European Technology Platform
Food for Life

European Technology Platform on Food for Life

Strategic Research Agenda 2007-2020

This document was developed by individual ETP Working Groups following consultations with stakeholders and it was subjected to an extensive national-, regional- and web consultation process.

Acknowledgement

We would like to convey our thanks to the participants of individual ETP Working Groups and all other individual and organisational stakeholders whose inputs, comments and experience have contributed to this document.

European Technology Platform
Food for Life

CIAA
Confédération des industries agro-alimentaires de l'UE
Confederation of the food and drink industries of the EU

For more information on the ETP, visit our website http://etp.ciaa.eu

Foreword

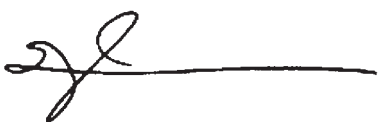
The European Technology Platform (ETP) Food for Life was created under the auspices of the Confederation of the Food and Drink Industries of the EU (CIAA) in 2005 to strengthen the European-wide innovation process, improve knowledge transfer and stimulate European competitiveness across the food chain. The vision of the ETP, published in July 2005, aims at an effective integration of strategically-focussed, trans-national, concerted research in the nutritional-, food- and consumer sciences and food chain management so as to deliver innovative, novel and improved food products for, and to, national, regional and global markets in line with consumer needs and expectations.

These products, together with recommended changes in dietary regimes and lifestyles, will have a positive impact on public health and overall quality of life ('adding life to years'). Targeted activities will support a successful and competitive pan-European agro-food industry having global business leadership securely based on economic growth, technology transfer, sustainable food production and consumer confidence. The ETP unites a wide variety of stakeholders around this common vision including agriculture, food processing, supply and ingredient industry, retail, catering, consumers and academia. The direct connection with consumer needs makes it unusual amongst all other ETPs, and offers a unique opportunity to integrate the natural sciences and humanities.

This document represents the Strategic Research Agenda (SRA) of the ETP Food for Life for the coming fifteen years. The SRA has been developed by six different Working Groups focussing on the scientific and technological requirements in Food and Health, Food Quality and Manufacturing, Food and Consumer, Food Safety, Sustainable Food Production and Food Chain Management. A further Working Group has developed an outline for needs in Communication, Training and Technology Transfer, whilst the Horizontal Activities Working Group has focussed on optimising internal and external contacts and co-operations amongst other responsibilities. The outputs from these Working Groups have been combined to focus on key challenges that will need to be addressed if the agro-food industry is to be in a better position to respond to consumer's likely demands and concerns, now and in the future. A Board consisting of high-level representatives from the stakeholders has overseen this work. The Board, like the ETP itself, is industry-led but has a composition reflecting the diversity of food chain stakeholders.

The SRA has been subjected to national, regional and web consultations to set priorities and align these with national activities. The SRA will form the basis for the development of an Implementation Plan. In the course of developing this SRA, good links have been established with other ETPs, especially those addressing agriculture and biotechnology. These links will ensure that the knowledge-based bio-economies of the EU Framework Programme 7 can combine to address effectively the serious challenge of global competition that Europe currently faces.

We are convinced that this SRA represents a unique opportunity for the stakeholders in the European food chain to increase their competitive strength and ensure the continuing well-being and welfare of consumers across Europe. Success will, however, require the long-standing commitment of all these stakeholders.



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Executive summary

The European Technology Platform Food for Life has developed a Strategic Research Agenda (SRA) following an extensive programme of national, regional and web consultations with its principal stakeholders (consumers and society, industry, academia and the research community). This SRA represents the priorities for research, communication, training and knowledge transfer in the food sector for the coming years as a basis for improving the competitiveness of the largest manufacturing and distributing industry in Europe, as well as ensuring that European citizens are supplied with a healthy, safe, varied, affordable, ethically-produced and environmentally-sensitive food supply.

Knowledge generation and knowledge exploitation are essential in driving an effective innovation agenda. This SRA addresses both of these elements in order that the ETP Vision can be fully realised. Research priorities have been identified that cover all scientific and technological areas that are relevant to the production, manufacture and distribution of food with specific attention being paid to identifying the social (consumer) science studies that are necessary if the consumer's desires and trust in the food supply are to be met. The document describes the benefits of this research to stakeholder communities.

The research challenges in six key areas are defined. These are:

1. Ensuring that the healthy choice is the easy choice for consumers,
2. Delivering a healthier diet,
3. Developing quality food products,
4. Assuring safe foods that consumers can trust,
5. Achieving sustainable food production, and
6. Managing the food chain.

However, successful implementation of the ETP's programme will require further prioritisation according to:

- the importance of the societal challenge,
- the economic impact, and
- the need for a major, long-term investment in multi-disciplinary, multi-national knowledge generation and dissemination.

When these criteria are applied, three key thrusts emerge; these involve research that will lead to improved competitiveness of the agro-food industry by developing new processes, products and tools that:

A. Improve health, well-being and longevity,

B. Build consumer trust in the food chain, and

C. Derive from sustainable and ethical production.

Focus on these thrusts, which will lead to a quantum leap in new innovation opportunities, must be encompassed through a European food research strategy. They must be implemented effectively, and with sufficient resources made available to deliver outputs over the next decade and beyond. These thrusts will be addressed in detail in a subsequent ETP Food for Life Implementation Plan but it is already evident that, if it is to have maximal impact, the research effort must be innovation-driven rather than simply research-led.

Given that the overwhelming majority (>95%) of European food producers are SMEs, who are usually unaware of the benefits of engaging and fully participating in R&D activities, there will need to be an improvement in existing structures, and/or new initiatives undertaken, to engage the interest and involvement of the SME sector in public and private sector research activities. The ETP has established an SME Task Force to address this important issue. The challenge of how best to involve the SME sector in research activities is being actively considered.

ETP Food for Life has given particular attention to the changes that are necessary throughout Europe to enhance awareness of the impact that research could make on business efficiency, costs of production and more robust markets. Particular stress has been placed on identifying new, effective measures in communication, training and knowledge transfer activities, both as a means of ensuring increased consumer trust and understanding of food science and technology, and in engaging the industry.

To achieve the goals of the ETP Food for Life it will be necessary to encourage change throughout the food research community of Europe and the national organisations that support the public sector food research base, to ensure it becomes more innovation-driven. Greater flexibility in responding to change is required within these institutions. The resources necessary to meet the research, social and economic objectives identified by the ETP must be effectively utilised and duplication of investment by national and European administrations should be prevented. In its turn, research communities need to become more aware of their need to engage industry and the consumer.

Part I. Introduction

ETP Food for Life: history

The European Technology Platform (ETP) on Food for Life Vision Document was published in July 2005 (see etp.ciaa.eu). By that time the draft Vision had been extensively discussed with stakeholders, had been subjected to a web consultation and was revised according to suggestions made by stakeholders. Following the launch of the ETP, Working Groups were formed for each of the themes identified in the Vision Document and a Board and Operational Committee were installed (see Annex 1). The Working Groups formulated a Stakeholders Strategic Research Agenda (SSRA). This SSRA was discussed in February 2006 during workshops in which a large number of stakeholders participated. Following this meeting, again a web consultation was opened and several national and regional meetings were organised to discuss the SSRA. In 2007 the Working Groups met again to revise the SSRA and this final Strategic Research Agenda (SRA) was written.

Although the SRA describes a research agenda on food until 2020, it will regularly be evaluated and, when appropriate or new insights occur, updated or adapted. Following the finalisation of the SRA, the Working Groups will work on an Implementation Plan (IP). The final IP will indicate the way to put the research challenges identified into action and the deliverables that will contribute to realising the ETP's vision.

Vision of the ETP on Food for Life

The European Technology Platform on Food for Life seeks to deliver innovative, novel and improved food products for, and to, national, regional and global markets in line with consumer needs and expectations through an effective integration of strategically-focussed, trans-national, concerted research in the nutritional-, food- and consumer sciences and food chain management. These products, together with recommended changes in dietary regimes and lifestyles, will have a positive impact on public health and overall quality of life ('adding life to years'). Such targeted activities will support a successful and competitive pan-European agro-food industry having global business leadership securely based on economic growth, technology transfer, sustainable food production and consumer confidence.

The Vision Document set out some of the issues that are considered necessary to sharpen the innovation edge of the agro-food industry in Europe. It also highlighted the threat the industry is facing if effective and timely measures are not taken to improve its innovative power in order to ensure that there is no adverse impact on the European economy. This is a significant challenge given the key importance of this industry across the European Union.

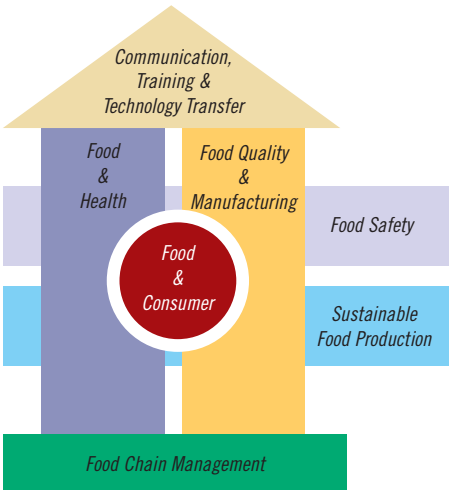


Figure 1. Schematic presentation of the research areas required to reach the vision of the ETP Food for Life.

Within the ETP Food for Life Vision Document a coherent strategy for the future of the food chain was developed based upon the shared vision of its diverse stakeholders. Key elements of this flexible strategy are initiatives in food and health, food quality and manufacturing, food and consumer, food safety, sustainable food production and food chain management. These elements need support from an effective input from communication, training and technology transfer (Figure 1). This SRA has developed the Vision Document into a coherent series of key research challenges to ensure that the research is conceived with perspective of the consumer as the major driver ('fork-to-farm').

The concerns and opportunities of all stakeholders have been the engine that has powered development of the ETP Food for Life. In the process of consultation, three principal stakeholder sectors have been identified. These are:

- the consumers, society and public policies,
- the agro-food industry (which are overwhelmingly SMEs), and
- the research community.

This Strategic Research Agenda takes particular account of the comments and opinions of each of these stakeholder sectors, with special attention being given to consumers and society. This is because of the familiarity of every consumer with 'food and drink', the increasing demand of society for foods and diets that optimise health and well-being and the recognition that, once consumers' responses and society's objectives are understood, scientists and industry will be better able to address their needs. The effectiveness of this interaction will ultimately determine the impact of new product development and realise the potential for innovation.

Whilst the drivers for market change are understood, what is not yet clear is exactly how this can be achieved. Science and technology provide the basis for innovation through knowledge generation and transfer. In the recent past this has assured consumers of a constant and varied food supply, at prices that they can afford, and of a quality in terms of variety, consistency and safety that were unknown in previous generations. Even so market developments have not always been embraced by consumers, with the result that many new products, with high associated costs of development and marketing, are launched each year but fail to make any impact on the market or engage the consumer's trust. This can be a particular problem with products that embrace new technologies. Innovation will be more successful if the market knows what consumers want, what they are willing to accept, and what information consumers need in order to make better informed decisions.

This ETP has responded to this situation and consequently has developed, and will drive forward, a consumer-friendly research agenda.

The consumer, society and public policies

Many consumers feel passionately about their food, its method of production, its quality (or lack of it), its price and its effect on their health. In no other industrial sector are there so many factors contributing to a direct consumer involvement in the products delivered. This provides both an enormous challenge and a huge responsibility.

Whilst some consumers long for the bucolic days of old and would prefer to see the clock turned back on the industrialisation of food production, others accept and welcome the variety of choice, the ready availability of products that, until quite recently, were seasonal, and the convenience that many products offer.

In the past two decades or so Europe has seen a dramatic rise in concerns amongst its citizens over the quality, safety and long-term health effects of their food. A number of safety issues that arose in relation to the food supply chain provided a legitimate background for consumer groups to demand political actions. As a direct result, food and dietary issues are one of the most important topics of debate throughout the European Union. Despite the security of supply, diversity and increasing affordability of food products, many consumers remain suspicious about the effect that the industrialisation of food production has on their health and that of their families, and about the role of the scientist in the process. These concerns are difficult to dispel as attitudes are formed through complex influences.

The goal of any response to innovation must be to ensure consumer's attitudes are not based on irrational concerns or misinformation since this will have an adverse impact on innovation. In this regard scientists themselves have an important responsibility since statements have been made in the past that have been alarmist and which were not accepted by majority expert opinion. Thus the application of new technologies and novel products must go hand in hand with ensuring that they have the consumer's acceptance and trust. An increased engagement with consumers will be necessary to address these issues.

Together with the heightened interest of consumers in the safety of their food, evidence that diet is one of the most important environmental influences on healthy development, well-being, health and longevity, is another dynamic for change in the market.

Consumers are not just concerned with issues that directly affect their health and well-being. They increasingly demand that food producers assure them that their ethical and environmental concerns are reflected in the products made available to them. But whilst all of the above factors play a part in putting pressures on the market for change, consumers remain very price-sensitive and seek solutions that are affordable. The need to embrace these diverse consumer concerns, yet provide foods that are affordable, places challenging constraints on the market and on the potential for innovation.

How will consumers and citizens benefit?

Implementation of the SRA will ensure:

- a validation and development that will provide consumers with a greater choice of healthy options that are appealing and will encourage the promotion of healthy ageing.
- safer and more effective consumer products that will meet people's needs and improve their quality of life, by lowering risks, providing for health benefits and optimising health and well-being.
- tailor-made, personal nutrition (nutraceuticals, functional foods, food ingredients and supplements) that will provide better, healthier foods that will form part of a diet with improved health attributes.
- foods designed for special consumer groups, e.g. the elderly, and to promote health and prevent diseases.
- consumer expectations for a more efficient use of the world's resources, environmental protection and animal welfare will be met through a more sustainable approach to food production.

Opportunities to enhance public health

The relationship between diet, health and lifestyle is now a key priority for most EU governments as they seek to deal with the major increase in obesity and the rise of diet-related chronic diseases among their ageing populations. Good health is an integral part of successful modern societies and is closely intertwined with economic growth and sustainable development. Achieving good health means preventing disease as well as curing disease. Since food is the fuel for all life it is hardly surprising that it is the most important non-genetic contributor to age- and lifestyle-related diseases. The rising imbalance between energy intake and energy expenditure is causing an increase in obesity of epidemic proportions with all of its adverse consequences on health. In the UK alone the incidence of obesity has risen amongst children from 9.6% in 1995 to 13.7% in 2003. Once obesity is established in the young there is good evidence that it continues into adult life with all its associated health-related problems. These lifestyle-related diseases, including type 2 diabetes, cardiovascular diseases, hypertension, and a range of cancer types, are becoming increasingly significant causes of disability and premature death and will increase to unacceptable levels, leading to spiralling medical and other costs unless appropriate measures are taken now. The increasing economic burden that such diseases place upon national governments is one that cannot be sustained indefinitely.

The food industry has a clear impact on the health of consumers through the quality, cost and availability of its products. Advances in science are rapidly producing new, in-depth insights into the relationship between nutrition and health, which are given wide publicity in the media; this in turn creates a common interest among many stakeholders. At present, the opportunities and benefits offered by good food and healthy diets are only just being realised and will be severely constrained within Europe unless there is a major and sustained investment in research to better understand the relationship between diet, health and energy control. Prevention of disease is becoming increasingly important to society, and represents one of the major targets for the agro-food industry. Particular emphasis should be placed on preventing life-style related diseases by delaying their initiation; that is, reducing the risk rather than nuturing it (Figure 2). Other health effects of better diets that are important for preventing morbidity (and high costs to health services) in large target groups include improved infant nutrition (higher nutritional value leading to improved development of bone and cognitive function and avoidance of disease risks in later life); avoidance of cramps and allergies; avoidance of general, ubiquitous intestinal health problems; avoidance of dental erosion; sustained mobility for the elderly; enhanced sleeping patterns; and less bone fractures.

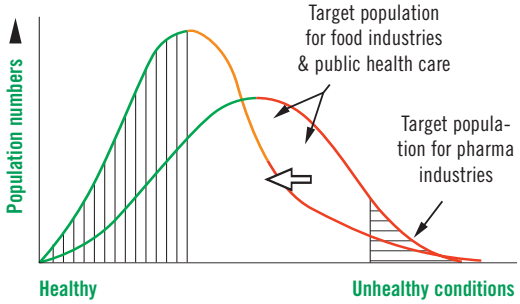


Figure 2. A schematic presentation of improving population health: target areas of the food and pharma industries in public health (Green MR and van der Ouderaa F, Nature Pharmacogenomics, 2003).

Personalised health and nutrition

Nutritional goals have been set traditionally at the population level but genomic technologies are revealing that the balance between risk and benefit will vary according to genotype/phenotype, and that there will be differing requirements for different sectors of the population, including ethnic and immigrant groups. Much more knowledge is required to understand these requirements but when available it will be possible to offer dietary advice, which is more focussed on the needs of groups of consumers. One consequence would be the increasing development of specialised food products, including functional foods, in addition to those currently classified as 'foods for specific nutritional purposes'.

Even when the public is made more aware of how one can eat 'more healthily', patterns of food purchase and food consumption change very little. It will be a challenge for the food industry to find new ways to introduce foods that are tasty and enjoyable as well as contributing to a healthy lifestyle. Importantly, this situation offers opportunities to work with social scientists to identify the key barriers to, and key drivers for, change and to develop, validate and disseminate such information to all sections of society. Such an integrated approach involving scientists and technologists is a key aim of the European Research Area and the food sector is one of the few where the true impact of such trans-disciplinary activity can be realised.

Innovation in the European food sector will lead to a market with targeted novel and more personalised foods on one side and improved conventional, biological and traditional food on the other, offering scientific support for a healthy choice. For a consumer to make a well-informed and healthy choice, education, information and communication are required. Consumer science must deliver the answers to question such as:

- Why does a consumer make certain choices?
- What does the consumer understand about food?
- What information does the consumer seek?
- How can this information be best provided?

There is no doubt that inputs from the consumer sciences and humanities is crucial if individual consumers, society and industry are all to gain benefits.

What are the benefits for society and policymakers?

The agenda described here will ensure:

- improvements in the health status of European society and thus on the quality of life of Europeans.
- targets for improving healthy ageing can be set knowing that the industry will be able to offer foods that can contribute to policies to limit the exponential growth in health and social care costs.
- better integration of research investments on improving competitiveness and wealth creation.
- innovation and effective technology transfer will stimulate economic growth.
- increased sustainability of the European agro-food sector leading to a conservation of resources for future generations.
- industrial competitiveness is increased in a vital manufacturing sector that will protect European jobs and promote social and economic cohesion.
- careers in science and industrial research will be stimulated in areas that are of direct benefit to the economy and society.
- society will better understand, and engage with, science and technology that provides clear and unambiguous health and environmental benefits.
- development of a dynamic high quality research infrastructure, which will attract international food companies to invest in research in Europe.
- a scientific basis for the development of regulations and standards will be improved helping to reduce non-tariff barriers to trade.

The agro-food industry

The European agro-food industry is the largest manufacturing sector in Europe. The food and drink industry itself had a turnover of 836 billion euros in 2005, transforming over 70% of the EU's agricultural raw materials and employing 3.8 million people, the majority (61%) within the SME sector. The nature of this industry sector is unique and creates particular challenges for communication, training, and knowledge transfer. The European agro-food industry is a leading global exporter (€ 48 billion in 2005) and affords significant value addition. It also offers scope for economic growth within new EU Member States, Candidate Countries and European Neighbourhood Countries, development of regional economies and exploitation of Europe's rich cultural diversity and traditions. The agro-food industry is thus central to the wider, economic development of Europe as it develops over the next decades.

The food sector is unique

The food sector differs from other manufacturing industries in a number of important ways, as follows:

- The sector is overwhelmingly populated by SMEs (99% of companies). Food companies in Europe are mostly micro (78.9%) and small (16.6%); medium size companies account for 3.6% with only 0.9% being multinational;
- Products are highly diverse and often production methods are based upon craft rather than technology;
- SMEs often lack the resources, qualified personnel and time for research and innovation. Medium-sized enterprises, in comparison, are more innovative, adopt new technologies faster and have some in-house R&D activity;
- In general, the timescale by which innovation must produce a return on investment is short and it is difficult to patent food products;
- Profit margins in the highly-competitive food markets are low;
- The food sector has a responsibility for producing safe foods and preferably also healthy foods;
- In many Member States the market is increasingly dominated by a few large retailers. The support and involvement of these companies in this ETP will be vital if the objective of a more sustainable food supply is to be fully realised.

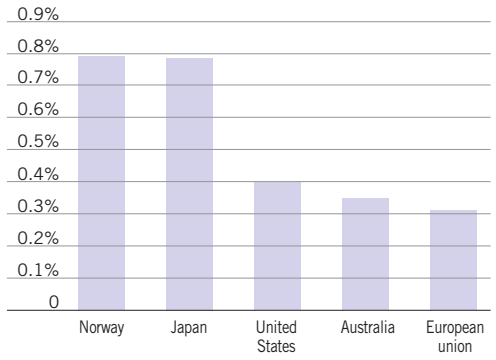
The food sector is under pressure

The European food and drink industry's competitiveness is at risk. New emerging economies, for example China, India and Brazil, are seeing export growth of value-added products. Over the last decade, Europe's share of the global food and drink market has declined from 24% to 20%. Since Europe is increasingly unable to compete on cost alone, effective and rapid innovation will be needed to reverse this decline.

The extent of the challenge facing the European food and drink sector may be seen from data recently published by CIAA (Benchmarking Report on food and drink industry competitiveness, 2006). Investment in European R&D in the food sector was only 0.32% in 2003, lagging behind Norway, Japan, US and Australia (Figures 3 and 4). In addition, most innovation indicators show the food and drink sector to be below the European manufacturing industry's average. In summary, CIAA identified:

- slow growth in total production value - European growth over the last ten years was similar to that of USA but lower than many of its competitors, especially Brazil (Figure 5),
- constant growth in value addition - Europe performs slightly better than USA but worse than Australia, Canada and Brazil,
- slower growth of labour productivity - since 2002 European productivity has slowed and the gap with USA has widened; between 2000 and 2004, European productivity increased by 16% compared with 27% in Brazil,
- a decline of the global export of food and drink products over the last ten years much to the benefit of exporters such as Brazil.

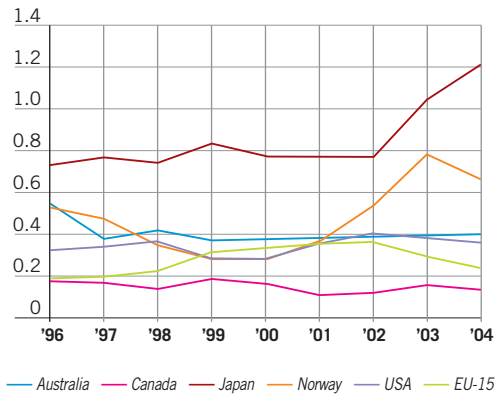
Business expenditure on R&D as a percentage of output (various f&d ind. - 2003)



Source: OECD, Research and Development Expenditure in Industry, 2003. European Union: based on Industry Output and R&D expenditure of Belgium, Finland, France, Germany, Ireland, Netherlands, Spain, Sweden, UK.

Figure 3. Business expenditure on R&D as a percentage of output in 2003.

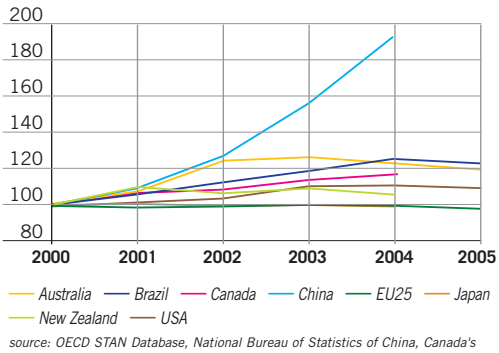
R&D intensity worldwide (%)



Source: OECD STAN Database,and CIAA calculations

Figure 4. Food-related R&D in the EU: 0.24%; in the US 0.35%; in Australia 0.4%; in Japan 1.21%.

Evolution of production value in various food and drink industry (deflated, 2000 = 100)



source: OECD STAN Database, National Bureau of Statistics of China, Canada's business and consumer site, AFFA, Japanese Ministry of Economy, Trade and Industry, New Zealand's Economic Development Agency, U.S. Department of Commerce

Figure 5. Production values of the food and drink industry in various countries

Europe's leading position will be threatened unless timely and effective measures are taken to increase R&D investments and improve its innovative power in order to compete with the new emerging economies.

The European Commission has consistently urged the food sector to become more competitive by increasing its spending on R&D as a means of introducing new products and processing techniques to the market. The food and drink industry, traditionally a sector with low R&D investments (of which often more than 80% is development and less than 20% is research), must change its course after a long period of incremental innovation ('mixing and stirring'). For ingredient suppliers, the R&D investments are generally higher. Food equipment manufacturers are also investing more in R&D and this is helping to secure a strong global performance in this sector.

On the other hand, supermarkets across Europe have been cutting prices, forcing producers to provide goods for less at a time when input and commodity costs have been rising. Cost pressures will continue and opportunities to pass these on to the consumer through price increases will remain limited. This also points to the need for greater investment in technological solutions.

The European food and drink industry also recognises its role in the prevention of lifestyle-related diseases. This implies new and innovative concepts of foods and diets, which cannot be introduced and exploited without substantial and targeted research investment. The future lies in the production of value-added, quality foods.

European food companies are well-positioned to launch more value-added products due to the fact that they have access to superior technology. This is an important instrument for reinforcing their positions and profitability. Consequently, the rate of innovation must increase, supported by more powerful R&D. Research conducted by many 'Fast Moving Consumer Goods' companies shows that step-change innovations have a much higher impact on value and market share than do incremental ones.

However, in order to capture the new, vast opportunities for foods and drinks innovation, especially in the area of healthy foods, investments and technologies are required that are not widely available in the SME-dominated sector. Effective public-private partnerships are imperative to prioritise research needs and to pool resources. In other words, individual food companies cannot take on the innovation challenge alone: a joined-up initiative is required.

Small and medium sized enterprises

Much of the research identified in Part II would require an input of skills and resources that are absent in almost all SMEs although there are companies, especially in the food ingredient sector, that are highly skilled.

The problems of organising the information flow and improving the technical skills in the SME sector is especially challenging and of particular importance given their overall contribution in the European food production. Possible solutions to this issue are considered in Part III of this document, partly as a result of the activity of the SME Task Force.

What will be the benefits for industry?

Implementation of the SRA will ensure:

- the multidisciplinary and integrated approach to research that will generate knowledge and technologies essential to stimulate the European food and drink industry and ensure the industry expands its world-leading position.
- the industry is able to adopt a safe, socially responsible and sustainable approach to food production in an economically-viable way that meets the expectations of society.
- public-private partnerships are promoted for collaboration in research to boost overall research investment and maximise the potential opportunities for exploitation.
- a stronger EU position in world markets for environmental technologies, which will contribute to sustainable consumption, production, delivering sustainable growth through business opportunities and improved competitiveness, while protecting our cultural and natural heritage.

The research community

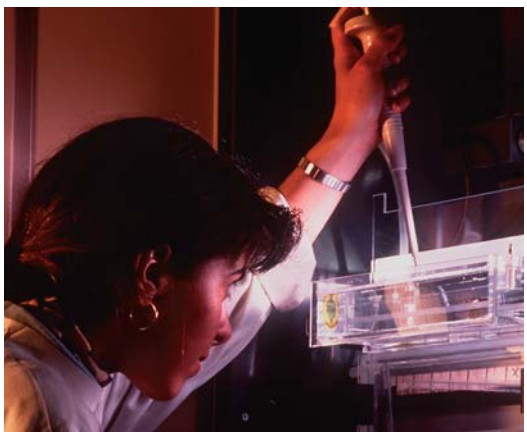
The research community in Europe has been in the forefront of developing the knowledge that has enabled safe, varied and nutritious food products to be available at all times. Research is undertaken within university faculties and research institutes, as well as in the agro-food industries. Throughout Europe though the research focus has varied, with food science and technology being the main focus and where the research quality is variable, from the excellent to the routine. It has had an agenda that has been driven mostly by the research community itself, rather than one where all the stakeholders with an interest in food have had an input.

One result of this is the difficulty of distinguishing between research excellence per se and excellent research that is necessary to stimulate or underpin innovation - the criteria by which individual ETP challenges and activities must be judged. Although excellent research has been carried out throughout Europe, this has not resulted in substantial innovative power. This is known as the European Paradox. This situation can be attributed to inhibited knowledge transfer and it is essential to improve the communication and other processes involved in effective knowledge transfer between the research communities and the industries and vice versa.

The areas of ETP activity necessitating most innovation will require a multi-disciplinary approach involving areas that are

- emerging (consumer sciences, sustainability of production),
- under-represented (fundamental toxicology and nutrition), or
- present in only a few centres (food chain management).

An effective interaction of the physical, biological and social sciences is a requirement for delivery and this poses unique challenges since the skills required cross traditional academic boundaries. For effective advances in the food, nutrition and health area there will be a need to devote a considerable amount of resources to the area as well as to ensure appropriate inputs from molecular biologists, nutritionists, toxicologists and consumer scientists. It is clear that Europe as a whole would benefit considerably from a generation of young and enthusiastic professionals aware of the goals that could be achieved by such a broad approach. Such young people would make a considerable impact on the European Research Area and would also help to deliver the benefits of a true knowledge-based economy.



Research across the food chain sector involves support from a multitude of different funding agencies both nationally and internationally and there is not always a close co-operation between them. This dilutes the resources that are targeted on specific scientific challenges, results in a duplication of effort when co-operation would use resources more effectively and efficiently, or leaves gaps that, if filled, would impact on innovation. The European Commission has recognised all of these weaknesses and is attempting to encourage high quality, collaborative R&D. However, much more needs to be done at the national level to raise the skill base and use resources more effectively. These issues are addressed in Part III and will be given more focus in the ETP Implementation Plan.

What will be the benefits for the research community?

Implementation of the SRA will ensure:

- improved communication between researchers and industry, which will stimulate the development of an entrepreneurial culture in Europe and enhance opportunities for innovation.
- increased interaction between science and society, leading to a greater understanding of, and engagement with, science by society.
- formation of cross-functional networks of scientists with an open eye for innovation.
- a new generation of scientists able to translate fundamental knowledge into industrial applications.
- well-designed training opportunities with a focus on improved innovation, and enhanced communication- and interpersonal skills amongst researchers.
- an effective integration of food science and technology, and the social sciences, which will contribute to a more dynamic European Research Area.
- delivery of durable career opportunities for future generations of social and natural scientists, and technologists.
- spreading of scientific and technological knowledge and best practice across the European Research Area.
- greater awareness of the ethical, business and societal context of research.
- promotion of the excellence of European food research to a global audience.

The way forward

The food and drink industry is making a crucial contribution to the economy of Europe but is in need of revitalisation to ensure that it continues to improve on its current performance, and provides European consumers with the products they wish to buy. To remain dynamic, innovative and competitive ETP Food for Life proposes an agenda for knowledge generation and transfer that will ensure the success of future internal and export markets. This requires a future knowledge base that must be connected to industry by effective knowledge transfer through a multi-disciplinary focus on the key determinants of change.

The ETP Food for Life Vision Document, published in July 2005, presented a strategy for the future of the food chain based upon the shared vision of its diverse stakeholders (Figure 6).

The concept of ETP Food for Life is to integrate strategically focussed, trans-national research that will deliver innovative processes, products and tools in line with the needs and expectations of the consumer. In considering how best to create the knowledge base and to focus this around innovation opportunities, it is clearly sensible to consider those areas where Europe is already strong in international markets, and where policy issues are forcing an agenda for change that will have to be met through changes in the production base.

Given the very large number of research topics that have been identified in this SRA as being of the highest priority, consideration must be given to how best they might be implemented. This issue will be addressed in detail in the subsequent Implementation Plan but there are clearly areas where national funding, as well as European funding, could help implement the SRA.

Successful implementation of the ETP's programme will require further prioritisation according to:

- the importance of the societal challenge,
- whether the nature of the challenge is so great that no single Member State could be expected to achieve a successful outcome in the next decade,
- the economic impact,
- whether there is a need for a major, long-term investment in multi-disciplinary, multi-national information generation and dissemination, and
- whether the research is necessary to support the development of European policy objectives.

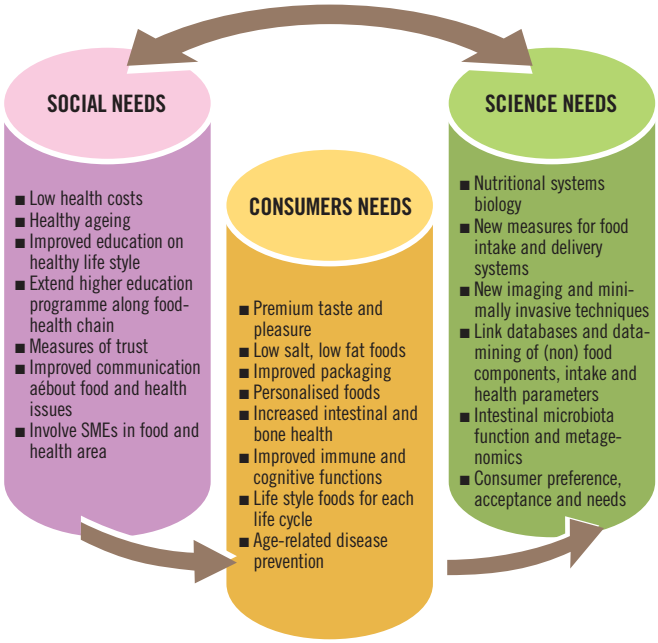


Figure 6. The integrated picture: societal-, consumers- and science needs.

When these criteria are applied three key thrusts can be identified where a multi-disciplinary research agenda, appropriate for funding at the European level, must be implemented. Focus on these thrusts will lead to improved competitiveness by developing new processes, products and tools that:

- improve health, well-being and longevity,
- build consumer trust in the food chain, and
- derive from sustainable and ethical production.

These thrusts have been conceived with the consumer's likely needs and desires as the major driver ('fork-to-farm' approach) and with priority European policy objectives taken into consideration. Each represents areas where major research resources are needed now and where the greatest return on investment is likely in terms of future market opportunities.

Processes, products and tools that improve health, well-being and longevity

Food and drink, in the right amounts and proportions, are crucial for the development, well-being and healthy ageing of citizens. Europe now has a large proportion of people living well beyond current retirement ages, and this trend will continue. Future changes in both population demographics and life span demand that European public health policies focus on 'healthy ageing' if countries are to continue providing the social and economic benefits that have been in place since the end of the Second World War.

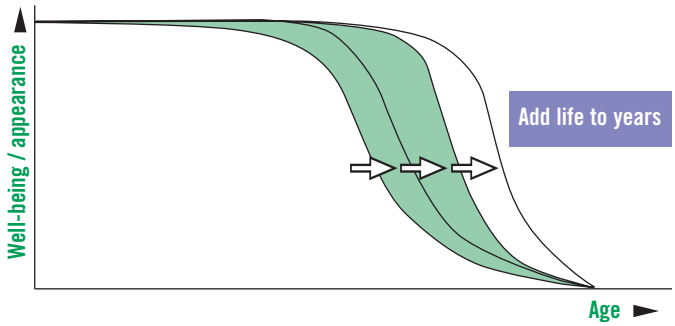


Figure 7. Healthy ageing.

Healthy behaviour is related not only to a higher chance of survival but also to a delay in the deterioration of health status. The key challenge for the long-term will be to influence an individual's state of ageing and to deliver a personal regime of nutrients, lifestyle and advice for healthy longevity or to 'add life to years' (Figure 7).

The availability of new foods that will assist the population to live a healthy and active life remains a major challenge especially as the knowledge of the differing responses of population groups to specific foods gathers pace. There is a major opportunity to develop foods that meet the specific needs of population groups ('personalised nutrition').

One significant barrier to innovative products based on information from the food, nutrition and health sciences is the lack of understanding of the mechanisms underlying the effects of food intake on health. New and advanced technologies that are now available include genomics, post-genomics and high-throughput tools, and novel insights to be gained as a result of their application will provide mechanistic explanations for effects of foods. A better understanding of the mechanisms underpinning the physiological functionality of food components will be required to substantiate health claims. The discovery and validation of biomarkers based on epidemiological studies, cellular- and physiological studies (including the outputs of systems biology) and intervention studies will all be essential elements of this substantiation process. Key Challenge 2: Delivering a healthier diet (Part II).

However, the effective delivery of this research to improve consumer health will require important and complementary inputs from the consumer sciences and humanities, particularly in relation to attempts to influence changes in habits and motivate healthier eating. Key Challenge 1: Ensuring that the healthy choice is the easy choice for consumers.

Whilst it is evident that consumers find considerable difficulties in changing their habitual diets this process will be made easier by extending the range of healthy food products that are available for purchase. Even when the public is made more aware of how one can eat more healthily, patterns of food purchase and food consumption are found to change little. This observation requires the food industry to find new ways to introduce foods that are tasty and accessible and contribute to a healthy lifestyle. In addition, this situation offers significant opportunities to work with social scientists to identify the key barriers to, and key drivers for, change and to develop, validate and disseminate such information to all sections of society. This is particularly important given the numbers of existing and future ethnic minorities, economic migrants and refugees across Europe.

It is clear that progress in food and health research will require strong support of many of the technologies that are increasingly helping to advance knowledge across the biomedical and social sciences field. It will be important though to focus on the application of these technologies to the priority areas detailed in Key Challenge 2: Delivering a healthier diet. These priorities have been chosen because European science is in the lead, the food industry is already exploiting products based on this knowledge, or the future opportunities for exploitation were felt to be good if more basic science was undertaken in the areas given priority.

The development of a new generation of foods tailored to the needs of consumers will require the input of much of the work described in Key Challenge 3: Developing quality food products and the effective integration of this challenge with focussed inputs from the humanities.

Processes, products and tools that build consumer trust in the food chain

The consumer's response to food safety issues is of paramount importance to the competitiveness of European food products. Any evidence, or indeed belief, of a potential risk from food has the potential to result in severe disruption as well as a loss of sales. High standards of food safety will, therefore, remain important to the industry.

Potential food hazards are usually determined by fully evaluating the risks associated with exposure of the consumer to these hazards through a process of risk assessment. The determination of a hazard will always err on the side of safety, which can sometimes result in small, or even theoretical risks, being highlighted. Consumers seek clear messages, not ones that are qualified or difficult to relate to; in turn, the media and politicians are also expected to convey complex issues in a simple and direct way. But it is rarely possible to express issues that relate to food safety or nutrition in black or white terminology.

Legislation and communication

The increasing tendency to legislate to ensure all risks are minimal, places a heavy burden on the food sector and, in particular, upon its ability to innovate and this is especially true for SMEs. Legislation should be evidence-based but it can be introduced when the evidence is still uncertain, or when concerns are expressed that are not valid. These actions fuel consumer's concerns and may be heightened if there is a failure to communicate in an appropriate way. There remain many obstacles to effective communication and this is a priority that must be addressed. Advances in understanding the needs and concerns of the consumer, and how best to portray positive messages without being accused of bias, are critical research needs that affect the food industry to a greater extent than is the case for many other production sectors. Effective solutions will only occur if effective interactions with social scientists are established in the activities of Key Challenge 4: Assuring safe foods that consumers can trust.

When an individual is told a food is 'safe to eat' they do not understand that there still might be associated risks, depending on the individual or on the amount of food consumed. If this situation is to be addressed effectively, much better communication is needed and an environment of trust and mutual confidence is required. Consumers need to understand that their food, like every other human activity, poses a balance between benefit and risk. The challenge will be to measure benefit (which is rarely done, unlike within the pharmaceutical sector) and to communicate the concept of risk-benefit in a way that is well understood.

Whilst it is important to continue to strive to make food as safe as possible, a balance must be struck; the more rigorous the scientific data that are available the better the final judgement. The relationships between food safety and consumer trust are highlighted in Key Challenge 4: Assuring safe foods that consumers can trust.

Counterfeiting and fraud is a major issue for the food and drink industry since it can undermine consumer trust in the quality and safety of a branded food product, leading to a loss in market share. It is essential to build robust systems of product tracing and identification that consumers have trust in. Some of the research outlined in Key Challenge 5: Achieving sustainable food production and Key Challenge 6: Managing the food chain will help to tighten controls and provide consumers with greater assurance.

Processes, products and tools to support sustainable and ethical production

The environmental impact of modern food production is high. There has been a tendency in the past to focus on the production of high-yielding, disease-free raw materials, which has led to less diversification of available products in the market. Livestock production has also become less diverse and more intensive. This policy has nonetheless resulted in a supply of food, which has been both secure and affordable.

All aspects of food production and the supply chain will have to be much more conscious of their future energy and water use and huge potential cost savings will result if they can be reduced. Nonetheless energy and water use are vital components of safe food production and a fine balance between safety and environmental goals will need to be struck in order that con-

sumer's trust in the food supply is ensured. The challenge now is to apply scientific and technological solutions to ensure that food production becomes more sustainable whilst still remaining affordable to all.

Without well co-ordinated and targeted research the opportunity for really important innovation will be lost. The input from Key Challenge 5: Achieving sustainable food production is focussed on the research necessary to ensure food production becomes more sustainable. At the same time there will have to be an input from Key Challenge 3: Developing quality food products to ensure that processing methods are more flexible as well as more efficient in the use of energy and water whilst ensuring food safety. To ensure the latter it will be essential to have a research input from Key Challenge 4: Assuring safe foods that consumers can trust.

The efficiency of the food supply chain is far from optimal with many supply sources and intermediaries in the production and distributing process. Trends towards greater diversification make it imperative that the relevant research outlined in Key Challenge 6: Managing the food chain is fully integrated within the research programme. This work will be especially relevant to SMEs, which will have an important role in ensuring food diversity in the future.

Part II. Key Challenges

Key Challenge 1: Ensuring that the healthy choice is the easy choice for consumers

Scope

Food and drink brings pleasure to the consumer and, if consumed in the right amounts, they should make a major contribution the well-being and healthy ageing of European citizens. Consumer confidence in foods is of paramount importance and can be enhanced by appropriate communication and public participation that facilitates an effective dialogue between food producers, governments and consumers. Consumers must be able to trust that their foods are safe to eat and of high quality; they also need to understand the information that is given about products so that they can make an informed food choice.

The objective of this Key Challenge is to enhance the consumer orientation of the European food industry by strengthening the fundamental understanding of food consumer behaviour and behavioural change, and by increasing the consumer's understanding of healthy foods and food consumption patterns and their production.

Although (food) consumer science has progressed considerably during the last few decades, a number of areas still require development, in order that capabilities and competencies can develop in parallel. This challenge focuses on the core capabilities structured around the four main elements of the so-called 'consumer research cycle' shown in Figure 8.

- Improved methodologies for measuring and quantifying consumer behaviour;
- Advanced consumer understanding by integration of the social sciences;

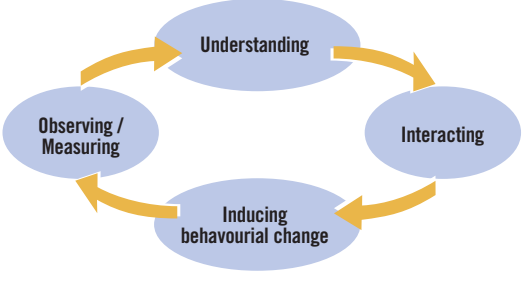


Figure 8. The consumer research cycle.

- Effective and efficient ways of involving and interacting with consumers, addressing information provision, education and public consultation based on an understanding of what drives their (re)actions: this will require the development of effective communication models and practices as well as public consultation methodologies; and
- Effective strategies to induce behavioural change, which will be quantified through observation; this will require an understanding of habit breaking and -formation.

This cycle emphasises both the importance of being more responsive to consumer needs and preferences, and the strong need to connect or reconnect with consumers through active participation. Whilst acknowledging the need and benefits, the European Commission and national governments have had only limited success in bringing together the expertise bases in the natural sciences and humanities. The ETP Food for Life provides an excellent opportunity not only to achieve this (and gain the subsequent added value), but also to develop and promote best practice for achieving these interactions and their fullest integration. In addition, it also provides a welcome opportunity to address the needs and expectations of all consumers and not just those within the mainstream ethnic and cultural populations.

Within each of the other Key Challenges, more applied research on consumer science is included as separate goals; these researches will build on and extend the outcomes of the research proposed below.

There are four different goals that need to be addressed.

Goal 1. Measuring consumer behaviour in relation to food

Eating behaviour is a complex interaction of food choices and habits differ widely across (sub-)cultures and cuisines. A key requirement is to develop and agree on measures for food-related concepts with pan-European validity.

Accurate measurement of purchase and consumption behaviour, and the theoretical explanation of these measurements, is a pre-requisite for theory development, strategy development and strategy evaluation. European cross-cultural diversity adds an extra dimension to this challenge. Measurement takes place in various sub-disciplines, at different levels of abstraction with only limited integration and synergy occurring.

Major research challenges

1. To improve methodologies to measure various parameters of the conceptual model of consumer science taking into account cross-cultural differences.

Deliverable

- Methodology for determining cross-cultural validity and sensitivity in order to quantify food-related concepts across Europe (2015).

2. To develop, align and interrelate different types and levels of information on behaviour to obtain a better understanding of behavioural patterns. This requires making better use of available large-scale databases (e.g. scan, purchase and consumption panel data).

Deliverables

- Methodology-integrated data sources, synergised to quantify food intake (including epidemiological data, retailer data bases and consumer data) (2010),
- Mapping of European food cultures using large-scale purchase and consumption data, which includes similarities and differences in large-scale purchase data. This should include values, attitudes, beliefs, personality and behaviour, but also different sub-populations, such as low-income consumers and ethnic populations (2015).

3. To develop (unobtrusive) methods of measuring behaviour (e.g. observational research including RFID, tags, etc.) that complements self-reported measures of attitude and purchase intent.

Deliverable

- New modelling approaches to understand the discrepancy between actual versus optimal dietary behaviour over time (2020).

Goal 2. Developing integrated models of consumer choice processes

Understanding the fundamental processes that lead to the actual food choice behaviour of consumers is the crucial challenge for the research field of consumer science. This is a complex task given that consumer behaviour is determined by a variety of influences related to the product, the individual and the choice context, which requires an integration of many disciplines, including psychology, sociology, sensory science, physiology, neurosciences and economics, amongst others.

Major research challenges

1. To develop and test comprehensive models of consumer behaviour, thereby integrating knowledge from various disciplines, the role of advertising and marketing on food choices, the role of sub-conscious processes in food choice behaviour, the role of biological (e.g. genetic predisposition, neuroscience), emotional, and economic drivers, socio-economic and cultural determinants in family decision-making and ethical considerations.

Deliverable

- A pan-European multi-disciplinary food consumer science resource initiated which will overcome fragmentation and build the necessary critical mass) (2010).

2. To understand the process of repeat choices and food habit formation as found from eating patterns and consumption baskets, including the role of critical stages in life where food habits are (re-)established.

Deliverables

- An integrated framework created for the analysis of food consumer behaviour, which integrates the various uni-disciplinary approaches to food choice with particular emphasis on understanding the process and determinants of repeat purchasing and consumption choices (2015),
- Large-scale scanner databases of actual purchase patterns analysed to understand the influence of retail and out of home food outlets on food consumer behaviour (2015).

3. To understand cross-cultural similarities and differences in consumer (food choice) behaviour and particularly in emerging markets and in different regions and countries.

Deliverables

- Demonstration of the feasibility of multidisciplinary and cross-cultural analysis of con-

sumer behaviour of specific subpopulations in Europe (e.g. children, adolescents, elderly, as well as immigrant populations reflecting specific regions and food cultures) through three proof-of-principle projects (2015),

- An improved understanding of the trade-offs between personal and societal consumer motivations, including insights and inputs from the neurosciences (2020).

Goal 3. Promoting effective interaction with consumer groups and consumers directly through communication and public participation

Adequate understanding of consumer behaviour will form the basis for how consumers can best be informed (communication) and how they can be actively engaged (e.g. public participation) regarding new developments in the food production area. This requires that communication and public involvement are organised in a way that optimally aligns to consumer interests and consumer levels of understanding and learning. Communication with the consumer and public participation are areas where important progress is required to allow consumers to make informed choices, to actively involve them in developments in the food area, to enhance transparency and, ultimately, to increase consumer confidence in food.

Major research challenges

1. To quantify and understand how consumers process information in the field of food and nutrition as a result of information content and format, consumer education and learning processes.

   #### Deliverable

   - Consumer needs, expectations, knowledge and attitudes with regard to information on food and food production mapped in a pan-European context (2010).

2. To develop better tools for communication with the consumer, including insights from semiotics and persuasive and interactive communication through different media.

   #### Deliverable

   - A set of validated methods, models, practices and tools for effective consumer information and education regarding food and nutrition in a multiple actor context (2020).

3. To develop effective tools for public participation in food and nutrition issues that optimise information and optimise transparency and consumer confidence in the food industry.

   #### Deliverable

   - Validated models and methods for effective public participation and engagement with consumers from different backgrounds on new developments in food and the food industry (2015).

Goal 4. Developing strategies to induce behavioural change in order to improve consumer health and social responsibility by making the healthy choice the easy choice

One of the most important public and commercial policy goals in food and nutrition is to induce behavioural change in consumer choices in such a way that long-term personal-, public- and societal interests are better served by those choices (e.g. better personal diets, public health and well-being). For most consumers, these choices are based upon taste, convenience and affordability but some consumers also include longer-term aspects such as safety, sustainability, ethics and public health. Many of the existing choices are deeply rooted in habits and cultural practices.

Major research challenges

1. To understand the process of food habit formation and change and the key motivations that trigger or hamper change particularly in relation to unhealthy eating behaviour.

   #### Deliverable

   - Intervention strategies, integrating legislation, education/information and market/marketing influences, for inducing long-term behavioural change towards better dietary habits (2015).

2. To understand consumer trade-offs between personal and societal motivations, including insights from neuroscience, marketing and other disciplines. This includes analyses of changes in meal patterns and consumption habits over time and foresight studies to identify emerging needs in consumer behaviour.

   #### Deliverable

   - Foresight or scenario studies on emerging issues in consumer behaviour from joint consideration of consumer trends with scientific and societal developments (2020).

Key Challenge 2: Delivering a healthier diet

Scope

The objective is to develop new and effective food-based strategies to optimise human health and to reduce the risk or delay the onset of diet-related diseases. The nutritional sciences now stand at an important turning point. In the past, nutrition was above all a question of ensuring food intake and remedying dietary deficiencies, and was largely based on observational research. With recent advances in genomic- and molecular technologies and know-how, a new paradigm is created on the interaction between nutrition and health. The ability to link the impact of food to health at a cellular level, as well as at a whole body level, creates a new horizon for the food industry and offers benefit to the individual consumer.

The effective exploitation of such technologies can change general nutritional guidelines into more targeted, nutritional advice and may in the long-term lead to more personalised nutritional guidelines for high-risk groups. Furthermore, the benefits can be made visible on food products by health claims based on sound scientific evidence, which is required as part of a legislative framework developed in Europe.

Consumers are becoming increasingly aware of the relationship between food intake and health, and also the relationship of inappropriate diets with major chronic diseases such as obesity, type 2 diabetes, cardiovascular diseases, cancer, sarcopenia (muscle wasting) and osteoporosis. Ensuring foods provide for healthy ageing must be one of the key topics in the research efforts for the coming years. Leveraging knowledge for the prevention of diet-related health disorders and generating knowledge on the impact of nutrition on the quality of life of individuals at all ages will also lead to innovation and breakthroughs, thereby increasing the competitive advantage of the EU food and drink industry.

To reach this milestone of improved daily quality of life at all ages, a new food concept is needed, which includes nutritional value, food safety and emotional values of taste and convenience. Physical activity is an integrated part of a healthy lifestyle and close contacts will be maintained between ETP Food for Life and the European Platform on Diet, Physical Activity and Health[1].

The progress in life sciences from the level of DNA up to systems biology and incorporating the technical sciences (for example imaging, nanotechnology) provides an opportunity to focus on a few emerging areas which in the past lacked the necessary technologies to generate knowledge on the interaction between diet and quality of life (Figure 9). This is particularly true for the function of the brain. Cognitive decline with ageing and diseases such as Alzheimer's and dementia, are emerging areas for nutritional research.

A common factor in most, if not all, of the currently important diet-related chronic diseases is low-grade chronic inflammation. Intestinal and immune function is strongly related to nutrition, starting at the first contact of ingested food within the gastrointestinal tract. Until now it has been difficult to study this important interaction due to a lack of valid biomarkers and diagnostic tests. Given the recent advances in life science technology, a more focussed research approach will have the potential to deliver great breakthroughs that will lead to diet-induced immune modulation and improved quality of life.

One of the major nutrition-related health threats for the coming decade is obesity with all its related metabolic impairments, such as type 2 diabetes, cardiovascular diseases and metabolic syndrome. Arguably, obesity will be the greatest challenge for the food industry in the coming years. Therefore, the need for improved knowledge of the metabolic function at all ages associated with obesity and related diseases must have the highest research priority.

To reach these goals in the coming years a number of nutrition-related infrastructures are required and specific enabling technologies must be developed (these are addressed in Part III).

This research challenge will focus on studying and validating mechanisms underpinning research on new breakthrough areas and identifying and validating biomarkers.

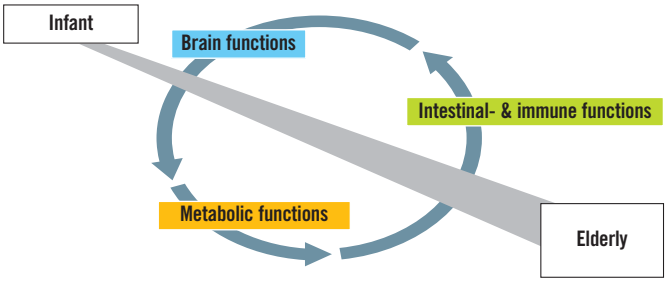


Figure 9. Priority research areas in food and health.

*(1) ETP Food for Life is linked with the EU Platform for Action on Diet, Physical Activity and Health, **http://ec.europa.eu/health/ph_determinants/ life_style/nutrition/platformdatabase/we/dsp_search.jsp**, through the involvement of CIAA, the Confederation of the food and drink industries of the EU.*

Goal 1. Understanding brain function in relation to diet

It is well established that diet can have both a positive and a negative impact on our physical health and performance. Although significantly less scientific data are available, there are clear indications that the same holds true for our mental health and cognitive abilities. Several studies indicate that diet can influence brain and cognitive development *in utero* and in neonates, infants and young children. Food intake can also affect brain function (in all age groups) in terms of cognitive processes, mood-, and brain performance. Reciprocally, brain function can affect components of food intake such as type of food and amount of energy consumed. Although the relationships between brain function and nutrition are still relatively poorly understood, it is generally accepted that the former does impact significantly on overall health and well-being.

Major research challenges

1. To chart the scope of diet and individual nutrients to influence brain health and performance. To interpret these results and maximise the impact, mapping will be required of the underlying mechanisms through which dietary components are capable of modulating brain development, cognitive performance and preventing depression and ageing-associated cognitive decline.

Deliverables

- Diet and cognitive function: understanding the impact of nutrition on brain and cognitive development *in utero* and in neonates, infants and young children (2015); achievement of healthy ageing by nutritional strategies in childhood (2020); establishing the relationship between nutrition and learning abilities and other cognitive attributes (2020),
- Mood and optimal performance: mapping the impact of specific food ingredients on mood and mental performance through building an understanding of the mechanisms underpinning these effects (2015),
- Understanding of the molecular and cellular mechanisms behind neuro-protective effects by dietary compounds (2020),
- Prevention of cognitive decline and other disturbances of brain function (e.g. hearing loss): mapping the scope of diet to reduce or prevent the decline in cognitive functioning with ageing and charting underlying mechanisms which may eventually lead to a decline of incidence of Alzheimer disease or dementia (2020).

2. To increase understanding of the neural pathways controlling functions such as food intake, hunger and satiety so as to provide powerful new insights to combat the obesity epidemic.

Deliverables

- Brain conditioning: understanding of how early exposure to dietary components leads to taste perception and food preferences later in life (2010),
- Nutrition and inter-organ signalling with a key emphasis on the brain: understanding the mechanism of gut-central nervous system interaction (2010),
- Food intake regulation and hunger/satiety: identifying the brain pathways that regulate hunger/satiety (2015); identifying dietary components that can help control food intake (2020).

Goal 2. Understanding effects of diet-gut interactions on intestinal and immune functions

An optimal immune system is pivotal for a person's health, preventing acute and chronic disorders and determining how the body reacts to and copes with environmental stimuli and physiological and psychological stresses. Food is an important factor able to affect immune reactions in either a negative (e.g. allergy) or positive manner (e.g. prebiotics and probiotics). The immune system is intimately involved in several pathophysiological processes including cancer development. The human immune system controls the so-called innate/native immune functions (such as the intestinal barrier function) and the acquired or adaptive immune functions (like inflammatory regulators).

The intestine, which possesses a metabolic activity equivalent to the liver, is regarded as the key organ able to maintain health and influence resistance to disease and immune function in relation to food. The intestinal tract is the primary site for food intake and is colonised from birth by a microbial community that contributes to food conversion, produces host-active compounds and stimulates a variety of relevant functions, including the immune system. It has proven difficult to define a 'healthy intestine', because of its complexity, the large inter-individual variability and the active interactions between the host, its microbes and the diet. However, recent applications of innovative holistic systems and subsystems approaches, including metagenomics, have provided tools for determining microbial activity and its impact on intestinal function in health and disease.

An emerging body of knowledge now points towards the benefits of several bioactive food components, including microbes and their constituents, interacting with the immune system and the intestine. There is recognition of the importance of chronically increased inflammatory activity in the body, partly due to immune deregulation, as a key detrimental factor in the development of obesity-related disorders, chronic inflammatory disorders (including rheumatoid arthritis, chronic obstructive lung disease and chronic inflammatory bowel disease), functional bowel diseases, and the ageing process. It has been demonstrated that diet is able to affect these and other inflammatory processes (not induced by immune activation) by means of, for example, prebiotics and probiotics, fatty acids and antioxidants.

Major research challenges

1. To enhance the knowledge and study the mechanism of the relation between the immune system and other organ systems such as the brain, the endocrine system and the intestine and their relation to physical activity.

   #### Deliverables

   - Knowledge and tools to positively modify systemic inflammatory activity by diet-gut interaction, especially with regard to the intestinal system such as Irritable Bowel Syndrome and metabolic disorders such as type 2 diabetes, cardiovascular diseases and the ageing process (2010-2015),
   - Improvement of the allergome databases of plant- and animal-derived food, knowledge of allergen post-translational modifications and allergenicity modulation, and persistence after cooking; detection of allergens derived from human gastrointestinal or hepatic metabolites (2015).

2. To study foetal and neonatal nutrition in relation to immune (de)regulation during later life by metabolic/immunologic imprinting.

   #### Deliverable

   - Determination of a healthy diet in terms of type and timing of introduction of specific dietary constituents with regard to the mother, before and during pregnancy and lactation, and with regard to the newborn during early life, in order to optimise immune function and decrease the risk for allergy (2015-2020).

3. To identify and validate minimally invasive biomarkers of the immune system and related systems in order to achieve and accelerate progress. The limited availability of widely accepted and effective pre-clinical model systems for screening purposes must also be addressed to improve mechanistic understanding and stimulate scientific progress, innovation and regulatory decisions.

   #### Deliverables

   - Identification of dietary factors that improve the barrier function of the intestine (including the impact of intestinal microbes) and the resistance to infections (common, food borne, etc.) and its inflammatory sequalae (2010-2015),
   - Development of biomarkers of intestinal and related functions to define and improve intestinal health; improvement of e.g. abdominal comfort, digestive function, systemic immune function and decreased risk cancers of the gastro-intestinal tract, in particular colorectal cancer (2010-2015).

Goal 3. Understanding the link between diet and metabolic function (obesity and associated metabolic disorders)

Obesity rates have risen three-fold or more since 1980 in many areas of the world. Currently at least 300 million of the world's one billion overweight adults are clinically obese. Obesity occurs when energy intake is greater than energy expenditure, therefore physical activity, diet-induced thermogenesis and food intake regulation must all be addressed to reduce the prevalence of obesity.

Obesity plays a central role in the metabolic syndrome, which includes hyperinsulinemia, hypertension, hyperlipidemia, type 2 diabetes and an increased risk of atherosclerotic cardiovascular disease. In order to develop preventive strategies it would be important to identify biomarkers (including polymorphisms) of early metabolic changes utimately leading to metabolic syndrome. There is today a growing body of evidence that obesity is associated with a chronic low-grade inflammation, and a focus on better understanding of low-grade inflammatory pathways could be critical in the mechanisms underlying obesity and its complications. However, triggers of the inflammatory process and other related diseases in humans have yet to be clearly identified.

Some of the metabolic alterations linked with ageing, such as decreases of insulin sensitivity, bone quality (e.g. mineral density), and muscle mass (sarcopenia), and increase of body- and visceral fat are associated with increased systemic inflammatory activity. Dietary measures that could counteract these ageing-related metabolic disorders would offer a real breakthrough in an ageing society. Furthermore, recent publications indicate

a link between obesity and the energy-harvesting capacity of gut microbiota, and provide new targets for intervention linked to a 'healthy intestine' (see Goal 2).

Maternal and post-natal nutrition is not only central to the growth and development of infants but may also condition health later in life (programming/imprinting). The alarming increase in the incidence of overweight and obesity reported in children has renewed interest in determining the influence of the maternal and infant diet on the risk of developing excess fat mass and metabolic disorders later in life. The relationships between early nutrition and increased obesity risk are poorly understood and not well established in humans. Research should deliver dietary recommendations for both mothers and infants and provide the basis for optimising nutrition during the critical period of rapid development both *in utero* and post-weaning.

Major research challenges

1. To understand the genetic background of individual metabolic profiles in relation to body weight control and the risk for development of co-morbidities such as type 2 diabetes and metabolic syndrome with increasing weight.

Deliverables

- Early biomarkers of metabolic syndrome (2010-2015),
- Knowledge of individual variations in metabolic energy efficiency, including the contribution of gut microbiota, and in susceptibility to high energy intake and sedentary lifestyle (2020),
- Identification of food components alleviating chronic low-grade inflammation associated with obesity and determination of their impact on the prevention of insulin resistance and metabolic syndrome (2015-2020),
- Knowledge on the contribution of epigenetic events on chronic diseases later in life and the contribution of nutrition (2020),
- Understanding drivers (diet, genes) that regulate habitual levels of physical activity (2010-2015).

2. To develop effective food ingredients and dietary strategies to prevent (re-)gain of weight.

Deliverables

- Intervention strategies to align research on exercise physiology/physical activity and obesity/metabolic syndrome (2010),
- Specific food components for regulating food intake and increasing diet-induced thermogenesis (2015),
- Greater insights into the effects of meal composition, size and frequency on appetite regulation and energy intake (2015).

3. To define the effects of diets and nutrients early in life for health outcomes in later years.

Deliverable

- Maternal and infant dietary recommendations for optimal metabolic health (2020).

4. To tackle the nutrition-related wasting diseases in the elderly population and understanding the role of nutrition in healthy ageing.

Deliverable

- A dietary strategy to counteract ageing-associated muscle wasting (sarcopenia) and decrease of bone quality (2015).

5. To develop risk-benefit (disease) models and scenario studies on obesity and on nutrition and healthy ageing.

Deliverable

- Models and studies indicating how the incidence of obesity can be decreased and that of healthy ageing supported (2010).

Goal 4. Understanding consumer behaviour and effective communication in relation to health and nutrition

The translation of scientific insights into consumer-relevant innovations requires understanding of the consumer's perception and his relation to food, nutrition and health. Consumers need to be motivated to move towards a healthier lifestyle and take advantage of the scientific progress made within the life sciences. Among other challenges this will require transparent and consumer-aligned communication of the importance of nutrition and the desirability of specific food products being incorporated in healthy eating patterns. Building on a fundamental understanding of how food choice habits are formed, how they can be changed and on the key motivations that trigger or hamper positive behavioural change, intervention strategies are required to break unhealthy habits and develop them into healthier food lifestyles. In the next decades, breakthroughs are expected, particularly in the fields of (nutri-)genomics and cognitive neuroscience, and in the fundamental understanding of the biological and cognitive drivers of eating habits and lifestyles. This, together with improved understanding of food-related consumer behaviour, will make it possible to develop product and communication strategies that, together, will make it much easier for consumers to live a healthy life.

Major research challenges

1. To understand the process and key determinants of behavioural change, such as food habit-formation and -breaking.

   Deliverable

   - Effective intervention strategies for habit-breaking and behavioural change toward healthier food choices (2020).

2. To understand consumer knowledge of nutritional concepts and responsiveness to communication formats, including health schemes (e.g. pyramids etc), health claims, simplified labelling (e.g. sign posting) as well as targeted, more personalised food recommendations (e.g. from advances in nutrigenomics).

   Deliverable

   - Improved knowledge of consumer understanding of nutritional concepts and communication formats, incl. health schemes (e.g. pyramids), claims and labelling (e.g. signposting) (2015).

3. To understand the perception and determinants of a 'healthy food lifestyle', analysing the cross-cultural and subpopulation group differences.

   Deliverables

   - A quantified model for consumer interpretation of (un-)healthy food lifestyles and its interaction with other lifestyle factors (2015),
   - A quantified model for determinants of (un-)healthy food choice habits (2015).

4. To understand the role of biological determinants in food choice (including the role of genomics and brain functions).

   Deliverable

   - A quantified framework model for the role and relative importance of biological determinants in consumers' food choice, including brain functions and genomics, together with the identification of potential intervention routes to affect these biological determinants (2020).

Key Challenge 3: Developing quality food products

Scope

The concept of food quality in Europe has changed significantly over the years and will continue to do so. From the guaranteed availability of food, via uniform quality, food safety and changing production methods and processes, food is now increasingly associated with enjoyment, health and anticipated well-being. Changes in society and demographic trends (such as increasing participation of women in the workforce, decreasing family sizes and increasing number of households, the ageing society and increases in proportion and integration of ethnic groups in many EU Member States) will impact significantly on the choice of foods, the ways in which food will be prepared, and where it will be consumed.

Although manufactured foods are safer than ever, excessive food intake, in conjunction with a decrease in physical activity has led to an increase of lifestyle-related diseases in European society. In the medium- to long-term, lifestyle-related diseases will increase to unacceptable levels unless appropriate measures are taken now to reduce intakes of energy and salt. Since taste is the most important enabler that facilitates the

intake of healthy products, the challenge facing industry is the production of tasty foods that:

- are consistent with health status and a healthy lifestyle,
- address the consumer's preferences, and
- ensure repeat purchases.

Convenience is an important factor of interest to consumers. Grazing, eating on the move and ease of container-opening for children and the elderly are all demands that, when met, increase the convenience and enjoyment of food. It is also notable that food is increasingly being consumed away from home, in canteens, catering establishments and restaurants.

Changes in eating habits and a clear demand for improved quality food create opportunities for the agro-food industry to add value to their produce and to develop novel foods. Although diversity will be of key importance for future food production and product developments, by itself it will be insufficient to create the required innovations. Increased R&D investments are necessary to develop new processing equipment, processing lines and manufacturing systems.

On the one hand, exporting traditional, regional products from the rich and diverse European cuisine will be enhanced and supported through a longer product shelf life that will be obtained with new mild preservation technologies. On the other hand, new products on the market will be based increasingly on novel ingredients and processes. New (natural) ingredients could be produced by improved, mild separation technologies, or by novel bioprocessing schemes. New structures and textures will be produced as a consequence of responses to developments in micro- and nano-technologies.

A challenge for the European food and drink industry will be to provide the consumer with the right type of food at the right time and in the right place. Innovative processes, value-added products, new marketing concepts, novel ways of selling products and novel ways for the production and supply chain to co-operate to create products targeted at consumer needs will ensure that the consumer is provided with safe products and products possessing the required sensory characteristics, at maximum convenience, and at an affordable price. In addition, environmental issues related to sustainable food production, minimisation of waste production and use of non-renewable raw materials will have increased priority.

To respond successfully to these opportunities, the food industry will need to adapt and incorporate modern production philosophies, such as lean manufacturing and agile manufacturing, which have proven successful in other market sectors and which allow producers to remain at the forefront of market change. Overall, attention must be paid to the complete process line and production plant as well as to ways of optimising their individual elements. In this manner, 'quantum leaps' may be achieved that would both secure niche markets and exploit uncontested market situations.

Close contacts will need to be established between the ETP Food for Life and those addressing, for example, Textiles and Automobiles[2], which are sectors that have already benefited from minimising processing steps that fail to add value for the consumer. For the same reason, establishing close links with the ERA-Net on Manufacturing is also a priority.

(2) such as the European Steel Technology Platform, ESTEP, cordis.europa.eu/estep/ and ETP Future Textiles and Clothing, ECTP, ***www.textile-platform.org****.*

Goal 1. Producing tailor-made food products

The creation of tailor-made food products that encompass all consumer preferences, acceptance and nutritional needs, requires a complete redesign of the way food is presently produced. Food in 2020 will be tailor-made to the specific Preference, Acceptance and Needs (PAN) of consumers. Consumer science will deliver reliable data on consumer preferences and acceptances and provide a basis for new product development. Nutritional science will deliver the needs with respect to energy intake and also identify any need to fortify foods with e.g. bio-ingredients, and suggest appropriate levels of fortification.

The PAN concept (Figure 10) developed here, should evolve in the long term to a completely reversed engineering approach, in which the total product development is modelled back through the chain from consumer to raw material. This innovation will lead to faster product development and more flexible processing possibilities.

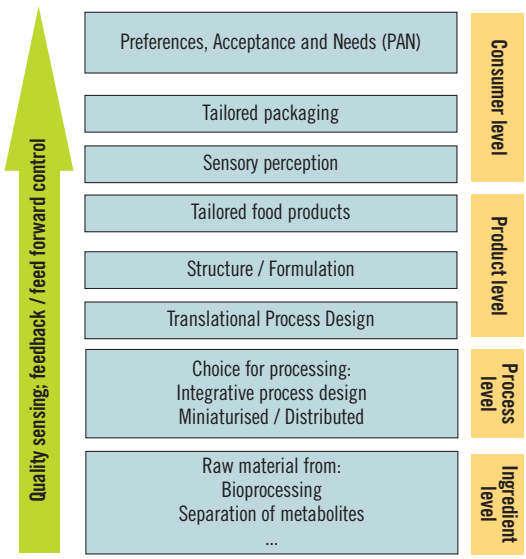


Figure 10. Schematic presentation of the food production process.

However, for this revolution to achieve maximum impact, an increased understanding is required on the dynamics of sensory perception from receptor to the brain, including cross-modal interactions of the senses, flavour release and structure breakdown. In addition, an improved understanding of quality has to be delivered from multidisciplinary studies into the relation between the compositional and structural features on different levels of scale and attributes of the product and the gastrointestinal, (oral) physiological and neural effects in the body. Engineering food structure, a better knowledge

(including prediction) of ingredient interactions and the complex reactions in food will all be necessary to deliver the compositions and structures desired and demanded by the consumer.

The trend for addition of bioactive compounds to foods so as to benefit consumer health has been strong during the past decade and, in all likelihood, will expand further in the future in parallel with an increased knowledge base on the impact of individual food constituents on human health. External contacts will be necessary to most fully exploit the diversity of plant raw materials and incorporate their components within traditional, novel and ethnic foods. Ultimately, the PAN approach could be used to identify quality targets for plant scientists, agronomists and breeders. In addition to plants, other dietary sources of bioactive compounds will be explored, including those of animal and microbial origin.

Major research challenges

1. To develop and apply novel processes for the implementation of the PAN profiles through innovative product functions.

Deliverables

- Assessment tools and diagnostics for PAN profile evaluation from consumer, nutrition and health science (2010),
- Models for PAN patterns as a function of quality and well-being factors to produce a diversity of foods for specific consumer groups, PAN relationship to food manufacturing and packaging concepts, predictive and operational methodologies and toolboxes for PAN patterns (2015),
- Understanding the dynamics of a) sensory perception from receptor to brain, including cross-modal interaction of the senses, flavour release and breakdown of structure and b) the gastrointestinal mechanics, nutrient interactions and availability (2015),
- Improved knowledge and global databases regarding individual, target group and region related variation of PAN profile to food composition and structure. New tailor made, personalised foods targeted at specific consumer groups (2020).

2. To develop convenient, tailored personalised food products to meet all consumer preferences, acceptance and needs.

Deliverable

- New tailor made, personalised foods targeted at specific consumer groups (2020).

3. To identify bioactive food constituents from plant, animal and microbial sources, and beneficial micro-organisms and their mechanisms of action.

Deliverables

- In vitro assays and biomarkers to predict *in vivo* functionality of bioactive components (2015),
- New product functions arising from new ingredients or from processing via biotechnology, separation technology or nanotechnology, Understanding and predicting a) impact of bioactive compounds in food and beneficial micro-organisms on human health, b) effect of food matrix formulation (structure, components) on the activity, delivery and transfer of bioactive compounds and beneficial micro-organisms (2015),
- Targeted delivery of bioactive compounds and micro-organisms with beneficial properties (2020).

4. To develop environmentally friendly sustainable food processes, such as better utilisation of side streams and innovations to avoid excessive packaging.

Deliverable

- Food technology innovations enabling environmentally-friendly and sustainable production with a special focus on better utilisation of side streams and minimal use of non-renewable and non-biodegradable materials (2020).

Goal 2. Improving process design, process control and packaging

In order to improve the competitiveness of the European food industry, innovations in process design and process control are required. In addition, the consumer demand for convenience foods with a long shelf life and a fresh appearance will increase. Mild preservation technologies that achieve this goal, together with appropriate packaging concepts, will enable industry to comply with this demand and stimulate the export possibilities of traditional and regional products, and contribute to the growth of the European economy.

Pressure to reduce the time of food processing will increase, and one response to this will be to develop models that incorporate increasing flexibility. Advanced mathematical modelling will also have a role to play in optimising production lines and plants, and can even extend to the food supply chain. Such 'supply chain engineering' approaches are likely to be increasingly adopted in diverse

manufacturing sectors and it will be important to identify, capture and adapt emerging best practice. This will require, in addition to sustained attention on mild manufacturing:

- the development of new food products, based on completely new processing routes, using new components from plant and animal resources and from biotechnology and processing,
- new, efficient and sustainable processes that deliver personalised quality products, based on cascades of existing unit processes and on output demands,
- increased flexibility, through redesigning processing and logistics. Food process design will need to exploit a lean manufacturing approach in order to optimise user value and minimise losses. The introduction of agile manufacturing will increase the likelihood of competitive advantage.

Robust and reliable quality sensing systems must be researched and developed over differing time scales to assess quality throughout the life history of a food product. In-line, preferably non-destructive, and integrative quality sensors are prerequisite for modern process control. It will be essential to adapt read-outs of such quality-sensing systems to generate useful parameters for the design of new processes and for the creation of new food systems. An important new area will be the development of quality sensors to be used by consumers; one route will be through integrated sensing systems contained within the packaging.

With rising demands of consumers for quality, health, security and convenience, and with regulatory requirements for environmental protection, significant needs and opportunities for novel food packaging concepts are emerging. Optimisation and improvement of conventional packaging is still important to reduce use of expensive products and minimise wastage of packaging and packaging materials. The development of recyclable or biodegradable packaging materials is also anticipated so as to offer new and environmental-friendly packaging solutions.

Simultaneously, new concepts such as biodegradable active and intelligent (A&I) packaging will offer numerous innovative solutions for extending shelf life and maintaining, improving or monitoring food quality and safety. A&I packaging will be developed that incorporates active or intelligent components intended to release or to absorb substances into, onto or from the packaged food or the environment surrounding the food, or to provide the information on the product and/or the conditions for its use. A&I packaging will be combined with new mild preservation methods to provide optimal pathways for quality enhancement and for in-package processing and in-home preparation of foods.

Major research challenges

1. To provide improved PAN functions through the redesign and optimisation of food processing and packaging, in order to increase competitiveness and sustainability.

Deliverables

- New PAN function-driven sustainable food processing in synergy with new packaging technologies, point of use processing systems developed for timely delivery of freshly produced personalised food (2015),
- Process optimisation through combinations of new and conventional technologies with respect to process structure property relationships in new and traditional foods (2015),
- Process optimisation through combinations of new and conventional technologies with respect to process structure property relationships in new and traditional foods (2015).

2. To introduce scaleable and flexible food manufacturing techniques and their intelligent in-line control.

Deliverables

- High resolution, spectroscopic in-line sensors yielding complex food structure information and for *in situ* control of process variables, such as pH under high pressure or temperature in pulsed electric fields (2015),
- Application of artificial intelligence methods for data mining, pattern recognition and software sensors (2015),
- Application of integrated and pervasive sensor networks throughout the food chain recording fluctuations of quality and safety (2020).

3. Risk-benefit balanced innovative, sustainable, and safe food packaging for implementation into integrated food chain concepts.

Deliverables

- Production, use and disposal of eco-friendly packaging, and tailor-made packaging for perishable, diverse and complex foods such as fresh, living, composite or traditional foods (2015),
- Novel intelligent packaging including the use of nanotechnology for monitoring food quality and safety during transport, storage and processing, from producer to consumer, such as using tags as miniaturised analytical tools with wireless communication (2015),
- New active packaging reducing food degradation and for controlled delivery of functional components (2020).

Goal 3. Improving understanding of process-structure-property relationships

Knowledge on process-structure-property relationships will increasingly allow the creation of tailor-made food products by new processing technologies. By 2020 available knowledge on phenomena, mechanisms, driving forces and kinetics responsible for changes in physical, chemical, biological and structural properties will allow foods to be produced through processes that are flexible and easily adaptable to PAN patterns. Rules for structure/formulation-property functions and structure-processing functions, and tools for translational and precise process design and processing in order to adjust PAN profiles within processed food systems will then be available. Mathematical models will be available to calculate how the structure-function relations at different levels of scale will evolve during processing in order to deliver the desired characteristics.

Major research challenge

1. To understand relationships of food structures from molecular via nano- to macro scale with respect to product and process design, and to develop new processing principles for improved PAN profiles.

Deliverables

- Quantitative methods developed to assess process-structure-property relationships, such as extrusion based cereal structure processing for satiety profile adjustment (2015),
- Structure-property functions and their relationships with formulation and processing (2020).

Goal 4. Understanding consumer behaviour in relation to food quality and manufacturing

Increased consumer understanding can serve to better communicate new developments in food quality and manufacturing and help to build up trust for new technological opportunities. An understanding of how consumers react not only to different product qualities, but also to different production technologies, will enable the food industry to align both food quality and food manufacturing processes to consumer wishes and demands. Co-operation with technologists (product), consumer scientists (behaviour) and marketing (developing the concept) is crucial in development of better methods to turn the engineering approach around to a consumer-led process.

Major research challenge

1. To integrate consumer-orientation in new product development, and to understand consumer responses to new products, processes and packaging technologies across different target groups.

Deliverables

- New methodologies for the effective incorporation of consumer understanding into new product development (2015),
- Quantitative models of how product, process and packaging features affect consumer responses (2015),
- Regained consumer trust in processed food, in terms of food safety issues and improvement of the quality of the food (2020).

Key Challenge 4: Assuring safe foods that consumers can trust

Scope

Europe has an absolute necessity for a safe food supply; it is an imperative for health, social, and economic reasons. That the food produced and consumed in Europe is now safer than ever is a dry fact rather than a particularly useful statement. In spite of this, recent food safety crises have created a high degree of concern among consumers. Consumer perception has evolved to a high level of awareness and a much reduced certainty, a combination which has led to a generalised lack of confidence.

Food safety is a major public health and economic issue for Europe both for foods consumed within the EU and those that are exported. The total costs attributable to failures in food safety are notoriously difficult to estimate and should certainly include costs associated with the consequence of the diseases themselves as well as losses of product and consumer confidence. For instance, the annual costs of Salmonella outbreaks alone have been estimated to be around 2 billion $ for USA. This gives some idea of the economic losses for a single pathogen. This figure does not take into account the considerable costs of measures set in place to control this pathogen in the food chain, including analyses, specific management and hygiene measures, research and surveillance.

In many cases it is far from certain that control measures required by regulators or by distributors and retailers are adequate for the protection of health. Such a situation represents a cost burden, supported by producers and consumers, which does not necessarily contribute greatly to a reduction in morbidity. To adequately protect the health of the consumer and, at the same time, ensure competitiveness of the food industry it is essential to have effective and targeted control measures. This is one of the reasons that makes food safety an essential element of a competitive strategy for the European industry. The capacity of EU Member States to contribute to the maintenance of a safe food supply in an increasingly science and technology-driven society, is intrinsically linked to its scientific resources in areas relevant to food safety. The desired model of a united, but diverse, continent requires that food traditions be both preserved and modernised. Competitiveness is essential within all parts of the EU food industry and at all levels; therefore, the science applied to support it must respond to the needs of the sector as a whole.

That food safety concerns are more and more centred on the consumer and his or her perception of how safe the food supply is a healthy state of affairs. The food sector has a very clear interest and responsibility in addressing food safety challenges. Properly identified, co-ordinated and executed research programmes will, when successfully communicated, form the basis of this response.

The European food and drink industry's response must be to develop an integrated and holistic approach to food safety (Figure 11). Safety is not guaranteed only by 'safe' product manufacture; the total chain has to be taken into account. Designing safety into foods requires the integration of know-how and interventions along the 'research to market' continuum.

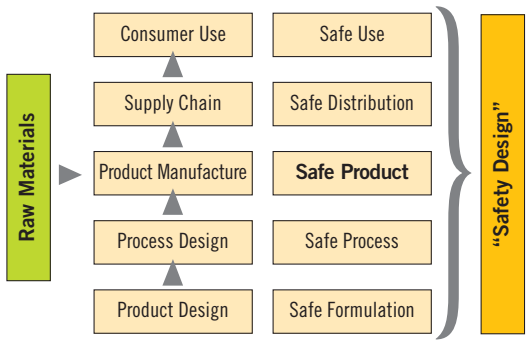


Figure 11. Safety by design.

Research, which addresses the European food industry's needs over the coming years in relation to food safety, will be applied through this integrated, holistic approach. At the same time, there should be a focus on those aspects of understanding, development, application/implementation that will exert the biggest impacts on alleviation of food-borne diseases. Such well-focussed

research will provide a framework for rapid incorporation into practice in a manner, which will bring maximum impact.

The research broadly follows three lines:

- improved understanding of hazards and their risks at different steps in the food chain, i.e. creating the knowledge base needed to support the rational application of control measures and the development of new methods and systems;
- tools to further secure the food chain, e.g. the development of systems and technologies for continuously improving the safe production and supply of foods;
- understanding of the human factor, i.e. consumer perception of risks and the need for communication.

Among the different hazards, contamination of food with pathogens or with the plethora of chemical agents, which may be present naturally or inadvertently, affords the greatest challenge to the food industry.

There is a major challenge to understand biological hazards individually, in combination, and in the context of their multiple environments throughout the food chain. This includes their behaviour in complex ecosystems and (in the case of pathogenic micro-organisms) their interaction with the host, both animal and human. This understanding should be extended to a full evaluation of the risks resulting from exposure of the consumer to these hazards (risk assessment). Complementary to this, is the evaluation of risks versus benefits of food products, and their nutritional, economic and social significance for the population.

Goal 1. Predicting and monitoring the behaviour and fate of relevant known and emerging biological hazards

Knowledge is required about the nature and behaviour of food-borne pathogens and other undesired micro-organisms, to facilitate decisions on metrics (i.e. food safety objectives, performance objectives, etc), enable adequate control measures and their validation, and support risk assessment. It is important for the European food sector that such knowledge is generated, analysed and integrated with information available today. The overall aim is to efficiently and effectively control relevant microbes and to minimise their risk to the extent possible, in line with the national and international standards. To achieve this it is essential that the characteristics and ecology of pathogens and their complex interactions along the food chain are described as fully as possible. This knowledge will reinforce the basis for the development of tools and approaches for control.

Major research challenges

1. To describe and understand how micro-organisms respond to the various environmental stimuli and stresses which the food matrices present and to predict the effects and eventual consequences that these might have on resistance and persistence.

Deliverables

- Scientific data describing the ecological behaviour of priority food pathogens at different stages of the food chain, including primary animal and plant sources; resistance and resistance development will be of particular relevance (2010),
- Database on the 'omic' description of organisms and microbial communities and factors relevant to ecological behaviour of pathogens (2015).

2. To enhance understanding of behaviour and virulence traits of food-borne pathogens and the mechanisms of emergence: using epidemiological and typing data, monitoring virulence traits and better describing mechanisms of virulence and emergence of virulence, and the effects of the food chain on these characteristics. Reduce or limit and, if possible, replace animal testing.

Deliverables

- Biological models for studying virulence and microbial behaviour in infection including; functional mammalian cell culture systems, artificial organs, both cell culture based and mechanical (computer aided). Validated protocols to study microbial behaviour in such infection models (2015),
- Methodology for studying microbial behaviour in model systems (2018),
- Identification of emerging pathogens and their characteristics (2020).

Goal 2. Predicting and monitoring the behaviour and fate of relevant known and emerging chemical hazards including toxins of biological origin

Chemical contaminants include crop protection agents, veterinary pharmaceuticals, persistent organic pollutants (POPs), packaging contaminants, process contaminants such as heat-generated

toxicants, heavy metals, and biological toxins; they represent known and potential health hazards to humans, most commonly by long-term exposure, through the consumption of contaminated foods.

The manner in which these hazards are currently controlled is sub-optimal for two main reasons: firstly, there is a large knowledge gap as to the importance of specific hazards at the quantities at which they occur in foods, and secondly, detection and monitoring are often complex and expensive.

The risk of chemicals need to be evaluated considering the entire food chain, giving a particular attention to the conditions of agricultural practice, which is a main source for contamination of foodstuffs with biological and chemical hazards. There is a need to develop knowledge on the occurrence of chemical agents as well as their complex interactions in various foods, and to develop an innovative and holistic approach to food safety.

Efficient control of chemical hazards within food safety assurance schemes requires new knowledge about the risks they represent and new tools for their management.

Major research challenges

1. To generate data and knowledge on chemical contaminants in food and strategies for reduction; generating and interpreting data on the fate of chemicals in the food chain (role of primary production, processing, persistence, biotransformation, destruction, accumulation of metabolites, recontamination) and improving exposure assessments for key potential hazards, including the migration of chemicals from packaging materials into food. Such knowledge will be both valuable *per se* and essential to support the modelling activities proposed in Goal 3. Development of measures to avoid biological and chemical contamination in agricultural production and to reduce formation of heat-induced contaminants (which is important for ensuring optimal sensory characteristics), for example, using novel food preservation technologies.

Deliverables

- Data on a) the dynamics of prioritised chemical hazards (e.g. structural changes, interactions with other molecules, heat-induced formation of chemicals from inoffensive precursors and migration from packaging) and b) the levels at which they occur in specific product types (2015),
- Knowledge on the technological, economical, legislative and social impacts of agricultural practices to support strategies for the management of priority chemical hazards (2015).

2. To describe and understand the effects of chemical hazards in humans; new approaches to hazard characterisation for the determination of chemical risks, including improving the risk estimation at very low levels of exposure; identifying chemical hazards and their health effects on humans and determining the levels at which chemical hazards have adverse effect on humans; interaction between toxicants; bioavailability of chemical contaminants; development of artificial organ- and cell culture-based procedures to determine toxicological effects in order to limit and, if possible, replace animal experiments; and gathering and analysis of epidemiological data (special care will be taken to gather and analyse in a population-disaggregated manner including gender).

Deliverables

- Data allowing effective hazard characterization for determining the risks of priority chemical hazards including risks at very low levels of exposure (2012),
- A set of well described exposure biomarkers and a database of epidemiological data organised in a population-disaggregated manner (including gender) (2018),
- Robust and reliable alternatives to animal testing for key toxicological endpoints, based on artificial organs and cell culture to determine toxicological effects so as to limit and possibly replace animal experiments (2020).

3. To develop new methods to support chemical food safety; development and validation of analytical techniques and sampling plans for chemical contaminants, of non-destructive technologies for on-line monitoring of chemical residues and for off-line screening, based on a holistic approach, to evaluate the 'total toxic charge', including both targeted and untargeted compounds. This includes novel biomarkers of exposure to key contaminants and analytical tools for multi-residues exposure scenarios.

Deliverable

- Validated analytical techniques and sampling plans for priority chemical contaminants including a) reference/precision techniques, for research and anticipation, and confirmatory purposes, b) rational/accessible and simple techniques for direct field application, and c) in-line methods for continuous safety management in food processing (2015).

Goal 3. Improving risk assessment and risk-benefit evaluation

Quantitative risk assessment is the knowledge base for building a food safety strategy. The tools being developed within this area (including predictive modelling) are important competitive instruments that underpin innovation in the development of novel products. Research in this area will be important both to further develop the science and to make these tools more widely available within the food industry. The approach will need to address the increasing complexity of food products and it is certain that the trend will be towards risk-benefit assessment.

The European Union already possesses, at national and regional levels, highly credible public organisations with responsibility for food safety and which are capable of identifying their own R&D needs to support their legislative and control functions. The food industry has a history of healthy 'antagonism' with these official food control institutions and the rationality in the current legal and control environment has been greatly influenced by this. It will be important for the food industry to continue to identify and promote its own research into aspects of food safety, which may influence the development and application of control measures.

The challenges here deal with risk (pertaining to negative effects), benefit (pertaining to positive effects) and communication. European society will need to approach these research challenges in a well-integrated manner. Applying risk-benefit analysis in a holistic way is the means to evaluating the real impact of the total of a food (or dietary pattern) to human health and well-being in its many forms, as an alternative to focussing on the individual toxicological characteristics of each molecule. Elements of this overall task are dealt with in other key challenges of this ETP.

The food sector needs to:

- evaluate the risks and benefits associated with consumption of specific foods, food categories including traditional foods, and based on consumption patterns (knowledge),
- integrate this knowledge into appropriate risk-benefit assessments, and
- communicate this information in an appropriate form to the various stakeholders of the food chain (knowledge and skills).

The overall objective is to build a 'science and skills' base that successfully supports the development and communication of risk-benefit analyses on specific raw materials, food products and product categories, and to develop further knowledge on consumption patterns.

Major research challenges

1. To gather and generate relevant data on food composition and consumption patterns including ethnic and traditional foods, where possible in a continuous way building on existing initiatives such as EuroFIR; and on epidemiological, analytical and toxicological or physiological data on chemical and biological contaminants.

   Deliverable

   - Databases on food composition and consumption patterns including ethnic and traditional foods (2010).

2. To develop and validate appropriate science based quantitative risk assessment tools and models (*in vitro, in vivo, in silico*) based on the generated data for those areas with the biggest impacts on reducing food-borne illnesses; refinement of data required for risk assessment of food allergens and tools to analyse such data.

   Deliverable

   - Tools, protocols (including user-friendly software) and their application for comparative risk analysis (2012).

3. To develop and validate scientific approaches to carry out risk versus benefit evaluation along the food chain.

   Deliverable

   - Validated approaches to carry out risk and benefit evaluation along the food chain (2015).

4. To develop and design tools based on models (see above and see Goals 1 and 2), for the evaluation of the individual and combined effects at every stage of the integrated food chain.

   Deliverable

   - alidated tools/models/software for the design of safe products and processes (2016).

Goal 4. Developing tools to ensure security of the food chain

The aim is to further improve the safety of competitive foods in the market place by developing and making available tools for prevention and control of specific hazards, traceability, authenticity and food defence (adulteration and bioterrorism) at appropriate points in operational food chains. This will provide the technologies on which harmonised, focussed and cost-efficient management activities and safety policies can be implemented. The understanding and knowledge generated from the research needs identified in Goal 1, above, will be employed in the development of technologies presented here.

The detection and prediction of hazards in foods have also advanced considerably in recent years. This has permitted a more precise evaluation and validation of existing and novel technologies, speeding up both their development and time-to-market. The success of the modelling approach to hazard behaviour demonstrates the wisdom of investing in tools, which address the complexity of modern foods.

New techniques for detection of hazards or their controlling parameters are constantly being sought to improve food safety assurance. Successful new approaches frequently represent new opportunities for surveillance, tracing of sources of hazards and many other areas of research, which have a direct impact on food safety at a societal level. Research on new or improved measurement of hazards will have a multiplier effect and these lines of study should always be advanced wherever they show genuine promise. Advanced technologies for safety interventions throughout the food chain will provide new options for control over the safety of raw materials, processes and finished products. Their development, validation and implementation must cover all aspects of food production.

Development and agreement on validation concepts and models is a crucial pre-requisite to successful acceptance of the outputs of this type of research and must be addressed in the drawing up of EU-wide initiatives. 'Validation' must not only include technical performance but also aspects of regulatory- and consumer acceptance.

Major research challenges

1. To develop technologies for reduction or elimination of hazards at the level of primary production.

   Deliverable

   - Technologies for improving practices in primary production, including breeding and selection of intrinsically safe plants and animals for foods (from 2015).

2. To develop novel technologies for reduction or removal of chemical and biological hazards during processing.

   Deliverable

   - Robust and flexible processing technologies that assure food safety (2015).

3. To develop effective methodologies for tracking and tracing of microbes, contaminants and allergens along the food chain

   Deliverable

   - Validated technologies for tracking and tracing (2012).

4. To develop new logistic approaches for strengthening safe distribution of foods, including abuse detection and approaches for the prevention of food adulteration and bioterrorism.

   Deliverable

   - Efficient and safe distribution of foods (2020).

Goal 5. Understanding and addressing consumer concerns with food safety issues

Despite the fact that, in objective terms, food has probably never been safer, consumers continue to express concerns with the safety of their food. This has at least partly to do with the fact that consumers do not have direct first-hand insight in the safety of food products and food production systems. For such assessment they must rely on information provided by others and so the trust or confidence that they have in actors and institutions is an important factor in their perceived confidence in the food provision system. It is generally accepted that zero risk is not possible and increasingly the focus shifts towards risk-benefit approaches, which in turn brings new challenges for risk communication. An understanding of the way in which consumers perceive risks, and also of the role of various stakeholders, including the media, is a prerequisite for successful risk communication.

Major research challenges

1. To identify and quantify determinants of consumer trust and confidence in the food provision system (including trust in actors and institutions) for an understanding of consumer confidence and its changes over time (monitoring).

   Deliverable

   - Quantification of the determinants of consumer confidence in food provision systems and similarities and differences across Europe (2010).

2. To understand consumers' perception of risk issues, particularly in the context of risk-benefit trade-offs and the amplification of risk perceptions beyond the available scientific evidence.

   Deliverable

   - Effective prediction of how public perception of risk develops through interactions between consumers, media and stakeholders (2010).

3. To understand the way the European consumers prefer risks to be communicated to them (by whom, frequency, modality) in normal times as well as in case of incidents or crisis.

Deliverable

- Insight into the preferences of European consumer's for risk communication (2012).

4. To develop effective consumer communication strategies and messages on risk-related issues (including communication of risk-benefit and cost-benefit analyses, and uncertainties).

Deliverable

- A set of effective risk communication strategies for the public (2020).

Key Challenge 5: Achieving sustainable food production

Scope

Consumers are increasingly motivated to purchase foods that conform to production criteria that are environmentally-friendly and to their ethical principles while still being affordable. In addition there are overall societal pressures for food production and supply to be more sustainable. Over the past three generations, food production systems in Europe have developed with a focus on security of supply with low prices to the consumer, whilst at the same time seeking to reduce environmental impact and maintaining economic returns to rural communities.

However a number of factors contribute to the unsustainability of existing European food production and supply system. These include:

- Heavy reliance on an input of nonrenewable resources such as fossil fuels,
- Contribution of food production to environmental problems, such as the diffuse distribution of nitrogen and phosphorous in the aquatic environment,
- Reduction of farm work and changes in demography of rural populations,
- Environmental impact of chemical use in agriculture,
- Socio-economic impact of trade barriers, and
- Uneven distribution of revenues to the different actors in the food production system.

The recent expansion of the EU has brought about an increasing diversity of food production systems affording the opportunity to utilise this diversity to create and support a variety of sustainable global, regional and local food production systems.

Considerations of sustainability will need to guide future developments in European food production and must be an integral part of all developments.

Given the highly interlinked nature of food production and the many aspects of 'sustainability' that need to be addressed, it is important to embrace a holistic view of European food production and supply systems. The agricultural production of non-food systems must also be included in consideration of sustainablity. The transition towards more sustainable European food production and supply systems must also go hand-in-hand with strengthening the competitiveness of the stakeholders in the European food system. To achieve this, synergies must be created between economic growth, environmental protection and fair social conditions. To achieve this it will be necessary to:

- understand the sustainability of food production and supply in Europe,
- develop scenarios of future European food production and supply,
- develop sustainable processing, packaging and distribution systems,
- ensure sustainable primary food production in Europe, and
- understand consumer's attitudes and behaviour towards sustainable food production issues.

In developing the responses described below, close contacts will be developed with the other Knowledge-based Bioeconomy ETPs Plants for the Future, Global Animal Health, Biofuel and Sustainable Chemistry which address sustainability issues ithroughout their Strategic Research Agendas.

Within this ETP sustainability development is defined as: "an environmentally sound, economically viable, and socially acceptable development".

Goal 1. Progressing the sustainability of food production and supply in Europe

The ETP Food for Life aims to substantially contribute to more sustainable food production, processing, storage, distribution and consumer handling of foods. Several analytical approaches are available. Life Cycle Assessment (LCA) has been developed to identify and quantify the environmental impacts of individual products and services with a system analysis perspective.

The food chain is a complex inter-linked system, requiring a system analysis approach for assessement of sustainability, including evaluation of social (e.g. fair working conditions, rural development and gender equality) and economic (such as fair distribution of revenues along the food chain) dimensions of the studied systems, as well as the environmental impacts. Input/output analysis is likely to be another useful approach and will need to show both the social- and environmental consequences of alternative food supply systems. These analytical assessment methods must also be developed to show clear comparisons between different scenarios, including imports of foods into Europe, so as to reveal the consequences of different supply and consumption patterns.

Models must be constructed to identify sustainability indicators, which can then be validated and used for comparing different scenarios. These indicators should then be used to monitor progress towards sustainability in different food chains. To support multi-criteria decision processes, models should be developed that can be optimised to show the effect that positive changes in one indicator might have on another. The system analysis should also study the possibilities involved in sustainable utilisation of biological materials for food and non-food applications. These models will also provide data for inclusion in public databases of European food and biological material chains, to be used in improvement analysis and scenario development.

Major research challenges

1. To develop a methodology for describing the essential parameters of sustainability of the food supply system using system analysis-based sustainability indicators.

Deliverable

- A range of regional and commodity food chains will have undergone system analysis of sustainability; appropriate sustainability indicators will be developed (2010).

2. To develop dynamic modelling tools to determine and demonstrate the sustainability frontiers of different food production systems in order to drive innovation into more sustainable solutions.

Deliverable

- Sustainability indicators will be quantified for many food chains and applied to show the scope for improvement; (this information will have been used to guide development in the other goals of this theme) (2015).

3. To formulate models to describe food and biological raw material chains in Europe in order to show the sustainability of different supply chains in the context of the whole European system.

Deliverable

- Dynamic modelling tools will have been developed and used for the rapid identification of more sustainable production and processing systems for a range of food products at different regions in Europe, as well as systems for sustainable use of biological materials for both food and non-food applications (2020).

Goal 2. Developing scenarios of future European food production and supply

Scenarios are 'possible futures', intended to provide insight into the consequences of multifactorial change, e.g. demographics, economy, environment and world trade, often based on projections of societal futures and quality of life issues. Scenarios are a well established way to structure "What if?" questions. While scenarios are widely used, there have been few applications to the European food production system. The need for such scenarios is becoming more evident as changes in European food consumption, and thus production, are expected to be more dramatic in the future. The following examples highlight how scenarios can elucidate 'possible futures':

- Global climate change is projected to have multiple impacts on primary food production, populations and markets, including changes in the suitability of certain areas for particular crops. A comprehensive picture of the effects of climate change on the sustainability of the food production system is still elusive.
- Dependency on fossil fuels. The European food production system depends heavily on fossil fuels, with both production and distribution sensitive to fuel prices. The effect of energy prices and fuel availability on the sustainability of the European food supply system must be explored.
- Political boundary conditions such as the economic compensation to farmers through the European CAP (Common Agriculture Policy) and the CFP (Common Fishery Policy) and global trade agreements also influence the sustainability of the European food supply system. The consequences of alternative policies should be studied using scenario techniques. These studies will be carried out in close co-operation with those described under Key Challenge 6 (Managing the food chain), and in consultation with the Key Challenges 1, 2 and 3 (Food & Health, Food Quality & Manufacturing and Food & Consumer).

Major research challenges

1. To identify relevant factors in the future that will affect or improve the sustainability of European food production systems, and use them to build scenarios, integrating demographics, economy, policy and trade and environmental change. Scenarios of a global and 'top down' character will be undertaken where expert assessments are made based on existing knowledge and methods for analysis and prediction. Comparision with 'bottom up' scenarios based on participation and interviews with stakeholders are also required.

Deliverables

- A number of scenarios will be developed illustrating the consequences of different futures, based on the present food production systems (2010),
- Future food production scenarios will be possible on the basis of a few relevant general scenarios (2010),
- New and alternative highly sustainable food production systems will have been identified. (2015).

2. To use scenarios to study “What if?” alternatives, for a number of food production systems and policy options, using a 15 to 100 year perspective.

Deliverable

- Radically novel food production systems will have been proposed (2020).

Goal 3. Developing sustainable processing, preservation, packaging and logistic systems

Industrial food production focuses on economic efficiency, reliability, safety and consistency to meet market demands. Current systems of manufacturing, preservation, storage, processing, packaging, transportation and distribution, and retail show limits in their sustainability, in wasteful use of natural resources through extensive losses, and waste creation along the food chain. Valuable food raw materials are wasted and the consequence is overproduction in the primary sector. Policy or market circumstances may favour unsustainable patterns of production and consumption.

Reduction in uses of energy, water and materials will require close links between raw material production, processing, packaging and waste management. The development of viable processes and strategies for converting and adding value to food industry by-products, into compounds suitable for agro-, biotechnology-, or food industry applications using the biorefinery concept, will be important for increasing sustainablity.

A reliable cold chain is of major importance to food safety and quality. Food refrigeration is facing a number of sustainability-related challenges, which require special attention. Identification of the potential for improvement through sustainability analysis will be an important driver for innovation that is directed towards new and novel technological solutions for food processing, packaging and transportation. As food industries are highly complex and spatially-distributed, research into more sustainable food production systems must explicitly account for this complexity.

The 'Industrial Ecology Approach' aims to restructure production systems into clusters of industrial firms with output-input connections as stocks and flow of materials, energy and information, according to the principles of ecosystems. Such an approach applied to the food chain will include analysis of interlinked networks of primary food production, food processing, distribution and packaging. It will also help to identify possiblities for innovative new agro-, biotechnology-, and food industries.

Major research challenges

1. To develop methods for value chain analysis of entire food chains explicitly incorporating the assessment of economic, environmental and social factors.

Deliverable

- Methodologies will be developed for coupled value chain and sustainability analysis (2010).

2. To develop viable approaches and innovations to reduce energy, water and material use in food processing and packaging; improve utilisation of food raw materials and reduce waste throughout the production chain by developing systems for reprocessing of adding value to food waste to food or feed, using the 'biorefinery' model.

Deliverables

- Improvement potentials for highly wasteful processing, packaging and transportation operations will be identified and solutions will be identified (2010),
- New scientific approaches will underpin the sustainable management of biological raw materials in food production systems and clearly established methods for improving their sustainability, including options for non-food uses will result (2010),
- Novel multi-dimensional food production and chain systems will be developed which will strengthen the economical viability of rural areas based on research on sustainable food production (2020).

3. To build different industrial systems, including food primary production and food industries in 'industrial ecology' relationships, exchanging matter, water and energy and economic value in inter-industrial networks.

Deliverable

- Highly integrated sustainable village systems, including food production systems will be developed and implemented (2020).

Goal 4. Ensuring sustainable primary food production in Europe

Within the next few decades, primary food production in Europe will experience major environmental, social and economic changes. These include climate change, changing international trade relations and regulations, and large-scale shifts in global food production and demand. The future knowledge-based bio-economy will also bring about an increased competition for land for production of biological raw materials for food, feed, fuel, forestry and green chemistry. The societal demands on improving the sustainability, and the environmental impact of primary food production, will force a continued adaptation to these changes towards more sustainable systems.

In this industry-driven ETP the view of the primary production is principally that of a raw material supplier within the food chain. Other aspects of primary production, such as improving plants, animal welfare and alternatives to traditional fishing are addressed in other ETPs (Plants for the Future, Global Animal Health, Sustainable Chemistry, and Aquaculture). This ETP will focus on analysing and promoting the sustainability of primary production systems in a food chain perspective.

While additional research will expand knowledge to further enhance traditional food production, radically different primary food production systems may provide additional sources of food to that derived from traditional food production. These should be analysed in terms of their sustainability in order to target effectively further research into the most promising approaches, as exemplified below.

Biotechnology may, beyond its present role, be used to produce desired crop biomass in a targeted way, and to provide plants with better taste and nutrition besides intrinsically better production properties. Further fine-tuning of production systems through precision farming and other high-tech solutions could increase the efficiency of primary food production. Alternative systems for protein supply from animal and plant sources should be evaluated, including ethical issues e.g. animal welfare.

Major research challenges

1. To identify and analyse the major environmental, social and economic pressures of primary food production (crop, livestock and fish) constraining the sustainability of the food chain and investigate options for alleviating these pressures and analyse the implications for sustainability.

Deliverable

- The knowledge base required to optimise existing primary food production systems and identify novel systems and assessment of their sustainability will be achieved (2010).

2. To identify novel primary food production systems and evaluate their sustainability.

Deliverable

- The fully integrated management and assessment of sustainable primary food production systems (both established and novel) will have been achieved (2015).

3. To analyse and optimise sustainable biological production systems of food, feed, fuel, forestry and green chemistry including aspects of landscape and quality of life issues.

Deliverable

- Sustainable management of man-nature systems for biological raw material production, including primary food production systems will have been established (2020).

Goal 5. Understanding consumers and their behaviour regarding sustainable food production

To succeed in the market, sustainable food production must meet consumer expectations and preferences. But consumers need to be informed about these other values of food. Food supply systems have become global and agricultural production is increasingly striving for economic efficiency and reduction of pressure on resources such as biodiversity, land, energy and water.

Consumers appreciate products originating from all over the world all year round. A diet with for example more meat exerts considerable pressure on resources, for animal husbandry and fisheries use disproportionate quantities of resources. At present almost half the world's grain harvest is presently fed to animals. Consumers are concerned by how far their food is transported and under what conditions animals are kept or plants are cultivated. There is also increasing consumer awareness about the ethical dimensions of food production, including sustainability and this is influencing purchase decisions in the more affluent societies.

In view of the increasing complexities of food choices, research is needed into value-related purchasing motives and into how sustainability and other food values can become one of these motives. Effectively harnessing multidisciplinary research into the production of sustainable diets will by itself be innovative and will also provide a model for other areas of activity.

Major research challenges

1. To analyse and monitor the sustainability of emerging lifestyle trends (including food waste generation, energy and water use) and food consumption patterns.

   #### Deliverable

   - The influence of lifestyle trends on sustainability of the food production system will be analysed (2010).

2. To understand how consumers are prepared to pay for, or deny themselves (e.g. in terms of convenience and taste), food products produced in a sustainable manner, and how responses differ between different consumer groups (according to gender, age, region, socio-economic grouping).

   #### Deliverable

   - The effect on consumer actions of future socio-economical policy options of sustainable food production will be known (2010).

3. To analyse purchasing motives, related to ethical convictions, of different consumer groups in different European regions.

   #### Deliverable

   - A quantified model of how (groups of) consumers understand, value and behave in response to more sustainable food products and production systems will have been developed (2010).

4. To analyse dietary sustainability, develop and validate measures for quantifying the level of sustainability of shopping baskets/food consumption patterns and understand consumer expectations, attitudes and responsiveness to sustainable products, production systems and corporate social responsibility.

   #### Deliverables

   - An enhanced consumer responsiveness to sustainability in food products and food production systems will have been proposed (2015),
   - Future sustainable protein supply in the European food production system will have been analysed and solutions proposed (2015).

5. To develop appropriate materials for educating and informing stakeholders about sustainable food production (to maximise consumer preference for products derived from sustainable food production systems).

   #### Deliverable

   - Research will have lead to a more general public acceptance and preference for food from sustainable food production systems (2020).

Key Challenge 6: Managing the food chain

Scope

The food sector as a whole is faced with major challenges that arise from changes in the sector's economic and non-economic environments, from changes in lifestyles, from global increases in food consumption, and from a diminishing production base due to, e.g., the loss of arable land or its divergence for non-food production alternatives.

The challenges cannot be met by any individual enterprise but require concerted actions and co-ordination of initiatives. Food Chain Management (FCM) provides support for the identification and realisation of 'best' concepts for such actions and co-ordination needs. This support, in turn, provides enterprises with the means for improving their own and the sector's competitiveness, sustainability and responsibility towards the expectations of its customers and the society.

In meeting its challenges the sector needs to innovate in organisational relationships that reach beyond innovations in process improvement by building on the innovation potential inherent in enterprise networks and their flexibility in responding to customers' and consumers' demands. There is an urgent need to adjust the trend towards increased process integration along the value chain to the organisation of a flexible and responsive network approach by utilising the potential of technological change, of information and communication systems, and of institutional change.

Food Chain Management support is towards the actors that represent the food value chain, suppliers, primary producers, processors, manufactures, and retailers which have consumers as the final customers. Its support can focus on operational improvements or on strategic development perspectives (Strategic Food Chain Management) that involve major investments and long-term commitments. A specific strategic development perspective concerns the investment in sector-wide infrastructures such as electronic networks for tracking and tracing in food safety control. Such infrastructures could serve and benefit the sector as a whole but are beyond the investment capability of any single group, especially if their benefit depends on participation of a majority of enterprises, including SMEs which might take time to materialise. For the infrastructures to become feasible and to deliver the envisaged benefits not just for enterprises and the industry but for society as a whole the investment in conceptual design, organisational agreements, and financial responsibilities require complementary engagement of groups from outside the value chain including research and policy, i.e. a Food Chain Management view that integrates policy and management initiatives alike.

Specific issues the food sector and its individual actors need to deal with for timely and appropriate response to the sector's challenges.

- To adapt rapidly through changes in resource use, products, processes, services, and governance structures to changing scenarios (markets, policy, resource availability etc.) and their requirements within a sector organisation that is difficult to co-ordinate as its enterprises are rarely confined to well-structured chain relationships with established communication and co-ordination mechanisms but are usually part of an open enterprise network where enterprises may change their suppliers and customers at will.
- To overcome the sector's structural problem with its large number of SMEs. Their ability to innovate and interact successfully with the large and multinational enterprises, especially in agricultural supply industry and retail, depends on co-operation initiatives and the provision of external co-ordination support.
- To focus on changing consumer needs. These depend on a continuous adaptation of new developments in technology, production, management, communication, organisation or co-operation and on the establishment of trust between all stakeholders along the food value chain including the consumer.

The challenge for Food Chain Management is to integrate and balance the interests of all stakeholders, including enterprises, consumers, and society as a whole considering of all of the relevant factors for successful integration e.g. economic efficiency, environmental control, process organisation, food safety, marketing or transaction rules, etc.

Four interrelated strategic research initiatives have been identified as decisive for the sector's ability to

meet its future challenges and to overcome its inherent development problems. They focus on serving:

- consumers through the provision of quality and diversity in food they can afford and trust,
- food chains through better transparency for advancements in governance, trust, efficiency, and innovation dynamics,
- SMEs through better integration into the global and regional value chains, and
- the sector through better understanding of the dynamics in those critical success factors that will improve competitive performance and sustainability in times of globalisation and change.

These initiatives involve a three-stage approach:

1. Analysis of external scenarios, the analysis of development needs and development opportunities,
2. Identification (engineering) of problem solutions that could serve Food Chain Management initiatives, and
3. Estimation of costs and benefits for different stakeholders including enterprises, consumers, and policy.

Because of the sector's complex enterprise infrastructure and the difficulties in reaching sector agreements, pilot and demonstration activities are required to facilitate acceptance and implementation (Figure 12).

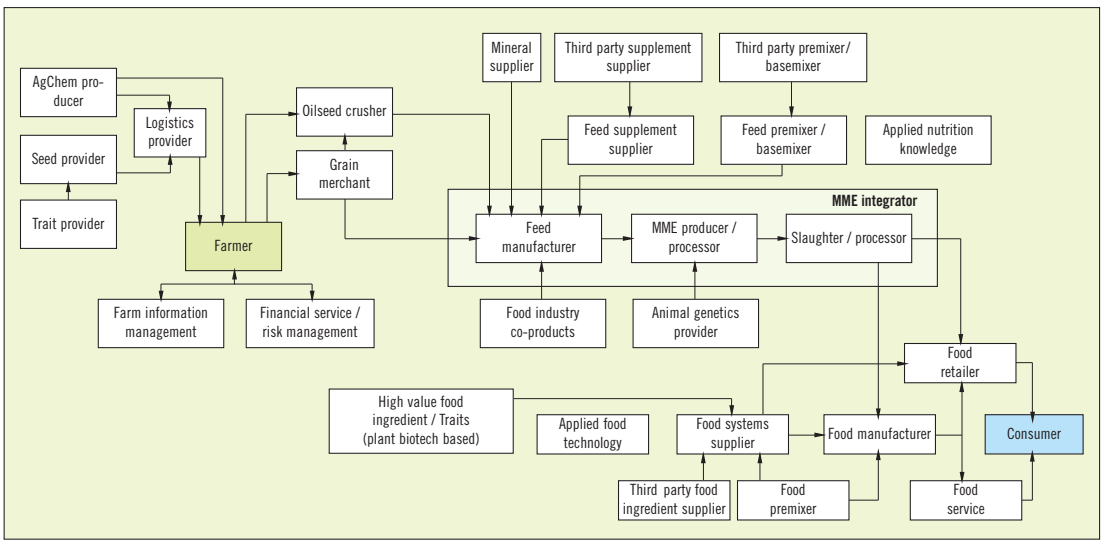


Figure 12. The value chain: focus of Food Chain Management.

Goal 1. Serving consumer needs for affordable food of quality and diversity

The food sector faces three strategic developments regarding its production base that put pressure on its capacity to innovate. They are: a) increasing demand for bio-energy, b) limits in the availability of water and c) diminishing production resources (e.g. land for agricultural use). Furthermore, food production will be affected by pressure from a growing world population and the desire for an increased consumption of meat. Possible changes in climate might aggravate the consequences. At the same time, consumers expect a steady increase in quality and in the diversity of food. Without innovations, consumers' need for affordable food without compromises in quality, and which continues to retain their trust, cannot be served in the long run.

Consumers' perception of food quality is a dynamic variable. It might focus on products, processes, process management or on management issues such as fairness in trade, working conditions, environmental consciousness, or the origin of products. Its understanding depends on lifestyles, cultures, etc. New types of efficient and responsive co-ordinated production, distribution, and communication networks (logistics networks) must emerge that can support these changing demands, taking into account varying quality parameters, organisational conditions and different requirements of market segments. This may include, e.g. new organisational structures

for flexible chain-encompassing distribution and logistics systems that utilise advanced technologies for communication, control, or tracking and tracing, developments in quality preservation, new packaging and processing technologies or organisational innovations like parallel chains that could provide opportunities to better serve the needs of consumers.

Diversity in food is a strength of the European food system. This places the European food sector in a good position to further diversify e.g. in the production of tailor-made foods that specifically relate to people's age, health status, activity, or any other criteria. However, Europe's strength in food diversity is not yet adequately integrated into the emerging global food system. New business-to-business relationships are required that are highly responsive to dynamic consumer and market demands and at the same time cost-effective. This poses challenges for innovations in chain encompassing production, distribution and communication networks that can efficiently compete with classical systems in commodity markets.

The continuous provision of affordable quality food from a decreasing production base can be supported through process improvements involving, e.g. reductions in losses, delivery on demand to avoid over-supply (just-in-time), the efficient integration of new technological developments (in, e.g., production, analytical methods, logistics, or communication) and through an institutional environment that supports successful adoption of different principal technological developments. The analysis of 'best practice' experiences can serve as a basis for suitable process reorganisations and institutional infrastructures on which innovations in technology, manufacturing, organisation, and management can build.

Efficiency and flexibility are at the core of quality assurance in scenarios with changing consumer demands. Research on the identification of separable functions in production and trade and on the standardisation of interactions allows the formulation of models for the re-bundling of functions into new types of efficient, flexible, and responsive logistics networks that could reduce current inefficiencies, lower costs and increase the creation of value and product differentiation. New flexible enterprise relationships are required that support the re-bundling of functions across enterprise borders for better serving changing consumer needs (Figure 13).

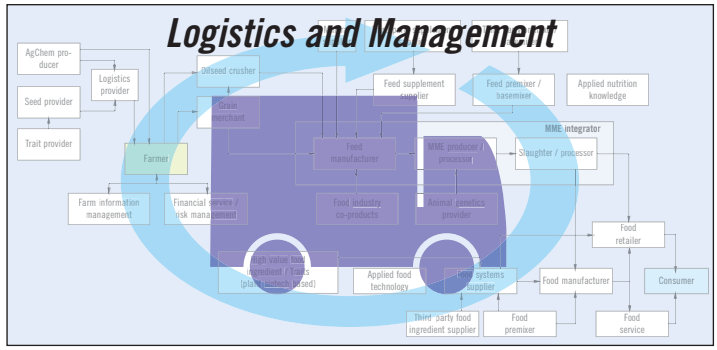


Figure 13. The improvement focus of Goal 1 for better serving consumers.

Major research challenges

1. To determine opportunities for innovations and improvements in the organisation of processes (in production, logistics and management) along the value chain.

Deliverables

- Specification of 'best practice' process organisation alternatives from production agriculture to food deliveries at the retail stage (through, e.g. the reduction of waste) that will allow the potential for further improvements to be identified (2010).
- Specification of 'hot spots' in process organisations that will allow improvements in the delivery of food through appropriately focussed developments and innovations and the elimination of development and innovation barriers in processes and institutional environments (2013).
- Specification of a priority 'landscape' for the initiation of activities that reduce barriers and support process development, process innovation, and institutional change (2015).

2. To analyse and model organisational network alternatives that combine efficiency and responsiveness to changing consumer demands for quality and diversity.

Deliverables

- Identification and analytical analysis of functions along the food value chain that could be separated for individual process optimisation 'in their own right' together with the specification of possible linkages with other functions for the creation of value chains and the formulation of appropriate standards for connectivity (2010).
- Identification and analysis of 'best practice' experiences in the realisation of separable functions, of major weaknesses in those functions that ask for developments and innovation, and of regulations or barriers

from institutional, legal, cultural or any other environment that might limit the efficient integration of functions into value chains (2015).

- Design of generic simulation and optimisation models that support flexible adjustments of global production and logistics networks in case of changing customer and consumer demands or in case of disruptions in deliveries or distribution networks (2020).

Goal 2. Serving transparency needs for advancements in chain governance, efficiency, innovation dynamics, and trust

Strategic advancements in the competitive strength of food value chains and their adherence to society's values build on a number of critical success factors, of which 'appropriate' transparency, i.e. transparency that fits the different needs of the various stakeholders stands out as decisive. Focussed information and communication concepts that serve the different transparency needs are the key for the dissemination of knowledge, for innovation, for risk containment, for appropriate co-operation and co-ordination within the value chain, for appropriate integration of SMEs in chain activities, and for the establishment of trusted relationships between enterprises, consumers and the society.

Transparency follows the production and distributions paths along the value chain. As such, it builds (and depends) on information infrastructures that monitor process activities and allow the tracking and tracing of products and services throughout the value chain. Transparency has a backward and a forward perspective depending on the stage of the value chain from where the value chain is looked at. For the consumer, transparency is based on a backward perspective. However, for enterprises it might have both, a backward and a forward perspective. In its risk containment strategies it might not only want to know the production history of its products

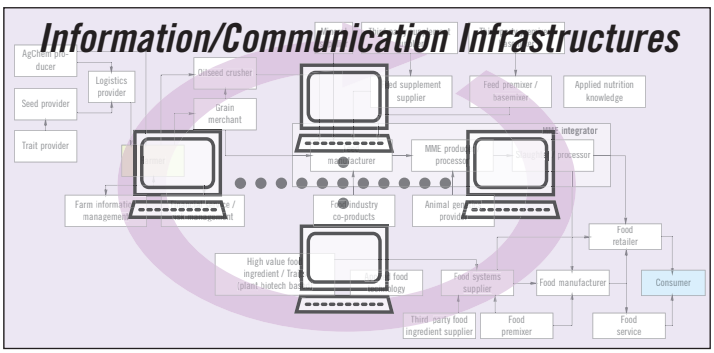


Figure 14. The improvement focus of Goal 2 for better transparency.

(backward perspective) but the distributional activities of its enterprise customers (forward perspective) to understand its potential risk in recall situations, especially if consumers are involved.

The ability for tracking and tracing is a pre-condition for the identification of many other food quality issues. Its implementation requires a consistent system approach that in order to be effective requires a broad acceptance by the food sector, including its SMEs. It involves sector agreements on many different issues, including content and format of communication, data ownership, management organisation, system organisation, technology, access, rules, decision authority, etc. While systems for tracking and tracing are the basis for any further development of quality-based communication networks, the dynamics of these innovations need to be supported by complementary quality communication that allows the efficient exchange of information on quality innovations within the food value chain and, eventually, with the consumer.

Transparency may be served through an institutional environment that finds its expression in business norms, technology standards, communication agreements, information networks, codes of practice, legislative frameworks and societal rules. To take food safety and quality as an example, its understanding has many dimensions and might differ between cultures, regions, or products or along the value chain. It might focus on products, processes, process management or on management issues such as fairness in trade, working conditions, environmental consciousness, or the origin of products. This makes co-ordination of trade relationships and harmonisation of policies, quality systems, standards, information networks and communication agreements a prerequisite for transparency and balanced development.

Transparency along the value chain of enterprise relationships and process activities needs to support the objectives of the different actors in a variety of ways. This support includes e.g. improvements in efficiency or flexibility, the ability to deliver guarantees of various kinds, including guarantees for food quality, for food safety or for continuing deliveries in case of failures in food safety or quality, in risk control, and for the sustainable generation of trust. This wide array of transparency needs shows the complexity and variability of transparency needs which need to be understood and integrated into a transparency map which serves as a basis for the development of appropriate transparency schemes and systems.

Limitations in actual implementations of sector transparency together with dynamically changing needs require the design and delivery of reference models for the establishment of flexible transparency systems that match current transparency needs. They must be flexible to adapt to changing requirements and sector infrastructures (Figure 14).

Major research challenges

1. To understand and map tracking/tracing and transparency needs of enterprises, chains, and consumers (transparency needs).

Deliverables

- Identification and analysis of tracking and tracing needs across enterprise and country borders and specification of contents and standardisation needs in content and communication (2010).
- Identification and analysis of 'best practice' transparency experiences (including those with local and regional scope) and the feasibility of transfer to the sector level (2013).
- Identification and analysis of a 'transparency map' that builds on tracking and tracing needs and capabilities, best practice experiences, and analytical approaches and specifies the different layers of transparency needs related to the focus of transparency, the different cultures (countries), the different stages of the value chain, and the different consumer groups (2015).

2. To design reference models (blueprints) for tracking, tracing and transparency networks that serve value chains and consumers (system design).

Deliverables

- Reference models (blueprints) for integrated and flexible networks for tracking, tracing and food quality transparency that serve different user groups and transparency needs, identify organisational, managerial, technological, and economic alternatives, outline flexible development paths and specify suitable information sources (2015).
- Reference models (blueprints) for flexible multi-layer transparency networks that build on tracking, tracing and quality assurance needs but add transparency layers supporting chain efficiency, chain governance, and innovation dynamics (2020).

Goal 3. Serving SME needs for better integration into value chain relationships

For SMEs, organisational and managerial integration concepts are key issues for improving competitiveness given the complexity of food markets now and in the future. Food Chain Management support builds on the identification of integration needs and barriers, and the initiation and management of integration initiatives and SME networks that allow SMEs to participate in the food sector's innovation dynamics, and become an integral part of future food value chain developments on a regional and global level.

However, little is known about the integration needs that relate to different scenarios, value chain organisations, regions, cultures, etc. Integration could focus on many different functions as planning, quality management, research, logistics, knowledge, sales, procurement, information management, marketing, packaging, production, etc.

For SMEs, horizontal integration and the participation in horizontal networks is usually the base on which efficient vertical integration can build. However, while horizontal integration could strengthen the ability of SMEs to become successful partners for vertical co-operation requirements, as, e.g. in quality improvement initiatives, the ability of SMEs to cope with the challenges of vertical integration may still differ. As a consequence, the food sector will need to develop different levels of integration, resulting in a segmentation of markets with different levels of excellence and regionalisation (local, national, or global). SMEs with lower levels of management excellence might remain outside the emerging global food chain developments and remain restricted to local or regional markets with different integration needs and barriers but also different needs for support.

Integration support initiatives require information on what are the integration needs in various functions, their importance for different food chain scenarios, the possible levels of integration, and the consequences for performance and innovation support. However, integration needs usually have to face integration barriers, which prevented integration in the past. There is a need to understand these barriers and how they might be overcome. This knowledge allows the development of reference models for the utilisation of integration opportunities and development paths for their realisation.

Integration needs to build on operational co-operation concepts that may involve many detailed issues such as the organisation of internal information and communication systems, co-ordination procedures for resource utilisation, integrated logistics designs for vertical relationships, collaborative planning approaches, risk management procedures, etc. Research needs to identify and analyse economically feasible SME co-operation options, which could support the most common integration needs. An evaluation of possible performance gains, and of the innovation potential of co-operation alternatives, should allow realistic proposals to be formulated.

Innovation builds on knowledge, knowledge generation, and knowledge exchange in networks.

Innovation results from the combination of knowledge, the identification of suitable comprehensive utilisation concepts (technology, information, management, logistics, marketing, etc.) and their realisation in the food sector environment. The challenge for research is the design of a knowledge concept that supports the generation of innovation and builds on knowledge about discoveries, new product developments, patents, new managerial concepts, new technologies, new communication potentials, etc. with potential relevance for food production and distribution (Figure 15).

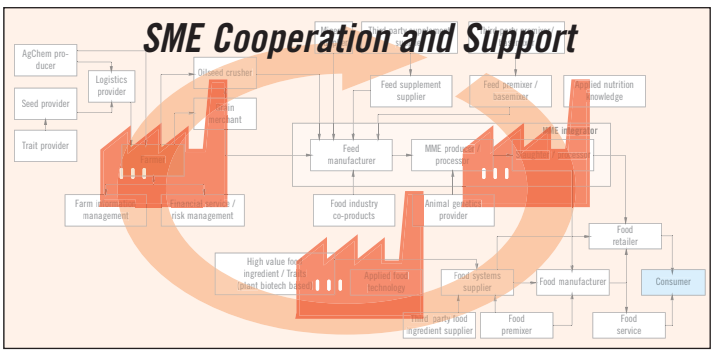


Figure 15. The improvement focus of Goal 3 for SME support.

Major research challenges

1. To better understand integration needs and integration barriers.

Deliverables

- Specification of horizontal and vertical integration needs, of barriers for successful realisation and of opportunities for policy and the institutional environment to facilitate integration through a reduction or elimination of barriers (2010).
- Specification of 'best practice' horizontal and vertical integration experiences with their approaches for overcoming barriers and the role of institutional environments (2013).
- Specification of reference models (blueprints) for suitable organisational integration alternatives (and paths towards their realisation) that best cope with potential barriers and possible institutional environments for different food chain scenarios (products, regions, stage of the value chain, etc.), and for their integration into global or regional food chain activities (2015).

2. To model and deliver suitable approaches for functional co-operation (e.g. collaborative quality planning) in SME networks.

Deliverables

- Specification of 'best practice' functional co-operation concepts (2015).
- Specification of reference models (blueprints) for suitable and 'optimal' functional co-operation alternatives (related to financial feasibility, transition costs, benefits, etc.) for different integration scenarios (e.g. institutional environment), different chain relationships (regional, global) and different regions and product lines (2020).

3. To model and support knowledge communities for SME innovation support.

Deliverables

- Specification and mapping of SMEs' knowledge needs and 'best practice' experiences in knowledge exchange in global or regional food chain activities (2015).
- Specification of reference models (blueprints) for knowledge generation and dissemination networks that identify sources of knowledge, requirements for their utilisation, and organisational, managerial and technological implementation alternatives (2020).

Goal 4. Serving sector needs for better understanding the dynamics in critical success factors for competitive performance and sustainability in times of globalisation and change

Successful competitiveness and long-term sustainability depend on benefits exceeding costs. The indicators for their determination can vary in times of change as can the critical success factors for performance and sustainability. This reduces the competitive advantage of the established production and distribution organisation. A current example is the emergence of competitive bio-energy production.

Any improvements in food chain activities build on the perceived anticipation of a positive balance of benefits over costs. However, there are different perceptions and priorities for society (policy) and for enterprises. From a society's point of view, benefits may involve monetary and non-monetary elements. From an enterprise view the profitability must be evident. This has consequences for sector developments and enterprise activities. In principle, enterprises have to focus on those critical success factors that improve their profitability. However, they cannot neglect society's view on benefits and costs and the dynamics in society's performance indicators to remain sustainable in order to avoid regulations and other limitations on an enterprises' decision flexibility. The consideration of society's views is, therefore, one of the critical success factors for the sector's sustainability in a competitive environment.

In determining their long-term development paths, enterprises and chains need to find a balance between improvements in their monetary benefit-cost balance to assure general competitiveness in their markets, and society's consideration of the benefit-cost balance to assure acceptance and sustainability. It will be essential to understand the relevance and dynamic developments in those critical success factors and indicators that determine performance from the view point of enterprises, chains and society (Figure 16).

Comparative benchmarking studies within the food sector, as well as across sectors, are required to understand the complex interdependencies between chain organisation alternatives and their performance in economic and non-economic (e.g. quality, environmental consequences, etc.) aspects. Benchmarking research does focus on the basic functions chain organisation alternatives build on and identify 'best practice' reference models, the critical success factors for success in different dimensions of interest (quality, environment, etc.) and the related performance indicators for their evaluation. Cross-sector benchmarking studies attempt to identify so-called 'best of class' examples for organisational functions irrespective of the products under consideration.

Results from benchmarking studies can be combined with modelling results and linked to performance indicators to produce performance maps, which support evaluation of alternatives and the decisions required for their realisation.

Major research challenge

1. To understand and utilise success factors for food value chain performance.

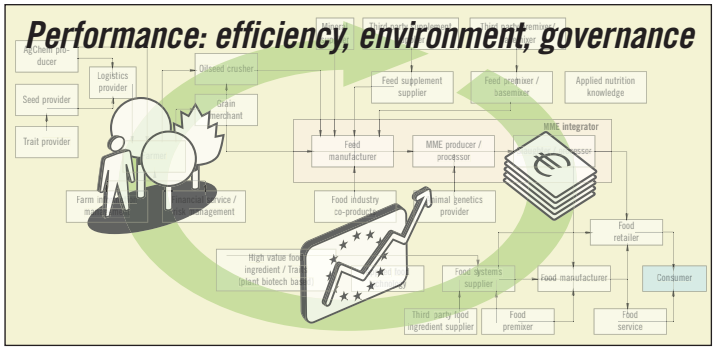


Figure 16. The improvement focus of Goal 4 for sustainable performance.

Deliverables

- Specification of a dynamic framework of critical success factors and performance indicators for performance evaluation of horizontal and vertical organisational alternatives in food value chains (2010).
- Identification of 'best practice' reference models (blueprints) for value chain organisation and development linked to different performance views (economic, non-economic, etc.) and their development over time (2013).
- Specification of 'performance maps' that a) link performance indicators to organisational alternatives and organisational development paths derived from 'best practice' reference models as well as from reference models determined through modelling research and b) provide support for decisions on value chain developments (2015).

Part III. Enabling Activities

Introduction

In addition to the Key Challenges described in Part II there are a number of complementary and underpinning activities that must be undertaken if ETP Food for Life is to deliver the anticipated benefits to stakeholders in an effective and timely manner.

The European Commission has emphasised repeatedly the importance attached to the principle of subsidiarity where a prime function of European research and training activities is to more effectively co-ordinate the investment in research resources by individual EU Member States so as to:

- avoid duplication and optimise synergy,
- enhance the complementarity and added-value of national and European activities,
- improve the skill base of European scientists and technologists, and
- provide an environment in Europe where innovation is promoted and embraced.

The activities presented below have been developed according to these criteria and may be divided into:

- actions necessitating stakeholder involvement,
- implementation of new networks involving the public and private sectors,
- construction and exploitation of infrastructures,
- underpinning activities required to optimise the overall performance of the ETP, and
- societal considerations.

Stakeholder involvement

Communication

Background and opportunity:

Stimulating societal awareness on science and technology should focus on all stakeholders with a direct or indirect agenda on food issues and to the public at large. Sound information about the food sector and its products will contribute to a more positive attitude in society and, as a result, to sustained support to science and innovation.

In order to most effectively exploit the potential for innovation in the food sector, a coherent communication strategy must be developed, which embraces all stakeholders. This strategy must recognise that the nature and aims of communication with these stakeholder groups will differ and that a single communication channel will be ineffective.

The expectations and priorities of different stakeholders towards innovation and related R&D activities differ significantly. The priorities of these stakeholders, their requirements and shared interests must all be identified so that confidence and trust between all can be built and maintained, especially that between industry, the research community and consumers. An effective communication strategy must, therefore, create trust and confidence. This will be an on-going and long-term process and its ultimate impact will depend upon the ETP being seen as an industry-led initiative that is open and transparent, and responsive to the needs and concerns of society.

The communication system of ETP Food for Life must ensure that all interested food businesses and other stakeholders obtain the necessary

information about the main trends and research results in a manner that is both fit for purpose and timely, and in addition, receive encouragement and support for their innovation activities. It is vital that scientific advances in for example, the food and health area can indeed be used to develop new products. This challenge is especially daunting considering the limited resources and capacity for information absorption of most SMEs, and their necessary focus on shorter-term business results.

ETP Food for Life will support, and partly undertake, activities that will empower SMEs in different countries to obtain clear, concise and reliable information on trends, opportunities and research results in their respective areas of activity. These activities, developed through the SME Task Force, will be undertaken through the communication activities of the ETP together with more focussed, national efforts exploiting the network of national food platforms.

To address the current state of innovation in the food and drink sector, ETP Food for Life must establish a regular and effective exchange between industry and the research community to focus scientific efforts on the innovation needs of industry. This process requires scientists talking and listening to industry, and vice versa, a real dialogue is needed. ETP Food for Life will provide the basis for information, proposals for action and messages, but these will need to be amended to address local needs and conveyed in the national language.

There is no single communication system that can achieve this goal. Effective communication across Europe and across stakeholder communities can only be assured through a number of complementary and integrated activities, covering Europe-wide, regional and national events. Best practice from one country or region should only be extended after demonstration of its effectiveness and/or adaptation for broader use. Subsidiarity considerations demand that the majority of initiatives be implemented and funded at national level and be harmonised with, and integrated into, the specific actions of the national food platforms which will ensure that exchanges of experience and best practices are effectively achieved.

The main messages for individual governments and policymakers must emphasise the importance and opportunities of the food and drink sector across Europe, because of its:

- creation of employment, both full- and part-time,
- contribution to improving the quality of life, thereby delivering health benefits to society and reducing spiralling welfare and social costs associated with ill health, and
- generation of sustainable economic growth through innovation.

To respond to these opportunities, the ETP Food for Life communication strategy will be implemented at three levels:

1. **European wide initiatives**, which are general in character and address food-related issues and innovation within the context of the global economy and the positive effects of individual foods and the overall diet on quality of life and public health. Such initiatives would be targeted at high-level representative bodies, such as the European Parliament, individual Directorates of the European Commission, European Food Safety Authority, regional associations for businesses and entrepreneurs, food trade unions, consumers' associations. Effective communication would also be established with European associations of professionals active in the sector, including scientists and technologists. The key aim would be to communicate and explain the European dimension of the ETP Food for Life.

2. **National communication initiatives**, which will be identified and managed within the framework of the national food platforms since these are better suited to the needs and expectations of companies and consumer bodies. Measures will be implemented to ensure that the core content of the SRA is most responsive to the community of food businesses and that their ongoing needs are addressed. National bodies representing science and technology at national level would be engaged via their involvement in national food platforms.

3. **Subsidiary communication actions**, which relate to specific issues (nutritional content of given foodstuffs, GMOs, differences in food safety issues related to different types of products) and requiring a rapid response. Such communication will need to be prepared and disseminated on a case-by-case basis.

These initiatives include the following activities:

- Consumer-oriented communication actions, which are aimed at securing a steady and continuous relationship with the consumers via the 'umbrella role' of the consumer associations. It is also aimed at assuring an important societal dialogue with governmental and non-governmental bodies with a direct or indirect agenda on food issues.
- Company-oriented communication actions, which will serve to exchange reliable information and the use of appropriate communication technologies including direct contact on the national level. This will establish the ETP and the national platforms as 'partners of trust'.

- Researcher-oriented communication actions, which entail the establishment of measures to motivate food researchers to see their work in a larger societal context, and where their success ultimately will be determined by their ability to understand and support the interests of companies and consumers.

Goal:

To establish an effective dialogue with consumers, food businesses, researchers and other stakeholders; to create a better awareness of the importance of innovation in the food industry for business success, competitiveness, enhanced quality of life and improved public health; to improve the innovation culture in the research community and to improve mutual understanding, trust and respect between researchers and industry, and to establish new, efficient methods for structuring of existing fragmented information to SMEs and make it available in an easily-understandable format.

Scope:

- promoting channels of communication and discussion among stakeholders in the whole food chain (through seminars, technology days, workgroups for technology evaluations, technology assessment, etc.),
- encouraging effective national links between policy makers, scientists, technologists and food and drink companies,
- demonstrating the importance of R&D activities, technology transfer initiatives and increased training for the sector's workforce to reduce the vulnerability to competition of the European food sector, especially SMEs,
- establishing a web-based 'benchmarking facility' where companies can compare their experiences with providers of information, support and training, providing encouragement of best practice,
- stimulating and exploiting new methods and formats for the effective diffusion of awareness for consumers and the food producers,
- optimising trust and confidence between all stakeholders.

Training

Background and opportunity:

Training is one of the main tools for transfer of knowledge and a key component in increasing competitiveness. At a time of rapid advances in technology and changing consumer demands, lifelong learning will increasingly be needed throughout the whole professional career pathway. Although training is perceived by all actors in the food sector as crucial to maintain the competitiveness of companies, and such activities are organised and promoted by the trade associations and academia, the investment of the food industry in training for its workforce is lower than is necessary and this deficiency is even more apparent within SMEs. The proportion of companies employing internal or external training as a key component of a clear innovation strategy is particularly low.

The training of a significant proportion of the workforce can be made more attractive to food companies by exploiting innovative forms of training developed over the last decade. Distance- and e-learning schemes are highly effective for delivering value-for-money: they are flexible enough for employees who have limited time and resources, and can be adjusted to the particular needs of the company concerned. Such courses can also lead to formalised expertise qualifications, which have been shown to be an added attraction to members of a workforce. Finally, work-based learning renders the work environment more receptive to the future uptake of innovation and development.

To increase the capacity for innovation development of food SMEs, their staff must be trained in innovation management, skills to convert outputs of commercially viable R&D projects to new products, processes, services and business skills, including information, knowledge and resource management. Evidence indicates that the majority of SMEs prefer to learn from each other, which suggests that the use of collective research activities that offer the opportunity of learning through exchange of views with other industry personnel and with scientists should be promoted.

Recent experience of an approach using 'Techno-Science Mediators' (TSMs) have shown encouraging results. TSMs are specifically-trained mediators, skilled in technology audit and communication and who are able to increase innovation awareness within companies. This model may be seen to be a promising 'new frontier' in the link between the demand from the companies, new efficient training formats and technology transfer programmes. However, via the benchmarking facilities its fitness for purpose will be continually compared with other structures to ensure an optimal supply of options for the companies.

To secure a future to this triangle (company needs, training initiatives capable of serving the companies, efficient and pervasive technology transfer), some meta-initiative can be useful. This objective can be achieved by networking the best available practices in Europe with the help of a new virtual organisation that can (provisionally) be called European Foundation for Advanced Food Training and Technology Transfer (EFAFTTT). It will be a resource of skills and advice for the European system of food research and implementation communities, which mixes company employees, scientists and engineers. It will function as a Think Tank, combining the European Union's best competencies and the main task would be to exercise a co-ordinating and stimulating role on training and technology transfer practices in Europe. EFAFTTT would secure a two-way dialogue with existing experience and resources in diverse parts of Europe.

The network of national trainers co-ordinated via the European Foundation for Advanced Food Technology Transfer and Training, will be responsible for the training of internationally accredited Techno-Science Mediators who at the national level will represent the link and dialogue between the needs of food companies and the deliverables from the research community.

Goal:

To stimulate the development of effective training programmes to establish and maintain the skills base for high quality and innovative food production.

Scope:

- building up a virtual organisation for creating and diffusing new, quality-assured formats for effective training linked to the innovation processes; this is the core task of the European Foundation for Advanced Food Training and Technology Transfer,
- developing and defining a training curriculum for groups of specialised personnel, so-called Techno-Science Mediators, to promote new training techniques closely associated with national programmes of technology transfer,
- elaborating on improved training methods based on best practices as documented from the companies' feedback and achievements,
- ensuring that the training and technology transfer programmes for industry and researchers are regularly updated and systematically extended with new research results,
- stimulating and guiding national training initiatives.

Technology transfer

Background and opportunity:

Technology transfer at its simplest is the conversion of existing knowledge into an appropriate format so that it can be used by the industry to develop new products, processing and services. Because the European food and drink industry has a clear need and high potential for innovation, a credible partner supporting innovation and delivering its associated solutions should be the driver for its future success. Yet the reality is that the appropriateness of knowledge available from the research community to industrial application is far from optimal and a substantial variation can be observed between different countries, regions and (receiving) companies. Large companies usually have specialised staff to manage this activity, but SMEs need external help.

To deal with this situation it will be of crucial importance to explore the effectiveness of existing models of technology transfer and potentials for improvements. Within Europe, such models are available in, for example, Austria, Denmark, France, Norway, Sweden, Spain, the Netherlands and the UK. Each possesses strengths and weaknesses and all are designed for operation within their own cultural context. An evaluation of existing best practice should be carried out, including analyses and further improvements of the feedback obtained from benchmarking, with the aim of developing a generic model of practice capable of adaptation at national and regional level.

Based on these activities, initiatives for the improvement of technology transfer will be launched. The introduction of the Techno-Science Mediators will ensure successful technology transfer to support company-oriented innovation and the link to research.

Adapted to country specific needs, national food platforms will have the important role to act as national technology transfer centres, being the partner of trust for the food industry on site. In addition, these centres will close the triangle between consumers, research and innovation providers and companies.

Goal:

To significantly enhance the innovation culture of the food and drink sector in Europe by identifying weaknesses, proposing solutions based on sound experience, and benchmarking results.

Scope:

- developing and promoting appropriate measures and mechanisms for technology transfer and training, including on-the-job options, based on benchmarking,

- developing R&D and industrial partnerships for training and technology transfer,
- encouraging personnel transfer and exchange at all levels of the food chain,
- providing training and dissemination services to stakeholders in the agro-food sector.

SME[3] Task Force

Background and opportunity:

The structure of the food and drink industry sector in Europe and its relatively poor record for innovation require that measures be identified, developed and implemented for overcoming existing barriers to knowledge transfer amongst SMEs, and that effective benchmarking of such measures is employed on an ongoing basis. Experience and best practice from other sectors and from outside Europe must be obtained and evaluated, and adapted for use in Europe.

Goal:

To develop recommendations for measures and activities supporting the improvement of the competitiveness of food SMEs by systematically identifying, adapting and exploiting tailor-made mechanisms for enhancing the innovation capacities and capabilities of SMEs, increasing their participation in research and exploitation of research results, and providing assistance and support in targeting efforts to achieve these aims across ETP Food for Life.

Scope:

- identifying the hurdles and constraints of intensive involvement of SMEs into the innovation process and participation in R&D programmes,
- collecting best practices and successful models of innovation support and knowledge transfer,
- providing assistance to national food platforms in consultations with national funding bodies on harmonisation, impact assessment and promoting participation of SMEs in innovation activities,
- exploring the possibility of the Risk-Sharing Finance Facility to support projects.

(3) Given the nature of the food and drink industry sector, this term is used to include MSEs, medium-sized enterprises.

Actions towards implementation

EC-oriented activities

Lead markets[4]

Background and opportunity:

The European Commission's initiative on Lead Markets will be developed through a series of pilot actions. ETP Food for Life has responded positively to the initial consultation and will seek opportunities to develop and promote this approach within the European agro-food sector.

Goal:

To identify, facilitate and promote areas of research and related activities that are recognised as being of crucial importance to the creation of new international markets, or the maintenance of existing markets, and ensure future EU competitiveness.

Scope:

- dentifying areas of research where the EU has particular strengths and where increased and focussed investment would create exploitation opportunities within a reasonable time scale,
- identifying strategic areas in the EU where insufficient funding investment is limiting progress for future exploitation opportunities,
- highlighting organisational, structural and regulatory issues that constrain efficiency improvements and are likely to impede future competitiveness.

(4) Markets for new research and innovation intensive products/systems/solutions for which Europe can provide the initial marketplace and European businesses have the potential to become global leaders. Putting Knowledge into Practice: A broad-based Innovation Strategy for Europe, COM (2006)502, 13/9/06.

ERA-NETs and Mirror Group[5]

Background and opportunity:

The funding of research and training activities by the European Commission represents only around 7% of the total figure, the remainder being provided by individual EU Member States, COST, ESF, EFSA, etc. A key ETP deliverable is to more effectively integrate public and private financing (this will be presented within the Implementation Plan) so as to minimise duplication and optimise trans-national opportunities for value addition.

Currently the only ERA-NET that is directly relevant to ETP Food for Life is that addressing food safety[6], which has been in operation for several years and, therefore, offers a model relevant to other areas of activity. It is proposed to build on the experience available from this network and the contacts that have been established between national funding bodies, in order to make a convincing case to the European Commission for future ERA-NETs to be established in the areas of:

- Food, Nutrition and Health, and
- Sustainable Food Production and Food Chain Management.

Should these arguments be accepted, ETP Food for Life will work with interested parties to develop the most effective proposals and will establish a close, and mutually-beneficial, dialogue.

The Mirror Group is a network of national public sector bodies funding agro-food research; its aim will be to exchange information on the targets of strategic funding, outcomes of non-confidential projects and best practice; to identify and minimise duplications of effort; to identify opportunities for developing a common funding agenda, and to manage the resulting programme of research so as to gain the greatest added-value from integration with funding from the European Commission, industry and other sources[7].

Goal:

To establish and support an active network of representatives of national food platforms to facilitate two-way communication between these and the ETP, promote trans-national contacts between stakeholder communities, develop and disseminate best practices, identify common opportunities and challenges at regional level, facilitate the creation of an effective Mirror Group and promote the benefits of specific food-related ERA-NETs.

Scope:

- responding to opportunities for ERA-NET and ERA-NET Plus formation and identifying and promoting topics suitable for future ERA-NETs,
- working with existing and future ERA-NETs or ERA-NET Plus.
- inputting into discussions on the updating and development of the Implementation Plan and collating information on national funding for agro-food research,
- presenting information on national food strategies, national best practices and disseminating summarised results of completed projects,
- integrating and co-ordinating ETP activities with local, national or regional initiatives and activities in the agro-food sector.

European Institute of Technology

Background and opportunity:

The European Institute of Technology (EIT)[8], has been proposed by the European Commission as a means to promote knowledge transfer and innovation by establishing a critical mass of excellence; integrating the individual elements of the Triangle of Knowledge (education, research and innovation); developing a pole of attraction for the world's best talents; providing a catalyst for change across Europe and creating and promoting a European Education and Research Area.

Whilst specific details of the EIT are still to be finalised, Knowledge and Innovation Communities[9] (KICs) have been proposed as mechanisms by which strategic operational activity, performance and integration of innovation, and research and education activities will be delivered.

(5) ERA-NETs are networks, which bring together representatives of national funding bodies to discuss the detail of national funding programmes and strategies, share results and best practices, identify potential overlaps and, in the longer term, open up national funding to international competition (ERA-NET Plus actions). Taken together, their objective is to develop and strengthen the co-ordination of public research programmes conducted at national and regional level. Details to be found at ***http://cordis.europa.eu/co-ordination/fp7.htm.***

(6) ***http://wwwsafefoodera.net.***

(7) Terms of reference for the Mirror Group of the ETP Food for Life, see ***http://etp.ciaa.eu.***

(8) The current (July 2007) vision of the EIT foresees, by 2015, 10 KICs, 4000-5000 scientists, 6000 Masters students, 4000 PhD students and an annual budget of €1.5-2 billion.

(9) Knowledge and Innovation Communities are joint ventures of partner organisations selected by the EIT to carry out at the highest level an integrated programme of education, research and innovation activities in a specific field.

The size, national or regional importance and global competitiveness of the food and drink industry make a compelling case for a KIC on Food Technology and Health. It will be necessary for stakeholders to agree and promote the requirements for such a KIC in order that appropriately-qualified personnel are in place at the earliest opportunity to address the challenges identified in this SRA.

Goal:

To ensure that a convincing case is made for a food-related KIC. The barriers to effective integration of education, research and innovation will be identified and cost-effective means of overcoming these will be identified and built into a business model, including tangible indicators of success.

Scope:

- planning a structured programme of activities, and a supervisory group, to identify barriers to effective integration of education, research and innovation and produce an organisational and business case to overcome these,
- consulting with stakeholders on the training and career development requirements for a vibrant and innovative food and drink sector,
- identifying and ensuring opportunities for synergy and added value between the Implementation Plans for the ETP and the KIC.

Links with the new generation of researcher, technologist and entrepreneur

Background and opportunity:

Europe must match its promotion of knowledge transfer by stimulating societal awareness in science and technology. In this way society will be positively engaged and an environment created in Europe for durable, well-paid career development in food and related sciences and technologies. This environment, the European Research Area, ERA, will provide challenging opportunities for Europe's young people and attract the most able young scientists to Europe. ETP Food for Life has recently responded to the policy proposals regarding the ERA, which were included in the European Commission's Green Paper[10].

A new generation of European scientists is needed who are not only familiar with the most recent scientific and technological skills, but are also aware of the wider industrial and societal context of their activities and who are, in addition, good communicators, able to work within and extend the ERA, capable of enthusing their peers and fully responsive to the trans-national, trans-disciplinary, trans-sectoral nature of 21st century science.

ETP Food for Life will work closely with professional bodies to promote and underpin the quality of those engaging in European food science and technology. Training and career development activities are assuming a greater and broader importance within national and trans-national projects and networks, and new career opportunities in managing trans-national R&D projects, disseminating their outcomes and optimising knowledge transfer to industry demand well-trained and enthusiastic personnel.

It is crucial that account be taken of the concerns and interests of the young people that will form the new generations of scientists working in industry and academia who will deliver the benefits foreseen in this SRA. Links will be established with networks of young researchers, through professional bodies such as EFFoST and EuChemMS[11], and early-stage researcher networks such as Young-Train[12] having interests in the agro-food sector to:

- promote and encourage young people within the food chain area,
- acquit them to most efficiently respond to Europe's future challenges and opportunities, and
- ensure that they are effective partners in, and beneficiaries of, Europe's knowledge-based bio-economy.

Goal:

To ensure that the opinions and concerns of the next generation of Europe's agro-food professionals are reflected in the activities of ETP Food for Life.

Scope:

- developing effective networks with national and regional networks of young professionals,
- encouraging young professionals to consider an entrepreneurial career,
- promoting the activities of Europe's young food professionals.

(10) Green Paper: The European Research Area: New Perspectives, COM (2007) 161final 4.4.2007.

(11) European Federation of Food Science and Technology and European Association of Chemical and Molecular Sciences, respectively.

(12) ***http://www.young-train.net****.*

ETP-driven activities

National Food Platforms

Background and opportunity:

In addition to delivering inputs that have informed this SRA, the consultations on the SSRA held between April 2006 and January 2007 have resulted in national food platforms being initiated in almost all European countries as well as Russia, Ukraine and Israel[13]. Added benefits will be gained by their active networking. An initial meeting of this network has been held and priority issues identified. National platforms will provide a fast-track mechanism for links between the ETP and national stakeholders.

Goal:

To establish and support an active network of representatives of national food platforms to facilitate two-way communication between these and the ETP, promote trans-national contacts between stakeholder communities, and develop and disseminate best practices, identify common opportunities and challenges at regional level.

Scope:

- promoting the activities of and benefits from national food platforms so as to encourage their formation in additional countries,
- developing agreed best practice to be used as a model to assist the formation of new national platforms,
- obtaining national feedback so as to better focus and target ETP proposals, position papers, etc.,
- establishing and maintaining a regular national dialogue between the food industry, the research community and other stakeholders,
- identifying and exploiting regional issues,
- enhancing technology transfer with emphasis on SMEs,
- promoting, organising and conducting pre-competitive research projects.

Public-private partnerships and financing

Background and opportunity:

Central to the concept of ETPs is the need to effectively encourage public and private investments in R&D and innovation and to respond most effectively to opportunities provided by the European Investment Bank (EIB) and, specifically, to exploit the Risk Sharing Finance Facility (RSSF), newly introduced by the European Commission and the EIB.

Quantitative estimates of the financial needs required to deliver the SRA will be set out in the forthcoming Implementation Plan; however, it is already evident that wide-ranging contributions (for example, from EUREKA and EU Structural Funds) will be needed to support an industry sector composed overwhelmingly of SMEs. The experience and best practice of other ETPs will provide a necessary input in optimising overall financing. A workshop bringing together representatives of public-private partnerships in the food and health area was organised in January 2007 and its outputs will feed into the ongoing discussion.

Goal:

To develop EU-wide networks of significant public-private partnerships in the food and nutrition area.

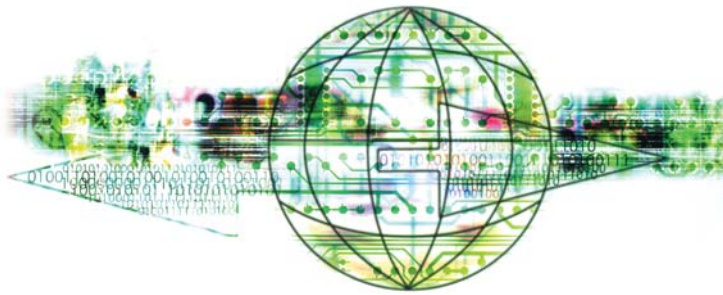
Scope:

- providing and promoting examples of best practices of public-private partnerships,
- optimising interactions between public-private partnerships,
- increasing the scale of public-private partnership operations via strategic alliances, collaborations and joint funding initiatives,
- providing a EU dimension to public-private partnerships.

(13) A list of these, with contact details is presented in Annex 2.

Required infrastructures

Building research infrastructures and enabling technologies



Background and opportunity:

There is a pressing need to invest more in health and nutrition research infrastructures and to develop enabling technologies if Europe is to remain a global centre of excellence for nutrition research. Breakthroughs will be created by sharing ideas across disciplines and sectors, exploiting best practices and databanks, and establishing structured and effective processes to build trust and consensus across national borders. The anticipated outcomes will include the development of more effective nutritional interventions and dietary recommendations, and the development of more rigorous approaches to risk-benefit analyses, which will address nutritional as well as toxicological issues.

Goal:

To ensure investment in health and nutrition research infrastructures and to develop enabling technologies required to carry out high quality research in Europe.

Scope:

Investment should be targeted at:

- establishing a **European Nutrition Research Council**, which would bring together diverse research strengths across European research. A key objective would be to best integrate the humanities and social sciences. The European Nutrition Research Council could lead to a virtual European Nutrition Institute.
- **fostering cross-disciplinary research centres**, which would address the need for:
  - integration and collaboration (including public-private partnerships),
  - multidisciplinary approaches,
  - dietary surveys across Europe,
  - models of risk-benefit analyses of foods of, in particular, innovative products.

Particular support should be given to food research institutions in the newer Member States and Candidate Countries so as to build true interdisciplinary relationships, develop critical mass, and improve their management structures. This latter could be achieved by building on the existing co-operation and twinning initiatives of the FOODforce network of publicly-funded European food research centres.

- **developing, maintaining and exploiting facilities** (including databases, biobanks, standardised protocols, research networks devoted to data handling, imaging and metabolomics, and a European stable isotope standard repository for metabolic nutrition studies). Nutrition research, like all biological sciences, provides a wealth of data and results; this is partly driven by the 'omics' revolution and systems biology approach, and partly by the availability of IT infrastructures. However, there is a danger that inappropriate analysis of the very large datasets emerging from such research will obscure key associations and, thereby, limit opportunities to optimally profit from these developments. To address such a possibility a number of key objectives must be addressed, such as:
  - ensuring an optimal availability and exchange of relevant data, results and information through dedicated formats, standards, IT-infrastructures and protocols,
  - closely interacting with mainstream organisations, primarily the European Bioinformatics Institute, to optimise usage of generic developments and data,
  - facilitating the application of 'omics' tools that will be required to study the biological effects of food components, and to understand their optimal levels of intake,
  - establishing and maintaining relevant databases and knowledge networks targeted at the needs of nutrition research, including a nutritional phenotype database, a nutritional metabolomics database, a gene-diet interaction database, and a whole body imaging phenotype database,
  - facilitating, co-ordinating and promoting the development of dedicated bioinformatics solutions for nutrition research,
  - providing training in these areas in order to facilitate optimal implementation by European scientists.

To address these objectives, there should be close contacts with the European Nutrigenomics Organisation, which was established in 2004 to produce a sustainability model for these purposes.

- **fostering prospective cohort studies** and building them into public nutritional databases. The European Prospective Investigation of Cancer (EPIC) study, which is supported by European and national funds, involves collecting data on food consumption data and as well blood samples and physical data of over half a million people in ten European countries. By studying very many people in different countries with varying diets, using carefully-designed and validated questionnaires, EPIC should produce much more specific information about the effect of diet on long-term health than was previously possible.

  This 'virtual' centre of food epidemiology needs to be broadened to reflect an interest in all issues in relation to diet and health, not just cancer. Links to the European Clinical Research Infrastructure Network (ECRIN) would be beneficial, especially if a common network emerged on which to build a specialist focus on diet and health issues. Such a facility would require a long-term financial support.

- **exploiting standardised and updated European food tables.** The investment in EuroFIR, an FP6 Network of Excellence, which seeks to build a global food composition information system must be continued. Accurate and complete food composition data ensure the correct assessment and validation of safe and healthy foods. Researchers and industry have to rely on authoritative food composition databases to comply with regulatory demands and to have a reasonable basis for further food development. Such sources need to be maintained and developed further and an improved access to the relevant data created. This will make an essential contribution to a positive development of the food sector towards novel and/or healthy food choices or constituents with putative health benefits.

  EuroFIR has developed a BASIS databank on both the composition and biological effects of non-nutrient bioactive compounds with putative health benefits, which is a unique resource for Europe and should be maintained and updated continuously. An expansion of the work should also address additional objectives, such as:

  - harmonising standardised European food databank systems, linked through the internet and maintained at the European level,
  - promoting the standard for exchange of nutritional composition data in food ingredients and composite recipes as a new European Standard,
  - adoption of certified processes and protocols for increased data quality on food data by national compilers in all EU countries,
  - linkage of food databank systems with food intakes and epidemiology databases (the same should apply to consumer behaviour, including that of minority populations, regarding selection of foods that use bioactive compounds),
  - expanding the classification of European foods and using LanguaL (a food description system) to ensure international harmonisation,
  - linking food nutritional information with data on origine, post-harvest treatment and processing,
  - linking European food databank systems and methodology of measurement with similar databases in other countries, especially those that export substantial quantities of major foodstuffs to Europe.

- **initiating scenario studies.** These studies, also described as foresight studies, provide challenging visions of the future to ensure the effective targeting and focussing of research strategies by providing evidence to inform actions by governments, business and academia. They focus around key issues where scientific research is expected to provide solutions to a problem and ask feasible 'what if' questions. In addition they frequently address the policy framework that will be needed for a successful outcome, and their results will inform policy development

Education

Background and opportunity:

A striking feature of food and nutrition research is its multi-disciplinary nature. A successful implementation and outcome for research investment demands an effective interaction of the physical, biological and social sciences. This poses unique challenges since the skills required cross traditional academic boundaries. For this reason education of the young in the challenges, opportunities and excitement of a career in the food sector is crucial. In addition, there will be a continuing requirement to retain those employed in the food and drink industries to better support innovation and exploit knowledge transfer.

Another feature of the majority of the food research institutions in Europe is their focus on the characterisation of food materials and constituents, and their quantification. The vast majority of such institutions are unable to provide all of the skills necessary in a single institution. This is an excellent argument in support of transnational co-operation and of the European Research Area itself. There is a general lack of

skilled input from clinical scientists, molecular biologists, nutritionists, toxicologists and social scientists and for diet and health-related work their input is essential.

The ETP Food for Life welcomes training initiatives[14] focussed around the skill areas that are judged to be weak in Europe. A particular priority in this regard is the need to train scientists to be effective communicators with other stakeholders, including industry and consumers. Attention to these aspects should be given in the curricula of the education of scientists in the food sector. In addition there is a dearth of properly trained and equipped young people to take advantage of the opportunities for project management within FP7. Finally, Europe needs to train, identify and support young entrepreneurs who will be key to Europe's vision of innovation, and who will be to the fore in delivering the benefits of the European Research Area to industry and society.

Goal:

To ensure the availability of work force in the food sector in the future.

Scope:

- attracting young people to choose a career in the food sector,
- improving the innovation culture and awareness and including food and nutritional aspects into curricula of the scientist education in the food sector,
- developing skills for communication with other stakeholders.

(14) The current draft of call 2B (2008) of the Food, Agriculture and Fisheries, and Biotechnology pillar of the FP7 Co-operation pillar includes a call addressing the requirements for food researchers of the future. Fisheries, and Biotechnology pillar of the FP7 Co-operation pillar includes a call addressing the requirements for food researchers of the future.

Supporting activities

Links with other ETPs

Background and opportunity:

The importance of cross-platform interactions as a means of raising awareness and efficient overall structuring has been emphasised in the Third Status Report of European Technology Platforms (EUR 22706; March 2007). A number of ETPs with interests complementing those of ETP Food for Life have been established within the Knowledge-based Bio-economy (KBBE) area[15]. ETP Food for Life will support measures to bring together representatives of these ETPs to discuss common issues, share knowledge and exchange best practice. Such meetings allow participants to share a common position and promote a common cause, for example, in approaches to the European Commission and the European Parliament.

In addition to KBBE ETPs, there are others[16], which may have some relevance to ETP Food for Life, such as Future Manufacturing Technologies (MANUFUTURE); Water Supply and Sanitation Technology Platform (WSSTP); NanoMedicine; and the Innovative Medicines Initiative (InnoMed).

One issue common to all ETPs is the need to exploit optimally public-private funding partnerships. As is evident from Part II, the food and health sector has a very significant interface with the pharmaceutical sector; these sectors share common interests in topics such as risk-benefit analysis, the exploitation of nanotechnology and 'omic' technologies, nano-manufacture and the safety of nano-particles. In addition, food research has produced a plethora of information about colloids and gels having relevance to targeted delivery of pharmaceuticals.

A joint workshop will be organised in 2008 that will bring together leading figures from the food and pharma sectors to discuss such common interests and available knowledge, and to identify the most effective mechanisms for ongoing knowledge transfer and co-operation. This activity provides a focus for links with ETP Nanomedicine and the Innovative Medicines Initiative[17].

(15) These are Plants for the Future, Global Animal Health, Farm Animal Breeding and Reproduction, the Industrial Biotechnology component of Sustainable Chemistry, Forestry, Biofuels and Aquaculture.

(16) Information on individual ETPs: ***http://etp.ciaa.eu/asp/nat_food_platforms/nat_foodplatforms.asp.***

(17) The Innovative Medicines Initiative is a candidate for a Joint Technology Initiative, JTI, based on Article 171 of the EC Treaty.

Goal:

To identify cross-platform issues with KBBE and other ETPs, agree common strategies and share best practices.

Scope:

- participating in KBBE ETP meetings,
- establishing bilateral links with ETPs having common interests,
- identifying best practices in working together,
- establishing and exploiting a network of ETP Horizontal Activity/Issue Groups.

Links with Food National Contact Points (NCPs)

Background and opportunity:

During the recent process of national consultations, the ETP engaged with a number of FP6 and FP7 National Contact Points, a number of which are involved in the ongoing activities of national food platforms. There is a mutual benefit in such co-operation, affording effective national communication channels to the ETP, and enabling NCP personnel to be better informed about the programme of the ETP.

Call 2A of the Food, Agriculture, Fisheries and Forestry, and Biotechnology theme of the Co-operation pillar includes the opportunity to establish a trans-national network of KBBE NCPs. ETP Food for Life will seek to be actively involved, using its own funding, to facilitate communication and information exchange. This will assist the ETP in developing effective links in countries that have not established national food platforms and with countries outside Europe.

Goal:

To promote the activities of the European food and drink industry sector and support national activities in the KBBE area.

Scope:

- establishing effective contacts with KBBE NCPs,
- facilitating links between NCPs and national food platforms.

Links outside the Europe Union

Background and opportunity:

The ETP's Regional Consultation Meeting for Central and Eastern European Countries co-sponsored by the Central European Initiative (CEI) involved EU Member States (Austria, Czech Republic, Hungary, Italy, Poland, Slovakia and Slovenia), Candidate Countries (Bulgaria, Croatia and Romania), Belarus and Ukraine. Russia has established a number of national technology platforms, including one on addressing food.

Establishing links with countries on the periphery of the current European Union (CEI and European Neighbourhood States) are necessary because over the next 15-20 years it is likely that many of these will develop closer economic and political links with the European Union. The anticipated shift of significant primary production eastward will have a significant impact on activities designed to promote sustainable production and effectively manage and regulate these longer and more complex food chains.

Given the extent of global competition, ETP Food for Life must be outward-looking to most effectively capture and exploit new developments and activities within its global competitors. The ultimate rationale of the ETP is to address the European Paradox, whereby the continent's basic research is the equal or better of that anywhere in the world but it largely fails in its ability to transfer this knowledge effectively to industry for the development of new products and services that will benefit the local and regional economy, and society.

The ETP must take account of countries and regions where such knowledge transfer is much more efficient so as to identify key elements of the innovation process, adapt these (as appropriate) and transfer them to the European environment. One such country is New Zealand, which has a highly innovative and, hence, successful dairy and meat sector.

Goal:

To ensure that ETP Food for Life is best placed to capture global best practice, identify potential lead markets and establish mutually-beneficial relations.

Scope:

- engaging in science-led discussions on regulatory, standardisation and other issues,
- exchanging of experience,
- identifying and sourcing strategic research needs.

Societal considerations

Gender

Background and opportunity:

Women continue to be under-represented in many areas of European science and technology. Whilst the situation in the food and health area is better than some others, women are not well represented in positions of responsibility in the academic and industry sectors of the food and drink area. The vast majority of Europe's entrepreneurs are men. There is a pressing need to ensure real equal opportunities for men and women in national labour markets and ETP Food for Life will work with other organisations to attract the best young people into research and entrepreneurial activities, remove barriers to women (reconciling the demands of professional, private and family life) and promote gender issues as a key to translating the vision of the European Research Area into a reality for all.

Goal:

To identify and promote areas and activities where gender aspects have a key role to play and to raise awareness of the importance of gender issues within the ETP.

Scope:

- disseminating the importance of gender equality and other issues at national level, through national food platforms and other channels,
- ensuring that gender issues are effectively addressed in all activities initiated by ETP Food for Life.

Ethics

Background and opportunity:

There is a very strong ethical framework to the activities of ETP Food for Life, which extends beyond the issues of innovative technologies and growing public concern for sustainability and ethical production. Together with ETPs and organisations addressing ethical issues across the plant, food and pharmaceutical areas, ETP Food for Life will support and promote broad public debates at national and regional level and ensure that young researchers, in particular, are made aware of the wider, ethical context of agro-food production. In these activities the ETP will demonstrate and promote the importance of an ethical input into planning and execution of research, thereby contributing to the necessary interaction between science, technology and the humanities.

Goal:

To develop, promote and monitor an ethical framework for activities conducted by ETP Food for Life and to facilitate engagement between ETP Food for Life, national food platforms and civil society organisations.

Scope:

- promoting the engagement of civil society bodies within ETP Food for Life and national food platforms,
- ensuring that society has a greater role in determining the agenda of research (society-driven research),
- promoting an ethical framework for European researchers, engineers and industry,
- supporting activities leading to a reduction or elimination of the use of animal testing.

Annexes

Annex 1. ETP Food for Life Board, Operational Committee, Working Groups and Editing Team

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Until 1 July 2007: Ms Daniela Israelachwili, General Director of CIAA (BE)

From 1 July 2007: Ms Mella Frewen, General Director of CIAA (BE)

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Dr Jürgen Kohnke, President of FEI (DE)

Dr Jan Maat, Chairman Operational Committee (NL)

Professor Brian McKenna, President of EFFoST (IE)

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Mr Daniele Rossi, General Director of Federalimentari, Italy (IT)

Dr Alphons Schmid, Chairman of Food Policy Committee, Eurocommerce (NL)

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Dr Andras Sébok, General Manager, Campden & Chorleywood Hungary (HU)

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Professor Hans van Trijp, Wageningen University & Unilever, Vlaardingen (NL)

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Glossary

A&I	Active and Intelligent (packaging)
AFT	Advanced Foundation for Food Training
CAP	Common Agriculture Policy
CEI	Central European Initiative
CFP	Common Fishery Policy
CIAA	Confederation of the Food and Drink Industries of the EU
DALY	Disability-Adjusted Life Year
ECRIN	European Clinical Research Infrastructure Network
EFAFTTT	European Foundation for Advanced Food Training and Technology Transfer
EFFoST	European Federation of Food Science and Technology
EIB	European Investment Bank
EIT	European Institute of Technology
EPIC	European Prospective Investigation of Cancer
ERA	European Research Area
ESF	European Science Foundation
ETP	European Technology Platform
EuChemMS	European Association of Chemical and Molecular Sciences
EU	European Union
FCM	Food Chain Management
FP	Framework Programme
IP	Implementation Plan
IT	Information Technology
KBBE	Knowledge-Based Bio-Economies
KIC	Knowledge and Innovation Community
LCA	Life Cycle Assessment
NCP	National Contact Point
PAN	Preference, Acceptance and Needs
R&D	Research & Development
RFID	Radio Frequency Identification
RSSF	Risk Sharing Finance Facility
SME	Small and Medium-sized Enterprise
SRA	Strategic Research Agenda
SSRA	Stakeholders Strategic Research Agenda
TSM	Techno-Science Mediator

Agro-food industry:	industries related to agriculture and food.
Agro-food sector:	the sector of the economy that produces agricultural and food products.
Bio-economy:	all industries and economic sectors that produce, manage and otherwise exploit biological resources (and related services, supply or consumer industries), such as agriculture, food, fisheries, forestry, etc.
Biological material:	any natural material that originated from living organisms containing carbon and being capable of decay.
Biotechnology:	technologies for cultivating, modifying or deriving products from living organisms.
Commodity food:	agricultural products of value and of uniform quality, produced in large quantities by many different producers e.g. wheat, milk, beef, coffee. The price of commodity foods is determined on the basis of an active market.
Commodity food chain:	interaction of all participants responsible for production, processing, refining, trading and consuming of an (agricultural) product.
Non-food:	biological (raw) materials used for applications others than food.
Primary sector:	production of agricultural raw materials (= primary products) for other industries. The primary sector involves the changing process of natural resources into primary products.
Regional food chain:	interaction of all participants responsible for production, processing, refining, trading and consuming of an (agricultural) product, whole process is limited to a region.
Sustainability:	an environmentally sound, economically viable and socially acceptable development.

For a more detailed glossary please refer to:

http://europa.eu.int/comm/research/biosociety/library/glossaryfind_en.cfm

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