FRONT PAGE

PROJECT FINAL REPORT

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Name of the scientific representative of the project's co-ordinator[1], Title and Organisation:

Karin Zimmermann, BSc RM,

Tel: +31 70 3358185

Fax: +31 70 3615624

E-mail: Karin.zimmermann@wur.nl

Project website Error! Bookmark not defined. **address:** www.eurodish.eu

[1] Usually the contact person of the coordinator as specified in Art. 8.1. of the Grant Agreement.

4.1.Final publishable summary report

1. Executive summary

The goal of the EuroDISH project was to provide advanced and feasible recommendations for research infrastructure development to the European Strategy Forum on research Infrastructures (ESFRI) and future European funding programmes as well other stakeholders. The following conditions were taken into account:

- The needs of different stakeholders (e.g. policymakers as the EU and national level and researchers covering a broad range of disciplines from the public sector and industry;
- The focus on integration of existing and the developments of new food and health research infrastructures which were most relevant for innovation in mechanistic research and public health nutrition strategies across Europe and
- The integration of past experiences and aligned with on-going activities.

EuroDISH has been organised around the 'DISH' model: 'Determinants, Intake, Status and Health' (figure 1). This model represents four key building blocks of food and health research. Each area of research is expected to contain research infrastructures at differing stages of development.
EuroDISH was comprised of three phases:

1. To map the existing research infrastructures and identifying gaps and needs.
2. To integrate the findings within and between DISH pillars and to identify new gaps and needs.
3. To develop a conceptual design for research infrastructure with a roadmap for implementation.

Based on the results of EuroDISH it was concluded that:

- There is a need for an overarching research infrastructure that is specific for food, nutrition and health, and connects existing RIs.
- The overarching research infrastructure would:
  (a) enable research for better understanding the behaviour of consumers concerning food intake and lifestyle, including emerging opportunities in ICT and neuroscience;
  (b) find a structure for public-private partnership that accommodates the different interests;
  (c) help to connect research on food production and on health and address the societal challenges in these domains.

Coördinator: Dr Krijn Poppe, DLO
E-mail: Krijn.Poppe@wur.nl
Tel: +31 (0)70-33583131

Karin Zimmermann, DLO
E-mail: Karin.Zimmermann@wur.nl
Tel: +31 (0)70-3358185

Scientific coordinator: Prof. Pieter van 't Veer, WU
E-mail: pieter.vantveer@wur.nl
Tel:+31 (0)317-485105

2. *Summary description of project context and objectives*

The EU and its member states are facing an increasing incidence of obesity and other diet-related chronic diseases such as heart diseases, stroke, cancer, diabetes, and mental disorders (WHO 2009). Effective public health policy and (intervention) strategies need to be designed to be able to improve health, increase quality of life, and prolong productive life (EC 2011a, JPI HDHL 2011). Individual Member States have the main responsibility for health policy and healthcare of their respective European citizens. However, there are areas where the individual Member States are unable to be effective by acting alone. Cooperative action at the European community level is then necessary (http://ec.europa.eu/health-eu/doc/whitepaper_en.pdf). Several visions on how to address these societal challenges have been positioned at the forefront of future health research and policy applications. Central to these visions is the importance of a knowledge-based society and high quality research *throughout* Europe to enable effective public health policy and innovative research. High quality research in the food and health domain has been supported by national as well as EC Directorate programmes. However, research in this field is still scattered with difficulties regarding the alignment of disciplines and how to use research outcomes. Moreover, research capacity and comparable high quality data are still limited for many European countries, especially in the CEE region (Gurinović, et al. 2010; Pavlovic, et al. 2009). Food and Health Research Infrastructures are specific for the research area 'Food and Health' and need to strengthen high-quality research and provide sound knowledge for public health nutrition strategies across Europe. Although a good start is made with the development of EU-wide food and health research infrastructures, integration or linkage of existing research Infrastructures is required to enhance the quality, cost effectiveness and availability of comparable methods and data in Europe to support the monitoring and refinement of dietary recommendations and interventions.

The goal of the EuroDISH project was to provide advanced and feasible recommendations for research infrastructure development to the European Strategy Forum on research Infrastructures (ESFRI) and future European funding programmes as well other stakeholders. The following conditions were taken in account:

- The needs of different stakeholders (e.g. policymakers as the EU and national level and researchers covering a broad range of disciplines from the public sector and industry;
- The focus on integration of existing and the developments of new food and health research infrastructures which were most relevant for innovation in mechanistic research and public health nutrition strategies across Europe and
- The integration of past experiences and aligned with on-going activities.

To realise the goal three steps were performed:

- Mapping of existing research Infrastructures and identification of gaps and needs of hard and soft research Infrastructures and governance issues of different stakeholders.
- Syntheses of the results integrated by the needs for hard and soft Infrastructures and governance within and between DISH pillars and defining larger entities of required Infrastructures and identifying new arising gaps and needs.
- Developing a conceptual design for research infrastructure with a roadmap for implementation.

EuroDISH mapped existing research infrastructures (RIs) in a systematic way and identified the needs. Mapping was done for each domain of research related to food, nutrition and health: Determinants, Intake, Status and Health (DISH). The following gaps and needs were identified:

- RIs in the domains of Status and Health are emerging.
- RIs in the domains of Determinants and Intake of food are lagging behind.
- There is no specific RI that serves the needs of the food and health research community across the DISH domain, as a whole.

Based on discussion with stakeholders in interviews and workshops, it was concluded that:

- There is a need for an overarching research infrastructure that is specific for food, nutrition and health, and connects existing RIs.
- The overarching research infrastructure would:
  (a) enable research for better understanding the behaviour of consumers concerning food intake and lifestyle, including emerging opportunities in ICT and neuroscience;
  (b) find a structure for public-private partnership that accommodates the different interests;
  (c) help to connect research on food production and on health and address the societal challenges in these domains.

An overarching research infrastructure in the food and health domain will support the research community by integrating the fragmented data and tools and provide services across the DISH domains:

- Data generation, storage, management, harmonisation, access, analysis and interpretation, e.g., pan-EU food surveillance; pan-EU nutritional health cohorts and interventions; data on food quality, food safety and sustainability.
- Tools: The development, utility, innovation, standardisation and evaluation of innovative technologies for assessment of lifestyle, diet, biomarkers of exposure, functionality and health outcomes.
- Services to the research community and stakeholders relevant to integration of data and knowledge. These services will enable a systems approach for food, nutrition and health; attract young researchers; promote education, capacity building and e-training; provide a platform for industry, research, and policy; widen participation between European countries and global partners.

The proposed governance and organisation structure is in line with current European research infrastructure models (e.g., BBMRI). It is based upon the hub and spokes model with a central co-ordination hub and connected expertise from different countries. Central elements are:

- ICT backbone supporting the interoperability, standardisation and quality management of data and tools.
- Central entry point to provide services to researchers, stakeholders, and related RIs.
- Governance structure that (a) provides conditions for access such as membership, ownership, privacy, and trust, (b) organises centralised and distributed activities, and (c) enables flexibility regarding innovation within the RI.

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Website: http://www.eurodish.eu

Coördinator: Dr Krijn Poppe, DLO
E-mail: Krijn.Poppe@wur.nl
Tel: +31 (0)70-33583131

Karin Zimmermann, DLO
E-mail: Karin.Zimmermann@wur.nl
Tel: +31 (0)70-3358185

Scientific coordinator: Prof. Pieter van 't Veer, WU
E-mail: pieter.vantveer@wur.nl
Tel:+31 (0)317-485105

3. Description of the main S&T results/foregrounds

3.1. Background

3.1.1. Research infrastructure

Research infrastructure is a widely used concept to denote facilities, resources or services of a unique nature (i.e. with a clear purpose) set up to facilitate the work of researchers. Development of world-class infrastructures is seen by European heads of Research Councils (EUROHORCs) and the European Science Foundation (ESF) as an important vehicle to a globally competitive European Research Area (ERA) of excellence, advancement of science and creation of a knowledge-based society in Europe.

Research infrastructure provides the opportunity to address societal challenges by linking research disciplines, knowledge and resources between and across countries (EC 2011b, JPI HDHL 2011). This plays an important role for stimulating innovation, impelling openness, excellence and collaboration (ESFRI – Europe 2020 Strategy). Research infrastructure can be defined as: "*Research Infrastructures (RIs) are facilities, resources or services of a unique nature that have been identified by European research communities to conduct top-level activities in all fields. This definition of RIs, including the associated human resources, covers major equipment or sets of instruments, in addition to knowledge-containing resources such as collections, archives and data banks. RIs may be "single-sited", distributed", or "virtual". They often require structured information systems related to data management, enabling information and communication."* (ESFRI (2011) and SCAR (2005)).Many EU-wide networks, projects, activities and organisations such as EFSA, WHO, IARC have contributed to the development of new innovative methods, definition of best practice methods, development of training e-modules, development of RIs (Slimani, et al. 2011; Ocké, et al. 2011; Verhagen, et al. 2011; van Ommen, et al. 2010a; Bouckaert, et al. 2011) or have been involved in the mapping of the needs for RIs as part of the setting of strategic research agendas (EC 2011b, JPI HDHL 2011, ETP-FFL 2011).

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3.1.2. Food and health research infrastructure

There has been progress in the development of European food and health research infrastructure. For example, BBMRI (Biobanking and Biomolecular Resources Research Infrastructure) was one of the first projects entering the European Research Infrastructure preparatory phase of the ESFRI roadmap which was funded by the European Commission. Over the past 3 years BBMRI has grown into a 54-member consortium with more than 225 associated organisations (largely biobanks) from over 30 countries, making it one of the largest research infrastructure projects in Europe (see http://bbmri.eu). BBMRI is a typical example of a 'distributed' RI (a network of distributed resources).

The necessity pf developing new and innovative food and health research infrastructures still remains (JPI HDHL, 2011; EFSA, 2009). For example, past EC funded projects such as DISH RI and EURRECA concludethat there continues to be a lack of EU-wide harmonised, sensitive and specific scientific tools to assess determinants of food intake, nutrient intake, nutritional status and health status (Dish RI 2011). Further gaps in knowledge and resources surround high-quality mechanistic research; the surveillance and monitoring of the European food and nutrient intake; the study of intervention efficacy; issues surrounding open access data; enabling technologies for data sharing.

EuroDISH (http://eurodish.eu/) was a three year project that began in September 2012 (supported by the European Commission: Food, agriculture and fisheries, and biotechnology theme of the 7th Framework Programme for Research and Technological Development, no 311788). EuroDISH provided advanced and feasible recommendations on the needs for European food and health research infrastructures to the European Strategy Forum on Research Infrastructures (ESFRI).

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3.2. EuroDISH design/methods

3.2.1. Hard and soft research infrastructure

The ESFRI definition of research infrastructure has been adopted by EuroDISH to represent *hard* infrastructures, such as major buildings, equipment and instruments, knowledge-containing resources such as e-platforms and data banks). EuroDISH has identified an additional classification of *soft* infrastructures, such as unique data management, interpretation and handling capacities, harmonisation of data and procedures, training staff, professional networks and knowledge transfer.

3.2.2. DISH model

The term food and health covers a broad area of research, including biomedical, production, population and policy fields (DISH RI Mapping food and health research programmes in Europe: synthesis of the 32 country reports. Draft report 27 January 2011). EuroDISH built upon previous work (e.g., DISH RI) and ensured a breadth of research areas to maximise the opportunity for linking and developing new research infrastructures. This was achieved by depicting four interrelated DISH research areas which would be the conceptual starting point for the EuroDISH body of work: Determinants of dietary behaviour; Intake of foods and nutrients; Status and functional markers of nutritional health; Health and disease risk of foods and nutrients: the DISH model. This model represents the key causal chain of food & health research. The four pillars, i.e. **D**eterminants, **I**ntake, **S**tatus and **H**ealth will be used for organising the research area.

The DISH model summarises the research area visually using the causal chain as a base. It emphases that there are multiple determinants (i.e. social, psychological and physiological) that influences our dietary behaviour and thereby our intake of foods and nutrients. Our food and nutrient intake effects on the short term our nutritional health status. This is the level of nutrient body stores, functional nutrient parameters like enzymes or other common and innovative biochemical and clinical biomarkers. In the long run our intake will affect our health and the incidence and burden of dietary related chronic diseases. All steps along the chain are affected by societal and biomedical factors, such as lifestyle and disease prevention, or genetic susceptibility and risk factors. In this project the four building blocks and the connecting factors of the model: Determinants – Intake – Status – Health (DISH) were used for organising the research area.

3.3. Work plan overview

EuroDISH consisted of three phases, each of which was accompanied by a stakeholder workshop:
1) Mapping existing RIs in the food and health domain and identifying gaps and needs across DISH research areas.
2) Exploring synthesis of DISH needs and governance aspects accompanying the development, maintenance and sustainability of research infrastructures.
3) Designing a conceptual design and roadmap for necessary food and health research infrastructure.
Two ambitious and innovative case studies were conducted parallel to each phase. These cases represented the RIs identified as relevant for future research programmes and initiatives (JPI, Horizon 2020). The case studies contributed to and tested the feasibility (acceptance, sustainability and implementation) of EuroDISH recommendations and their practicality to relevant stakeholders both inside and outside of Europe. Case study one was a nutritional surveillance research infrastructure that explored the integration of existing food consumption and composition platforms (building upon previous work from EPIC-Soft and EuroFIR Nexus). Case study two was a nutritional phenotype database (DBNP) research infrastructure that explored a research infrastructure proposal to facilitate molecular nutrition research (building upon previous work from NuGo).

3.3.1. Phase 1: Mapping existing RIs in the food and health domain and identifying gaps and needs across DISH research areas.

Research infrastructures were mapped in four areas of food and health, represented by the DISH model: Determinants of dietary behaviour; Intake of foods and nutrients; Status and functional markers of nutritional health; Health and disease risk of foods and nutrients. The study design consisted of desk research, qualitative semi-structured interviews (n=30) and a stakeholder workshop (n=49). A common protocol was followed by each of the four DISH model research areas to a) compile an inventory mapping existing research infrastructures and b) identify research infrastructure gaps and needs. Data were collected via: desk research, qualitative semi-structure interviews and a two day international, interdisciplinary stakeholder workshop. Desk research and interviews were conducted concurrently and iteratively. Mapping provided an overview of existing research infrastructure to indicate gaps and needs. It was not designed to be an exhaustive inventory. The total data collection period ran from December 2012-Jun 2013.

Desk research

Academic and grey literature was sourced using common desk research criteria. Key word term searches and filters were subsequently tailored to each DISH area. Literature was excluded if it did not meet the ESFRI definition of research infrastructure. Further desk research literature was sourced using expertise within the EuroDISH consortium, manual searches of sourced desk research reference lists and iteratively via interview findings.

Interviews

Semi-structured interviews were conducted via telephone or face-to-face. Preparatory information or a questionnaire version of the interview schedule was sent in advance of the interview. A preliminary list of interviewees was developed within the EuroDISH consortium. This list was updated iteratively via desk research and interviews. Interviewees were selected due to their expertise rather than the organisation they represented. Each interviewee was recognised as an expert in at least one DISH relevant area and had an insight into the European context of collaborative projects.

Workshop

A workshop “Food and health research infrastructures – mapping existing infrastructure and identifying gaps and needs”, took place in Brussels, Belgium on the 17-18th June 2013. A total of 49 persons attended the workshop over the two days: 19 external stakeholders, nine EuroDISH consortium members and a workshop organisation team of 21 EuroDISH members (facilitators, chairs, rapporteurs, organisers).

Analysis

Desk research and interviews were analysed using a flexible qualitative content analysis. Identified research infrastructures were extracted into a data recording template. Queries in coding were discussed and resolved within each DISH research team and between DISH teams at monthly meetings.

The data recording template was designed to record a) existing food and health research infrastructures and b) research infrastructure gaps and needs.

Results

A number of food and health research infrastructures were identified. The majority of established research infrastructures were concentrated in the *status and functional markers of nutritional health* and *health and disease of foods and nutrients* research areas. Whereas those in the *intake of foods and nutrients* research area were under further development and *determinants of dietary behaviour* infrastructures were in their infancy. Several research infrastructure gaps and needs were identified. In general, a need for greater accessibility to data, methods and equipment across countries and disciplines was highlighted. In addition, a requirement to create sustainable infrastructures (not only project based) which pool resources and address multiple/broader research questions.

Conclusion

Research infrastructure is not evenly distributed across food and health research areas. There remains enormous potential to create, open, advance and connect infrastructures to stimulate high-quality food and health research.

3.3.2. Phase 2: Exploring synthesis of DISH needs and governance aspects accompanying the development, maintenance and sustainability of research infrastructures.

The objectives of Phase 2 was to provide evidence from current approaches for developing governance for food and health RIs and extrapolate key aspects of the governance of RI for food and health.
The study design included data sources as:

- Desk research and informal interviews to identify best practice food and health RIs (part of mapping exercise)
- Semi-structured interviews with key informants of best practice food and health RIs
- Workshop with European and international stakeholders relevant to best practice

The interviewees selection was based on a) prior mapping exercise to develop an initial long list of infrastructures in food and health and b) sampling the strategy developed based on a set of criteria (specified) and the principal-agent concept of RI infrastructure governance.
The workshop was conducted with 39 stakeholders in Brussels, with the core objective to share, discuss and refine the results of phase 1 & 2 and to outline RIs with stakeholders and the EuroDISH consortium.

Desk research and informal interviews to identify best practice food and health RIs (part of mapping exercise)

The objective of the desk research and the informal interviews was to identify key facilitators and barriers of successful governance of EU-wide research infrastructures (RI) in order to contribute to the design and roadmap of successful EU-wide RIs for the research area “food and health”. The literature review from work package D6.1, is the first EuroDISH step towards understanding governance

mechanisms relevant to food and health RIs. Developing a good governance of research infrastructures ensures efficiency, effectiveness and certainty of interactions, expectations and behaviours; it enables uniformity and equality and ethical and lawful research, and therefore ensures that a research infrastructure achieves its key objectives of quality research and collaboration. The desk research and informal interviews revealed a need for a concept of RI governance that goes beyond a narrow definition of "corporate governance" (procedures and rules of decision making and accountability). Best practise includes considerations of the broader regulatory and societal context in which the governance emerges. This is a world of multiple actors, levels and interests. Such a definition shifts the focus from procedures towards the role of networks in society – and how the structures, processes and relationships involved in exercising authority work in the pursuit of common goals. Whilst it is not the case that all successful international research infrastructures are networks (e.g. some are single-sited), much of the food and health RIs require better links between the multiple data types and data sites. Therefore, the literature review paid particular attention to governance of networks and in particular three models of governance of networks: 1) participant-governed 2) lead organisation governed 3) externally governed (network of administered organisations). The literature search strategy included a range of academic and grey literature cutting across a number of disciplines with a particular focus upon two types of RI: biobanks and e-infrastructure. Grey literature included: literature published by key RI European bodies; RI project reports; literature published about key European RIs (e.g. CERN), documents published by key international think-tanks and scientific advisory bodies (e.g. OECD). Academic literature includes: governance of research infrastructure/collaborative projects governance literature, sociological and socio-legal literature, organisational and individual behavioural literature, with a special focus upon the behaviour of stakeholders (e.g. incentives, ownership, trust) and the behaviour of users. The analytical framework for the analysis of literature included three broad levels of analysis: macro level – social and regulatory context; meso level – organisational context; and micro level –concerned with individual level factors such as trust, skills or attitudes. The research identified facilitators and barriers operating at macro, meso and micro level, using the examples of **biobanks** and **e-infrastructures** for illustrative purpose because the literature addressing governance in these domains is extensive and well-established. The barriers and facilitators are described in detail and classified. These barriers are further discussed in relation to the 3 models of governance. The conclusion is that, whilst these "ideal" models of governance provide a useful starting point for developing the initial governance structure of networked research infrastructures, also the historical, socio-cultural, political and economic context must be included in order to develop proper governance structures and mechanisms. The development of governance will require that not only the objectives and the intended use of RIs are taken into account, but also the broader socio-historical, cultural and economic context.

Semi-structured interviews with key informants of best practice food and health RIs

This part of the study design gives an overview of governance requirements for food and health research infrastructures. This has mainly been based on interviews with executive directors and representatives of members or supporters of eight existing key food and health research infrastructures, namely HBSC (the WHO network Health Behaviour of School-aged Children, and AiMark (The centre for Advance International Marketing Knowledge); both in pillar D, EuroFIR (The European Food Information Resource Network), and WHO NOPA (The WHO European database on nutrition, obesity and physical activity); both in pillar I; ECRIN (The European Clinical Research infrastructures Network); EMIF (The European Medical Information Framework), and BBMRI (The European Biobanking and Biomolecular Resources Research Infrastructure), all three pillar S and WCRF (the global network of the World Cancer

Research Funds), pillar H. The large scale and international examined RIs are likely to be networks. Governance involves the use of institutions and structures of authority and collaboration to allocate resources and to coordinate and control joint action across the network as a whole. The networks can be seen as groups of legally autonomous organizations that work together to achieve not only their own goals but also a collective goal. Three basic models of the governance of networks can be distinguished: participant governance, lead organisation governance, and network administrative organisation. Based on desk research and the interviews, for each of the eight RIs the following issues are described in this report: historical development, kind of governance form, current phase of development of the RI, collective goal of the RI, participants or members of the RI, the organisation of the governing body and what and how it governs. The eight studied RIs have different historical backgrounds and are in different stages of development and have different legal forms or business entities (such as project, association, foundation, consortium, public private cooperation). Furthermore most examined RIs can be considered as networks of organisations governed by a kind of separate entity: an international coordinating centre Health Behaviour of School aged Children (HBSC), an executive management steered by assembly of members (EuroFIR, EMIF, WCRF, ECRIN, BBMRI) or board of the foundation (AiMark). These governing bodies correspond with the model of *lead organisation-governance* and the model of *network administrative organization*. Based on the interviews with representatives of existing research infrastructures a number of relevant governance issues can be identified: privacy, ownership of data, diversity between national regulations, standardization and quality management, trust, centralized versus distributed, participation, data access, role of industry, role of government, role of other stakeholders, and innovation. Some key elements of governance should be considered when designing the EuroDISH roadmap. Firstly protecting the privacy of people. Privacy has everything to do with ownership of data and to ethics. Currently the protection and usage of personal data is regulated by national law. The use of data for a certain purpose and the transfer of data to another (data sharing) should be noticed as very relevant for designing future RIs on food and health. Thereby also taken into account the coming new EU Regulation on Data Protection. Furthermore trust between data owners and data users is crucial for the success of the RI. The governance of the network (the RI) must be consistent with the general level of trust density that occurs across the network as a whole. Another key success factor is when in the network of cooperating researchers one person (or two) are present who are carrying (out) with a lot of energy and enthusiasm the development and further implementation of the concerned RI and so becoming possibly the father (Mr) or mother (Mrs) RI. And one also has to take into account that developing and implementing an eventually well-functioning RI takes many years. Looking at the eight examined existing RIs a time span of around 10 till 15 years is not unusual. During that period the governance structure is not always final but is influenced by and depends on the scale it functions (project, national, international, global) and whether both public and private parties are involved.

Workshop with European and international stakeholders relevant to best practice

Objectives of the workshop on Synthesis and Governance was 1) to share the results of phase 1 & 2 and to outline RIs with stakeholders and the EuroDISH consortium, 2) to discuss and refine a roughly outlined food and health research infrastructures and 3) to provide opportunity to stakeholders to share their expertise to add to the integrated findings.

Key points of conclusion:

- Substantial work has been completed in the area of mapping and governance. The next phase will depend on building and integration systematically all findings on these two strands of EuroDISH work (and the various sources of information linked to them – the mapping process, the workshops, the literature review and interviews).
- The synthesis will require transparent, clearly laid out and justified procedural plan or methodology, which will also help establish the decision-making rules for identifying "needed" RIs. Considerable work has been done already to move towards developing a plan which needs to be formalised into clear protocols for decision-making.
- Next steps: Developing conceptual design and roadmap for new RIs.

3.3.3. Case studies

The case studies were included into the project to optimise and feed Phase 2 and Phase3. The case studies designed pilot RIs and a roadmap for implementation to test the technical feasibility, acceptance, sustainability and embedding by relevant stakeholders and third countries.

Case study one: Nutritional surveillance RI

The first case study related to the "I" pillar of the DISH model, i.e. the assessment of dietary intake. The assessment of nutrient or component intakes requires integration of food consumption and food composition data, procedures and systems. There have been major sustained improvements in the development of standardized dietary methodologies to be used at the EU level (EFSA 2009; Slimani, et al. 2011; Ocke, et al. 2011), in particular for the two well established existing RIs:1) EPIC-Soft Methodology Platform (EMP) including Software for collation of dietary intake data, and the management of collected food consumption data developed by IARC-WHO in scope of several EU projects and, 2) EuroFIR Food Composition Data Interchange Platform, initiated by EUROFIR (FP6). The case study has build on expected outcomes of EuroFIR Nexus (FP7) and evaluate and tested the feasibility of an initial conceptual design of the interface modules and tools linking the two platforms as well as a roadmap for implementation.

The GloboDiet and EuroFIR RIs were the two key elements of the proposed "Interfaced pan-EU food and nutrient intake" RI, with already advanced but still to be completed support RIs. The simplified model of the interfaced Intake RI is composed of three main components: the standardised food consumption data originating from the GloboDiet-RI; harmonised food composition data available through the EuroFIR platform; and an interface module to facilitate the matching of food and nutrient (and other databases) composition. Linking these two infrastructures was enormously challenging, with a considerable number of technical and governance considerations, but it also represented an important step in connecting intake assessment with composition data. The process of matching consumed foods to appropriate composition food codes was time-consuming and largely still undertaken manually by experienced researchers. EuroDISH was exploring the possibility of an algorithm that can match consumption and composition data, which greatly reduce the workload associated with assessing dietary intake, and improve standardization in the process. However, there are complexities in developing something that was applicable to multiple datasets (e.g. incorporating different languages and classification systems), and an automated system does not remove quality considerations, but instead brings different ones to light.

During EuroDISH, the algorithm was developed, tested, and refined accordingly. Stakeholders were invited to provide feedback on the concept of the algorithm and the work conducted in the casestudy, with the results disseminated to the wider research community. The practicalities of linking the two RIs through a mechanism such as the matching algorithm is discussed with the focus on some of the more complicated and contentious aspects, such as finances, ownership and governance. These outcomes were of use in later work in EuroDISH, which aims to develop recommendations for future RIs and collaborations among existing infrastructures.

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Ocke MC, Slimani N, Brants H, Buurma-Rethans E, et al. (2011) Potential and requirements for a standardized pan-European food consumption survey using the EPIC-Soft software. Eur J Clin Nutr Jul;65 Suppl 1:S48-S57.

Case study two. RIs for Nutritional phenotype database (DBNP)

This second case study related to the "S" pillar of the DISH model, i.e. it addressed Research Infrastructures which supported mechanistic research with integrated approaches (human intervention studies, cell and animal models) to tackle the molecular basis of metabolic dysfunctions leading to diet-related diseases. Diet-related diseases are polygenic and a marked effect of individual genotype on disease risk is increasingly recognized. Individual and population disease risk can be modulated through elucidation of the molecular mechanisms underlying such interactions, while taking into account genetic variation. From 2004 onwards, the Nutrigenomics Organisation (NuGO) has worked on the infrastructural basis of modern nutrition and health research and launched two initiatives in this direction: the Nutritional phenotype database (van Ommen, et al. 2010a) and Micronutrient Genomics (van Ommen, et al. 2010b). Taking these initiatives as an example and including all information collected by the mapping and syntheses phase of EuroDISH this case study provided a design and roadmap for implementation for a research infrastructure which advances innovative mechanistic nutrition and health research.

The optimal organisational and governance structure for both the RI for mechanistic nutritional research and the overarching DISH-RIDISH-RIDISH-RI would be that of a virtual Research Infrastructure using the hub-and-spokes model with a central coordinating hub and national nodes. This would also allow smooth streamlining with core projects ELIXIR and ISBE, which both follow the same model. Another important partner for collaboration is NuGO, which represent the nutritional community and can provide much expertise on specifics of the required RIs. Furthermore, direct collaboration with the JPI-HDHL was very important to further specify the RIs needed by a European Nutrition and Food Research Institute and involve all the participating countries. Discussions with these main connecting initiatives should be held by the central hub within the first phase of the setup of the DISH-RI for systems biology.

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van Ommen B, El-Sohemy A, Hesketh J, Kaput J, et al & The Micronutrient Genomics Project Working Group. (2010b) The Micronutrient Genomics Project: a community-driven knowledge base for micronutrient research. *Genes Nutr* 5, 285-296.

3.3.4. Phase 3: Designing a conceptual design and roadmap for necessary food and health research infrastructure

The objective of Phase 3 was to feed the overall conceptual design and roadmap by designing, testing and evaluating Research Infrastructures pilot as well as making a roadmap for implementation including financial and governance issues. Two case studies have been carried out to test the feasibility (acceptance, sustainability and embedding) of the recommendations by relevant stakeholders in Europe and third countries. The case studies focused on Research Infrastructures identified as highly relevant for future research programmes and initiatives and also were scheduled by the Joint Programme Initiative a Healthy Diet for a Healthy Life (JPI HDHL 2010 & 2011) for 2012-2015.
The study design included data sources as:

1) Conceptual design on relevant and urgent RI's – Rationale
2) Conceptual design-Detailed
3) Roadmap, including assessment of feasibility
4) Workshop with European and international stakeholders relevant to best practice

References
Joint Programming Initiative - A healthy diet for a healthy life. (JPI HDHL) (2010). The vision for 2030.
Joint Programming Initiative - A healthy diet for a healthy life. (JPI HDHL) (2011). Strategic research agenda.

Conceptual design on relevant and urgent RI's – Rationale

Referring to the ESFRI definition of Research Infrastructures EuroDISH has developed a conceptual design for the Determinant, Intake, Status and Health (DISH-RI which includes facilities, resources, services, and major equipment. The central concept DISH-RIenabled interdiciplinary research by connecting the DISH-pillars at the level of DATA, TOOLS and SERVICES. To this end, the DISH-RI conceptual design has been equipped with an "ICT-backbone"; a virtual research environment with associated facilities, providing services to enable access and exploitation by scientific, public and private stakeholders using well-described and transparent governance principles. The DISH-RI bridges ecological and psycho-social determinants of food supply and consumption, via nutrient intakes, to molecular, functional and (patho)physiological health effects.
The DISH-RI attracted young researchers and enabled innovative projects, and it also fostered interdisciplinary data integration. It stimulated development and application of new research tools and instruments. It stimulated Food&Health research to generate data, information and knowledge on an innovative level, and advanced the scientific knowledge-base on food and health systems in order to arrive at effective public health nutrition strategies.

Roadmap, including assessment of feasibility

A roadmap is designed to outline the implementation of the conceptual design DISH-RI within the EU research area including implementation of the interaction with basic relevant not- food and nutrition specific RIs, the linkage with third countries and industry where applicable. The roadmap is aligned with on-going activities and strategic research agendas of EU (Horizon2020), JPI HDHL and ETP FFL. A draft of the roadmap is discussed in bilateral meetings with key stakeholders and a final workshop with all relevant stakeholders and updated after the workshop.

Based on the drafted conceptual design and in line with the roadmap the feasibility (costing, acceptance, sustainability, embedding) is assessed on basis of bilateral discussions IT and business specialist as well as workshop discussions with EURO-DISH partners and public and private stakeholders, and a business plan is made. An assessment of costs and investments, for the inclusion of existing and new infrastructures, is contrasted with financing options.

References

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Workshop with European and international stakeholders relevant to best practice and feasibility

The results of the first and second phase of EuroDISH were presented. The objectives of this workshop on Conceptual design and Roadmap was to get reflection and suggestions on the results from a policy, industry and research perspective. At this moment there is no RI that is specific for the Food and Health domain and that overarches the different DISH pillars. Over the DISH pillars such an overarching RI should:

1. Exploit interdisciplinary **data** from food & health / nutrition research,
2. Stimulate and align development and interoperability of innovative **tools**, and
3. Generate interdisciplinary research, system approaches and **services**.

3.3.5. Main results

To assure a balanced attention in the needs and recommendation on Research Infrastructures to all food and health research areas EuroDISH has been organised around the 'DISH' model: 'Determinants, Intake, Status, and Health' to represent four key building blocks research. Further to this, we identified three areas 'behaviour', 'diet' and 'effect on health' as where RI such as 'Public health interventions', 'Monitoring and surveillance' and 'Nutritional epidemiology' could operate in and between. EuroDISH has developed an overall conceptual design and roadmap for the implementation of key hard and soft Research Infrastructures, including options for governance structures, the definition of hubs with existing basic Research Infrastructures, recommendations regarding collaborations with third countries, ways to enhance integration with industry and the assessment of its feasibility.

4. Specific impacts relevant to different end-users and key players

EuroDISH had the aim to design research infrastructures in the food and health domain that will contribute to innovative research and improved knowledge for public health nutrition strategies across Europe and aid in tackling the earlier mentioned societal health challenges of promoting health and reducing the burden of age- and diet-related NCDs by lifestyle, food, and nutrition. It is anticipated that research infrastructures will contribute to more efficient research via collaborative and integrated research-efforts and by better exploitation of available scientific data (e.g., BBMRI). Recognising the short-term difficulties and wide budgetary cut due to the present economic crisis, ESFRI has suggested in its roadmap to make good use of the crisis to spur improvement by e.g. prioritising RIs. At the same time, standardization in measurement enables comparable monitoring, surveillance, registries etc. An example here is the pan-European surveys. Through standardisation and improved efficiency the implementation of current initiatives and emerging RIs will be better used and easier to access by different stakeholders, including NGOs.

4.1 Potential impact

Value creation by DISH-RI

DISH-RI will support the research community by integrating the fragmented data and tools and provide services across the DISH domains:

- Data generation, storage, management, harmonisation, access, analysis and interpretation, e.g., pan-EU food surveillance; pan-EU nutritional health cohorts and interventions; data on food quality, food safety and sustainability.
- Tools: The development, utility, innovation, standardisation and evaluation of innovative technologies for assessment of lifestyle, diet, biomarkers of exposure, functionality and health outcomes.
- Services to the research community and stakeholders relevant to integration of data and knowledge. These services will enable a systems approach for food, nutrition and health; attract young researchers; promote education, capacity building and e-training; provide a platform for industry, research, and policy; widen participation between European countries and global partners.

DISH-RI, the Research Infrastructures that has been designed in this project will:

1. Strengthen research on food, nutrition and health
2. Increase exploitation of the scientific evidence base by the EU food industry.
3. Policy makers to increase the impact of public health nutrition strategies and improve the health of all Europeans.
4. Private partners to be involved as providers of data and as users of the services of the RI, to foster product innovation and strengthen competitiveness.
5. Societal organisations and professionals to build their strategies and advice on solid evidence.

4.2 Capacity building

Capacity building is needed to close bridges in knowledge between EU countries. At three points the European level of RIs has main advantages and capacity building is crucial. First, an EU rather than national level will have a higher potential to improve the efficient use of research funding. Second, multi-centred studies will provide more robust results in the relations between determinants and behaviour due to the variability between countries in consumer behaviour, culture, etc. Third, to link monitoring of food behaviour determinants to public health nutrition policies and the other way around

to test the effectiveness of interventions the inclusion of more countries will provide better results, also due to the variability in policy (interventions) between the different countries.

4.3 Impact on public health research

EuroDISH conceptual design aimed to build RIs that improve standardisation and efficiency. While doing this it was essential to on top of that also build overarching RIs which take the multi-dimensional links between areas of food and health, such as those depicted by the DISH model, as the leading principle that can enhance multidisciplinary collaboration. This will encompass the wide and multidisciplinary area of food and nutrition research, including sociology, psychology, nutrition, biology, (bio) chemistry, epidemiology, medicine, economy and statistics. Integrating knowledge on psycho-social and physiological determinants of food choice at the individual level with that on dietary behaviour and health and disease risks will stimulate innovative research and innovative technologies. Examples of research across the DISH pillars in relation to PAN EU health include: Pan-European nutrition surveillance could identify the need for innovative food products, fortification, alternative or sustainable food production systems, production valorisation and practice, use and exchange of private (industry) data. New laboratory techniques and standardised assessment for early markers (omics), clinical markers of function, as well as cognition and fitness, could lead to operationalizing the concept “healthy life” of the JPI-HDHL and modular inclusion in monitoring of such markers to surveillance could be considered.

4.4 Impact on innovative research

Integration of research over the DISH pillars will stimulate innovative research or methods for assessing dietary exposures, on incorporating relevant determinants of dietary behaviour, or on innovative biomedical mechanistic or functional markers. Examples could be to address the highly diverse food environment in Europe by using Geographical Information Systems and exploit opportunities of “big data” from e.g. GPS to monitor and characterize public health relevant behaviour in youth and elderly. This could enable the development of cohort studies, quasi experimental or cluster-randomized intervention programs that disentangle the role of food-environment and personal characteristics of dietary behaviour. Disease-registries could be aligned and further linked, which might include early and sensitive indicators of nutritional inadequacies and changes in health status, to improve setting priorities in policies and to study the predictive value of markers in the Status domain. Finally, such European level RIs would allow intra- and inter-country comparisons prioritized in the H2020 agenda; moreover, these RIs will enable the research community to extract key-knowledge that is yet hidden in the European diversity of food supply systems, food culture, and national interventions (and people’s behaviour).

Innovative research will be stimulated by identifying needs for research both within disciplinary fields as well as among disciplines and among existing, emerging and future infrastructures; e.g., high-tech MRI-methods and X-omics might be useful for research on dietary behaviour and regulation of food intake and ICT-methodologies and social media could be applied in modern dietary assessment, together with the newest biostatistical models on estimating usual intake of individuals and population groups. At a higher level of RIs, these innovative methodologies can be integrated in new large cohort or intervention studies characterising the nutritional “status” or nutritional phenotype, as related to genetic and acquired determinants and exploiting the European diversity in food and health. Such RIs will boost the research of new biomarkers of the link between nutrition and health. As mentioned, this will contribute to better dietary advice which could be more focused on the needs of particular

consumer groups. To generate and exploit such knowledge, EURO-DISH is built upon the existing ESFRI RI ECRIN and align with on-going ECRIN activities, and the conceptual design and road map will define PAN European hubs to harmonise data collection for clinical phenotyping, sampling of relevant population groups, initiating relevant animal and molecular studies.

4.5. Impact on policy

The EU needs innovative research that supports Public Health Nutrition policy. The new RIs designed in the EuroDISH roadmap should advance on the existing ones to support this type of research. One of five ambitious objectives set by the EU at the Europe 2020 Strategy is innovation, since Europe's future economic growth and jobs will increasingly need to emerge from innovation in products, services and business models. This will enlarge the competiveness of European research and technology in the public and private sector. Additionally there was the earlier mentioned need for effective intervention on the societal challenges to maintain health and prevent disease of its citizens. Food and health research across Europe should therefore provide: First, the availability of comparable EU-wide nutritional data required for policy making, and second, more sound evidence on the causal relationships between determinants of behaviour, food intake, nutrition status, and health (DISH). Insight in associations (e.g. cohorts) and causation (trials) of the different determinants as well as their levels (by monitoring) will strengthen the logic framework for designing public health intervention scenarios, as well as the evaluation of their effectiveness and implementation in public health policy. Harmonised scientific tools for data integration and synthesis relevant to comparing policy options scenario's will provide evidence on the effectiveness of various strategic options to stimulate a healthy diet by EU food, nutrition, and health policy stakeholders (?).

At the same time, joined agenda setting is part of RIs and essential to ensure high quality research and harmonisation. There should be alignment between HORIZON2020 and member state national agendas, which can be realised via JPIs. Also, this should be in line with the progress and realisation of the (future) RIs. Both on the content in the agenda settings and on the structure in ESFRI. The goal of EuroDISH is therefore to inform the ESFRI roadmap and future EU funding programs. EuroDISH will also directly contribute to the future achievement of the HORIZON2020 Societal challenge ´Food Security and the Bio based Economy' and the currently ongoing theme "Food, Agriculture and Fisheries, and Biotechnology" within the FP7 Cooperation Work Programme. Most specifically, the new infrastructure(s) will be able to support the Commission Recommendations on the Joint Programming Initiative addressing 'A healthy diet for a healthy life'. More efficient RIs enable overarching structures that supports sustainable FN policies (sustainable FN policy is a topic in the 2014 H2020 call).

4.6 Impact on stakeholders

In the previous paragraphs we described the implications for researchers and EU policy makers that we envision in EuroDISH. However, to be able to actually build the RIs these have to be mediated by stakeholders in the public and private sector. Stakeholders include industry, national governments, and organisations operation in the field and health area such as NGOs. Working in the same direction will increase the impact in public health. More practically, the availability of comparable EU-wide nutritional data will aid for policy making for the preventive health sector (monitoring and evaluation of food and nutrient intake) as well as for product innovation and reformulation by the food and beverage industry. At the same time, we need alignment within Europe. Earlier, we mentioned the scientific advantages of

multi centre studies in terms of more robust data. An advantage of the multi centre studies and harmonisation across Europe is also that the conclusion on for example the effectiveness of policy interventions are relevant and available not only for a small part of the EU countries. The main reasons of stakeholder connection in future RIs are thus that it is necessary to make it work and the increased power of working together. Other advantages are innovation and valorisation of research. At the same time, experiences with e.g. functional foods, have shown that this is a sensitive area, where interests and independency of public and private parties should be clearly distinguished.

By bringing together different stakeholders to the same discussion tables, innovative ideas and a shared vision and approach will be stimulated. For example, in the private industrial sector, better understanding of consumers' food choice and their determinants will assist the food and beverage industry in (re)designing specialised food products and services for more targeted consumer groups. It will enable food and beverage industry to better monitor special needs given the changes in society and demographic trends. For the public sector and NGOs, the RIs will contribute to a better basis for deciding on the most cost-effective interventions by both public and private initiatives and partnerships.

In the European knowledge economy, the research-policy-practice model is crucial. The valorisation of de research in practice, both public and private will increase exploitation of the scientific evidence base by the EU food industry by the translation of know-how to industry and at the same time provide research and policy makers with insights on the food-environment and product innovations. Specifically, EURO-DISH will design RIs that will have the following impact on the competitiveness of EU food and beverage industry: First, enhance the access to Pan European information on food habits, nutritional needs and health priorities in population segments, relevant to competitive markets; Second, comparable and up-to-date reliable and accessible databases throughout Europe, allowing efficient use of available scientific information and expertise; Third, in-depth knowledge of the nutritional and functional characteristics of foods and diets that will contribute to market advantages for the European food and beverage industry; Fourth, scientifically sound information that can support targeted food-reformulation strategies, informative food labelling to consumers and/or content claims/health claims. Pan-European RIs will provide a portal with open and easy access for the EU food and drink industry, including SME's. Altogether, efficiency and innovation will provide the European food industry with competitive advantage at the global level. EuroDISH fully recognizes the importance of involving industry in the design of RIs. Two network organisations (EUFIC and ILSI) with strong links to food and beverage industries have participated in the EURO-DISH whilst more industrial partners have been active in the Project Advisory Board. During the various stakeholder workshops and Project Advisory Board meetings, contacts with the European Technology Platforms 'Food for Life' and others has been enhanced. Such strengthening of links with industry ensured that the project results are transmitted and absorbed rapidly by the industry.

4.7 Main dissemination activities and exploitation of results

Final Conference

The conference was organised in the pavilion of the European Union at the World Expo Milan 2015 which gave the project additional visibility and exposure. The conference was promoted on the project's website and social media channels, and on those of related projects. The EuroDISH conference brought together 57 stakeholders (including EuroDISH partners), from the scientific research community,

industry and policy. The conference was by invitation only, which was circulated to a list of approximately 770 relevant contacts put together with input from consortium partners.

The results and discussion at the conference were shared with other stakeholders live on Twitter. The presentations at the conference have also been made into a webinar, it has been made freely available to download from the internet to ensure wider outreach

Picture 2-4. Audience of EuroDISH final conference, 15 May, European Union pavilion, World Expo Milan, Italy.

Stakeholder engagement and community building

The EuroDISH platform was established to connect stakeholders, stimulate interaction and to disseminate the results of EuroDISH. The platform contains a website forum and a LinkedIn Group; in addition the platform was used to conduct surveys among its members to gather their views and opinions on specific aspects of the project.

The Linkedin group was initiated. It started with the EuroDISH partners and audience of the website who further invited their relevant contacts to join the EuroDISH Group.

Project Leaflets, Press release, Food Today articles, podcast and webinars

Two leaflets were created (to create awareness of the project; to present final results), two press releases (for project/website launch, final results shared at the final conference), two EUFIC multi-lingual Food Today articles. These materials have been promoted online, and project partners have distributed print materials at conferences and events.

5. Public website and relevant contact details.

Website and contact details

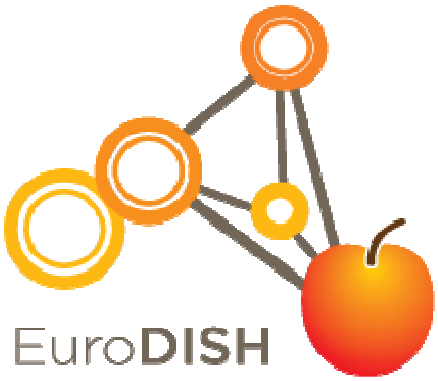
Website: http://www.eurodish.eu
Social Media: LinkedIn group of EuroDISH
Twitter

Coördinator: Dr Krijn Poppe, DLO
E-mail: Krijn.Poppe@wur.nl
Tel: +31 (0)70-33583131

Karin Zimmermann, DLO
E-mail: Karin.Zimmermann@wur.nl
Tel: +31 (0)70-3358185

Scientific coordinator: Prof. Pieter van't Veer
E-mail: pieter.vantveer@wur.nl
Tel:+31 (0)317-485105

Logo



Consortium

List of Beneficiaries					
No	Name	Short name	Country	Project entry month[10]	Project exit month
-11	ISTITUTO NAZIONALE DI RICERCA PER GLI ALIMENTI E LA NUTRIZIONE	INRAN	Italy	1	7
1	STICHTING DIENST LANDBOUWKUNDIG ONDERZOEK	DLO	Netherlands	1	36
2	WAGENINGEN UNIVERSITEIT	WU	Netherlands	1	36
3	UNIVERSITY OF SURREY	SURREY	United Kingdom	1	36
4	EUROPEAN FOOD INFORMATION COUNCIL AISBL	EUFIC	Belgium	1	36
5	DANMARKS TEKNISKE UNIVERSITET	DTU Food	Denmark	1	36
6	INSTITUTE OF FOOD RESEARCH	IFR	United Kingdom	1	36
7	UNIVERSITE LYON 1 CLAUDE BERNARD	UCBL	France	1	36
8	UNIVERSITE PARIS 13	UP13	France	1	36
9	CENTRE INTERNATIONAL DE RECHERCHE SUR LE CANCER	IARC	France	1	36
10	RIJKSINSTITUUT VOOR VOLKSGEZONDHEIDEN MILIEU*NATIONAL INSTITUTEFOR PUBLIC HEALTH AND THE ENVIRONMENTEN	RIVM	Netherlands	1	36
11	CONSIGLIO PER LA RICERCA E LA SPERIMENTAZIONE IN AGRICOLTURA	CRA-NUT	Italy	7	36
12	Vereniging European Nutrigenomics Organisation	NuGO	Netherlands	1	36
13	EUROPEAN FOOD INFORMATION RESSOURCE AISBL	EUROFIR	Belgium	1	36
14	INTERNATIONAL LIFE SCIENCES INSTITUTE EUROPEAN BRANCH AISBL	ILSI	Belgium	1	36
15	LUNDS UNIVERSITET	ULUND	Sweden	1	36

Photographs illustrating and promoting the work of the project

2nd Plenary Project Meeting

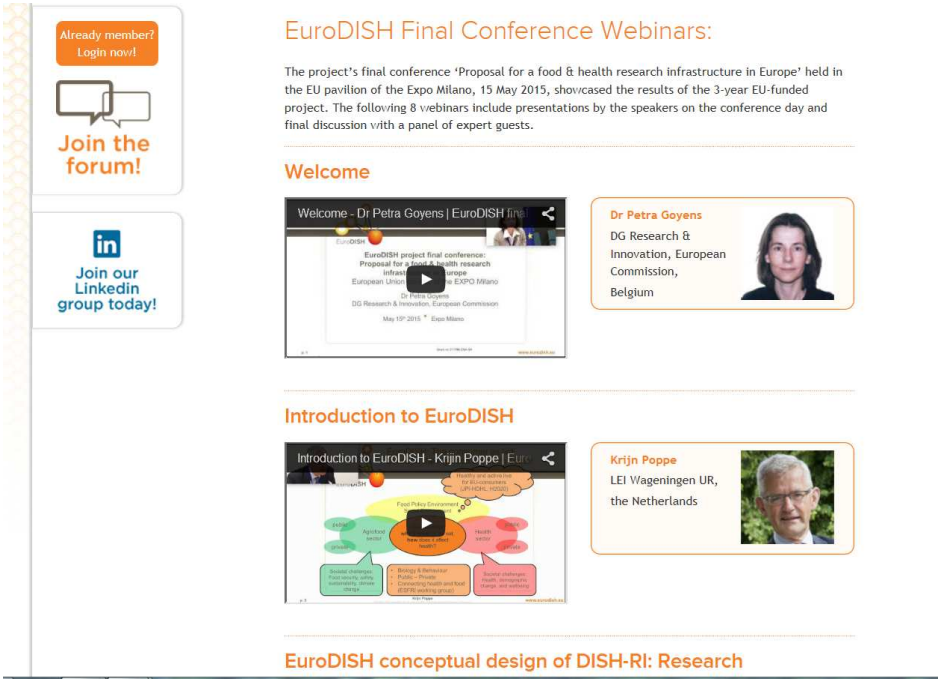
1st EuroDISH workshop

1st EuroDISH workshop

2nd EuroDISH workshop

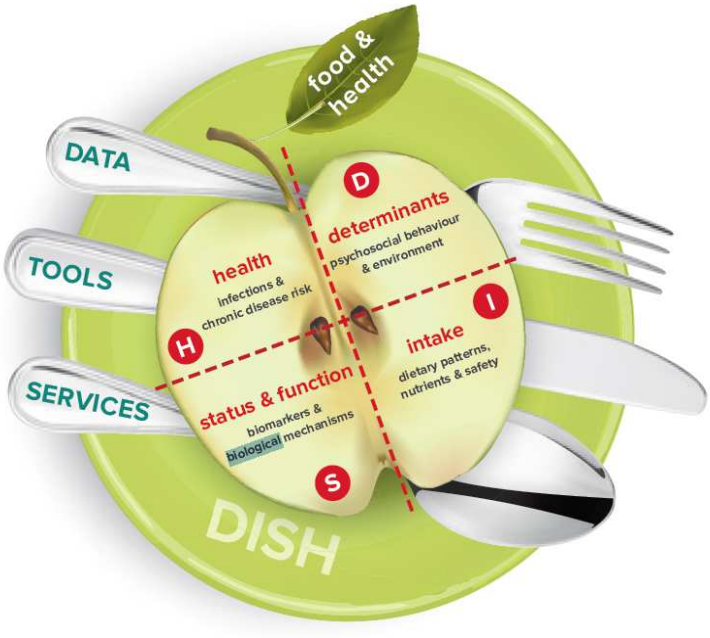
4th Plenary Project Meeting

4th plenary project meeting



EuroDISH Final Conference webinars. http://www.eurodish.eu/webinars

Figures



DISH-RI: Data, tools and services connecting the DISH domains in the food and health area

Organisation and governance

The proposed overarching structure is in line with current European research infrastructure models. It is based upon the hub and spokes model with a central co-ordination hub and connected expertise from different countries. Central elements are:

- **ICT backbone** supporting the interoperability, standardisation and quality management of data and tools.
- **Central entry point** to provide services to researchers, stakeholders, and related RIs.
- **Governance structure** that (a) provides conditions for access such as membership, ownership, privacy, and trust, (b) organises centralised and distributed activities, and (c) enables flexibility regarding innovation within the RI.

Ambitions for the future

The aim for DISH-RI is to reach a fully operational status within a 10-year period. Stakeholder support is required as well as funding at both Member State and EU level to construct the building blocks that shape the RI.

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