

TNO report**TNO 2014 R11360****Speurwerkprogramma 2015-2018****Thema Voeding****P202 Gezonde en veilige voeding****Uitwerking 2015****Healthy Living**

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1 Introduction

This document describes the strategic roadmap for the Food & Nutrition research at TNO in the period 2015-2018. This roadmap is an alignment of the strategic choices of TNO, the internal technological capabilities of TNO and the strategic themes of the Topsector Agri&Food. This results in the development and application of innovative technologies in the following Topsector themes:

- a. **Valorisation** (Topsector Theme 1) of side streams and raw materials – bio-based economy for food solutions, increase of resource efficiency in the food chain.
- b. **Health** (Topsector Theme 6) - cardiovascular health, weight management, oral health, healthy aging, child nutrition, clinical nutrition, food and brain-cognitive performance.
- c. **Products and sustainable processing** (Topsector Theme 7) – taste and texture, behaviour of products in body, protein technology, minimal processing.
- d. **Food Safety** (Topsector Theme 8) – allergy, mild conservation, reduction of antibiotics, risks of chemicals and microorganisms.
- e. **International** – market access, system approaches in developing countries.

The overall goal of this roadmap is to *contribute to lifelong health maintenance by enabling the production and consumption of high quality food products from flexible valorised sources that have been refined and processed to retain their intrinsic value. These products must be safe and help to optimize metabolic and immune health. TNO wants to reach these goals by helping companies innovate through public private partnerships and in business to business partnerships.*

The graphical representation of the roadmap is given as attachment 1. This roadmap will be refined on an annual basis through interaction with the specific Theme Committees of the Topsector. Furthermore, this roadmap will be the basis for overall annual plans to be agreed upon by the Topsector. The annual plans will be the basis to come with the Theme Committees to specific plans for projects and public private partnerships.

2 Inspirational message

The International Food and Nutrition industry faces major challenges. The western as well as the rich part of the developing world, suffer from too much and relatively cheap food and ready to eat meals with a low nutrient density and a high caloric density, mostly from fat and sugars, which contribute to all kinds of different life style related diseases like obesity, diabetes type 2, and cardiovascular diseases. Furthermore, it is evident that mental diseases like Alzheimer, depression and dementia, but also cognitive performance are related to nutrition and lifestyle. An increasing prevalence of food allergy, which is expected to further increase with the introduction of alternative sustainable food protein sources, and an increasing risk posed by microorganisms and antibiotic resistance factors threaten our health maintenance. In the last decade, the significant influence of the microbiota on human health has become much more clear, but efficient microbiota modulation to improve health and techniques to investigate this relationship still need further development. In many lifestyle related conditions, metabolic imbalances and inflammatory processes play a key role. Metabolic health and immune health to an important part depend on an adequate diet for their maintenance. However, for many consumers, choosing a healthy diet is hard. Making healthy nutritional and other lifestyle choices can be assisted by personal dietary advice services and providing products that meet the nutritional requirements of individual consumers, making the healthy choice the easy choice.

The impending rise of the world's population and the increasing demands for affordable, healthy and safe foods by consumers under the stress of environmental change and competing use of limited resources are urgent issues affecting global food production. In order to feed the people of the future with healthy, high quality and safe food under such challenging conditions, current food production chains must rise up to these challenges. They necessitate the development of more robust food production chains through innovations that allow for flexibility in the use of resources and continual sustainability. Food production chains encompass the interrelated operations of raw material processing to obtain functional and healthier ingredients for use in end-product applications. Strengthening the links in the chain requires increased resource efficiency, flexible food ingredients, improved nutritional benefits and safety of end-products and prevention of the risk of new allergenic reactions associated with alternative and/or modified food proteins.

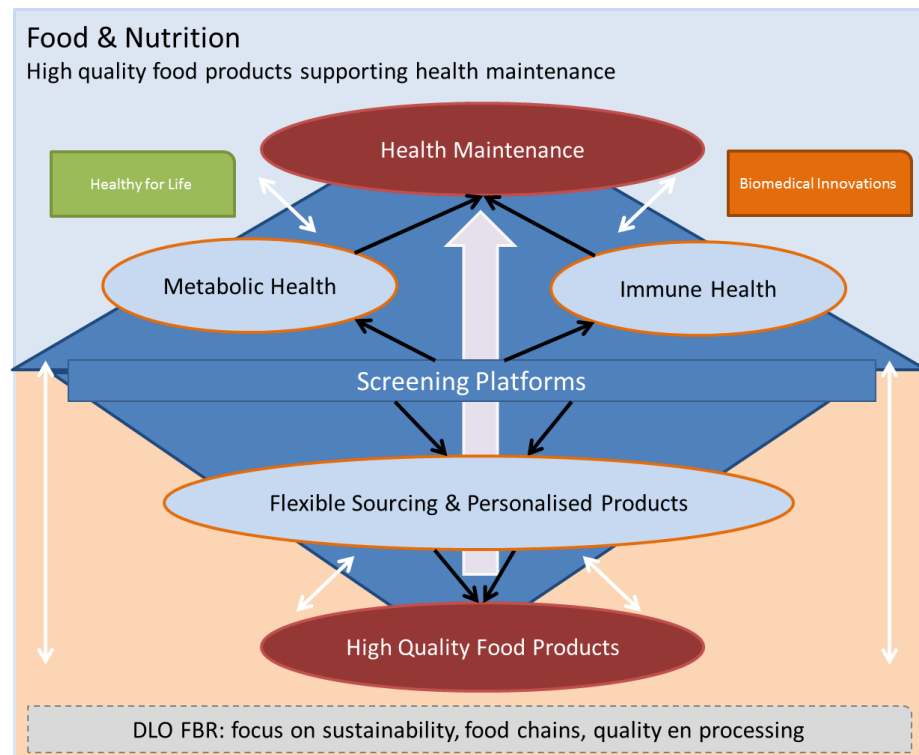
3 Background to the Graphical representation of the Roadmap

3.1 Impact

In attachment 1 the graphical representation of the Roadmap is given. Our goal is to contribute to lifelong health maintenance by enabling the valorised production and consumption of high quality and safe food products from flexible sources that help to optimize health. We aim to do so in the context of the Topsector Agri&Food in public private partnerships, whenever needed in close collaboration with DLO. The ultimate goal will be to build a first in class worldwide leading Food and Nutrition research infrastructure together with knowledge partners, large food companies and SMEs.

Within TNO this roadmap contributes to the overall objectives of the theme “Healthy Living” in the sense that the best way to reduce health care costs is to provide consumers with effective products for health maintenance. Together with the Roadmap “Biomedical Innovations” we contribute to the development of healthy foods by developing personalized diets for target groups like infants and elderly. The latter group is rather vulnerable, and very much suited for a personalized treatment to maintain a healthy body and to improve immune health by food and nutrition. We innovate to enable the development of nutritional solutions, in which drug efficacy can be improved by consuming proper diets. This can be achieved either through preventing negative side effects of drug use or by enhancing the therapeutic effect of the drug. Furthermore, we aim for the development of preventive diets to decrease the amount of days spent in hospital after specific surgeries and to prevent malnutrition.

Our goals can be achieved by integration of new and existing technologies from three different focus areas: High Quality Food Production (Theme 1, 7 and 9), metabolic health (roughly fitting within Theme 6), and Immune Health (mainly fitting within Theme 8, to be extended into Theme 6). In the ideal situation we can offer companies support with the development of healthy products through a large part of the value chain.



Our contributions to the societal and economic challenges and aimed impact for the coming years in the various Topsector Themes are as follows:

Theme 1, 7, 9: High quality food products (sub roadmap attachment 2):

- 1 Enable the food industry to come-up with food products and ingredients which fit in a healthy diet and meet personal dietary needs and food preferences.
- 2 Provide the industry with novel solutions in order to provide the world's increasing population with sustainable, safe and nutritious food with a prolonged shelf-life to reduce undesired waste.
- 3 Develop robust food production chains for flexible sources of carbohydrates, proteins and fats that are resilient against climate change, feedstock availability, market fluctuation and consumer demands while applying biorefinery principles to maximize valorisation of the intrinsic value.

Theme 6 and 10 Metabolic health (sub roadmap attachment 3)

- 1 To assist the food industry with easy to use and reliable methods to quantify the diet-health relationship in terms of phenotypic flexibility, with the aim to claim a specific (metabolic or mental) health effect of a nutritional product, dietary advice, or lifestyle change.
- 2 To develop systems physiology based innovative 'personalised dietary advice services' through determination of diet-health relationship.
- 3 To develop methodologies to study the dietary modulation of microbe-host related (metabolic or mental) health.

Theme 8 Immune health (sub roadmap attachment 4)

- 1 To develop food based strategies to support immune health maintenance.
- 2 To protect food allergic patients from having allergic reactions to food
- 3 To prevent the development of allergies caused by the use of novel or modified proteins.
- 4 To develop food allergy therapeutic and prophylactic approaches (cross-over with Topsector Life Sciences and Health).

3.2 Market

The Agri&Food industry is a highly diverse and complex global market. The global market consists of the food manufacturing industry, the food ingredient industry and the equipment manufacturing industry. These markets are highly diversified in agro bulk products, processing technologies, food applications and personalized food applications. The Agri&Food industry is the largest industry in the Netherlands with a turnover of EUR 51 billion and an added value of EUR 9.4 billion. Sustainability and technological innovations are for the Agri&Food industry 'a must' to cope with food security issues in an healthy environment. Furthermore, the market is suffering from the very strict health claim regulations of the EFSA (regulation on claims for functional products), authenticity (fraud) scandals (melamine, horsemeat) and safety (EHEC, Salmonella) issues; joining forces in the R&D landscape is very much needed.

The Agri&Food industry is working in a competitive environment, but willing to collaborate in the field of non-competitive fundamental research in consortia, and applied research in multi-client public-private-consortia (PPP'en). Above that, the Agri&Food industry is aware of the need to efficiently transfer fundamental knowledge via applied research to the SME industry. TNO has the position to offer the international food industry the organization of non-competitive technology platforms, in which different consortia collaborate on market driven technology development.

TNO's unique selling position is the combination of specific domain knowledge of food ingredients, food processing, food products and their relationships with human health. Our right to play has been obtained during a more than 60 years presence in this field with a very strong Dutch Agri&Food industry. The product portfolio of TNO has been aligned in the last years with WUR-DLO in such a way that the portfolios are mainly complementary rather than competing. TNO focusses with its activities on platforms technologies to obtain higher added value in healthy foods, complex taste and texture attributes, sustainable processing and products, and food safety. Another market opportunity is developing in which consumers are seeking information for an optimal diet. This opens up possibilities in new areas, where TNO's knowledge of the self-quantification of health can be applied in personal dietary advice systems.

This roadmap fully complies with the grand Challenges in the Horizon 2020 context, which therefore constitutes an important public market for competitive funding. TNO currently plays an important role in several large EU projects, and the JPI "Healthy

Diet for Healthy Life". In these consortia we work multidisciplinary, combining various technologies and are often have a leading role.

3.3 Technologies

We aim technologies and concepts that help us reaching our impact goals, which is amongst others serving the needs of companies that develop their products that contribute to these goals. In essence our portfolio consist of three items:

- 1 Application of platform technologies (mono- or multidisciplinary).
- 2 Consulting services in which TNO employees provides experts opinions.
- 3 IP licenses on patented knowledge.

These can be applied in pre-competitive research in public-private partnerships and on competitive research in B2B relationships with private partners.

Our key platform technologies are:

- Microbial Genomics.
- (Stem) cell & Tissue culture.
- Modelling (Machine Learning, PBPK, Statistics, pathway analysis).
- Systems Biology.
- (System) Toxicology.
- Exposure assessment.
- Risk management and assessment.
- Process technology.
- Physics.
- Carbohydrate technology.
- Protein technology.
- 3-D printing.
- Translational animal models for development of metabolic diseases.

The main further technological developments for this roadmap, mapped onto the focus area of the Topsector are:

Metabolic health (Theme 6):

- Preclinical models to elucidate mode of action and find novel biomarkers.
- Methodology to apply (DIY) diagnostics to at-home intervention and self-monitoring.
- Bioinformatics, systems biology network analysis, machine learning.
- Technologies to study food-microbiome-host health (metabolic, mental) interactions. Biomics.
- In silico modelling of human physiology and microbe-host interaction (TIM Satiety, other).

A best in class quantification of the diet-health relationship is one of the main challenges for this roadmap. This quantification depends on in-depth knowledge of the human physiology and of systems biology. The groundwork for this has been laid down in the 2011-2014 strategy period and will be continued, for example in preclinical models and systems biology network analysis. The interaction between diet, microbes and their host has been and will be an important research field for TNO. In the new strategy period, we seek to expand this knowledge in the field of

gut-brain interactions. Also, the enormous challenges to fight obesity and metabolic disorders requires a drastic change in diet and lifestyle, which will be supported by the self-quantification of health. To enable this, new technologies to (self)measure and use biomarkers of metabolic health in personal dietary advice services need to be developed.

Immune health (Theme 8):

- Testing, modelling and prediction of food protein, structure and process -digestion (miniaturization of TIM-1) – Allergenicity relationships.
- Food allergy and food allergen risk assessment and management.
- Testing, modelling and prediction of immune balance changes and microbial flora-health interactions and intervention strategies and risk-benefit analysis.

In comparison to the current situation, more human oriented research will be added to our program, to enable us to bridge our food product-oriented research with the health maintenance goals. This bridge will be built in collaboration with the University Medical Centre Utrecht, one of the leading international Immune & Infection Centers. To do this, a strong immunology-microbiology-gut physiology group within TNO is essential and needs further development and clustering.

High quality food production (Theme 1,7,9) :

In order achieve the goals of flexible sourcing it is required to invest the available resources on the following key technologies:

- Mild separation techniques tailoring complex mixtures from agro-feedstock.
- Sustainable processing techniques improving ingredient functionality and nutritional benefits applying biorefinery principles to maximize valorisation of the intrinsic value.
- Novel food structuring methods creating high quality and healthy foods.
- State-of-the-art food physics analysis assessing product quality.

Via mild separation techniques TNO aims to efficiently separate multiple compounds from complex feedstock matrices while still maintaining their health and technological functions. The main gap that this technology intends to address is the improvement the selectivity and sensitivity of current process technologies.

The sustainable processing techniques will enable TNO to maximize ingredient functionalities and nutritional benefits obtained from various feed stock matrices. A major gap that this technology will address is the introduction of flexibility in the food production chain by identifying alternative ingredients that can replace or increase existing ingredient functionalities and improve nutritional value. Central to the development of this technology will be the characterization of the relationship between processing technologies and the ingredient functionalities that determine taste, shelf life and other quality aspects as well as nutritional benefits.

Additive Manufacturing (AM), popularly known as 3D printing has traditionally been used outside the food sector. Recently we have shown that the layer wise building of complete, 3D, well-structured, multi-material food products has great potential. different printing technologies were tested at TNO for their applicability for the production of food products. Future research will focus on studying ingredient formulations that give the required structures. State-of-the-art food physics analysis is the foundation for all of these technologies and TNO will continue to expand

knowledge and methodologies to determine the relationship between ingredient functionality, microstructure and food texture.

3.4 Organization and Partners

Currently there is a political trend to concentrate the applied research in the food and nutrition field. This has led to the formation of the “grand design” committee. This committee makes a plan how the final situation ideally should be and what steps are required.

In the Netherlands TNO and DLO are applied research organizations that have worked together on project basis. Closer collaboration between TNO and DLO is desired for by these two organizations and the Topsector. The current technology portfolios of TNO and the FBR department of DLO are highly complementary, so this transition should be possible and lead to a world leading center for applied food and nutrition research. In a broader sense stronger alignment of fundamental, applied and corporate research is sought for. Such an ecosystem consisting of academic partners, applies research partners and companies would be able to join various partners in the field and have a substantial size (30-50M euro).

3.4.1 Stakeholders

We want to build relationships with the various stakeholders in the sector under the agenda of the TKI Agri&Food, for different reasons and with different levels of dependency. Stakeholders include:

- 1 Global food and feed ingredients, equipment and food and feed production companies.
- 2 Governmental policy institutes (ministries, local government, EU etc.).
- 3 Over-arching stakeholder organisations such as EFSA, FDA, FSA.
- 4 Private parties such as NIZO and TOP BV and VITO.
- 5 Knowledge organizations, WUR-DLO, RuG, UMCU, UVA, Unimaas, UU, University of Nebraska, Fraunhofer, DIL and VTT.
- 6 Politicians with influence on legislation (public affairs).
- 7 General public, e.g. organized through patient advocacy groups.
- 8 NGO's like ICCO, SNV and their local partners.

3.5 Programmes, Projects and Actions

Public private partnership are the cornerstone of the Topsector policy. Several definitions for PPP's exist. The Topsector AgriFood has defined a few modalities in which public private partnerships can be executed. Furthermore, there are certain conditions which must be fulfilled in order to apply TNO capacity in such partnerships. PPP-s can range from small bilateral collaboration between a company up consortia with multiple knowledge partners and companies. TNO aims for large multi-partner programmes that fit within the different themes of the Topsector and align with the strategic needs of the food industry. This will enable us to profile The Netherlands as the first in class region for food research. This implies that we also want to attract foreign companies within these PPP-s. The definition of PPP-s is currently not uniform. Strategic Innovation Programmes and Shared Research Programs all refer to structures in which public and private

partners collaborate. The details of the different programs lies in the duration (finite vs infinite) and the possibility of partners to enter or exit the partnership.

We strive to build the PPP-s in close collaboration with the Theme committees. In the ideal world the Theme committees determine at the beginning of each year what topics within the context of the Innovation Contract of the Topsector they feel worth pursuing for the following year. Next, these ideas are validated in a conference in which partners that are interested in the Theme can express their opinion and give commitment for the topics they find of interest. Next, TNO and the companies can work on rough proposals that can be submitted at the call for proposals in the second half of the year. Upon ranking by the TKI-office the proposals can be worked out into full proposals for programmes or projects. Upon agreement by the IBC of TNO (check on precompetitive nature of the proposal) and the TKI office, the execution can start in the next fiscal year when new research capacity comes available within TNO. This way we arrive at a rolling planning and act cycle which makes best use of the research capacity of TNO. Research capacity within TNO for which no PPP can be found will be used by TNO in the spirit of the Themes, building further capabilities and technologies from which the Themes can benefit in the next year.

Worth special mentioning are the Strategic Innovation Programs (SIP's) that are meant to facilitate collaboration between TNO and DLO. The government has reserved financial means to facilitate the startup of these SIP's. These SIP's are *Biorefinery for Raw Materials Availability and Flexibility* and *Customized Processed Food Quality and Health*. They form the start for a programmatic collaboration and give the possibility to intensively work together and to jointly approach private partners. The ultimate collaboration between TNO and DLO will then be in 5 program lines:

- 1 Food Product & Process Innovation.
- 2 Biobased.
- 3 Food Chains.
- 4 Food & Health.
- 5 Food Safety.

Besides the PPP-s TNO engages in bilateral business to business relationship with companies worldwide to valorise the knowledge basis of TNO as efficient as possible.

3.6 Intellectual Property

The know-how development within TNO has been enabled by governmental funding. We strive at optimal valorization of this know-how. For non-protectable know-how we strive to make these research projects and knowledge known via presentations, scientific and non-scientific publications, and several other forms of communication. For know-how that can be protected by patents publication of these research projects can be delayed up to 6 months and results will be published in such a way that IPR, trade secrets and crucial background knowledge can be kept. We are able to apply IPR with multiple partners in contract research, as well as background knowledge for PPP-s. This leads to optimal exploitation and benefits for the companies that make use of it. For the coming period we foresee IPR in the

area of food structures with flexible sources in the field of alternative processing, novel functional ingredients in processing and in 3D printing / structuring. Specifically for SME, TNO has a specific program, including valorization instruments, to enable SMEs to obtain access to and be able to make use of know-how. Within the Food and Nutrition we closely together with the TNO SME Market Manager who is responsible for this SME program. For technologies that are mature we have a large track record on the spin out in the last 5 years (Dyadic, Alfa Biogene, Hydrochip, Triskelion).

4 Research Program 2015

4.1 Metabolic Health (closely linked to theme 6, Food and Health)

In this program line the main technological developments for 2015-2018 will be:

- (Preclinical) models to elucidate mode of action and find novel biomarkers.
- Methodology to apply (DIY) diagnostics to at-home intervention and self-monitoring.
- Bioinformatics, systems biology network analysis, machine learning.
- Technologies to study food-microbiome-host health (metabolic, mental) interactions.
- In silico modelling of human physiology and microbe-host interaction.
- Measuring health with self-tracking devices and other techniques.
- Health Space and Marvel tools to determine and visualize personal health status.
- DIY human interventions.

4.1.1 *Important deliverables for 2015*

A best in class quantification of the diet-health relationship is one of the main challenges for this roadmap. This quantification depends on in-depth knowledge of the human physiology and of systems biology. The groundwork for this has been laid down in the 2011-2014 strategy period and will be continued.

- 1 First proof of concept of 'profiling' and stratification of consumers according to health status. Which criteria to use, how to measure and visualize?
- 2 Careful selection and subsequent test run with (a selection of) self-tracking devices and personal feedback on health status. Evaluation of consumer expectations and feedback of used tools.
- 3 First test runs with a nutrition & health database, comprised of available and new knowledge to link a personal profile to a known health outcome for a clear and personalized advice. Consumer evaluations.
- 4 Practical application of measurements of host-microbe interactions in a DIY setting.

4.1.2 *Projects and programmes 2015*

- TO2 Flex project Personalized Food and Health (TNO/DLO cooperation).
- ERP Personalized Food (linked to theme 6).
- ERP Complexity: Use case Personalized Foods.
- SMO/PPP project DIY host microbe interactions research program/DIY health monitoring and simulation.
- SMO project Nutritech Fecal microbiota project (carry over from 2014).
- SMO project First 1000 days of life model development.
- Several applications for EU Horizon 2020 projects.
- PPP Healthy Lifestyle: DIY.
- PPP The quantified chef and consumer.
- PPP ProLiver.
- PPP NutriPhaSE.
- PPP Food4Life Solutions phase 2.
- PPP Phenflex phase 2.
- PPP Streptless phase 2.

4.2 Immune health

In this program line the main technological developments for 2015-2018 will be:

- 1 Quantitative risk assessment and risk management technologies and underlying databases and models for existing allergens.
Goal: to protect food allergic consumers from having allergic reactions to food and reduce industry risks and costs associated with unintended cross contamination and/or other allergen-related issues.
- 2 Hazard and risk assessment technologies and underlying test models for quantitative allergenicity assessment of new or modified food proteins.
Goal: to prevent the development of allergies caused by the use of novel or modified crops or proteins and to support the development of new crops, new protein sources and new or modified protein (containing) products and enable industry to improve the efficiency of product development and reduce costs and failure by early de-selection of potentially high allergic ingredients or source materials.
- 3 Models and markers for immune health effect assessment and for diagnostic, prognostic, safety and monitoring purposes.
Goal: to support the development and safety assessment of food based strategies for immune health maintenance and recovery, the prevention of infectious and inflammatory diseases and the development of food allergy therapeutic and prophylactic approaches (cross-over with Topsector Life Sciences and Health).

4.2.1 Deliverables 2015

The main technological developments and activities for 2015 are in 3 areas that are strongly aligned with a Shared Research Program (SRP) Food Allergy aimed to be started in 2015. Depending on the progress of the SRP set up and the priorities set in consultation with sponsors and partners, activities will take place under the umbrella of the SRP and additional activities will be executed. Irrespective of the (moment of) start of the SRP, the following main activities and results are aimed for in 2015:

4.2.2 Food allergy and food allergen risk assessment and management

Implement steps and activities that promote the global application of quantitative guidance for precautionary labelling by food companies

- Collection of threshold dose information for the TNO-FARRP threshold database (PPS projects TKIAF12078/TKIAF12079), publications with partners and i-depot filing.
- Development of a tiered risk assessment and risk management approach in EU project iFAAM (*integrated Approaches to Food Allergen and Allergy Risk Management*)
- Dissemination and application development in collaboration with stakeholders (ILSI, Cost Actions, Expert groups, patient groups, health professionals, food industry trade associations).

Depending on priorities that will be decided together with sponsors and partners of the Shared Research Program additional activities will be developed in the SRP on:

- Incorporation of appropriate food consumption information to companies by developing easy to use online tools.
- Development of computer models to determine cross-contamination levels in food production lines.

4.2.3 *Allergenicity assessment of (novel) food proteins*

Development of a risk assessment strategy for predicting the relative allergenicity of new protein sources and new or modified protein (containing) products:

- A method to scale the allergenicity of allergenic foods.
- Structured database for collecting predictive data.
- Development of a probabilistic framework based on physico-chemical and biological properties of (allergenic) proteins.
- Develop validated methods and biological test systems (cell/animal models) for the relative allergenicity of protein (sources).
- Set up the EU funded Cost Action ImpARAS to build an interdisciplinary European network of scientists to improve the current allergenicity risk assessment strategy.

Depending on priorities that will be decided together with sponsors and partners of the Shared Research Program additional other activities will be developed in the SRP on

- Investigation of the role of food matrix, food structure, food processing and digestion on the allergenicity of proteins.
- The development of relatively cheap, easy and reliable tools (*in vitro*, *in silico* and *in vivo* models) to predict allergenicity.
- Investigation of the sensitisation route of proteins.

4.2.4 *Immune health effect assessment and markers for diagnostic, prognostic, safety and monitoring purposes*

Development of technologies to reduce the risk of infectious diseases and to support the maintenance and optimization of immune health of the immune diseased individual and the individual at risk for development of immune (atopic) disorders

- Development of (genomics based) microbial risk and risk-benefit modelling.
- Investigate mechanisms and the role of in- and extrinsic (risk) factors in immune health and disease (incl. the role of microbial flora and exposure).
- Identify biomarkers for diagnostic, prognostic, monitoring and safety purposes.
- Develop safety and risk-benefit assessment for modulation of and effects on the (developing) immune system.
- Develop Emerging Risk Identification Support approach for microbiological, allergenic and immunity risks.

Relationship with Topsector AgriFood Theme 8 (Food Safety) priorities

- In 2015, the development of a TTC-based method for the chemical safety assessment of complex food matrices will be accomplished and a program in chemical food safety assessment focussed on the development of safety and risk-benefit assessment for modulation of and effects on the (developing) immune system will be started (see above).
- The development of risk assessment methods for all known priority allergens and for new proteins will be continued (see above).

- The development of molecular tools for microbial risk and risk-benefit modelling will be continued (see above).
- The development of an Emerging Risk Identification Support system (ERIS) for chemical risks will be accomplished in 2015 and modules focussed on microbiological, allergenic and immunity risks will be further developed (see above).

4.2.5 *Projects and programmes 2015*

- EU – iFAAM.
- EU – LIFE.
- EU – CostAction IMPARAS.
- EU – CostAction Infogest.
- NWO – TA-COAST.
- STW – NUTRALL.
- Cofin. – Meelworm.
- Cofin. – Kruiscontaminatie.
- Cofin. – Biodiversity.
- Cofin. – Challengetesten.
- PPS – Walnoot.
- PPS – Threshold datamining.
- SRP/KIP - Food allergy and food allergen risk assessment and management.
- SRP/KIP - Allergenicity assessment of (novel) food proteins.
- SRP/KIP - Immune health effect assessment and markers.
- KIP – Product Safety.
- KIP – ERIS.
- KIP – Microbial Risk Modelling.

4.3 **High quality food production**

In this program line the main technological developments for 2015-2018 will be:

- Mild Separation Technology.
- Ingredient Modification and Functionalization.
- Novel Food Structuring Techniques.
- State of the Art Food Physics.

4.3.1 *Important Deliverables 2015*

- Market introduction of 3D food printing technology developed within EZCo 3D Pasta Printing.
- Market introduction of reformulated products developed within EZCo Clusterproject Herformuleren.
- Market introduction of VALORIE Biorefinery Pilot developed for EZCo GAIA.
- Pilot large scale personalized meal production for dysphagia patients as part of EU KP7 Performance.
- Defining a biorefinery protocol to produce hydrophobic protein fractions from leaves (non-rubisco fraction) as part of STW Eiwit (Bietenblad).
- Many more within individual projects.

4.3.2 *Projects and programmes 2015*

In 2015 this part of the program will continue or renew PPP projects that are key to the roadmap for 2015-2018. The other focus is the definition, formation and execution of new PPP projects. These include SIP projects that will further the collaboration with TNO, PPP projects with national and international industrial partners to execute the relevant part of the roadmap for 2015-2018.

4.3.3 *Committed projects 2015:*

- EU KP7 Performance.
- EU KP 7 Enthalpy.
- TNO-PPP GAIA Algenbioraffinage consortium.
- TNO-PPP Clusterproject Herformuleren.
- TNO-PPP Chocolate Printing.
- TNO-PPP 3D Printing Pasta.
- STW Eiwit (Bietenblad).
- Buza Flying Foods project.
- TA COAST PTR-MS.
- EFRO Go without salt.
- TIFN Food Structure.

4.3.4 *PPP's submitted in TKI call 2014*

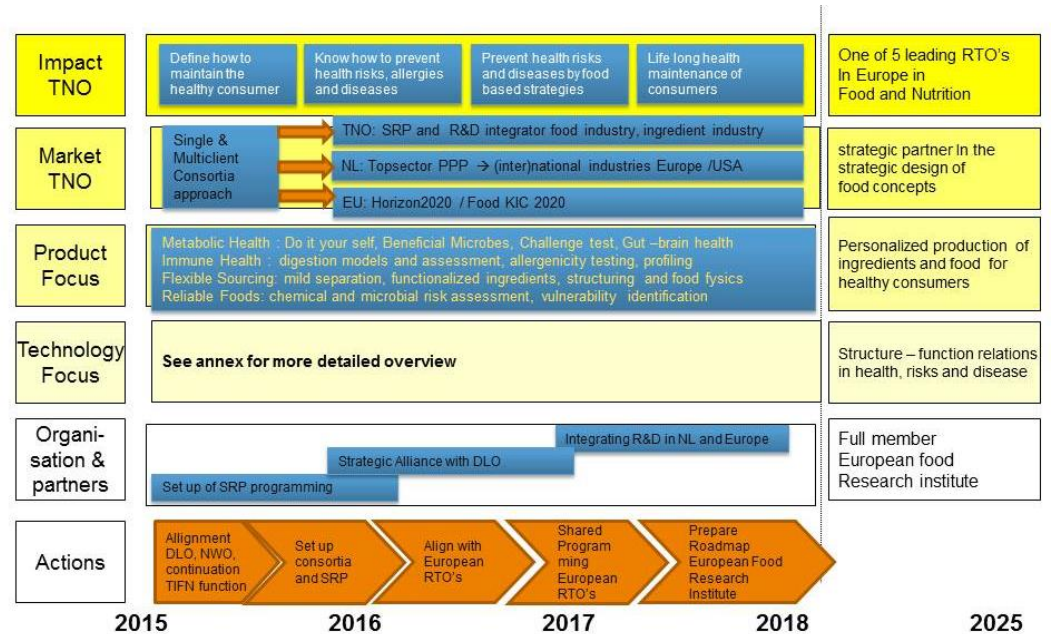
- TKI PPP clean up your label.
- TKI PPP FAT functionality.
- TKI PPP clean batter.
- TKI PPP Novel anti fungal solutions.
- TKI PPP Monodisperse Drying .
- TKI PPP Dysphagia.
- TKI PPP Gebruik je brijn.
- TKI PPP Fat Functionality.
- TKI PPP & TIFN verduurzaming verpakkingen.

4.3.5 *PPP's in preparation*

- TNO PPP Reduction of spores.
- TNO PPP SMO ALIGN 2.0.
- EU Horizon 2020 program initiatives.

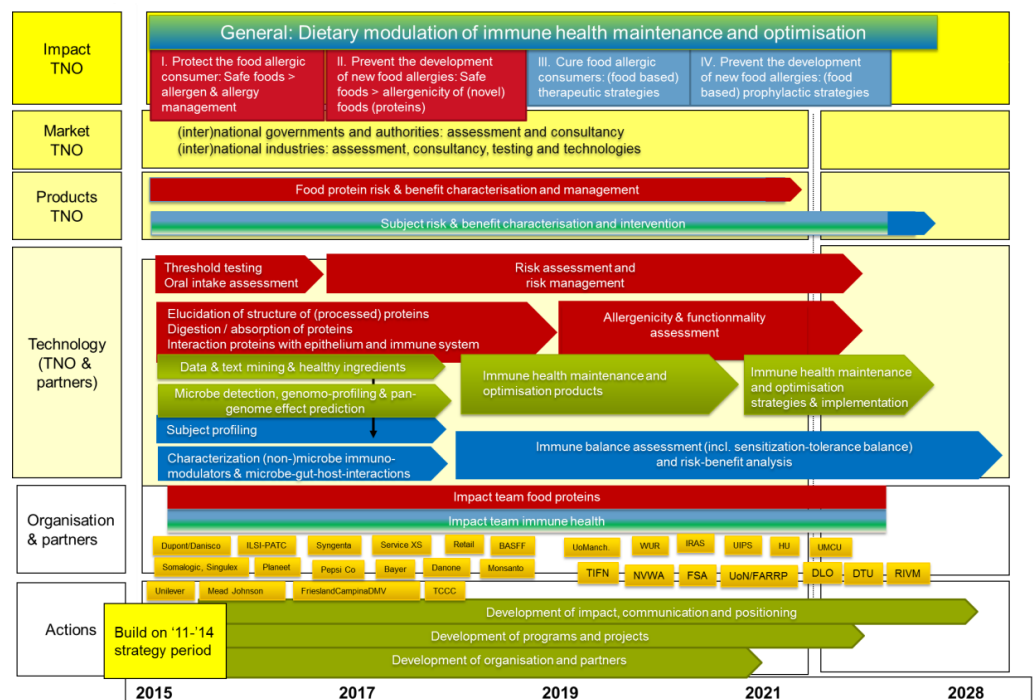
5 Annex sub roadmaps

5.1 Overall Roadmap Food & Nutrition

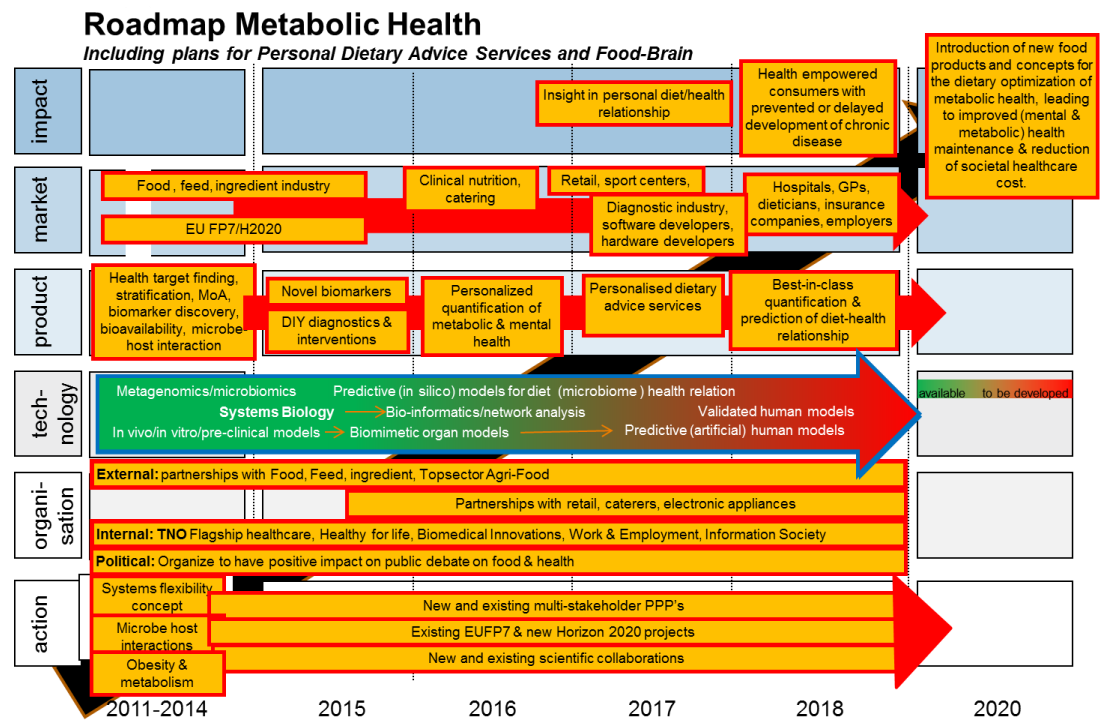


5.2 Roadmap Immune Health & SRP Food Allergy

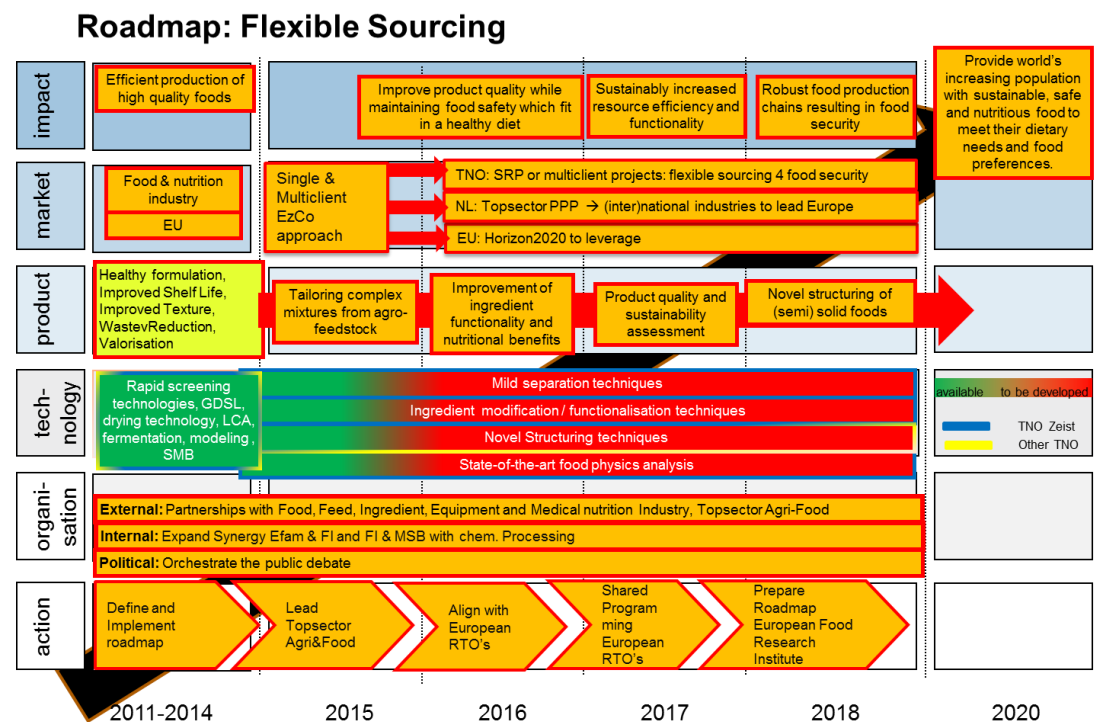
“Towards a Food allergy free world”



5.3 Roadmap Metabolic Health



5.4 Roadmap Flexible Sourcing



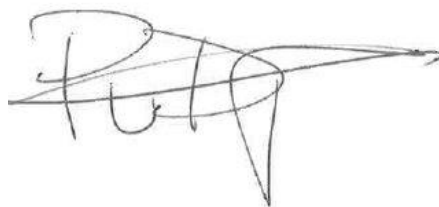
6 Signature

Zeist, 9 October 2014

TNO

A handwritten signature in blue ink, appearing to read 'N. Snoeij', with a large, stylized initial 'N'.

Dr. Niek Snoeij
Theme Director Healthy Living

A handwritten signature in blue ink, appearing to read 'P. van Dijken', with a large, stylized initial 'P'.

Dr. Peter van Dijken
Program Director Food & Nutrition