Italian Food for Life

FEDERALIMENTARE
Federazione Italiana dell'Industria Alimentare

CRUI
Conferenza dei Rettori delle Università Italiane

Italian Technology Platform on

Food for Life

The Vision for 2020 and beyond
(A Research Agenda)

LUISS (Rome, 5th July 2006)

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Vision of the National Technology Platform

«Italian Food for Life»

Introduction by Luigi Rossi di Montelera, President of Federalimentare

The Food and Drink Industry in Italy: SMEs and the challenge of innovation

The Italian Food and Drink Federation– which Federalimentare represents through its 17 sector Associations members of Confindustria – is one of the pillars of our national economy, representing the second manufacturing industry of our country with a turnover of 107 billion euros (of which 15 in export) and 36,000 companies - of which 6,600 with more than 10 employees and 2,600 with more than 20 employees-, with over 400,000 employees, 260,000 of them direct employees.

Along with agriculture, induced activity and distribution, the Food and Drink Industry is the central element of the first economic chain of the Country. Industry buys and processes 70% of the national agricultural primary products and is generally recognized as the ambassador of Made in Italy in the world considering that almost 80% of the Italian agro-food export is represented by high quality brands.

The sector can claim several important factors and its image is an heritage extremely appreciated in Europe and in the world, divided in an enviable range of high quality products and on a wide series of products of protected or controlled designation of origin which are leading in the international markets.

It's a success due to the strict bonds of the Italian food and drink production with land and with the cultural heritage of Italy, and due to the safety standards, along with the ability to mix tradition and innovation of processes and of products. This is the reason why the sector is the target of a wide range of actions of imitation and forgery, especially on rich and demanding markets, like the American and the North European ones.

Nevertheless, in spite of the positive figures reached in 2005, the food and drink industry is penalized by some structural gaps that hold down its growth and its capacity to compete. The main factor that penalizes the growth of the food and drink industry is the extreme fragmentation of production, that comes even before the other bonds that restrain the whole system of our companies (structural lacks

and logistics, exaggerated costs of production like energy, low quality offer of services for the companies). The sector is characterized by an extreme fragmentation, that sees only 20% of the companies above the threshold of 9 units and the remaining 30.000 firms tied to such a small dimension (3-9 units) that with the global trends adopted by our competitors it would seem unthinkable to realize any kind of competition.

Its clear that the dimension of the companies in one of the major obstacles to the capacity to invest in research and innovation or to have access to the processes of transfer of technological innovations.

Instead, a strong impulse to the transfer of process and product innovation would certainly contribute to improve the position of competition of our food industry, especially of the small and medium enterprises.

About 25% of the turnover of the agro-food industry comes out from products for which innovation is an essential factor and which possess more added value; we are speaking of the so-called *traditionally evolved,* ready to eat sauces, spicy oils, fresh seasonings, frozen foods, etc., and of the real *new products*, that are products with a high content of wellness and of services. If we consider the trends of the models of food consumption, this line of more "evolved" products is likely to reach more space in comparison with the so-called *classic food* (pasta, preserved foods, cheese, wine, oil), that at the moment reach about two thirds of the entire turnover (65%), while the remaining 9% is represented by products of brand of origin and, by a smaller percentage, by biological products. So, if the internal market begins to show that research and innovation are one of the incentives of progress, the international one shows us that without capacity to innovate the risk to stay out of the market is going to become a reality, especially for our commodities.

There is no doubt, therefore, that the success of our products rises from the capacity of our managers to mix tradition and innovation, giving due emphasis to applied research. During these last years our food companies, as a matter of fact have employed the most recent technologies, adapting them to the traditional gastronomical recipes, in order to create products easy to prepare, with higher security standards and a high level of quality. These results are possible only allocating resources every year to research. This financial commitment would not only mean an investment for the future but also an immediate response to the consumers' demands within the *Italian Style.*

The Italian and international market of food products will be more and more affected by the changes in society (especially by the ageing an individualization), by the changes of the nutritional habits and by the way of life. For this reason the Italian food and drink industry is constantly involved in meeting the consumers' needs supplying products adapted to the various nutritional needs, considering as well the different ways of consumption that enable the consumer to make responsible choices and to follow a diet suitable to his lifestyle and the physical activity performed. The consumers themselves, especially the Italian and the

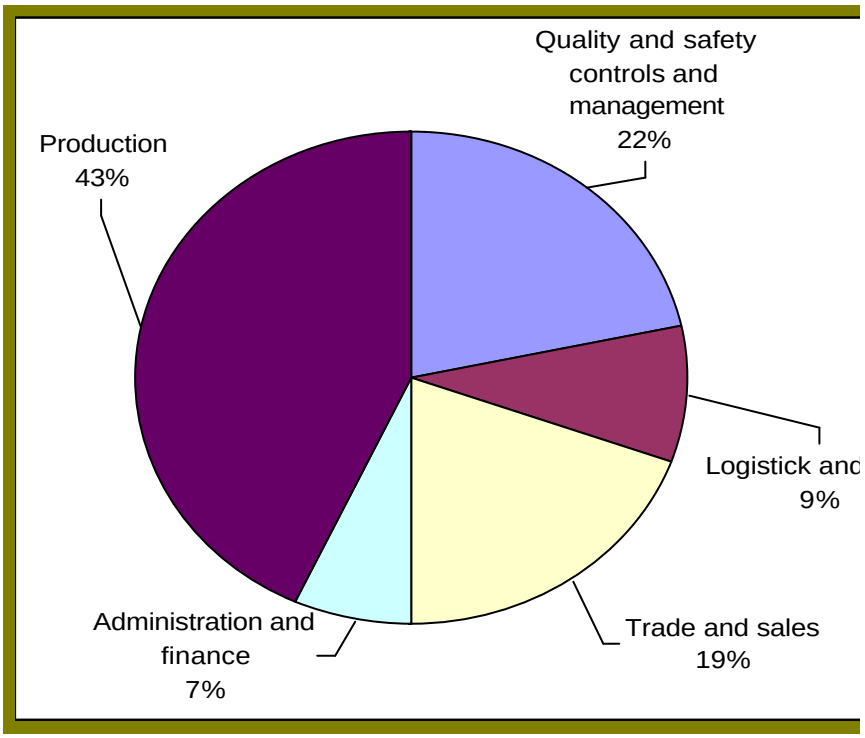
European, are more and more in a position to recognize the real value of what they are buying, from the choice of the primary products, the technological features, to the attention given to the correct employ of natural resources, to logistics and packaging, from the point of view of the conceit of global quality.

As a response to these requirements Federalimentare, while already involved in Brussels coordinating the European Technological Platform "Food for Life", has started up, together with Crui (Conference of the Chancellors of the Italian Universities) and in cooperation with the University of Bologna, ENEA Biotec, Tecnoalimenti and with the most representative experts of the agroindustry sector in Italy, the National Technology Platform "Italian Food for life". It is an instrument created with the aim to stimulate research and technological innovation in the agro-food sector at a national level in order to strengthen the scientific and technological basis of our food and drink industry, encouraging the development and international competition, especially to help the Small and Mediun Enterprises. The technology Platform "Italian Food for life" is a unique opportunity not only to promote the coordination of the research activity of primary products and nutrition, assuring whether the direction, whether enough critical mass, but also to guarantee transfer of know-how to the companies.

Without any doubt the promotion of the culture of innovation, of research and training is the keystone for the success of our products in Italy and abroad. We are speaking of what will be recognized as the future Made in Italy of food, that today needs to pass through specialization, research and technological progress in order to become, tomorrow, the "new classic" in which stands out our capacity, typically Italian, to elaborate culture and know-how, innovation and tradition.

TOTAL DIRECT EMPLOYMENT OF THE ITALIAN F&D INDUSTRY (2005)

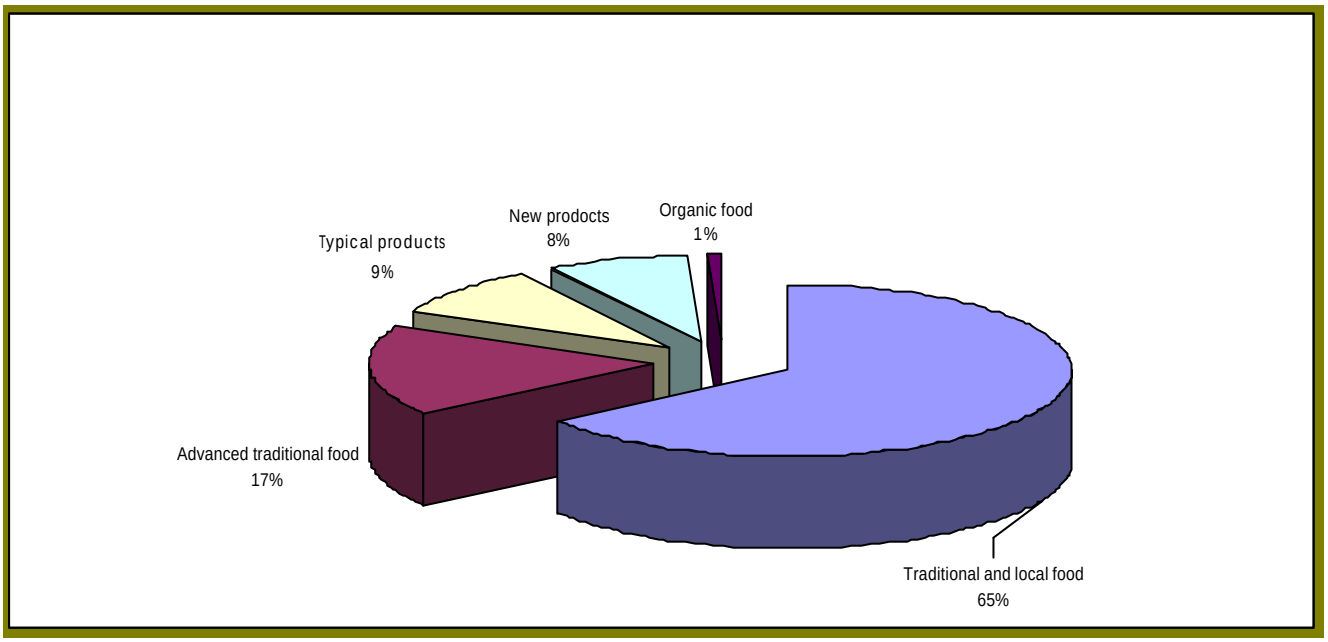
Quality and safety controls and management	85.800
Logistic and stock	35.100
Trade and sales	74.100
Administration and finance	27.300
Production	167.700
Total	**390.000**



Source: Centro Studi Federalimentare 2005

TOTAL TURNOVER BY PRODUCT AND R&D (2005)

Traditional and local food	70	65%	
Advanced traditional food	18	17%	
Typical products (PDO, PGI and wine)	9,5	9%	(of which 2,9 billion € of export)
New products (novel, functional, healthy, ready to eat, etc.)	8,5	8%	
Organic food	1	1%	
Total	**107**	**100%**	(of which 15 billion € of export)



Source: Centro Studi Federalimentare 2005

The Italian Food & Drink Industry
Basic figures
(current values)

2004		2005
105 billion (*)	Turnover (value)	107 billion (+1,9%)
+0,5%	Production (quantity)	+0,9%
-0,5	Production (quantity) working days being equal	+1,7
2.580 with + than 19 employees (37.000 companies with more than 2 employees)	Number of companies	2.550 with more than 19 employees (36.600 companies with more than 2 employees)
398.000 of which 264.000 employees	Number of employees	390.000 of which 258.000 (66,2% employees)
14,7 billion	Exports	15,1 billion = + 2,7 %
12,8 billion	Imports	12,7 billion = - 0,8 %
1,9 billion	Balance	2,4 billion = +26,3 %
188,7 billion	Total consumption	193,2 bilion = 2,4 %
129,1 billion	Home consumption	131,7 billion = +2,0%
2nd manufactoring sector (12%) after the engineering sector	Position within the Italian manufactoring Industry	2nd manufactoring sector (12%) after the engineering sector
Dairy sector (13,8 billion), confectionary sector (10,9 billion) meat processing (7,4 billion) wine sector (7,2 billion)	The 4 first sectors of the Italian Food Industry	Dairy sector (14,1 billion), confectionary sector (11,2 billion) meat processing (7,5 billion) wine sector (7,6 billion)

(*) Data value are expressed in billion euro

Source: data processing and estimates Federalimentareon ISTAT data

The Vision 2020
(A Research Agenda)

Italian Food for Life

1. Food & consumer

Italian Food for Life

Following the structure of the European document, research within the area "Food & Consumer" answers to two types of challenges:

1. (Horizontal) *Strengthening the fundamental understanding of food consumer behaviour;*
2. (Specific) *Answering to the specific tasks within the other pillars of the "Food for Life" ETP.*

According to this structure, researchers in the Food & Consumer area are called to answer to a double set of activities: (a) Methodological, i.e. improving data, methods, models and practices in consumer research and consumer education; (b) Applied, i.e. providing a significant contribution to research within the other pillars.

This is recognised in the structure of the European working document, where:

- Challenge 1 ("Ensuring that the healthy choice is the easy choice for consumers") and its 4 goals (1 – Measuring; 2 – Modelling; 3 – Communicating and Interacting; 4 – Inducing behavioural change) answer to the **first type of challenges (horizontal);**
- Challenge 2 ("Understanding consumer behaviour in relation to health and nutrition"), Goal 4 of Challenge 3 ("Understanding consumer behaviour in relation to food quality and manufacturing"), Goal 5 of Challenge 4 ("Understanding and addressing consumer concerns with food safety issues"), Goal 5 of Challenge 5 ("Understanding consumers and their behaviour regarding sustainable food production") and Goal 6 of Challenge 6 ("Integrating food chain management and the consumer") are goals of the **second type of challenges (specific).**

Research priorities:

The following basic principles driving the identification of research priorities for the Italian Technology Platform have been selected:

1. The fragmentation and the prevalence of Small and Medium Enterprises in the Italian food industry currently limit the potential for adequate consumer research;
2. All the data collected by the food and consumer group either experimentally or from a database obtained should be oriented to show to the users (SMEs) the new food product development or, as seems more appropriate, the incremental innovation approach;
3. There is a need to take into adequate account the specificities of the Italian food cultures and traditions when mapping and analysing European food consumers;
4. Lifestyles, eating patterns and their dynamics are key elements in understanding Italian consumers;
5. The Italian socio-demographic and nutrition trends highlight the need for prioritising two sub-group of the population: (a) children, whose overweight rates are among the highest in Europe and are rapidly growing; (b) the elderly, as the Italian population has one of the highest ageing indices

making it necessary to take into account their emerging needs and demands in terms of food consumption and health.

On the basis of these principles, the following scale of priorities has been set as compared to the goals envisaged in the European Working Document:

1. Measuring consumer behaviour in relation to food (goal 1);
2. Developing comprehensive models of consumer food choice processes (goal 2);
3. Developing strategies to induce behavioural change in order to improve consumer health and social responsibility (through healthier food choices) (goal 4);
4. Promoting effective interaction with consumer groups and consumers directly through communication and public participation (goal 3).

The Food and Consumer area also includes goals that are specific to the other pillars of the Food for Life Platform. In this document, goals 5 to 10 are the outcomes of priorities identified within the other themes of the Platform, namely Food and Health (goal 5), Food Quality and Manufacturing (goal 6), Food Safety (goal 7), Sustainable Food Production (goal 8), Food Chain Management (goal 9), Communication, Training and Technology Transfer (goal 10).

Challenge 1. Ensuring that consumers make the healthy choice the easy choice

Goal 1. Measuring consumer behaviour in relation to food

Information on the Italian food consumer is affected by several shortcomings:

- The prevalence of Small and Medium Enterprises in the food sector and the consequent limitations to the R&D budget seriously constraints the ability to promote effective consumer research; marketing actions and new product developments are often based on secondary commercial data, which are not necessarily calibrated on the specificities of the Italian markets;
- There are a high fragmentation and lack of consistency in the data collection process, so that it is impossible to link consumption data with information on health status, lifestyle and consumer attitudes; this prevents effective research on the determinants of food choice and dietary habits and a proper understanding of the major modifications in the Italian diet over the last decade.

Consumer research could enhance competitiveness of the Italian food SMEs by providing a clearer picture of the Italian consumers and their segmentation for a more appropriate food product development In addition to that, and to make the proposed approach less theoretical and more pragmatic some case histories as example of new consumer science approach for a more accurate development or upgrading of food products is required.

Hence, among those indicated in the European working document, a key research challenge is to *improve measurement approaches in terms of their validity and accurateness* and more specifically it is expected that research could provide the following deliverable:
Mapping Italian food cultures, lifestyle and dietary habits using large-scale purchase and consumption data, integrated with information about values, beliefs, personality and behaviour. The integration of existing data sources and the data collection process should take into account different sub-populations with respect to geographical, socio-economic and demographic background, with a special focus on children, the elderly and low-income populations. According to the specific goals of the projects some example will be carried out able to show to food companies the new paradigm in consumer and product development research.

Goal 2. Developing comprehensive models of consumer food choice processes.

Subject to the availability of adequate data (as in goal 1), or alternatively consumer information could be experimentally obtained for particular clusters of food products and population, it is recognised that the subsequent analysis and modelling need to take into account the wide range of determinants of food choice. This requires an interdisciplinary approach to consumer science. Furthermore, dietary habits in Italy are undergoing relevant transformation also in response to market globalisation, transformations of the retailing systems and the related marketing and advertising impact.

A major research challenge is the *analysis of determinants of eating patterns and consumption baskets*, where the concept of "eating patterns" should include lifestyle determinants (e.g. eating out, structure of meals, etc.) and the drivers of change in diets over time. Among these drivers, there are certainly demographic changes (ageing of the Italian population), societal changes (immigration, multiethnicity) and the major modifications in family lifestyles, especially affecting children. Modelling the relative weight of and the interactions between the many factors that influence food choice and behaviour represents another major objective, with a special focus on physiological changes which deeply affect food perception and sensory evaluation during particular periods in life. Thus, it is expected that consumer research will be able to produce the following deliverable:
A multidisciplinary (and cross-cultural) analysis of consumer behaviour of specific sub-populations (children, elderly, immigrants) taking into account lifestyle and societal determinants and the modifications over time.

Goal 3. Developing strategies to induce behavioural change in order to improve consumer health and social responsibility (through healthier food choice)

It is now an European (and World) priority to promote informed food choice, which is expected to serve long-term private, public and societal interests. The rising health costs following unhealthy dietary trends are already affecting the Italian economic system and are expected to rise exponentially given the high

overweight rates observed in childhood. The adverse health consequences for the Italian population (for example the alarming diabetes prevalence predicted by WHO) and the economic risks for the private sector are calling for an immediate intervention to readdress consumer choice toward healthier choice. This priority should be reflected by the research challenge of *understanding the process of habit formation and habit change and the key motivation that trigger vs. hamper change, particularly in relation to 'risky' eating behaviour.* In this context the role of culture, tradition and information in determining dietary choices should be investigated, with cultural marketing as a potential tool for promoting healthier diets.

This research challenge should result in the following deliverable:
Intervention strategies (including research supporting education and communication policies) for inducing long-term behavioural change towards better dietary habits.

Goal 4. Promoting effective interaction with consumer groups and consumers directly through communication and public participation

A major effort of private and public consumer research should be targeted at transferring knowledge to all steps of the food chain, intensifying the link between the changing consumer needs and the response of the food sector, which will also facilitate the challenge of inducing behavioural change. The recent food scares in Italy have undermined consumer trust towards the food chain, so that enhanced interaction and transparency are expected to have a positive effect on competition of the Italian food SMEs.

Thus, it will be necessary to *develop effective tools for public participation in food and nutrition issues allowing for optimal information and maximum transparency and consumer confidence in the food industry*. This translates into the following deliverable:
A set of validated methods, models, practices and tools for effective consumer information and education regarding food and nutrition, with a special emphasis towards strengthening and rebuilding consumer trust.

Goal 5. Understanding consumer behaviour 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. A better understanding of food-related consumer behaviour will make it possible to develop product and communication strategies that will make it much easier for consumers to live a healthy lifestyle.

Research challenges:

- Understanding 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 personalised food recommendations (e.g. on the basis of nutrigenomics);
- Self ID of refrigerated foods and linkages with diagnostic centres and prevention of foodborne disease (food intolerance, calorie intake, dietetics);
- Investigating sensory perceptions and the relative evaluation of taste with respect to perceived food healthiness, especially considering the effects of health information on preference and acceptability of food products;
- Assessing consumer reaction to conflicting information on health issues and the relative effectiveness of nutrition information released by experts as compared to the impact of mass-media information.

Deliverables:

- Assessment of consumer understanding of nutritional concepts and communication formats, incl. health schemes (e.g. pyramids), claims and labelling (e.g. signposting);
- Regulatory nutrition profiling of foods in nutrition and health labelling and its effect on changes in consumer attitude and preferences, together with an accurate economic assessment of costs and benefits for the consumers and for the food industry;
- Individual factors involved in food selection and food choices and habits.

Close contacts are necessary between this Challenge, Challenge 2: *Delivering a healthy diet and Challenge* 3: *Developing value added food products with superior quality, convenience, availability and affordability*

Goal 6. Understanding consumer behaviour in relation to food quality and manufacturing

Research challenges:

- A better understanding of how consumers react to different product qualities, taking into account their preliminary expectations

Deliverables:

- A quantified model of how product, process and packaging features affect the complex consumer response (appreciation, cost/benefit, perceived risk and uncertainty) (2020) ;
- A validated methodology to qualify and quantify the consumer-relevant (i.e. beyond experimentally controlled situations) effects of new ingredients and their manifestation in real life consumer situations (e.g., affective and neuroscientific effects) (2020);
- An accurate evaluation of consumer expectations on food quality, considering their relevance in quality perception and the factors influencing expectations. The study of factors contributing to the concept of perceived "freshness" from a consumer's perspective will be taken into account in trying to understand the consumer's behaviour in relation to food quality.

Goal 7. Understanding and addressing consumer concerns with food safety issues

Research challenges:

- Identifying and quantifying determinants of consumer trust and confidence in the food provision system (including trust in actors and institutions) for an understanding of consumer confidence and how it changes over time (monitoring);
- Understanding consumers' risk perception of products and lifestyles, particularly in the context of risk-benefit trade-offs and in the amplification of risk perceptions beyond the available scientific evidence;
- Understanding the role of public opinion formation for consumer risk perception;
- Development of effective consumer communication strategies and messages (e.g. use of layman's language) on risk related issues (including communication of risk-benefit and cost/benefit analysis and of uncertainties);
- Estimating consumer willingness to pay for safer foods and their willingness to trade sensory characteristics with safety provisions.

Deliverables:

- Quantification of the determinants of consumer confidence in food provision systems and similarities and differences across Europe (2010);
- Quantification consumer willingness to pay for safer foods and the relative value attached to safety characteristics with respect to other food properties;
- A better way of understanding how public perception of risk develops in interaction between consumers, media and stakeholders (2010);
- A tool to quantify consumer risk perception of products and lifestyle from a cost-benefit perspective (2015);
- A set of effective risk communication strategies to the public (2020).

Goal 8 – Understanding consumers and their behaviour

This goal is strictly correlated with the "Sustainable food production" pillar of the *Food for Life* platform and, therefore, it should be developed in close collaboration with that pillar.

To succeed in the market, sustainable food production has to meet consumer expectations and preferences. European consumer behaviour and lifestyles show a growing demand for products delivering greater convenience, but consumers are concerned about how food is produced transported and stored. There is also increasing consumer awareness about the ethical dimensions of food production and this is influencing purchase decisions amongst the more affluent sectors of society.

In view of the increasing complexities of food choices, research is needed into value-related purchasing motives and into how sustainability can become a

central part of consumer preferences; this will require qualitative social research inputs to better understand how preferences are formed and how they can be influenced.
Multidisciplinary research into sustainable diets, based on alternative animal and plant protein products, is also necessary.

Research challenges:

- Profiling consumers with respect to their consumption habits by recording their actual consumption within the household (usage of refrigerators, behaviours with respect to use-by-dates, refrigeration and storage habits...);
- Analysis and monitoring of the sustainability of emerging lifestyles trends (including food waste generation, energy and water use) and food consumption patterns;
- Understanding 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;
- Analysis of purchasing motives related to ethical convictions of different consumer groups in different European regions;
- Analysis of dietary sustainability and development of multidisciplinary strategies, including studies of acceptability of sustainable diets by different consumer groups. Developing and validating measures for quantifying the level of sustainability of shopping baskets/food consumption patterns;
- Understanding consumer expectations, attitudes and responsiveness to sustainable products, production systems and corporate social responsibility;
- Developing appropriate materials for educating and informing stakeholders about sustainable food production (to maximise consumer preference for products derived from sustainable food production systems).

Goal 9 - Interaction with consumers in order to assess their willingness to pay both for innovative products and for food chains which take into account sustainable consideration of environment, ethics and fair trade.

Goal 10 - Designing and testing new ways to communicate nutritional/other values to target populations, with some attention devoted to changes in "kitchen logic" (Kitchen logic conveys to customers how the benefit is delivered, using language that they can easily understand and quickly relate to).
Improved household appliances in accordance with consumers' expectations. The Food and Drink Industry is oriented towards food and health, freshness and the extension of the shelf life. These choices have an impact on the chilly and frozen chains and on the retail logistic. It could be interesting to investigate on the role that Household Appliances and Energy Industry could play (energetic sources, temperature management, remote control, shelf life and handling) in the view of food quality products modernization (i.e. ready to eat, time saving, easy to handle), without reducing the food safety level and without loosing the traditional relationship with food and food cooking. Therefore specific systems of networks and advanced electronics will be studied.

2. Food & health

Italian Food for Life

Good health is an integral part of thriving modern societies and is closely intertwined with economic growth and sustainable development. Achieving good health for all means not just curing diseases, but *preventing* diseases. Food and eating habits and physical activity are the *most important non-genetic contributors to age- and lifestyle-related diseases*, including obesity, diabetes, cardiovascular disease, hypertension and stroke, and some types of cancers (*preventing rather than curing).*

Research priorities:

- To obtain a better understanding of the mechanisms underlying the effects of food intake on health by nutrigenomic and toxicogenomic studies by new technologies (genomics, post-genomics and high-throughput tools) and to obtain novel insights to provide mechanistic explanations for effects of foods by the identification of bioactive food constituents and of their mechanism of action.;
- To discover and validate biomarkers based on epidemiological studies, cellular-, biochemical- and physiological studies and intervention studies. Development of *in vitro* and *ex vivo* assays and biomarkers for the study of *in vivo* effect of bioactive components;
- To valorise traditional food (and of their functional components) as a part of a healthy diet and a development of specialised food products in addition to those currently classified as 'foods for specific nutritional purposes';
- To introduce new methods of analytic control on nutraceutical compounds(carotene, fenolic acid, flavonoids, secoiridoids, etc…);
- To introduce new methods of analytic control on antioxidants and oxidation state in quality control of any food lipidic matrixes and in finished food products.

The general objective is to develop new and effective food based strategies to optimise human health and to reduce the risk or delay the onset of age and diet related diseases: from food production to the understanding and valorisation of healthy properties of traditional food (typical of the Mediterrranean area) as well as the identification of innovative healthy food products, through the recognition of nutritional, anti-nutritional and allergenic components that influence the functional properties to optimise brain function, immune and intestinal function, cardiovascular function and metabolic function and to prevent cancer.

According to this objective, close contacts are necessary between this Challenge and the Challenge 3: *Developing value-added food products with superior quality, convenience, availability and affordability.*

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 and osteoporosis. Healthy ageing must be one of the key topics. *Physical activity is an integrated part of a healthy lifestyle.*

New emerging areas: Function of the brain, Immune and intestinal function, Metabolic function at all ages.

Challenge 2. Delivering a healthy diet

Goal 1. Understanding brain function in relation to diet

Diet can influence brain and cognitive development in uterus and in neonates, infants and young children. Moreover, diet may influence both short- and long-term cognitive performances.

Research challenges:

- Diet and individual nutrients / non nutrients / metabolites influence on brain health and performance. Study of the mechanisms through which dietary components modulate brain development, cognitive performance and prevent ageing-associated cognitive decline.

Deliverables:

- Healthy ageing by nutritional strategies in childhood Molecular, cellular and system-level mechanisms behind neuroprotective effects by dietary compounds;
- Neuroprotective effects of bioactive components of foods against cognitive impairments and neurological degeneration in brain injury sequelae. Food impact on neurogenesis either during development or during neurorecovery after impairing events;
- Psycho-physiological effects of foods and meals, with particular focus on control of food intake.

Goal 2. Understanding dietary effects on immune and intestinal function

Food is an important factor able to affect immune reactions in either a negative (e.g. *allergy*) or positive manner (e.g. *probiotics and prebiotics*). The intestine is regarded as the key organ able to maintain health and influence resistance to disease and immune function in relation to food. An emerging body of knowledge now points towards the benefits of several bioactive food components (including probiotics, fiber, fatty acids, peptides and antioxidants) interacting with the immune system and the intestine.

Research challenges:

- Knowledge 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;
- Fetal and neonatal nutrition in relation to immune (de)regulation during later life.

Deliverables:

- Determination of the health promoting potential of traditional foods with regard to the intestinal flora, immune function. Evaluation of the functional properties of specific components/ingredients of traditional foods;
- Determination of a healthy diet with regard to the mother, and with regard to the newborn during early life, in order to optimize immune function and decrease the risk for allergy. Nutrigenomic studies on the effect of nutrients on pediatric disease risk reduction;
- Identification of dietary factors that improve the barrier function of the intestine and the resistance to infections and its inflammatory sequelae. Food and intestinal microflora balance driving immunoresponse. Gut microbiological imprinting;
- Development of biomarkers of intestinal functions to define and improve "intestinal health"; improvement of e.g. 'abdominal comfort', digestive function, systemic immune function, celiac disease, phenylketonuria and decreased risk of colorectal cancer. Bioactive components of food in the control of colon cancer, primary and secondary prevention of gastrointestinal diseases, set up of nutritional intervention protocols to evaluate food protective activity, as biomarkers of effect;
- Consideration of possible interactions of potential bioactive molecule with dietary macronutrients and effect on absorption and biological activity;
- Improvement of the allergome databases of plant- and animal-derived food, knowledge of allergen post-translational modifications and allergenicity increase by additives or contaminants, and persistence after cooking; detection of allergens derived from gastrointestinal or hepatic metabolites. Reduction of food allergens by crop selection and study of food and pollen cross-reacting allergens under climate changes and environmental conditions.

Goal 3. Understanding the link between diet and metabolic function

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. Dietary measures that could counteract these ageing-related metabolic disorders would offer a real breakthrough in an ageing society.

Osteoporosis is defined as a reduction in bone mass and disruption of bone architecture resulting in reduced bone strength and increase fracture risk. Nutritional survey data consistently show that most children and adolescents in the European Union currently do not achieve the recommended intake of calcium. Optimal calcium intake is especially relevant during adolescence, when most bone mineral accretion occurs.

Maternal and post-natal nutrition is not only central to the growth and development of infants but may also condition health later in life, influencing the risk of developing excess fat mass and metabolic disorders later in life.

Research challenges:

- Defining the effects of diets and nutrients early in life for health outcomes in later years;
- Establishing dietary practices in childhood that promote adequate calcium intake throughout life;
- Tackling the nutrition-related wasting diseases in the elderly population and understanding the role of nutrition in healthy ageing.

Deliverables:

- Contribution of epigenetic events on chronic diseases later in life and the contribution of nutrition;
- Understanding the interlinked effect of dietary components on intestinal and adipose tissue endocrine functions and their relation to metabolic regulation and derangements;
- Prospective studies on the relationship between calcium intake and fractures to assess the magnitude of increased fracture risk at different calcium intake levels. Dietary factors maximizing or decreasing the retention of dietary calcium;
- Maternal and infant dietary recommendations for optimal metabolic and bone health; good dietary practices that begin in childhood and are followed throughout the life span.

3. Food quality & manufactoring

Italian Food for Life

New innovative manufactoring technologies, addressing consumers' expectations for high quality, novel or modified products with attractive taste and convenience characteristics will enhance the competitiveness of the Italian food sector and contribute to the welfare and wellbeing of consumers. Significant and sustained investment will be necessary will be necessary to maintain a global and competitive agro-food complex, maximise the market share of high quality European products and ensure a leading market position with net trade surpluses and increased employment.

Challenge 3. Developing value-added food products with superior quality, convenience, availability and affordability

Goal 1. Producing tailor-made food products

Research challenges:

- Identifying bioactive food constituents and their mechanisms of action, optimisation and quality determination of raw materials by functional property approach;
- Determining/predicting the effect of food structure on bioactive delivery and transfer to the target site;
- Assuring best risk/benefit potential of heat treated food by minimising of toxic compound formation and optimising technological process to obtain best nutritional, functional and acceptable sensorial properties;
- Determining/predicting the impact of processing formulation and storage on bioactive component content, delivery and transfer to the target site
- Use of advanced multivariate statistical procedures (Mixture Design) in order to optimise desired food properties;
- Optimising production of live pathogenic organisms used as delivery vehicles for bioactive components;
- Production by biotechnology, nanotechnology and mild technology of bioactive ingredients (e.g. extracts) for tailor-made foods formulation;
- Identification of consumer's target ranges and need of tailored food in the Italian reality.

Deliverables:

- *In vitro* assays and biomarkers to predict *in vivo* functionality of bioactive components (2010);
- Models for PAN patterns as a function of quality factors to diversify to specific consumer groups (2015);
- New ingredients (from by-product extraction, biotechnology, nanotechnology, microbial metabolites, etc.) possessing beneficial health properties; targeted delivery of selected bioactives (2015);
- PAN relationship to physical/chemical properties and structure (either nano-, micro- and molecular) of products, and packaging concepts.

Goal 2. Improving process- and packaging design and process control

Research challenges:

A. Process design

- Use of Mild & selective technology / combined technologies to prolong shelf-life;
- New, efficient and sustainable processes that deliver personalised quality products, based on cascades of existing unit processes and on output demands;
- Use of genetic information to select animal products best suited to particular processing techniques (e.g. casein types vs. cheese production, etc). New meat/milk constituents or characteristics may be suited to new processors and could have a genetic component of variation.

B. Packaging design

- New packaging in terms of new material and packaging systems / development active packaging and edible films;
- Development of concepts such as active and intelligent (A&I) packaging
- Innovative MAP for MPF / fresh-like foods.

C. Process control

- Necessity to increase flexibility, through the redesign of both processing and logistics and to develop new processing plants for specific application to design tailored foods;
- Develop of in-line statistical control systems based on Multivariate St atistical Process Control (MSPC) to manage and to elaborate processing data in real time;
- To develop in-line, preferably non-destructive, and integrative quality sensors are a prerequisite for a modern process control. (NIR, EN, NMR, Image Analysis, etc) for process control;
- Minimization of toxicants from processed foods.

Deliverables:

- Mild preservation technologies to deliver products with long shelf life and a fresh appearance; direct freshness indicators on packaging (2010);
- New ingredients from biotechnology, and plant and animal extracts (2010);
- New packaging materials with optimized functionality and controlled biodegradability; optimized ways to combine active packaging with others preservation technologies; improvement of properties, potentialities and usage of currently existing A&I packaging concepts (2010);
- Identification of prioritized A&I packaging concepts to meet needs and trends in foods preservation, processing, retailing and domestic use (2015);
- Bio- processes to optimize viability, activity, and functionality of bioactive compounds in finished foods (2020);
- New in-line non-destructive control systems to assess the quality and safety of food through processes (2020);

- New active packaging concepts acting on different reactions of degradation or as vector of compounds of interest and integrated on the whole food technology itineraries (synergistic hurdles technologies) for maintaining or improving qualities of food products (2020);
- Intelligent packaging using tags as miniaturized analytical tools with wireless communication for monitoring food quality during transport, storage and processing, from producer to consumer (2020);
- Tailor-made packaging for perishable, diverse and complex foods such as fresh, living, composite or traditional foods (2020).

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

Research challenges:

- Food microstructure can be identified as a 'generic aspect' with a close functional relationship to food quality (including sensory/taste, nutritional and health-related functions);
- of new processing techniques for improved micro-homogeneous (HTC) functional structure formation and investigations of process-induced micro-structuring mechanisms from molecular to macro structure level;
- Investigations on new/new combinations of processing principles (magnetic, electro magnetic, electric, mechanical (pressure/shear/ elongation) force-/stress fields, resulting structure formation mechanisms/-kinetics and received structure-quality characteristics;
- Developing shared and reliable criteria and methodologies to evaluate acceptability limits for shelf-life assessment;
- Processing Modelling by using Multivariate Statistical Approach in order to obtain reliable relationship between processing conditions and product characteristics.

Deliverables:

- Laboratory and process analytics developed to quantitatively prove process-structure-property relationships (2010);
- Structure/formulation-property functions (SFP) and Structure-Process functions (SPC) available and coupled with the major PAN quality criteria (2015);
- Well validated predictive models for shelf-life assessment (2015);
- 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 consumer profiles within processed food systems (2020).

4. Food safety

Italian Food for Life

The research broadly follows two lines:

- Improved understanding of known and emerging hazards in the food chain, with an holistic view, e.g. 1) the understanding the effect of climate changes on food safety (microbiologic risks, metal contaminants, technical instruments against fungin attacks like Fusarium Toxin – OTA, pesticides uptake) 2) 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 methods and systems for continuously improving the safe production and supply of foods.

Understanding the hazards includes a full assessment and characterization of the risks associated with exposure of the consumer to these hazards (risk assessment). Complementary to this is the evaluation of risks versus benefits of food products, and food consumption patterns.

The core of food safety organizational issues seem gathered around three main critical areas: (i) distribution of information, mainly arising with regards to final and intermediate transaction due to the features of food intermediate and final products; ii) coordination needs, since the degree of safety depends upon the activity of all the supply chain's agents; (iii) governance options in relation to different strategic positioning.

The complex link between information flows, asset specificity, uncertainty, and organizational solutions suggests that the governance structures chosen by agents along supply chains affect levels of food safety supplied. Complex public and private institutional framework also support the organizational choice in this field.

The study of relationship between institutional environment and governance choice and its influence upon the food safety supply seems thus to provide a research challenge concerning the organizational adaptation of food chains and the managerial conceptualization related. Critical points may emerge which could be inserted in one or more of the Strategic Research Agenda 2010-2020.

Challenge 4. Assuring safe foods that consumers can trust

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

Major research challenges, for relevant hazardous agents:

- Improved understanding of ecological behaviour (growth, survival, inactivation and contamination, matrix effects, matrix and processing effects, adherence and biofilm formation) and interaction with naturally occurring microbiota and predictive modelling of behaviour in food systems, including traditional ones;
- Interactions between communities of pathogenic organisms including the potential role of non-pathogenic food organisms to modulate the risk of

colonisation by pathogenic organisms (this includes links to the genomic analysis of human intestinal microbial communities – intestinal micro biome);
- improved understanding of the safety of intentionally added micro-organisms in new food (e.g.: probiotics);
- Molecular biology of pathogenic and toxigenic agents m.o. to understand their behaviour in the food chain;
- Understanding and predicting the risks of resistance development to environment;
- Virulence and risks of pathogenic organisms in the food chain;
- Improved understanding of behaviour and virulence traits of foodborne pathogenic and toxigenic m.o. including viruses is essential to determine requirements for providing safety without unnecessarily affecting desired characteristics (flavour, etc.). This will require research into host-microbe interactions;
- Gathering and analysing epidemiological data combined with typing and characterisation methodology - special care will be taken to gather and analyse these data in a population-disaggregated manner including gender;
- Understanding settlement and diffusion of pathologies mediated by zoonotic pathogenic organisms;
- Monitoring virulence traits and understand virulence mechanisms;
- Understanding mechanisms of emergence;
- Using genetic information to track and verify source of products and track back disease and chemical contamination to source, and to select genotypes associated to a lower health risk. Also information on genetic variation in pathogens could be used to track back the source of disease outbreaks.

Deliverables:

- Models developed by mining of existing data (2010);
- Design and monitoring of microbial communities in food to control pathogens (2015);
- Validated models predicting resistance developments to heat, high hydrostatic pressure, high homogenization pressure and one other emerging preservation technique (2015);
- Functional mammalian cell culture systems for determination of virulence (2015);
- Validated protocols to study microbial behaviour in such infection models (2015);
- Rules/models to minimise risks from biological hazards based on predicting interactions between foods, the ecosystem and pathogenic organisms (2020);
- Artificial organs, both cell culture based and mechanical (computer aided) to limit and, if possible, replace animal testing (2020);
- Improved methods to detect VNC cells;

- Evaluation of food of animal origin including aquaculture products as possible spreading source of microbial resistance to antibiotics and drugs and antimicrobials and setup of appropriated strategies;
- Development of feeding strategies (including the exploitation of the antibacterial effectiveness of numerous substances widely diffused in plants) to improve the immunity response of animals against pathogens;
- Evaluation of the role of physical factors in determining bacterial differentiation and resistance to inactivation.

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

Fate and occurrence of chemical contaminants in the food chain Chemical contaminants, as a general category should include crop protection agents, veterinary pharmaceuticals, persistent organic pollutants (POPs), heavy metals, and biological toxins like mycotoxins, residues included those deriving from illicit treatments of farm animals, phytotoxins and shellfish toxins and heat-induced contaminants, polycyclic aromatic hydrocarbons and cholesterol oxydation products. Elements of this category represent known and potential health hazards to humans, most commonly by long-term exposure, through the consumption of contaminated foods.

Understanding and predicting the risk related to the presence of neurotoxic pesticides and endocrine disrupter molecules in food on neurogenesis and neural growth in embryos and children, including a sound knowledge of contaminant biotransformation in neurogenesis.

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

Research challenges:

- Improved toxicological risk assessments for key potential hazards, such as the feed-food-human transfer chain or the migration of chemicals from packaging materials into food;
- Studying the effects of conditions of primary production and industrial processing on incorporation of chemical contaminants into the food chain;
- Understanding the fate of chemical hazards (production, persistence, destruction, (re)contamination) in the food chain including the effect of technological procedures and mechanism-based predictive modelling of environment-food interactions;
- Finding novel biomarkers of exposure/effect/susceptibility to key contaminants with special regard to critical effects (e.g., endocrine, immune and/or neurological effects) for potentially vulnerable population groups such as pregnant women, children, the elderly;
- Improved knowledge of interactions of co-occurrence of chemical hazards and food components.

- Understanding the metabolic fate of chemical and hazards (including the carry over from feed to food from animal origin) in plants and animals and human body including extra-hepatic metabolism (e.g. role of placental metabolism for fetal risk assessment).
- Studying the fate of chemicals in the human body

Deliverables:

- Well-validated predictive models for the behaviour of known and emerging hazards in foods (2015);
- Robust and reliable alternatives to animal testing for key toxicological endpoints, based on artificial organs and cell culture to determine toxicological effects in order to limit and possibly replace animal experiments (2020);
- Development of novel production methods for high quality primary products (fruit and vegetable and food from animal origin in particular) with aim of minimizing the presence of toxic compounds from biotic and abiotic source based on an holistic view including climate changes;
- Development of strategies for reduction of allergenicity also in the view of the climate changes and environmental conditions.

Goal 3. Improving risk assessment and risk-benefit evaluation in the food chain

The food sector needs to be able to:

- evaluate the risks and benefits associated with the consumption of specific foods, food categories including traditional foods, and based on consumption patterns (knowledge), taking into account human differences (age, gender etc.), regional differences in food production and habits;
- develop the ranking of risks associated with the food chain, followed by the comparison between the ranking of risks and the analysis of cost/benefit associated with the reduction of risks;
- communicate this information in an appropriate form (e.g.: ALOP, ALAR, FSO, ALARA, etc..) to the various stakeholders of the food chain (knowledge and skills);
- build a robust knowledge of the complex interactions among the many chemical species that are present in each food as a whole, developing an innovative holistic approach to cooked foods safety.

Research challenges:

- The gathering and generation of epidemiological and analytical data to support and model scenario studies on trace contamination of current and unidentified hazards associated with specific food consumption;
- Studying the fate of chemicals in the human body, including metabolic and not metabolic interactions among food components and contaminants;
- Monitoring the dietary intakes of contaminants in different age-sex groups from total diet studies;

- Exhaustive risk characterization with special consideration for subpopulation at higher risk also using validated biomarkers of susceptibility;
- The development and validation of science based models (in vitro, in vivo, in silico) which describe the risks and benefits associated with exposure to biological and chemical components in the consumption of specific foods and the diet as a whole;
- Approaching risk/benefit analysis in a holistic way should be privileged as the main avenue to evaluating the real impact of the total of a food (or of a diet pattern) to human wellness, as an alternative to applying a 'brute force' approach by singling out the toxicology of each molecule.

Deliverables:

- Development of integrated and preventive measure to minimize risks in the food chain;
- Improved analytical methods for the detection and monitoring of food safety hazards that can be integrated into quantitative risk assessment routines (2010);
- Developed protocols for the integration of food quality and safety systems into microbiological risk assessment (2012);
- Knowledge on risks and benefits associated with the consumption of specific food, food categories including traditional foods based on consumption patterns (2015);
- Development of an appropriate form to communicate the above mentioned information to the values stakeholders of the food chain (2020);
- Improved understanding of the heterogeneity of the microbial population.

Goal 4. Developing tools and addressing measures to ensure safety of the food chain

Research challenges:

Monitoring and control

- Development of effective methodologies for culturing, tracking and tracing of microbes, natural toxins, toxic, carcinogenic and/or genotoxic contaminants, endocrine-active (hormones, corticosteroids, etc.) and potential allergens along the food chain. This should include new plant varieties and GM-plants, other GMOs and novel foods; - biosensors, proteomics and genomics technologies and nano-technologies are expected to play a major role;
- Development of design tools based on models (see above), for the evaluation of the individual and combined effects at every stage of the integrated food chain. e.g. environmental and food matrix effects on the fate of microbial and chemical hazards.

Deliverables:

- Improved and harmonised analytical methods for the detection and monitoring of food safety hazards that can be integrated into quantitative risk assessment routines. (2010);
- Development, optimization and validation of sensitive specific high-throughput and rapid analytical and biological methods, and non-invasive instrumental method to identify, characterize a low level of pathogenic bacteria (< 2 log CFU/g), mycotoxins, allergens, veterinary drugs, food contaminants including natural ones, toxis metabolites, residues included those deriving from illicit treatments of farm animals;
- Developed protocols for the integration of food quality and safety systems biology data into microbiological risk assessment (2012);
- Knowledge on risks and benefits associated with the consumption of specific foods, food categories including traditional foods, and based on consumption patterns (2015);
- Assessment of zoonotic agents and drug resistance in traditional and innovative food chain;
- Novel solution for assuring food safety of organic industrially-treated products.

Technologies - Sourcing and raw material

- Development of technologies for the reduction or the elimination of hazards at the level of primary production (bio-derived and bioengineered chemicals bioenvelops with enhanced spectrum of action and/or time limited life cycle; GM plants and animals with traits which contribute to the reduction of chemical and biological hazards; and strategies to prevent colonisation of farmed animals by food-borne pathogens (e.g. competitive exclusion, immunization exploitation of interspecific signalling molecules and their interference with pathogen colonization and biofilm formation), new feeding and breeding programs in farm animals that affect the quality and safety of foods of animal origin;
- Development of technologies for the screening, sorting, and developing safe raw materials, including the decontamination of 'contaminated' raw materials;
- Identification and development of microbial metabolites and/or new plant and fungal constituents having antimicrobial activity and able to interact with pathogen growth and host defences;
- Use of specifics enzymes able to improve the safety and textural properties of food.

Technologies – Processing

- Development of novel technologies supporting flexible and safe manufacturing of foods incorporating for e.g. hygienic design and new contact materials;
- Advanced multi-hurdle concepts, combining different types of hurdles (e.g. preservatives, advanced preservation techniques, active packaging, etc.). This would include combination of hurdles (recipe and technology);

development of new hurdles, including the technologies able to enhance the activity of natural antimicrobials, and modelling;
- Development and optimisation of alternative technologies to classical heat treatments: irradiation, ultra-high pressure, high pressure homogeneization and high pressure modified antimicrobial enzymes pulsed electric field, radiofrequency, pulsed light, ohmic heating and sterilisation, nano-thermosonication, plasma process etc. Research needs include developing novel technologies and assessing the implementation of relevant existing ones;
- Study of the effects of the new technologies on the stress response, gene expression and mutation rate increase of pathogenic and spoilage bacteria.

Retailers and Consumers

- Development of new logistic approaches for strengthening safe distribution of foods, including abuse detection;
- Create novel solutions for the maintenance of low temperatures in the supply chain;
- Active and 'intelligent' packaging technologies, with safety enhancing properties.

Deliverables:

- Validated technologies for the optimal processing, distribution and use of foods with safety assured (from 2010);
- Intelligent food contact surfaces to prevent microbial adhesion will be available (2010);
- Development of new antimicrobial molecules associated with bacteria signalling mechanisms and their possible use as anticoating factors;
- Food safety indicators integrated within the entire food chain (2015);
- Food contact surfaces able to signal the presence of residues and pathogenic organisms after cleaning (2015);
- Novel software and hardware for use in the supply chain to ensure the safe and efficient distribution and storage of foods (2015);
- Internationally accepted and recognized protocols to demonstrate the safety of food with new ingredients and/or processed with novel technologies (2020).

5. Sustainable food production

Italian Food for Life

Consumers are increasingly motivated to purchase foods that conform to production criteria that are generally environmentally-friendly and conform to their ethical principles. To achieve these, synergies must be created between economic growth, environmental protection and fair social conditions, with a multidisciplinary scientific and technical approach and the integration between public and private research sector enterprises area.
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. The recent expansion of the EU brings about an increasing diversity of food production systems, affording the opportunity to utilise this diversity for creating and supporting more sustainable food production systems.
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 transition towards more sustainable systems must go hand-in-hand with strengthening the competitiveness of the stakeholders in the European food system.

Challenge 5. Achieving sustainable food production

Goal 1. Understanding of the sustainability of food production and supply in Italy

A system analysis perspective is essential in assessing the sustainability of food chains since their environmental impacts can occur in different places and different times. Life Cycle Assessment (LCA) has been developed to identify and quantify the environmental impacts of individual products and services (such as collective catering systems). However, food production is a complex inter-linked system, so that the LCA approach must be extended into a more complete and realistic form of system analysis; it should enable products to be examined in the context of the background system in which they are embedded. In addition, the Environmental Product Declarations (EPD), generated by LCA, must correspond to the specificity of the agro-food system and this approach should be uniformed within Europe.
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, and must also address fair working conditions, rural development and gender equality.
Models must be constructed to identify sustainability indicators, which can then be validated and used for comparing scenarios. A systematic programme is needed to measure these indicators so as to monitor progress towards sustainability. To support multi-criteria decisions processes, models should be developed that can be optimised to show the effect that positive changes in one indicator might have on another.

Research challenges:

- Develop a system analysis methodology for describing the essential parameters of sustainability over the whole food chain**,** using sustainability or extended LCA indicators. The latter should include both production aspects, as well as indirect features that can influence the sustainability of the system;
- Develop dynamic modelling tools;
- Formulate models to describe and evaluate the sustainability of regions and supply chains in the whole European system. This aspect includes both analysis and project development and should be applied to trans-European situations that interact and influence each other;
- Apply LCA methodology and formulate models to describe and evaluate the sustainability of Italian typical productions, to evince their characteristics of environmental, economical and social sustainability. This should favour innovation and development of both agricultural and food enterprises;
- Generate EPD that correspond to the specificity of the agro-food system and uniform this approach within Europe, by applying system analysis methodology and case studies for describing the essential parameters of sustainability over the whole food chain.

Deliverables**:**

- LCAs performed for a range of regional and commodity food chains; appropriate sustainability indicators developed;
- Sustainability indicators quantified for many food chains and applied to show the scope for improvement;
- Dynamic modelling tools developed and used for rapid identification of more sustainable production and processing systems for a range of products at different geographical levels;
- Uniformed EDP for agro-food systems.

Goal 2. Research on scenarios of future Italian food production and supply

Scenarios are 'possible futures', intended to provide insight into the consequences of multi-factorial changes (e.g. demographics, environment and world trade), which are expected to be more dynamic than previously.
Global climate change, the heavy dependency on fossil fuels and the political boundary conditions, are some aspects that will also influence the sustainability of the European food supply system, so they should be considered when studying scenarios.

Research challenges:

- Identify relevant factors for the sustainability of European food production systems, their projections into the future and use them to build long-term scenarios, integrating demographics, economy, policy and trade, and environmental change. Evaluate their priority in the Italian context;

- Enforce an holistic genomic approach to ensure sustainability.

Deliverables:

- Presentation of a number of scenarios illustrating the consequences of different "futures", developed out considering the present food production system;
- Selection of general scenarios to be used as a basis for future food production scenarios;
- Presentation of a number of scenarios illustrating new and alternative highly sustainable food production systems.

Goal 3. Developing sustainable processing, packaging and distribution

Current systems of manufacturing and processing, packaging, transportation and distribution, and retail are not necessarily sustainable. The wasteful use of natural resources and food raw materials, as well the policies or markets, may favour unsustainable patterns of production and there is an inequitable remuneration of actors in the system.
Reduction in uses of energy, water and materials will require close links between raw material production, primary and secondary processing, packaging, waste management and reprocessing. Identification of improvement potentials from sustainability analysis will be an important driver for innovations that are 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, as does the *'Industrial Ecology'* (IE) approach. This 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 will include analysis of complex and interlinked networks of primary food production, food processing, distribution and packaging.
It is necessary an integrated approach towards the identification of the critical points of the process and the sustainability, so as to optimize methods and techniques that lead to an increase of competitiveness of the enterprises and to sustainable manufacturing and processing, packaging, transportation and distribution systems.

Research challenges:

- Reduce uses of energy, water and materials (food, feed and packaging);
- Identify improvement potentials from sustainability analysis;
- Improve utilisation of food raw materials and reduce waste throughout the production chain. Develop side-structures for in-field preliminary food processing;
- Reprocess valuable food waste to food or feed;
- Promote recycling, recovering and management of biomass, organic wastes and by-products;

- Optimise energy production in industry including the development and use of alternative/renewable energy sources;
- Utilise and recycle by- and co-products of food chain as energy and active compounds sources;
- Develop new techniques and new materials for packaging;
- Promote storage and transport with "zero- release" of contaminants;
- Integrate 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;
- Develop methodologies for value chain analysis;
- Develop methodologies for integrated assessment of sustainability.

Deliverables:

- Methodologies for value chain analysis;
- Identification of wasteful food processing, packaging and transportation operations with potential for substantial improvement;
- Methodology for integrated assessment of sustainability of food production systems developed;
- Scientific approaches underpinning sustainable management of food production systems and clearly-established sustainability measures;
- Development and implementation of novel processing, manufacturing, packaging and distribution methods based on research on sustainable food production;
- Development and implementation of highly integrated sustainable village systems, including food production.

Goal 4. Developing and implementing sustainable primary food production

Within the next few decades, food production in Europe will experience climate change, changing international trade relations and regulations, large-scale shifts in global food production and demand, and stronger demands from society to reduce the environmental impact of food production. Primary food production must adapt to these changes to be sustainable. However, the study and preservation of local plant and animal biodiversity is a fundamental aspect for the development of sustainable production systems. While additional research needs to expand further knowledge on the interactions of biological cycles to enhance traditional food production, radically different primary food production systems may provide additional sources of food to traditional food production.
Biotechnology may be used to produce desired crop biomass in a targeted way, and to provide plants with better sensory, nutritional and 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 *animal husbandry* should be evaluated, including the dimension of animal welfare.
Fishery systems in Europe must be assessed for their sustainability and alternatives to traditional fishing must be explored, such as *aquaculture.*

Research challenges:

- Identification novel food production systems and evaluation their sustainability;
- Conservation & exploitation of biodiversity for native plant, animal and mushrooms species production, including breeding;
- Rationale use of natural resources: conservation of soil fertility, reduction of contamination of water resources & improved water use efficiency leading to more effective management of nutrients and xenobiotics in primary production systems;
- Alternative production and pest & disease control methods in the frame of ecological services;
- Development and evaluation of biotechnologies in sustainable agriculture
- Development of innovative techniques for the characterization of food according to the geographic origin, typicality components and safety;
- Creation of Indexes and Models of Geographic Characterisation (IGC, MCG) of the products;
- Production of food with better sensory, nutritional and technological properties;
- Ethical aspects of food production related to both consumer well-being and animal welfare, focused on developing alternative systems for food and animal production;
- Utilisation of statistical multivariate techniques to assess the weight of different variables (qualitative, environmental, managerial), on the qualitative and quantitative production of raw materials;
- Utilisation of fine-tuning of production systems;
- Decision making systems based on real-time control of primary production processes;
- Reduction of energy inputs and emissions of greenhouse gases addressing climate change issues;
- Application of system analysis, including performance evaluation, risk assessment of the processes and technologies.

Deliverables:

- Establishment of the knowledge base required to optimise existing primary food production systems, further development of novel systems and assessment of their sustainability;
- Scientific data underpinning the fully integrated management and assessment of sustainable primary food production systems (both established and novel);
- Scientific data on adaptive sustainable management of man-nature systems, including primary food production systems;
- Indexes and Models of Geographic Characterisation (IGC, MCG) of the products;
- Network research-production enterprise.

6. Food Chain Management

Italian Food for Life

The STRATEGIC RESEARCH AGENDA (SRA) 2010-2020 document regarding Food Chain Management appears comprehensive in terms of research challenges and deliverables grouped in six goals to be reached in the next 10-15 years.

In the light of this document a series of research challenges which could fit in with and satisfy the needs of the Italian agro-food industry were identified for the Italian platform and will be presented hereafter.

The starting point at which to identify these challenges is the structural situation of the Italian agro-food industry which is characterized by a large numbers of SMEs with a high degree of complexity according both to the sector and to the geographic area of production. These peculiarities render an analysis of the Italian food chain at national level difficult without considering differences existing at regional or local level.

The way in which these challenges are presented mirrors the ETP document i.e. placement inside one of the six goals. However, since the identified research challenges can be inserted in more goals, the identification in one goal has to be interpreted as a major contribution to the objective in question. In other words the various research challenges could also be inserted in other goals.

Challenge 6. Managing the food chain

Goal 1. Identification of possible scenarios

The identification of possible scenarios is a priority particularly for Italian SMEs if they want to maintain and gain competitiveness both on the domestic and international market. Particular attention should be given to products, which have always represented the image of Italian foodstuff on international markets.

Research challenges:

- Global supply strategies and long term structural changes (positioning of SMEs in agro-food chains, districts, developed and less favourite areas);
- Responsiveness of food chains to policy changes especially in consideration of the future role of Common Agricultural Policy and WTO and EU enlargement. In particular the analysis should be focused on typical Italian food products.

Deliverables:

- A scenario expert group should produce a yearly report picturing expected changes in the short, medium and long run. A quarterly updating is suggested.

Goal 2. Stabilising markets and supporting food chain dynamics through the generation and preservation of trust

Taking into consideration the complexity and heterogeneity of Italian SMEs the generation and preservation of trust in business-to-business relationships as well as between food production and consumption is the key for market stabilisation and the creation of an innovative environment for dynamic chain and network developments.

Research challenges:

- Links between information flows and organizational solutions chosen by economic agents along supply chains, in order to ensure trust relationships with respect to food safety and quality of agro-food products;
- Simulation of agent-based models of local interaction and emergent district structure.

Deliverables:

- An Italian communication infrastructure delivering information which has to be transmitted quickly and at the same time to be trusted by the various stakeholders operating in the food production, distribution and consumption network. The delivery of this information should both address Italian stakeholders to take business decisions on issues regarding the food sector and improving trust relationships among economic agents.

Goal 3. Improving the innovation potential of the food chain

To compete on the international market and to respond to the needs of consumers the Italian food system needs to improve its quality systems and quality standards, risk management, inter-organisational information systems, chain governance structures and logistics systems.

New types of efficient and responsive chain and distribution networks must emerge that can support these demands, taking into account varying quality parameters, organisational conditions and different requirements of market segments.

Innovative consumer oriented food chain solutions, such as direct retailing, must become part of these designs.

Research challenges:

- Improving the logistic and distribution system of the food supply chain in order to lower transaction costs taking into account solutions which promote sustainable development;
- Increasing competitiveness of SMEs, through the development and diffusion of innovative standards and systems.

Deliverables:

- Evaluation and pre feasibility studies about alternative routes which can improve the distribution of food products between North and South and towards other world trading areas. For example shipments of food products via sea could improve and promote trade relationships between Mediterranean and Middle-East countries.
- Innovative standards able to satisfy consumer demands for food products which respect the environment, safety, animal welfare etc.

Goal 4. Supporting competitiveness through integration

Taking into consideration the peculiarities of the Italian food industry integration is a key factor for increasing the level of competitiveness of SMEs on a regional and global scale.

Research challenges

- Evaluation of strategic opportunities offered by short-chain distribution channels, as well as by distribution channels based on the use of Information and Communication Technologies (ICT);
- Integration strategies for supply chains regarding typical or local products.

Deliverables:

- Electronic platforms improving B2B and B2C trade relationships for food products.
- Studies evaluating benefits deriving from horizontal and vertical integration of typical and local products, with suggestions about regulations to improve integration.

Goal 5. Participation of small producers in complex food chain operations

The participation of small producers in development scenarios in disadvantaged areas of Italy requires specific efforts in order to support them on international markets. So Italian SMEs operating in economically disadvantaged areas need to gain better control over production, trade and distribution of their food products so as to be able to guarantee traceability of products and to operate in a cost-effective way and thus compete on the global market.

Research challenge:

- Enhancement of traditional products, especially those which are able to promote natural and cultural landscapes of rural areas;
- Role of collective brands to improve competitiveness of supply chains and networks.

Deliverables:

Evaluation of benefits deriving from the enhancement of traditional product and from the adoption of collective brands.

7. Communication, training & technology transfer

Italian Food for Life

Communication, Technology Transfer and Training are universally recognized to be key elements in support of an effective strategy for affirming the success of the ITP Food for Life. The food sector, representing one of the most important activities of Italian economy, is structurally slow to adopt of cutting edge innovations, although technical progress and results of scientific R&D are becoming a relevant part of product design, improvements and dialogue with consumers and society at large.

The Italian SMEs are especially vulnerable to rapid and unexpected changes at the level of 1) different market conditions and requirements, and 2) fluctuating scenarios (cost reductions, new and improved manufacturing processes, definition of new products, compliance with norms for enhanced food safety). Few companies, with the exception of larger multinational firms, are in a position to react to these challenges. In fact the innovation activities, in many cases, are intermittent by using different approaches (i.e. adoption of new machineries, materials and processing; comparison with other operators during national and international fair; new suggestions by suppliers or specific client's request); moreover, this lack of responsive is more often a psychological and cultural impediment than merely a matter of finance. Effective technical and organisational innovation requires a rapid response and detailed understanding of future likely scenarios. The food sector, characterised by large turnover and small margins, has generally been slow to adopt and exploit cutting edge innovations (although food equipment manufacturers was be an exception), but technical developments and the results of scientific R&D are becoming a relevant part of product design.

An effective dialogue with consumers and society at large is an imperative since the industry is constantly under surveillance by all sections of society.

Challenge 7. Communication, training and technology transfer

Goal 1. Communication

The Italian panel on Communication, Training and Technology Transfer complies with the European objective to develop more dissemination activities in the field of research and innovation for the food industry is a major topic of the communication strategy.

Within the communication scheme all players have to be included in the information flow:

1. Food producing companies – especially SMEs
2. Mediators, Researchers inside and outside of companies
3. Consumers, Consumer Associations
4. Retailers
5. Other economic stakeholders (farmers, suppliers, equipment providers et al)
6. Strategy Development Team of FP7
7. Specialised media, trade press

Communication in the field of R&D activities, technology transfer, but also aspects of food consumption with a direct link with food safety and risk perception, environmental impact and ethical issues do present a very sensitive character. This aspect should be taken into due consideration and "food communicators" should be trained *ad hoc*. Usually best results are obtained by mixed teams of professionals with a good knowledge of the most important aspects of food sciences and technologies and of communication tools and methodology.

As communication has a very global approach, two strategies have been recommended:

1. A general communication structure aiming at the overall information of all stakeholders, not necessarily specialised, parties as e.g. consumers or interest groups with the main objective to increase trust and understanding in foods and food production;
2. Specific information schemes are designed for the focused and direct information of specialised groups like researchers, food producers and consumers.

Communication must thus be conceived as a structural set of actions capable of:

- Promoting channels of communication and discussion among stakeholders in the whole food chain;
- Showing the importance and the feasibility of a greater amount of R&D activities, technology transfer initiatives and need for a more intense training for the sector workforce as the key structural course of action for reducing the vulnerability of the European food sector, especially at the level of SMEs;

Implementation plan will include the following:

- Use of traditional and modern communication tools (internet vs. brochures,...), depending on the stakeholders and Communication content
- Promotion of specific designed seminars and research workshops;
- Contact with the companies via local trade associations and other institutions;
- Development of communication programs based on ethical issues and food, as well as process sustainability;
- Frequent contacts with media;
- Monitoring and evaluation of the effectiveness and efficacy of the different communication strategies and contents;
- Development of an efficient strategy for implementing cross-linking among stakeholders' communication strategies and needs.

Challenges:

- Establish an effective dialogue with society;
- Create a cultural desire to possess innovative goods and experience innovative services;
- Identify and transfer best practice at all levels;

- Establish new, simple methods for structuring existing fragmented information to SMEs and make it available, in an easily-understandable format, for factory personnel.

Deliverables:

- ITP Communication Network for strategic issues of the ETP (2010-2015);
- New communication formats for food related issues as identified by the steering committee (2015-2020);
- Specific Information Communication of focussed and updated information to food companies about state-of-the-art in food research, in depth food analysis on national level, country specific information (2015 – 2020);
- Continuous communication flow to and from consumers via associations and other sources (2015-2020).

Goal 2. Training

Education means investing in the future. Training of researchers, professors and retailers covers all activities destined to empower knowledge within the company and to enable personnel to achieve higher standard of performance in their job. Training is therefore a powerful component of the process building of innovation. Training is nonetheless perceived by all actors in the food sector as a crucial element to sustain the competitiveness of companies.

The mobility of researchers towards industry has to be improved, so that competence and knowledge will be directly integrated on site. Mobility shall not be one way directed – a flexible flow of researchers towards industry and vice versa back to universities and research institutes will be enabled and supported by the technology platform. However there are also well know barriers, in terms of language and environment, that make SMEs sceptical about the value of training and technology transfer programmes that would be highly qualified by them. For this reason new directions must be identified and novel training and communication techniques put into force.

A network of national trainers having been educated at the AFT (Advanced Foundation for Training) will be responsible for the national training of Techno Mediators. These Mediators will be the connection link between needs of food companies and research offers in order to realise efficient and target orientated problem solving strategies. As the interface between the platform and the Food Industry has to be situated at a national level, the national mirror groups will use national institutions to deliver the needed infrastructure for the Mediators to do their work.

This complex articulation should be put into action stepwise:

- STEP 1: definition of the *curriculum* and prospectus of an European Advanced Foundation for food training. This activity ("training the trainers") must be centralised and based upon the advanced expertise and skills of leading innovations labs and universities in contact with the more "field"

approach of national agencies of technology transfer, and "bottom up" mindset of trade associations;

- STEP 2: creation of a sustainable system of dissemination of the methods and approaches certified a the level of the AFT in a twofold way:
    - at the national context, in terms of general organisational networks for adopting innovative training and stimulating the relative technology transfer;
    - at sector (branch) level, to ensure the dissemination of specific contents in " sector based communities" that should take the best out of the existing practices and current projects developed in single firms or branch;
- STEP 3: progressive accumulation of data and libraries of solutions built upon the current innovation technology transfer and training initiative implemented during the years.

Challenges:

- To establish and benchmark measures and mechanisms for training, including on-the-job options;
- To develop R&D and industrial 'partnerships' for training and technology transfer;
- To encourage personnel transfer and exchange at all levels of the food chain;
- To provide training and dissemination services to stakeholders in the agro-food sector.

Deliverables:

- National and sector trainers will be educated at the Advanced Foundation for Technology Transfer (2015);
- National trainers will operate in Italy (2015 – 2020);
- Training agreements are taken at European level (European certification at High School/University level) (2020).

Goal 3. Improved Technology Transfer

The Technology Transfer (TT) is the activity of assisting companies in improving their own technology oriented capabilities, by adopting new available technology or by using the available results and concepts of the scientific research.

According to the Italian working group, and in particular to the Italian SMEs operating in the food sector, this goal is the most important among the other previously described and included in the EPT food for life. The starting point is that process, product and system innovation are activities which derive from the scientific research, but that the Technology Transfer, (i.e., the introduction of new concepts into industrial manufacturing processing) requires time and procedures that are strongly linked to research, but that at the same time are quite independent. Therefore Technology Transfer cannot be performed through

industry-scientific department relationships, but requires intermediate bodies which translate the scientific concepts in a language accessible to SMEs, taking into due account the needs of the SMEs which cannot afford the time and the cost of scientific research, but should rapidly and without high costs access the results of the research activities.

The development of innovation process in the food industry, as well as in any other manufacturing area, requires different expertises as economical, marketing, technology and legislation aspects are involved altogether. The old sequential approach is not effective anymore and at the same time the concurrent engineering (described in figure 1) results the more effective one, in order to obtain a *time to market* consistent with the requirements of the global competition (as powerfully described by R. Treillon – Food innovation management, FoodNet Europe-Canada programme with Foodatlantic project).

Generally only the large size companies can count on *in house* expertise to support an innovation policy. Commonly SMEs and micro enterprises are not able, for lacking of financial means and expertise, to explore the first aspect of this process, and thus they do not know what kind of innovation may be useful for improving their market. Moreover, they are not able to develop all phases of the innovation process.

The possibility to use expertise to support specific needs in human resources could be a good solution only for big and medium sized food enterprises, but not for the small and micro enterprises that represent the majority of the food enterprises operating in our country. For these companies it is very difficult to pursue an innovation policy because of the long time necessary to develop innovative ideas and also to the high costs associated to preliminary studies carried on in partnership with scientific bodies before turning any ideas in an industrial process.

A different specific initiative must be implemented, including:

- The development, under the industrial coordination, of different activities at European, national and regional level, to support the settlement of specific agencies (Service Centres) strictly linked to Universities and Public Research Centres, but at the same time independent from them;
- These agencies should be able to supply the companies with human resources (Techno-Scientific Mediators), expertise and technical facilities and assist them in introducing innovation in the food area. Techno Scientific Mediators will support companies in: a)recognising their needs for innovation, b) identifying potential partners from technology providers, c) facilitating communication and d) managing the interaction with providers.

The suggested approach should be based on the criteria “think big, start small, scale fast”. The network should be built up around one or more groups (i.e. one or a few universities and public research centres should be selected on the basis of the available multidisciplinary competences and existing expertise in this field in

order to set up and tune the action in a way that it could applied also in other situation).

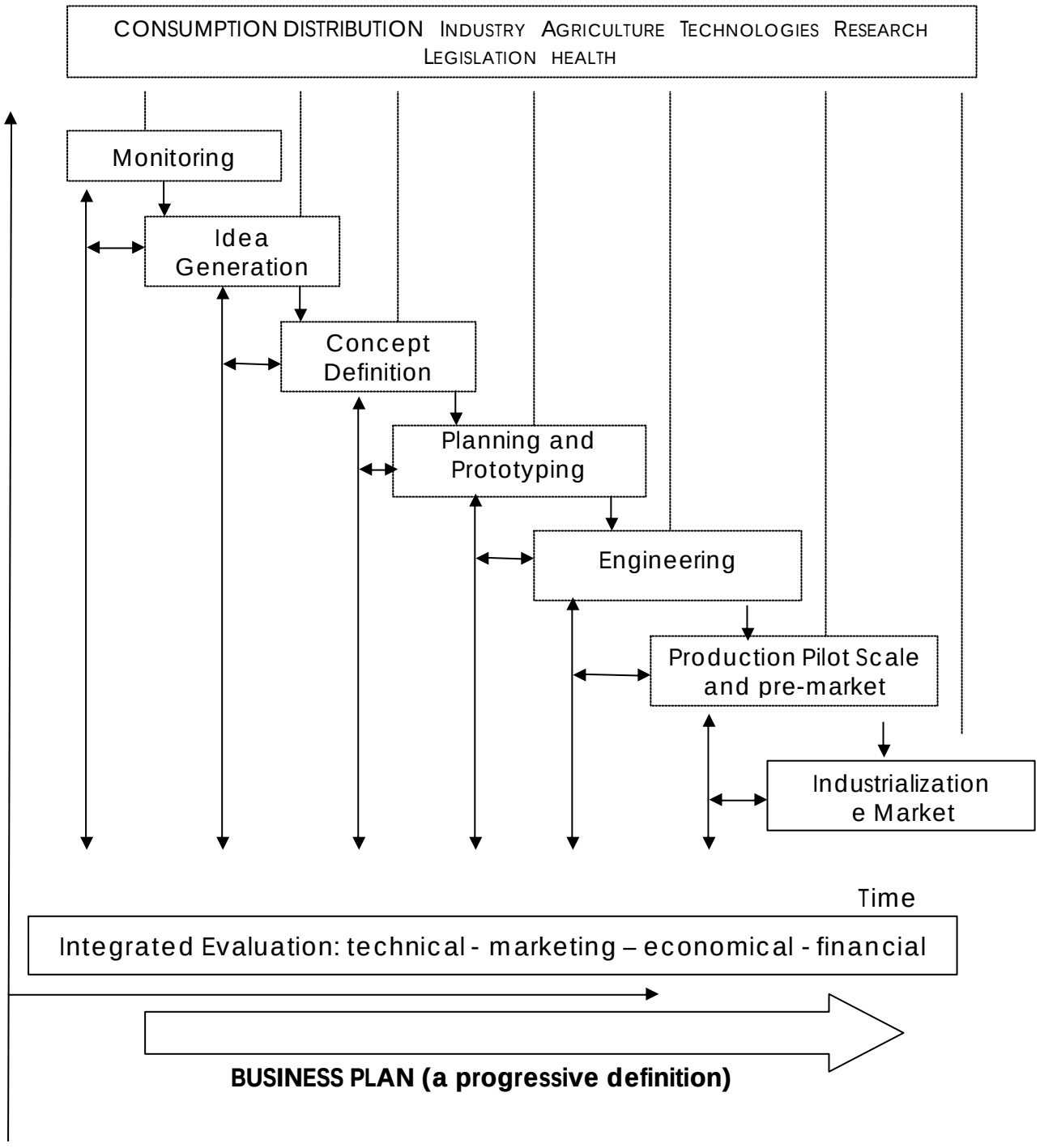
Challenges:

- Building an observatory for innovation that SMEs can consult with the aim of obtaining information regarding legislation, statistics and patents. The observatory should also be addressed by SMEs to draw up sector studies and market surveys and identify possible innovations in the food sector, also referring to effects produced by innovation in the food sector on human health and wellbeing;
- Developing a differentiated food communication policy for big and medium size enterprises. For the small and micro enterprises it would be better to foresee a one to one relationship and it is crucial the intermediation role of the TSM and industrial associations for the diffusion of information through the available means;
- Building a structure for the technical, economic and financial evaluation of innovation ideas and for the elaboration of a business plan;
- Promoting the benefits of a collective research addressing the shared interests of SMEs;
- Building a technology centre to realize prototypes, to optimize the food formulas, to realize pilot scale productions of new products and to train technicians in the use of the new technologies.

Deliverables:

- Knowledge base and information structure (2006-2010), including databases on 'centres of excellence', food research activities, national technology transfer 'bottleneck' centres and legislative obstacles for innovation;
- Job description for Techno-Science Mediators (2006-2008);
- A constant monitoring of the results of this differentiated communication policy in order, if necessary, to correct some aspects (2010-2015);
- A permanent training of technicians aimed at spreading the innovation culture in the food area and the possible interactions between food products and health, with particular reference to safety and wellbeing (2010-2015).

Figure 2: MANAGEMENT of food innovation
Context - Phases - Planning



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