recent advancements in technology make it possible to use nanomaterials for innovative products and opportunities in the food sector. Some of the new emerging applications include water purification systems, rapid pathogen and chemical contaminant detection systems, and nano-enabled renewable energy technologies applied along the food chain.

Trends in food nanotechnology

The value of the global food nanotechnology market is projected to grow to USD 112.48 billion during the period 2019–2023.

41 percent of the market share of food nanotechnologies originated in Asia and the Pacific in 2018.

One of the growing trends for this market is expected to be the application of food nanotechnology in nutraceuticals.

Source: Technavio, 2020

Alongside these exciting technological advancements, nanotechnologies have also started raising concerns regarding their possible safety, including their applications for food packaging, food processing and food testing. The potential implications of nanotechnologies on human health are still not fully understood, and many countries have stressed the need for early consideration of the food safety implications of these technologies. During an expert meeting, it was agreed that regular risk analyses can be applied to assess the safety of applications of nanotechnologies to food.

Consideration points

- Materials that are produced intentionally with nanoscale structural features (between 1 and 100 nm) may have different properties when compared with their conventional counterparts.
- The current risk assessment approaches used by FAO/WHO and Codex are suitable for engineered nanomaterials used in food and agriculture.
- Nanotechnology is used as developers see considerable opportunities for the innovative applications for agriculture, water treatment and food production, processing, preservation and packaging.
- Development of transparent and constructive dialogues among stakeholders regarding all the aspects of application of nanotechnology in food are essential.

FAO has addressed the topic of nanotechnologies and through Codex Alimentarius it has developed and finalized a technical paper entitled, "State of the art on the initiatives and activities relevant to risk assessment and risk management of nanotechnologies in the food and agriculture sectors" (FAO and WHO, 2013a). The paper resulted from a previous expert meeting consultation on the potential implications of nanotechnologies on human health, "Application of nanotechnologies in the food and agriculture sectors: potential food safety implications" in June 2009. The final report (FAO, 2010a) is available at: http://www.fao.org/3/i1434e/i1434e00.pdf.

O

Organic Agriculture and food safety

See booklet 6: "Organic foods – Are they safer?".

In your opinion, is organic food safer than traditional food? Do you believe that the absence of pesticides indicates that foods are safe?

The truth is, pesticides are used in organic agriculture, but they are plant based, and these pesticides are coupled with methods that rely on mechanical and cropping practices. Organic labels are not a seal or guarantee of food safety; they only indicate that food production occurred under certain standards that consider environmental and socio-economic factors.

Trends in organic agriculture

From 2000 to 2018, the global sales of organic food increased by USD 77 billion USD (Statista, 2020g).

In 2017, there were nearly 70 million hectares of organic farms worldwide, 835 of which were in India alone (Statista, 2020g).

The worldwide sales of organic food amounted to nearly USD100 billion in 2018, up to nearly six times from USD 18 billion in 2000 (Statista, 2020g).

These increases may be linked to consumer perceptions concerning human health, environmental concerns, and sensory attributes such as nutritive values, taste or freshness (Shafie and Rennie, 2009).

A considerable number of studies on organic farming and the consumption of organic foods have confirmed that the majority of consumers often consider organic food as being healthier, safer, tastier, and more environmentally friendly.

Consideration points

- The sales of organic food are increasing at the global level.
- "Organic" and "safe" are not synonymous: "organic" is a way to grow food (following specific standards and guidelines), while "safe" is a basic requirement of all foods to be produced and marketed.
- Food safety competent authorities might like to consider checking if food safety measures for both microbiological and chemical contamination risks are included in the existing organic certification schemes.
- Various forums with the organic food industry can be organised to discuss possible approaches to ensuring the inclusion of food safety measures in organic agriculture.

FAO has an organic agriculture programme to enhance food security, rural development, sustainable livelihoods and environmental integrity by building capacities of member countries in organic production, processing, certification and marketing. Many other resources are available.

Further readings

- **FAO.** 2020p. Organic agriculture. http://www.fao.org/organicag/oa-faq/oa-faq1/en/
- **FAO.** 2020q. Organic agriculture publications. http://www.fao.org/organicag/oa-publications/search-results/en/
- **FAO.** 2020r. The world of organic agriculture – statistics and emerging trends. http://www.fao.org/agroecology/database/detail/en/c/1262695/
- **FAO.** 2002a. Organic agriculture, environment and food security. http://www.fao.org/3/y4137e/y4137e00.htm
- **FAO and WHO.** 1999. Organically produced foods. http://www.fao.org/3/a1385e/a1385e00.pdf

P

Parasitic diseases

See booklet 7: "Parasites in food – An invisible threat".

Did you know that the most common foodborne parasitic diseases are toxoplasmosis and ascaris infection? Unfortunately, reliable data on parasitic diseases are still very limited, but the estimated number of illnesses from parasitic diseases is 48.4 million, 48 percent of which are transmitted through food (Torgerson *et al.,* 2015).

While many people are familiar with diseases caused by bacteria, such as *Salmonella* and *Escherichia coli*, people may be unaware that parasites can be transmitted through food and water, and lead to disease in humans. Some of these parasites can produce mild or chronic disease, while others can be deadly.

Major foodborne and waterborne parasites in Asia

Parasites in pigs: *Tenia solium, Trichinella* spp., and T*oxoplasma gondii.*

Parasites in freshwater fish: *Clonorchis sinensis, Opisthorchis viverrini.*

Parasites in freshwater crustaceans: *Paragonimus* spp.

Parasites in vegetables, water and environment: *Tenia solium, Toxoplasma gondii, Echinococcus granulosus, Echinococcus multilocularis, Fascicola hepatica, Fascicola gigantica, Ascaris* spp., *Cryptosporidium parvum, Entamoeba hystolitica, Giardia intestinalis.*

In many countries, the prevention of human exposure to some of these foodborne parasites is the responsibility of a veterinary authority or food safety authority, while in other countries, parasites are not controlled at all. One of the challenges is that the animals that are affected might not show signs of the disease, making it difficult for farmers and authorities to detect a problem. And, if there are no production or monetary losses associated with the parasite in animals, there is no incentive to control them. Therefore, the role of food safety authorities becomes even more important.

Consideration points

- Foodborne parasitic diseases can cause both acute and chronic health problems.
- Limited surveillance capacities and extreme under-reporting situations of parasitic disease cases makes the problems invisible to the authorities and the public.
- Developing and applying validated detection methods to monitor foodborne parasites can enhance the understanding of their routes of transmission, the identification of their attributed food commodities, and monitoring of critical control points.
- Developing training packages or programmes for the general public and for food business operators can promote the implementation of treatments and measures that can decrease the risks of foodborne parasites.

While foodborne parasitic diseases mostly remain an invisible threat, they cannot be neglected. International organizations, including FAO, provide materials that can be taken as a reference for further considerations on the topic.

Further readings

- **FAO.** 2020s. Food safety and quality: Foodborne parasites. http://www.fao.org/food/food-safety-quality/a-z-index/foodborne-parasites/
- **FAO.** 2020t. Be safe from fish liver flukes. http://www.fao.org/3/ca9100en/CA9100EN.pdf
- **FAO.** 2020u. Be safe from pork tapeworms. http://www.fao.org/3/ca9095en/CA9095EN.pdf
- **FAO and WHO.** 2014. Multicriteria-based ranking for risk management of food-borne parasites. http://www.fao.org/3/a-i3649e.pdf
- **FAO.** 2013b. Highlights: Foodborne parasites – Ranking for risk management. http://www.fao.org/fileadmin/user_upload/agns/pdf/ParasiteHighlight3.pdf
- **FAO.** 2013c. Summary risk profile on Trichinella in meat. http://www.fao.org/fileadmin/user_upload/agns/pdf/Foodborne_parasites/RiskProfTrichinellaOct2013.pdf
- **FAO.** 2013d. Summary risk profile on *C. bovis* in meat from domestic cattle. http://www.fao.org/fileadmin/user_upload/agns/pdf/Foodborne_parasites/RiskProfTaeniasaginataOct2013.pdf
- **FAO and WHO.** 2013c. Risk-based examples for control of *Trichinella* spp. and *Taenia saginata* in meat. http://www.fao.org/fileadmin/user_upload/agns/pdf/Foodborne_parasites/Risk-based_Control_Trich_and_Taenia_17June_Eng.pdf
- **FAO, OIE and WHO.** 2020a. Foodborne parasitic infections: Trichinellosis. http://www.fao.org/3/cb1206en/cb1206en.pdf
- **FAO, OIE and WHO.** 2020b. Foodborne parasitic infections: Taeniasis and cysticercosis. http://www.fao.org/3/cb1129en/cb1129en.pdf
- **FAO, OIE and WHO.** 2020c. Foodborne parasitic infections: Fascioliasis (liver fluke). http://www.fao.org/3/cb1127en/cb1127en.pdf
- **FAO, OIE and WHO.** 2020d. Foodborne parasitic infections: Cystic and alveolar echinococcosis. http://www.fao.org/3/cb1128en/cb1128en.pdf
- **FAO, OIE and WHO.** 2020e. Foodborne parasitic infections: Clorochiasis and opisthorchiasis. http://www.fao.org/3/cb1208en/cb1208en.pdf

PORK TAPEWORMS

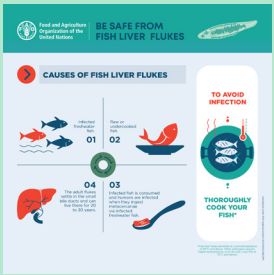
http://www.fao.org/3/ca9095en/CA9095EN.pdf

http://www.fao.org/3/ca9094en/CA9094EN.pdf

http://www.fao.org/3/ca9097en/CA9097EN.pdf

http://www.fao.org/3/ca9096en/CA9096EN.pdf

FISH LIVER FLUKES



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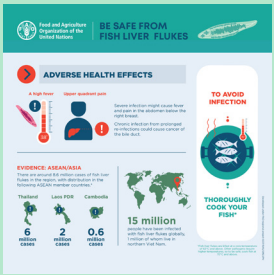

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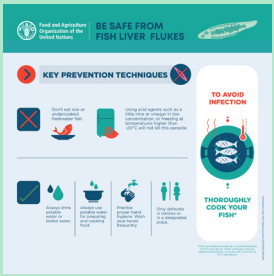

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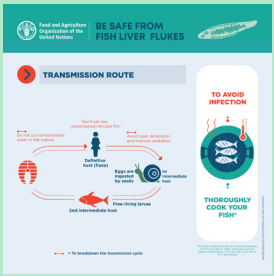


http://www.fao.org/3/ca9101en/CA9101EN.pdf

Q

Quality and safety of food

Did you know that consumers mostly choose their foods based on freshness, taste and appearance (Petrescu, 2019)? For example, a study in China revealed that consumers use freshness, perceived as "immediacy", as one of the key principles of food shopping (Zhong *et al.,* 2019).

A list of demands that are popular on the market may contain, for example, information on juice concentrate, water and sugar content, and acidity or dry substance content. The food industry not only needs to put emphasis on safety and conformity with the product's intended purpose, but it also needs to focus on consumers' expectations and perceptions, and for this it needs standards.

Facts of food quality labels

Surveys in Europe have shown that consumers are willing to pay more for food products that have food quality labels (Velčovská and Del Chiappa, 2015).

Food quality schemes in the European Union aim at protecting the names of specific products to promote their unique characteristics, and are linked to the geographical origin of food (European Commission, 2020).

The demand for products that are perceived to be healthy is growing in Asia and the Pacific. In Australia, carbonated drink consumption is projected to decline by 2.5 percent, while in China, the demand for beverages considered to be healthy will surpass that of fizzy drinks, and the consumption of juice and bottled water will increase by 42.5 percent and 59.3 percent, respectively (The Economist, 2013).

Food quality is gaining increasing importance in consumers' choices and behaviour changes; however, quality and safety are often regarded in an unrelated way, which could create a blurred line between the two concepts. Food safety refers to all those hazards, whether chronic or acute, that may make food injurious to the health of the consumer. It is non-negotiable. Quality includes all other attributes that influence a product's value to the consumer.

The foremost responsibility of food control is to protect consumers against unsafe, impure and fraudulently presented foods. Quality labels may, however, be important in contributing to rural development by attributing and promoting the unique features of local products, and they could be an opportunity to further promote safety as a non-negotiable characteristic. FAO is implementing the Quality and Origin Programme to support the development of quality, linked to geographical origin products that will contribute to rural development.[11]

[11] For more details, see : http://www.fao.org/in-action/quality-and-origin-program/

R

Raw food consumption

What would make you feel safe when consuming raw food? Science often recommends to eat cooked foods to mitigate the risks of food poisoning, but raw food consumption is a long-lasting food habit linked to traditions and culture.

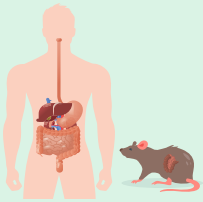
Beyond that, raw food consumption is also a movement that takes the name of raw foodism, and is the dietary practice of eating food that is uncooked (or mostly uncooked) and unprocessed.

Selected facts about raw food consumption

By 2016, sales values of wholesale raw foods in the Republic of Korea were projected to reach approximately USD 56.58 billion (Statista, 2020).

Data related to raw food consumption are still very limited.

The first traces of sushi were introduced in Japan during the Yayoi period (Lee *et al.,* 1993).



Studies have reported that raw food consumption has led to significant changes to the gut bacteria of rats and humans. (Carmody *et al.,* 2019).

Raw food consumption, both meat and vegetables, carries the risk of food contamination and food poisoning if foods are not processed. While the advice from science is to avoid eating raw foods in order to mitigate the risk of food poisoning, traditional food cultures in Asia and the Pacific often go the opposite direction.

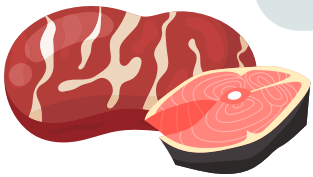
Consideration points

- Raw foods are generally highly exposed to microorganisms, and overall, this may increase the food safety risks connected to its consumption.
- Traditional and cultural aspects of raw food consumption may need to be considered when developing regulatory rules and actions.
- Providing accurate information to consumers and food handlers on the risks of consuming raw food is important.
- Promotion of good hygiene practices among all the people involved in the food production, processing and preparation is important.

FAO is committed to promoting food safety as well as transforming food systems and rural development. To ensure that all factors can be taken into account, the food safety measures promoted by FAO apply to raw foods too. An important part of this has to do with awareness among consumers and food business operators.

Further readings

- **FAO.** 2017a. Food handler's manual: Student. http://www.fao.org/3/I7321EN/i7321en.pdf
- **FAO.** 2017b. Food handler's manual: Instructor. http://www.fao.org/3/I5896EN/i5896en.pdf
- **FAO.** 2016e. Risk communication applied to food safety – handbook. http://www.fao.org/3/a-i5863e.pdf
- **FAO.** 2009. Good hygiene practices in the preparation and sale of street food in Africa. http://www.fao.org/3/a-a0740e.pdf



S

Standards – Codex Alimentarius

Did you know that there are 20 systems for food safety assurance in Europe? These non-obligatory standards have been developed by the industry to impose standards on a great variety of food products.

Although food safety standards cover about 80 percent of food production in Europe, consumers may still find it difficult to choose the right product, as standards differ in action, documentation, transparency, control and logo (Savov and Kouzmanov, 2014).

Selected facts on food trades and food standards

The World Trade Organization (WTO) uses Codex Alimentarius standards as the basis for food trade disputes.

From 1995 to 2020, there were 49 food trade disputes that fell under the Sanitary and Phytosanitary (SPS) Agreement.

188 countries and one member organization (the European Union) have negotiated science-based recommendations in all areas related to food safety and quality; these are the Codex Alimentarius Standards that ensure that food is safe and it can be traded.

The first Codex Alimentarius meeting was held in 1963.

The Codex Alimentarius, or "Food Code", is a collection of standards, guidelines and codes of practice adopted by the Codex Alimentarius Commission. The Commission is the central part of the Joint FAO/WHO Food Standards Programme, and was established by FAO and WHO to protect consumer health and promote fair practices in food trade.

The main objective of Codex in Asia is to promote mutual communication among Asian members, and to develop regional standards for certain food products. In the Pacific, the focus is on supporting the development of Codex-based national food safety legislation, promoting risk-based food inspections, and considering how Codex and national food control systems can contribute towards the prevention and control of non-communicable diseases and micronutrient deficiencies.

FAO supports its member states with the development and implementation of food safety standards, and over the years it has carried out numerous projects. For example, the project on “Support for Capacity Building for International Food Safety Standard Development and Implementation in ASEAN Countries” was started in 2007 and is still ongoing. The project has led to the development of documents, guides and case studies, and to the overall improvement of capacities related to food safety controls and data generation.

Further readings

- **FAO and WHO.** 2020a. Codex Alimentarius. http://www.fao.org/fao-who-codexalimentarius/
- **FAO and WHO.** 2020b. Codex Alimentarius: Introduction to key areas of work in Codex. http://www.fao.org/fao-who-codexalimentarius/thematic-areas/
- **FAO and WHO.** 2020c. Codex Alimentarius: The CCASIA Region. http://www.fao.org/fao-who-codexalimentarius/committees/codex-regions/ccasia/about/
- **FAO and WHO.** 2020d. Codex Alimentarius: The CCNASWP Region. http://www.fao.org/fao-who-codexalimentarius/committees/codex-regions/ccnaswp/about/

T

Trendy foods

What is the trendiest food in your country today?

Trendy foods are food and beverage that have recently been popular among consumers. These foods and beverages are driven by new diet habits, or new concept of food. The trend is often the result of people's willingness to eat healthier, curiosity of new food concepts, posts on social media, or follow fashion trends (Beijing Evening News, 2019).

What is "trendy foods"?

Currently, there are no market reports on trendy foods.

In Southeast Asia, the number of people claiming to be a vegetarian increased by 140 percent in the period between 2012 and 2016, and the number of people claiming to be a vegan increased by 440 percent during the same period for food and drink launches in the region.

While trends in food consumption constantly change and are mostly linked to culture and geographical factors, some practices linked to trendy foods could be unsafe. For example, several food safety issues were raised in China in recent years that can be linked to food trends:

- Double egg yolk cream was found to exceed microbial standards by three times (China Well-Off Network, 2019).
- Potential risks may rise from the substances and methods used to produce these foods, for example the use of liquid nitrogen to produce smoky ice creams can cause frostbite (Beijing Evening News, 2020).

- Fake news is also a major issue. For example, "honeycomb cake" is claimed to be made of bamboo charcoal powder that can absorb harmful substances and has the effect of detoxification and beauty, but this has never been scientifically proven (China Well-Off Network, 2019).

Consideration points

- Consumers' food choices are largely influenced by the marketing and communication on certain foods and/or diets.
- Some trends in food consumption can have an impact on food safety. For example, the trend towards raw foods may require a close attention, when heat-cooking can be a key factor to reduce the risk of the pathogenic microorganisms potentially present in the food.
- Close monitoring of news and information on trendy foods is useful to detect possible food safety hazards to estimate their risks.

U

Urban food systems

Are you aware that 50.9 percent of Asia's population live in urban areas? At a time when our food is travelling great distances and causing pollution and waste, and when more and more of us live in cities, how can we feed everyone with safe and nutritious food while also preserving the environment?

By 2050, an estimated 70 percent of the world's population will live in cities, which will create enormous challenges to our food systems. Urban food systems aimed at feeding urban populations through urban and peri-urban agriculture will need to be accompanied by access to sanitary facilities and safe foods, both at the household level and at the public level.

Consideration points

- It is estimated that, by 2050, 70 percent of world's total population will be urban, and this will lead to fundamental changes to the socio-economic environment and to the prospect for food and nutrition security.
- Expected challenges for the megacities of the future include sanitation and hygiene issues, water scarcity and pollution, food spoilage and wastes, risk of food poisoning, and impaired food transportation, storage, processing, preparation, and distribution.
- Understanding of urban demographic shifts, poverty levels in the cities and consumers' behaviour patterns can help develop resilience for relevant food safety risks.
- Urban food safety can be improved through collaborations among authorities and all value chain actors. Improving the awareness that providing safe food is a shared responsibility is important and can lead to effective investments in establishing domestic safe food market infrastructure.

In 2001, FAO launched a multidisciplinary initiative "Food for the Cities", which aims at addressing the challenges that urbanization brings to urban and rural populations, as well as the environment, by building more sustainable and resilient food systems.

Further readings

- **FAO.** 2020v. Food for the Cities Initiative. http://www.fao.org/fcit/fcit-home/en/
- **FAO.** 2020w. City Region food systems programme. http://www.fao.org/in-action/food-for-cities-programme/en/
- **FAO.** 2020x. City Region food systems programme tools examples. http://www.fao.org/3/i9255en/I9255EN.pdf
- **FAO.** 2020y. *Improved rural urban linkages: Building sustainable food systems.* [video]. https://www.youtube.com/watch?v=DJgMzxUTx2U

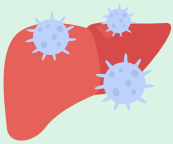
V

Viruses in food

In 2007, viruses were estimated to be responsible for nearly 12 percent of all reported foodborne outbreaks in the European Union (EFSA, 2011). Telephone surveys in the United States of America and Australia have also shown that such illnesses are common, but no data are available in developing countries.

Virology is a complex world. Viruses belonging to at least ten families have been associated with foodborne illnesses that cause various diseases. These range from self-limiting diarrhoeal diseases to severe liver disease that leads to hospitalization. The best estimates of the burden of foodborne diseases associated with viruses are available for viruses causing gastroenteritis.

Main foodborne viruses



Hepatitis A: in early childhood the infection is usually asymptomatic, but later in life it may result in a more severe outcome.

Norovirus: the infection can be common and with mild symptoms, but it can cause more severe effects among vulnerable people.

Human rotaviruses: they are the leading cause of viral gastroenteritis in infants and children worldwide, causing a severe dehydrating illness. The primary mode of transmission for human rotaviruses worldwide is person-to-person, but in areas with poor hygienic conditions, waterborne and foodborne illnesses spread are likely to play a role.

Hepatitis E: it is a long-known virus in areas with poor hygienic conditions. In pregnant women, illness is often severe, with a high risk of mortality. Foodborne transmission through consumption of raw or undercooked meat has been documented.

Source: FAO and WHO, 2008.

The potential for foodborne transmission is a concern with every new emerging infection, and ruling out such concerns is often difficult. To clarify that COVID-19 is not foodborne, FAO has developed a series of infographic with a message that states "Food is not known to transmit COVID-19" (See: http://www.fao.org/3/ca9174en/ca9174en.pdf) in collaboration with three partner organizations. For more relevant infographics, visit http://www.fao.org/asiapacific/resources/2019-ncov-asiapacific/.

Many viral outbreaks have been traced to food that was manually handled, rather than industrial processing; thus, personal hygiene plays a determining role in preventing viral foodborne diseases. If the virus is present during the pre-processing of foods, infectivity could remain after processing, and attention needs to be given to ensure the hygiene of manufacturing practices. If the virus is present after food processing, it could remain in those foods for some time, especially if those foods are kept cool (Koopmans and Duizer, 2004).

Consideration points

- At least ten out of 22 known families of viruses infecting humans can be transmitted by foods.
- In many countries, epidemiological surveillance systems for common foodborne viruses are either not existing or not complete, and data is insufficient to estimate the fraction of diseases caused by foodborne viruses.
- Partnering with academia and applying molecular detection methods may help improving the capacity for investigation on the presence of viruses in food.
- Collaborating with regional and global centres and networks for the detection of foodborne viruses would help the countries without effective food control systems.

At the international level, the Codex Alimentarius is considering the types of risk management tools that it can develop to assist countries in their efforts to protect consumer health from foodborne viral illness. FAO and WHO convened an Expert Meeting in May 2007 on viruses in food, and the report of the meeting is available online. More information is available at: http://www.fao.org/3/a-i0451e.pdf.

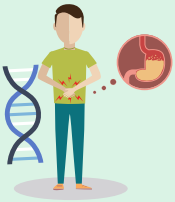
W

Whole genome sequencing (next generation sequencing)

Food is evolving. Meal-replacement beverages, three dimensional printed pasta and meat grown in laboratories... These are just some of the paths it is taking, and so as food changes, so will our need to ensure its safety.

When foodborne illnesses occur, it is the job of health and agriculture officials to track down the common denominators of the outbreak and work with private enterprises to find the source of contamination. This is no easy job, although new scientific tools are making it faster and more effective. One major scientific advance in particular, whole genome sequencing (WGS), which is a technique that reads genetic information, potentially unveiling a distinct sequence by which to recognize specific microorganisms. These DNA sequences are like fingerprints: they are unique to each organism and its strain, and as such, this technique can track down pathogens with precision not previously possible.

WGS for food safety



WGS can help single out, with more precision, which ingredient in a multi-ingredient food is responsible for an outbreak. When you eat an egg and get sick, you know it is the egg. But what happens if you get sick from a quiche? Is it the eggs, the butter, the milk or another ingredient? WGS can more accurately detect, than conventional methods, which specific ingredient carried the pathogen.

WGS can determine the source of contamination. Knowing at what point in the food chain the food was contaminated enables from prematurely or inadvertently blaming restaurants or other businesses.

WGS can help determine which illnesses are part of an outbreak. When outbreaks happen, it is very hard to know if the cause of one person's sickness is the same cause as someone else's, especially if they are in different parts of the country. With WGS, it is easier to tell what the pathogen is and the type of illness it can cause.

WGS can more definitively show the linkages between multi-national outbreaks. It is important to make WGS data available across multiple countries. Global sharing of WGS data could enhance the response to a foodborne outbreak and to stop it from spreading further.

WGS technology is universally applicable and global data-sharing is essential to benefit fully from using this tool. However, while the cost of this technology is decreasing, not all countries have the means to adopt it. Laboratory infrastructure and capacities for performing this type of analysis are often lacking, especially in less-developed countries. There should be a global commitment to make WGS available to all countries in order to strengthen the global and local food safety systems, so that WGS can become an effective tool for all. FAO facilitates an informal network of developing countries to share information, knowledge and experience in using WGS for food safety management.

Consideration points

- Globally, more than 22 countries regularly use WGS for food safety management at the national level.
- Access to global WGS foodborne pathogen databases is crucial in application of WGS for food safety management.
- Educational curricula that include bioinformatics may bring a significant advantage of using WGS in the long run.
- While initial investment might be substantial, early implementation of WGS in national food control systems may be of a strategic option for countries with fundamental capacity challenges in microbiology.

Further readings

- **FAO.** 2021. Whole Genome Sequencing (WGS) and food safety. http://www.fao.org/food/food-safety-quality/a-z-index/wgs/
- **FAO.** 2020z. Applications of whole genome sequencing in food safety management. http://www.fao.org/3/a-i5619e.pdf
- **FAO.** 2020aa. Food safety and quality: Whole genome sequencing (WGS) and food safety. http://www.fao.org/food-safety/scientific-advice/crosscutting-and-emerging-issues/wgs/

X

eXperts on food safety

Have you ever looked for an expert on a particular food safety issue and could not find one? There is always something new in food safety, and this adds up to the fact that many food safety issues can be transboundary.

In a world where incredible amounts of information are available, it can be hard to identify an expert: networking and collaboration within the same area could really help. For example, countries could work together to improve or complement their technical capacity, providing them with cost-effective results.

Examples of collaborations among FAO members

Kenya, Uganda and Zambia wanted to build a collaborative structure to assess the safety of GM foods. First, they conducted training sessions and workshops among themselves. Then, they addressed the common issues the three countries were facing, then they established a common roster of experts and join risk assessments.

Australia and New Zealand piloted a project to develop pre-market assessments together for GM foods. First, they conducted trust-building exercises, then they started conducting parallel reviews of the assessments. Finally, they established work-sharing arrangements to conduct pre-marketing assessments.

Bhutan has collaborated with Argentina and Australia to improve their risk communication strategies and the way they handle GM food safety assessments, and this collaboration was mediated by FAO.

Source: FAO, 2019b.

Can you think of any possible similar collaboration with other countries in the region on the topic of food safety? FAO could have the double role of supporting connection among its member states and of providing your country with sound scientific advice. FAO webpage on the provision of scientific advice for food safety and quality is available at: http://www.fao.org/food-safety/scientific-advice/.

FAO mechanisms for the provision of scientific advice

Source: FAO, 2020bb.

- Joint FAO/WHO Expert Committee on Food Additives (active since 1956);
- Joint FAO/WHO Meetings on Pesticide Residues (active since 1963);
- Joint FAO/WHO Expert Meetings on Microbiological Risk Assessment (active since 2000);
- Joint FAO/WHO Expert Meetings on Pesticide Specifications (active since 2002);
- The Joint FAO/WHO Expert Meeting on Nutrition; and
- ad hoc expert consultations and meetings organized in response to specific ad hoc requests or emergency situations.

Y

Youth and food safety

How do you picture the food safety world in 10, 20 and 30 years from now?

Maybe there will be newly invented technologies that rely on some scientific principle that haven't yet been discovered, or maybe it will be very similar to our present. Will future generations be capable of addressing present and future food safety issues?

The Asia-Pacific region has the highest and most youthful population in the world. While on the one hand, these young people are consumers who need food safety education, they are also the future players of food safety and, therefore, deserve the focus and attention of food safety authorities. To do this, there needs to be equity in education, lower unemployment levels, and more citizen participation and engagement (McKinsey Center for Government, 2014).

Selected data on youth in the Asia-Pacific region

The Asia-Pacific region contains 60 percent of the world's youth population (i.e. persons aged 15 to 24 years) (UNESCAP, 2015).

Youth makes up about the 19 percent of the region's total population (UNESCAP, 2015).

The youth unemployment rate in Asia and the Pacific is estimated at 14.1 percent in 2020, with 86.3 percent of those working at an informal job (ILO, 2020b).

The proportion of youth who are unemployed, not receiving an education or training is estimated to 24.4 percent in 2020, compared to the global rate of 22.3 percent (ILO, 2020b).

What kinds of skills and knowledge are necessary to cover the constantly evolving scenario of food safety? Some governments have started teaching young children about food safety and hygienic measures.

- In the United States of America "4-H" is a youth development organization that helps young people and their families gain the skills needed to be proactive forces in their communities. Various issues, including food safety, are addressed by the programme. 4-H is led by a unique private–public partnership of universities, federal and local government agencies, foundations and professional associations, and was established by the Nation's Cooperative Extension System and the United States Department of Agriculture (4-H, 2020).
- In China, several initiatives have been conducted to educate young students about food safety and so that they can teach their parents at home. This was done, for example, in Longshua District in Shenzen during the Food Safety Month, and during the food safety promotion week in Dongying.

Consideration points

- The Asia-Pacific region contains 60 percent of the world's youth Population (UNESCAP, 2015).
- Some food safety educational programmes for children at school have shown a positive impact on the food safety knowledge of their parents.
- Targeted educational curricula for food safety will increase the number and the qualification of the food safety professionals of the future.
- Youth population is often technology-oriented and their insights can be valuable in the area of food safety where innovative approaches are useful.
- Collaborations among governments and academia are useful to unleash the potential of youth to improve food safety and they are strategic for the implementation of food safety education programmes.

Be Young, be food-safe, be heard

To creatively amplify the voices of young people in the region with regards to food safety, FAO's Regional Office for Asia and the Pacific has organized a multimedia competition for individuals under age 30 who are currently living within the region. Participants have submitted posters, videos and photos related to food safety and were asked to provide innovative points of view on the topic. The competition was launched on 20 April 2020 and closed on 31 August 2020. All submissions received before 31 May 2020 and had passed the screening, were featured on FAORAP's official accounts on Twitter, Weibo and WeChat. The multimedia of the winners can be seen in the brochure called "Be Young, Be food-safe, Be heard: an FAO Poster, Photo and Video Making Competition for Young Food Safety Ambassadors", also available at http://www.fao.org/3/cb2871en/cb2871en.pdf.

Z

Zoonosis and food safety

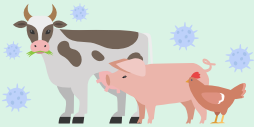
Did you know that three of the main foodborne pathogens are zoonoses?

Campylobacter spp., *Salmonella* spp., and Shiga toxin-producing *Escherichia coli* O157:H7 are among the most infamous foodborne pathogens, and they are transmitted from vertebrate animals to humans. Brucellosis and listeriosis can also be transmitted from animals to humans, in particular through contaminated foods, and in some cases, by contact with the live or slaughtered animal.

Zoonoses and food safety in figures

In China, at the height of the avian influenza epidemic, chicken production was reduced by over one third.

In Viet Nam, in 2009, 12 percent of the total annual poultry stock died.



In the last decade, the direct costs attributed to zoonotic diseases were estimated to be USD 20 billion, and indirect costs of more than USD 200 billion.

Investments of a range of USD 1.8 to 4.5 billion in preventive measures would avoid costs of USD 30 to 60 billion per year.

Source: ADB, 2020.

FAO, OIE and WHO recognize that addressing health risks at the human-animal-ecosystem interface requires strong partnerships among players who may have different perspectives on some issues and different levels of resources. Some priority areas were identified to develop new approaches to tackle zoonotic diseases (FAO, OIE and WHO, 2010f), including:

1. Making data more accessible and to wider groups.
2. Engaging with non-traditional partners to improve existing surveillance systems.
3. Including the aspects of ecosystems, and interactions within them to understand roles more clearly.
4. Developing and implementing diagnostic tools for early, field-based detection of emerging diseases.
5. Promoting engagement and participation of the public and stakeholders through communication campaigns.
6. Building capacities based on national-level needs, cross-training among sectors, and multidisciplinary approaches to education; and
7. Using collaborative and multi-sectoral approaches that consider all stakeholders.

3 Conclusions

Food safety is a complex topic. This document provides a non-exhaustive overview over some of the contemporary topics related to food safety, with the hope of offering readers some issues and ideas to consider, and the hope of encouraging research and analyses for their country situation. A list of key FAO publications was also provided for each topic.

This guide introduces the food safety toolkit. While a number of classic food safety topics are covered, specific issues that touch on contemporary topics are also included. The food safety toolkit comprises the following booklets:

1. Layman's guide to food safety in Asia and the Pacific – Introduction to the food safety toolkit;
2. Backyard farming and slaughtering – Keeping tradition safe;
3. Investing in food safety for global benefits – A concrete case in the Association of Southeast Asian Nations (ASEAN) countries;
4. Food allergies – Leaving no one behind;
5. Food fraud – Intention, detection and management;
6. Organic food – Are they safer?;
7. Parasites in foods – An invisible threat;
8. Slowing down superbugs – Legislations and antimicrobial resistance (AMR);
9. Measuring food safety – Indicators to achieve the Sustainable Development Goals (SDGs); and
10. Community of practice – Codex address book for Asia and the Pacific.

FAO will continue to assist its member countries in the area of food safety and provide references that can be easily utilised by countries that are willing to improve areas of food safety.

4 Resources

4.1. FAO Bibliography

FAO. 2000. FAO statement on biotechnology. In: *FAO Biotechnology.* Rome. [Cited 12 June 2020]. http://www.fao.org/biotech/fao-statement-on-biotechnology/en/

FAO. 2001a. Overview on food allergies – In: *Evaluation of Allergenicity of Genetically Modified Foods Report of a Joint FAO/WHO Expert Consultation on Allergenicity of Foods Derived from Biotechnology 22–25 January 2001* [online]. Rome. [Cited 6 July 2020]. http://www.fao.org/3/y0820e/y0820e04.htm#bm04

FAO. 2001b. Principles and practices of small- and medium-scale fruit juice processing. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/3/y2515e/y2515e00.htm#toc

FAO. 2002. Organic agriculture, environment and food security. In: *FAO* [online]. Rome. [Cited 18 September 2020]. http://www.fao.org/3/y4137e/y4137e00.htm

FAO.. 2008a. Abattoir development: Options and designs for hygienic basic and mediums-sized abattoirs. [online]. Rome. [Cited 6 October 2020]. http://www.fao.org/tempref/docrep/fao/010/ai410e/ai410e00.pdf

FAO. 2008b. The Codex code of practice on good animal feeding. In: *FAO* [online]. Rome. [Cited 9 October 2020]. http://www.fao.org/3/i1379e/i1379e06.pdf

FAO. 2009. Good hygienic practices in the preparation and sale of street food in Africa. In: *FAO* [online]. Rome. [Cited 11 October 2020]. http://www.fao.org/3/a-a0740e.pdf

FAO. 2010. FAO/WHO expert meeting on the application of nanotechnologies in the food and agriculture sectors: Potential food safety implications. In: *FAO* [online]. Rome. http://www.fao.org/3/i1434e/i1434e00.pdf

FAO. 2011. Good emergency management practice: The essentials. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/3/a-ba0137e.pdf

FAO. 2013a. FAO GM Foods Platform. In: *FAO Food safety and Quality. Rome.* [Cited 12 June 2020]. http://www.fao.org/gm-platform/

FAO. 2013b. Highlights: Foodborne parasites – Ranking for risk management. In: *FAO Food Safety and Quality* [online]. Rome. [Cited 18 September 2020]. http://www.fao.org/fileadmin/user_upload/agns/pdf/ParasiteHighlight3.pdf

FAO. 2013c. Summary risk profile on Trichinella in meat. In: *FAO Food Safety and Quality* [online]. Rome. [Cited 18 September 2020]. http://www.fao.org/fileadmin/user_upload/agns/pdf/Foodborne_parasites/RiskProfTrichinellaOct2013.pdf

FAO. 2013d. Summary risk profile on *C. bovis* in meat from domestic cattle. In: *FAO Food Safety and Quality* [online]. Rome. [Cited 18 September 2020]. http://www.fao.org/fileadmin/user_upload/agns/pdf/Foodborne_parasites/RiskProfTaeniasaginataOct2013.pdf

FAO. 2016a. Strengthening veterinary diagnostic capacities: the FAO laboratory mapping tool. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/3/a-i5439e.pdf

FAO. 2016b. Risk communication applied to food safety – Handbook. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/3/a-i5863e.pdf

FAO. 2016c. Handbook on food labelling to protect consumers. In: *FAO* [online]. Rome. [Cited 7 July 2020]. http://www.fao.org/3/a-i6575e.pdf

FAO. 2016d. Risk based imported food control manual. In: *FAO* [online]. Rome. [Cited 8 November 2020]: http://www.fao.org/3/a-i5381e.pdf

FAO. 2016e. Risk communication applied to food safety handbook. In: *FAO* [online]. [Cited 11 October 2020]. http://www.fao.org/3/ai5863e.pdf

FAO. 2016f. An INFOSAN meeting on regional perspectives of food science developments in Asia. [slideshare]. [Cited 12 June 2020]. https://www.slideshare.net/LeeGheeSeow/new-science-for-food-safetysupporting-food-chain-transparency-for-improved-health

FAO. 2016g. Strengthening veterinary diagnostic capacities: The FAO laboratory mapping tool. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/3/a-i5439e.pdf

FAO. 2017a. Food Handler's Manual: Student. In: *FAO* [online]. Rome. [Cited 11 October 2020]. http://www.fao.org/3/I7321EN/i7321en.pdf

FAO. 2017b. Food Handler's Manual: Instructor. In: *FAO* [online]. Rome. [Cited 11 October 2020]. http://www.fao.org/3/I5896EN/i5896en.pdf

FAO. 2018a. *World livestock: Transforming the livestock sector through the Sustainable Development Goals*. Rome. 222 pp. Licence: CC BYNC-SA 3.0 IGO.

FAO. 2018b. Family farming in the Pacific Islands countries – Challenges and opportunities. In: *FAO* [online]. Rome. http://www.fao.org/3/ca0305en/CA0305EN.pdf

FAO. 2018c. Ensuring the safety of imported food – Current approaches for imported food control in Myanmar, Nepal, the Philippines and Sri Lanka. In: *FAO* [online]. Bangkok. [Cited 8 November 2020]. http://www.fao.org/3/ca0286en/CA0286EN.pdf

FAO. 2019a. FAO GM Foods Platform: Are we effectively evaluating food safety? In: *FAO* [online]. Rome. [Cited 1 June 2020]. http://www.fao.org/3/ca7770en/ca7770en.pdf

FAO. 2019b. Global Community Meeting of the FAO GM Foods Platform – Towards effective risk-based food safety assessment and regulatory management. In: *FAO* [online]. Rome. [Cited 12 June 2020]. http://www.fao.org/3/ca8945en/CA8945EN.pdf

FAO. 2019c. *Creating a Food Safety Culture in Bhutan* [video]. [Cited 12 June 2020]. https://www.youtube.com/watch?v=E88Mnh0MVxE

FAO. 2019d. Digital transformation of the food system. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/3/CA2965EN/ca2965en.pdf

FAO. 2019e. Science, innovation and digital transformation at the service of food safety. In: *FAO* [online]. Rome. [Cited 12 June 2020]. http://www.fao.org/3/CA2790EN/ca2790en.pdf

FAO. 2019f. Sharing responsibility for consumer empowerment. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/3/CA3542EN/ca3542en.pdf

FAO. 2019g. Technical guidance principles of risk-based meat inspection and their application. In: *FAO* [online]. Rome. http://www.fao.org/3/ca5465en/CA5465EN.pdf

FAO. 2019h. The First FAO/WHO/AU International Food Safety Conference – Sharing responsibility for consumer empowerment. In: *FAO* [online]. Rome. [Cited 12 June 2020]. http://www.fao.org/3/CA3542EN/ca3542en.pdf

FAO. 2019i. The First FAO/WHO/AU International Food Safety Conference Addis Ababa, Digital transformation of the food system. In: *FAO* [online]. Rome. [Cited 12 June 2020]. http://www.fao.org/3/CA2965EN/ca2965en.pdf

FAO. 2019j. The status of application, capacities and the enabling environment for agricultural biotechnologies in the Asia-Pacific region In: *FAO* [online]. Rome. [Cited 29 June 2020]. http://www.fao.org/3/ca4438en/ca4438en.pdf

FAO. 2020a. Antimicrobial resistance. In: *FAO* [online]. Rome. [Cited 16 July 2020]. http://www.fao.org/antimicrobial-resistance/en/

FAO. 2020b. Antimicrobial resistance: Background. FAO's role. In: *FAO* [online]. Rome. [Cited 16 July 2020]. http://www.fao.org/antimicrobialresistance/ background/fao-role/en/

FAO. 2020c. Antimicrobial resistance: Key issues. In: FAO [online]. Rome. [Cited 16 July 2020]. http://www.fao.org/antimicrobial-resistance/keysectors/food-safety/en/

FAO. 2020d. Biotechnology and food safety. In: *FAO food safety and quality, scientific advice, crosscutting emerging issues.* Rome. [Cited 12 June 2020]. http://www.fao.org/food-safety/scientific-advice/crosscutting-and-emerging-issues/biotechnology/

FAO. 2020e. FAO-BAFRA national seminar and workshop on food safety culture and food safety indicators pilot project in Bhutan.Technical summary report. [Cited 12 June 2020]. http://www.fao.org/3/ca7021en/ca7021en.pdf

FAO. 2020f. Microbiological risks and JEMRA. In: *FAO Food safety and quality* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/food/food-safety-quality/scientific-advice/jemra/en/

FAO. 2020g. Food safety in the new normal. In: *FAO* [online]. Rome [Cited 5 October 2020]. http://www.fao.org/3/cb0481en/CB0481EN.pdf

FAO. 2020h. Food for thought on food fraud. Development Law – Issue #1 of 2020. http://www.fao.org/legal/development-law/magazine-1-2020/en/

FAO. 2020i. Food safety and quality. In: *FAO* [online]. Rome. [Cited 18 September 2020]. http://www.fao.org/food-safety/background/en/

FAO. 2020j. Food safety activities. In: *FAO* [online]. Rome. [Cited 29 June 2020]. http://www.fao.org/asiapacific/perspectives/onehealth/food-safety/en/

FAO. 2020k. FAO offices in Asia and the Pacific. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/asiapacific/our-offices/en/

FAO. 2020l. Worldwide Offices. In: *FAO* [online]. Rome. [Cited 29 June 2020]. http://www.fao.org/about/who-we-are/worldwide-offices/en/

FAO. 2020m. Stock-taking report: food biotechnology communication materials in the world [online]. Rome. [Cited 28 January 2021]. http://www.fao.org/3/cb1394en/cb1394en.pdf

FAO. 2020n. Biotechnology. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/biotechnology/en/

FAO. 2020o. The status of application, capacities and the enabling environment for agricultural biotechnologies in the Asia-Pacific region. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/3/ca4438en/ca4438en.pdf

FAO. 2020p. Organic agriculture. In: *FAO* [online]. Rome. [Cited 18 September 2020]. http://www.fao.org/organicag/oa-faq/oa-faq1/en/

FAO. 2020q. Organic agriculture publications. In: *FAO Organic Agriculture* [online]. Rome. [Cited 18 September 2020]. http://www.fao.org/organicag/oa-publications/search-results/en/

FAO. 2020r. The world of organic agriculture – Statistics and emerging trends 2020. In: *FAO* [online]. Rome. [Cited 18 September 2020]. http://www.fao.org/agroecology/database/detail/en/c/1262695/

FAO. 2020s. Food safety and quality: Foodborne parasites. In: *FAO* [online]. Rome. [Cited 23 November 2020]. http://www.fao.org/food/food-safety-quality/a-z-index/foodborne-parasites/en/

FAO. 2020t. Be safe from fish liver flukes. In: *FAO* [online]. Rome. [Cited 15 October 2020]. http://www.fao.org/3/ca9100en/CA9100EN.pdf

FAO. 2020u. Be safe from pork tapeworms. In: *FAO* [online]. Rome.[Cited 15 October 2020]. http://www.fao.org/3/ca9095en/CA9095EN.pdf

FAO. 2020v. Food for the Cities Initiative. In: *FAO* [online]. Rome. [Cited 11 October 2020. http://www.fao.org/fcit/fcit-home/en/

FAO. 2020w. City Region Food Systems Programme. In: *FAO* [online]. Rome. [Cited 11 October 2020. http://www.fao.org/in-action/food-forcities-programme/en/

FAO. 2020x. City Region Food Systems Programme – tools examples. In: *FAO* [online]. Rome. [Cited 11 October 2020. http://www.fao.org/3/i9255en/I9255EN.pdf

FAO. 2020y. Improved rural urban linkages: Building sustainable food systems. [video]. https://www.youtube.com/watch?v=DJgMzxUTx2U

FAO. 2020z. Applications of whole genome sequencing in food safety management. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/3/a-i5619e.pdf

FAO. 2020aa. Food safety and quality: Whole genome sequencing (WGS) and food safety. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/food-safety/scientific-advice/crosscutting-andemerging-issues/wgs/en/

FAO. 2020bb. Food safety and quality: Scientific advice. In: *FAO* [online]. [Cited 13 October 2020]. http://www.fao.org/food-safety/scientificadvice/en/

FAO. 2021. Whole Genome Sequencing (WGS) and food safety. In: FAO [online]. Rome. [Cited 28 January 2021]. http://www.fao.org/food/foodsafety-quality/a-z-index/wgs/en/

FAO & ITU. 2019. E-agriculture in action: Blockchain for agriculture. Opportunities and challenges. Bangkok. 72 pp. (Also available at http://www.fao.org/3/CA2906EN/ca2906en.pdf).

FAO, OIE & WHO. 2020a. Foodborne parasitic infections: Trichinellosis. In: *FAO* [online]. Rome. [Cited 15 October 2020]. http://www.fao.org/3/cb1206en/cb1206en.pdf

FAO, OIE & WHO. 2020b. Foodborne parasitic infections: Taeniasis and cysticercosis. In: *FAO* [online]. Rome. [Cited 15 October 2020]. http://www.fao.org/3/cb1129en/cb1129en.pdf

FAO, OIE & WHO. 2020c. Foodborne parasitic infections: Fascioliasis (liver fluke). In: *FAO* [online]. Rome. [Cited 15 October 2020]. http://www.fao.org/3/cb1127en/cb1127en.pdf

FAO, OIE & WHO. 2020d. Foodborne parasitic infections: Cystic and alveolar echinococcosis. In: *FAO* [online]. Rome. [Cited 15 October 2020]. http://www.fao.org/3/cb1128en/cb1128en.pdf

FAO, OIE & WHO. 2020e. Foodborne parasitic infections – Clorochiasis and opisthorchiasis. In: *FAO* [online]. Rome. [Cited 15 October 2020]. http://www.fao.org/3/cb1208en/cb1208en.pdf

FAO, OIE & WHO. 2010f. Influenza and other emerging zoonotic diseases at the human-animal interface: FAO/OIE/WHO Joint Scientific Consultation 27–29 April 2010, Verona (Italy). [online] [Cited 13 October 2020]. http://www.fao.org/3/i1963e/i1963e00.pdf

FAO, OIE & WHO. 2010g. The FAO-OIE-WHO Collaboration Sharing responsibilities and coordinating global activities to address health risks at the animal-human-ecosystems interfaces – A Tripartite Concept Note [online]. [Cited 23 November 2020]. https://www.who.int/foodsafety/zoonoses/final_concept_note_Hanoi.pdf

FAO & WHO. 1999. Organically produced foods. In: *FAO* [online]. Rome. [Cited 18 September 2020]. http://www.fao.org/3/a1385e/a1385e00.pdf

FAO & WHO. 2001a. Evaluation of allergenicity of genetically modified foods. Report of a Joint FAO/WHO Expert Consultation on Allergenicity of Foods Derived from Biotechnology 22–25 January 2001. In: *FAO* [online]. Rome. [Cited 15 June 2020]. http://www.fao.org/3/y0820e/y0820e00.htm#Contents

FAO & WHO. 2001b. Codex Alimentarius Food Hygiene Basic Texts,Second Edition. In: *FAO* [online]. Rome. [Cited 5 October 2020]. http://www.fao.org/3/y1579e/y1579e00.htm#Contents

FAO & WHO. 2007. FAO biosecurity toolkit. Rome, FAO. 140 pp. (Also available at http://www.fao.org/docrep/pdf/010/a1140e/a1140e.pdf).

FAO & WHO. 2008. Viruses in food: Scientific advice to support risk management activities meeting report. Microbiological risk assessment series. In: *FAO* [online]. [Cited 13 October 2020]. http://www.fao.org/3/a-i0451e.pdf

FAO & WHO. 2010a. Application of nanotechnologies in the food and agriculture sectors: Potential food safety implications. In: *FAO* [online].Rome. [Cited 8 November 2020]. http://www.fao.org/3/i1434e/i1434e00.pdf

FAO & WHO. 2010b. FAO/WHO Framework for Developing National Food Safety Emergency Response Plans. Rome. 24 pp. (Also available at http://www.fao.org/3/i1686e/i1686e00.pdf).

FAO & WHO. 2011. FAO/WHO guide for application of risk analysis during food safety emergencies. Rome. 52pp. Also available at http://www.fao.org/3/ba0092e/ba0092e00.pdf

FAO & WHO. 2012. FAO/WHO guide for developing and improving national food recall systems. Rome. 68 pp. (Also available at http://www.fao.org/3/i3006e/i3006e.pdf).

FAO & WHO. 2013a. State of the art on the initiatives and activities relevant to risk assessment and risk management of nanotechnologies in the food and agriculture sectors. In: *FAO* [online]. Rome. [Cited 9 October 2020]. http://www.fao.org/3/i3281e/i3281e.pdf

FAO & WHO. 2013b. Risk-based examples for control of *Trichinella* spp. and *Taenia saginata* in meat. In: *FAO Food Safety and Quality.* [online]. Rome. [Cited 18 September 2020]. http://www.fao.org/fileadmin/user_upload/agns/pdf/Foodborne_parasites/Risk-based_Control_Trich_and_Taenia_17June_Eng.pdf

FAO & WHO. 2014. Multicriteria-based ranking for risk management of food-borne parasites. Report of a joint FAO/WHO Expert Meeting, 3–7 September 2012, FAO Headquarters, Rome, Italy. Microbiologicalassessments series. [online]. Rome. [Cited 18 September 2020]. http://www.fao.org/3/a-i3649e.pdf

FAO & WHO. 2017. Codex Committee on Food Import and Export Inspection and Certification Systems. Twenty-third Session. Discussion Paper on "Food Integrity and Food Authenticity". Prepared by Iran with assistance from Canada and the Netherlands. CX/FICS17/23/5. http://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FMeetings%252FCX-733-23%252FWD%252Ffc23_05e.pdf

FAO & WHO. 2018. Committee on Food Import and Export Inspection and Certification Systems. Twenty-Fourth Session. Discussion Paper on "Food Integrity and Food Authenticity", CX/FICS18/24/7. http://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FMeetings%252FCX-733-24%252FWorking%2BDocuments%252Ffc24_07e.pdf

FAO & WHO. 2020a. Codex Alimentarius standards and related texts. In: Codex Alimentarius International food standards [online]. Rome. [Cited 7 July 2020]. http://www.fao.org/fao-who-codexalimentarius/codex-texts/en/

FAO & WHO. 2020b. Codex Alimentarius: Introduction to key areas of work in Codex. In: *FAO* [online]. Rome. [Cited 11 October 2020]. http://www.fao.org/fao-who-codexalimentarius/thematic-areas/en/

FAO & WHO. 2020c. Codex Alimentarius: The CCASIA Region –Regional Coordinator India. In: *FAO* [online]. [Cited 11 October 2020]. http://www.fao.org/fao-who-codexalimentarius/committees/codexregions/ccasia/about/en/

FAO & WHO. 2020d. Codex Alimentarius: The CCNASWP Region – Regional Coordinator Vanuatu. In: *FAO* [online]. [Cited 11 October 2020].http://www.fao.org/fao-who-codexalimentarius/committees/codexregions/ccnaswp/about/en/

FAO & WHO. 2020e. Animal feed. In: FAO [online]. Rome. [Cited 9 October 2020]. http://www.fao.org/fao-whocodexalimentarius/thematic-areas/animal-feed/en/

4.2. Bibliography

Agence France Presse (AFP). 2021. AFP Fact Check. In: *AFP* [online]. https://factcheck.afp.com/fact-checking-search-results?keywords=food

Asian Development Bank (ADB). 2020. What Asia can do to protect against animal-borne diseases. In: *Asian Development Bank* [online]. Manila. [Cited 13 October 2020]. https://development.asia/explainer/what-asia-can-do-protect-against-animal-borne-diseases

Bacon, F. and In Fowler, T. 1889. *Novum organum.* Oxford: Clarendon Press.

Barras, V. and Greub, G. 2014. History of biological warfare and bioterrorism. *Clinical Microbiology and Infection,* 20(6): 497-502. (Also available at https://doi.org/10.1111/1469-0691.12706).

BBC. 2018. A brief history of fake news. In: *BBC* [online]. London. [Cited 8 November 2020]. https://www.bbc.com/news/av/stories-42752668

BBC. 2010. China dairy products found tainted with melamine. In: *BBC* [online]. London. [Cited 5 October 2020]. https://www.bbc.com/news/10565838#:~:text=Chinese%20food%20safety%20officials%20have,the%20toxic%20industrial%20chemical%20melamine.&text=Test%20samples%20showed%20the%20milk,babies%20and%20made%20300%2C000%20ill.

Beijing Evening News. 2019. Internet celebrity food is more popular and safer (网红食品 要红更要安全). In: Fashion [online]. Beijing. [Cited 11 October 2020]. http://fashion.ce.cn/news/201907/04/t20190704_32524058.shtml

Bonnemaison, J. 1986. *The tree and the canoe: History and ethnogeography of Tanna*. Honolulu, University of Hawaii Press.

CAFIA. 2015. Adulteration of food: current problem? [online]. Brno. [Cited 5 February 2021]. https://ec.europa.eu/food/sites/food/files/safety/docs/official-controls-food-fraud_brochure_2015.pdf

Carmody, R.N., Bisanz, J.E., Bowen, B.P. *et al.* 2019. Cooking shapes the structure and function of the gut microbiome. *Nature Microbiology,* 4: 2052–2063. (Also available at https://doi.org/10.1038/s41564-019-0569-4).

Centers for Disease Control and Prevention (CDC). 2015. Diarrhea: Common illness, global killer. In: *Centers for Disease Control and Prevention* [online]. Atlanta. [Cited 29 June 2020]. https://www.cdc.gov/healthywater/pdf/global/programs/Globaldiarrhea_ASIA_508c.pdf

中国小康网 (China Well-Off Network). 2019. Attention: How is internet celebrity food "red" and safe? In: *Baijiahao* [online]. [Cited 11 October 2020]. https://baijiahao.baidu.com/s?id=1623611530844797344&wfr=spider&for=p

Chryssohoidis, G.M. & Krystallis, A. 2005. Organic consumers' personal values research: Testing and validating the list of values (LOV) scale and implementing a value-based segmentation task. *Food Quality and Preference,* 16: 585–599.

Collignon, P., Beggs, J.J., Walsh, T.R., Gandra S. & Laxminarayan, R. 2018. Anthropological and socioeconomic factors contributing to global antimicrobial resistance: A univariate and multivariable analysis. Lancet Planet Health, 2(9):e398-e405. (Also available at https://doi:10.1016/S2542-5196(18)30186-4).

Dadonaite, B. & Ritchie, H. 2018. Diarrheal diseases. In: *Our World in Data* [online]. Oxford. [Cited 29 June 2020]. https://ourworldindata.org/diarrheal-diseases#citation

Dreezens, E. & Martijn, C. *2005.* Food and values: An examination of values underlying attitudes toward genetically modified- and organically grown food products. *Appetite,* 44: 115–122.

The Economist Intelligence Unit. 2013. A healthy future for all? Improving food quality for Asia. In: *The Economist Intelligence Unit.* [online]. London. [Cited 11 October 2020]. https://business.nab.com.au/wp-content/uploads/2013/10/improving-food-quality-for-asia.pdf

European Food Safety Authority (EFSA). 2011. Update on the present knowledge on the occurrence and control of foodborne viruses. *EFSA Journal* 9(7):2190.

European Commission. 2020. Quality schemes explained. In: *European Commission* [online]. Brussels. [Cited 11 October 2020]. https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/quality-schemes-explained_en#geographicalindications

Food Industry Asia. 2018. Food e-commerce across Asia. In: *Food Industry Asia* [online]. Singapore. [Cited 28 May 2020]. https://foodindustry.asia/documentdownload.axd?documentresourceid=30715

Founou, L.L., Founou, R.C. & Essack, S.Y. 2016. Antibiotic resistance in the food chain: A developing country perspective. *Frontiers in Microbiology,* 7: 1–19. (Also available at https://doi:10.3389/fmicb.2016.01881).

4-H. 2020. 4-H. [online]. [Cited 13 October 2020]. https://4-h.org/

Friedrichs, S. Takasu, Y., Kearns, P. Dagallier, B. Oshima, R., Schofield, J. & Moreddu, C. 2019. An overview of regulatory approaches to genome editing in agriculture. Biotechnology Research and Innovation, 3(2): 208–220.

Gaj, T., Sirk, S.J, Shui, S. & Liu, J. 2016. Genome-editing technologies: Principles and applications. *Cold Spring Harbor Perspectives in Biology,* 8(12): a023754.

Global Burden of Diseases Collaborators (GBD). 2016 Diarrhoeal disease collaborators. Estimates of the global, regional, and national morbidity, mortality, and aetiologies of diarrhoea in 195 countries: A systematic analysis for the Global Burden of Disease Study 2016. *Lancet Infectious Disease,* 18(11): 1211–1228. (Also available at https://doi:10.1016/S1473-3099(18)30362-1).

Gelpi, E., De la Paz, M., Terracini, B., Abaitua, I., Gomex de la Camara. A., Kilbourne, E.M., Lahoz, C. Nemery, B., Philen, R.M., Soldevilla, L. & Tarowsky, S. 2002. The Spanish toxic oil syndrome 20 years after its onset: A multidisciplinary review of scientific knowledge. *Environmental Health Perspectives,* 110(5): 457–464. (Also available at https://doi:10.1289/ehp.110-1240833).

Hadley, C. 2006. Food allergies on the rise? Determining the prevalence of food allergies, and how quickly it is increasing, is the first step in tackling the problem. *EMBO Reports Science and Society,* 7(11): 1080–1083.

International Labour Organization. 2020a. More than 68 per cent of the employed population in Asia-Pacific are in the informal economy. In: *ILO* [online]. Geneva. [Cited 10 October 2020]. https://www.ilo.org/asia/media-centre/news/WCMS_627585/lang--en/index.htm

International Labour Organization. 2020b. ILO global report sheds light on the youth employment challenge in Asia-Pacific. In: *ILO* [online]. Geneva. [Cited 13 October 2020]. https://www.ilo.org/asia/media-centre/news/WCMS_737997/lang--en/index.htm

International Service for the Acquisition of Agri-biotech Applications (ISAAA). 2017. Brief 53: Global status of commercialized biotech/gm crops. In: *ISAAA* [online]. Ithaca, New York. [Cited 1 June 2020]. http://www.isaaa.org/resources/publications/briefs/53/

Food Systems Dashboard. 2020. *Food Systems Dashboard* [online]. Baltimore, MD.[Cited 9 October 2020]. https://foodsystemsdashboard.org/

Koopmans, M. & Duizer, E. 2004. Foodborne viruses: An emerging problem. *International Jounal of Food Microbiology,* 90(1): 23–41. (Also available at https://doi:10.1016/S0168-1605(03)00169-7).

Lee, C.O., Steinkraus, K. & Reilly, P.J.A. 1993. *Fish Fermentation Technology.* New York, United Nations University Press.

Lee, J., Thalayasingam, M. & Wah Lee, B. 2013. Food allergy in Asia: How does it compare? *Asia Pacific Allergy.* 3(1):3–14.

Market Data Forecast. 2019. Asia Pacific genome editing market research report – segmented by application, by technology, by end user and by country (India, China, Japan, South Korea, Australia, New Zealand, Thailand, Malaysia, Vietnam, Philippines, Indonesia, Singapore and the rest of APAC) – Industry analysis, size, share, growth, trends, and forecasts (2019–2024). In: Market Data Forecast. [Cited 29 June 2020]. https://www.marketdataforecast.com/market-reports/apac-genome-editing-market

Mascarello, G., Pinto, A., Parise, N., Crovato, S. & Ravarotto, L. 2015. The perception of food quality. Profiling Italian consumers. *Appetite,* 89:175–182. (Also available at https://doi:10.1016/j.appet.2015.02.014).

McKinsey Center for Government. 2014. Unleashing youth in Asia. Solving for the "Triple-E" challenge of youth: Education, Employment and Engagement. [online]. [Cited 13 October 2020]. https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/public%20sector/pdfs/unleashing_youth_in_asia.ashx

Nayak, R. & Waterson, P. 2017. The assessment of food safety culture: An investigation of current challenges, barriers and future opportunities within the food industry. *Food Control*, 73B: 1114–1123.

O'Neill, J. 2014. Antimicrobial resistance: Tackling a crisis for the health and wealth of nations. *Review of Antimicrobial Resistance* [online]. [Cited 16 July 2020]. https://amr-review.org/sites/default/files/AMR%20Review%20Paper%20-%20Tackling%20a%20crisis%20for%20the%20health%20and%20wealth%20of%20nations_1.pdf

Petersen, T.N., Rasmussen, S., Hasman, H., Carøe, C., Bælum, J., Schultz A.C., Bergmark, L., Svendsen, C.A., Sicheritz-Ponten, T., Aerestrup, F.M. 2015. Meta-genomic analysis of toilet waste from long distance flights; a step towards global surveillance of infectious diseases and antimicrobial resistance. Nature Scientific Reports 5, 11444. https://doi.org/10.1038/srep11444

Petrescu, D.C., Vermeir, I. & Petrescu-Mag, R.M. 2019. Consumer understanding of food quality, healthiness, and environmental impact: A cross-national perspective. *International Journal of Environmental Research and Public Health,* 17:169 [online]. [Cited 12 November 2020]. https://doi:10.3390/ijerph17010169

Redman, M., King, A., Watson, C. & King, D. 2016. What is CRISPR/Cas9? *Archives of Diseases in Childhood – Education and Practice,* 101(4): 213–215.

Savov A.V & G.B. Kouzmanov. 2009. Food quality and safety standards at a glance. *Biotechnology and Biotechnological Equipment,* 23:4:1462–1468. (Also available at https://doi:10.2478/V10133-009-0012-8).

Shafie F.A. & Rennie, D. 2012. Consumer perceptions towards organic food. *Procedia – Social and Behavioral Sciences,* 49: 360–367.

Shek L.P.C. & Lee, B.W. 2006. Food allergy in Asia. *Current Opinion in Allergy and Clinical Immunology,* 6(3):197–201. (Also available at http://doi:10.1097/01.all.0000225160.52650.17).

Sichao, L. & Xifu, W. 2016. Toward an intelligent solution for perishable food cold chain management. *7th IEEE International Conference on Software Engineering and Service Science (ICSESS).* Beijing. pp. 852–856. DOI: 10.1109/ICSESS.2016.7883200.

Soll, J. 2016. The long and brutal history of fake news. *Politico*, 16 December 2018. (Also available at https://www.politico.com/magazine/story/2016/12/fake-news-history-long-violent-214535).

Statista. 2020a. Global adoption rate for major biotech crops worldwide 2018, by type. In: *Statista* [online]. New York. [Cited 1 June 2020]. https://www.statista.com/statistics/262288/global-adoption-rate-major-biotech-crops-worldwide/

Statista. 2020b. Online food delivery Asia. In: *Statista* [online]. New York. [Cited 28 May 2020]. https://www.statista.com/outlook/374/101/online-food-delivery/asia#market-globalRevenue

Statista. 2020c. Amount consumers are willing to pay extra for zero food fraud certified products in Canada as of October 2016. In: *Statista* [online]. New York. [Cited 17 September 2020]. https://www.statista.com/statistics/713665/consumer-willing-to-pay-for-zero-food-fraud-certification-label-canada/

Statista. 2020d. Orange juice production volume worldwide from 2014/2015 to 2019/2020 (in million metric tons). In: *Statista* [online]. New York. [Cited 5 October 2020]. https://www.statista.com/statistics/1044906/world-orange-juice-production/

Statista. 2020e. Juices Asia. In: *Statista* [online]. New York. [Cited 30 May 2020]. https://www.statista.com/outlook/20030000/101/juices/asia

Statista. 2020f. Market value of the street food stalls Thailand 2015–2019. In: *Statista* [online]. [Cited 9 October 2020]. https://www.statista.com/statistics/1133616/thailand-street-food-market-value/

Statista. 2020g. Worldwide sales of organic food from 1999 to 2018. In: Statista [online]. New York. [Cited 15 July 2020]. https://www.statista.com/statistics/273090/worldwide-sales-of-organic-foods-since-1999/.

Statista. 2020h. Level of risk regarding food fraud perceived by consumers in Canada as of October 2016. In: *Statista* [online]. New York. [Cited 17 September 2020]. https://www.statista.com/statistics/713717/consumer-risk-perception-regarding-food-fraud-canada/

Taylor, S.L. 2017. Food allergies – An increasing public health concern [online]. [Cited 23 November 2020]. http://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FMeetings%252FCX-712-49%252FPresentations%252FTaylorCCFHChicago2017.pdf

Technavio. 2019. Global food nanotechnology market 2019–2023. In: Technavio. SKU: IRTNTR30663.

Torgerson, P.R., Devleesschauwer, B., Praet, N., Speybroeck, N., Willingham, A.L., Kasuga, F., Rokni, M.B., Zhou, X.Z., Fèvre, E.M., Sripa, B., Gargouri, N., Fürst, T., Budke, C.M., Carabin, H., Kirk, M.D., Angulo, F.J., Havelaar, A. & Nilanthi de Silva, N. 2015. World Health Organization estimates of the global and regional disease burden of 11 foodborne parasitic diseases, 2010: A data synthesis. PLoS Med. 12(12): e1001920 [online]. [Cited 12 November 2020]. doi:10.1371/journal.pmed.1001920.

Havelaar, A. & Nilanthi de Silva, N. 2015. World Health Organization estimates of the global and regional disease burden of 11 foodborne parasitic diseases, 2010: A data synthesis. PLoS Med. 12(12): e1001920 [online]. [Cited 12 November 2020]. doi:10.1371/journal.pmed.1001920.

United Nations Department of Economic and Social Affairs (UNESCAP). 2015. Population facts. [online]. [Cited 13 October 2020]. https://www.un.org/esa/socdev/documents/youth/fact-sheets/YouthPOP.pdf

United Nations Educational, Scientific and Cultural Organization (UNESCO). 2018. Journalism, 'fake news' and disinformation: Handbook for journalism education and training [online]. [Cited 8 November 2020]. https://en.unesco.org/sites/default/files/journalism_fake_news_disinformation_print_friendly_0.pdf

United Nations Children's Fund (UNICEF). 2020. *UNICEF data warehouse. In: UNICEF Data: Monitoring the situation of children and women.* [Cited 29 June 2020]. https://data.unicef.org/resources/data_explorer/unicef_f/?ag=UNICEF&df=GLOBAL_DATAFLOW&ver=1.0&dq=.MNCH_ORTCF+MNCH_ORS+MNCH_ORSZINC+MNCH_ZINC+MNCH_DIARCARE..&startPeriod=2015&endPeriod=2020

United States Food and Drug Administration (USFDA). 2020. What you need to know about foodborne illnesses. In: *FDA* [online]. [Cited 5 October 2020]. https://www.fda.gov/

Van Boeckel, T.P., Pires, J., Silvester, R., Zhao, C., Song, J., Criscuolo, N.G, Gilbert, M., Bonhoeffer, S. & Laxminarayan, R. 2019. Global trends in antimicrobial resistance in animals in low- and middle-income countries. *Science,* 365:1266.

Van Boeckel T.P., Brower C., Gilbert M., Grenfell B.T., Levin S.A. & Robinson T.P. 2015. Global trends in antimicrobial use in food animals. *Proceedings of the National Academy of Sciences USA,* 112(18):5649–5654. (Also available at https://doi:10.1073/pnas.1503141112).

Velčovská, S. & Del Chiappa, G. 2015. The food quality labels: awareness and willingness to pay in the context of the Czech Republic. *Acta universitatis agriculturae et silviculturae mendelianae brunensis,* 63(2): 647–658.

World Bank. 2018. Food products imports by country in US$ thousand 2018. In: *World Integrated Trade Solution* [online]. Washington, DC. [Cited 13 October 2020]. https://wits.worldbank.org/Default.aspx?lang=en

World Bank. 2017. Food imports (percent of merchandise imports): China, United States, India, Argentina – In: World Bank [online]. Washington, DC. [Cited 13 October 2020]. https://data.worldbank.org/indicator/TM.VAL.FOOD.ZS.UN?contextual=default&end=2017&locations=CN-US-IN-AR&start=2002

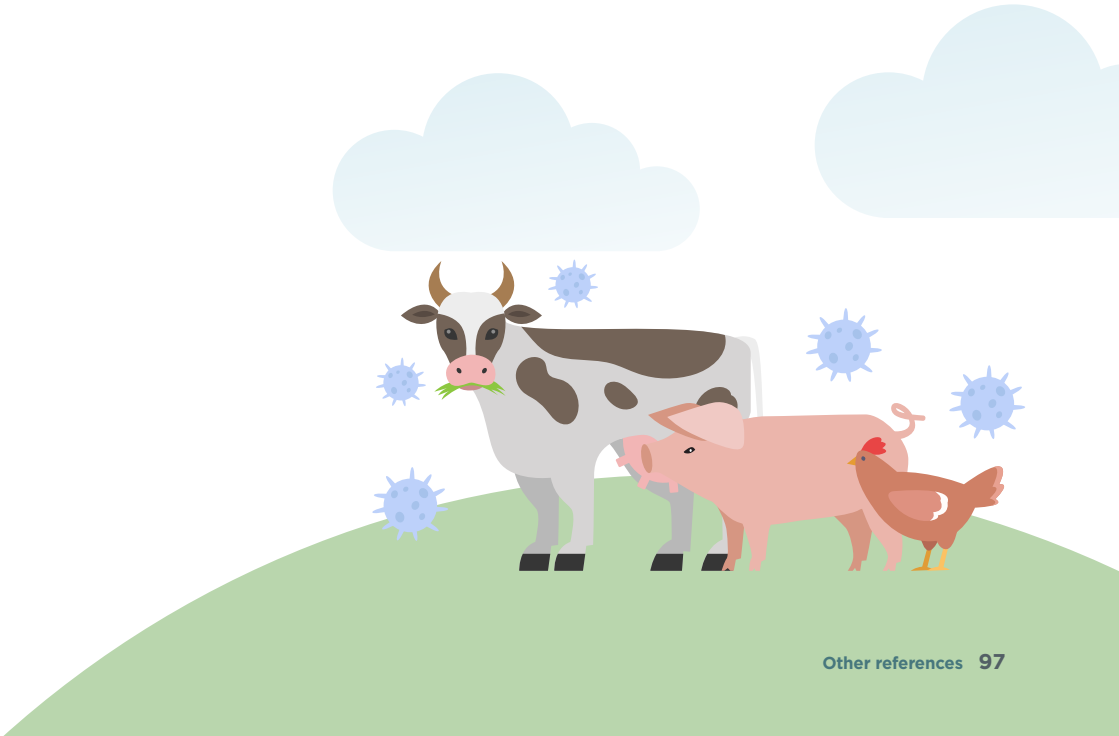
World Health Organization (WHO). 2020. Diarrhoeal disease. In: *World Health Organization* [online]. Geneva. [Cited 29 June 2020]. https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease

World Health Organization (WHO). 2006. Five keys to safer food manual [online]. Geneva. https://apps.who.int/iris/rest/bitstreams/51699/retrieve

Yam, E., Hsu, L., Yap, E. et al. 2019. Antimicrobial resistance in the *Asia Pacific region: A meeting report. Antimicrobial Resistance and Infection Control* 8: 202 [online]. https://doi.org/10.1186/s13756-019-0654-8

Zhang, Y., Pribil, M., Palmgren, M. & Gao, C. 2020. A CRISPR way for accelerating improvement of food crops. *Nature Food,* 1:200–205.

Zhong, S. Crang, M. & Zeng, G. 2019 Constructing freshness: The vitality of wet markets in urban China. *Agriculture and Human Values,* 37:175–185.



Layman's guide to food safety in Asia and the Pacific

Introduction to the food safety toolkit

1

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