



**PARMA**  
**SUMMER SCHOOL**  
26 – 28 SEPTEMBER 2023

# Innovative food products

Ensuring Preparedness for the assessment of safety of  
new food/feed sources & production technologies

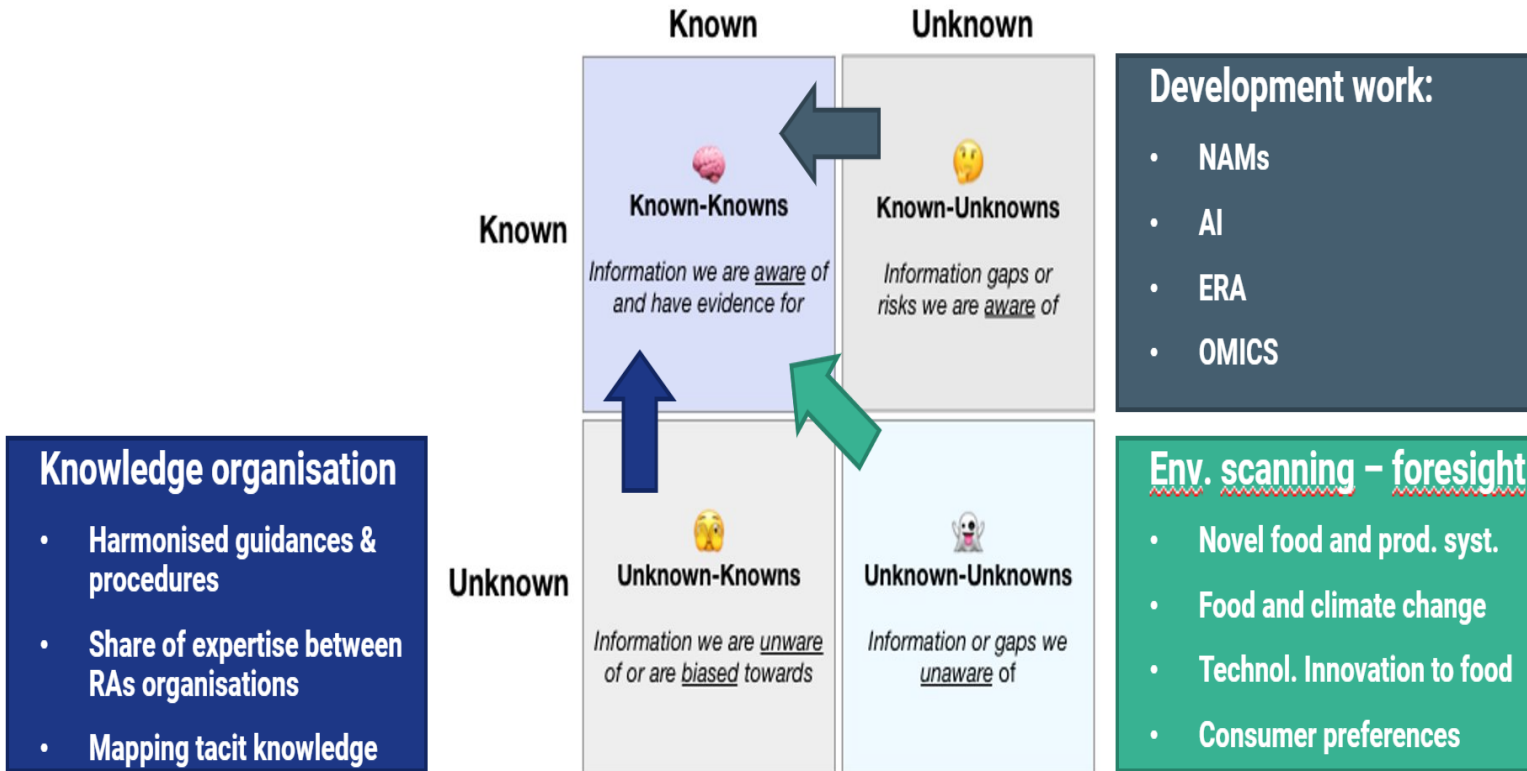
Horizon scanning

Bernard Bottex, Team Leader, EXPLORE Team, KNOW Unit

Dr Georgia Gkrintzali, SNE, EXPLORE Team, KNOW Unit



# KNOW Unit and 8.1 Process



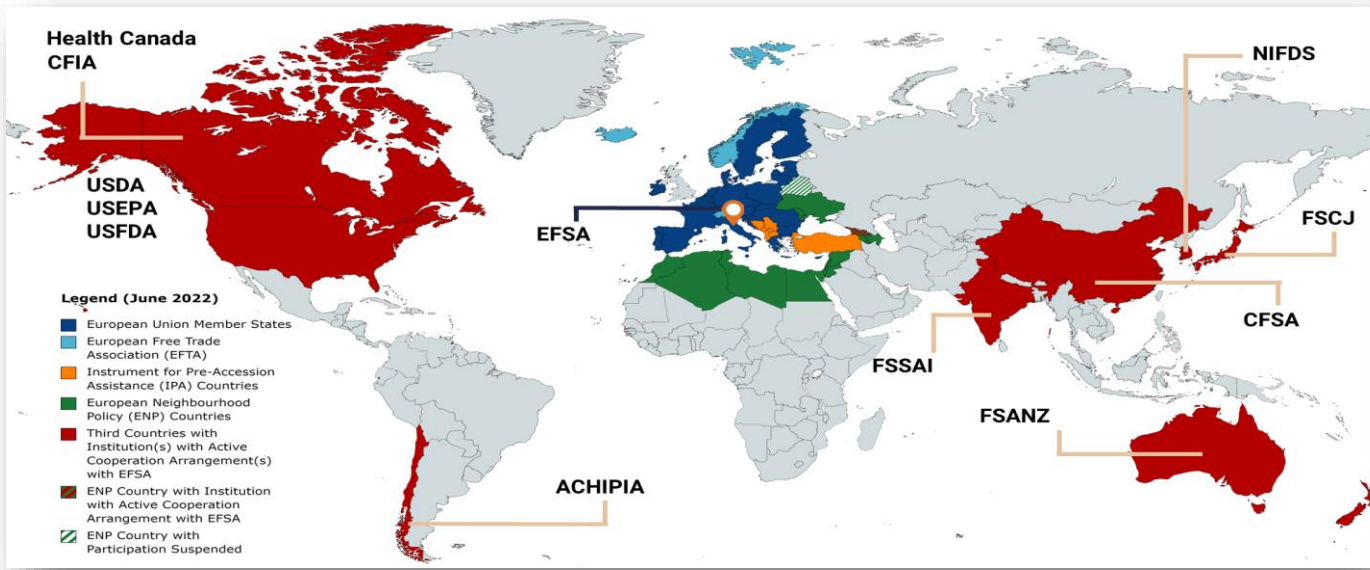
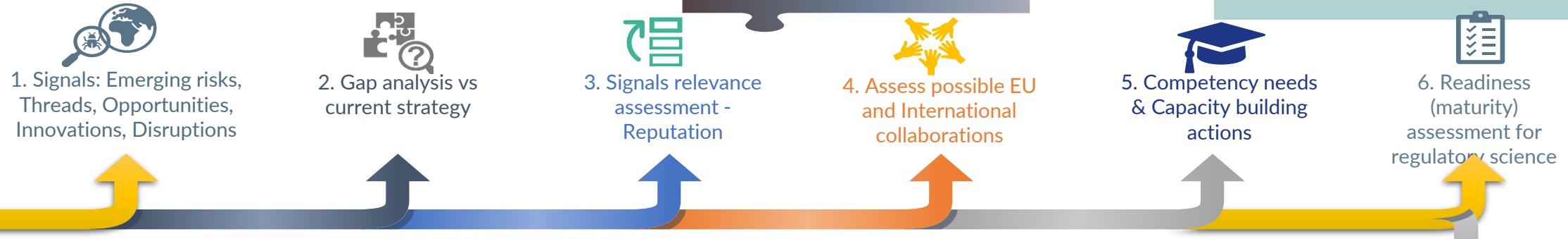
- **Identification / anticipation of gaps / opportunities**
- Contribution to the **definition of EFSA's working agenda and long-term strategy**
- **Identification of emerging risks** (Art. 23 and 24 of Reg. (EC) 178/2002)

# Environmental Scanning



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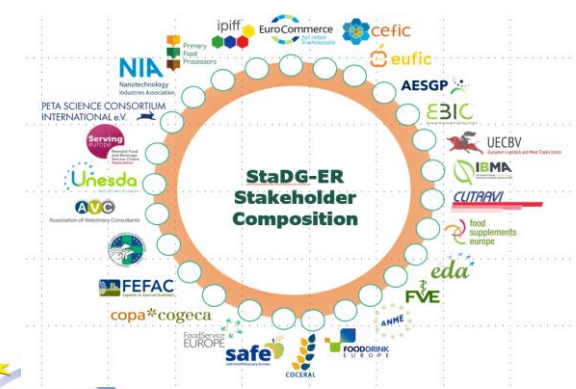
## Innovative food products



### 8. Strategy update



### 7. Decision at Preparedness Council





# Innovation project (SLA JRC/35116/2020, JRC)

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*Weak signals: signals defined as unclear observable trends or patterns that warn about the possibility of future events. They illustrate potential future developments (i.e. emerging issues) for which limited and scattered evidence is currently available (Donohoe, et. al., 2018)*

## Aim:

- **identification of weak signals in the field of new food, feed sources and innovative production technologies using JRC TIM tool**
- **setting up new stakeholders' engagement approaches**

# Innovation project

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## Data

Scopus and Patstat patents collection were used for the detection of raw signals

## Methodology

2 complementary processes:

- targeted searches were made in TIM technology environment to constitute specific collections of documents,
- TIM tool: extracted from Scopus relevant keywords and used to build collections of documents that then were ranked and selected according to various indicators

# Innovation project

- Detected raw signals were reconstructed in TIM technology

Tools for Innovation Monitoring  
TimDictionaries

Georgia GKRINTZALI (Logout)

NFo - ALT PROT -Edible insects

CREATE Dataset

locusta migratoria  
macrotermes bellicosus  
macrotermes natalensis  
musca domestica  
oecophylla smaragdina  
oryctes rhinoceros  
oxya chinensis  
protaetia brevitarsis  
protaetia brevitarsis seulensis  
rhyncophorus palmarum  
rhyncophorus phoenix  
ruspolia differens  
rynchopetera fairmaire  
schistocerca gregaria  
sphenarium  
spodoptera littoralis  
Tenebrio molitor  
vespa affinis  
vespa velutina  
zonocerus variegatus  
zophobas atratus  
zophobas morio

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Documents: 35

Article Book chapter Patent Review

Date, Type 2000 2021 highlight text

Insects, rodents, and pets as reservoirs, vectors, and sentinels of antimicrobial resistance  
Entry type: Review Entry ID: S\_2-s2.0-85099446439 Year: 2021

Production techniques of the maggots of house flies (musca domestica l. 1758) for poultry feed: a bibliographical summary  
Entry type: Article Entry ID: S\_2-s2.0-85116426491 Year: 2021

Insect left-over substrate as plant fertiliser  
Entry type: Article Entry ID: S\_2-s2.0-85112388408 Year: 2021

Effect of using insects as feed on animals: pet dogs and cats  
Entry type: Article Entry ID: S\_2-s2.0-85108894188 Year: 2021

Housefly maggot meal as a potent bioresource for fish feed to facilitate early gonadal development in clarias gariepinus (burchell,1822)  
Entry type: Article Entry ID: S\_2-s2.0-85099555039 Year: 2021

Feed capable of improving content of selenium in egg by using wastes and preparation method and application of feed  
Entry type: Patent Entry ID: pat\_fam\_71485320 Year: 2020

An optimal control problem for carrier dependent diseases

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Documents: 35

Article Book chapter Patent Review

Date, Type 2000 2021 highlight text

Insects, rodents, and pets as reservoirs, vectors, and sentinels of antimicrobial resistance

Entry type: Review Entry ID: S\_2-s2.0-85099446439 Year: 2021

Gwenzi W., Chaukura N., Muisa-Zikali N., Teta C., Musvovugwa T., Rzymiski P., Abia A.L.K.  
University of Zimbabwe, Sol Plaatje University, Chinhoyi University of Technology, University of Cape Town, Poznan University of Medical Sciences, Universal Scientific Education and Research Network (USERN), University of KwaZulu-Natal

This paper reviews the occurrence of antimicrobial resistance (AMR) in insects, rodents, and pets. Insects (e.g., houseflies, cockroaches), rodents (rats, mice), and pets (dogs, cats) act as reservoirs of AMR for first-line and last-resort antimicrobial agents. AMR proliferates in insects, rodents, and pets, and their skin and gut systems. Subsequently, insects, rodents, and pets act as vectors that disseminate AMR to humans via direct contact, human food contamination, and horizontal gene transfer. Thus, insects, rodents, and pets might act as sentinels or bioindicators of AMR. Human health risks are discussed, including those unique to low-income countries. Current evidence on human health risks is largely inferential and based on qualitative data, but comprehensive statistics based on quantitative microbial risk assessment (QMRA) are still lacking. Hence, tracing human health risks of AMR to insects, rodents, and pets, remains a challenge. To safeguard human health, mitigation measures are proposed, based on the one-health approach. Future research should include human health risk analysis using QMRA, and the application of in-silico techniques, genomics, network analysis, and 'big data' analytical tools to understand the role of household insects, rodents, and pets in the persistence, circulation, and health risks of AMR.

Production techniques of the maggots of house flies (musca domestica l. 1758) for poultry feed: a bibliographical summary

Entry type: Article Entry ID: S\_2-s2.0-85116426491 Year: 2021

Insect left-over substrate as plant fertiliser

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# Innovation project

- screening stage of the identified raw signal: 3 teams of scientists

Criteria to characterise a raw signal as a WS	Questions that can contribute to the assessment of the datasets gathered
Novelty	Is this issue a new issue? If yes which is its novelty? Is this a known issue but in another matrix/environment?
New or increased exposure	Do we have a new or increased exposure of the identified issue through the food/feed chain?
New susceptibility	Could the possible exposure or new or increased exposure to the new issue lead to adverse effects in (vulnerable) subgroups of the population?
Soundness	What is the reliability of the source of info?
Severity	What could be the severity of effects on human, plant and animal health or the environment?

- identified weak signals: monitored through TIM



# Areas of Innovation Project

Novel Feed	Novel Food	Cross cutting
Feed from Marine Resources	Cell culture-derived meat	Novel Production Technologies
Insect as feed	Edible insects	Techniques with Novel Purposes
Other Novel Feed	Human Identical Milk Oligosaccharides	Novel Additives and Flavourings
Feed from Aquatic Plants	Alternative Sugars	Novel Packaging
Feed from biofuels-by products	Alternative Fibres	Nanotechnology
Feed from food waste	Fungi	
Feed from industrial by products	Alternative Carbohydrates	
	Alternative plant-based proteins	
	Alternative sources of vitamins	
	Novel Plant Extracts	
	Novel Foods-Nanomaterials	
	Microalgae – Macroalgae	

# Innovation project

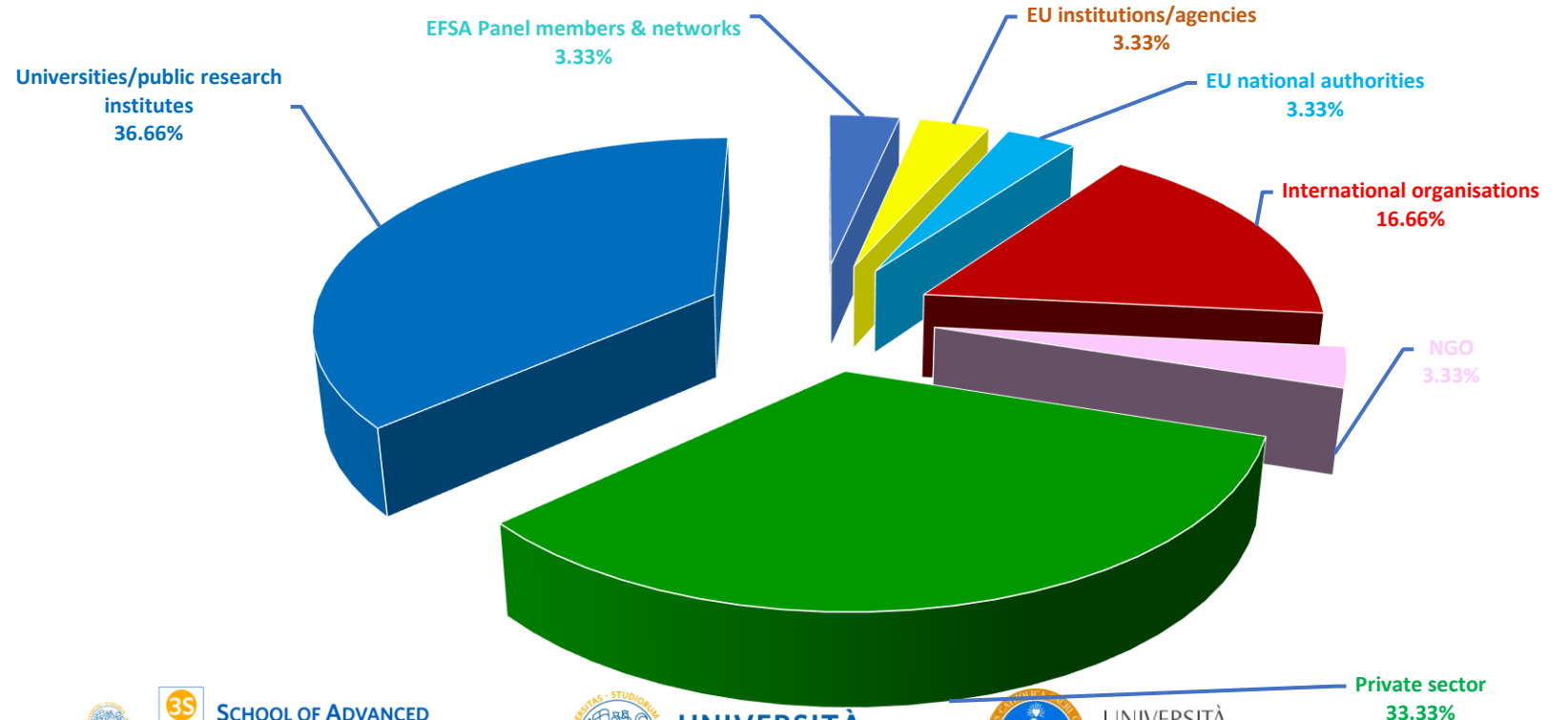
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Novel Feed	Raw signals	Weak signals	Initial no of abstracts/patents	No of abstracts/patents after 'risk' filtering	No of abstracts/patents 2018-2021
Insect as feed	6	0	867	273	169
Feed from Marine Resources	3	3	217	43	12
Other Novel Feed	2	0	88	32	17
<b>Total</b>	<b>11</b>	<b>3</b>	<b>1172</b>	<b>348</b>	<b>198</b>
Novel Food					
Cell culture-derived meat	3	3	79	35	25
Edible insects	40	9	1750	730	337
<b>Total</b>	<b>43</b>	<b>12</b>	<b>1829</b>	<b>765</b>	<b>362</b>
Cross cutting area					
Nanotechnology	19	4	2,779	2360	1140
<b>Total</b>	<b>19</b>	<b>4</b>	<b>2,779</b>	<b>2360</b>	<b>1140</b>

# Future Food/Feed Lab

Date/Place: 06-07 March 2023, Milan

- 4 Break out groups: i. Edible insects (novel food)  
ii. Cell culture-derived meat (novel food)  
iii. Nanotechnology (cross cutting)  
iv. Feed from marine resources, insect as feed, feed from aquatic plants, other novel feed (novel feed)



Number of participants: 30

# Future Food/Feed Lab

Macro-area	Category	No of WS	Weak signal	Comments from participants of the B/G	Additional weak signals
Novel food	Cell culture-derived meat	3	<b>Scaffolding structures</b> Can be contaminated by non-food-safe chemical solvents or may include other non-food-safe components used for scaffold polymerization.	<b>Weak signal</b> <ul style="list-style-type: none"> <li>- <b>Chemical and physicochemical behaviour of scaffolds</b> during food processing.</li> <li>- Synthetic/reusable scaffolds may pose safety issues via <b>migration</b>. Scaffolds may be dissolvable and their <b>potential residues in the final product</b> should be investigated.</li> </ul>	<ul style="list-style-type: none"> <li>- <b>outflow of by-products from the bioreactors</b> during culturing (e.g., ammonia)</li> <li>- <b>micronutrients</b> and factors involved in their <b>dietary bioavailability</b></li> <li>- <b>culture ingredients/input materials</b> (serum replacers, growth factors). Other input materials: components with antibiotic activity (e.g., peptides, antibiotics,)</li> </ul>
			<b>Stem cells</b> The proliferation of stem cells in culture for many population doublings could lead to the accumulation of genomic alterations Problems associated with cell lines derived from stem cells including genetic instability and phenotypic drift.	<b>Weak signal</b> <ul style="list-style-type: none"> <li>- <b>Genetic stability of cell line</b> could impact the safety of the final product</li> <li>- It is <b>impossible to fully exclude</b> that some cells, after genetic drifting, <b>may produce components with toxigenic potential</b></li> <li>- Use of <b>chemical substances</b> to check and regulate cell growth</li> </ul>	

# Future Food/Feed Lab

Macro-area	Category	No of WS	Weak signal	Comments from participants of the B/G	Additional weak signals
			<p><b>Integration of nanosensors in the bioprocess of cell culture-derived meat</b></p> <p>This integration eased the quality assessment throughout the food supply chain but the potential of food safety risks stemmed from the maintenance of nanosensors in the final product should be investigated.</p>	<p><b>Not weak signals</b> It was characterised as an outlier.</p> <ul style="list-style-type: none"> <li>- The participants declared not being familiar with this element, and none of the companies represented in the group declared using nano sensors in the production of CCDM.</li> <li>- Could be relevant to “future foods” in general.</li> </ul>	<ul style="list-style-type: none"> <li>- possible risks linked to <b>upscaling and recycling (re-use) of input materials</b> (feasibility, and impact on food safety/environment).</li> <li>- <b>co-culturing</b>: currently not practiced</li> </ul>

# Future Food/Feed Lab

Macro-area	Category	No of WS	Weak signal	Comments from participants of the B/G	Additional weak signals
Novel Food	Edible insects	9	<b>Gonimbrasia belina</b> Microbial contamination/Allergenicity/Aflatoxin	All identified weak signals were concrete insect species, which were not relevant for the participants. The weak signals were rather the hazards that the insect might have on human health.  They suggested the following weak signals:  <u><b>Consumption of plastic materials by insects</b></u> The metabolism of plastics by insects remains an unexplored field. The participants highlighted that consumption of insects fed with plastics on purpose is not expected, it is rather expected as incidental events; as examples they referred to uncontrolled rearing practices, via contaminated feed, via microplastics.  <u><b>Antinutrients and specific metabolites:</b></u> Antinutrients or toxic metabolites depend on the feed the insects are fed with and the degree of metabolism of those substance by insects.	<b>Genetically modified insects:</b> Very few articles on this topic.  <b>Veterinary medicines:</b> No veterinary medicines have been approved for edible insects for the moment. Their presence in edible insects may come via the feed and may pose a risk for human health or lack of approved veterinary medicines for edible insects may lead to diseases (e.g. viruses in crickets)  <b>Innovative feed:</b> may impact on hazard profile of edible insects (e.g. other type of contaminants)
			<b>Gryllus bimaculatus</b> Allergenicity/Microbial contamination		
			<b>Musca domesitca</b> Microbial contamination/contribute to the global spread of pathogenic resistant bacteria		
			<b>Ruspolia differens</b> Microbial contamination/Allergenicity		
			<b>Schistocera gregaria</b> Allergenicity		

# Future Food/Feed Lab

Macro-area	Category	No of WS	Weak signal	Comments from participants of the B/G	Additional weak signals
			<p><b>Zophobas atratus</b> Microbial contamination/Allergenicity</p>	<p><b>Antimicrobial resistance (AMR):</b> There is lack of veterinary medicines allowed for farmed insects despite the fact that insects may be reared in large quantity.</p>	
			<p><b>Henicus whellani</b> Presence of saponins, oxalates and tannins</p>		
			<p><b>Protaetia brevitarsis</b> Presence of alkaloids</p>		
			<p><b>Zophobas morio</b> Polysterene biodegradation</p>		

# Future Food/Feed Lab

Macro-area	Category	No of WS	Weak signal	Comments from participants of the B/G	Additional weak signals
Cross cutting	Nanotechnology	4	<b>Nanowarming</b> Nanowarming is a form of bioheat transfer and has been approved and applied in biomedical applications. It's a new trend with possible application in food sector.	<b>Weak signal</b> Limited knowledge about nanowarming application	<b>Perinatal exposure to foodborne inorganic nanoparticles</b>  <b>Prevalence of unlabelled nanomaterials</b>
			<b>Foodborne nanoparticles</b> The research activities in the foodborne nanostructures that arise during natural food processing, to characterize their chemical composition and the formation mechanisms are limited, and there are gaps in the current knowledge.	<b>Weak signal</b> Misinterpretation of the definition. The size and scale of nanomaterials falls between 1 and 100 nanometers, but there's no fixed cut-off point for what is considered a nanomaterial. The EU Commission defines it as 1-100 nm, but particles larger than 100 nm can still be considered nanomaterials.	
			<b>Essential oils nano-emulsions</b> Essential oils based nano emulsions in general are increasingly used in the food sector due to their antimicrobial properties. It could be considered as weak signal due to the increased expose of a number of botanicals some of which may contain components that may be genotoxic and/or carcinogens.	<b>Weak signal</b> Companies need to take into account safety considerations, such as bioavailability and toxic effects, when determining functionality	



# Future Food/Feed Lab

Macro-area	Category	No of WS	Weak signal	Comments from participants of the B/G	Additional weak signals
			<p><b>Nanoencapsulation</b></p> <p>The increased use of the technology of nano - encapsulation may require new considerations on exposure and nano-specific assessment</p>	<p><b>Weak signal</b></p> <p>The group commented on various definitions and keywords utilized to identify the process of nano-encapsulation</p>	

# Future Food/Feed Lab

Macro-area	Category	No of WS	Weak signal	Comments from participants of the B/G	Additional weak signals
Novel feed	Feed from marine resources, insect as feed, feed from aquatic plants, other novel feed	3	<p><b>High dietary level of wheat gluten</b></p> <p>High dietary level of wheat gluten -&gt; negative impact on the intestinal and liver health of salmon with symptoms similar to gluten sensitivity in humans</p>	<p><b>Weak signal</b> when applied to a specific sub-category i.e., fish, while it would not be a weak signal for others because of extensive relevant knowledge.</p>	<p><b>Availability of phosphorus</b> for production of new and innovative feeding ingredients</p>
			<p><b>Undesirable substances in novel feed</b></p> <p>The inclusion of plant ingredients pose a potential threat to fish due to the presence of various undesirable substances including anti-nutritional factors (ANFs), such as phytoestrogens and mycotoxins as well as chemical contaminants, which can negatively affect growth and health.</p>	<p><b>Not weak signal</b></p> <p>Undesirable substances (mycotoxins) already well known</p>	

# Future Food/Feed Lab

Macro-area	Category	No of WS	Weak signal	Comments from participants of the B/G	Additional weak signals
			<p>Cultivation of microalgal biomass on waste nutrients and use of the resultant microalgae crops as a feed source for aquaculture industries or animal production</p> <p>Challenges in large scale cultivation of algae on digestate</p>	<p>Not weak signal Already very well known issue</p>	

# Future Food/Feed Lab

## Innovative food products

Methodology offers centralized access to a large amount of data but the screening of results is very resources intensive

It was considered that the input to detect signals was highly specific

More and additional sources of information should be considered e.g., market info, early research, media

TIM tool is a useful tool to detect grey and unknown weak signals, assisted with manual literature search

“Time is of essence”: publications or patents may come after years of research and development, to identify weak signals, it may be too late

Human intervention may bring subjectivity

It's not sensitive enough to detect emerging “unknowns”

Recommendation for TIM tool: focus of the TIM tool on innovation in other areas also: medicine, cosmetics and investigate whether there are applications related to food area

Suggestion: to engage with industry and authorities to analyse and validate results as well as identify gaps.



# Future Food/Feed Lab: Follow up actions

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- EFSA's Scientific Colloquium "Cell culture-derived foods and food ingredients"
- Communication to EFSA Nano WG: weak signals identified within the innovation project in the area of nanotechnology
- Presentation of the innovation project to EREN & StaDG ER
- Creation of a community of knowledge in the area of new food/feed sources and innovative production technologies.



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