Food for Life.dk
Food research to combat global challenges

The reinforcement of the Knowledge Triangle (Research, Innovation and Education) in the follow-up of the Lund Declaration announced during the Swedish EU Presidency and the Vision 2020 for the European Research Area (ERA) stated during the French EU Presidency, are the two primary steps towards redefining the future European research and innovation program for the European financial period 2014-2020. Industrial needs for research must have high priority as must the involvement of the end users (consumers and businesses) in order to improve the innovation power in the European food sector and increase growth and competitiveness of the sector at large as well as stimulate job creation.

The Danish National Technology Platform Food for Life.dk wishes to contribute to the discussion on the future of the ERA and set focus on the grand challenges within food science. Many of the thematic areas in FP7 have significant overlaps, with food being an area encompassing a range of key research issues. Future focus should be on the grand challenges therefore, food should become one of the central issues for research with its strong linkage to other key areas such as health, security, sustainability, energy, environment and trade. The challenges provide opportunities for the food sector to develop innovative products, technologies and services to open up new markets and hereby create growth and highly qualified jobs in Europe.

General comments
The Common Strategic Framework should strengthen the competitiveness of Europe through a strong collaboration between research and innovation, and between public and private actors. The organisation of the coming Framework Programme must be thought into new structures and organized in a way to support growth and competitiveness. There is a huge benefit in joining education, research, innovation and market needs within the same picture. Thus a strong connection between these must be created, and incorporate demonstration trials and knowledge transfer to the industry as an important parameter. To do this, it is necessary to improve the synergies with other instruments and programmes - both within EU and in the member states. Also, the Common Strategic Framework needs to increase the involvement of the European food industry in defining the future research and innovation topics. This is a necessary condition to ensure that knowledge generated in research translates into innovation in the food industry and thereby strengthen the competitiveness and exploiting the growth potential of the food industry.

The synergies between Competitiveness and Innovation Framework Programme (CIP), Knowledge and Innovation Communities (KIC) and the future FP8 need to be developed further to support the activities between research, innovation, education and dissemination.

A great challenge ahead is to involvement of enterprises in research and innovation. In relation to this, there are at least two main issues that need to be addressed:

- One is the application process and administrative demands during both the application process and during the project period. Should more enterprises be engaged in future research projects a simplification is necessary.
- In addition there ought to be fewer demands on how projects should be constructed, i.e. counting a certain amount of partners, rigid time-spends and project durations. The motivation for SMEs to
cooperation in research is the projects goals, and this could vary across the time-span of a research project. Hence a more flexible participation structure is recommended.

Some means to support this would be to:

- Support and further develop existing and new ERA-nets and ETPs
- Develop Joint Programming initiatives further – covering more instruments
- Implement and further develop the use of Industry PhDs
- Further develop the Innovation partnerships

The food sector is not only an important pillar of the European economy, the sector is also a substantial sector in Denmark, and plays a vital role in the Danish economy and employment situation. Globally Danish food products are in great demand. The export of food and agricultural products contributes to the Danish trade balance with a total export value of DKK ~100 billion corresponding to 21 % of the total Danish export [10]. Companies such as Danish Crown has made Denmark the world’s largest exporter of pork meat and within the biotechnological field, the companies Novozymes, Danisco and Chr. Hansen are responsible for Denmark being world leading in the production of enzymes, bacterial cultures and natural colorants. At the same time, the sector plays a significant role for the conditions of life in the rural areas and the remote areas e.g. in terms of employment - 15% of the total workforce in Denmark is employed in the food sector. In Denmark, investments in R&D are of great importance, private as well as public. In 2007, 3.65% of the total private research costs were used for the food sector, giving Denmark a third place among OECD countries with regard to total research costs used for food research. However, this percentage has increased continuously, and in 2008, the private agriculture and food research constituted 6% of the total research costs in Denmark [10]. In Denmark the food industry and the public food research and also education are closely connected giving ideal conditions for innovation. The public food research is allocated at five universities (amongst the leading in Europe) all embedded in the Danish Centre for Advanced Food Studies (LMC). In 2008 a panel of 13 international advisors evaluated 31 Danish research groups within the LMC and 10 of these were classified as world leading. Furthermore the food sector in Denmark, with its world class researchers and innovative food community is ready to contribute to the breakthrough which is needed to fulfil the Europe 2020 strategy.

With this paper Food for life.dk would like to stress the paramount importance of the food sector in addressing major issues of our time: Economic recovery that has to evolve into a sustainable growth in order to address the environmental challenges and provide welfare, i.e. food and health, food security, food safety and sustainable production and management for a globalised and ageing society. If Europe wants to live up to its ambitions and tackle today’s major challenges, breakthroughs are needed that only a strong integrated approach comprising research, education and innovation can deliver.

Food and Health

Diet and health are key priorities for many EU Member States in order to cope with the consequences of the steady increase in incidences of obesity and diet-related chronic diseases. Another priority is the ageing populations. Each year more people die from hunger and malnutrition than from AIDS, tuberculosis and malaria together [1]. At the same time it is estimated that globally one billion people are overweight (exactly the same number who is undernourished), 300M of them being obese [2]. Further, increased affluence and urbanisation are linked to lifestyles where daily routines require less physical activity and there is greater access to foods of high energy density. The prevalence of lifestyle-related diseases will have
a negative impact on life expectancy, reduce the quality of life and lead to increased health costs unless approaches to alleviate such consequences are adopted by the EU population.

Improving the quality of our diet in a sustainable way, promoting better nutrition and focus on physical activity will contribute to prevent or reduce the risk of illnesses. *Food for Life.dk* therefore supports the prioritized research areas within the Joint Programming Initiative “A healthy diet for a healthy life”; these are: “Determinants of diet and physical activity”, “Diet and food production” and “Diet-related chronic diseases”.

The European food sector wish to support the agenda by bringing health promoting products and servings to the market and this way make the healthy choice the easy choice for the consumers. The European food sector is convinced that science based innovations lead to increased market shares.

*Potential Danish research topics to be part of a future strategy towards Food and health*

- Monitoring dietary habits, patterns of physical activity and interactions between them
- Nutrigenomics – individualized diets, intestinal health and immune functions
- Elucidation of synergy effects of meal components – from bioactivity in simple ingredients to the nutrigenomic effects of the whole meal in the body and in the way food is consumed
- Probiotics, prebiotics & bioactive components – functional foods, designed functionality, individualized foods, fermentation technology, systems biology, synthetic biology
- Defining biomarkers for health, and based on biomarker information re-focus product development towards sustaining health among the consumers
- Utilisation of beneficial emerging and converging technologies, including nanotechnology for improved nutrition and targeted delivery of precious food components
- Quality and health benefits of raw food material, beneficial natural substances and there bioavailability, and implications of processing/post-harvest changes
- Genomic potential to increase beneficial natural substances of animal and plant foods
- Obesity – behavioural & environmental approaches to modify lifestyle to prevent or treat obesity, including research on specific populations at high risk for obesity
- Paediatric nutrition - Research in development of food, nutrition and health interventions in kindergarten and pre-school
- International nutrition – Food intervention studies to clarify the type of diet/nutrient components for preventing and treating malnutrition
- New integrated approaches to food and nutrition at worksites. Interactions between shift work and food intake, the effect of “distributed work” and the influence of domestication of new worksite operated concepts such as canteen take away on family meal pattern and diet
- Consumer attitudes, choices, and habits – deeper understanding of food habit formation and change, effects of cultural differences and similarities on food-related consumer behaviour
- Communication of food & nutrition messages to consumers. New theoretical based approaches for better communication with consumers from industry and authorities. Special emphasis on communication with children and emerging social media

*Food Security – including new value chains changing from fossils to bio-based society*

Multiple factors cause food security to be one of the most important global issues. For example an increasing part of the population demands a more varied diet and we try to grow more food on less land
with limited access to water, whilst facing increased costs for fertilisers, feeds and fuel for storage and transport.

The food security agenda and the shortage of fossil resources call for innovative and sustainable solutions. Some of the major biotech industries are Europe based which leaves the European industry with huge potential to generate new value chains, utilize the most valuable parts and integrate the by-products in holistic solutions. The European agri-industrial sector has a great potential in meeting the challenges in a sustainable transition from fossil to bio based solutions. Meeting this challenge will create jobs in Europe for handling biomass and for development of technology including an increased export activity.

The challenge is to produce and supply enough safe, affordable and nutritious food in a sustainable way for a growing global population (which is predicted to reach 9Bn by 2050). One of the consequences is an increased demand for food, i.e. the global food demand is expected to increase 40% by 2030 and 70% by 2050 [3]. Already today, the problem is overwhelming. The UN annual report on global food security confirms that more than one billion people – one sixth of the world's population – is undernourished [4] and at that poor people in the developing countries spend from 50-80% of their income on food [5]. If we don’t act promptly, this will intensify over the years to come. Besides increasing the production, new ways of handling food by-products must be considered. Estimates vary, but in the developing world up to 37% of food harvested are lost before it is consumed owing to insufficient processing, storage and transport. A review of food waste in the US calculated that 43Bn kg of food, just over a quarter of the amount available to consume, was lost from retailing onwards [6].

Potential Danish research topics to be part of a future strategy towards global Food security

- Creation of new value chains by utilizing by-products – via e.g. enzymatic treatment, bio-catalysis, new technologies
- Improved utilization of raw materials along the processing line – this includes e.g. intelligent process optimization through multiple sensor technologies/image analyses to monitor quality and attributes, multivariate data analyses, mathematical modelling etc.
- Waste management. New methods for biomass conversion and add value to ‘waste’, introduce energy-saving methods to minimize waste, management systems to utilize ‘waste’ and sensor technologies to monitor in-house logistics in the large scale catering units such as hospitals
- Consumer attitudes towards alternative food products – insects, vegetable “waste to value products”, under-utilized species
- Introduction of new food products with improved functional properties – increased understanding of molecular structures and promotion of health, new compositions, new recipes

Global Food safety

Food safety crises such as BSE or transfer of illicit or toxic production chemicals via the food chain have added to the European worry about the safety and health of food. Consequently, food safety continues to be an important issue to address. The citizens worldwide are becoming increasingly concerned about the health risks posed by microbial pathogens, potentially hazardous chemicals in food, food allergies and new technologies introduced in food manufacturing. The availability of safe food improves the health status of people and is a basic human right. Safe food contributes to health and productivity and provides an effective platform for societal development and poverty alleviation.
Food safety is a matter of global concern as globalization of food production and trade increases the likelihood of international incidents involving contaminated food. Disease-causing organisms and chemicals in food are transmitted far and wide by today’s interconnected global food-chains - escalating how often and where food-borne illnesses occur. Millions of people fall ill every year and many die as a result of eating unsafe food. About 75% of the new infectious diseases affecting humans over the past 10 years were caused by bacteria, viruses and other pathogens having their origin in animals and animal products [7]. Furthermore emerging and converging sciences within nanotechnology, biotechnology, synthetic biology, information technology and cognitive science are new areas of concern which must be addressed in order to supply safe foods.

**Potential Danish research topics to be part of the future strategy of Food safety**

- Minimize health hazards of microbial, chemical or physical origin
- Increased zoonotic understanding – integration of epidemiology, risk assessment and diagnostics, new emerging zoonoses, new diagnostic methods for fast microbe detection and characterization, new non-invasive online detection methods. Improved methods to monitor and control zoonoses, antimicrobial resistance and chemicals, including global monitoring and warning systems
- Influence of climate change and globalization on human exposure to food borne health hazards
- Antibiotic resistance – interventions, alternatives to antibiotics, e.g. virus engineering
- Monitoring methods and improved practices for monitoring
- Microbiological modelling and use of process-analytical techniques to control food safety
- New techniques for fast detection of pathogens and other undesirable organisms in foods
- New methods to secure food safety in low-salt products
- Risk assessment of emerging and converging technologies - emerging risks, complex or multidisciplinary risk issues, interaction of risk factors, synergic and cumulative effects, engineered and adventitious products of new technologies, risk-benefit analysis of food sources
- Determinants of consumer trust and confidence in food
- Consumer acceptance of the new technologies used in food production - globally accepted quality and hygiene criteria
- Integration of innovation and safety policies
- HACCP and HACnCP: Better understanding of the interfaces between food safety and healthy eating in foodservice outlets. Better understanding of how “HACnutritionalCP (HACnCP) can be applied in food service as a tool to promote healthy eating in settings”. Develop the concept of HACnCP as a twin to HACCP to facilitate the planning of healthier meals and eating in food service

**Sustainable production and management**

European food industries needs to increase productivity and competitiveness in general and especially compared to countries with low production costs. The key to that will be smart processing of high quality food. Smart regarding flexibility, sustainability, ICT support, costs and energy reduction i.e. in all aspects of sustainability and total resource utilisation, including optimal use of water resources by better management throughout the production line. The European food sector has the potential to take the lead in the overall development replacing fossil resources with bio based resources in an approach where raw materials are fully utilized and the food value chains become truly sustainable. Today the leading industries are primarily found in the ingredient business where the largest companies are front runners utilizing their
unique opportunities of economies of scale. The challenge is that further improvement concerning sustainability must be applicable to the SME producers at large and also incorporate the entire value chain in order to become truly sustainable and not just offer suboptimal improvements that satisfy local needs.

**Potential Danish research topics to be part of a future strategy towards sustainable food manufacturing**

- Energy efficiency adaptation and application of appropriate measuring and monitoring devices for energy consumption of individual processing steps and machines and procedures for optimisation with particular focus on processes with high energy consumption such as heat treatment, refrigeration, drying etc.
- New cleaning technologies in the food industry with focus on new chemicals and enzymes suitable in future sustainable food production systems and design of hygienic processing systems.
- Holistic approaches to resource efficiency. Optimise material and resource use in food processing and minimise waste production by adaptation and application of appropriate measuring and monitoring devices and procedures, new maintenance strategies.
- Adaptation of cost reduction techniques from the manufacturing sector by considering the large variation of the properties and perishable nature of foods.
- Introduction of new production methods – e.g. in-vitro meat or synthetic biology for the production of enzymes, bioactive components, various additives
- Improved shelf life of food products – new sustainable packaging methods, new processing methods, new rapid methods for predicting quality and identity, predictive food microbial control
- Reduction of environmental impact. Eco-efficient energy management systems for food processing plants, energy efficient production equipment. Lifecycle management recycling and recovery, with main focus on reduction of calculated carbon values in transport and processing.
- Green products manufacturing / developing “greener” products. Developing efficient sensors for recognition, selection and sorting of materials for recovery from waste, application of Lean Manufacturing in the food sector.
- Improved management of water used in production processes. Focus on reuse and recirculation of e.g. condensate and water will reduce both environmental load and energy consumption.
- ICT to support value creation from global networked manufacturing & logistics. Increasing management efficiency in food supply chains, RFID, logistics, SCM software, store management systems. Predictive and remote equipment management systems.
- Exploiting new materials for food manufacturing. Using manufacturing processes to integrate materials of different scale and functionality to provide completely new products with functionalities e.g. smart packaging, antimicrobial surfaces, biosensors.

**Innovation integrated education**

Innovation needs to penetrate the European food sector to a much greater extent. There is evidence that this process needs mediators and moderators who speak the language of the industry. Key players today are technological institutes, industrial advisors and service providers. In future integration of students
activities at European scale can facilitate bridging of the communication barrier between SME’s and universities. There are several Danish initiatives that have proven thus. Furthermore there is a need for European networking of innovation and entrepreneurship education specifically targeting the food sector. Also the applied research in Europe needs to get a funding infusion which may be achieved by relocating 1-2 % of the support for agriculture to research (DG Agri may have some influence on the utilization of funds).

Potential Danish contributions to be part of a future strategy towards increased innovation

- Utilizing students to solve the needs identified by companies or mediators. There are examples proving that the students already from the first year can contribute significantly to the challenges of the industry. Several Danish universities have taken an initiative in the biotech area with the BioBusiness & Innovation Programme\(^1\) utilizes and spark the innovative spirit of young life science engineers. At Aalborg University Problem Based Learning programs are employed to give the students real life challenges. These initiatives assist bridging the dialog between universities and industry. Problem Based Learning could be developed into lifelong problem based learning and and extended backwards into primary schools too.
- The SPIR platform (Strategic Platform for Innovation and Research) recently initiated in Denmark also provides a new and more efficient means of bridging between university research and industrial needs. This initiative integrate industry needs into research priorities at universities and at the same time provides funds to address these issues.
- Experience may also be drawn from the rather extensive network of knowledge centres and technological service institutes that exist in Denmark. These all take active part in the transfer of knowledge from science to industry and play a pivotal role in bringing information on industrial needs back to academia.
- EU programmes may also benefit from implementation of new tools such as industrial PhD’s and innovation consortia involving industry and academia focusing on future technology needed.

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6. Disappearing Food: How big are postharvest losses? (PDF)
7. WHO
8. ETP Food for Life SRA
9. ETP Manufuture Roadmap
10. The Danish Agriculture and Food Council, 2010

\(^1\) The BioBusiness & Innovation Program is the first attempt to bridge the competency gap between business and biotech graduates. It is also the first course cooperation between Copenhagen Business School (CBS), The Technical University of Denmark (DTU) and from the fall semester 2010, The Faculty of Life Science of the Copenhagen University (LIFE).