Digital Food Institute

Annual Report

2020

VETERINARIANS WILL NOT BE REPLACED BY ARTIFICIAL INTELLIGENCE ...

... THEY WILL BE REPLACED BY VETERINARIANS USING ARTIFICIAL INTELLIGENCE

UNIVERSITY OF VETERINARY MEDICINE BUDAPEST DIGITAL FOOD INSTITUTE

2020 results

Established: 1st April 2020
DFI staff: 6 persons

https://dfi.univet.hu/en

The Institute was established on April 1, 2020 at the University of Veterinary Medicine in Budapest.
The legal basis for the establishment of the Digital Food Institute was laid down by the Government Decision No 1470/2019. (VIII. 1.) on the promotion and coordination of the digitalization of the Hungarian agriculture, Hungary's Digital Agriculture Strategy.

The Institute integrates food chain safety data analysis and research along the whole food chain and takes networking in this area to a new level. The main objective of the Institute is to provide analysis, education, research, development and innovation services in the area of food chain safety for all the stakeholders.

3 RDI projects awarded funding in 2020, 2 projects under development with the participation of DFI

RDI projects

Emerging risk identification

Identification of 21 emerging risks with national interest, whereof 11 risks also have relevance in th EU, and initiation of actions as the result of the analysis of more than 40.000 food chain safety related news using data mining algorithms

Participation in more than 20 meetings in relation to 8 international working groups and networks
Building relationships with several national and international organisations

National and international relations

With the contribution of our staff 5 scientific publications were published in peer-reviewed, high-impact international journals,
and 2 manuscripts have been submitted for publication

Education

Development and adoption of 2 new courses and their lecture themes, further courses under development for the students participating in the Marek József scholarship programme
Guest lectures

1 related pubilcation
Preparation for carrying out risk-benefit analyses
Search for national and international partners, monitoring calls for project proposals

Food Health Technology Assessment (Food HTA)

Data analysis

Enhancing data analysis capacities
RDI projects
Epidemological modelling of the SARS-Cov-2 during the spring of 2020 in Hungary

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Foreword

The University of Veterinary Medicine Budapest (UVMB) has a centuries-old link with veterinary public health and food safety. Treating our companion and farm animals, tackling epidemics and solving current animal health and public health challenges are all part of food chain safety. As the national custodian of veterinary public health, the University currently has a key role to play in updating and continuously improving food chain safety trainings.

We aspire to continue to be among the best in this field. An essential part of this process is to build digital opportunities into the agri-food chain, in partnership with veterinary training in all areas. The food professionals of the future, in science, agri-food industry and public administration, will need to be better equipped to deal with complex systems, which will require a higher level of data and information management and computer science skills.

As a first step, we will start to integrate digitalisation efforts and data-driven thinking into research and education in the veterinary public health sector, and later extend this to companion animals across our entire professional platform.

As part of this long-term strategy, the Digital Food Institute (DFI) was established on April 1, 2020.

The Institute is the University's research and education unit that provides practical support to actors in the agri-food economy, develops digitalization opportunities and supports complex veterinary education based on digital technology with a food chain perspective.

Nowadays, the transition to digital technologies has also become inevitable in the agri-food chain. The agriculture of the near future will be based on large amounts of data generated by precision technologies and sensors. However, data-driven operations and data-based decision making are becoming increasingly important not only in crop production, but also in the livestock and food industries.

The role of veterinarians in the food chain is multifaceted, as they support the prevention of diseases and epidemics, the treatment of diseases, the compliance and enforcement of legislation, in addition to the development of optimal production results. The veterinarian is the common point of contact between crop production and animal nutrition, animal husbandry and disease control, and food production.

To achieve these goals, veterinarians must have a broad range of knowledge, including animal genetics, biological needs, the ability to distinguish between healthy and diseased conditions, and the ability to prevent, detect and manage risks. Data from a variety of sources, from which the veterinarian can generate information, can help achieve these goals.

Thus, the veterinarians of the future will therefore not only work in the surgery or the barn, they will also have to navigate the world of data. By analysing the interrelationships between data from on-farm sensors, applications that support production processes, production management systems and other systems, solutions can be developed to improve production, increase efficiency and reduce costs.

In addition, data analysis enables early detection of symptoms and risks, disease management, rapid intervention and monitoring, which can also contribute to the prevention and effective management of epidemics. Data from outside the farm can be used to predict food chain safety events or new risks. The importance of such forecasting systems is demonstrated by the current pandemic: research and early detection of new pathogens and chemical contaminants saves animal and human lives.

DFI also plays a key role in the training of the Marek József scholarship students. The scholarship is designed for dedicated veterinary students with an interest in farm animal medicine and food chain safety, who wish to work in these fields in the future. Each semester, the Institute will provide a dedicated course, where students will acquire state-of-the-art knowledge related to food chain safety and data analysis. The aim of the Institute is to complement the high quality of the Doctor of Veterinary Medicine training, to contribute to the training of future veterinarians and to enable colleagues to start their work by making extensive use of the knowledge acquired during the 11 semesters in the world of digitalization.

Our work does not end with the establishment of the Institute, the field needs to be continuously developed and enriched. These are only the first steps in the creation of a new quality of which we do not yet know any examples in this form, in a university environment, and this will provide an opportunity to further expand our already diverse international relations and to play a leading role in the field of digital food chain safety.

Dr. Miklós Süth   Dr. Péter Sótonyi
Director of DFI   Rector of UVMB

About the Institute

The legal basis for the establishment of the Digital Food Institute was laid down by the Government Decision No 1470/2019. (VIII. 1.) on the promotion and coordination of the digitalization of the Hungarian agriculture, Hungary's Digital Agriculture Strategy.

The Institute was established on April 1, 2020 at the University of Veterinary Medicine in Budapest which is one of the most important places for the training of food safety professionals in Hungary. The Institute integrates food chain safety data analysis and research along the whole food chain and takes networking in this area to a new level. The Institute aims to be an internationally recognized hub of experts and researchers in the field of food chain safety data analysis.

It is important to see that "big data", computational methods and artifitial intelligence will not replace agricultural professionals, food engineers and veterinarians. Our data-driven colleagues who use these methods will replace those who do not.

Activities

The food professionals of the future – in academia, industry and public administration alike – need to be better prepared for complex systems, which inevitably means a need for higher level of information management and computational science knowledge. The key to this is a multidisciplinary education and research, which requires proactive steps towards closer collaboration of all scientific fields involved.

The Institute carries out food chain-based, integrated research for the agri-food chain actors in areas requiring scientific complex problem solving and data analysis. The Institute uses innovative approaches, the latest technological solutions and modern data science methods and makes them available to a wide range of stakeholders. The Institute works in close collaboration with Hungarian and foreign universities, research institutions, authorities and with international organisations active in this field.
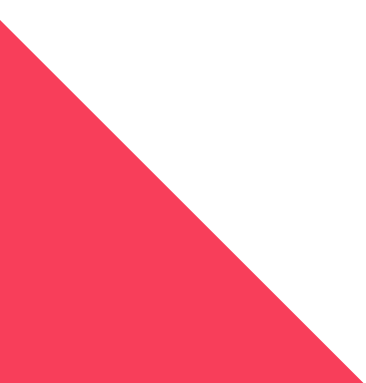
The main activities of DFI include the collection and analysis of food economy data, the identification of food related emerging risks, the application of health technology assesssment methodology in the food safety domain (Food HTA), such as burden of disease studies, cost-utility or cost-benefit analyses.

The Institute aims to participate in national and international RDI projects related to food safety (e.g. data analysis, forecasting and modelling), and liaise with international organisations working in the area of food safety data science.

The Institute also takes an active part in the educational activities of the UVMB, by providing such courses to the students that focus on their computational science skills and enable them to create, manipulate and analyse large datasets.

This report describes the works started and/or carried out by the DFI in 2020, according to the main areas of activity.

Emerging risk identification

One of our ongoing tasks is to identify emerging risks. This is a complex task that requires a high level of expertise and an interdisciplinary approach. The process is designed to contribute to both corporate and regulatory strategic planning and analysis, decision making processes, risk assessment and appropriate risk management measures, in addition to protecting human, animal and plant health.

Due to the complexity of emerging issues and the often incomplete information and data they contain, a fully automated system cannot be built, and expert experience is always required to assess the novelty and relevance of the issues.

Currently, we are accessing information on potential emerging risks through network-based analysis of patent databases and text mining of food and food safety related news. The development, improvement and practical application of related methodologies and algorithms is a permanent task of our Institute.

We intend to share the results of the development of methodologies and algorithms with the professional community in the form of scientific publications.

For the moment, the identification of emerging risks are supported by the following data mining methodologies:

- Analysis of patent databases
    - Citation network based analyses
        - Structural hole analysis
        - Co-occurrence analysis
        - Community detection/evolution tracking
        - Bray-Curtis similarity matrix analysis
- News analysis
    - Analysis of the co-occurrence network of words (topic detection)
    - Machine Learning algorithms used to identify emerging risks

Visualisation of a network of co-occurrences of words from a weekly Europe Media Monitor (EMM) news item

Among the patent system analysis methodologies, the main focus in 2020 was on structural hole analysis, which identified 4 categories (based on the International Patent Classification grouping) as emerging technologies related to agri-food.

Technological aspirations falling into these categories, as well as the potential risks associated with them identified through news analysis, will be given particular attention.
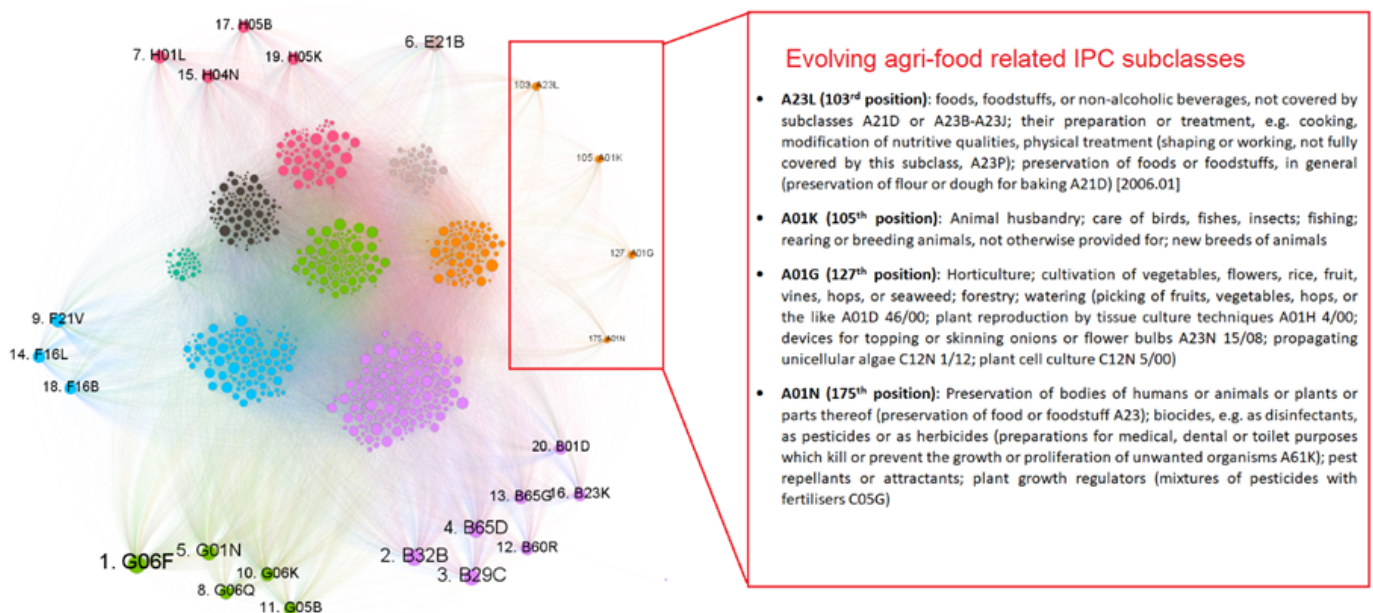
Emerging technology categories in agriculture and food based on patent network analysis

The external communication of emerging risks is a complex task, with the methods, timing and target audience being determined on a case-by-case basis. Depending on the nature of the issue, the target group may be the authority (in particular the National Food Chain Safety Office – NÉBIH), senior managers, the professional community, food businesses or the wider community, consumers interested in the issue, etc. Not only emerging risks requiring action may be communicated, but some issues may also help to promote research or be important due to their educational character, and therefore may be communicated through communication channels such as the DFI's website.

DFI staff are also members of the European Food Safety Authority's (EFSA) Emerging Risk Exchange Network (EREN), so they can also share issues with the EU professional community through this channel. The signals discussed at European level play a role in defining research directions for food chain safety risk assessment and, where appropriate, in allocating research and data collection resources.

In the year 2020, DFI has identified 21 potential emerging risks out of more than 40.000 food chain safety related news items using data mining algorithms, whereof 9 issues are considered as potential emerging risks at EU level based on EREN's opinion. The Institute has published 12 issues on its website, including 2 issues for which DFI sent a rapid information note to NÉBIH, and reported 11 issues of potential emerging risk to EFSA's Emerging Risk Exchange Network.

Emerging risks in 2020

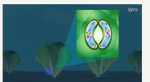| Action	Issue	EU interest
Information to NÉBIH **DFI website**	Plastic substitutes in the food industry – bamboo	
Information to NÉBIH **DFI website**	Dietary supplements with herbal active ingredients	
DFI website	Risks related to BARF feeding	
DFI website	Zoonotic spread of Carbapenemase-producing Enterobacteriaceae	
DFI website **EFSA EREN**	Ecdysterone in spinach	
DFI website	Shiga Toxin-Producing E. coli O121 in flour	
DFI website **EFSA EREN**	Gluten-free flour and oils from spent coffee grounds	
DFI website **EFSA EREN**	Antibiotic treatment of citrus fruits	
DFI website **EFSA EREN**	Risks related to homemade and commerciallly available plant-based milks*	
DFI website	MCPG found in lychee, a probable reason for acute encephalitis syndrome	
DFI website **EFSA EREN**	Barcoded microbial system for tracking agricultural products**	Under EREN discussion
DFI website **EFSA EREN**	New hypervirulent Listeria monocytogenes serovar 4H reported	Data/information collection will start
EFSA EREN	Exposure to environmental levels of pesticides stimulates antibiotic resistance***	Under EREN discussion
EFSA EREN	Dicamba based weed killers blocked in the USA	
EFSA EREN	Some Salmonella strains can enter leaves of lettuce by opening up the plant's breathing pores****	Under EREN discussion
EFSA EREN	Shiga Toxin-Producing Escherichia albertii	EU-level ER
EFSA EREN	Transgenic Aedes aegypti mosquitoes transfer genes into a natural population	Under EREN discussion
EFSA EREN	SARS-CoV-2 survives on meat	Data/information collection will start
EFSA EREN	Cell-based milk development*****	Data/information collection will start
EFSA EREN	MicroRNA in breast milk	
EFSA EREN	Euphorics - plant-based drinks using nootropics ******	Data/information collection will start

Food Health Technology Assessment (Food HTA)

Adapting the methodology of health technology assessment (HTA) to food safety risk analysis is a relatively new field.
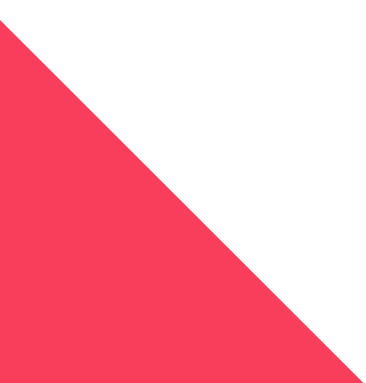
In 2020, an article prepared with the assistance of the DFI staff, which conducted a retrospective cost-utility analysis of the Hungarian *Salmonella* control programme, was accepted. The analysis covered the period 2007-2017, the main findings were:

- There is no international agreement yet on the methodology, so issues such as the perspective of the analysis or the range of cost elements included in the analysis are not yet standardised.
- The result of the analysis depends largely on the the quality and reliability of the data used, which need to be improved.
- Of the cost items included in the analysis, the cost of productivity loss due to absenteeism was the highest, followed by the programme costs and health care costs.
- Most of the health gains determined as a result of the programme are due to survival from avoided deaths, so the return on intervention is mostly a function of this. If the number of deaths from salmonellosis is not reduced, the programme ceases to be cost-effective.
- According to our calculations, the estimated number of hospitalisations avoided was 5.416 and the estimated number of deaths avoided was 29, as a result of the eradication programme for the period 2007-2017.
- Based on our analysis, the value of the incremental cost-effectiveness ratio (ICER) - which shows how much one unit of QALY gain costs - was HUF 8.394.507/QALY in 2017. In Hungary, the cost-effectiveness threshold is set at 3 x GDP/capita under the relevant directive, which was HUF 11.757.000/QALY in 2017. As our calculated ICER falls below this threshold, the control programme is considered cost-effective.

Some elements of HTA can also be used in risk-benefit analysis. The essence of these analyses is that they consider both the risks (e.g. microbiological, chemical) and benefits (e.g. nutrients, micronutrients) of food. The methodology is not yet fully developed and there is a need to clarify the concepts and standardise the analytical process.

DFI aims to introduce the methodology of food HTA and risk-benefit analysis to the Hungarian professional community. To this end, the preparation of an awareness-raising, educational article and the exploration of possible national collaborations have been initiated. As a first step, the risk-benefit analysis of freshwater fish consumption was identified as a potential research topic, for which the Institute has already contacted several national stakeholders and started to monitor the possibilities for funding.

Data analysis

The Institute conducts integrated, chain-oriented research for agri-food chain actors in areas requiring scientific, complex problem solving and data analysis. To this end, it applies innovative approaches, state-of-the-art technologies and modern data analysis methods and makes them available to small and medium-sized enterprises. The ultimate goal of the various analyses and studies is to assist partners in their decision-making processes.

The analysis of the data used, covering the entire agri-food chain, together with short, medium and long-term forecasts, as well as industrial process reviews and laboratory testing, provides a complex analytical and advisory environment. This will provide a useful and effective decision support service to both the public authority (by channelling industrial self-monitoring and process management data) and to the industry (by reusing public data and aggregating data provided by actors throughout the chain).

The scope of food chain process analysis includes:
- Assessment of production processes along the food chain
- Problem-focused analysis of processes, identification of problems, proposals for solution
- Preventive advice for actors in the agri-food chain
- Epidemiological modelling.

By analysing data from a food chain safety perspective - taking into account privacy, data security and confidentiality principles - it is possible to optimise process management, develop technology, make forecasts at different levels and times, thereby increasing preparedness and reducing exposure.

Workflow of a data analysis process in KNIME software

Modern and professional problem solving through data analysis should be consistent, reproducible and objective. The open source data analysis software KNIME (Konstanz Information Miner)* provides a framework for this, capable of handling the entire data analysis process, from data collection to data evaluation. Through the process management concept of KNIME, different components can be integrated for machine learning, data mining and network analysis. Furthermore, it is possible to integrate R and Python programming languages into the software.

The Institute is also involved in epidemiological modelling. In the past, we have carried out a risk assessment summarising the possible routes and speed of the spread of African swine fever, mainly by compartmental modelling and network analysis taking into account spatial and temporal dynamics.

In 2020, we started epidemiological modelling again in response to the coronavirus pandemic. The open source software GLEAMviz (The Global Epidemic and Mobility Model)** was used to model the spread of SARS-Cov-2 in Hungary for the spring 2020 period (under publication).

RDI projects

R&D&I activities focus on participation in national and international projects aimed at food chain safety. The main research areas of the Institute are data analysis, foresight and research in support of decision-making methodologies. DFI has successfully joined several R&D projects in 2020.

Full digitalisation of the rabbit meat production chain

A joint project with the Department of Pathology, the Department of Pharmacology and Toxicology and TETRABBIT Animal Breeding and Trade Ltd. The aim is to improve rabbit meat as a food product and the production process. The main tool is a big data analytical system fed by an automated data collection system, which can provide information from the barn to the table, covering the whole vertical of rabbit meat production. In addition, the system to be developed will be able to provide information or forecasts to all steps and actors in the supply chain. The project was launched in January 2021.

Veterinary Public Health Data Lake

The aim of the project is to build a veterinary public health data lake at the University of Veterinary Medicine Budapest, modelled on the human medical data lake at the University of Pécs. The data lake will allow the storage and preparation for analysis of structured and unstructured data from different sources. It is a novel data storage method that can reveal previously unexplored correlations through AI-enabled data mining and analysis.

If data from animal health, veterinary public health, food safety, human health and other sources can be analysed together, the resulting veterinary public health data repository could serve as a model for other countries and for the common European food chain safety profession. Possible applications of the dataset include the fight against antimicrobial resistance (AMR) and drug repositories. The project will start in May 2021.

NETPOULSAFE project

NETPOULSAFE is a European Union Horizon2020 project that aims to support stakeholders in the effective implementation of biosafety practices. Launched in 2020, the project aims to improve biosecurity compliance in poultry production in seven major poultry producing countries by collecting, evaluating and sharing data on practices already implemented or about to be implemented.

Supporting measures to improve disease control are gathered from the consortium's network of experts, relevant disciplines and literature. The results will be analysed by the consortium, validated on pilot farms and made directly available to breeders, operators and advisors (including veterinarians). The national actors will be brought together by the Institute and the Department of Animal Hygiene, Herd Health and Mobile Clinic.

NetPoulSafe

Digital Success Programme

DFI was called to life by the Digital Agriculture Strategy of Hungary (DAS), "*as a center for food chain (animal husbandry, feed production, food raw material production, etc.) assessment, data analysis, education, research, development and innovation, and separately from the food chain information system operated by the food chain control body, it provides practical support and the development of digitalisation possibilities to the actors of the agricultural and food economy, and ensures complex veterinary training based on digital technology with a food chain approach*."

As such, the Institute is actively involved in the promotion of digitalization efforts in Hungary, including the Digital Success Programme (DSP) and the Digital Food Strategy (DFS). The main objective of the DFS is to promote the digitalization potential of data in the food industry, thereby helping the sector to operate more efficiently. This requires the processing of the large volumes of data available in the food industry, the use of artificial intelligence and the development of human resources.

Education

It is essential for veterinarians and food chain scientists to acquire, during their studies (postgraduate training), the computational skills that will enable them to create and analyse large databases and networks.

The creation and development of databases and the use of analytical methodologies are not only a matter of computer science and data science, but also require the ability to evaluate and analyse input data and results from a professional point of view. This implies a level of knowledge of the relevant food chain science domain that allows the interpretation and determination of the validity of individual data.

Accordingly, these interdisciplinary values are given a prominent role in the development of our training system. At present, there is no integrated training of this kind either in Hungary or in the wider region, so the launch of postgraduate courses in Hungarian and English is under preparation.

In the past year, DFI has developed the following course themes, which will be taught from the academic year 2021/2022:
- Application of data analysis in the field of food chain safety
- Complexity in veterinary medicine: veterinary public health.

In recent years, our Institute staff have regularly taught at other universities and in the European Commission's Better Training for Safer Food (BTSF) training scheme, in courses related to risk assessment, risk communication, HACCP, strategic planning of the food chain, marketing. With the creation of DFI, these courses will continue to be taught, but we plan to extend our teaching portfolio at the University of Veterinary Medicine Budapest as well.

National and international relations

The Institute also works closely with the National Food Chain Safety Authority (NÉBIH) in several areas, including the identification of emerging risks. A cooperation agreement has been signed between the two organisations. An important part of the cooperation is based on that Article 38/A (11a) of Act XLVI of 2008 on the food chain and its official control states that NÉBIH "*shall provide the University of Veterinary Medicine Budapest with free access to the individual data stored in FELIR* for scientific purposes related to risk assessment, data analysis, research and development and statistical purposes, in accordance with the schedule specified in the contract*".

Through our international contacts, we are able to involve the University in international research projects on food chain safety, as well as providing a platform for the exchange of knowledge and experience and international networking of students. Over the past year, DFI has established links with several foreign institutions and participated in the work of international organisations.

The most important foreign partner of the Institute is the European Food Safety Authority (EFSA). DFI staff represent Hungary in several working groups and networks of EFSA.

It is a great opportunity for the Institute, for the University and for Hungary that Dr. Ákos Bernard Józwiak is the chair of the EFSA's Advisory Group on Data. The task of this group is to prioritise and strategise project proposals on data and to develop long-term concepts for food chain data in consultation with Member States, EFSA and the European Commission.

*Food Chain Control System

PARTICIPATION IN THE WORK OF INTERNATIONAL ORGANISATIONS

DFI staff participated in the following working groups and network meetings in 2020

EFSA CAPACITY BUILDING DISCUSSION GROUP

6 MEETINGS

EFSA ADVISORY GROUP ON DATA

4 MEETINGS

EFSA SOUNDING BOARD

2 MEETINGS

EFSA EMERGING RISK EXCHANGE NETWORK

2 MEETINGS

EFSA ADVISORY FORUM

4 MEETINGS

EFSA COMMUNICATION EXPERT NETWORK

2 MEETINGS

EU COMMISSION: BETTER TRAINING FOR SAFER FOOD (BTSF)

FAO-WHO Codex Alimentarius Codex Committee on Methods of Analysis and Sampling (CCMAS)
1 meeting

BUILDING INTERNATIONAL RELATIONS

GERMAN FEDERAL INSTITUTE FOR RISK ASSESSMENT (BFR)

BERLIN, GERMANY

BARABÁSI LAB
BOSTON, USA

WAGENINGEN UNIVERSITY & RESEARCH

WAGENINGEN, THE NETHERLANDS

PURDUE UNIVERSITY

WEST LAFAYETTE, USA

Future plans

Research topic ideas, search for international and national partners

Since its establishment, the Institute has been actively seeking opportunities for collaboration both within and outside the University. Working relationships have been established with several universities (e.g. University of Debrecen, Hungarian University of Agriculture and Life Sciences) and for-profit organisations, businesses. The exploration of research topic ideas and the search for national and international partners is ongoing.

National Laboratory Project

The project will focus on antimicrobial resistance (AMR), which has a significant human relevance. In the project, the virtual Institute of Veterinary Public Health and Food Chain Safety will be created, which will aim at a higher level of food chain safety through a process approach to the agri-food chain and the analysis of the large amount of data generated by the project using modern computational methods. The Institute's working groups will identify key risk points and possible areas of intervention by focusing on key chemical and biological risks (with antimicrobial resistance as a priority target area), using a process and driver analysis approach.

It will also explore the links of the animal and environmental microbiome and probiotic microorganisms to food chain safety risks and their potential applications. As a synthesis task, by analysing the data generated by the National Laboratory research in a complex, holistic 'One Health' approach, the Institute will contribute greatly to understanding and effectively addressing one of the most threatening global problems of the future. Within the framework of the National Laboratory project, our Institute is working closely with Széchenyi István University, thereby expanding its domestic links.

Emerging risks identification

In addition to the data mining methods currently in use, several planned directions for improvement have been identified that could further support the identification of emerging risks in the future. These are:

- Keyword-based web searches - Development of an emerging risk ontology;
- Analysis of rapid alert systems (e.g. RASFF), monitoring systems to track trends.

Several international project initiatives related to this topic have been identified and are in the initial, preparatory phase. One of the possible projects to be launched by EFSA in 2021 would take forward the objectives of a previous project, DEMETER (Determination and Metrics of Emerging Risks). In this project, DFI would participate in a consortium collaboration.

The other direction is to participate in Horizon Europe programmes. This is the European Union's Framework Programme for Research and Innovation, which runs from 2021 to 2027. The programme is the EU's flagship initiative to support research and innovation from ideas to market application. The programme will also support research to address societal challenges and industrial technology development in areas such as digitalization, food or natural resources.

One of the calls in the 2021 draft programme is entitled "Identification, assessment and management of existing and emerging food safety issues", which is closely linked to the Institute's activities and could therefore provide additional opportunities for DFI to apply for funding.

Food health technology assessment (Food HTA)

The next objective of DFI is to carry out a risk-benefit analysis of freshwater fish consumption, for which it is seeking national (e.g. NRDI*) and international (e.g. Horizon Europe) funding opportunities. At national level, several organisations have already been contacted (Wessling Hungary Kft., Hungarian University of Agriculture and Life Sciences, Syreon Research Institute). In addition, a foreign institute (DTU - Technical University of Denmark) has also expressed its interest in food health technology assessment as a research topic.

Hoodome

The objectives of the project are to collect and organize the components of domestic foods at the molecular level into a knowledge graph using AI-assisted methods, in order to later combine this data with biochemical, genomic, mycobiome data, to help formulate nutritional and food safety recommendations.

The national project would be implemented in conjunction with the international Foodome project. The main partners of DFI in the project are the Barabási Lab (Northeastern University, Boston) and the Institute of Nutrition at the University of Debrecen.

The project is comparable to the Human Genome Project in terms of complexity, and its results have a potential to change the way we do nutritional research, healthcare and agriculture in the future.

*National Research, Development and Innovation Office

Digitalization project proposals identified by DFI

A system for early warning of food chain safety hazards and identification of emerging risks to support food business operators

Systems for food chain safety Health Technology Assessment, cost-benefit and risk-benefit analyses

Food chain safety, quality management decision support systems for food chain managers

A secure, credible, blockchain-based traceability pilot system for one or two product lines

Meat inspection digitalization

Developing digital food chain monitoring subsystems for the authority, in cooperation with the authority

Assessing food safety and nutritional impacts on consumers at the molecular level using data-driven, AI-assisted methods

Education

The Marek József Foundation has announced the Marek József Scholarship for dedicated veterinary students interested in farm animal medicine and food chain safety, who wish to work in these fields in the future. The aim of the Marek József Scholarship is to significantly increase the number of veterinarians wishing to work in the field of farm animal medicine and food chain safety. The scholarship is only available for veterinary training in Hungarian. A minimum of 15 students per year will be awarded the Marek József Scholarship.

DFI will actively participate in the training of scholarship students. The staff of the Institute will give 1-1 course to students each semester. Work has started on the topics of the planned courses:
- Proper nutrition and gastronomy
- Sustainability aspects in the food chain
- Feed Law.

Additional course topics, which are being developed:
- Risk Communication
- Risk Assessment
- Food-drug interactions
- Emerging risks in the food chain
- HACCP
- Food testing - sampling and analysis.

Our Institute attaches great importance to talent management and the education of young scientists, and therefore actively participated in the judging of the papers for the Scientific Students' Associations Conferences of the 2020/2021 academic year. The Institute's management has also supported and plans to continue to support the work of the University as committee members at student conferences.

From the 2021/2022 academic year, the Institute will offer the following possible PhD topics for students:

- Improving the process of identifying emerging risks
  - Automated data extraction, text mining, data mining, network analysis, visualization
- Veterinary Public Health Data Lake: storing structured and unstructured data from different sources
  - AI-enabled data mining and analysis
- Risk identification using a process and driver approach to the food chain (in several projects)
  - Process-oriented analysis, big data analysis fed by automated data collection systems
- Hoodome
  - Collecting food ingredients at the molecular level and organising them into a knowledge graph.

We believe it is important to participate in the high quality training courses at the University not only as lecturers, course instructors and subject leaders, but also to help with organisational and quality assurance tasks. Thus, our Institute is involved in the successful preparation of the AVMA accreditation. To this end, we work closely with the EAEVE working committee responsible for accreditation. We have summarised the missing tasks for a successful AVMA accreditation on a time scale, according to which we plan to proceed in the coming period.

EU-FORA fellowship programme

UVMB is a member of EFSA's collaborating organisations*, and we were therefore able to apply for the EU-FORA (The European Food Risk Assessment) fellowship programme as a training site. The aim of the programme is to promote knowledge exchange and networking between organisations that carry out risk assessment or related activities in the EU. Our Institute has been successfully awarded the opportunity to be a host partner in 2021.

*According to Regulation (EC) No.178/2002 Article 36.

Communication, workshops, conferences

The experience gained during the operation of the Institute and the research results must be integrated into the national and international professional and scientific circulatory system, and it is also critical for the Institute to maintain its international and national network, to collect information and to keep contacts with potential consortium partners.

In this context, the Institute intends to organise workshops and conferences in the future on topics within its field of activity, and to pay particular attention to the publication of its scientific results.

In addition to the professional network, the Institute considers it important to involve "lay" actors in society as well as non-institutionalised professional actors. The aim is twofold: on the one hand, the Institute would also serve as an information base and would like to bring the science of food chain safety closer to consumers (science to public), on the other hand, it would like to actively channel the needs and knowledge of social actors into its analysis, research and education activities (public science). In this context, the following activities are planned:

- Knowledge dissemination, information base, webinars, newsletter service
- Living lab: involving consumers and users in R&D (co-creation, discovery, experimentation, evaluation)
- Hackathon ("hacking marathon"): involving non-institutional researchers (mainly data analysts) in a rapid, hitherto unexplored analytical process
- Young researchers: although we aim to build a partnership with research institutions, we see young researchers as a specific social target group with whom a food chain data analysis network could be established.

Through these, we aim to build bridges between general social knowledge about food chain safety, veterinary public health and digital literacy, and the scientific community, which is paddling increasingly abstract waters with ever more modern tools.

Publications

DFI staff have contributed to several scientific publications that were published in peer-reviewed, high-impact international journals:

Alvarez-Pinera, J.; Bager, F.; Bystrický, M.; Rasmussen, S. D.; Foster, D.; Fuchs, K.; Gilsenan, M.; Grahek-Ogden, D.; **Jozwiak, Á.**; Moez, S.; Neagu, M.; O'Dea, E.; Perrella, A.; Richardson, J.; Scharfenberg, E.; Sokolic, D.; Stack, M.; Vermeersch, K.; Wienk, K.: Report of the Advisory Forum Task Force on Data Collection and Data Modelling. EFSA Supporting Publications 17: 9 p. 1901E, 63 p. (2020)

Miklós, G.; Angeli, Cs.; Ambrus, Á.; Nagy, A.; Kardos, V.; Zentai, A.; Kerekes, K.; **Farkas, Zs.**; **Jóźwiak, Á.**; Bartók, T.: Detection of Aflatoxins in Different Matrices and Food-Chain Positions. FRONTIERS IN MICROBIOLOGY 11, 21 p. (2020)

Meijer, N.; Filter, M.; **Jóźwiak, Á.**; Willems, D.; Frewer, L.; Fischer, A.; Liu, N.; Bouzembrak, Y.; Valentin, L.; Fuhrmann, M.; Mylord, T.; Kerekes, K., **Farkas, Zs.**; Hadjigeorgiou, E.; Clark, B.; Coles, D.; Comber, R.; Simpson E.; Marvin, H.J.P.: Determination and Metrics for Emerging Risks Identification DEMETER: Final Report. EFSA Supporting Publications 17: 7 p. 1889E (2020)

Dövényi-Nagy, T.; Rácz, C.; Molnár, K.; Bakó, K.; Szláma, Z.; **Jóźwiak, Á.**; **Farkas, Zs.**; Pócsi, I.; Dobos, A.C.: Pre-Harvest Modelling and Mitigation of Aflatoxins in Maize in a Changing Climatic Environment – A Review. Toxins, 12, 768. (2020)

Országh, E.; Pitter, J. Gy.; Kaló, Z.; Vokó, Z.; **Jóźwiak, Á**.: Retrospective cost-utility analysis of the Non-typhoidal Salmonella control programme in Hungary. Food Control, 120, 107529. (2021)

The following papers were prepared in 2020 and submitted for publication in early 2021:

Zsuzsa Farkas, Szilveszter Csorba, Miklós Süth, Ákos Bernard Jóźwiak: Emerging risks and evolving agri-food technologies – Identification of structural hole spanners in patent citation networks

Zsuzsa Farkas, Tekla Engelhardt, Erika Országh, Miklós Süth, Szilveszter Csorba, Ákos Bernard Jóźwiak: Applicability of an open-source epidemiological simulation tool for the modelling of the Hungarian spread of COVID-19

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