Funded by the European Union

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HOLiFOOD

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

Frederic BAYER

EUFIC

Project objectives

Title: **Holi**stic approach for tackling **food** 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

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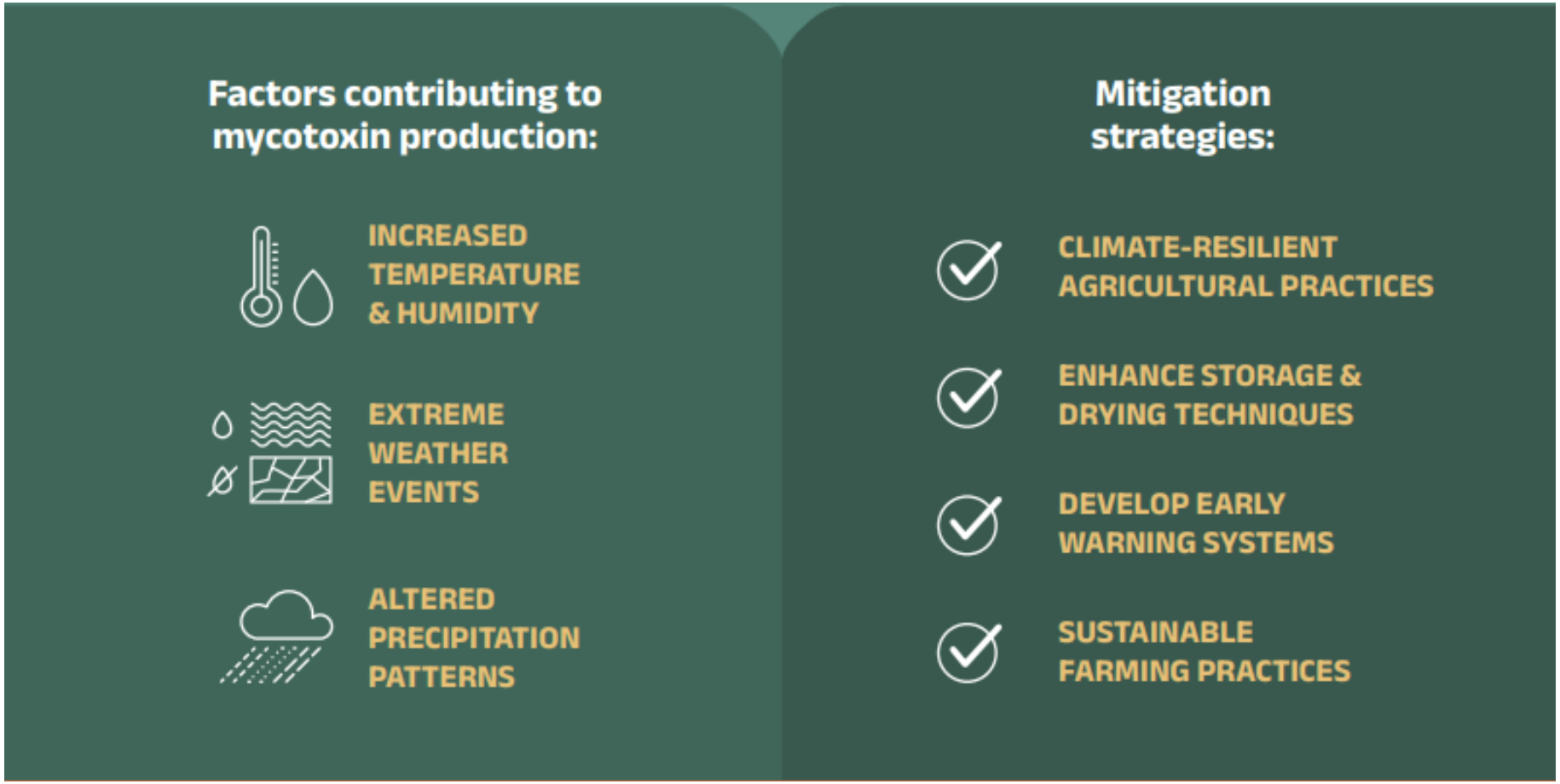
Emerging risks

Example: mycotoxins



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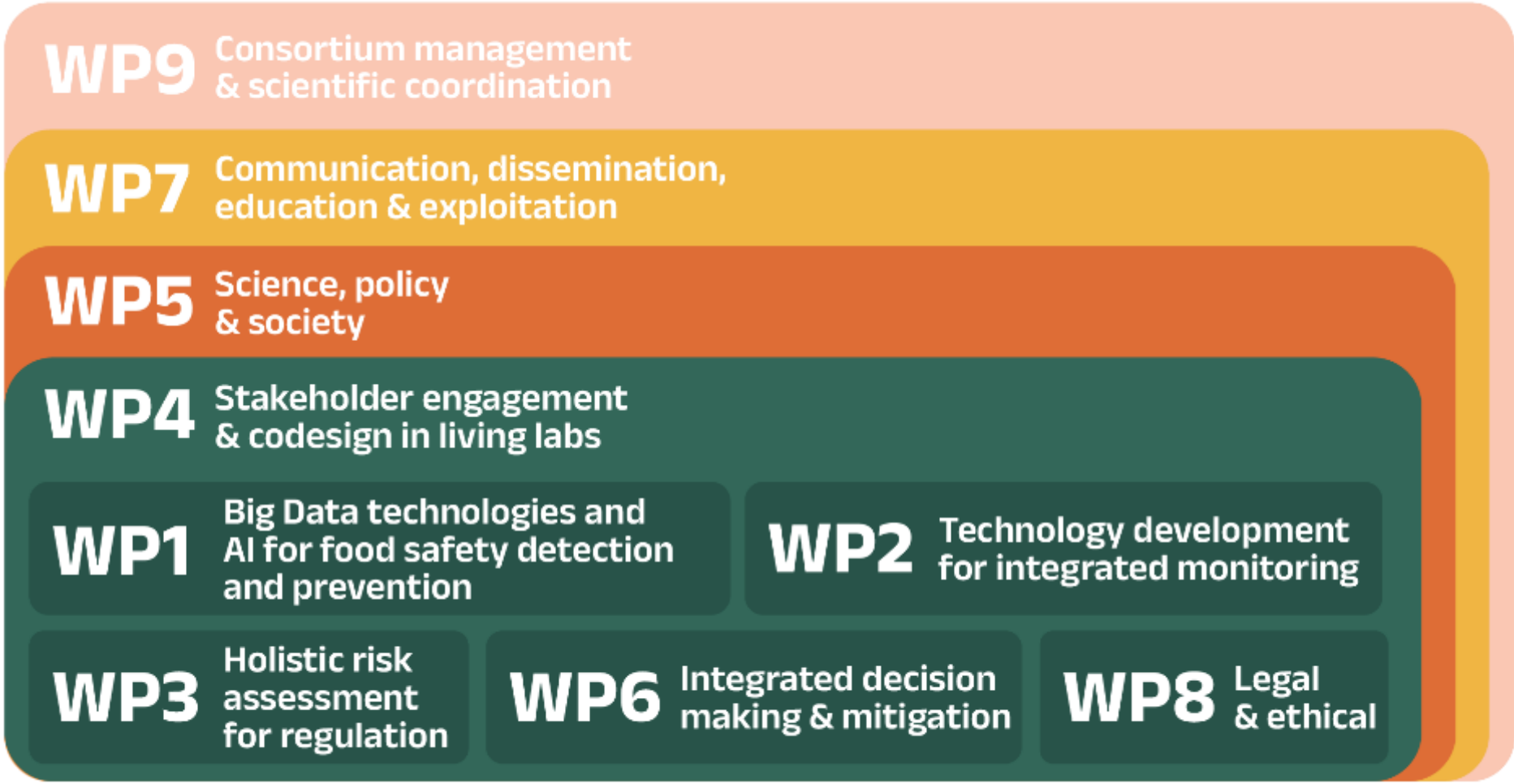
Supply chains of focus

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



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

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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)

EFSA ZENODO data

> 750 csv files

> 300 GB of data

~ 8.5 million samples

~ 300 million measurements

+

	A	B	C	D
1	columnname	driver_description	source	url
2	corruption_index	The corruption index of the origir	Transparency International	https://www.transparency.org/en/cpi/2021
3	human_development_index	The human development index o	United Nations	https://hdr.undp.org/data-center/human-development-in
4	control_corruption	The extent to which public powe	World Bank	http://info.worldbank.org/governance/wgi/#home
5	government_effectiveness	The quality of public services, the	World Bank	http://info.worldbank.org/governance/wgi/#home
6	political_stability	The likelihood of political instabi	World Bank	http://info.worldbank.org/governance/wgi/#home
7	regulatory_quality	The ability of the government to f	World Bank	http://info.worldbank.org/governance/wgi/#home
8	rule_of_law	the extent to which agents have	World Bank	http://info.worldbank.org/governance/wgi/#home
9	voice_and_accountability	The extent to which a country's c	World Bank	http://info.worldbank.org/governance/wgi/#home
10	governance_index	The governance index of the origi	World Bank	http://info.worldbank.org/governance/wgi/#home
11	press_freedom_index	he ability of journalists as indivic	RSF Reporters Without Borders	https://rsf.org/en/index
12	democracy_index	State of democracy per country p	Economist Intelligence Unit	https://www.eiu.com/n/campaigns/democracy-index-202
13	polity_democracy_index	Qualities of democratic and auto	Polity Project	https://www.systemicpeace.org/polityproject.html
14	gdp_current	The GDP of the origin countr	World Bank	https://data.worldbank.org/indicator/NY.GDP.MKTP.CD
15	gdp_growth	The economic growth of the origi	World Bank	https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG
16	legal_system	Strength of legal rights index of th	World Bank	https://data.worldbank.org/indicator/IC.LGL.CRED.XQ
17	food_security_index	The Global Food Security Index of	Economist	https://impact.economist.com/sustainability/project/foo
18	innovation_index	Annual ranking of countries by th	WIPO	https://www.wipo.int/global_innovation_index/en/
19	logistics_performance_index	Performance on trade logistics o	World Bank	https://lpi.worldbank.org/
20	internet_users_percent_of_population	% internet users of population	theglobaleconomy	https://www.theglobaleconomy.com/indicators_list.php
21	mobile_network_coverage_percent_of_the_populati	% mobile network coverage	theglobaleconomy	https://www.theglobaleconomy.com/indicators_list.php
22	quality_of_roads_1low__7high	quality of roads	theglobaleconomy	https://www.theglobaleconomy.com/indicators_list.php
23	quality_of_railroad_infrastructure_1low__7high	quality of railroad railroad_infra	theglobaleconomy	https://www.theglobaleconomy.com/indicators_list.php
24	quality_of_port_infrastructure_1low__7high	quality of port port_infrastructur	theglobaleconomy	https://www.theglobaleconomy.com/indicators_list.php
25	quality_of_air_transport_infrastructure_1low__7high	quality of air transport air_trans	theglobaleconomy	https://www.theglobaleconomy.com/indicators_list.php
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27	diesel_prices_at_the_pump_in_dollars_per_liter	diesel prices at the pump in dolla	theglobaleconomy	https://www.theglobaleconomy.com/indicators_list.php
28	globalization_index_0100	globalization index	theglobaleconomy	https://www.theglobaleconomy.com/indicators_list.php
29	economic_globalization_index_0100	economic globalization index	theglobaleconomy	https://www.theglobaleconomy.com/indicators_list.php
30	political_globalization_index_0100	political globalization index	theglobaleconomy	https://www.theglobaleconomy.com/indicators_list.php
31	social_globalization_index_0100	social globalization index	theglobaleconomy	https://www.theglobaleconomy.com/indicators_list.php
32	pesticide_import_price_dollar_ton	Indicator of the price of pesticide	FAOSTAT	https://www.fao.org/faostat/en/#data/RT
33	pesticide_export_price_dollar_ton	Indicator of the price of pesticide	FAOSTAT	https://www.fao.org/faostat/en/#data/RT
34	pesticide_use_kg_per_ha	Use of pesticides (in kg per hecta	FAOSTAT	https://www.fao.org/faostat/en/#data/RP
35	sustainable_pesticide_use	The sustainable pesticide use in	Yale	https://epi.yale.edu/epi-results/2022/component/spu
36	ratio_organic_fertilizer	ratio of organic fertilizer (manure	FAOSTAT	https://www.fao.org/faostat/en/#data/RFB
37	agricultural_producer_price_index	Agriculture Producer Prices (in th	FAOSTAT	https://www.fao.org/faostat/en/#data/PP
38	consumer_prices_index_food	consumer prices food indices (20	FAOSTAT	https://www.fao.org/faostat/en/#data/CP
39	food_price_inflation	food price inflation	FAOSTAT	https://www.fao.org/faostat/en/#data/CP
40	oil_price	Global yearly oil price	OPEC	https://www.opec.org/opec_web/en/data_graphs/40.htm
41	oil_price_std	standard deviation of the oil pric	OPEC	https://www.opec.org/opec_web/en/data_graphs/40.htm
42	gas_price	Global yearly natural gas price	US energy information administratic	https://www.eia.gov/dnav/ng/ng_pri_fut_s1_d.htm
43	gas_price_std	standard deviation of the gas pri	US energy information administratic	https://www.eia.gov/dnav/ng/ng_pri_fut_s1_d.htm
44	production_tons	Production of lentils in the origin	FAOstat	https://www.fao.org/faostat/en/#data
45	production_tons_sc	Production of lentils in the samp	FAOstat	https://www.fao.org/faostat/en/#data
46	import_price_global	Global lentil price per year base	FAOstat	https://www.fao.org/faostat/en/#data/TCL
47	export_price_global	Global lentil price per year base	FAOstat	https://www.fao.org/faostat/en/#data/TCL
48	import_value_scoc	Import value of lentils (in dollars	FAOstat	https://www.fao.org/faostat/en/#data/TCL
49	import_quantity_scoc	Import quantity of lentils (in tons	FAOstat	https://www.fao.org/faostat/en/#data/TCL
50	export_value_scoc	Export value of lentils (in dollars)	FAOstat	https://www.fao.org/faostat/en/#data/TCL
51	export_quantity_scoc	Export quantity of lentils (in tons	FAOstat	https://www.fao.org/faostat/en/#data/TCL
52	import_price_scoc	Import price (in dollars per ton) t	FAOstat	https://www.fao.org/faostat/en/#data/TCL
53	import_value_oc	Import value of lentils (in dollars	FAOstat	https://www.fao.org/faostat/en/#data/TCL
54	import_quantity_oc	Import quantity of lentils (in dolla	FAOstat	https://www.fao.org/faostat/en/#data/TCL
55	export_value_oc	Export value of lentils (in dollars)	FAOstat	https://www.fao.org/faostat/en/#data/TCL
56	export_quantity_oc	Export quantity of lentils (in dolla	FAOstat	https://www.fao.org/faostat/en/#data/TCL
57	import_value_sc	Import value of lentils (in dollars	FAOstat	https://www.fao.org/faostat/en/#data/TCL
58	import_quantity_sc	Import quantity of lentils (in dolla	FAOstat	https://www.fao.org/faostat/en/#data/TCL
59	export_value_sc	Export value of lentils (in dollars)	FAOstat	https://www.fao.org/faostat/en/#data/TCL
60	export_quantity_sc	Export quantity of lentils (in dolla	FAOstat	https://www.fao.org/faostat/en/#data/TCL
61	consumption_sc	consumption in sampling countr	FAOstat	https://www.fao.org/faostat/en/#data/TCL and https://ww
62	population	population of a country (used to	FAOstat	https://www.fao.org/faostat/en/#data/OA
63	consumption_per_capita_sc	consumption per capita in sampl	FAOstat	https://www.fao.org/faostat/en/#data/OA and https://ww
64	disaster_damage	Sum of damages (in dollars) in a y	EM-DAT	https://www.emdat.be/
65	disaster	Indicator whether a hydrological	EM-DAT	https://www.emdat.be/

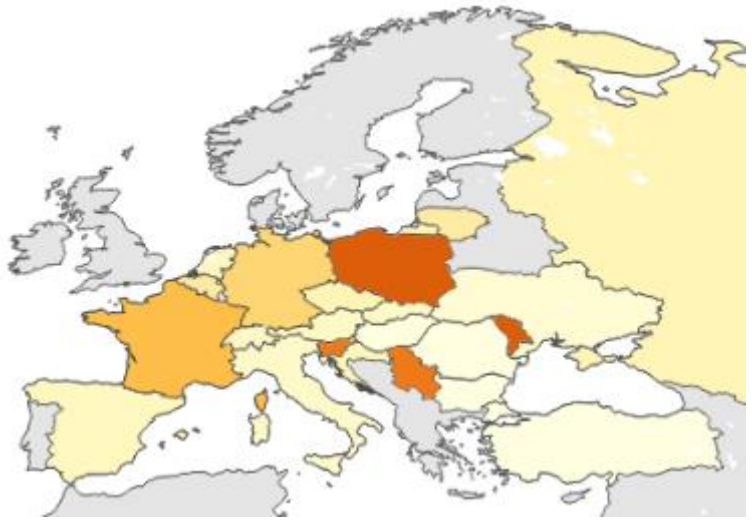
Prediction model for food safety contamination

Monitoring data

Drivers of change

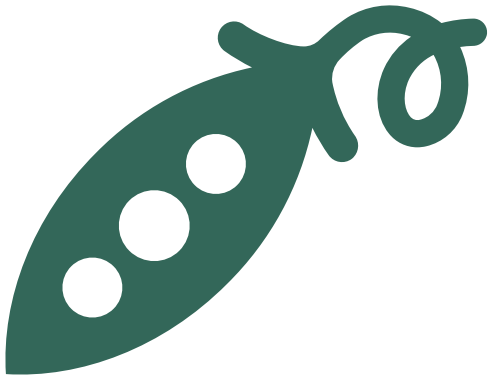
Prediction model

Food safety contamination



Predictive / forecasting AI

2024



2025

Extending existing AI mycotoxins classifier with new maize dataset: AGROKNOW
Expanding AI mycotoxins model into a time-series model: AGROKNOW
Mycotoxin classifier in multiple products: WFSR

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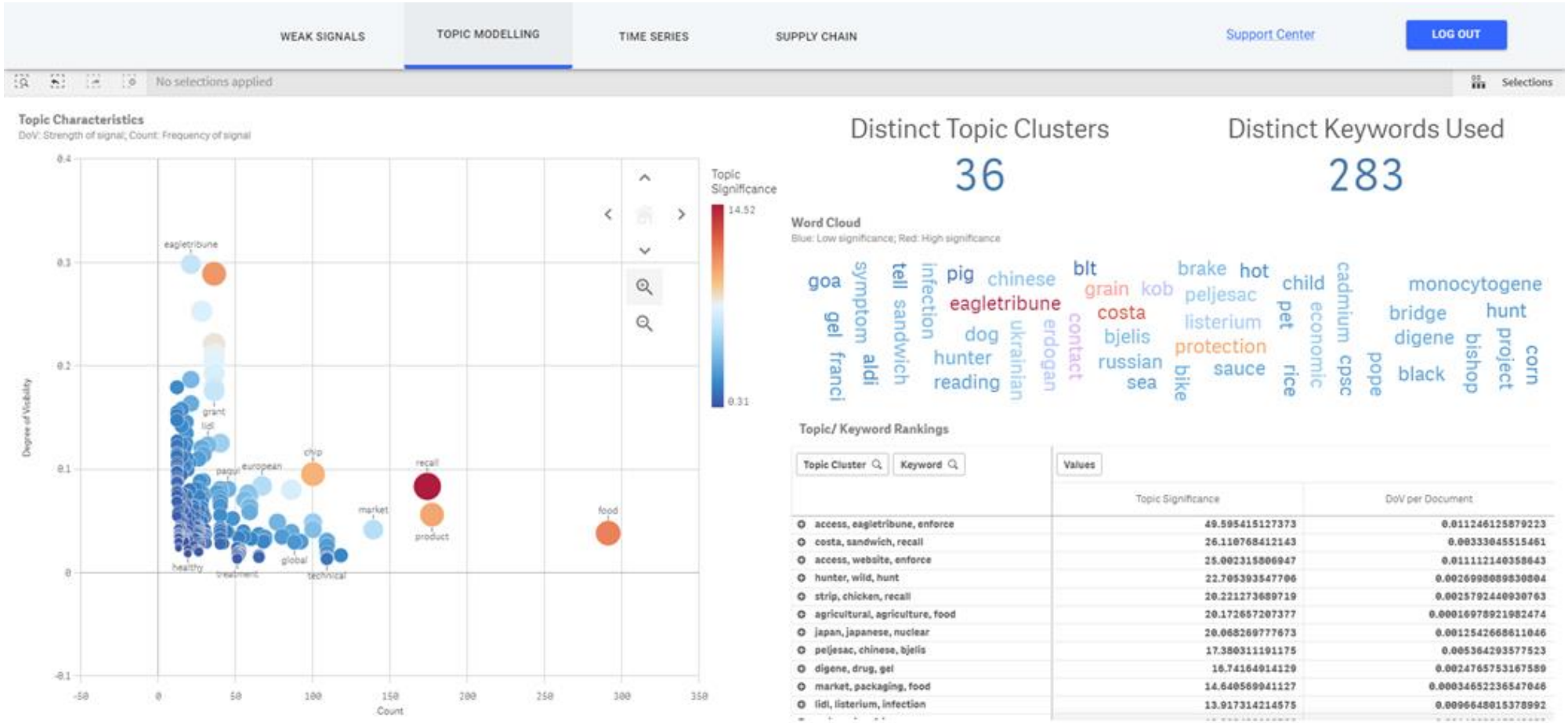
Topic modelling

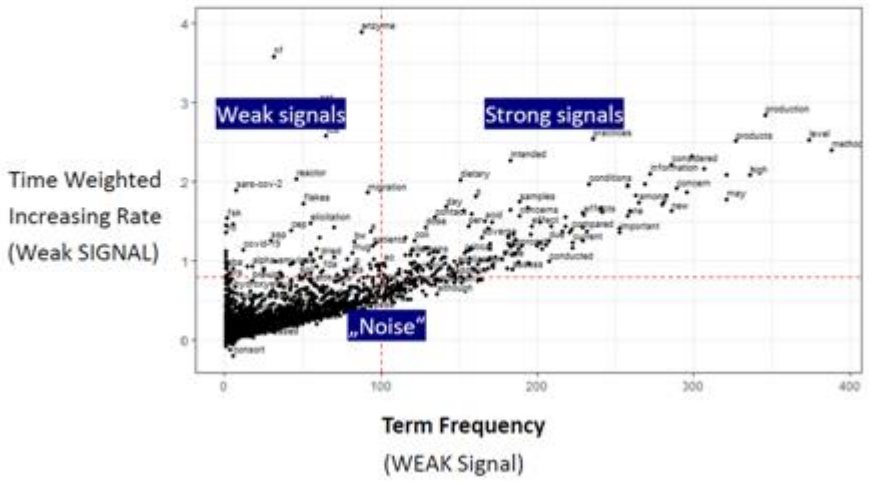
- **Identify and extract abstract topics** from a collection of **documents** by analyzing the **patterns of word co-occurrence** within the **texts**

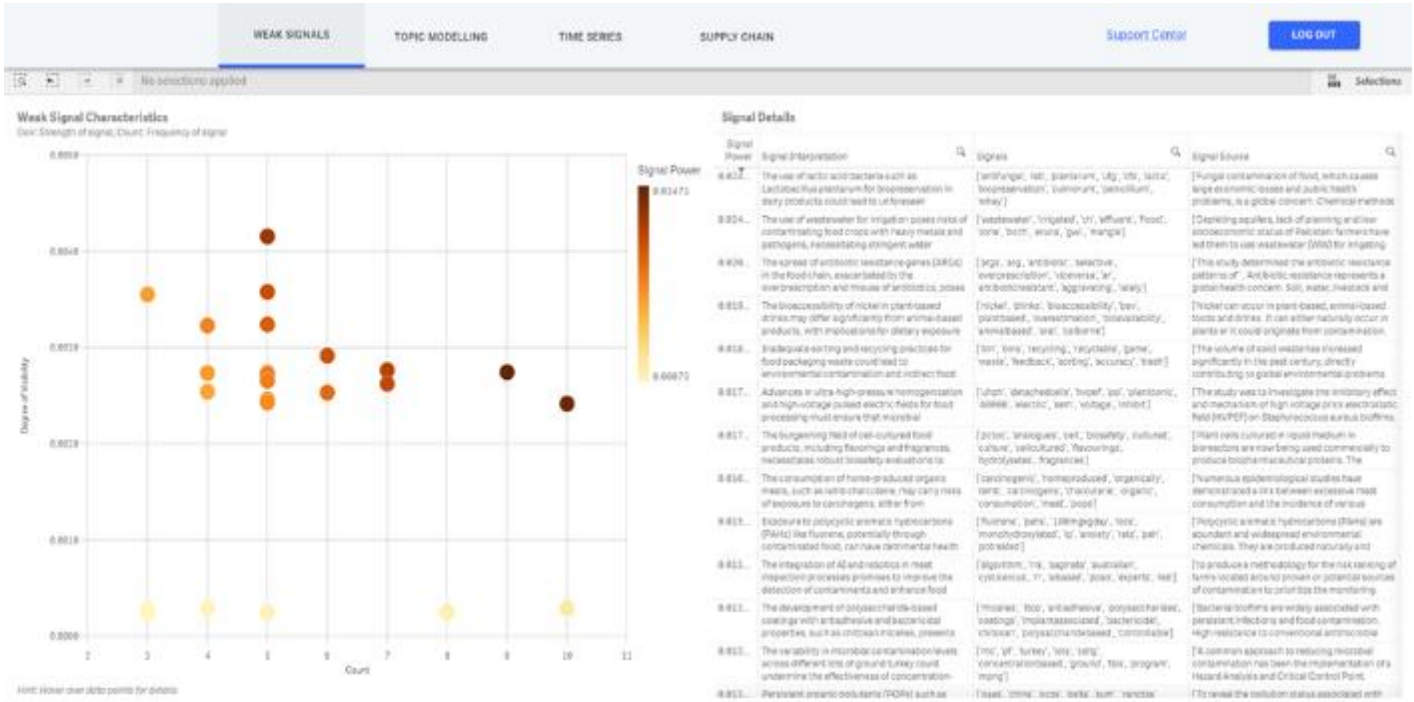


Weak signal miner

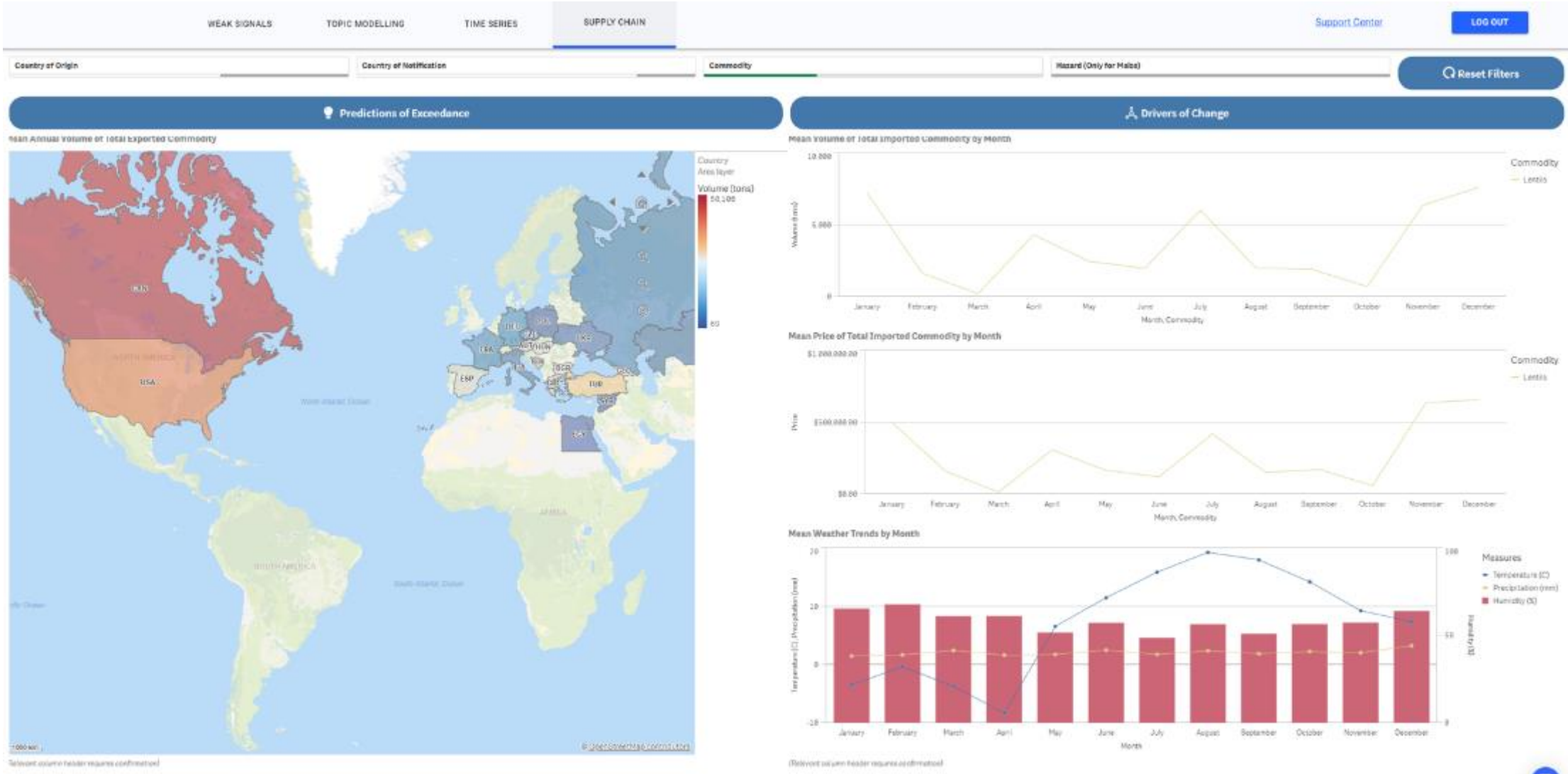
- **Weak signals** focus on concepts that are **infrequently mentioned** yet exhibit **significant changes over time**

Keyword Emergence Matrix





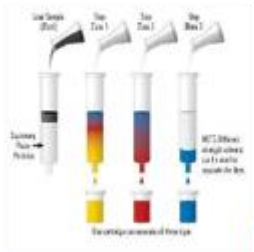
Dashboard


WEAK SIGNALS
TOPIC MODELLING
TIME SERIES
SUPPLY CHAIN
Support Center
LOG OUT
Country of Origin
Country of Notification
Commodity
Hazard (Only for Malta)
Reset Filters
Predictions of Exceedance
Drivers of Change
Mean Annual Volume of Total Exported Commodity
Volume (tons)
Mean Volume of Total Imported Commodity by Month
Commodity
Lentils
Mean Price of Total Imported Commodity by Month
Mean Weather Trends by Month
Measures
Temperature (C)
Precipitation (mm)
Humidity (%)
Months

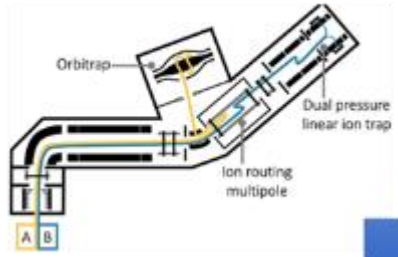
Untargeted methods for chemical Hazards: HRMS/AI

Antibiotics
Growth Promoters

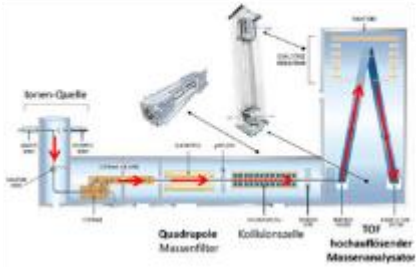
Mycotoxins
Plant toxins



Generic
Sample Clean-up

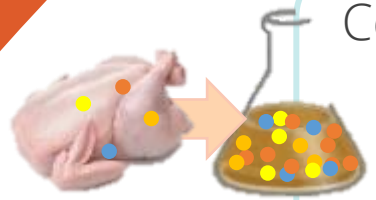


HRMS
(Full Scan, DDA, DIA)



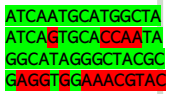
- Data conversion
- Data reduction
- *m/z* and RT corrected
- Feature detection
- AI/SVM

Untargeted methods for biological hazards: quasimetagenomic approach



Co-enrichment of four foodborne pathogens

Total DNA extraction and shotgun sequencing

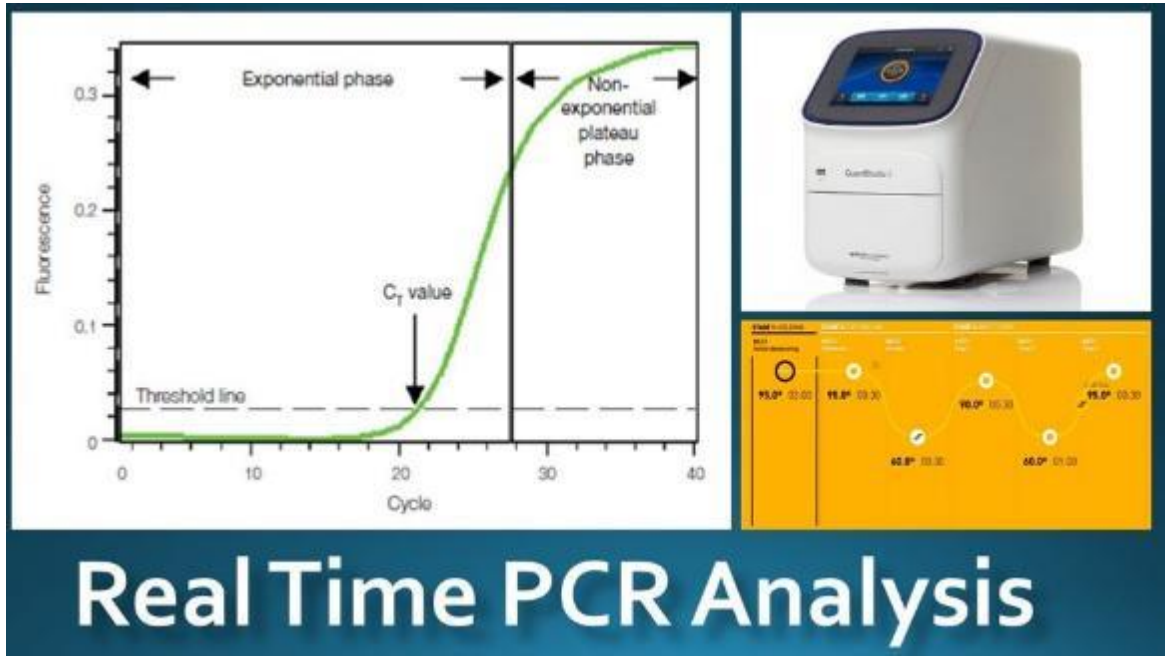


Alignment to pathogens database: detection

Typing, AMR, virulence,...

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

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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*

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

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

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

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

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Living Labs Methodology

PHASE 1

Exploration

Objective: Identify priorities and set the foundation for the Living Lab's action plan.

Activities:

- Organize a face-to-face workshop to define challenges, explore stakeholder needs, and establish goals.
- Engage participants in brainstorming, stakeholder mapping, and discussions to align objectives.

Outcome: A well-defined action plan tailored to the Living Lab's focus area.

PHASE 2

Experimentation

Objective: Test and validate tools, models, and approaches developed in the project.

Activities:

- Conduct two rounds of online workshops for discussing and refining the action plan based on initial results.
- Facilitate usability testing and gather feedback to improve prototypes or methodologies.

Outcome: Adjusted approaches and tools, incorporating stakeholder insights for improved relevance and functionality.

PHASE 3

Evaluation

Objective: Assess the outputs of the Living Lab process and plan for further exploitation.

Activities:

- Organize a final face-to-face workshop to review results and stakeholder feedback.
- Evaluate the impact of the tested solutions and gather recommendations for future application or scalability.

Outcome: A comprehensive evaluation report, including insights for replicability and alignment with project goals.

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From Data to Decisions: Shape Food Safety Risk Detection with our Developers

- Interactive online Living Lab
- Co-creating a dashboard allowing early risk detection
  - navigate through the current concept dashboard
  - including 4 types of AI tools
- June 18th 2025, 10:00 – 13:00 CET

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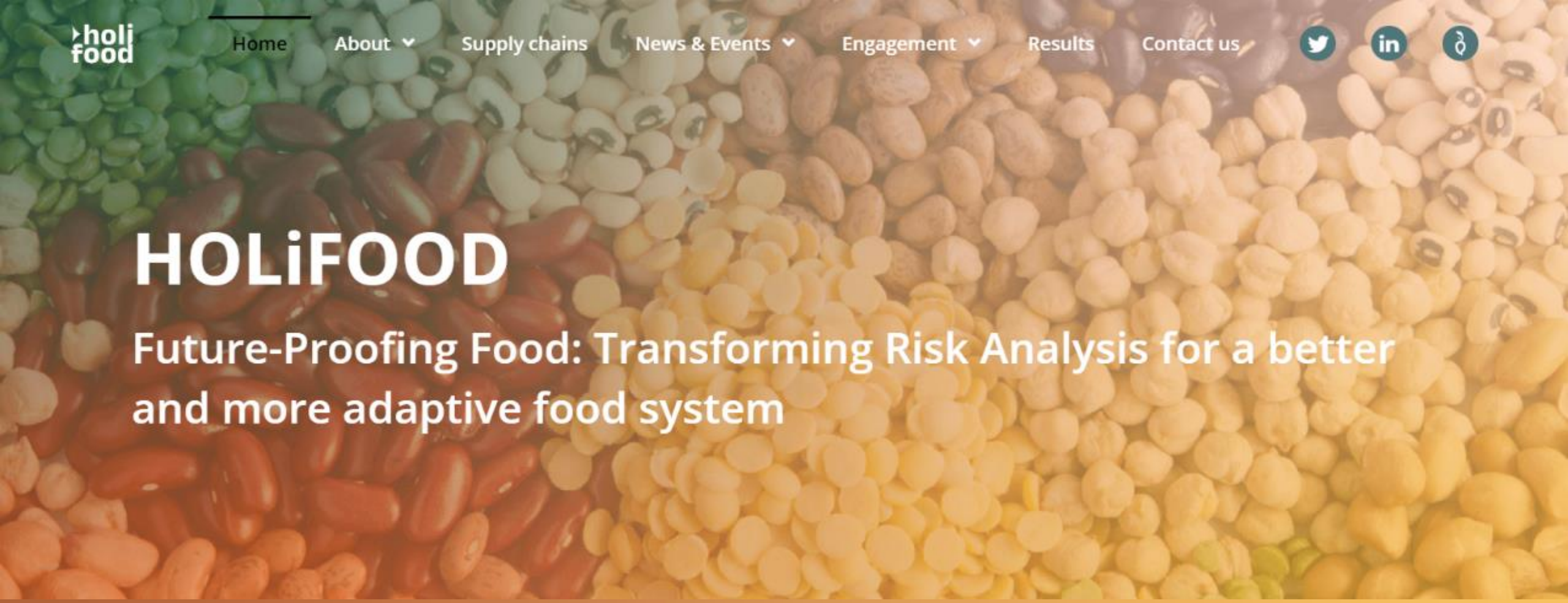
EVENT : Workshop: AI in food safety in the HOLIFOOD project

- AI for emerging food safety risks: a holistic approach
  Bas van der Velden (Wageningen University Food Safety Research)
- AI for emerging food risk identification based on text
  Ákos Józwiak (UVMB)
- Dashboard for managing emerging food risks
  William O'Sullivan (Creme)
- AI Act's legal framework for predicting emerging risks
  Malgorzata Wilinska (UNIVIE)
- 13th June 2025, 11:00-12:00 CET



https://holifoodproject.eu

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