



Funded by  
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# HOLiFOOD

Holistic approach for tackling food systems risks  
in a changing global environment

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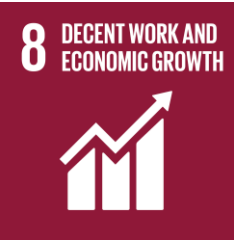
# Project objectives

Title: **H**olistic approach for tackling **f**ood systems risks in a changing global environment

Coordinated by Prof Dr Ine van der Fels-Klerx, Wageningen Food Safety Research (WFSR), deputy coordinator Nathan Meijer (WFSR)

Aims: improve the integrated food safety risk analysis framework in Europe to

- I. meet future challenges arising from Green Deal policy driven transitions in particular in relation to climate driven changes,
- II. contribute to the United Nations' Sustainable Development Goals (SDG 2, 8, 9, 12, 15) and
- III. support the realization of a truly safe and sustainable food production



# Emerging risks

## WHAT IS AN 'EMERGING FOOD RISK?'

A risk resulting from a newly identified hazard to which a significant exposure may occur, or from an **unexpected new or increased significant exposure** and/or susceptibility to a known hazard.



INCREASED EXPOSURE  
TO KNOWN HAZARD



NEW  
HAZARD



INCREASED SUSCEPTIBILITY  
TO HAZARD

# Example: mycotoxins

## Factors contributing to mycotoxin production:



**INCREASED  
TEMPERATURE  
& HUMIDITY**



**EXTREME  
WEATHER  
EVENTS**



**ALTERED  
PRECIPITATION  
PATTERNS**

## Mitigation strategies:



**CLIMATE-RESILIENT  
AGRICULTURAL PRACTICES**



**ENHANCE STORAGE &  
DRYING TECHNIQUES**



**DEVELOP EARLY  
WARNING SYSTEMS**



**SUSTAINABLE  
FARMING PRACTICES**

# Supply chains of focus



Three selected supply chains:

- ▶ Poultry [chicken]
- ▶ Cereals [maize]
- ▶ Legumes [lentils]

‘Drivers of change’ may act as modifiers of effect on the onset of emerging risks

# Project WP structure

**WP9** Consortium management & scientific coordination

**WP7** Communication, dissemination, education & exploitation

**WP5** Science, policy & society

**WP4** Stakeholder engagement & codesign in living labs

**WP1** Big Data technologies and AI for food safety detection and prevention

**WP2** Technology development for integrated monitoring

**WP3** Holistic risk assessment for regulation

**WP6** Integrated decision making & mitigation

**WP8** Legal & ethical

# Drivers of change

## Science & Technology

Innovation  
Digitalisation

## Geo-politics

Globalisation  
International trade

## Socio-economics

Consumer preference  
Income distribution

## Demographics

Population growth  
Urbanisation

## Environment

Climate change  
Natural resources

## Socio-cultural

Social values  
Food choices

## Policy

Food security  
Regulation

# Cloud computing

AI & Big Data

AI & Big Data

AI & Big Data

# Outcomes

Data collection, processing and visualisation from a number of actors throughout the food chain, using a system approach.



System approach



System approach



System approach

# Food safety emerging risks system

# Food security

# Data sources



Structured data e.g., historical food safety monitoring data (EFSA), data on drivers of changes (e.g., FAOSTAT, World Bank, United Nations)



Unstructured data e.g., scientific literature (PMC), media news (EMM)



# Prediction model for food safety contamination

Monitoring data



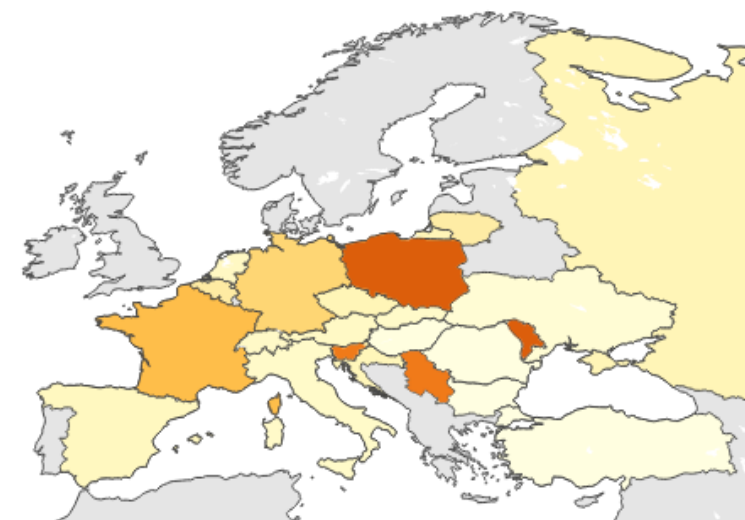
Drivers of change



Prediction model

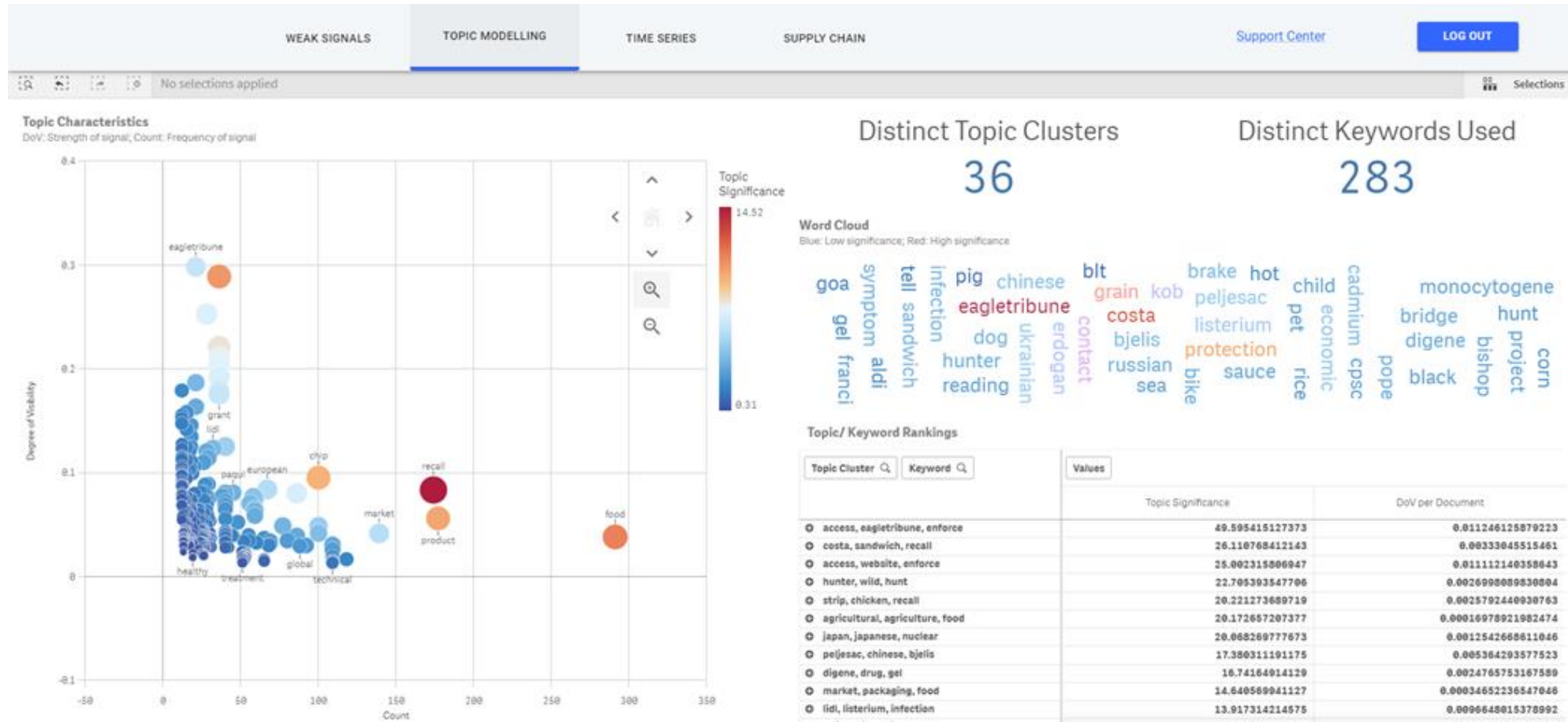


Food safety contamination



# Topic modelling

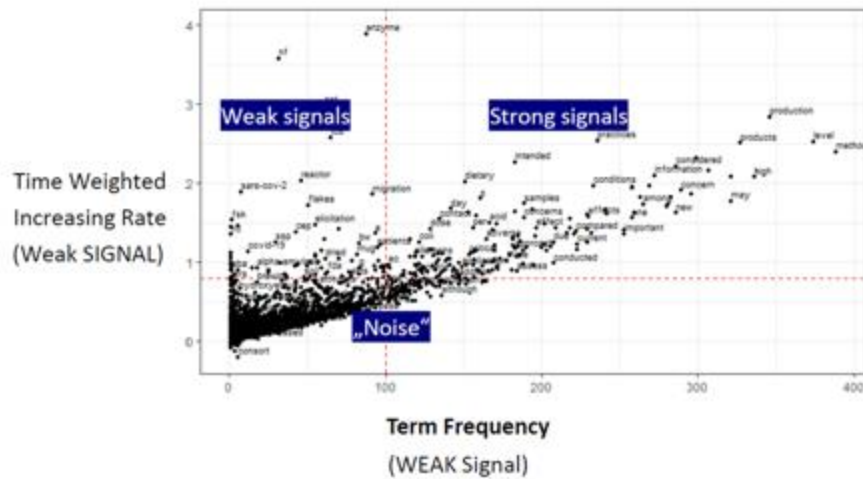
- Identify and extract abstract topics from a collection of documents by analyzing the patterns of word co-occurrence within the texts



# Weak signal miner

❑ Weak signals focus on concepts that are infrequently mentioned yet exhibit significant changes over time

## Keyword Emergence Matrix



WEAK SIGNALS TOPIC MODELLING TIME SERIES SUPPLY CHAIN Support Center LOG OUT

No selections applied

### Weak Signal Characteristics

DOV: Strength of signal; Count: Frequency of signal

The Weak Signal Characteristics plot shows 'Degree of Visibility' on the y-axis (0.0000 to 0.0060) and 'Count' on the x-axis (2 to 11). A color scale for 'Signal Power' ranges from 0.00073 (yellow) to 0.02471 (dark red). Several data points are visible, with the highest signal power point at approximately (5, 0.0045).

### Signal Details

Signal Power	Signal Interpretation	Signals	Signal Source
0.02471	The use of lactic acid bacteria such as Lactobacillus plantarum for biopreservation in dairy products could lead to unforeseen	[antifungal', 'lab', 'plantarum', 'utg', 'cty', 'lactic', 'biopreservation', 'culturom', 'penicillium', 'whey']	[Fungal contamination of food, which causes large economic losses and public health problems, is a global concern. Chemical methods
0.024	The use of wastewater for irrigation poses risks of contaminating food crops with heavy metals and pathogens, necessitating stringent water	[wastewater', 'irrigated', 'ch', 'effluent', 'food', 'zone', 'boch', 'eruca', 'gw', 'manga']	[Depleting aquifers, lack of planning and low socioeconomic status of Pakistani farmers have led them to use wastewater (WW) for irrigating
0.020	The spread of antibiotic resistance genes (ARGs) in the food chain, exacerbated by the overprescription and misuse of antibiotics, poses	[args', 'arg', 'antibiotic', 'selective', 'overprescription', 'viceversa', 'ar', 'antibioticresistant', 'aggravating', 'lately']	[This study determined the antibiotic resistance patterns of . Antibiotic resistance represents a global health concern. Soil, water, livestock and
0.019	The bioaccessibility of nickel in plant-based drinks may differ significantly from animal-based products, with implications for dietary exposure	[nickel', 'drinks', 'bioaccessibility', 'bav', 'plantbased', 'overestimation', 'bioavailability', 'animalbased', 'brai', 'colborne']	[Nickel can occur in plant-based, animal-based foods and drinks. It can either naturally occur in plants or it could originate from contamination.
0.018	Inadequate sorting and recycling practices for food packaging waste could lead to environmental contamination and indirect food	[bin', 'bins', 'recycling', 'recyclable', 'game', 'waste', 'feedback', 'sorting', 'accuracy', 'trash']	[The volume of solid waste has increased significantly in the past century, directly contributing to global environmental problems.
0.017	Advances in ultra-high-pressure homogenization and high-voltage pulsed electric fields for food processing must ensure that microbial	[uhoh', 'detachedcells', 'hupof', 'psl', 'planktonic', '40000', 'electric', 'sem', 'voltage', 'inhibic']	[The study was to investigate the inhibitory effect and mechanism of high voltage pulsed electrostatic field (HVPEF) on Staphylococcus aureus biofilms.
0.017	The burgeoning field of cell-cultured food products, including flavorings and fragrances, necessitates robust biosafety evaluations to	[pctoc', 'analogues', 'cell', 'biosafety', 'cultured', 'culture', 'cellcultured', 'flavourings', 'hydrolysates', 'fragrances']	[Plant cells cultured in liquid medium in bioreactors are now being used commercially to produce biopharmaceutical proteins. The
0.016	The consumption of home-produced organic meats, such as lamb charcuterie, may carry risks of exposure to carcinogens, either from	[carcinogenic', 'homeproduced', 'organically', 'lamb', 'carcinogens', 'charcuterie', 'organic', 'consumption', 'meat', 'pops']	[Numerous epidemiological studies have demonstrated a link between excessive meat consumption and the incidence of various
0.015	Exposure to polycyclic aromatic hydrocarbons (PAHs) like fluorene, potentially through contaminated food, can have detrimental health	[fluorene', 'pahs', '100mgkgday', 'locs', 'monohydroxylated', 'ip', 'arxivety', 'rats', 'pah', 'potreated']	[Polycyclic aromatic hydrocarbons (PAHs) are abundant and widespread environmental chemicals. They are produced naturally and
0.013	The integration of AI and robotics in meat inspection processes promises to improve the detection of contaminants and enhance food	[algorithm', 'ira', 'saginata', 'australian', 'cysticercus', 'rr', 'albased', 'poao', 'experts', 'red']	[To produce a methodology for the risk ranking of farms located around proven or potential sources of contamination to prioritize the monitoring
0.013	The development of polysaccharide-based coatings with antiadhesive and bactericidal properties, such as chitosan micelles, presents	[micelles', 'ttcp', 'antiadhesive', 'polysaccharides', 'coatings', 'implantassociated', 'bactericidal', 'chitosan', 'polysaccharidebased', 'controllable']	[Bacterial biofilms are widely associated with persistent infections and food contamination. High resistance to conventional antimicrobial
0.013	The variability in microbial contamination levels across different lots of ground turkey could undermine the effectiveness of concentration-	[mic', 'of', 'turkey', 'lots', 'cellig', 'concentrationbased', 'ground', 'tss', 'program', 'mpng']	[A common approach to reducing microbial contamination has been the implementation of a Hazard Analysis and Critical Control Point
0.013	Persistent organic pollutants (POPs) such as	[toaes', 'china', 'occs', 'delta', 'sum', 'vanotze']	[To reveal the pollution status associated with

Hint: Hover over data points for details

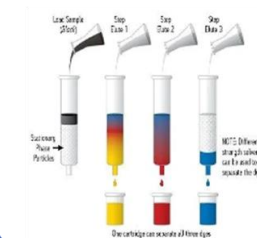
# Untargeted methods for chemical Hazards: HRMS/AI



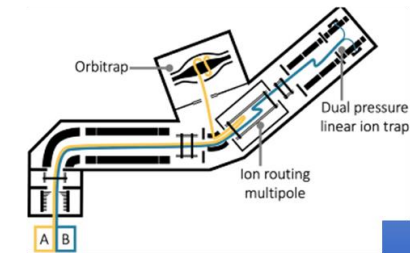
Antibiotics  
Growth Promoters



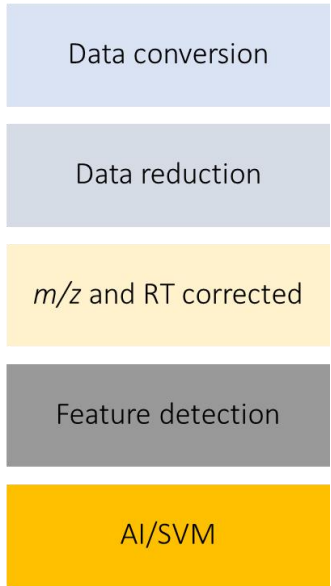
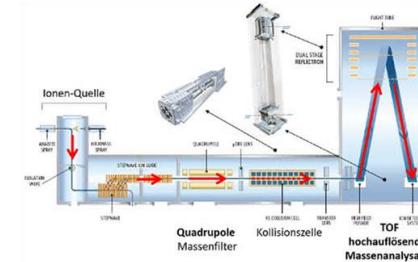
Mycotoxins  
Plant toxins



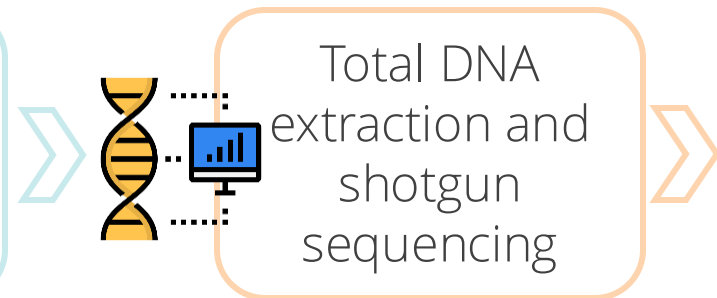
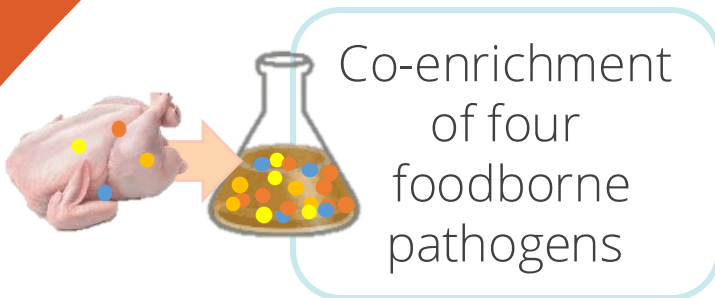
Generic  
Sample Clean-up



HRMS  
(Full Scan, DDA, DIA)

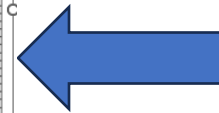
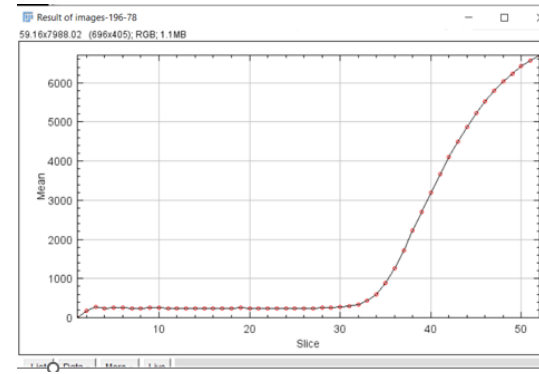
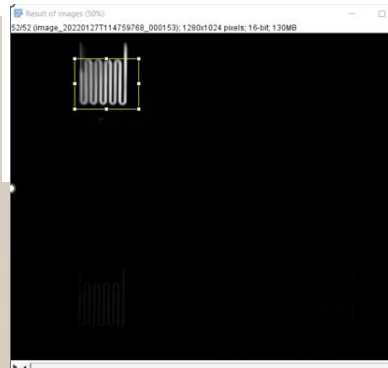
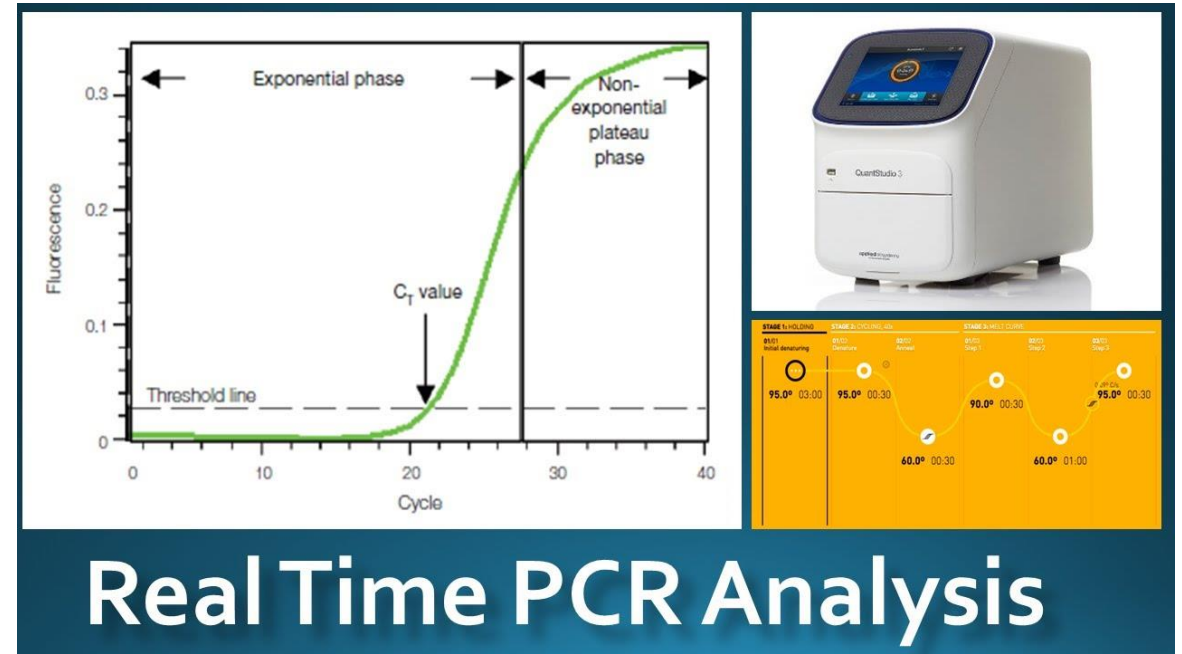


# Untargeted methods for biological hazards: quasimetagenomic approach



# Targeted methods for emerging and existing pathogens

Real time PCR, digital PCR and Integrity PCR assays for the detection of emerging pathogenic bacteria and viruses



on-chip qPCR for on-site quantitative detection of emerging pathogenic bacteria in the targeted food supply chains

# Holistic risk assessment



## Objectives

- ▶ Develop holistic risk assessment methods and tools to support regulation in a changing global environment
- ▶ Food safety risk will be embedded in a comprehensive cost-benefit analysis of the food system including
  - ▶ positive and negative health (Nutritional, Chemical, Microbiological)
  - ▶ Environmental
  - ▶ Economical dimensions
- ▶ Various aggregation methods in 3 supply chains:
  - ▶ **Cereals [maize]**: risk-benefit assessment
  - ▶ **Legumes [lentils]**: MCDA
  - ▶ **Poultry [chicken]**: cost-benefit aggregation (monetary values)

# Poultry case study

- ▶ Health risks & benefits, environmental impact, costs associated  
→ cost-benefit assessment (CBA)
- ▶ Baseline scenario → Current relevant risks and benefits for poultry chain
- ▶ Alternative scenario → Climate change

## Microbiological risks

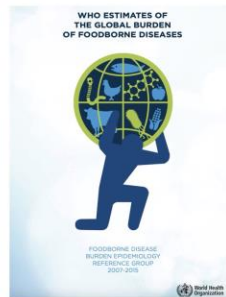
- ▶ Baseline scenario: *Campylobacter* & *Salmonella*

▶ 
$$\frac{\text{Estimated DALYs for global population}}{\text{Foodborne illnesses for global population}} = \frac{\text{DALY case}}{\text{case}}$$

▶ 
$$\frac{\text{DALY case}}{\text{Poultry attribution factor}} * \text{Number of total confirmed cases per country} * \text{underreporting factor} *$$

Country	DALYS campylobacteriosis in 2022	DALYS salmonellosis in 2022
Netherlands	1473	1396
Denmark	472	204
France	5623	15519
Hungary	5883	11200

\* Considering underreporting factors for campylobacteriosis of: 22 (Netherlands), 4 (Denmark), 28 (France), 52 (Hungary) and for salmonellosis of: 26 (Netherlands), 4 (Denmark), 27 (France), 67 (Hungary) – Havelaar et al. 2013



## Nutrients

- Contribution to total protein intake
- Vitamins B3 (niacin), B6 (pyridoxal) and B12 (cobalamin)
- Iron and Selenium
- *Choline (if data allows)*

## Chemical risks

- Dioxins
- PAHs
- PFAs
- *AFB1 (discuss)*
- *HCAs (if data and resources allows)*

# Living labs: iterative co-design

- ▶ WP4: facilitate LL managers organizing
  - ▶ Interact with specific other WPs to co-design outputs
- ▶ **WP1:** Methods and data sources for emerging risk identification: Verification and prioritization
- ▶ **WP3:** Inductive research using Delphi as both scoping and data gathering exercise
- ▶ **WP6:** Novel Digital Infrastructure for Food Safety

## **Definition:**

A user-driven open innovation ecosystem based on a business-citizens-government partnership which enables users to take active part in the research, development and innovation process



# HOLIFOOD

Future-Proofing Food: Transforming Risk Analysis for a better and more adaptive food system

<https://holifoodproject.eu>

