Food and Agriculture Organization of the United Nations

SUSTAINABLE DEVELOPMENT GOALS

Food safety and innovation

Cell-based food and precision fermentation

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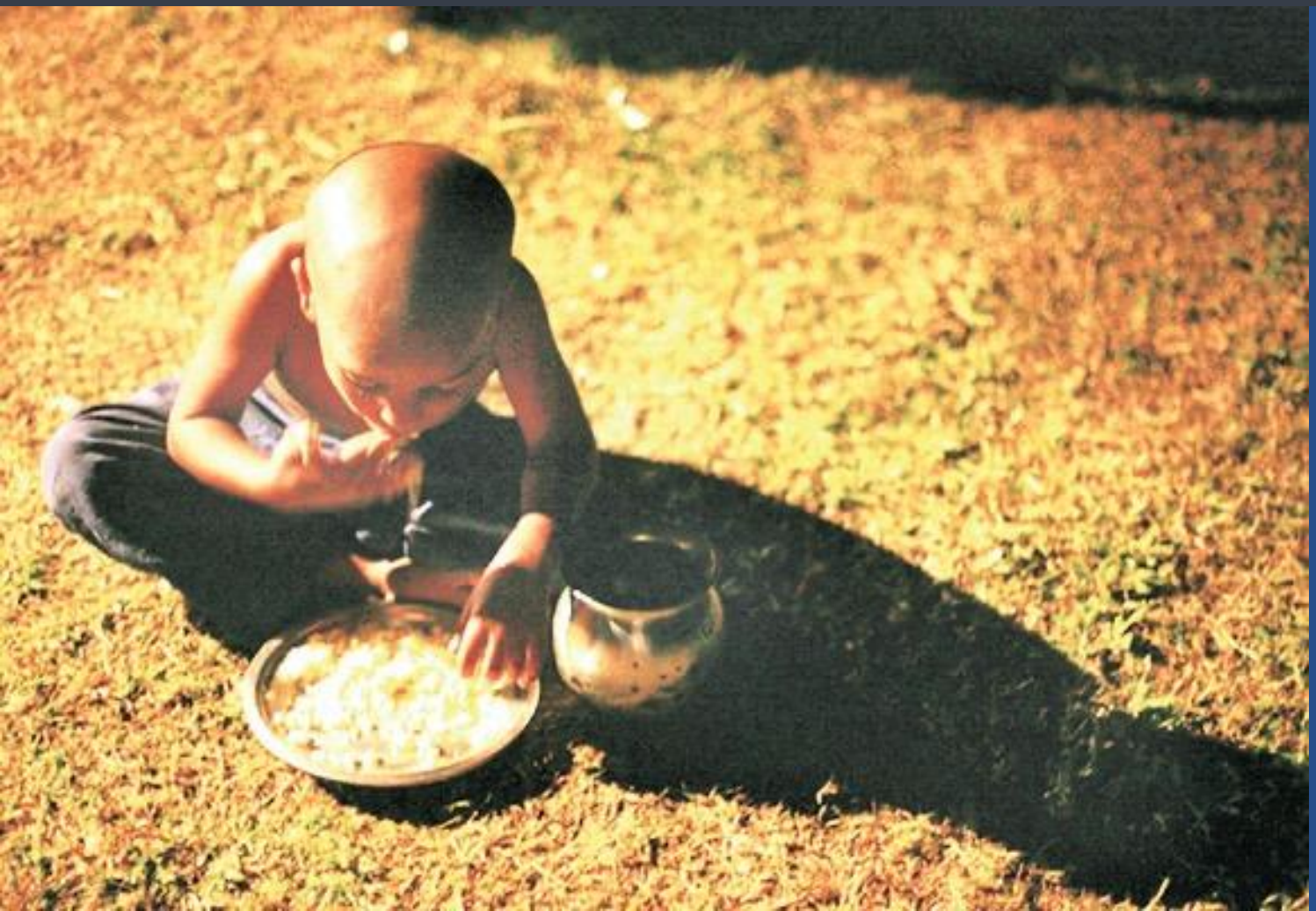
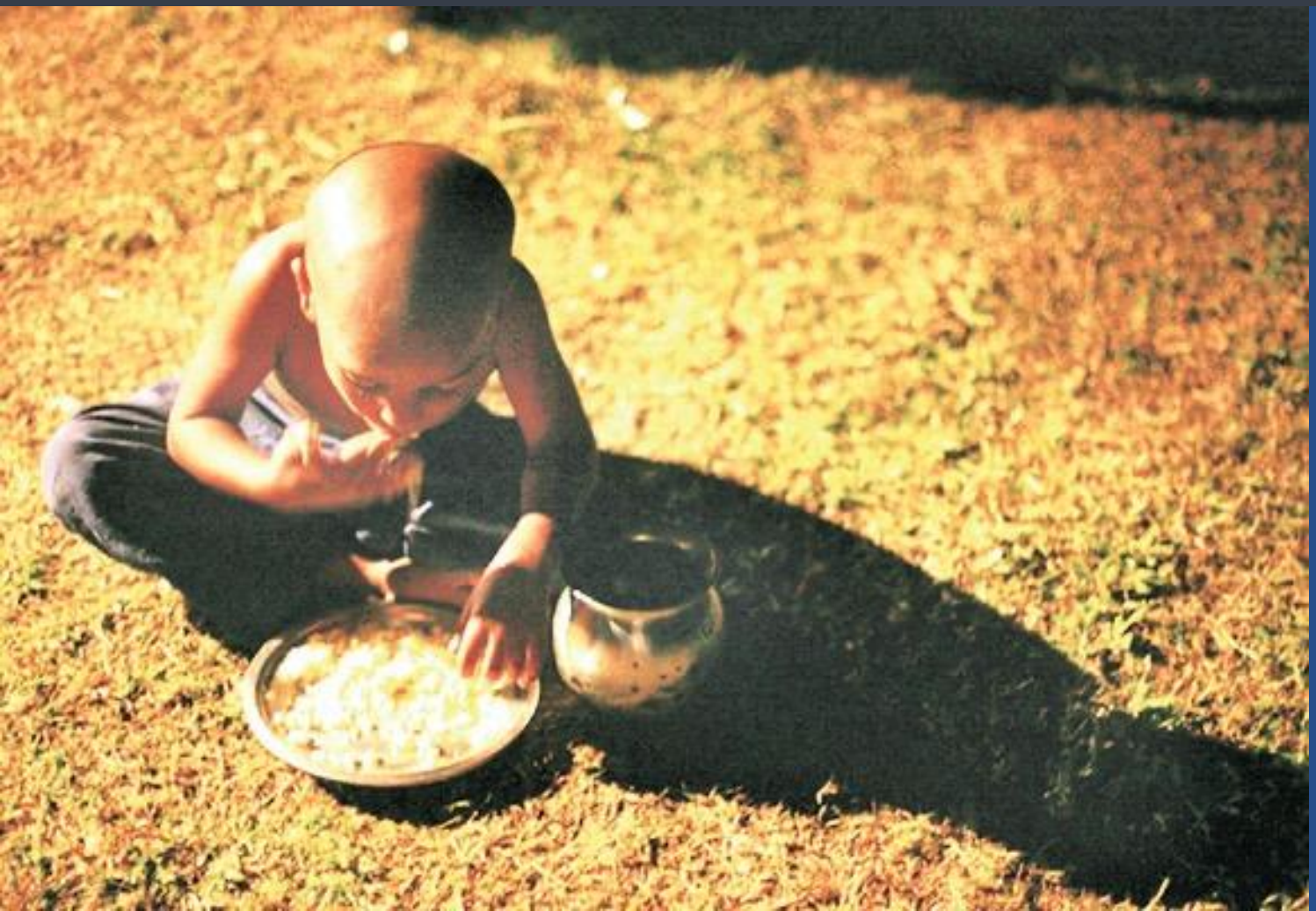
Food and Agriculture Organization of the United Nations(FAO)

Mandate of FAO



Mandate of FAO



Food security

FAO is a specialized agency of the United Nations that leads international efforts to defeat hunger.

Definition of food security

FAO World Food Summit, 1996

"Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food"

Sufficient

Safe

Nutritious

Food safety and nutrition

What is she making?

Mud cookies

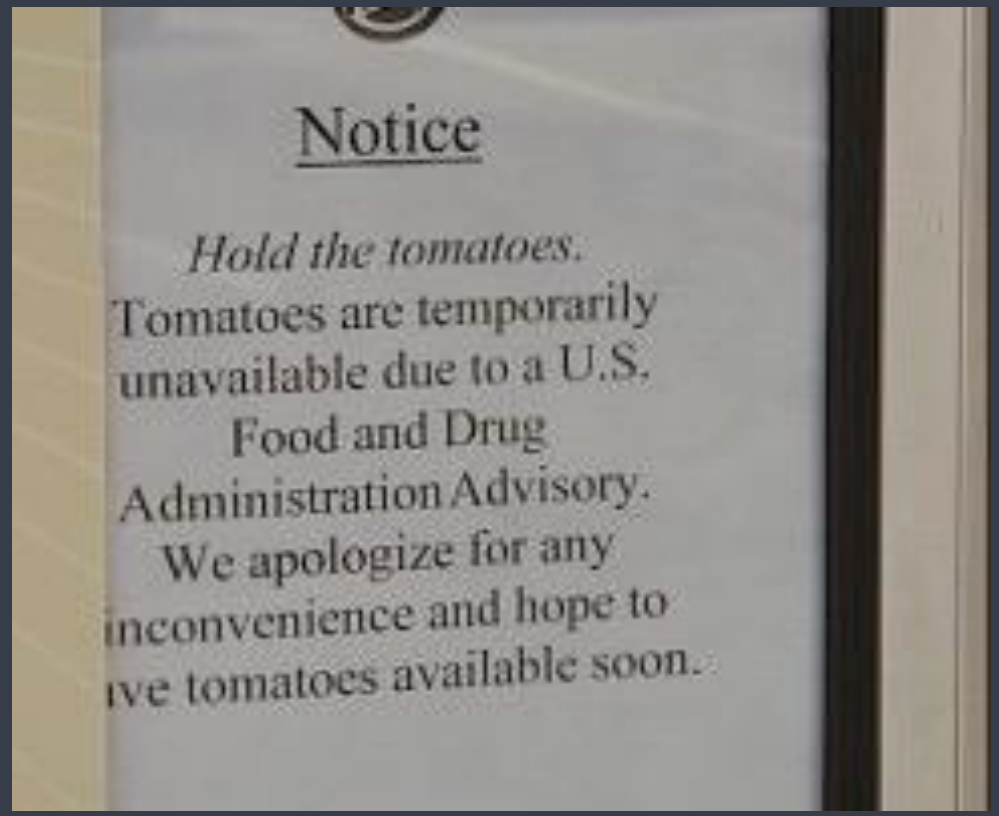
Food scarcity can coerce populations to consume whatever food is available.

Even if it can be **unsafe** and possibly **contaminated**.

What is this?

It is a waste management field

Salmonella contamination



Gaps between poor and rich are widening?

Food security, climate change, what will happen in the next generations?

- Population growth / explosion
- Extreme weathers
- Livestock zoonoses and epidemic?
- Another and more pandemics?
- Geopolitical conflicts affecting food/feed trades
- Environmental impacts of intensified agriculture practices?
- Insufficient amount of food for all?
- **Innovation** and **transformation** are critical

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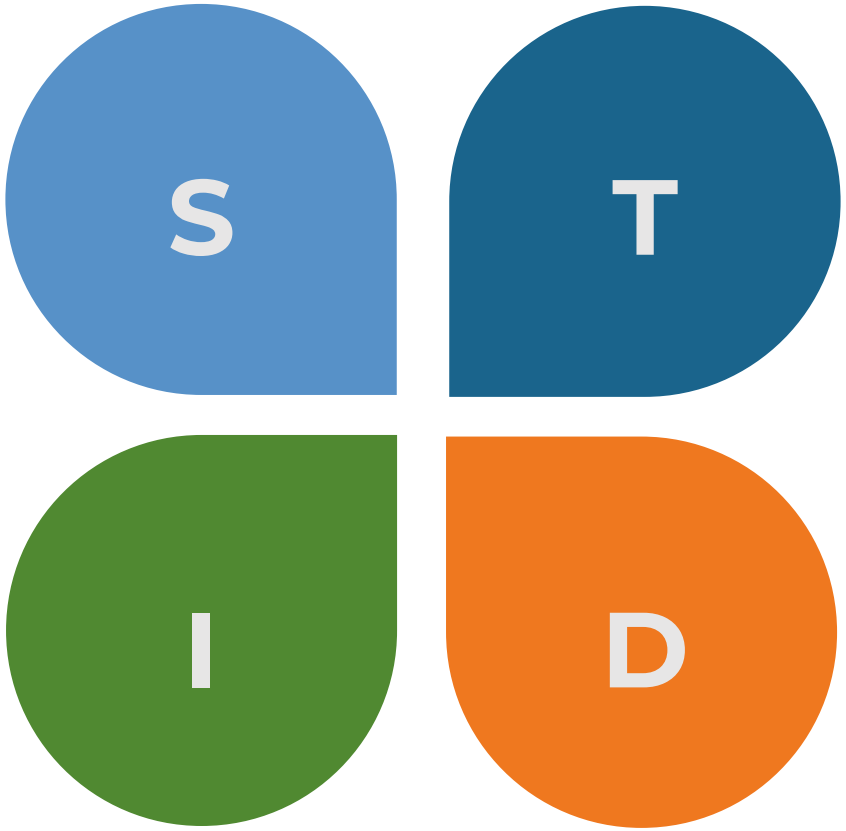
Innovations?

Science

Basic knowledge accumulation & transfer, evidence generation & building, theory verification and science education

Innovative approaches

Out-of-the-box ideas, new analytical methods, angle-changes, paradigm-shift, and incorporation of multiple theories & perspectives



Technology

Wide-scale practical applications of science, advancement with combination of multiple and multidisciplinary technologies, techniques & machineries

Digitalization

Computer-based knowledge management, Artificial Intelligence (AI)-based (big-)data interpretations, monitoring and analyses, bioinformatics and real-time data sharing

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Are “modern” food techs outpacing us?

- Understanding exactly what they are;
- Understanding how to effectively and appropriately use them; and
- Determining how (if) they should be regulated.

- Given the need to secure enough, safe and nutritious food – techs are necessary.
- Under pressure from demographic, dietary and climate changes, we need innovations.

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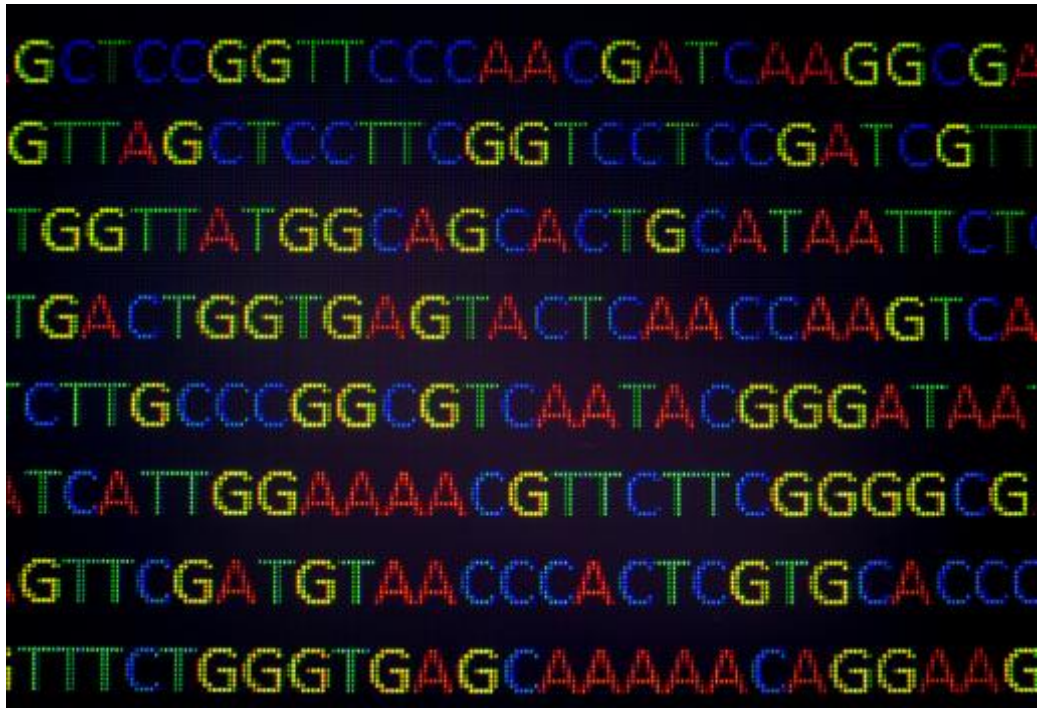
Whole Genome Sequencing

WGS

WGS has become routine in advanced food control systems. DNA sequence data on pathogens and other microorganisms in foods, the food production and processing environments can yield valuable insights into food hygiene and contamination.

- Because of the pandemic, many LMICs are already familiar with the technology and sequencers, but not so much applied in food safety.
- Nanopore sequencing allows the sequencing process to be mobile – more real-time applications can become common.



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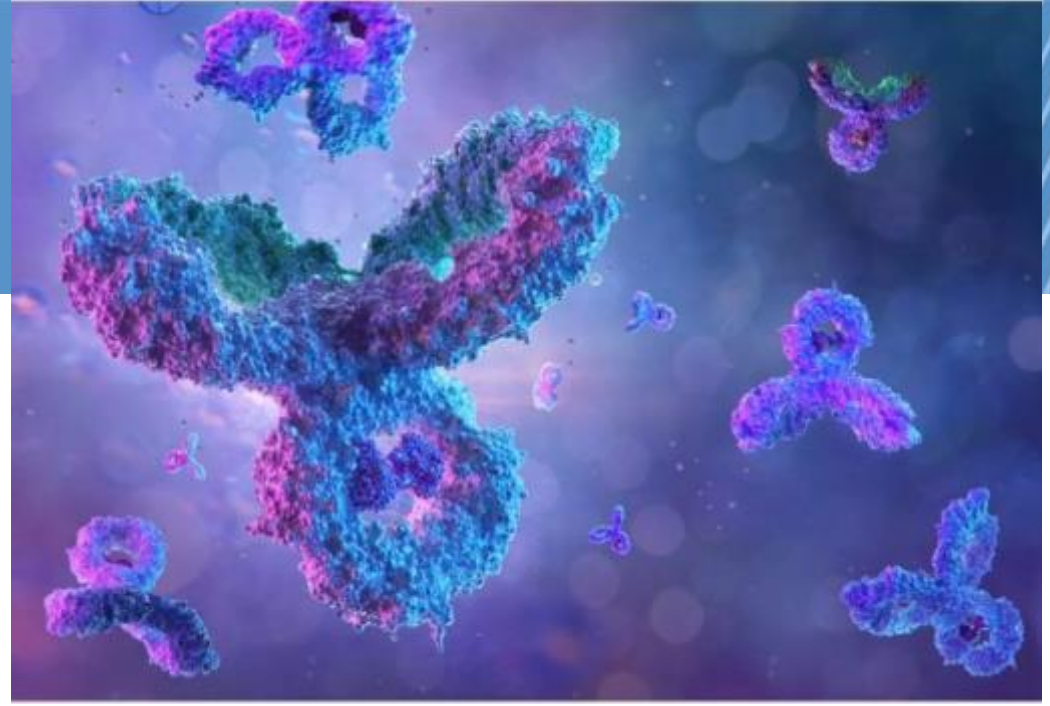
Novel analytical methods

New-generation analytical methods

Non-culture based diagnostics, nanomaterial-based assays, remote sensing or multiplexing, new spectroscopic applications, and quantitative nuclear magnetic resonance (qNMR) are the examples

- Accessibility to those novel analytical methods is a challenge for LMICs – international and regional collaboration is a must.
- These analytical methods may be useful conduct food safety assessment of food derived from newer/emerging technologies.



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Agri-food systems

Digital transformation

The ability to identify and handle emerging food safety risks and to decide on adequate risk management actions with the help of “self-learning” systems is potentially revolutionary.

- Digitalization may facilitate international trade with faster, more cost-efficient and less bureaucratic systems with e-certifications.
- Digital traceability of food by applying blockchain approaches may offer faster and more efficient food safety risk management options globally.

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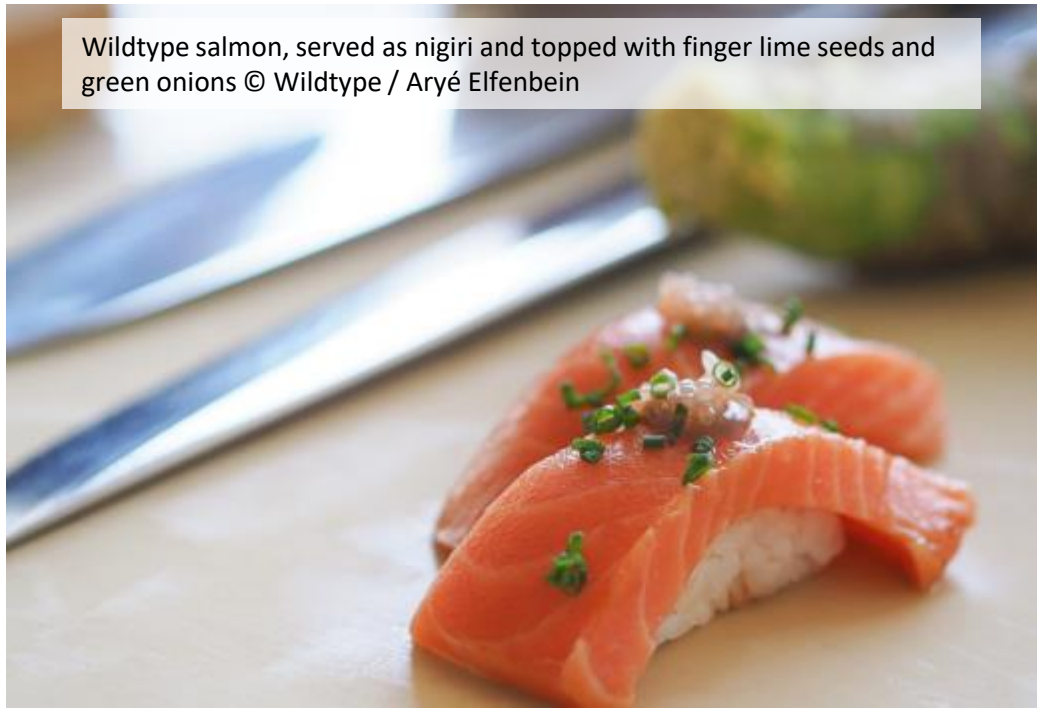
Future foods? They are already here.

“Novel” food production systems

With rapidly developing scientific advances, a number of new technologies with applications in food production systems are emerging.

- Cell-based food production, 3-D printed food production, gene-edited food production are just a few of the examples.
- As these new food become more available, engagement and dialog between governments and other stakeholders is critical in the shaping of innovation and assuring food safety

Cultivation room © UPSIDS foods

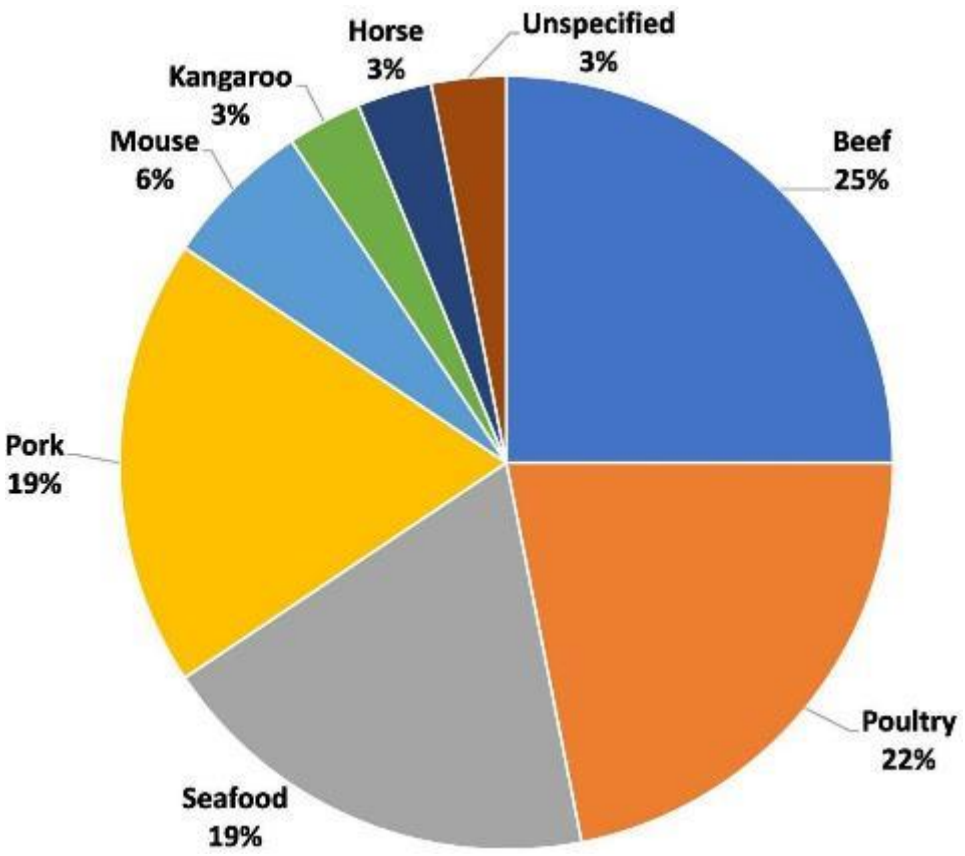


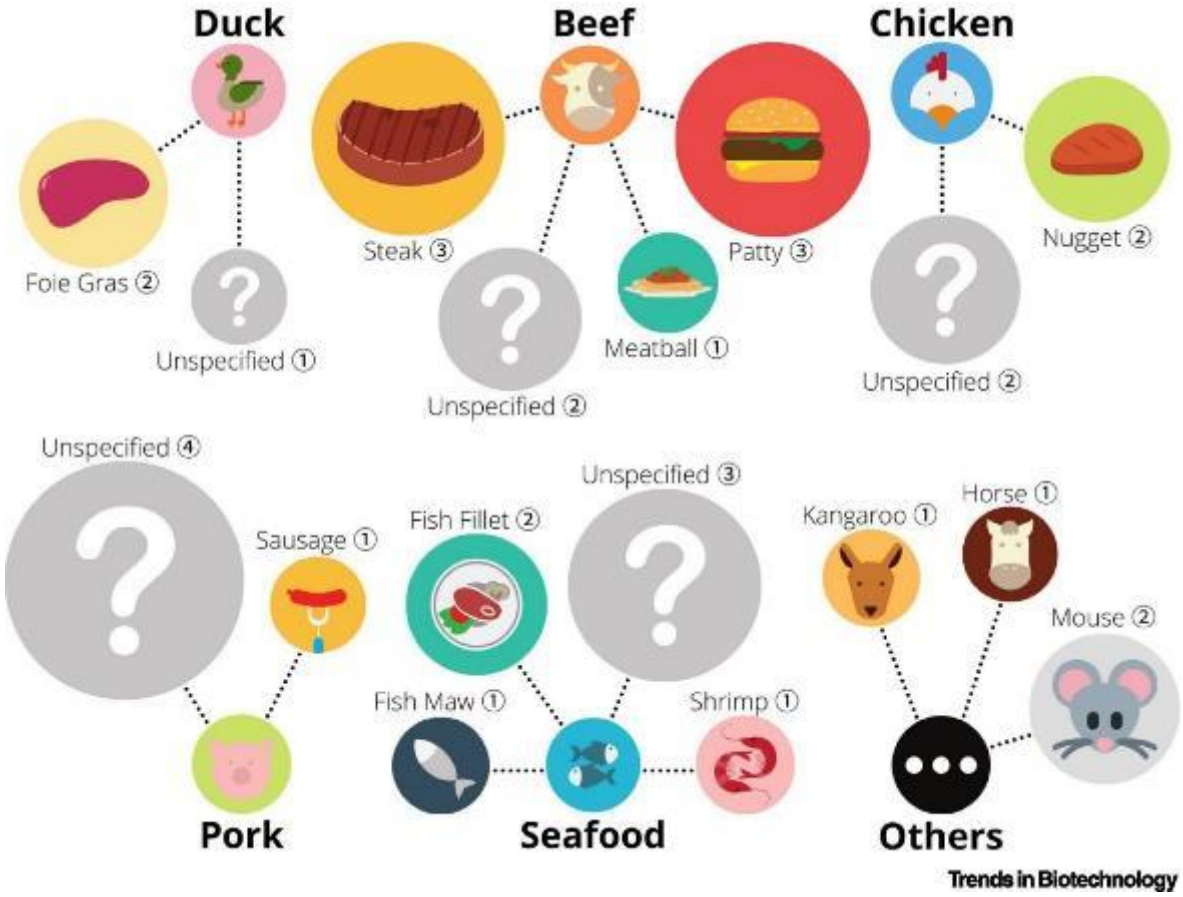
Wildtype salmon, served as nigiri and topped with finger lime seeds and green onions © Wildtype / Aryé Elfenbein

Cell-based food production and food safety
© FAO available at https://youtu.be/YyUoP2d3Zos

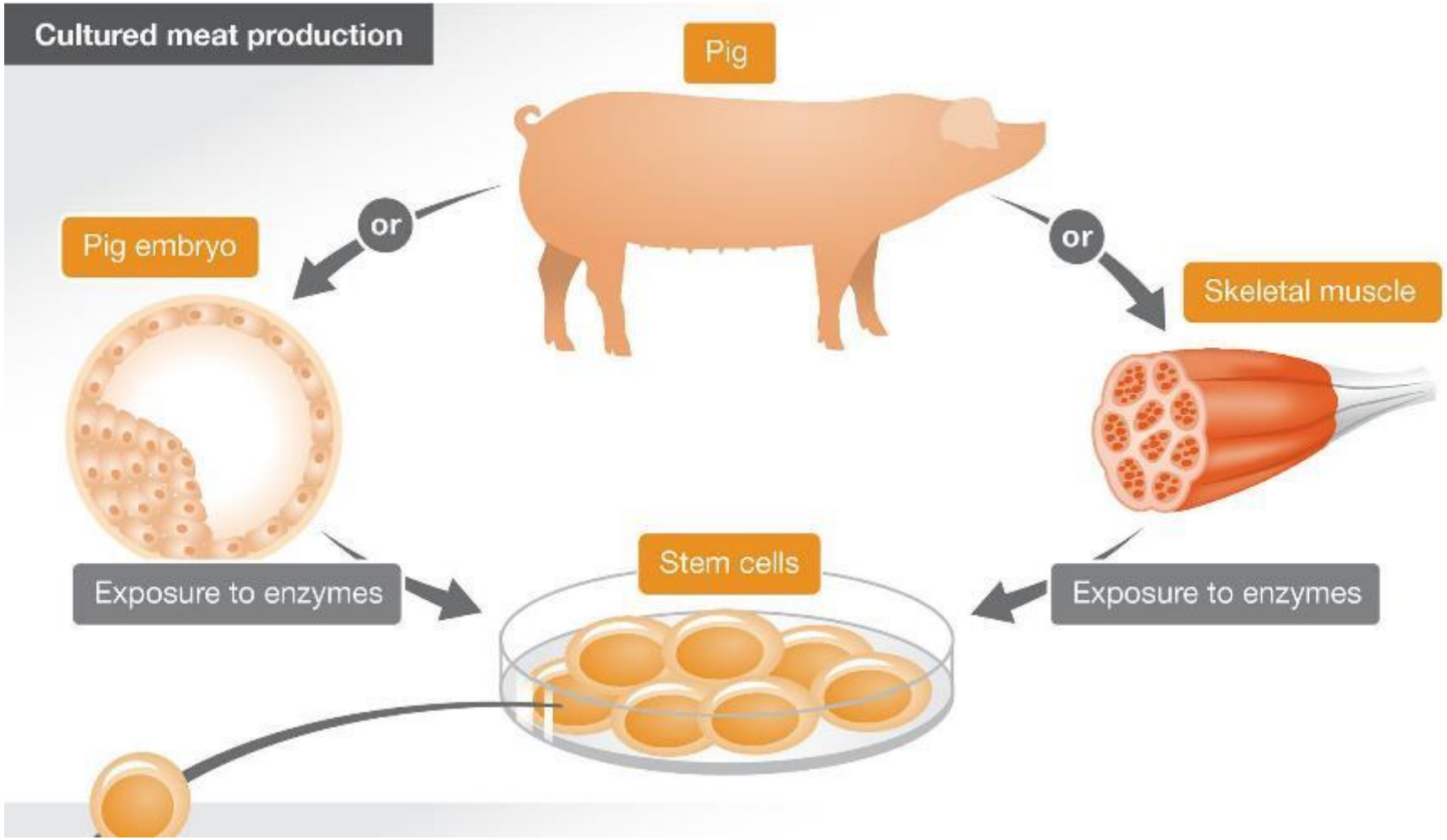
What is it?

- **Cell-based food products uses cell culturing techniques to develop muscle / fat tissues from various animal species. It can also be applied to plants.**
- **Production processes can significantly vary from one another.**
- **A high-level understanding of the production process can be in 4 phases:**
  1. Cell sourcing
  2. Cell production
  3. Harvesting
  4. Processing

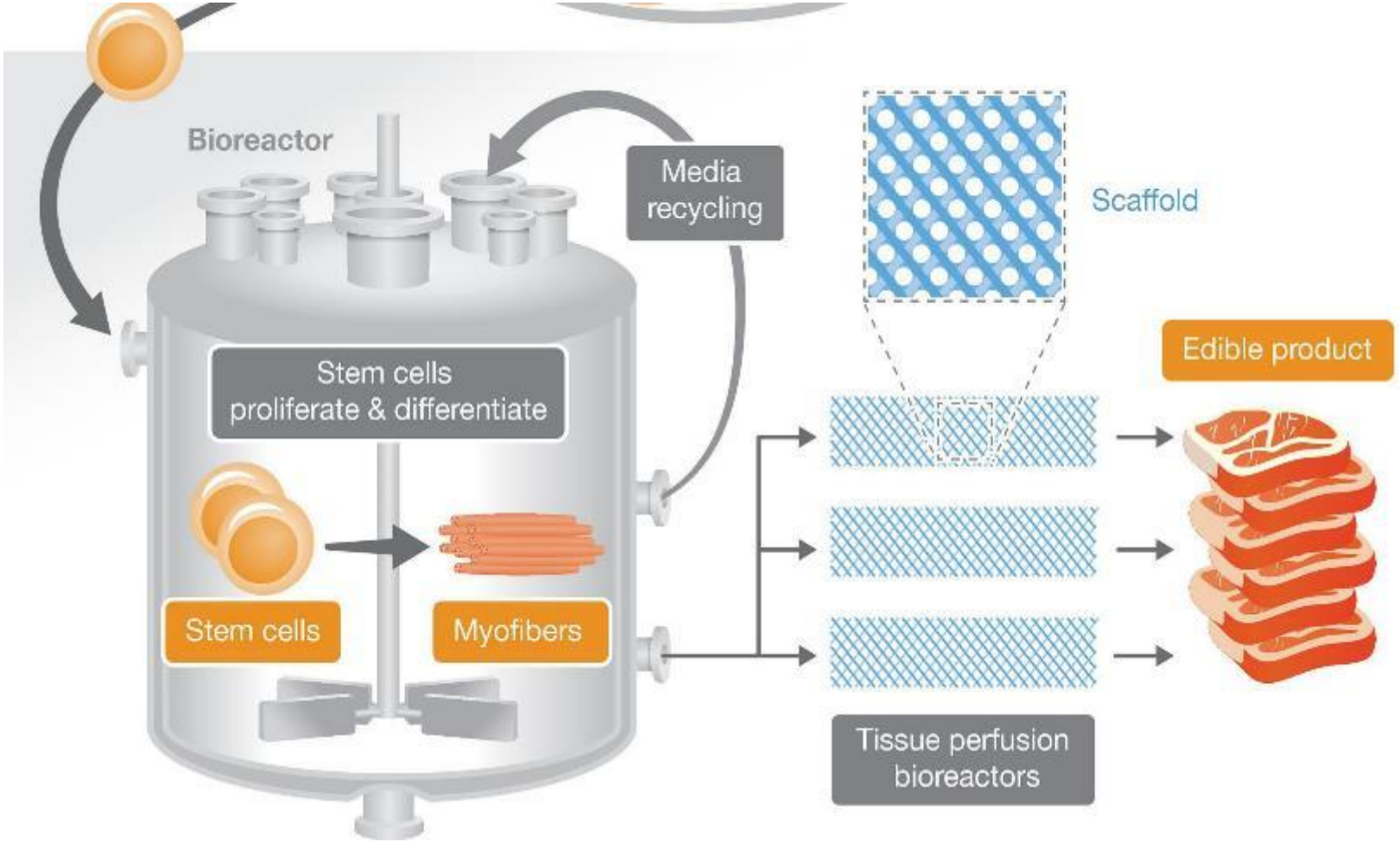




Source: Choudhury et al., 2020. DOI: https://doi.org/10.1016/j.tibtech.2020.02.012



Source: Tuomisto., 2019. DOI: https://doi.org/10.15252/embr.201847395



Source: Tuomisto., 2019. DOI: https://doi.org/10.15252/embr.201847395

What's in a name?

What would you call it?

Cultured meat, cultivated meat, lab-grown meat, clean meat, fake meat, synthetic meat, cell-based meat, etc.

How about the commodity name use? Can we use "meat" or "salmon" for these products?

And…

There are more than 6,500 languages exist – what do we do about the translated terms?

Does "cellular agriculture" make sense to you?

Photo credit: © Aleph Farms

Mice no words – terminology matters

- One global literature synthesis and one nation-wide study on nomenclature were referred.
  - No term that is 100% scientifically accurate
  - Better to find a single less-confusing (differentiations, allergy issues), relatively over-arching and relatively well-accepted (by consumers) term
- Working terminologies for the FAO: cell-based food products/production
- While internationally harmonized terminologies are ideal, country contexts and languages need to be considered

“Futuristic” products?

It sounds ”futuristic” but they are commercially available in at least 2 countries

Cell-line development is done in the laboratory setting.

But the production is taking place in the food production facility, not in the lab.

Equipment, materials, and inputs may be “new” to the food production arena

But the food safety assurance measures for the production steps are similar to the ones for conventionally produced foods.

And they are not only meat products.

Photo credit: © Eat Just

Photo credit: © WildType

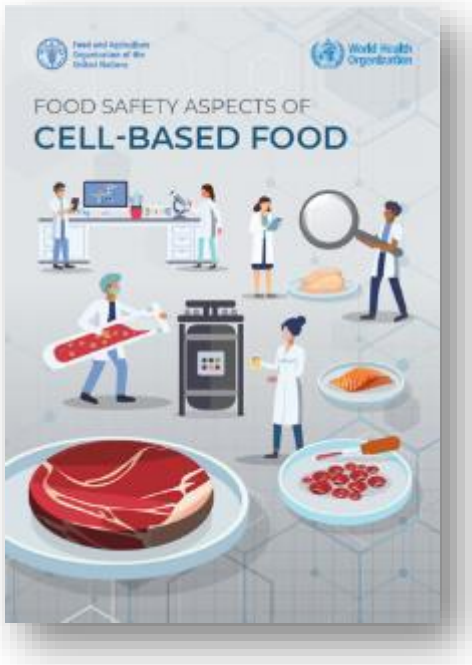
Photo credit: © CellX

Why should food safety come first?

- "If it isn't safe, it isn't food."
- If safety is not assured, there is no point of discussing the potential benefits of the products.
- Food safety is an **enabler**, not a barrier.
- If food safety is neglected / underestimated, these products will not have a future.

Provision of Scientific Advice (ad hoc scientific advice)

Food safety aspects of cell-based food



2021

Calls for experts / data

Identifying regulatory collaborators, partners, expert group, authors for the technical papers

Technical document development

Literature syntheses on terminologies, production processes, regulatory frameworks, and country case studies

2022

Stakeholder roundtable

One day global meeting to discuss with cell-based food researchers and developers on the food safety assurance issues as well as relevant communication issues

WHO joined FAO here

Expert consultation

3.5-day physical meeting to focus on food safety hazard identification of cell-based food production

2023

FAO/WHO Global dissemination

Webinar
Media interviews
Conference contributions

Hazard identification

Hazards are not Risks

Comprehensive hazard identification is the first step of food safety risk assessment process:

1. **Hazard identification**
2. Hazard characterization
3. Exposure assessment
4. Risk characterization

Extensive list of more than 40 potential hazards have been identified in 4 different production steps

Hazard identification based on 4 production phases

	Cell selection Cell sourcing, isolation, preparation and storage	**Production** Cell proliferation and differentiation	**Harvesting** Cell/tissue harvesting	**Food processing and formulation**
Hazard/Concern	• Transmission of zoonotic infectious diseases • Microbial contamination • Chemical residues & by-products	• Microbial contamination • Chemical residues & by-products • Biological residues & by-products	• Microbial contamination • Chemical and biological residues & by-products • Physico-chemical changes	• Microbial contamination • Chemical and biological residues & by-products • Processing contaminants • Physico-chemical changes
Potentially new hazard/concern	• Carry-over of cryoprotectants (used for cell storage)	• Risk of (epi)genetic drift in cell lines due to constant sub-culturing • Potentially allergenic scaffolds or microcarriers	• Culture medium residues	• None

Results of hazard identification

- Many hazards are already well-known and they exist in the conventionally produced food.
- For example, microbiological contamination can occurs at any stages of any food production processes, including the one of cell-based food.
- Various existing control measures and good manufacturing and hygiene practices, and Hazard Identification and Critical Control Points (HACCP), are applicable to ensure food safety for cell-based food.
- Food safety plans would also need to focus on the materials, inputs, ingredients, and equipment that can be specific to cell food production, referring to the use of new substance applications to nourish the cells; and the possibility of allergic reactions to them.

Effective communication

- Nomenclature issue – sounds like a “social” issue, but it is not. It is an important part of communication and a regulatory necessity (e.g. labelling).
- Do consumers know exactly what they are?
- Do consumers expect any food items should be 100% safe?
- While specialist clearly differentiate the concept of “hazard” and “risk,” the importance of this distinction is not always commonly understood and appreciated by the media or consumers
- Therefore, “hazards” we are talking about can be wrongly perceived as “risks”.
- To prevent any possible confusion of such, educational and tailored communication strategies need to be there to contextualize potential hazards and the probability or degree of threat each risk might represent.

Precision fermentation

- **Back to the basics:**
  - Terminology issues
  - Existing (various) definitions
  - Regulatory frameworks
- **The objective/result-driven:**
  - Consumer health (food safety) vs. mechanical compliance issues
  - Codex objectives – consumer protection and trade facilitation
- **Literature synthesis**
- **Hazard identification**

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Food safety and innovation

Key messages

Science, innovation and digital transformation at the service of food safety

Recognize the (huge) potential

Making use of new scientific discoveries, technical innovations and digital technologies can help attain more efficient and resilient food systems globally.

Equal accessibility is key

Supporting countries to gain access to scientific advances that enhance food production and safety can facilitate sustainable and more equitable development.

Safety first

Responsible approaches and global policies need to promote appropriate transfer of technology while assuring food safety first.

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Questions?

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