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Traditional Food Network to improve the transfer of knowledge for innovation

Consolidated Strategic Research and Innovation Agenda at the European Level

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Contents

1. Preface

In the European Union, Small and Medium-Sized Enterprises (SMEs) in the food sector are increasingly under pressure due to the development of open markets, an increasing demand for standardized and price-competitive food products by the consumers, rising importance of large retailers, and the challenges they face to comply with governmental regulations. This raises the risk of losing many traditional foods as well as traditional techniques of production, processing, preservation, and packaging that are applied by SMEs using regional raw materials and often play a role in the cultural identity of regions. SMEs for traditional foods must extend their skills in modern as well as competitive marketing and production techniques to comply with existing European regulations and to promote the aspects of their products related to nutrition and health.

To support traditional SMEs, the **FP7 TRAFOON** project (www.trafoon.eu) has established a knowledge transfer network of 30 European research institutions, technology transfer agencies, and SME associations from 14 European countries by covering the value chain of four groups of traditional food products based on (1) **grains**, (2) **fish**, (3) **vegetables and mushrooms**, and (4) **sweet fruits and olives**. These food categories include many traditional, healthy foodstuffs which are essential for a balanced diet. From November 2013 up until October 2016, TRAFOON supported Europe´s traditional SMEs in these food sectors to foster sustainable innovation and entrepreneurship in the sector of traditional foods for the benefit of the regions of Europe and the European consumer.

TRAFOON increases the communication and interaction between traditional food SMEs, SME associations, and research institutions to improve and increase the knowledge transfer towards traditional SMEs on different areas of influence/activities (e.g. food production, food processing, packaging, marketing, labelling, certification, stabilization of production protocols to assure food quality and food safety, legal issues), and to enable research topics that are needed by European food SMEs.

TRAFOON WORK PLAN

At the beginning of the project, the needs of traditional food SMEs all over Europe were investigated and collected (Inventory of Needs, IoN). With this purpose, four questionnaires, one for each traditional food category, were developed, including issues from the entire food production chain, but also questions related to food safety and quality, and entrepreneurship as well as legal aspects. All TRAFOON partners contacted the identified SMEs and SME associations via email/phone/visit, extracting the relevant information for the IoN through the corresponding questionnaire. After extracting the needs, SWOT analyses of the results for each TRAFOON traditional food category were carried out by country and sector.

Five multi-stakeholder workshops (MSWs) took place between September and October 2014 in Poland, Spain, Switzerland, the Netherlands and the Czech Republic. In each MSW, TRAFOON partners, relevant SME associations and external specialists analysed the results

of the IoN for the core regions of the food category. The main objectives of the MSWs were: 1) prioritizing the needs collected in the IoN, 2) matching the needs identified in the IoN with the available transferable innovations identified by partners, 3) identifying those needs which do not require in-depth research and may be resolved without the development of new research projects, finding the solutions within the consortium experts, external scientists, or in collaboration with ongoing projects and 4) identifying those needs requiring new scientific approaches to be included as recommended research guidelines/initiatives in the Strategic Research and Innovation Agenda (SRIA).

Based on the results of MSWs, more than 55 Training Workshops (TWs, http://www.trafoon.eu/training-workshops/) for SMEs were held in Europe during 2015 and 2016. During the TWs, the technological, legal, or business-related solutions for these previously identified needs/demands were transferred, where specifically trained mediators were used to communicate these solutions in the language of the respective countries.

A multi-lingual online Information Shop (www.trafoon.org) containing the information gathered and implemented within the TRAFOON network was created as an additional knowledge transfer tool. This free-access online tool includes information (PDF files, e-books, audio and video files, etc.) about innovations in the primary production, processing and marketing of traditional food using regional raw materials in different languages. The Information Shop also contains databases of experts and organizations to enable potential future collaborations and SME-oriented research projects, and includes all technology/innovation knowledge transferred during the TWs and guidelines for product innovations in diverse European languages.

STRATEGIC RESEARCH AND INNOVATION AGENDA (SRIA) FOR TRADITIONAL FOODS

Based on the innovation gaps detected and the needs identified that require further research, and complemented by the SWOT analysis of the demands of SMEs during the MSWs, TRAFOON has developed four SRIAs for the core regions of the TRAFOON traditional foods categories: (1) grains, (2) fish, (3) vegetables and mushrooms, and (4) sweet fruits and olives. These so-called "**TRAFOON SRIAs at the national level"** are available at http://www.trafoon.eu/trafoon-srias-at-national-level/. TRAFOON SRIAs at the national level will inform national policy makers about the future research needs of traditional food SMEs, fostering rural development in particular.

Additionally, a general SRIA for traditional foods at the European level has been developed. The present document, "**TRAFOON SRIA at the European level**", includes, from a European perspective, a collective list of identified and prioritized innovation needs of SMEs working on traditional food products based on (1) grains, (2) fish, (3) vegetables and mushrooms, and (4) sweet fruits and olives. This SRIA also presents identified needs of two cross-sectional issues: "**Food Quality & Food Safety**", and "**Entrepreneurship in Traditional Food Production**". TRAFOON SRIA at the European level will inform the European Commission and European policy makers about future research answering the identified needs of SMEs in Europe.

2. Grains

a. Functional breeding in traditional grains

Specific challenge: Traditional wheat species (such as Einkorn, Emmer, Durum, Spelt) show various advantages over common or bread wheat, the cultivation of which covers more than 95% of the total wheat area world-wide. Bread wheat products are mainly produced from refined flour. The advantages of traditional wheat species include several potentials: they create much more biodiversity in the field, introduce crops with increased resistance against diseases and environmental stresses requiring less chemical protection, offer good food-physiological properties, especially when consumed as a whole-grain product, are adapted to local cultivation practices and environments, and are applicable in local or regional and traditional food product specialties. These species and their varieties may also add to increased taste and enjoyment. In terms of agronomy, these species may help to reduce the environmental burden. In terms of nutrition, these species may make their specific contributions to healthy diets. In terms of food processing, these species have their own benefits, enabling SMEs to develop specific artisanal methods on a small scale on the one hand, but with disadvantages on the other hand, requiring specific technological adaptations and processing technologies in large-scale production. In terms of yield (expressed in tons per hectare), these traditional wheat species are economically less profitable and need the creation of added value. Here, functional breeding, with a focus on valuable characteristics, such as yield and disease resistance, resistance to lodging (breeding of short-straw varieties) and maintenance of species-specific qualities (i.e. authenticity, technology, taste), may boost the cultivation and the consumption of these wheat species.

Scope: Starting from accessions stored in gene banks as well as from seed material of local wheat species and varieties of Einkorn, Emmer, Durum, Spelt (and related varieties), selections of promising accessions can be made and breeding (crossings, mapping populations) can be performed for high yielding (e.g. reduced plant height against lodging, improving harvest index and increased resistance against biotic and abiotic stress) while maintaining their specific quality characteristics regarding healthy, nutritional, tasty and processing-technological compounds. Meeting the requirements for sustainable or organic cultivation, such as low input requirements and robust disease and pest resistance, will be in high demand, since this will allow more products with higher added value at an acceptable cost. High-throughput phenotyping, including for product quality, and genotyping is pivotal to achieve the efficiency needed to enable economically feasible work on a small (underutilized/neglected) crop. This will lead to an increase of knowledge (in addition to already existing knowledge) on the agronomic, food-processing and nutritional/health characteristics, which should become the basis of advanced breeding programs, including marker-assisted breeding and (targeted mutagenesis) genomics.

Expected impacts:

- Increased use of germplasm

- Increased knowledge on characteristics (agronomic, processing and nutrition and health-related) that can create added value to the crop
- Maintenance of species or variety-specific characteristics
- Development of short-straw varieties (through breeding or treatment) for higher and stable yield
- Applicable in local and/or traditional food products

b. Processing of ancient grains to improve health qualities

Specific challenge: The re-discovery of traditional fermentation processes to make high-quality artisan bakery products implies (re)learning of bakery skills. The daily practice of many modern bakers is far removed from traditional fermentation processes and thus, it is a challenge to make products that meet the demands of modern and health-aware consumers. In the bakery sector, there is a call for 'back-to-basics', a reduction in salt content, and the omission of additives/enhancers, such as enzymes and emulsifiers. Although many small-enterprise bakers advertise themselves as artisanal, the threshold for them towards baking with special (ancient) grains is often too high because of the lack of knowledge on the grains and their meal/flour, the processing of the dough, and the adjustment of their technical equipment (or even the lack of adequate equipment). In the bakery sector, time pressures are an important factor in limiting innovation. Long-term (sourdough) fermentation processes have been replaced by more efficient short-term yeast fermentation. However, consumers' demand for long-term processed bread products is growing rapidly. There is currently a lot of movement on this market.

Scope: Innovations in the bakery sector come mainly from a relatively small group of bakers who teach themselves about the production of high-quality products and the use of traditional products. This situation is less professional and needs improvement. Improvements can be achieved with the establishment of comprehensive, up-to-date training programs, also involving R&D, for larger groups of bakers in such a way that traditional and special techniques, applicable to ancient grains, become available efficiently for innovative bakers for the production of bakery and pastry products to meet the demands of the growing nutrition- and health-informed consumers. These consumers also show increasing interest in other products made from ancient grains, such as pastries and pastas.

Expected impacts:

- Education in good manufacturing practice for bakers to make high-quality, traditionally fermented bakery products from ancient grains
- Lowered production costs through better process control and waste reduction
- Increased availability on the market of high-quality end bakery products
- Higher added values for the bakers due to the increased efficiency in the production of superior bakery products from ancient grains
- Extension of practice towards pastry products and applications of other food processing technologies, such as extrusion (pasta).

c. Batch-to-batch quality and identity preservation for product consistency

Specific challenge: At the level of meal or flour, ancient wheat species have many biochemical characteristics in common with modern bread wheat. Visually, it is hard to distinguish between the flours of the various ancient grains in comparison to the meal/flour of bread wheat; the most striking difference is the price at purchase (being by far the lowest for bread wheat flour), and the quality during further processing (baking, extrusion, etc.) with specific characteristics for each individual ancient grain type. Therefore, the presently increasing use of ancient wheat species (e.g. einkorn, emmer, spelt) coincides with a growing need for improved batch-to-batch consistency regarding quality and identity. Quality as far as determined by genetic and environmental effects (local soil quality and annual climate factors) of cultivation on seed compound composition has consequences for further processing, and for nutritional and health characteristics. Additionally, due to cultivation practices and conditions, batch-related differences may occur with regard to the contents of crop protection chemicals and toxic residues such as mycotoxins.

Scope: The variation in raw materials is high. In addition, a clear trend for local sourcing of special wheat species is increasing with attention to the narratives of the local farmer, miller and baker/processor focusing on their comprehensive artisanal concept. When primary production introduces new species and varieties with distinguishing characteristics regarding colour, flavour, nutritional and health values, and processing characteristics), a set of rapidly applicable analytical detection methods on batch consistency should be available. Also, authenticity needs to be established, e.g. what defines spelt, i.e. which genetically improved varieties still fall under this definition (defining may need phylogenetic DNA-based or proteomics analysis).

Impacts:

- Increased application of ancient grains in bakery and other industrial food sectors
- Improved transparency on end products due to better testing and control of product authenticity which will enable proper certification
- Improved product safety
- Improved production transparency and product image

d. Establishment of consortia (legal organizations) for co-operation on acquisition/funding, marketing, pilot-scale product development

Specific challenge: SMEs involved in local food production are often limited in several critical factors that inhibit them in further development. Basic limitations are related to a lack of time and a lack of money. Their artisanal work is time-consuming and may be in the low-profit range. This may come at a cost of several factors, such as product quality and safety and being able to effectively integrate related complex regulations, product innovation and required acquisition and funding for pilot-scale experiments, efficient logistics, and sufficient

attention for marketing and contacts with consumers. Networking with local companies active in similar production chains might be a key for the improvement of all these aspects. Networks may become starting points for the further development of entities with a (more) legal status, such as a consortium, a foundation, a co-operation, in which the identity of the participating partners is guaranteed. Such entities may become fruitfully active in the bakery sector (with a focus on the use of local, traditional and ancient grains and traditional technologies) and in the gluten-free sectors, in which much expertise and technology has to be (re)developed, and for which stricter regulations should be developed, e.g. on labelling or claims on the use of sourdough.

Scope: Networks of partners in production chains should create time and space for such non-direct production activities as acquisition, pilot-scale product testing, lobbying to governments for improved legislation, better agreements on logistics, and improved marketing. These networks or co-operating entities should be established at the local or national level, but the establishment should be (financially) stimulated at the European level.

Expected impacts:

- Common goals funded from a well-defined holistic perspective (i.e. involving the entire product chain from breeders/growers to consumers)
- More money available for non-direct production activities
- Transparency and trust throughout the production chain
- Building common knowledge
- Fixed product definition and high product quality

e. Consumers' perception of ancient grains concerning health issues

Specific challenge: Consumers' knowledge about the health issues related to ancient grains and pseudo-cereals is limited. Therefore, the perception and the attitude towards foods produced from these grains is variable. There is solid scientific evidence available that these grains, including the various wheat species, barley, rye, oats and buckwheat, are especially healthy and nutritious in their whole-grain form. Especially, the bran layer (i.e. the outer layer of the seed kernel) of the cereal grains contain various types of compounds and minerals with proven health benefits; above all, the food fibres in the bran fraction play this beneficial role, contributing to the prevention of several chronic diseases like heart and vascular diseases, diabetes, and obesity. For oats and its soluble fibre called beta-glucan, there are several health claims that have been approved in Europe and the USA. Buckwheat seems to have similar health benefits: it is especially rich in bioactive polyphenolics. Fewer details are known about the old-world cereal grains einkorn, emmer, durum and spelt (in comparison to modern bread wheat). But here, it should be taken into account that the old grains are mostly consumed in less refined form than common wheat, thus retaining more health-related compounds. Despite the health-relationships, economic and agronomic factors inhibit market developments of einkorn, emmer and spelt, have led to a decline in the oats market, and to a fairly constant but heavily competitive market for durum.

Scope: European consumers should become better informed about the nutritional and health benefits of whole grain consumption. Scientifically based information on the individual species, and the effects of processing on the nutritional and health-related compounds should be elaborated. Such information should be dispersed Europe-wide to the population through mass communication (TV, radio, newspaper, social media), through regular educational systems (teaching young children in 'food and health'), through 'story telling' and advertisements in (retail) shops, and last but not least through healthcare organizations.

Expected impacts:

- Increased knowledge among the consumers on nutritional and health-related effects on the consumption of whole-grain food products
- Promotion of neglected crops (einkorn, emmer, durum, spelt, and also alternative uses or speciality varieties of barley and rye, oat and buckwheat should be included)
- Improved communication between producers, retailers and consumers
- Increase of production and consumption of these whole-grain products, creating a balanced European market regarding supply and demand
- Positive effect on human health and concomitant reduction of societal healthcare costs

f. Valorisation of by- and waste-products

Specific challenge: The transformation of waste products from agricultural production and food processing into valuable materials, natural food ingredients and livestock feed (and biofuel) is an emerging trend. Old grains produce a lot and a variety of 'waste', such as long straw (much longer than modern wheat that has been bred for short straw) and hulls. All these 'wastes' have a value that will be higher according to the processing refinement and adjustment to further application. This could significantly add to increasing the commercial viability of old-grain production. This requires careful market exploration.

Scope: Research should be developed on the biotechnological and food technological issues to optimize the application of the non-seed plant materials into food, feed and non-food products or into biofuel (e.g. through cell wall fermentation as intermediate step). Knowledge should be transferred to (SME) companies to efficiently improve the processing steps. Training workshops can be a useful tool in this knowledge and technology transfer. Training should also include the development of marketing strategies. Improved 'waste management' may contribute to improved environmental quality by more efficient use of resources.

Expected impacts:

- Economic management of by- and waste products from ancient-grain production and processing

- Product innovations and development of new markets
- Increased profit to SMEs
- Development of new types of co-operation between scientific researchers and grain producers and food processors
- Improved environmental sustainability

3. Fish

a. Regulatory framework concerning pond and raceway aquaculture

Specific challenge: Pond and raceway aquacultures have a lot of interrelationships and interactions with the environment and other human activity. European environmental legislation complex requests the application of an ecosystem-based management and environmental friendly technology process in this aquaculture. The current pond and salmonid aquaculture is increasingly under legislation and regulatory framework pressure (e.g. from Water Framework Directive, Natura 2000, Blue growth and economy initiatives etc.), mainly due to the minimization of the emission of biogenic matter from aquaculture, the minimization of negative effects on the ecosystem structure and function with support of occurrence in endangered animals and plant species. In many cases, pond and salmonid aquaculture is not deregulated free trade and it is disadvantaged by European legislation by different regulations and restrictions concerning fish density, rate of supplemental feeding, water manipulation, use of therapeutic treatments, inability to control the overpopulated fish predators (e.g. cormorants, otters and beaver), etc. In the Czech Republic and southern and central Poland, pond aquaculture has been more important and more prominent than in other European regions. Due to the currently uncertain economic situation in combination with the regulatory framework already mentioned, fish production from pond and raceway aquacultures in these countries has decreased significantly in the past 20 years in terms of cultivated area and production per unit area. This poses multifaceted threats to the ecological, production and cultural functions of ponds in the regions.

Scope and expected impacts: The development of aquaculture is not only influenced by the legislation specific to the aquaculture sector but also by numerous other laws, such as the water framework directive, other environmental and natural conservation legislation, and regulations governing regional planning and construction, animal welfare, food safety etc. Some of these regulations, at different decisional levels, have conflicting effects on the aquaculture sector and need to be harmonized in order not to impede its development. Systematic, continuous and detailed legislation that affects the aquaculture sector, analysis, corrections and updates must be applied with emphasis on the actual and changing situation related to all fields and activities associated with aquaculture (e.g. overpopulated fish predators – changing legislation for a decrease in fish predators protection – increasing the possibility for fish predator elimination – decreasing production losses of the cultured fish – maintaining of production efficiency). On the other hand, the aquaculture sector must accept and use all valid legislation for its production and apply sustainable development maintaining biodiversity, conservation of good water quality in the rivers and other water bodies, fostering the regeneration of groundwater resources and stabilizing the regional climate at international, regional and local levels.

b. Education, knowledge management and transfer, networking and best practice

Specific challenge: Generally, the aquaculture industry is characterized by its ability to fast-track progress from knowledge development and intellectual protection to innovation, industrial application and product development. Pond and raceway aquaculture needs continual, international and highly motivated applied research, co-operation between the RTD (Research Technology Development) and SME sectors, knowledge transfer and education about European freshwater aquaculture as a healthy and sustainable protein source for consumers. The aquaculture sector needs to use the best practice for an adaptation of knowledge to support state-of-the art technological development and practices. At the same time, this kind of aquaculture must be attractive to a wide range of highly educated and experienced people, with positive growth and employment opportunities and various networking.

Scope and expected impacts: Many of the challenges to traditional European freshwater aquaculture are common to all parts of Europe. Sharing knowledge and best practices will help to develop uniform standards for sustainability, and facilitate the legal procedures for the granting of permits and licences.

All the following activities are needed for future aquaculture technological development, an increase in the efficiency and sustainability of freshwater aquaculture through education, knowledge management, and transfer, networking and the use of best practice: the creation of a transparent knowledge database that can be interesting for aquaculture innovation and development, support for the protection of legal rights and the management of intellectual property to ensure innovation, to ensure international and interregional co-operation with the aim of developing research or development of infrastructures that can meet emerging needs, the development of new contacts, models and partnerships for learning and training activities, attraction and retention of talented, enthusiastic and able individuals to work in the aquaculture sector, maximisation of appropriate career paths and job satisfaction, the support of formal and informal lifelong-learning opportunities at all levels as a strategy for sustainable innovation in aquaculture, maximisation of transfer knowledge, co-operation, communication and relationships between RTDs and SMEs, the improvement of international co-operation among fish producing organisations, the promotion and enabling of peer-to-peer networking and collaboration as key components in an innovative European aquaculture sector.

c. Ecosystem service and other non-production functions and interactions of outside pond aquaculture and its threats

Specific challenge: Ponds are one of the most important sites for aquaculture and have several functions in addition to food production. They play an important role in the landscape by maintaining biodiversity, fostering the regeneration of groundwater resources,

stabilising the regional climate, diversifying land utilisation and food supply, and increasing income potential. Ponds have been an element in the landscape for centuries with fish ponds as essential production sites for traditional human foodstuffs, important elements in the countryside, and regional sources of income. However, aquaculture can only fulfil the above functions if production is economically and environmentally sustainable. On the other hand, pond aquaculture as an outdoor aquaculture system is affected by different interaction with its surroundings (other biocenoses, human activities etc.), which can bring new kinds of diseases and other threats for this kind of aquaculture.

Scope and expected impacts: An economic valuation is urgently needed to quantify the ecosystem services of pond aquaculture. A specific compensation payment system for fish ponds should be elaborated based on the value of ecosystem services achieved by pond aquaculture and should apply the principle of "public money for public goods". There is a need for farmers to improve environmentally-friendly technology and quality management systems in order to ensure a steadier supply of high-quality fish. This can be achieved by combining extensive and intensive production technologies and polyculture, which will improve the efficiency of resource use, animal welfare, and net economic returns and place greater emphasis on the ecological function of aquaculture systems. Adaptation and research strategies must be developed so the region can be resilient in the face of climate change and the threat of fish diseases as well as reduce the possibilities of the development of new food-borne diseases.

d. Technological innovation for the production and processing of high-quality, safe fish products

Specific challenge: For future development, traditional pond and raceway aquaculture must use a new farming approach, technology and activity in an evolving, modern food industry. It is crucial that technology and systems are used to maximum advantage to fully exploit the potential of the region where this aquaculture is based. The main aim of this activity is to ensure an environmentally sustainable, profitable industry by applying new knowledge and technology innovation for the ethical, healthy production of high-quality fish products. Contributions to the use of different technology systems (RAS, CIES and IMTA), new but native fish species, control of each production stage of the lifecycle, modern breeding programs and culture methods/techniques of cultured fish, the automation, monitoring and analysis of cultural processes are key to increasing the operational efficiency of current traditional pond and raceway aquaculture. Maximising advances in processing technology, with specific regard to product storage and shelf life, will complement the considerations on product quality.

Scope and expected impacts: Freshwater pond aquaculture basically involves the following scope and impact: diversification of aquaculture production in terms of species and time, maximisation of the efficiency of Recirculation Aquaculture Systems (RAS) with the combination of pond aquaculture, wide implementation of effective RAS into pond and salmonid aquaculture sector, development of farming equipment and operational

procedures for efficient fish production, improvement of technology for fish transfer, sorting and handling with respect to welfare and ethics, effective management of nutrients cycling in production systems in order to increase their retention in fish products with the use of integrated multi-trophic and multi-species aquaculture systems, reduction of waste release from aquaculture production, development and upgrade of existing and new technologies for more efficient use of water resources, development and implementation of renewable energy sources for aquaculture production facilities, development of automation for all stages of production (hatcheries, on-growing, processing) for present and future production systems, development of technology preventing the escape of fish and eggs from production systems, reduction of the incidence of disease by developing technology and systems, development of technology and systems for the improved utilization of existing sites and development of production systems for new aquaculture products (e.g. new species, premium class and/or certified products) for changing markets.

e. Consumer involvement/information, standardisation and certification

Specific challenge: Fish products play an important role in human diets by providing essential fatty and amino acids, minerals and vitamins. However, fish consumption in many European countries is below the level recommended by nutritionists. As a result, it is necessary to support increased fish consumption by promoting different activities (education, advertising, tastings actions, workshops, etc.) for the improvement of human health mainly by the elimination of civilization diseases.

All fish products should be certified, identified, traceable and labelled using the same, easy-to-understand system in the whole of Europe. The certification of fish products should be mainly based on the welfare of all fish stages, nutritional and organoleptic quality, food safety, originating and traceability aspects. The development of processing technology must be applied to prevent the contamination of fish products from external sources. Identical, standardised detection and quantification system for contamination and pathogens affecting humans must be developed and optimised for future use.

New innovative products should be developed to increase fish consumption. The identification and testing of relevant bioactive compounds in fish products have great potential for improved human nutrition, health and physiology with or without specific dietary needs and for the preservation of fish products related to the prolongation of their shelf life. The development of cultural technology to increase the content of the heath-benefit nutrition and bioactive compounds in fish is the next technology task for the future development of traditional fish production and processing.

Scope and expected impacts: Traditional freshwater aquaculture and its fish products must be organised/produced and presented through different actions as an environmentally friendly agricultural sector maintaining biodiversity, the high quality of water, energy and raw material sources and producing high-quality and healthy human food. The following

actions are very important for the achievement of the above-mentioned scope/impact: the development and improvement of the technology for transfer, the handling and slaughtering of aquaculture livestock with respect to fish welfare and ethics, nutritionally and organoleptic high-quality bioactive products without any contamination, the development of standardised detection and quantification of methods for contaminants and pathogens affecting humans and for nutritional and organoleptic quality, the development of technology designed to prevent the contamination of fish products through external sources, the development of uniform certification and labelling systems for fish products in the whole of Europe, the optimisation of the chemical analysis of fish tissue with respect to the content of specific bioactive compounds, testing of the effect of specific compounds of fish products on the human diet, health and physiology, the use of technology to improve fish products with respect to an increase in the content of bioactive compounds and their effect on human health and physiology.

4. Vegetables

a. Integrated pest management

Specific challenge: Pests and diseases decrease the yield and quality of any agricultural product, including vegetables. In extreme cases, phytophages can even destroy entire plantations. It is also important to know that some of the fungal and bacterial plant pathogens produce toxins harmful to humans. Therefore, efficient protection of crop plants against pest and diseases is of utmost importance. However, we must remember that plant protection chemicals are also harmful to the consumers and to the environment and should be applied with care and only when needed. Plant protection programmes should also take into account the protection of insect pollinators and also possibility for resistance development by pests due to inadequate pesticide rotation. Therefore, a strategy of plant protection called Integrated Pest Management (IPM) has been developed, aimed at reducing the use of synthetic pesticides in plant protection and replacing them with agronomical and biological methods. Using IPM has been mandatory in the European Union since 2014. However, despite the European efforts to promote IPM and the National Action Plans worked out by Member States, the implementation of IPM is far from ideal, mainly due to a lack of communication between plant protection officials and the farmers. As a result, the need to understand national problems and to focus on specific challenge is urgent.

Scope: Plant-phytophage interaction is a dynamic process which undergoes constant changes. On one hand, new cultivars with enhanced resistance to pests and pathogens are being bred and implemented, which reduces the need for plant protection. New, more effective pesticides and biological control methods, like introduction of pest predators and parasites, and biopesticides, are also being constantly developed. But on the other hand, the phytophages themselves evolve and new strains overcoming plant resistance mechanisms and pesticide treatments are now appearing. It must be also remembered that, with a few exceptions, vegetables are minor crops for which a limited number of pesticides is available. This makes proper pesticide rotation difficult, and speeds up the development of the pathogen's resistance as a result. In addition, new, invasive pests and pathogens that are difficult to control impose serious threats, just to mention the recent invasion of *Tuta absoluta*, *Drosophila suzukii*, *Phytophthora infestans* and others. These processes will be most likely affected by climate changes. Consequently, the practical use of IPM requires both in-depth knowledge on the biology of phytophages and their interaction with plants as well as the development of agronomical and biological methods for controlling noxious pests and diseases. The use of Precision Agriculture techniques shall be implemented in pest management.

Expected impact:

- Enhanced knowledge on plant-phytophage interaction in a changing environment
- Constant improvement of IPM methods and guidelines mitigating challenges resulting from climate changes, the development of pesticide resistance in pest populations and due to invasions of new phytophage species

- Decreased use of pesticides in vegetable production, with a beneficial effect on consumer health and on the environment
- Decreased costs for vegetable production

b. Vegetable plants breeding; breeding for resistance against most important diseases and environmental stresses (drought, soil salinity); breeding for improved nutritional values, especially for the increased content of bioactive compounds

Specific challenge: Creative plant breeding is essential for biological progress in plant production. It enables mitigating challenges resulting from climate change and helps to improve the quality of all plant crops, including vegetables. The traits most desired in new vegetable cultivars are: enhanced resistance to pests and pathogens, tolerance to drought and soil salinity, improved nutritional value, including the increased content of bioactive compounds, improved storability and, last but not least, improved sensory quality like taste, aroma and appearance.

Scope: Modern plant breeding is based on in-depth knowledge of genetics and genomics. In planning the crosses in modern breeding, the parental forms are carefully selected on the basis of the traits they carry and on the traits' heritability. The early selection of the hybrids obtained is frequently based on molecular markers (QTL), which significantly shortens the breeding process. Thus, the important breeding-related research is focused on identifying genes conferring important traits. Considerable progress in creative breeding is also due to the implementation methods of biotechnology, such as distant hybridisation and embryo rescue, somatic hybridisation, andro- and gynogenesis, *in vitro* cell and organ cultures, etc. There is also a lot of potential in genetic engineering. Although controversial and opposed by many politicians and consumers, this technique enables the introduction of traits that do not otherwise exist in a given species or genera, like resistance to some pests and diseases, controllable senescence or the biosynthesis of specific bioactive compounds not being produced in the species to be bred.

Expected impact:

- In-depth knowledge of vegetable plants genetics and genomic, which will speed up the progress in creative breeding
- New cultivars with enhanced resistance to pests and pathogens and tolerance to abiotic stresses released for cultivation, which will allow a reduction in the use of pesticides, with beneficial effects on consumers' health and on the environment and will help to mitigate the global climate change
- New vegetable cultivars with enhanced nutritional value, due to an increase in bioactive compound content

C. Water- and energy-efficient vegetable processing technologies

Specific challenge: The improvement of the competitiveness of the production system is essential in all countries in order to ensure sustainable growth. The 2012 European Energy Efficiency Directive (EED, 012/27/UE) established that all EU countries are required to use energy more efficiently at all stages of the energy chain, from its production to its final consumption.

Vegetable processing is energy- and water-consuming. It is estimated that 14 cubic meters of water is used to produce one ton of frozen vegetables or vegetable juices. The contribution of the energy costs to the overall vegetable processing costs is substantial; this is especially true in the event that drying technologies are exploited, as they are still the processing methods that place the highest demands on energy. This is a special burden for the small-scale production prevailing in SMEs, where the energy use per kg of processed vegetable product is far above the mean for industrial large-scale production levels. In vegetable processing plants, the high electric energy consumption is also due to the maintenance of low temperatures in processing halls and in the storage of both raw materials and final products. Furthermore, the wide use (and waste) of plastics, aluminium or other materials for vegetable packaging increase the carbon footprint of the products.

In SMEs, the energy is usually generated in local power plants by burning fossil fuels, like coal, natural gas and oil, which is expensive. Therefore, implementing water- and energy-saving technologies and generating energy from renewable sources is of a great importance.

Scope: Some water-saving solutions, like closed-circuits, are already implemented in many vegetable processing enterprises, especially in bigger ones. The challenge is to adapt these solutions for SMEs, which usually take water from municipal pipelines and dispose of sewage in municipal sewage treatment plants.

The energy coming from fossil-fuels-burning power plants, especially heat, can be replaced by renewable sources like solar panels for heating technological water. Electricity can also be generated using photovoltaic panels. Such panels can be easily installed on the roofs of the factory's halls, i.e. they would not take up any additional space. The technology of solar panels is well developed. The challenge is to provide cost-effective solutions for SMEs, in keeping with such approaches as the Lean Production System or the Green Production System.

Expected impact:

- Wide implementation of closed water circuits and renewable energy sources in vegetable processing plants will have a beneficial impact on the environment.
- Saving water and energy use in vegetable processing will decrease the cost of production, and thus increase the competitiveness of the European food industry.
- The "sustainable carbon foodprint" image will provide guidance for the consumers, whose demands for such products will increase.

d. Innovative processing technologies focused on developing/preserving functional properties of traditional food

Specific challenge: Traditional food products constitute an important component of European culture, contributing to the identity and cultural heritage and they are often recognized by consumers with characteristics linked to regional identity and sensory quality. In addition, their development and distribution act as protection against the extinction and depopulation of the rural areas in Europe. Producers of traditional foods still face the challenge to further improve the safety, healthiness, and convenience of their products by means of different innovations, which will enable them to maintain and expand their market share in a highly competitive and increasingly global food market. The maintenance of organoleptic quality is of key importance for traditional vegetable-based products. The same holds for the maintenance of all functional ingredients, like vitamins, polyphenols, dietary fibre, and others. Thus, the development of mild preservation methods – targeted to maintain the functionality of food matrices and ingredients for traditional vegetable products on a small scale is considered as a priority.

Scope: There are many technological solutions that make it possible to preserve the functional properties of raw vegetables during their processing. In order to preserve biologically active compounds, like vitamins and polyphenols, the pasteurization of vegetable juices is being replaced by microfiltration, ultra-high pressure or ultrasonic treatment, etc.

There are also technological processes that increase food functionality, like the use of selected probiotic bacteria for fermenting sauerkraut and other vegetables or the micronisation of smoothies to increase the biological availability of dietary fibre. The European Commission has subsidised numerous projects aimed at developing novel preservation technologies, such as high pressure, pulsed electrical fields, ohmic heating, continuous microwave, cold plasma etc. The Network of Excellence HighTech Europe has categorised a large variety of technologies, which are accessible via a Technology Portal. These technologies are presented with clear datasheets allowing the verification of opportunities for utilisation. Also, the technology-relevant public and semi-public research centres are clearly identified and easily accessible. However, new technologies, especially focused specifically on vegetable processing, are still needed.

Expected impact:

- The increased availability of functional foods on the market will have a beneficial impact on consumer health and well-being.
- It should specifically decrease the occurrence of diet-related “civilisation disorders”, like obesity, diabetes type 2, coronary diseases and some kinds of cancers.
- Indirectly, it should also decrease the costs of healthcare.
- Traditional food with increased functionality will allow SMEs involved in such production to increase and maintain competitiveness on the market.

e. Innovative packaging

Specific challenge: Packaging is an indispensable element in the provision of high-quality food. Its most important function is to prevent food contamination during handling and extending its storability and shelf life. It is especially important for fresh and minimally-processed vegetables, which are quickly perishable. Modern packaging for such products is made from semi-permeable materials, which prevent water loss by evaporation but at the same time have a different permeability for oxygen and carbon dioxide, which enables the creation of a modified atmosphere. Some packaging might also be equipped with temperature sensors to show the history of storage, sensors for product traceability and others. The use of antimicrobial packaging has been developed with the aim of prolonging the shelf life of the packaged foods by slowing down or inhibiting those mechanisms responsible for spoiling.

The principal strategies already known in this field concern the addition of antibacterial molecules to the packaging polymers, the addition of sachets/pads containing volatile antimicrobial agents into packages and modified atmosphere packaging (MAP) technology. A further important challenge in food packaging is the use of natural, renewable bio-based resources together with well-developed recycling systems.

Besides reducing food loss, packaging also has an important marketing function in improving the attractiveness of food products for the consumers.

Scope: Food packaging is a dynamically developing, multidisciplinary research involving chemistry, nano- and biotechnology and biochemistry. The main focus is on developing packaging to extend the storage and shelf life of perishable products, including vegetables. Modern packaging is frequently made of semi-permeable nanobiocomposites. The inclusion of nanosilver particles into packaging materials is being tested as a means of preventing food spoilage. A lot of attention is also paid to biodegradability in order to minimise the contamination of the environment with discarded packages.

An important help in this sector stems from the research for packaging strategies that are able to preserve the nutritional components of fresh or minimally-processed vegetables, such as vitamins and minerals, in an unchanged form, and, at the same time, to ensure the safety of the product. The research in that field has more than doubled in the past five years. The possible packaging solutions for minimally-processed vegetables range from the incorporation of natural active compounds into packaging polymers, to the addition of essential oils (thyme, oregano, rosemary, etc.) during packaging steps and the control of the internal atmosphere composition in modified atmosphere packaging (MAP) technology. The results are encouraging; the next step should be the application of these technologies in the traditional food sector.

Expected impact:

- Extension of storage and shelf-life of fresh and minimally processed vegetables

- Increased safety and quality of vegetable products, especially of minimally-processed vegetables
- Reduced food loss
- Reduction of environmental pollution due to the mass introduction of biodegradable packaging

5. Mushrooms

a. Mushroom breeding: New varieties adapted to production systems

Specific challenge: Until now, breeding efforts made by the industry has been very infrequent and mainly directed towards the needs of mushroom growers, traders and food processors in terms of yield, disease resistance and shelf life. A successful example in the field of exotic mushrooms is the sporeless oyster mushroom a few years ago. This innovation prevented growers from developing spore allergies. With the availability of new breeding techniques, it is possible to generate new types of varieties of mushrooms. Breeding can also be directed to consumer demands by improving taste, nutritional value and the content of beneficial compounds. However, the genetic variation within each species with respect to these traits has rarely been investigated so far. Breeding efforts are needed to increase the availability of organically produced mushrooms not only to meet legislative requirements but also to improve the performance of the sector through varieties that are better suited to the specific conditions of organic cultivation. It is also important that new varieties generated by investment in breeding should be protected by IP (breeder's rights) in order to encourage investment in breeding.

Scope: Research will develop efficient, long-term breeding strategies to improve diversification, productivity, stability, and the overall quality of mushrooms. Activities will seek to broaden the genetic base of certain exotics for breeding purposes and to analyse relevant and untapped genetic material. Especially the largely unexplored variety of cultivable wild mushroom species present in European natural environments can provide a good source to generate varieties adapted to European cultivation conditions. This activity reflects one of the themes mentioned in the preparatory action on EU plant and animal genetic resources (AGRI-2013-EVAL-7): Exploring the need for a pan-European network and infrastructure for the conservation and sustainable use of MiGRs in Food and Agriculture. The performance of a wide range of mushroom species and varieties in various production systems, taking into account the knowledge acquired from the Asian experience will be tested. Activities will identify species and varieties suited to a number of production systems: specific attention should be given to identifying the resistance of certain varieties to common cultivation systems. Research will make use of a wide range of breeding tools and methods available in the EU.

Expected impacts:

- Enlarged range of genetic resources of certain mushroom species and varieties available for use in breeding programmes
- Enhanced common methods, tools and technologies for the characterisation and evaluation of new genetic resources
- New varieties adapted to local production systems in order to increase the overall productivity and quality of mushrooms designed to benefit both conventional and organic cultivation

b. Innovative/novel drying technologies and value addition of mushrooms

Specific challenge: Fresh mushrooms are highly perishable with short shelf life under ambient temperature and humidity and their commercialization becomes difficult in the event of overproduction. Air drying is a standard postharvest technology to prolong their commercial life and ensure long-term distribution. Dehydration leads to the development of novel value-added products, which could also reduce the losses caused by surplus production enhancing the income of the growers. Accurate control of the drying conditions is required to avoid undesirable changes in the quality of dried mushrooms. Application of energy-efficient drying systems (heat pump dryer), or dryers using renewable energy sources to heat up the drying air (solar dryer) should be prioritised. The introduction of low-cost, locally manufactured solar dryers offers a promising alternative to reduce post-harvest losses. Another advantage of solar drying is the natural enrichment of mushrooms with vitamin D as ergosterol is converted to ergocalciferol under exposure to UV light, which may result in the development of new mushroom products and lead to market expansion.

Scope: Research supported by new advances in drying theory, modelling and data gathering is needed to understand the drying behaviour of each mushroom species in different drying systems. The work will seek to evaluate the parameters that influence energy requirement, drying time overall performance, quality and nutritional characteristics of mushrooms. Comprehensive analysis is needed to provide guidelines about optimum drying conditions of the most important exotic mushrooms in the EU. Special attention is required with respect to innovative drying technologies and specific quality attributes as well as vitamin D content after exposure to UV light.

Expected impacts:

- Development of a large database on drying-related data of certain mushrooms
- Optimisation of drying conditions, processes and methods with regard to energy demands and quality
- Development of novel products and utilisation of dried mushrooms as valuable ingredients (traditional food products, nutraceuticals)
- Reduction of postharvest losses and extension of shelf life

c. Rapid sensor-based analytical method for in-site quality measurements of compost and mushrooms, moisture content, physicochemical characteristics

Specific challenge: Substrate prepared specifically for growing mushrooms is a blend of natural products. Common ingredients are wheat straw bedding containing horse manure, hay, corn cobs, cottonseed hulls, poultry manure, brewer's grain, cottonseed meal, cocoa bean hulls. Exotic mushrooms are cultivated using a large variety of agricultural waste, such as straw, sawdust and wood chips. In particular, *Pleurotus ostreatus* is being commercially

cultivated on a substrate composed of cereal straw with the addition of corn cobs, corn meal and wheat bran. The growing use of wheat straw as a biomass feedstock for energy production causes a steady increase in the price of wheat straw and may lead to a shortage of wheat straw supply in the future. Sawdust supply is declining and its price has spiked in recent years. Thus, it is critical to seek potential alternative substrates to replace wheat straw and sawdust. Substrate preparation represents probably the most crucial stage of mushroom cultivation affecting both yield and quality of fruit bodies and consequently production costs and economic viability of the SMEs. However, the substrate may be composed of various agricultural residues and agro-industrial by-products. To improve the production efficiency as well as the quality and nutritional value of mushrooms, mixtures of locally available ingredients should be tested for the preparation of substrate. In addition, to ensure stable and even higher prices, growers may produce exotic mushrooms organically. However, organic sawdust and wood chips are still available in limited quantities. For the further development of organic cultivation of exotic mushrooms, the amount of organic-certified sawdust should be increased.

Such substrate quality parameters as organic nitrogen and cellulose contents and physicochemical characteristics can be determined in the laboratory, but this is a lengthy procedure. New methods for the on-site quality evaluation of compost and mushrooms during their production processes based portable sensors would save time (and money) for mushroom producers and enable them to take quick decisions regarding the technology process of composting and mushroom production.

Scope: The success of exotic mushroom cultivation on different substrates is a multifactorial process that depends on the presence of carbon, nitrogen, vitamins, fats and their ratio in the substrate, pH of the substrate. These factors are unique for each species of exotic fungi. Research should also be directed to explore the suitable substrate chemical composition: pH change, the addition of those or other biologically active substances, combinations of substrates; utilisation of selected substrates in submerged culture.

Recent advances in analytical techniques and electronics resulted in the miniaturisation of the measuring units and the simplification of measuring procedures. Especially promising in terms of analysing the chemical composition of substrates for growing mushrooms is the progress made in near infrared spectroscopy (NIR) and electrochemical biosensors. NIR has been applied to determine dry matter/moisture, organic nitrogen, organic carbon and ash contents in many plant materials, including composts. Electrochemical immuno- and genosensors have been proven effective in the detection and qualitative determination of various bacteria, fungi and viruses in plant and animal tissues. The attempt has been made to use these techniques for monitoring the progress of substrate composting and determining its quality, but their implementation requires further research and validation under different conditions.

Expected impacts:

- Selection of appropriate raw materials and methods for substrate production
- Improved technology of substrate production

- Enhanced yield of some commercially important mushrooms
- Reduction in production cost
- Improved quality and nutritional value of mushrooms

d. Integrated pest management (effective mushroom protection against pests, pathogens and weed moulds)

Specific challenge: Cultivated mushrooms are susceptible to many pests and diseases, which, if not controlled, may inflict heavy losses. There are a number of methods, including pesticide use and hygienic measures, which help to control the infections and mitigate damages. Similarly as in plant protection, the use of Integrated Pest Management (IPM) has been obligatory in mushroom cultivation in EU countries since 2014. It is based on the limited use of pesticides, replacing them with other methods, mainly hygienic. The methodology for IPM in mushroom cultivation, approved by the authorities, is available on the web-page of the Ministry of Agriculture and Rural Development. However, with time the pests and pathogens may acquire resistance to known pesticides and new chemicals have to be tested and implemented. New cultivars and species that have different levels of resistance to pests and pathogens have to be introduced. And finally, there is a risk of invasion by new pests, not occurring hitherto in the area. Those changes may be sped up by climate changes. Therefore, extensive research is needed to modify IPM protocols to mitigate the new risks.

Scope: The most important pests of champignons (*Agaricus bisporus*) are flies of the *Sciaridae, Phoridae and Cecidomyiidae* families (Diptera), which have the low economic threshold levels. They may be controlled effectively with pesticides, but because of residue problems, their use should be strictly controlled and, whenever possible, replaced with other methods like mechanical and sticky traps and the introduction of predators and parasites. The infestation of cultivated mushrooms with substrate-borne pests, mainly saprophytic mites and nematodes feeding on mushroom mycelia, can be controlled effectively by thermal treatment of the substrate prior to inoculation with mushroom spores.

Very dangerous and difficult to control are fungal diseases. The most dangerous are green moulds caused by *Trichoderma harzianum* and *Trichoderma agresivum*. The fungi develop in the substrate and destroy the mycelium of cultivated mushroom. They are highly aggressive and, in case of heavy infection, the only available treatment is liquidation of the plantation and sterilization of the production halls. In contrast, the green moulds caused by the *Penicillium* and *Aspergillus* species do not cause significant losses, but are indicative of inadequate hygienic standards. The fungal diseases affecting fruiting bodies, like dry rot (*Lecancillium fungicola*), white rot (*Mycogone perniciosa*) and dactylium (*Cladobotryum mycophilum*), decrease mushroom yield and quality.

Since both the cultivated mushrooms and pathogenic fungi belong to the same kingdom and have similar metabolism and physiology, most of the available pesticides are harmful to both. Thus, the control of fungal diseases is based on prevention and strict implementation

of hygienic measures, including thermal and chemical disinfection of cultivation halls, tools and transport unit, thermal sterilization of the substrate, the use of protective clothing by employees and the use of pads soaked with disinfectants on pathways and thresholds to prevent the transmission of fungal spores on foot.

Heavy losses may be also due to bacterial infections, mainly by *Pseudomonas* spp., although they only occur sporadically.

The interaction between pests and cultivated mushrooms is undergoing dynamic change. The occurrence of some pests and diseases common in past has decreased recently, but some others may become more virulent and difficult to control. Therefore, developing effective methods of pest control following IPM principles requires continuous intensive research.

Expected impacts:

- The main impact of research on IPM in mushroom cultivation will be the development of effective methods of pest and disease control. This will in turn have a beneficial effect on yield and quality, and thus on the competitiveness of the European mushroom industry.
- Reduced use of pesticides and other biocides will reduce the pollution of the environment and will have a beneficial effect on consumer health and well-being.

e. Innovative packaging for shelf life extension (fresh mushrooms) and traditional processed products (materials, presentation, shelf life)

Specific challenge: Packaging is an indispensable element in the food chain, including mushrooms. Its primary role is to protect food products from contaminants, preserve their freshness and quality and extend shelf life. Well-designed packaging enables easy handling of food products and is important for food marketing. Several innovative food packaging technologies and solutions (e.g. active, intelligent, recyclable, easy-to-use, organic, antibacterial) have been investigated and developed during the last decades. Research has aimed at reducing the environmental footprint of packaging materials, increasing the shelf-life of products and developing food spoilage indicators, improving product design and reducing the need for chemical preservatives while maintaining the nutritional and sensorial properties of both fresh and processed mushrooms. For instance, water-resistant packaging made from renewable/ compostable material has been slowly introduced into the market to replace conventional packaging materials for fresh mushrooms. Furthermore, a new, breathable packaging film made from natural bio-polymer has substantially increased the shelf life of fresh mushrooms and other commodities, preventing them from browning and condensation. Despite the current technological progress, much still remains to be done to bring these eco-innovative solutions into the market.

Scope: Modern food packaging has multi-fold functions. First, it prevents the contamination of food products along the food chain. Second, it prevents spoilage and wilting and prolongs shelf life. Packaging made of semipermeable materials is especially effective; it enables the formation of a controlled atmosphere delaying the senescence of plant products. Packaging in nitrogen is very effective in preventing discolouration and spoilage. Packaging also constitutes an important marketing tool by increasing product attractiveness to the customers.

Research should clearly address the problems associated with the scaling-up and commercialisation of innovative packaging solutions. Activities should aim at producing plans and arrangements or designs for new, modified or improved products and processes. For this purpose, they might include prototyping, testing, demonstrating, pilot projects, large-scale product validation and market replication. The participation of all the relevant stakeholders from the mushroom industry and supply chains should be encouraged. Demonstration activities will require the involvement of packaging and food processing companies, retailers and civil society organisations to bridge the gap between ideas that have been developed and their practical implementation.

Expected impacts:

- Increased food safety, prolonged shelf life and reduced food losses due to the employment of packaging tailored to the specific needs of various mushroom products
- Reduced negative impacts of mushroom production on the environment (e.g. resource utilisation, greenhouse gas emissions, pollution)

6. Sweet fruits

a. Breeding issues:

- **Trade-off between productivity and quality**
- **Multi-resistant varieties for organic production**

Example: Developing new varieties that offer reasonable productivity, maintaining good quality (external and internal); creating new varieties tolerant of or resistant to several important diseases for the successful cultivation of fruit species in organic production

Specific challenge: Fruits are partially consumed as fresh, without any industrial transformation. This implies the requirement for high quality to satisfy consumer expectations. In this setting, innovations regarding varieties become important. The large diversity of sweet fruit varieties allows the selection, creation and development of new varieties relevant for stakeholders. These varieties are essential to meet such challenges as the adaptability to climate change, pest and disease resistance/tolerance, fruit quality and health claim. At the same time, productivity needs to be preserved allowing cost-effective production. The selection of new varieties with improved technological properties and good yield would reduce defects and increase profit.

Scope:

- Design of varieties for each sweet fruit species adapted to current and future agroecological areas
- Production of relevant pre-breeding material associating techno-socio-economic characters to implement the agronomic value
- Shift from breeding activities based on novelties to breeding based on the maximisation of the agronomic value for the stakeholders
- Adaptation of newest breeding techniques used for major crops that are not yet developed for sweet fruits
- Increase in disease resistance by developing varieties specifically resistant to one or a few dangerous diseases to allow producers' choice to invest in varieties targeting the risks encountered in their local geographical plots

Expected impacts:

- Varieties accessible for EU-SMEs, producers, traders, processors and consumers and well-adapted to the specific needs of the market. The improved cultivars developed according to market needs and with lower inputs (e.g. chemical spread) will bring high-quality products, with a sustainable impact on conventional and organic systems
- Economic benefits to farmers and retailers (including a better market position), and increased health benefits for consumers
- Enhanced productivity by using cultivars with a regular yield and those which do not require pollinators, thus reducing the cost of growing and harvesting

- A larger choice for growers among a larger range of available cultivars allowing growers to make their choice of cultivars according to their local conditions and to their farming management practices (conventional or organic)

b. Implementation of modern packaging to enhance shelf life, to reduce waste and to improve post-harvest technology (storage)

Example: Intelligent packaging in modified atmosphere

Specific challenge: Fruits are highly perishable products. The quality of soft fruits, such as strawberries, diminishes quickly after harvest. Their shelf life does not exceed two days at room temperature, or four days when refrigerated. Just few days' extension of soft fruits shelf life would make a difference and decrease the losses due to the fruits that have perished. Efforts are being made to develop modern packaging in order to enhance the shelf life of fruits, using either modified atmosphere or adsorbent pads containing mixture of bioactive compounds (flavonoids and organic acids). The modification of the storage atmosphere aims to decrease the respiration rate of fruits. This effect is achieved by increasing CO_2 and/or decreasing O_2 concentration. High CO_2 concentration can also inhibit the generation of ethylene because it can influence enzyme activity. The adsorbent pads act as cushions to protect fruits from damage during transportation, whereas the mixture of flavonoids and organic acids work as antimicrobial agents. The results of the modern packaging usage in extending the fruit shelf life are promising, however, at the moment; these kinds of solutions are known mainly in the scientific world and are not yet implemented by SMEs.

Scope: New active packaging technologies have been developed intensively during the past few years. The aim is to implement smart and economically reasonable solutions in SMEs. Firstly, the knowledge of modern packaging should be introduced to fruit producers through training courses and educational programs. Then, the purchase of modern packaging technology could be enabled through specific funding allocated to support SMEs.

Expected impacts:

- Increased knowledge of modern packaging technology
- Enhanced shelf life of fresh fruits
- Decreased losses due to perished fruits

c. Faster and better implementation of food safety management systems

Example: Better implementation of all existing EU hygiene standards as good practice-based (GHP, GAP), hazard-based (HACCP) and risk-based (QMRA) systems

Specific challenges: The primary responsibility of food manufacturers is to provide a safe product to market. Potential risks during the production of fruits exist in all phases of the production process: on the field, during harvesting, handling, processing, distribution and storage. The product provided to the consumer should be free of chemical impurities (pesticide, nitrate, and heavy metal residues), pathogenic microorganisms and any harmful compounds they produce. The high hygiene of people working in fruit harvesting and processing is very important. The introduction of good manufacturing practice (GMP), good agricultural practice (GAP), good hygiene practice (GHP), and good storage practice (GSP) and their systematic application could increase the safety and quality of traditional fruit products.

Scope: The lack of skilled workers and technical personnel is one of the biggest problems for the introduction of good agricultural and hygiene practice. Continual hygiene audits and training should be performed frequently to educate producers and processors. Also, short-term training programmes for new employees in issues such as HACCP, hygiene, handling, irrigation, packaging, etc. could lead to faster implementation of food safety management systems. Such basic training can be conducted by local agricultural advisory services, regional Chambers of Commerce and producer organisations as well as thorough management risk assessment via traceability systems and recall procedures, which should also be implemented.

Expected impacts:

- Better implementation of all existing EU and other international hygiene standards as good practice-based (GHP, GAP), hazard-based (HACCP), risk-based (QMRA) systems
- Increased knowledge of producers/processors about the food safety management
- Increased safety and quality of products

d. Producer targeted dissemination of knowledge on health, nutritional properties of their products

Example: Measures aimed at spreading the knowledge of nutritional properties of traditional products, their beneficial effect on consumer health

Specific challenge: Fruits are highly valued for their taste and nutritional value. They constitute an important source of vitamins as well as bioactive compounds in the human diet. These compounds, either individually or combined, are responsible for various health benefits, such as the prevention of inflammation disorders, cardiovascular diseases, or lowering the risk of various cancers. Consumer awareness about the health benefits of fruits increases constantly. However, quite often their interest turns toward such tropical fruits as goji or açai, believing them to be superfoods. The producers should be aware of the health benefits of local fruits and communicate the nutritional value and potential health benefits of their products.

Scope: The producers should be able to inform their customers on the health benefits of their products. Therefore, it is important to increase consumer awareness of the importance of consuming traditional fruits.

- Developing measures to spread the knowledge of nutritional properties of traditional products through training programmes, networking events, the formation of science shops and the development of communication strategies
- Including the follow up phase in the new projects aimed at the evaluation of health properties of fruits, which will include the dissemination of the results obtained on the consumer-producer level since the next step will be establishing an effective dialog between producers and consumers

Expected impacts:

- Increased knowledge of producers on the health properties of their products
- Increased knowledge of consumers on the health properties of traditional fruit products
- Better communication between producers and consumers
- Increased consumption of traditional fruits and their products

e. Increase the awareness of traditional food through continuous education and communication

Example: Development of a greater role played by state institutions, public and private research sectors, as well as the private investment sector in the field of traditional product branding

Specific challenge: The lifestyle of Western societies is evolving constantly. Shopping and consumption habits are changing: the distances between production and consumption areas are prolonged; time dedicated to household shopping and mealtimes is reduced. Consequently, there is a lack of direct communication on fruits and their product properties between producers and consumers. Moreover, existing knowledge of traditional food health benefits does not efficiently reach the producers on one hand and the consumers on the other hand. Even though consumers become aware of the direct effect of nutrition on their health, the intake of fruits in Europe remains well below the levels recommended by the World Health Organisation. The exchange of information, transfer of knowledge and validation of innovative solutions need to be facilitated and should involve all stakeholders and a variety of measures. Continuous communication and education of consumers will help them to understand the quality and health benefits of fruit products.

Scope: Several important measures should be applied to increase consumer interest and trust in traditional foods: research on consumer attitudes to traditional fruit products, personalisation of consumer demand, transparency in traditional food production methods, research on the health benefits of traditional fruits and their products, research on the influence of processing methods on bioactive compounds in fruit and fruit products.

- Facilitating the formation of national and international network of SMEs

- Facilitating the information transfer from R&D to SMEs thanks to such activities as workshops, research institution open days
- Follow-up projects (following the research project) should be established and carried out in order to implement innovative solutions
- Improving communication between traditional food producers and consumers with activities like tasting panels, events gathering consumers and producers in retail stores
- Developing continuous education of consumers, the regular flow of information towards consumers regarding quality characteristics, health properties, seasonality aspect, varieties, etc.
- Public support to promote the branding of traditional products

Expected impacts:

- Expanded knowledge of both producers and consumers about the expectations and abilities of each body (quality characteristics, maturity evolution, healthy properties, price information, know-how and habits)
- Increased consumption of traditional fruits
- Increased awareness of the traditional aspect of local products (characteristics of production and harvesting activities, internal and external characteristics)

7. Olives

a. Preservation of the genetic pool by enhancing the knowledge of ancient varieties and the development of new olive varieties for new challenges (high yield and oil quality, pests and disease control, adaptation to climatic change)

Specific challenge: Over the past few years, olive growing has experienced a remarkable transformation, favouring the use of a reduced number of cultivars able to fulfil the requirements of the new intensive and mechanized orchards. Nevertheless, traditional olive cultivars and ancient olive trees represent an important and yet to be evaluated local genetic patrimony that could constitute a very useful source of diversity against new and unforeseen climatic changes in the near future and in the event of the outburst of new pests and diseases, like the case of *Xylella fastidiosa*. The knowledge, collection, conservation, characterisation and evaluation of olive genetic resources are necessary steps to be taken against the genetic erosion risk and towards their efficient use in breeding programmes. The need for new improved cultivars has promoted the development of olive breeding programmes aimed at obtaining new cultivars with early bearing, high yield and oil content, suitability to different growing systems, high oil quality and resistance to well-known (*Verticilium*) or recent outbursts of disease (*Xyllela*). As a result, only a few new olive cultivars have been released to date, and only some of them have been marketed successfully.

Scope: The work will aim at acquiring, maintaining and identifying local cultivars and ancient olive trees in ex-situ germplasm collections. These activities will be followed by the identification of the recently obtained germplasm by means of molecular markers (SSRs and SNPs). The identification data will be included in the database of germplasm collections. The on-farm conservation and use of such local and ancient olive trees will be promoted and enhanced. In addition, the new accessions will be evaluated for several pomological traits related to vigour, phenology, production, fruit and oil quality and for their resistance to pests and diseases. The results of such evaluations will help to determine the most interesting cultivars for their use as potential parents in future crosses of olive breeding programmes as well as for the establishment of comparative trials in different agro-climatic conditions.

Expected impacts: The project results are expected to:

- Increase awareness on the value of local genetic resources (cultivated and wild) as well as ancient trees
- Improve methodologies for the management, conservation, characterisation and evaluation of genetic resources
- Promote the on-farm conservation and management of ancient olive trees
- Enhance the use of local and ancient olive genetic resources into breeding programmes

- Develop new cultivars with improved agronomic behaviour and able to face future challenges for olive growing.
- Enhance the link between germplasm collections, breeding programmes and farmers.

b. Improvement of methods for the valorisation of olive oil by-products.

Specific challenge: The EU is the world's largest producer, consumer and exporter of olive oil. The production of olive oil generates large amounts of three main types of by-products/biomass:
-The wood, the branches and the leaves coming from pruning
-The wastewater derived from washing the olives and olive oil, on the one hand, and the Two-Phase Olive Mill Wastewater (TPOMW), also called "alperujo" in Spanish, on the other hand, both of them produced mainly in Spain
-The classical olive mill wastewater (OMW) and olive cake derived from the three-phase manufacturing process (majority system in Portugal, Italy, Greece and the rest of the producer countries in the European Union)

The recovery of all these by-products to use as energy, for thermal and electric use, is a first challenge for the olive oil mills and industries, given that there is currently little valorisation thereof.

In addition, the olive value chain biomass is rich in a wide range of bioactive compounds, such as polyphenols, triterpenics acids and tocopherols, among others. These molecules have antioxidant and antimicrobial activities so a second challenge for the olive sector would be their use in different food, cosmetic or pharmaceutical applications.

According to the EU, "European waste management policies aim to reduce the environmental and health impacts of waste and improve Europe's resource efficiency. The long-term goal is to turn Europe into a recycling society, avoiding waste and using unavoidable waste as a resource wherever possible. The aim is to achieve much higher levels of recycling and to minimise the extraction of additional natural resources. Proper waste management is a key element in ensuring resource efficiency and the sustainable growth of European economies".

Scope: In both cases, for energy and bioactive compounds recovery, it is necessary to increase the research efforts with the aim of enhancing current knowledge about these processes with a specific focus on the olive value chain, since most of the prevalent approaches are based on the results in other sectors. Additionally, this effort would help to achieve the objectives for European renewable energy use and sustainability for food waste recovery, with such an important crop and food product for the European economy.

Expected impacts: A holistic approach to olive processing industry waste valorisation would have the following impacts on the sector:

- A reduction or elimination of waste, in some cases contaminants, and reducing the risk of fires caused by burning agricultural residues and remains of pruning
- A reduction in the costs of waste management and even become a resource to generate additional income to their producers
- The increase of added value and profit margins in the olive value chain
- Ensure the resource efficiency and the sustainable growth of European economies
- The collection and management of biomass would generate a large number of jobs, especially in rural areas

c. New strategies to improve the management of table olive wastewater.

Specific challenge: The production of table olives plays an important role in the economies of several Mediterranean countries. Moreover, in recent years, there has been a worldwide increase in the production and consumption of these olives. Spain is the biggest producer in the world with 26% of total production.

The quality of olives differs from year to year and depends on such various things as climate, rainfall, the amount of pests etc. The most common method for producing green olives in brine is “Spanish-style” processing that comprises several steps: lye treatment (debittering), rinsing, brining, fermentation in brine, packaging and pasteurisation.

The production of table olives involves several flows of wastewater. The processing of table olives comes from traditional procedures that did not consider water as a resource and the environmental effects deriving from its use. The processing of table olives is an activity concentrated in a few months per year (autumn-winter) and in restricted geographic areas, sometimes with little surface water resources). This puts a lot of pressure on the water resources and on the quality of the surface water. The growing attention towards the use of natural resources and the arising of national laws and, in the case of the European Union, of community laws even more constricting as far as the draining of wastewater is concerned, makes it necessary to carefully assess the use of water in table olives production processes.

Scope: Wastewater is an important issue deriving from table olives industries, with eutrophication as the impact category mainly affected by the pollution of wastewater. Amongst the various methods used to process green and black table olives, wastewaters are produced in different amounts and affect the EU impact category in different ways.

In order to improve the environmental performance of this processing system, however, technological solutions could be adopted with the aim of reducing the amount of material used, the reuse of brines and/or the extraction of the most contaminant substances from olive wastewaters.

Expected impacts: The project results are expected to:

- Decrease the overall water requirements in the process
- Reduce the environmental impact of wastewaters
- Set specific wastewater treatment methods

d. Innovative approaches for consumer education and commercialisation: branding, changing habits and tapping into new markets.

Specific challenge: Olive oil and table olive sectors, as a food sector in general, are faced with increasingly changes in consumer behaviour and demands. In addition, these products appear to consumers as undifferentiated goods, despite being food products with clear potential for differentiation. As an example, some surveys show that there are major segments of consumers who have real difficulties to appreciate and even identify what extra virgin oil is.

As a main challenge, the efforts in the research and production of quality olive oil and table olives should be accompanied by measures aimed at the consumer broadcast: sensory education, olive culture, product differentiation, different uses, different quality and category of products, etc. Through consumer education, teaching them the difference between the products, the existing imbalance between a sector that demands efforts for greater quality and product improvement and a consumer who does not generally appreciate such quality could be resolved.

A second challenge for the sector would be the adaptation of both olive oil and table olive to international markets on issues related to the taste, processing and product uses, in a market that is increasingly global and international for the food sector.

Scope: The research on innovative presentations, sensorial characteristics and new uses applied to other cultures would be major priorities. These research activities might include conducting feasibility studies, understanding consumer concerns, attitudes and perceptions relating to food categories and promoting dissemination of results and technology transfer. Research proposals should be encouraged to include participants not only from EU producer and consumer Member States, but also from third countries, since they would also be targets of this topic.

Expected impacts: An improvement in the commercialisation barriers based on consumer education would have the following impacts on the sector:

- The opening of new niche markets, especially in non-producing countries
- The enhancing of the brands working on the previous issues
- A clear market differentiation between other edible oils and fats for the companies
- The increase of added value and profit margins in olive products
- The increase of confidence in consumers and markets about olive oil and table olive quality

- Assistance to food producers to better communicate the qualities, characteristics and attributes of their different food products

8. Food Quality & Food Safety

Food safety and quality is a horizontal activity in this project. It is an essential part of each food item produced in food industry. Due to the specific limitations integrated into the functioning of SMEs, each step in this project needed to analyse the state of the art in the four groups of traditional food products based on (1) grains, (2) fish, (3) vegetables & mushrooms, and (4) sweet fruits & olives, including food quality and safety aspects. These two overlapping aspects in the food supply chain proved to be of crucial importance in all the food clusters mentioned. However, the degree of overlap and importance varied significantly when the food clusters were analysed comparatively. Particular aspects of quality are food-specific and have been addressed in each fruit- vegetable- grain –fish cluster separately in extenso. Food safety can also be easily seen in its full specify in each selected food. The workshops addressed this question at great length. However, it looks like this important issue has a very distinct face of quality and safety, and the full picture of quality and safety is still developing in professional circles. We could sometimes see that commercial aspects have such a strong influence on production and processing that the product is important only as a link to marketing and brand, not to mention the consumer. Based on the findings mentioned, we can segregate and cluster many challenges which, properly addressed, will give us positive impact on (1) grains, (2) fish, (3) vegetables & mushrooms, and (4) sweet fruits & olives products, and services satisfying professional and consumer needs in safe and healthy diets.

Challenges:

- Meeting the needs of individual target groups of consumers (special needs groups, healthy lifestyles, food restrictions, etc.), and bringing to the market food products and services of adequate quality specific to traditional foods with all the elements of modern safety demands, including chemical, physical, microbiological with full respect of nutritional safety
- Implementation of new discoveries and incremental developments to primary production with a sustainable impact in conventional and organic systems, to processing and packaging respecting mild processing and nutritionally friendly preservation, product design and formulation of nutrition patterns respecting the traditional touch of a particular food item, with respect to substrates, technological processes and preservation to bring to market fresh food with preserved essential nutritional functionality at high quality and safety standards
- Creative breeding is essential for biological progress in food production to enable mitigation due to climate change and to retain/improve the quality and safety of plant crops in production and in consumption like: enhanced resistance to pests and pathogens, tolerance to drought and soil salinity, retained/ improved nutritional value, shelf life, sensory characteristics
- Conservation of good water quality in the rivers and other water bodies, fostering the regeneration of groundwater resources and stabilising the regional climate at international, regional and local levels to enable safe plant crops and fish production.

- All food items produced from traditional substrates with traditional technologies in distinct geographical regions should be certified, labelled, to give clear identification, and enable full traceability within the same system in the whole of Europe, which must be easy to understand, crossing all the linguistic barriers that exist in Europe.

Scope:

- New or improved methods or tools for food production, processing, packaging, distribution with a smaller ecological footprint, high efficiency and best conservation of tradition and regional specificity and beneficial impact on nutrition
- Collaboration projects between producers in the chain for increased efficiency, quality and quantity of foodstuffs
- Development of new value chain-based frameworks with high-efficiency food production processes for energy conservation as well as waste prevention or further exploitation keeping food quality and safety on advanced level standards
- New product designs and development of advanced nutrition patterns including new forms of edible packaging boosted by the improvement of consumer knowledge of preferences, specifically market niches connected with rising trends in healthy lifestyles
- Research will develop efficient long-term breeding strategies to improve diversification, productivity, stability and overall quality of grains, olives, sweet fruits, vegetables, mushrooms and fish. Activities will seek to broaden the genetic base of certain forgotten or exotics species or cultivars for breeding purposes, analyse relevant and untapped genetic material with a focus on the quality and safety of the substrate but also on the final food item.

Expected impacts:

- Bringing to market new varieties and breeds adapted to local production systems with respect to sustainability principles in order to increase the overall productivity, minimisation of chemical treatments in production and storage, extension of shelf life and quality and safety to satisfy production and consumer needs
- Increased safety and quality of grains, olives, sweet fruits, vegetables, mushrooms and fish and their products, especially of minimally-processed, traditionally preserved and European food culture heritage important food items created for specific market niches connected with rising trends in healthy lifestyles and serving modern people with hectic life styles
- Optimisation of processing conditions, implementation and/or improvement of processes and methods with regard to energy, water, waste and smart, sustainable packaging demands with respect to top quality and safety standards of food items to enhance trade also by extending food preservation/shelf life and maintaining food quality/functionality/safe use

- Expanded knowledge of both producers and consumers about the expectations and abilities of each actor (stakeholders) in the food production network of grains, olives, sweet fruits, vegetables, mushrooms and fish (quality characteristics, safety limitations, nutrition relevance, healthy properties, price information, consumer habits for purchasing, storage and consumption)
- The increase of confidence in consumers and markets about traditional and modern varieties of grains, olives, sweet fruits, vegetables, mushrooms and fish regarding their impact on food quality and safety requirements of primary products as well as the final food items produced
- Development and implementation of new requirements for food quality safety in legislation and in the realisation of good practices in grains, olives, sweet fruits, vegetables, mushrooms and fish chains and making sure that Europe is leading the way

9. Entrepreneurship

a. Responding to new consumer behaviour and food choices

Challenges:

- Meeting the needs of individual target groups (special needs groups, healthy lifestyles, food restrictions, etc.), in terms of adequate food products and services, on the basis of a Customer Needs Analysis
- Developing new production, storage, distribution and preparation processes to maintain positive health benefits
- Developing convenience, fast food and vending food to offer a balanced diet
- Promoting awareness and facilitating healthy food choices
- Establishing regulatory frameworks that facilitate practical foodstuffs, while ensuring the consumer health is maintained

Scope and expected impacts:

- Improvement of knowledge of consumer preferences, specifically of market niches connected with rising trends in healthy lifestyles
- Increased knowledge of nutritional properties
- Risk-benefit evaluation of food products, taking the full production lifecycle into consideration
- New dietary models and ingredients, and a corresponding risk-benefit evaluation
- Increased knowledge of and new research on diets, food and sources that contribute to decreased levels, or alleviation, of chronic diseases (cardiovascular diseases, diabetes, etc.).
- New research on food ingredients and products that may alleviate typical elderly diseases, such as osteoporosis
- Increased knowledge of the relationship between food and intestinal well-being, namely with respect to gastrointestinal flora / bacteria.
- Links between research project, nutritional claims and consumer expectations
- Development of guidelines to new practical and convenient products: pre-prepared, ready-to-use for home and restaurant
- Improvement of nutritional and pro-commercialisation properties of functional food (taste, smell, colour, etc.), such as probiotic food and foodstuffs
- Design of the consumer environment to facilitate healthy food consumption
- Redesign of food products

b. Increase industry sustainability

Challenges:

- Ensuring energy efficiency in food production, distribution, commercialisation and waste management

- Studying regulatory frameworks for energy efficiency in food production
- Facilitating, promoting and materialising local sourcing of ingredients in European food production
- Guaranteeing/increasing confidence in European food products, and particularly in organic, fair trade
- Improving image or confidence of industrial production methods
- Establishing new ways of co-operation and communication between agriculture, the food industry, the retail trade and the catering trade
- Facilitating collaboration between companies, researchers, and other players

Scope and expected impacts:

- Increase in full lifecycle knowledge
- New methods or tools for the evaluation of the environmental impact of food
- New methods or tools for the evaluation of the social impact of nutrition
- Collaboration projects with farmers for the increased efficiency, quality and quantity of foodstuffs, as well as fair pricing
- Development of new value chain-based frameworks for energy conservation as well as waste prevention
- Development of high-efficiency food production processes, while maintaining quality and safety standards
- New water, energy, and other non-renewables efficient technologies
- Added research on de-intensify food production systems, and subsequent impact on product pricing and efficiency
- Impact of present and expected climate change effects
- Re-usages of food production by-products / waste
- More sustainable processes for food preservation
- New forms of biopackaging
- Analysis of production constraints on the European food industry

c. Increasing the value of traditional products for competitiveness and innovation of SMEs

Challenges:

- Introducing open innovation in traditional sectors
- Incorporating high technology in low-tech sectors
- Transferring new knowledge and new technologies in a framing of local gastronomic traditions
- Maintaining competitive advantages through incremental innovations in products and manufacturing processes, while maintaining character, authenticity and quality
- Adaptation of existing specialities to the requirements of the national/international market, while taking care to retain their typical character

- Streamlining the best production, distribution and commercialisation practices of traditional foods
- Investigating, defining and determining foreign requirements to perceived European or individual Member States "character", and marketing/developing new products that fit the requirements based on authenticity and reliability/trust
- Disseminating and guiding based on the protected designation of origin (PDO), protected geographical indication (PGI), traditional specialty guarantee (TSG), and organic certification.
- Increasing consumer information and the transparency of traditional products
- Increasing multi-stakeholder co-operation
- Identification of technologies where Europe is at the forefront or where it is known for these
- Identification of areas where Europe shows technological potential, or where there is a region-wide concerted effort, such as Smart Specialisation Strategies
- Identification and uptake of promising research areas, and the corresponding implementation of processes, products and services

Scope and expected impacts:

- Development of new metrics for sustainability in food production/consumption
- Definition of additional analytical methods to describe a traditional product based on origin, authenticity, local impact, etc.
- New product development based on the use and enhancement of traditional foodstuffs or livestock
- New research into traditional production processes, raw materials, ingredients and products
- Minimisation of the impact of food safety requirements on product quality
- New research into market preferences and choice in traditional products vs industrial products
- Integration and evaluation of the impact of traditional crop strains
- Research and mainstream of new cultures, or combination of cultures, which contributes to biodiversity
- Delimitation of product quality discrepancy
- Investigation of the consumer reception to ethically controversial products (e.g. GMO)
- Application of nanotechnology and nanoscience in food products, food packaging and food processing, namely with respect to nutritional or health determinants
- The formulation, release and bioactivity of functional food products
- New technologies for coating and packaging food products
- New research that promotes the understanding of the interaction between nutrients and the human organism
- New dietary strategies and components
- New research on useful bacteria

- Information and new models for traditional food production and distribution processes
- Development of models for personalised diets
- Provision of consumer services using ICT

d. Improving marketing know-how and communication strategy in SMEs:

Challenges:

- Improving marketing advertisement of special product properties (health benefits, allergenic content, type of production), enhancement of packaging material/design, etc., digital marketing
- Advertisement of special product properties (health benefits, allergenic content, type of production)
- Improving and streamlining science-based communication to the public, including evidence-based risks and opportunities (health, sustainability)
- Enhancement of packaging material/design, etc.
- Applying digital marketing in traditional sectors
- Increased knowledge of international markets and dissemination of best market penetration guidelines accordingly, namely in the fields of safety, standardisation, health, environment, etc.
- Getting to know needs and information behaviour
- Building a trusted relationship with the consumer
- Creating novel packaging concepts (materials and designs) that promote re-use or recycling, minimise the overall environmental impact of food, etc., in order to make the products more attractive to consumers
- Developing smart and sustainable packaging solutions to enhance export: extending food preservation/shelf life and maintaining food quality/functionality/safe-use
- Establishing effective communication between all those involved in the food chain, including the authorities and inspection institutions
- Adoption of ICT for client service optimisation

Scope and expected impacts:

- Delivery of training programmes at SMEs to increase their awareness and knowledge regarding food labelling, legal aspects, certification and other IPR related to traditional food regulation
- Promotion of dialogue between the industry and research centres in order to establish collaborative R&D projects (research based knowledge at SMEs);
- Improvements on the connections between SMEs producing traditional food products and tourism
- Definition and set-up of strategic plans for traditional product valorisation

- Identification of success stories in the field of traditional food, including start-ups and spin-offs from other companies or from research centres; establishing a list of best practices for innovation, entrepreneurship, marketing and commercialisation to be disseminated
- Set-up of knowledge and technology transfer activities between stakeholders
- Delivery of knowledge and technology transfer tools in SMEs
- Identification and transfer of best practices for technology transfer and the commercialisation of research output across several sectors and multiple countries
- Improved awareness of how consumer confidence can be strengthened by communication

e. Enhancing awareness and knowledge of SMEs regarding the quality and safety of traditional food

Challenges:

- Enhancing awareness and knowledge in:
  - Food labelling (nutritional value, health benefits, advertisement of properties)
  - Legal aspects for environmental protection, phytosanitary certification, HACCP implementation and EU standards
  - Certification according to EU schemes: protected designation of origin (PDO), protected geographical indication (PGI), traditional specialty guaranteed (TSG), and organic certification
  - Intellectual Property Rights (IPR): copyright, trademarks, geographical indications, patents, design, plant's breeder rights, etc.
- Establishing common regulations/standards: harmonization of legislation between countries and the number and type of certifications needed for trading; standardisation of product labelling (what to include and how)
- Recognition and evaluation of potential risks at the earliest stage.
- (self-) Proactive establishment of food safety guidelines
- A priori establishment of solutions in crisis situations, thus ensuring consumer confidence
- Optimisation and perfection in terms of safety in production, storage and distribution procedures. Optimisation and implementation of traceability systems
- Ensuring that Europe is leading the way in new requirements for food safety

Scope and expected impacts:

- Consumer perception of risk, consumer behaviour and consumer confidence
- Early detection and characterisation of food hazards. Development of fast detection methods for pathogenic micro-organisms and their metabolic substances
- Study of pathogenic and spoilage flora (bacteria, fungi, viruses). Development of starter cultures for the inhibition of pathogenic and spoilage flora
- Suppression of the transmission of antibiotic resistances

- Chemical and immunochemical danger studies
- Development of predictive and risk assessment methods and tools (both microbiological and toxicological risks and dangers) by both exposure models and safety and traceability management in a risk-benefit approach
- Integration of comprehensive safety assessment (toxicology, side effects) into the development of new bio-active food. Development of comprehensive methods and guidelines to evaluate the risk-benefits of food
- Prevention and management of food crises by integrating social, economic and environmental consequences
- Integrity of the food chain including traceability
- Validation of cleaning processes and of the hygienic design of food production lines
- Translation of certification labels
- Implementing training programmes at SMEs to increase their awareness and knowledge regarding food labelling, legal aspects, certification and other IPR related to traditional food regulation

f. Stimulating entrepreneurship and inter-organisational co-operation

Challenges:

- Developing general training to improve the level of human capital at the firm level to equip companies with the appropriate qualifications and change mind-sets about entrepreneurial opportunities
- Promoting business and entrepreneurship education in school and in training
- Stimulating intrapreneurship in established companies in the creativity, business planning, and corporate entrepreneurship areas
- Streamlining of financial capital tools for the traditional food sector: private equity, corporate venture capital, crowd funding, business angel capital, and proof-of-concept funding
- Promoting cross-border capital investment and business networking
- Generating inter-business alliances to lobby, influence or change governance structures, legislation or attitudes towards the agri-food sector
- Networking activities to share and discuss cultural differences in food perceptions and trend
- Integrating across-the-board technological advances (Key Enabling Technology - biotechnology, nanotechnology, etc.)
- Promoting dialogue between the industry and research centres in order to establish collaborative R&D projects (research-based knowledge at SMEs).

Scope and expected impacts:

- Improvement of in-house industry-relevant qualifications

- Increased entrepreneurial knowledge and skill, positive perceptions of entrepreneurship, and intentions to start a business and on entrepreneurship outcomes (i.e., nascent and start-up behaviours, financial success)
- Raised awareness of the opportunities for venture creation, by means of short courses and EU-level boot-camps intended for academics, students, and the employees of technology companies who wish to start their own business or to commercialise the results of their research
- Stimulation of intrapreneurship and intra-business interaction, support, and guidance
- Availability of adequate financial capital for the traditional food sector
- Provision of peer support and motivation to entrepreneurs, and examples or role models
- Provision of expert advice and counselling
- Enactment of changes in government procedures or legislation
- Increased access to opportunities, information, and resources in the region
- Initiatives to support internationalisation of businesses
- Increased levels of R&D investment and technology transfer
- Diversification of technology transfer activities away from universities/big-science laboratories and business relations
- Matchmaking events between companies and intellectual property owners or other technological opportunities
- Investing corporate venture capital in start-ups
- Opportunities to be acquired by existing business units
- Sharing of technological or managerial knowledge and tangible resources
- Investments in knowledge sharing at the national and international level
- Improvement of connections between SMEs producing traditional food products and tourism
- Increased understanding and policy making based on the role of clusters, incubators, accelerators, science and technology parks, etc. as catalysts of the traditional food sector and regional growth via SME creation and development
- Sharing of facilities or laboratories between companies on same or similar research topics
- Provision of incubation facilities, where entrepreneurs can receive management and legal advice, finance channels, industry know-how and access to new markets
- Development of markets for ideas or dedicated platforms
- Creation of innovation brokers between companies and R&D producers
- Establishment of mutually beneficial co-operation through matchmaking events