ROADMAP FOR RESEARCH AND INNOVATION

Cluster Agrifood Nazionale CLAN
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PREFACE

This document is the result of intensive work which has involved the University, public and private Research organisations, food businesses, local agencies, trade associations and training bodies. This active partnership aims to draft a joint vision of the technological perspectives for the food industry. The document demonstrates that the Agrifood Cluster provides an outstanding opportunity for establishing a permanent cooperation channel between public and private research and the world of industry. This channel has the potential to generate practical suggestions from a large number of Italy’s food industry stakeholders, in keeping with the guidelines supplied by the MIUR (Italy’s Ministry for Education, University and Research) in order to identify potential opportunities for technological development in food businesses. The work has been developed in keeping with the ongoing European research policies of Horizon 2020 and in observance of the Strategic Agenda for Research and Innovation of Europe’s “Food for Life” Technological Platform, and as part of the regional Smart Specialisation Strategies.

The Roadmap of the Agrifood Cluster is being submitted to the MIUR and the MISE (Italy’s Ministry for Economic Development), as the themes of research outlined for tackling the mid and long-term challenges provide useful suggestions for developing initiatives to encourage planning which has a direct effect on the competitiveness of the agrifood sector. The method adopted for drafting the Roadmap was proposed by the Technical Scientific Committee, shared with the Coordination and Management Body and approved by the Assembly. The document on the priorities of the research and innovation of the Cluster is divided into six Technological Pillars. These are paths for the strategic development of Italy’s agrifood sector: Health and wellbeing throughout the entire life cycle, Food safety, Production processes for improved food quality, Sustainable and competitive production, Machines and plants for the food industry, ICT in the agrifood industry and tools for technological transfer.

The six Pillars correspond with priority challenges which the Food Industry now needs to face:

1. Preventing diet-linked diseases, with particular emphasis on the nutritional needs of specific groups of the population.

2. Improving the safety of products by intervening in every phase: from primary production to transformation, conservation, distribution and the preparation of foods.

3. Improving the quality of foods, with an end to improving the quality of life of consumers.

4. Intensifying production, reducing the environmental impact and the pressure on natural resources whilst at the same time making products that are healthy and safe, and which allow people to enjoy a varied and balanced diet in terms of energy and nutrients.

5. Improving the functional nature of production plants, products and materials used in food production processes.

6. Effective and efficient exploitation of data available throughout the supply chain for managerial and analytical purposes.
1. REFERENCE FRAMEWORK

THE ITALIAN FOOD INDUSTRY: SCENARIOS

In 2015, the Italian food industry, with a turnover of 132 billion Euro (of which around 29 from exports) and 54,400 businesses (of which 6,850 with more than 9 members of staff), confirmed its place as Italy's second largest manufacturing sector after the engineering industry. It ranked third place in Europe, behind the German and French food industries (see Fig. 1).

![Figure 1 – Europe's top five food industries (Source: FoodDrinkEurope)](image)

In 2014, the 34.6-plus billion Euro exported by the agrifood industry accounted for 8.8% of Italy's overall exports (395.157 million). Fig. 3 shows the main products exported. The weight of Italian food, however, varies considerably in the world market depending on whether the markets are European, in which it is well represented, or more far-flung areas with countries experiencing rapid growth, in which its weighting and competitiveness are much lower in terms of international competition (see Fig 2).

Within the framework of a mid-to-long-term growth strategy, the tough challenge faced by Italy's food industry lies in its ability to look further afield to conquer new markets, as well as defending and expanding those that are already consolidated. It is necessary to aim to increase the value of agrifood exports to 50 billion Euro by the end of the decade. This growth would guarantee an increase in direct and indirect jobs totalling around 100,000 units, and would allow Italian-made food to conquer the European leadership, filling its gap behind France and Germany. It is a very ambitious goal but one that can be achieved with the coordination of the Authorities responsible for using resources to promote Italian products and with a joint effort to counteract the main barriers to competitiveness within the sector (counterfeiting, Italian-sounding goods, non-tariff barriers and aggressive campaigns targeting the Mediterranean food model). Counterfeiting and Italian-Sounding are widespread everywhere, not least in Europe. Yet they are particularly serious issues in North and Central America, where the phenomenon has an impact which accounts for 27 billion Euro. In the United States, where the percentages are disconcerting (97% of pasta sauces, 94% of foods preserved in oil and pickles, 76% of tinned tomatoes and 15% of cheeses are imitations), only one product in

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1 Data source: Federalimentare Studies Office
eight of all those sold as Made in Italy is actually Italian. Yet the consequences within the European Union should not be underestimated either. Counterfeiting and imitations account for a turnover of 22 billion Euro in the EU.

A reduction in the counterfeiting phenomenon would provide an immediate boost to Italian food exports, whilst a reduction in Italian-Sounding goods would promote them in the mid-term. Fig. 4 shows the values of counterfeit and Italian-Sounding goods.

Figure 2 - Export 2014: the main destinations (values in Bln of Euro) (Source: Federalimentare Studies Office)

Figure 3 - Export 2014: main products exported (Source: Federalimentare Studies Office)
Unlike other industrial sectors which had to make heavy cuts to their production capacity and workforce during the recession, the Food Industry has proved it has the capacity to be the driving force of growth and recovery in our economy. This is due to a variety of reasons: the size and strength of its production system and its ties with national farming, from which it buys and transforms over 72% of the raw agricultural materials it needs, its role as ambassador to Italian produce worldwide (almost 80% of agrifood exports is made up of brand-name industrial products), and the social, cultural and environmental values it conveys.

Its intrinsic characteristics mean that the phenomenon whereby production is delocalised abroad is virtually non-existent in the Italian food industry, unlike other manufacturing sectors. And in the rare instances in which it occurs, it is solely geared towards conquering new foreign markets.

It is a sector with high employment intensity which has confirmed its invaluable role as a stabilising, anti-cyclical force, maintaining employment levels that are virtually unchanged, in spite of the crisis. Whilst there has been a loss of 927,000 jobs on a national level, the Food Industry has seen a marginal fall of 20,000 units from 2007 to the present, from 405,000 to **385,000 employees**. To this end, it is important to stress the point made in the last industrial census. Indeed compared with the one conducted ten years earlier, the considerable stability of the "industrial" sphere of food businesses with more than 9 employees emerged. In 2011 it recorded 6,857 units, virtually the same as that of 2001, of 6,910 units.

To obtain the total number of jobs in the entire agrifood supply chain, - which involves around 2 million people- it is necessary to add the Industry’s 385,000 employees to the 850,000 employed in farming, the 600,000 in modern and traditional distribution and approximately 200,000 employed by the national health system and food research spread throughout Italy. The latter are also responsible for analysing and controlling the supply chain itself (Centres of excellence, Universities, governmental agencies, animal disease prevention, local health authorities, fraud prevention, NAS (the Military Police’s Department for Health Protection, Forestry, etc).

The Italian food industry is increasingly setting itself the objective of meeting first and foremost the development needs of small and medium enterprises. It has identified staff training as a primary driver for growth of human resources and competitiveness of the sector, turning it into a field which offers considerable employment prospects for the younger generations. The subjects most in demand for graduates are, in order: business and economics, marketing and administration(35%); sciences, food technology and biochemistry (25%); environmental and logistical engineering, supply chain (21%) and legal (19%). Food businesses will also search increasingly for knowledge in the inter-disciplines needed to back the ongoing product and process innovation which the sector pursues: innovative technologies (nanotechnology, biotechnology, micro and nutraceuticals, soft processing, renewable energies, etc.); innovative models (consumer needs, new systems for organisation and distribution etc.); innovative designs (packaging, ingredients and recipes, flavour and colours, shelf-life, convenience and ready-to-eat, new varieties, etc.).
AN INCREASINGLY RESPONSIBLE INDUSTRY²

The Italian food industry has considerable interest in establishing sustainable production and consumption models on a global scale capable of meeting the increasing need of the world’s population and guaranteeing the competitiveness of agrifood systems whilst respecting the environment and local communities. The food industry has undertaken a number of measures - in conjunction with primary production - to promote environmental sustainability in agriculture. The aim is to ensure supplies of raw materials of sufficient quality and quantity whilst respecting the environment and boosting the competitiveness of the farming systems. As the food industry is not self-sufficient for raw materials in certain strategic supply chains, it has developed integrated management systems with Italian and foreign suppliers which also involve participating in activities upstream of the supply chain (cultivation/husbandry agreements, selection of seeds of animal species etc.) with a view to achieving “sustainable innovation”.

For the Italian food industry, offering food that is good, healthy and safe, with an increasingly well-balanced nutritional profile and at prices that are limited and accessible, is a key objective³. At the same time, it is vital for businesses in the sector to help consumers make choices that are informed and health-oriented whilst providing suitable information about the products, raw materials, consumption and preservation methods. They must also promote campaigns on food education in schools and within the family, conducting them in conjunction with the Authorities where appropriate. These must be aimed at young people and should encourage them to adopt balanced consumption models and healthy lifestyles.

The Industry in question has:

- **Wholly valorised agricultural raw materials and their by-products** From the dimensional standpoint, by-products of the food industry represent 2-3% of the entire volume of “dry” products, and 7-10% of “moist” products, making for a sizeable direct and indirect commercial value. The by-products are used for a variety of purposes. Mainly they are used for producing animal fodder (each year, around 85 million tonnes are used to make fodder in the EU); other important uses include producing bioenergy forms, food ingredients, in the cosmetic and pharmaceutical industry and for producing fertilisers.

- **The amount of water used in production processes has been halved, improving efficiency without compromising the strict hygiene standards imposed by the EU.** The water consumed by European industry fell by around 30-40% between the Nineties and today⁴. Outstanding experiences notched up by key Italian food companies have, at the same time, documented water savings of up to 60%-70% (per tonne of product) and 40-50% in absolute values (the water used has been rationalised whilst at the same time production volumes have increased). The food Industry is also dedicated to promoting responsible use of water throughout the entire food supply chain.

- **Energy efficiency has been pursued (-20% in 10 years) as a crucial force for driving industrial competitiveness, but also -and above all- as a factor for reducing greenhouse gases (-30%).** The food industry - the EU’s biggest industry - has a relatively low energy impact when compared with other industrial sectors: the consumption of electricity which can be attributed to the sector totals around 8% of electricity used for industrial purposes in OECD Countries and 1.5% of overall energy consumed in Europe, whilst the

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² Source: Position Paper Federalimenare “The Italian food industry is a good industry for creating value for the Country” 2012
³ Source: Research format study for Federalimentare
⁴ Source: European Environment Agency
CO₂ emissions attributed to the food Industry are estimated at around 1.5% of total greenhouse gas emissions in the EU 15.

- **Packaging has been optimised, cutting amounts of raw materials used (-40% in 10 years).** The food Industry alone uses 2/3 of product packaging, and dedicates considerable resources to preventing and reducing the environmental impact of packaging. Packaging plays a key role: it helps guarantee the quality and safety of food, ensuring the product is not damaged during transportation, distribution and consumption. It conveys the brand's values along with nutritional and service information which is essential for consumers. In addition, the packaging has a direct positive effect on the environment: by improving the shelf-life of food products, both for distribution and the end consumer, cutting food wastage whilst guaranteeing sizeable savings upstream. The food industry is dedicated to reducing the materials used for packaging, without sacrificing either the needs of consumers or the integrity, quality or safety of the products. Just some of the results achieved: in the last ten years, plastic has been reduced by -30/40%, aluminium by 30%, and glass by up to -60%. For cardboard, the proportion of renewable and recycled material used is now at 73%. In ten years, the combined commitment of the food Industry and packaging manufacturers has managed to reduce packaging by around 40%, transportation costs by 17% whilst at the same time increasing re-used material by 10%. This means that 300 million primary packages have not been placed on the market, with a saving of around 20% on CO₂ emissions 6. The national packaging recuperation and recycling scheme headed by CONAI and the supply chain Consortiums for the various materials has allowed us to achieve important goals when we consider that in 1998, when the National Packaging Consortium was first set up, two out of three packages were sent to landfill sites, whilst today only two out of ten are. In 20147, thanks to the CONAI system, in which the food Industry plays an active role, the amount of packaging waste recuperated overall totalled 77.7% of those placed on the market (9.2 m/ton, namely +547,000 ton compared with 2012). The amount of packaging sent for recycling totalled 65.9% of those placed on the market (+246,000 ton compared with 2012), 7.8 m/ton of packaging waste was put back into the production cycle (+3% compared with 2012), whilst the packaging recycled and recuperated avoided the consumption of 3.3 thousand/ton of raw materials (+10% compared with 2013), making it possible to achieve energy savings totalling around 18 TWh and saving emissions of over 3.5 m/ton equivalent of CO₂.

- **The nutritional characteristics of food products have been improved.** On 28 October 2015, Federalimentare and a number of member Associations signed a document with the Ministry of Health entitled “Joint objectives for improving the nutritional characteristics of food products, focusing particular attention on the child population(3-12 years)”. If work to inform and communicate with consumers is not to be in vain, it must be combined with genuine market innovation to guarantee new solutions that suit the different lifestyles and targets. The nutritional characteristics of food products can be improved by altering their composition, within limits posed by technology and which are also accepted by consumers, whilst endeavouring to maintain the organoleptic characteristics (flavour, consistency and shelf life of the product). This document summarises the current situation, outlining the measures implemented to date (around 4,200 new or reformulated and 3,600 re-portioned products) and highlights potential opportunities and priorities for future measures.8

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5 Source: FoodDrinkEurope
6 Source: CONAI
7 Source: CONAI “Contents and Containers”- Sustainability Report – Update 2014
8 Source: Federalimentare, 2015
THE FOOD INDUSTRY'S COMMITMENT TO RESEARCH AND INNOVATION

The Italian food industry is the result of all-Italian know-how: a consolidated tradition handed down from one generation to the next, with deep local roots and close ties with local cultures. The know-how starts with suitable selection of the best available raw materials obtained in Italy and the rest of the world, and takes the form of recipes and production processes which are inimitable, based on time-honoured gastronomic traditions. The result sees products of outstanding quality which know no rivals anywhere in the world. One of the elements which bears witness to the close ties between the food industry, the local territory and national culture is the well-established and widespread presence of protected designation products (with PDO, PGI, STG, CDO, CGDO and TGI status, which today number over 760 units). Yet it is also an industry which invests 8% of turnover in research and development (1.8% in formal and informal R&D on innovative products and processes, over 4% in new systems, automation, ICT and logistics, and around 2% in analysing quality control and safety), combining the knowledge, traditions and local characteristics of the Italian dietary model whilst continuing to innovate processes and products. All factors that have made Italy's outstanding food products accessible to over 1.2 billion consumers worldwide, which each year purchase a product or beverage which is Made in Italy.

None of the progress made by the food industry would have been possible without the sizeable investments made in Research, Development and Innovation. Thanks to these ongoing investments, the food industry is constantly placing new products on the market which meet the new needs of consumers, including products with functional characteristics which are in keeping with a health and proper diet. Thirty years ago, 85% of the value of Italy's food products was made up of "traditional and classic products", whilst the remaining 15% was divided between "traditional and evolved products" (e.g., frozen foods, ready sauces, fresh condiments and ready-prepared vegetables) and "new products" (foods with a high health-giving and service content). Today, around one quarter (25%) of agrifood turnover comprises products for which innovation, both incremental and otherwise, is essential and has higher added value. It is a range viewed as traditional yet evolved, and includes ready sauces, flavoured oils, fresh condiments, frozen foods etc., as well as fully-fledged new products, namely foods with a high health-giving and service content. Taking into account trends in food consumption models, this section of more "evolved" products is destined to increase in weighting compared with so-called traditional food products (pasta, preserves, cheeses, wine and oil), which currently make up around two-thirds of the sector's total turnover (65%), whilst the remaining 10% is represented by designation of origin products and, to a far lesser extent, by organic produce. Accordingly, whilst the domestic market continues to show that research and innovation create leverage for progress, the international market tells us that without the ability to innovate, the risk of being pushed out of the market is increasingly tangible, above all for our commodities.

<table>
<thead>
<tr>
<th>PRODUCT FAMILY</th>
<th>Bn €</th>
<th>Incidence %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Classic</td>
<td>85.1</td>
<td>64.5</td>
</tr>
<tr>
<td>Traditional Evolved</td>
<td>22.9</td>
<td>17.3</td>
</tr>
<tr>
<td>Protected designations</td>
<td>9.2</td>
<td>7.0</td>
</tr>
<tr>
<td>PDO/PGI</td>
<td>3.9</td>
<td>2.9</td>
</tr>
<tr>
<td>New Products</td>
<td>10.4</td>
<td>7.9</td>
</tr>
<tr>
<td>Organic</td>
<td>0.5</td>
<td>0.4</td>
</tr>
</tbody>
</table>

* Source: Federalimentare Studies Office
Figure 5 – 25% of the food industry's turnover is made up of products for which for which innovation, both incremental and otherwise, is an essential factor (Source: Federalimentare Studies Office Estimates based on 2010 figures)

Around half the businesses in the food sector\(^\text{10}\) undertake innovation measures and have a propensity to innovate, with a financial commitment only slightly lower than the averages recorded in the manufacturing industry as a whole: in the three years from 2006 to 2008, innovations were introduced by 51.2% of food businesses, versus 54.4% of the manufacturing average.

**Diffusion and extent of innovation\(^\text{11}\)**

<table>
<thead>
<tr>
<th>Economic activity</th>
<th>Total businesses</th>
<th>Total</th>
<th>Of which with technological innovations (product or process)</th>
<th>Of which with non-technological innovations (organisational or marketing)</th>
<th>Expenses sustained for innovation in 2008 per employee (in thousands of Euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food industry</td>
<td>6,699</td>
<td>51.2</td>
<td>35.1</td>
<td>42.5</td>
<td>7,125</td>
</tr>
<tr>
<td>Total manufacturing</td>
<td>85,694</td>
<td>54.4</td>
<td>41.5</td>
<td>41.6</td>
<td>8,029</td>
</tr>
</tbody>
</table>

More than one third of businesses (35.1%) has introduced at least one product or process innovation, and 42.5% introduced non-technological forms of innovation (organisational or marketing). The investments the food industry made in technological innovation in 2008 totalled around 1 billion Euro, accounting on average for over 7,000 Euro per employee, versus the 8,000 Euro recorded in the manufacturing sector as a whole.

Over 40% of food businesses has combined innovation in design (or packaging) of its products with at least one technological innovation. Over one quarter has carried out work combining technological innovation (new products integrated with new production processes) and innovation in design.

Clearly, over one half of innovative businesses has opted chiefly for joint product-process innovation. Not least because consumer preferences are rapidly evolving, and call for a flexible and competitive food sector. Trends seen recently show that consumers are aware of food safety, the long-term effects foods have on health, of sustainable production, clear social responsibility and animal welfare, amongst other issues.

Additionally, in spite of the fact they have not developed new products, 36.1% of innovative businesses have opted to adopt more technologically advanced production systems, highly innovative machinery, technologies that guarantee greater productivity and high performance in terms of speed, precision and flexibility (the percentage for manufacturing as a whole is 25.7%).

As stated beforehand, food businesses have a greater tendency to make investments in product design and packaging: 61.1% of these has developed design innovations and adopted new packaging and packing solutions as a strategy to diversify and improve their product ranges (a percentage which drops to 43.6% with reference to the manufacturing sector as a whole).

The main model of innovation in the food sector is based on the ability to integrate and adapt the technologies incorporated into cutting-edge machinery to its own production processes: over 40% of businesses with technological

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\(^{10}\) Source: ISTAT (the Italian Statistical Institute), Survey on business innovation. 2006-2008

\(^{11}\) Source: Innovation and competitiveness of food industry businesses. Roberto Monducci - Director of the Department for domestic calculations and economic statistics– ISTAT
innovations only uses this channel for introducing innovation, and two-thirds of the overall amount spent on innovation comprises material investments in more cutting-edge machinery.

The innovation is mainly carried out within the company. Almost half the innovative food businesses view the contribution of external parties as non-decisive in managing innovation processes, although the propensity towards external parties is somewhat greater than in the rest of the manufacturing industry.

In particular, innovation processes still see relatively little cooperation with the scientific community: just 12.7% of innovative businesses have worked with Universities and public research Institutions, through cooperation or informal agreements. Use of private consultants is equally limited.

The Cluster accordingly provides an outstanding opportunity for activating a stable channel for cooperation research and innovation between food businesses and external entities, meeting the sector's technology transfer requirements.

Informal relationships, on the other hand, are more common, particularly those which arise throughout the supply chain: amongst food businesses, around one quarter of the innovative businesses views relations with suppliers and clients as decisive (this figure drops to 20.9% in manufacturing as a whole).

A few figures: 40.1% of businesses have applied innovative measures to reduce pollution, with 38.1% of investments geared towards reusing process waste, recycling water and improving the way refuse is handled, whilst over one quarter of innovative businesses have adopted innovative practices for improving energy efficiency and industrial CO₂ emissions during the production and use of the goods.

Of the various areas of food sector innovation, a sizeable part is guided by the main consumption tendencies: natural and fresh products, the texture and organoleptic content, the recipe used and its many re-formulations, portions and presentation with the incorporated service, the nutritional and health values, practicality, occasion and place of consumption.

Nonetheless, the sector is penalised by certain structural gaps that restrain growth and the ability of food professionals to compete. The main factor inhibiting development of Agriculture and the Food Industry is the excessive fragmentation of the production structure. Added to this are the shortfalls affecting infrastructure, logistics and distributions, excessive production costs (starting with energy), the low quality of services offered to businesses, finance and credit. Boosting the transfer of process and product innovations would help improve the competitive positioning of our food Industry, particularly SMEs. It would make it possible to recover efficiency and margins whilst ensuring our products are distinctive, not least given international demand and changes in scenarios, in the delicate transition phase which has followed the major system-wide recession.

Research and innovation alone are not enough unless they are combined with a regulatory framework which helps businesses to develop. Harmonisation with constantly evolving EU regulations and the uniform application of rules throughout the area as a whole are vital for ensuring efficient industrial policies are developed. Safety, rationalisation of controls and lessening bureaucracy are the main areas to be considered. Yet sustainability of food products and the need for common European rules on conditions for procuring commodities on international markets which are crucial for developing high-quality supply chains of Italian-made goods must also be considered.
2. THE ROADMAP OF THE CL.A.N. CLUSTER

THE METHOD

The National Technological Clusters (NTCs) have been promoted with the aim of setting up permanent platforms for dialogue between the public research system and businesses which are in keeping with the Horizon 2020 priorities. Today, they represent an important intermediate infrastructure responsible for promoting public/private cooperation on innovation and technological development, reconstructing national policies in fields of strategic interest, and promoting the intelligent specialisation of given territories. The first phase of the policy applied by the NTCs led to eight Clusters being set up, which embarked on their own activities. The second phase involves the Clusters adapting their governance to the needs for openness and inclusion intrinsic in the intermediate platform objectives assigned to them, and which generate shared technological development Roadmaps (opportunities/technological perspectives for Italian industry).

In order to meet the guidelines issued by Ministries, the Scientific and Technical Committee of the Agrifood Cluster has identified six Technological Pillars around which the Roadmap for Research and Innovation of the CL.A.N. Cluster need to be structured. The Strategic Development Plan of the Cluster, the S3 of the Regions involved and the Strategic Research and Innovation Agenda - SRIA of the European Technological Platform “Food for Life” have constituted important reference points in this respect. The six Pillars have been shared and validated by the members of the Coordination and Management Body the Cluster and sent to the Assembly which approved them, along with the proposed method. Subsequently, six work groups led by a scientific Leader (member of the Technical Scientific Committee) and an industrial Co-leader were formed. These coordinated work to finalise the Technological Pillars into Core-Themes, each in turn divided into challenges, aims and expected outcomes, or into research and innovation priorities needing to be addressed in the coming years. The work done by the groups is inspired by principles of inclusion and expertise. Six links were opened for group enrolments, encouraging businesses to take an active part. The numerous expertise within the Cluster were also mapped.

Below is a table summing up the six Technological Pillars identified, indicating the Leaders / Co-leaders who oversaw the works of the six groups formed to develop the document:

<table>
<thead>
<tr>
<th>Pillar</th>
<th>Scientific Leader</th>
<th>Industrial Co-leader</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. HEALTH AND WELLBEING</td>
<td>PATRIZIA BRIGIDI (University of Bologna)</td>
<td>VITTORIO ZAMBRINI (Granarolo)</td>
</tr>
<tr>
<td>2. FOOD SAFETY</td>
<td>GIOVANNA ZAPPA (ENEA)</td>
<td>MICHELE SUMAN (Barilla G. e R. Fratelli)</td>
</tr>
<tr>
<td>3. PRODUCTION PROCESSES FOR IMPROVED FOOD QUALITY</td>
<td>EMANUELE MARCONI (University of Molise)</td>
<td>MAURO FONTANA (Soremartec Italia)</td>
</tr>
<tr>
<td>4. SUSTAINABLE AND COMPETITIVE FOOD PRODUCTION</td>
<td>GIOVANNI SORLINI (Inalca)</td>
<td>LUCA RUINI (Barilla G. e R. Fratelli)</td>
</tr>
<tr>
<td>5. MACHINES AND PLANTS FOR THE FOOD INDUSTRY</td>
<td>GIANLUCA CARENZO (Padano Technological Park)</td>
<td>ANNALISA MALFATTO (Sidel)</td>
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<td>6. ICT IN THE AGRIFOOD INDUSTRY AND INSTRUMENTS FOR TECHNOLOGY TRANSFER</td>
<td>ANTONIO PEPE (DA.Re. Puglia)</td>
<td>PAOLO CASACCI (BioResult)</td>
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Dividing up the six Pillars made it possible to hold wide-ranging, well-attended in-depth scientific debate which not only resulted in the main research and technological development needs being identified within each Pillar, but also made it possible to tackle a variety of issues from the different standpoints. This opened the way up to shared planning for tackling the sizeable challenges using a global and synergic approach. For example:

- the topic of traceability/authenticity/integrity in the supply chain is tackled by Pillars 2, 3, 5 and 6 from the viewpoint of product safety. It adopts a “field-to-table” approach and risk control and management (PILLAR2); valorisation of product quality and process management (PILLAR3); developing nanosensors for traceability (PILLAR5) and developing cooperative platforms for a systemic supply chain approach (PILLAR6).

- the topic of communication is tackled in all the Pillars for the different points of view (health, safety, quality, sustainability and innovation), and in particular Pillars 1-5 identify the various contents of communication. Pillar 6 places the emphasis on tools used for integrated communication and for developing computer applications that support the decisions of consumers.

- The subject of packaging is also tackled in a number of Pillars (PILLAR2, PILLAR3, PILLAR4), respectively from the standpoint of safety (improving safety with active packaging but also assessing the safety of products in connection with the use of nanotechnologies for packaging), the greater saleability of products (extension of shelf-life; conservation of the organoleptic properties; possibility of reaching new markets) and the sustainability of productions (reduction of refuse and food waste).
PILLAR 1

HEALTH AND WELLBEING THROUGHOUT THE ENTIRE LIFE CYCLE

In industrialised countries, an increasing number of people have health problems owing to what is normally referred to as “lifestyle”. These chiefly include diet, physical activity and various elements of emotional and mental stress.

Our “lifestyle” has undergone considerable change in a relatively brief timeframe. In fact social and economic change over the last decade caused by globalisation has had a sizeable impact on the way society is organised and functions, leading to pervasive and consistent changes in our eating habits and behaviour (e.g. eating out, need for personalised diets that take tastes and preferences of consumers into account, e-commerce). It is in fact estimated that EU citizens consume around 500 calories a day more than 40 years ago, and that they spend 5 hours a day sitting down.

In the meantime, there has been a fully-fledged demographic revolution which has led to a large increase in life expectation, which in the last fifty years has extended by over ten years amongst the EU population.

The flip side of these landmark phenomena is the unprecedented change in epidemiology: a dramatic fall in acute and infective illnesses has at the same time coincided with a dramatic increase in chronic diseases. In particular these include diet related diseases (DRD) such as obesity, metabolic syndrome, type 2 diabetes (T2D), cardiovascular disease (CVD), hypertension and some types of cancer. In many cases these illnesses are also linked to ageing, and are accompanied by a number of comorbidities.

At present DRDs, as well as varying individual responses to elements of the diet and the “lifestyle”, are amongst the greatest problems facing the Public Health system, and their prevention and treatment is one of the biggest goals on which research is being focused.

DRDs are chronic, non-transmittable diseases and involve complex processes with a variety of factors. There is a close relationship between them (e.g. obesity can lead to insulin resistance and T2D) and they can occur at any stage of life, although they are linked to advancing age. To tackle their complexity, it is accordingly necessary to adopt multi-disciplinary strategies that combine advanced technologies (metabolomics, metagenomics, metaproteomics, epigenetics) involving different parameters (metabolic – functional, metabolic-inflammatory, analytic and productive) to improve our knowledge of the main biological mechanisms responsible for DRDs (metabolic flexibility and resilience of the biological systems) and how given food products or traditional and typical products enriched with specific health-giving or bioactive molecules can have an impact on these mechanisms in specific groups of the population (nutrigenetics and nutrigenomics).

As a result it is necessary to give consumers the motivation, capacity and opportunity to find healthy foods on the market which provide clear benefits in preventing/delaying the onset of DRDs. This change in dietary habits would also make for a drop in the cost of medical care. In addition, it is necessary to increase consumer trust in the food industry, and increase their willingness to pay more for food products that offer clear benefits to health. A further segmentation of the market in response to constant growth in “niches” can also be seen as encouraging. These include the elderly, vegans, malnourished individuals, athletes or sub-groups of the population with specific nutritional needs (individuals sensitive to allergens, intolerances, celiacs, etc.).

In the complex scenario described above, it is also necessary to take into account the sizeable increase in the population, and the drop in availability of certain natural resources, the loss of biodiversity and growing attention amongst consumers to transparency in food production and the impact which diet has on health.

The food sector is an important part of the Italian economy, thanks above all to the variety and quality of products in the Mediterranean diet and typical regional products, such as PDO and PGI produce. The Mediterranean diet not only
represents regional traditions of unquestionable value; it is also recognised worldwide as a healthy dietary model which is properly balanced and ideal for maintaining good health and preventing the onset of diseases linked to diet. Owing to these characteristics, UNESCO has recognised the Mediterranean diet as an intangible cultural heritage of mankind.

At the same time, it should be noted that in Italy, the market of functional foods is less developed than in other countries. As a result, Italian businesses are barely represented in the advanced ingredient segment. As a result, in order to tackle the challenges of an increasingly global market, Italian businesses must valorise their products without sacrificing quality and the typical nature of the products. They must innovate in terms of the value and quality of local traditional foods in order to meet the changing needs and lifestyles of consumers.

All of which must, however, ensure they do not lose sight of the new approach to innovation, which has to transform from the classic "everything is homemade" approach to a new and open model of multi-partnerships. The food industry is in fact one of the last not to have adopted this model which, in a new "Open Innovation", approach, will makes it possible to gain faster and more effective progress on projects, pursuing clear objectives on pre-competitive development programmes whilst involving small and medium enterprises as much as possible.

To follow are the Core - Themes identified:

1.1 Dietary strategies for preventing diet-related diseases [development of new functional foods, formulations and diets for reducing the incidence of DRDs such as cardiovascular diseases, obesity and metabolic syndrome, as well as improving gastro-intestinal health by studying the way foods, gut flora and intestinal physiology/functions interact to prevent IBD (Inflammatory Bowel Disease), IBS (Irritable Bowel Syndrome), food intolerances, celiac disease and obesity].

1.2 Foods calibrated to meet the nutritional needs of specific groups of the population (proxy-personalized) [new personalised food products and nutritional strategies designed to meet specific needs of target groups such as children, pregnant women, the elderly, allergen-sensitive and intolerant individuals etc.].

1.3 The Mediterranean diet: products linked to regional traditions [returning to regional Italian products which feature in the Mediterranean diet and highlighting their nutritional characteristics; health promoting profiles of products linked to regional traditions. Identification of new products linked to different consumption opportunities, outside of the home, workplace, formal and informal situations, institutions, services, etc., which ensure balanced diets].

1.4 Ingredients and bioactive elements for developing health-giving foods [recuperation of high value fractions and/or bio-based molecules (polyphenols, PUFA, etc.) from different value-chains (plant, animal, marine, insects, etc.) and from by-products of the food industry; development of next generation probiotics; development of microbe strains for producing new fermented foods with an improved health-promoting profile; identification of newly conceived prebiotics, no longer single molecules but sets of different compounds to be used on a daily rotation basis, and which can provide the necessary diversity and flexibility to the gut’s ecosystem and the related metabolic homeostasis; etc.].

1.5 Promoting informed health and sustainability – oriented eating habits [Development of new tools and technologies that facilitate interaction between industries, specific stakeholders (including the catering and food service sector), consumers and policy makers, for promoting and enhancing both immediate and long-term benefits of new dietary strategies and lifestyles which can be adopted by the population at large].
### Challenge:

It has been proven beyond all doubt that a proper diet combined with an active lifestyle is vital for preventing chronic non-transmittable diseases (diet related diseases, DRDs) which are constantly on the rise in industrialised countries, including diseases such as obesity, metabolic syndrome, T2D and cardiovascular diseases. As a result, there is considerable interest in developing new healthy foods and understanding how their specific ingredients/components can help prevent the onset of DRDs.

If we also consider the increase in the average age of the population in industrialised nations, there is an urgent need to prevent these diseases to ensure quality of life for citizens and reduce costs for the National Health System.

### Specific topics:

- **Validation of a revised version of the Traditional Mediterranean Diet** which is rich in mono- (extra virgin olive oil) or polyunsaturated fats, fibre-rich foods (fruit, vegetables, whole grains and pulses) or with a low glycemic index (pasta, parboiled rice, milk, dairy produce), to replace foods rich in refined carbohydrates, in order to prevent diet-related diseases whilst reducing infiltration of fat in the liver triggered by a sedentary lifestyle, being overweight or imported unhealthy eating habits.

- **Analysis of mechanisms, biomarkers and risk factors specifically linked to DRDs to validate the effectiveness of nutritional measures in preventing these disorders.**

- **Production of new bioactive sugars and sweeteners through processes with a high environmental and energy sustainability, assessing their metabolic effects, including the impact on gut flora, in order to examine presumed effects and/or interactions which can have a direct or indirect link with the onset/prevention of obesity and DRDs.**

- **Analysing and evaluating aspects linked to sensory "gratification" in defining appropriate and consistent dietary strategies.**

- **Dietary education measures aimed at specific categories of consumers to prevent the onset of DRD, also taking into account the increasing presence of ethnic minorities.**

### The Core - Theme closely adheres to the following strategic documents:

- Strategies S3 of the Umbria and Emilia Romagna Regions [promoting human health, preventing diseases and improving the physical and psychological wellbeing of the population];
- Topics proposed by the JPI HDHL (ENPADASI, FoodBall);
- Strategic Agenda for Research and Innovation of the European Technological platform “Food for Life”;
- Horizon 2020 Agenda ;
- Implementation of Agrifood Cluster activities (PROS.IT project).

### Objectives:

- **Reduction of calorie density in foods to lower the glycemic index and negative metabolic effects by using natural ingredients which are also derived from the transformation of co-products/by-products of food processing.**

- **Assessment of the effects of a revised version of the Traditional Mediterranean Diet versus a “Western diet” on the accumulation of liver fat in people who are overweight.**

- **Identification of possible mechanisms linking lifestyle and fatty liver to other metabolic abnormalities (hyperglycaemia, abnormal insulin sensitivity, dyslipidemia), including the role of the gut’s flora.**

- **Promotion of proper education for the population on foods and on consulting product labels as a means of helping consumers shop with greater awareness**

- **Development of innovative extraction processes, concentration and purification with high environmental sustainability to obtain new sweeteners to replace those currently on the market Pursuing this objective includes**
a phase of transferring technology to Italian agricultural businesses to supply knowledge and expertise which enables them to industrialise these innovative processes, overcoming the present bottleneck posed by a production system that makes it obligatory to stockpile dried goods which have been collected without being used, or selling them on to European markets (e.g. Germany) at costs so low they do not provide a suitable return on investments.

- Development of measures based on a proper diet and suitable physical activity on sub-groups of the population at risk of DRDs, including individuals from ethnic minorities.

**Expected impacts:**

The research and development activities of this Core-Theme will make it possible to:

- Develop processes and products with a reduced glycemic load and/or metabolic impact, including foods enriched with dietary fibre and ingredients of a functional nature and of nutraceutical interest, as well as homeostatic factors that regulate the gut and inflammation;
- Improve knowledge of the nutritional characteristics of the diet to counteract the harmful metabolic effects of excess weight (links between habitual diet, fatty liver and metabolic alterations that can trigger T2D and cardiovascular diseases);
- Identify any health-promoting properties of the Mediterranean Diet which have not been suitably demonstrated in order to further promote the image of a dietary style firmly rooted in Italy, as the prototype of the healthy diet;
- Characterise healthy Mediterranean ingredients to be proposed to the Industry, with a view to offering a new take on the Traditional Mediterranean Diet;
- Increase the availability of high nutraceutical quality foods that meet food health and safety criteria;
- Increasing the relationship of trust between doctors and patients as far as diet is concerned as well;
- Analyse the relationship between diet-lifestyle-diseases, linking it to the genetic and epigenetic pattern of the individual;
- Create the production foundations for formulating novel food which include natural low-calorie sweeteners as ingredients obtained from green processes, and do not involve the use of organic solvents and/or other chemicals as is currently the case, in keeping with a traceable supply chain which makes it possible to valorise the end product for international markets (e.g. China) which are not always capable of satisfying these aspects.

**Type of activity:**

- Industrial research projects with experimental development on a laboratory and pilot scale, with an end to subsequent transfer of technologies and expertise to the production sector.
- Research based on mid-term measures.

**Reference documents:**

- S3 Emilia Romagna and Umbria Regions.
- JPI HDHL Implementation Plan.
- Agenda Horizon 2020.
- Strategic Agenda for Research and innovation for the European Technological Platform “Food for Life”.
CORE - THEME 1.2 - FOODS CALIBRATED TO MEET THE NUTRITIONAL NEEDS OF SPECIFIC GROUPS OF THE POPULATION

Challenge:
Recent years have seen an ever-increasing need to develop new food categories aimed at groups of the population with particular nutritional needs (consumers with food intolerances, consumers affected by hypercholesterolemia, women facing menopause, infants, athletes etc.). Accordingly research is being encouraged to develop foods that maintain high sensorial characteristics (pleasing taste), whilst having a specific nutritional profile for the diet of consumers with particular dietary limitations, or specific food requirements and/or intolerances.

In this perspective, considerable attention needs to be given to processes involving fermentation and enzymatic/microbe biotransformation. These are simple and effective processes for improving the nutritional profiles of proteins and glucides in foods to be aimed at particular sections of the population (e.g. those with a gluten sensitivity, diabetics, the elderly, those with kidney disorders, etc.).

Specific needs for satisfying nutritional needs:
- Development of new nutraceutics with health-promoting effects provided by plant matrices.
- Identification of hypo-allergenic fruit varieties.
- Use of microbial/enzymatic biotechnologies for developing fermented foods with nutritionally balanced protein and carbohydrate profiles (improving protein digestibility and nutritional values, reducing gluten concentration and proteins responsible for causing allergies; hydrolization of FODMAPs to reduce the glycemic index and load ) and low salt content.
- Development of new gluten-free products.
- Selection of bio-fortified vegetables for preventing deficiency-related diseases (e.g. osteoporosis).
- Development of nutritionally dense food products which are easy to digest, to meet the nutritional needs of certain sections of the population (e.g. the elderly, athletes etc.).

The Core - Theme closely adheres to the following strategic documents:
- COST Action EU “ImpARAS” (Improving Allergy Risk Assessment Strategy for new food proteins; FA1402).

Objectives:
- Developing food products for reducing immunophenotype and symptomatological effects (intestinal and extra-intestinal) which are linked to gluten intolerance and sensitivity.
- Assessing the effectiveness of leafy vegetables which are bio-fortified with silicon, iodine etc. on certain deficiency-related conditions (underactive thyroid, osteoporosis, etc.).
- Developing foods enhanced with nutraceutical compounds (polyphenols, carotenes, fibre, phytoestrogens, polyunsaturated fatty acids) or which are capable of acting as complexing agents for nickel and/or other heavy metals contained in food matrices (reduction of intolerances and toxicity).
- Characterising the functional proteins in non-cow’s milk.
- Developing nutraceutical products with a high microRNA content, contained in EVO and other food matrices, with health-promoting effects on different diseases.
- Assessing, using molecular, biochemical, immunological and clinical approaches, the allergenic potential of different varieties of fruits, or those subjected to different conditions before and after harvesting, as well as that of different plant-origin allergenic foods, to introduce plant-products on the market with appropriate brands and information which is useful for the consumers concerned.
- Valorising plant and animal-based products and by-products (in particular milk whey ) with fermentation and co-
fermentation to obtain balanced foods for the section of consumers interested in this product category.

- Producing gluten-free food ranges.
- Characterise the finished products from the chemical, nutritional, sensorial, health-giving and nutrigenomic standpoint in order to validate their health-giving characteristics and obtain the health claim from EFSA.

**Expected outcomes:**

The research and development activities of this Core - Theme will make it possible to:

- reduce the immune effects of gluten by transforming this protein matrix during the milling phase, whilst maintaining the functional characteristics which are responsible for the rheological properties;
- develop new formulations of products for celiacs and those with intolerances, using wheat varieties which are less toxic and easier to digest than soft wheat;
- perform bio-accessibility and bio-availability studies on the microelements which are consumed with bio-fortified leafy vegetables, and assess their functional effect on specific consumer targets;
- develop new foods enriched with phenol compounds for patients with chronic inflammations, cardiovascular diseases, diabetes, neurological diseases and other illnesses affecting the elderly;
- develop food formulations enriched with bioactive proteins and peptides from types of milk not obtained from cows;
- develop new nutraceutical products containing microRNAs which can modulate gene expression to improve health and promote longevity;
- develop plant-origin foods with a high nutritional value and low allergenic potential;
- identify bio-fortified vegetables for deficiency diseases as an alternative to supplements.

**Type of activities:**

- Industrial research project on a laboratory scale.
- Research project for development and subsequent technological transfer of new foods with functional characteristics.
- Project for research and demonstration, and pilot project.

**Reference documents:**

- COST Action EU “ImpARAS” (Improving Allergy Risk Assessment Strategy for new food proteins; FA1402).

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**CORE - THEME 1.3 - THE MEDITERRANEAN DIET: PRODUCTS LINKED TO REGIONAL TRADITIONS**

**Challenge:**

The state of health, longer life expectancy and the lower number of diseases in the Western world are all linked to the quality of the diet and food characteristics. The “Mediterranean Diet” is considered an extremely healthy food model.

The raw materials and foods produced in the Mediterranean area include compounds with anti-oxidant properties contained in concentrations not found in the same plant species grown elsewhere in the world. Anti-oxidants are important because they are directly responsible for preventing diet-related diseases, inflammations and above all preventing or slowing down the cell ageing process.

The Mediterranean diet is closely linked to sustainability and its produce is seasonal and local in nature. Seasonal foods have a better flavour because they have time to develop their aromas, to mature and to develop a given amount of vitamins and minerals which are undoubtedly reduced in a globalised cultivation distributed throughout the course of the whole year. In addition, eating produce outside of its maturation period also has a greater environmental impact owing to the resources used to cultivate them in greenhouses or for transportation, often from different parts of the world. In addition, eating produce outside of its maturation period also has a greater
environmental impact owing to the resources used to cultivate them in greenhouses or for transportation, often from different parts of the world.

The Mediterranean diet does not just consist of giving priority to certain food groups over others. Instead it focuses on how foods are picked, prepared and eaten. This is also reflected in the philosophy whereby companies produce clearly distinguished foods, in keeping with cultural interpretations linked to the local area and the social fabric.

**Specific topics:**
- Analysis of oil, focusing particularly on the mechanisms, biomarkers and interventions in insulin-resistance linked to non-alcoholic fatty liver disease (or NAFLD).
- Identification of new bioactive molecules contained in the Mediterranean diet.
- Effectiveness of the Mediterranean diet in preventing the risk of many non-transmittable modern diseases, such as cardiovascular diseases, cancer, obesity and metabolic syndrome.
- Impact on the composition/functionality of gut flora and the resulting effects on the gut-brain axis and on immunomodulation.
- Relationship between longevity and eating habits linked to the Mediterranean diet.

The Core - Theme closely adheres to the following strategic documents:
- JPI HDHL;
- Strategic Agenda for Research and innovation for the European Technological Platform “Food for Life”;
- Implementation of Agrifood Cluster activities (with the PRO.SIT project).

**Objectives:**
- Characterising and quantifying the different active substances contained in local products, in order to define a healthy nutritional profile, placing particular emphasis on the substances which have an anti-oxidant and anti-inflammatory effect as well as a synergic effect.
- Valorising the biodiversity of food products, creating an inventory using spectroscopic profiling techniques on the bioactive molecules contained in food products which form the basis of the Mediterranean diet. In particular, this should involve content in terms of the agronomic and farming techniques used, as well as the food transformation, conservation and gastronomic preparation technologies adopted.
- Analysing the health-giving properties of olive oil.
- Fodder and primary production (fat composition of meat and milk-dairy products which are optimal for consumers).
- Producing new foods based on the Mediterranean diet which are formulated or fortified with health-giving bioactive molecules (foods enhanced with polyphenols, anti-oxidants, resistant starches, polyunsaturated fatty acids etc.).
- Constructing a bio-bank of phenotype diversity to develop scientific nutritional research.
- Analysing the social, cultural and economic reasons which prompt younger generations in particular to abandon traditional eating habits and adopt imbalanced diets.

**Expected outcomes:**
Research and development activities conducted in this Core - Theme will make it possible to:
- valorise the products of the Mediterranean diet from the nutritional/health standpoint (reduced risk of onset of non-transmittable diseases);
- promote the Mediterranean diet model as a sustainable diet model (environment, health, traditions and culture);
- develop raw materials and food ingredients based on lipids (edible oils, vegetable and animal fats, micronutrients and liposoluble vitamins to be used as functional and/or nutraceutic agents) for preventing diseases for which saturated fat intake poses a risk factor (obesity and metabolic syndrome, fatty liver and non-alcoholic steatohepatitis, atherosclerosis, tumour forms such as colorectal, prostate and breast cancer, age-dependent neurodegenerative states etc.);
- develop innovative products using extra virgin olive oil, wheatgerm oil and oils from other plant species for their...
bioactive components;
• develop animal-origin products (meat and milk) with optimal fat composition (by selecting fodders and enhancing them with functional lipid principles);
• produce a multi-factor analytical overview of the reasons and values which underpin the anthropological change involved in people casting aside the Mediterranean diet to develop effective strategies for promoting a healthy and sustainable approach to food.

**Type of activity:**

- Research project.
- Industrial research project with experimental development activities on a laboratory and pilot scale.
- Industrial research project.

**Reference documents:**

- JPI HDHL Implementation Plan.
- Strategic Agenda for Research and innovation for the European Technological Platform “Food for Life”.

**CORE - THEME 1.4 - INGREDIENTS AND BIOACTIVE ELEMENTS FOR DEVELOPING HEALTH-GIVING FOODS**

**Challenge:**

Recent years have seen a considerable increase in consumer awareness of the close relationship between diet and health. As a result, health-related aspects of products have become one of the most important criteria influencing buying habits, as is the case with nutritionally and functionally improved foods. Scientific research in the agrifood sector has identified a wide variety of bioactive (nutraceutical) compounds of different origins, which have been recognised as playing a role in preventing a number of diseases (atherosclerosis, cardiovascular, neurodegenerative and chronic intestinal diseases) thanks to proven functional anti-oxidant, anti-inflammatory and anti-tumour effects.

Polyphenols, by way of example, constitute a type of bioactive substance which is contained in a large number of foods (wine, dried fruit and nuts, extra virgin olive oil) which reduce the risk of diseases such as T2D and heart attacks. Nonetheless, to achieve this effect it is not possible to aim merely to increase consumption of foods which are naturally rich in polyphenols (the food intake necessary would be excessive). An approach which involves selling products with industrial polyphenol enhancement alongside natural foods would instead seem more promising.

Another crucial family of anti-oxidants is that of anthocyanins, a type of water-soluble pigments which belong to the family of flavonoids contained in vegetables. The protective effects of anthocyanins against the onset of cardiovascular diseases have been widely proven on a scientific level (“French paradox”).

Accordingly, the isolation of new functional molecules with a powerful anti-oxidant effect and low cost, such as food industry by-products, might provide a useful source of active ingredients for producing food supplements.

Consumers are displaying increased interest in probiotics and their role on wellbeing of the intestine, amongst others. The evolution in the market can also be attributed to the profiling of certain specific molecular mechanisms involved in the beneficial effects of probiotics although they are often merely considered suitable for treating certain imbalances of the gut’s microbiota, given the absence of any clinical proof of their effectiveness.

**Specific subjects:**

- Profiling, developing and validating bioactive molecules and nutraceutical compounds (anti-oxidant phytochemicals, prebiotics, dietary fibre, minerals, polyunsaturated fatty acids and carotenoids), recuperated from products, by-products and waste from industrial agricultural processes in an operational
A biorefinery model to be adopted for formulating nutraceutical foods. The main critical areas which need to be tackled concern the problems involved in obtaining STANDARDISED and CONFORMING products using economical processes (to date, the extracts obtained are usually unrefined and of varying composition).

- Development of food prototypes enriched with polyphenols which are palatable, easy for the consumer to use and with documented health properties in terms of energy balance and the metabolism of fats and carbohydrates validated in intervention studies.
- Production of recognised functional foods (e.g. with health-related and nutritional claims), which are TECHNOLOGICALLY SUITABLE (therefore easy to use in recipes), SAFE (and therefore validated regarding purity requirements) and above all ECONOMIC.
- Formulation of new foods with new properties and functions with an accessible cost and which are suitable for different types of consumer, to be introduced in the everyday diet adopting technological processes thanks to know-how in the health-promoting "ingredients" sector.
- Analysis of the interaction between healthy ingredients and the gut microbiota. The beneficial effect of these ingredients can be linked to the direct way they modulate the microbiota positively (prebiotics, polyphenols), or the bio-transformations carried out by the microbiota, improving the bio-availability or biological activity.
- Optimisation of pre- and post-harvesting conditions of plant products in order to improve their nutritional profile, particularly with regard to "health-promoting" compounds such as polyphenols and isoflavones.
- Development of vegetable cell cultures from artichokes, a species which features a high polyphenol and inulin content. This would provide a system which could be standardised and rendered economically viable for maximising the production of bioactive compounds with a high anti-oxidant and prebiotic capacity. The effectiveness and safety of these bioactive compounds in treating hepatobiliary imbalances and digestive diseases in animals and in man has been demonstrated, as has its ability to reduce blood cholesterol levels.
- Use of unconventional plant matrices (e.g. myrtle, pomegranate, echinacea and quinoa) and/or agrifood by-products (e.g. wheatgerm, grape must, pomace, bran and milk whey) for producing bioactive molecules (e.g. anti-oxidant peptides, anti-carcinogens, anti-microbial and anti-inflammatory, lunasin, γ-aminobutyric acid and polyphenols) and/or nutraceutical foods using microbial fermentation processes.
- Development of probiotic products containing microbe strains or their bioactive (post-biotic) metabolites whose biological properties and health-promoting effects have been proven.

The Core - Theme closely adheres to the following strategic documents:

- JPI HDHL Joint Action Intestinal Microbiomics (The short-term and long-term functional effects of diet, dietary patterns and dietary constituents on human intestinal microbiota; The functional impact of diet-related variations in the intestinal microbiota on human health and/or the development of non-communicable chronic disease);
- JPI-HDHL: Diet and food production: the development of specialized food products (food supplements; personalized nutrition);
- Strategic Agenda for Research and innovation for the European Technological Platform “Food for Life” (Key Thrust 1: Improving health, wellbeing and longevity; 1.A.1 Optimal development of nervous functions, wellbeing and ageing);
- KET: biotechnologies for agriculture and the quality of foods;
- Agenda Horizon 2020 (production of ingredients based on bioactive molecules for obtaining functional foods);
- PNR: specialisation areas 2 (Agrifood) and 10 (Health);
- Agrifood Cluster: Pros.it Project- Promoting consumer health by developing new functional foods and improving the nutritional profile of traditional Italian products; line 2: bioactive, probiotic and nutraceutical
compounds;
- S3 Sicily: priority 4a: safeguarding, restoring and improving biodiversity;
- S3 Umbria: taking part in the PROSIT project with a nutraceutical branch;
- S3 Tuscany: the Technological District of life sciences works in the nutraceutical field;
- S3 Emila-Romagna;
- Cluster Alisei: innovative therapeutic approaches which pay attention to wellbeing, applied to nutraceutical products and supplements;
- S3 Puglia: Cluster Regional Technological Biotech– Biotechnologies of foods for innovation and competitiveness of the main regional supply chains: functional aspects.

**Objectives:**

- Improving and standardising the recuperation, stability, bio-availability, functionality and usage of bioactive compounds (polyphenols, carotenoids, tocopherols, fatty acids etc.) with anti-oxidant, anti-inflammatory, immunomodulating and neuroprotective properties etc also obtained using green methods from plant matrices, marine biomasses or by-products/waste from agroindustrial production processes, in keeping with the very latest dictates of sustainability to formulate healthy foods and/or food supplements.
- Obtaining standardised and conforming products using economical processes.
- Enhancing pasta and bakery products using aleurone, an element of wheat bran which is rich in highly bio-available ferulic acid.
- Evaluation of new products with enhanced bio-availability of polyphenols, assessing their health-promoting effects, particularly those affecting energy balance, fat and carbohydrate metabolism, identifying the effect mechanisms including the effect they have on the gut's microbiota and on the microbe fermentation activity involved in the bio-transformation into bioactive components.
- Development of microbe biomasses (lactic bacteria, probiotic bacteria and yeasts) containing bioactive compounds and their validation, or that of their components, as nutraceutical ingredients: carotenoids, polyunsaturated fatty acids, glutathione, vitamins, minerals and prebiotic carbohydrates.
- Development of functional foods (e.g. of a hypotensive, anti-inflammatory and/or anti-oxidant effect, as well as anti-tumour and anti-diabetic effect, etc.) using probiotics and/or yeasts, functional molecules from food matrices and/or from microbe metabolism.
- Effect of production factors both before and after harvesting, on the accumulation of compounds of a high nutraceutical interest and on the overall nutritional profile of plant products.
- Development of in vitro systems for producing biomolecules of nutraceutical interest.
- Identifying molecules of a tumour-preventing effect (of plant and microbial origin) both from products and agricultural by-products, and assessing their effect.
- Developing recognised nutraceutical products with specific health and nutritional claims which are easy to use in recipes, validated in respect of purity and requirement regulations and, above all, economical.

**Expected outcomes:**

The research and development activities of this Core – Theme will make it possible to:

- develop innovative ingredients containing natural bioactive compounds from cultivated and/or spontaneous plant species and marine biomasses/plant cell cultures and by-products of the farming industry. These ingredients must be standardised, conforming and economical;
- develop systems (natural micro/nanocapsules) for stabilising the natural bioactive compounds in foods.
- facilitate uptake amongst members of the population and a diet rich in polyphenols and functional ingredients;
- produce foods enriched with probiotics and/or with functional molecules and those of health-promoting interest (polyphenols, bioactive peptides, folates, fatty acids, fibres, serum proteins, etc.) and/or foods obtained with microbial biotechnologies to improve nutritional and functional quality (reduce cholesterol content, salt etc.);
• validate the immuno-functional effect of probiotic strains (bacteria and yeasts) which are selected by developing *in vitro* cell tests for making functional foods with specific immunomodulating effects and/or which can reduce inflammatory processes in chronic intestinal inflammatory diseases;
• improve the competitiveness of farming businesses by promoting processes that can yield higher added value products;
• promote agronomic and biotechnological competitiveness by developing new products and maximising research results (e.g. patents, setting up new businesses);
• reduce the environmental impact due to the valorisation of agroindustrial waste by promoting a biorefinery model;
• create a technological supply chain for preparing food products which contain bioactive molecules with distinctive anti-tumour properties which are recuperated from agricultural by-products.

**Type of activity:**

• Research project for development and subsequent technological transfer.
• Project on industrial research, demonstration/pilot project.

**Reference documents:**

- JPI HDHL (Joint Action Intestinal Microbiomics; Diet and food production: the development of specialized food products).
- Strategic Agenda for Research and innovation for the European Technological Platform “Food for Life”.
- KET: biotechnologies for agriculture and food quality.
- Agenda Horizon 2020.
- PNR: areas of specialisation 2 (Agrifood) and 10 (Health).
- Agrifood Cluster: Pros.it Project
- S3 Regions of Puglia, Sicily, Umbria, Tuscany and Emilia-Romagna.
- Alisei Cluster: innovative therapeutic approaches with focus on wellbeing, analysed in relation to nutraceutical products and supplements.

**CORE – THEME 1.5 - PROMOTING INFORMED HEALTH AND SUSTAINABILITY-ORIENTED EATING HABITS**

**Challenge:**

When it comes to food, the information which consumers receive is increasingly superfluous and confusing, with the result that consumers are often unable to make well-informed dietary choices. As a result, more scientifically correct information is needed, but simple and immediate tools are also needed (smartphones) which not only allow the user to choose what is most appropriate, but also to organise their eating day in the best way possible. On average, one in three meals is eaten out in Italy. Accordingly the Food Service is an outstanding springboard for promoting healthy eating styles.

**Specific topics:**

- Develop a dietary model inspired by the Mediterranean diet which is economically sustainable, environmentally sustainable, easy to export and to adapt to a variety of public catering contexts (company canteens, schools, hotels, ships, quick service, fast food...).
- Promote proper scientific awareness-raising.
- Develop innovative methods and instruments for providing users clear and immediate nutritional values for
recipes and menus, and improve consumer awareness on the importance of a healthy and balanced diet (to be
developed in close cooperation with 2.6, 4.6 and 6.1 of the Roadmap).

- Develop new integration tools and ICT technologies which involve industries, stakeholders (including the
  Catering and Food Service sector) and consumers for promoting healthy and sustainable eating (to be developed
  in close cooperation with 2.6, 4.6 and 6.1 of the Roadmap).
- Produce multimedia materials which help provide knowledge and promote a healthy diet amongst the
  population at large, and increasingly large specific groups of the population.
- Raise awareness of juridical-regulatory-legal issues linked to making foods more functional to encourage
  companies to work in this field. Companies have displayed considerable interest in being able to modify labelling
  regulations (more than the claims), thereby facilitating communication with consumers.

The Core – Theme closely adheres to the following strategic documents:
- JPI HDHL;
- Strategic Agenda for Research and innovation for the European Technological Platform “Food for Life” (Chapter
  4).

Objectives:
- Assess current choices of the population.
- Educate people about choosing healthy foods inspired by the Mediterranean diet.
- Raise awareness about the impact the food we choose has on the environment.
- Develop technological solutions and tools to educate people, keep track of food choices and the state of health
  of people in relation to their diets.
- Develop products that make it possible to increase uptake of the dietary model.
- Verify changes in dietary habits, and any impact these have on health.
- Increase the distribution of Guidelines for a healthy diet.
- Map initiatives currently being adopted, divided according to those involved (producers, distributors, chefs,
  NGOs, public institutions and universities) and analyse scientific literature to identify the theory models which
  are best suited to promoting a change in behaviour.
- Map the main players involved and the sectors which have the greatest influence on dietary behaviour.
- Analyse strengths and weaknesses of initiatives currently being adopted to raise awareness about sustainable
  diets amongst the population.
- Identify the most effective practices and types of initiative for changing food consumption in the different
  sectors. The results of the research will be processed in order to produce a series of ten-point practical guides
  with proposals for measures that suit the various sectors.
- hold public consultations with the various stakeholders (civil society, industries and institutions) to identify the
  action priorities for guaranteeing access to safe and healthy food, and to promote sustainable eating habits.
- Set up an On-line Business Forum aimed at industries, for sharing best practices in terms of improving the
  nutritional characteristics of products and initiatives to promote sustainable eating habits.
- Hold dietary education campaigns organised by non-governmental institutions and organisations with the
  support of local businesses.
- Develop tools and software for calculating the nutritional values of the recipes and menus proposed in a fast and
  immediate manner.
- Define a joint strategy amongst the various stakeholders of the catering trade to offer nutritionally balanced
  menus.
- Organise training meetings and initiatives for raising awareness amongst catering professionals, to encourage
  them to adopt nutritionally balanced menus and dishes.
- Create suitable communication tools (e.g. printed leaflets, suitable tables and pages on the website of the
various catering businesses, posters, printed paper napkins) to allow consumers to check the nutritional values of the recipes proposed, see whether they contain any allergens or whether they are coherent with particular dietary models.

- Encourage viral communication of products, excellence and virtuous eating habits within the Mediterranean diet interpreted as a lifestyle and a chance for sustainable development and well-informed consumption. The communication objectives also include debunking myths propagated by increasingly widespread dietary fads, such as those that tend to exclude milk and its derivatives from the nutritional range of the Mediterranean diet.

**Expected outcomes:**

The research and development activities of this Core - Theme will make it possible to:

- develop menus and products which are sustainable and based around the Mediterranean diets;
- develop technological solutions to keep track of eating habits and educate people;
- develop partnerships between food companies, professionals in food services and technology sector businesses;
- develop a database of the bar codes of transformed products available on the market, for using in an App which, together with a database of non-transformed foods, allows the individual to evaluate his or her own diet;
- render consumers aware and capable of working on their own lifestyles, using instruments that are simple and easy to understand, such as viewing their dietary choices and linking them to a symbolic image indicating a nutritionally and environmentally suitable diet;
- train professionals in the food service sector on nutritional issues and the requirements for creating balanced dishes;
- render businesses more sensitive and proactive where the requests for civil companies and institutions are concerned, and more inclined to supporting initiatives that promote sustainable diets;
- increase cohesion between the different players in the supply chain (industries, stakeholders, civil society) and define common strategies and objectives to guarantee access to a healthy diet;
- render institutions and non-governmental organisations more aware of the priorities to be adopted for promoting sustainable attitudes, and make them more open to dialogue with the private sector;
- develop and disseminate a multimedia archive on the Italian food culture.

**Type of activity:**

- Pilot project to be applied to different organisations, in order to assess their effect and success on different targets of people (e.g. company canteen, university canteen, school canteen).
- Multimedia research project.
- Research into initiatives currently underway, and analysis of scientific literature.
- Networking activities.
- Public consultations and interviews with the various stakeholders involved.
- Research to identify suitable tools and software for each sector (catering, restaurants and the food service industry) to calculate nutritional values.
- Awareness-raising activities.
- Production of promotional and information materials to support communication activities.

**Reference documents:**

- JPI HDHL Joint Action Intestinal Microbiomics.
- Strategic Agenda for Research and innovation for the European Technological Platform “Food for Life”, chapter 4.
## PILLAR MATRIX 1 - S3 REGIONS TAKING PART IN THE CLUSTER CL.A.N.

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<th>Regions in the CLAN</th>
<th>Abruzzo</th>
<th>Emilia</th>
<th>Lombardy</th>
<th>Molise</th>
<th>Piedmont</th>
<th>Puglia</th>
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<tr>
<td>1.1 Dietary strategies for preventing diet-related diseases</td>
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<td>1.2 Foods calibrated to meet the nutritional needs of specific groups of the population</td>
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<td>1.3 The Mediterranean diet: products linked to regional traditions</td>
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<td>1.4 Ingredients and bioactive elements for developing health-giving foods</td>
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<td>1.5 Promoting informed health and sustainability oriented eating habits</td>
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PILLAR 2

FOOD SAFETY

In order to guarantee food safety and protect the agrifood sector from recurrent crises, the European Union, and with it Italy as a member State, has adopted the global intervention strategy “safety from the fields to the table”. This aims to guarantee a high level of protection for human health, and to safeguard the interests of consumers, whilst at the same time ensuring the domestic market works effectively. The European legal framework governing food has gradually developed along several key principles in order to ensure freedom of circulation within the Community of the foods and fodder produced (or placed on the market) in compliance with general safety principles and requirements, and to achieve worldwide first place ranking for public health and consumer protection.

Hazards of a microbiological nature are a priority in global terms and owing to the rapid consequences they have, both in terms of their immediate impact on consumer health and for the food crises they can trigger. The recognised diseases of food-origin include those caused by toxins or harmful chemical substances which have contaminated foods. The chemical risk, whilst it has a lesser immediate and general impact on consumer health and choices, poses problems of paramount importance for the agrifood sector, and for long-term human health issues. Not all chemical substances that contaminate foods are residues of active ingredients used in production processes, or come from the industrial machinery and technologies used. Some toxic substances (such as man-made pollutants, including dioxins or natural origin substances like arsenic) can transfer from the environment to the food chain. Others are produced by the metabolism of certain fungi and algae (mycotoxins and phycotoxins). As regards environmental contaminants, considerable attention needs to be dedicated to so-called “emerging contaminants”, namely contaminants of different origins (e.g.: organostannic biocides, brominated flame retardants and perfluorurated organic compounds) which scientific literature tells us have been found in foods but are as yet not covered by legislation. A number of plants can produce toxic substances directly (e.g. nightshades) or anti-nutritional substances. Other toxic chemical substances can develop during the processing of food products (e.g.: 3-MCPD; acrylamide).

Food safety poses significant challenges for the world of research and the sphere of food production and marketing. In fact it is necessary to enable companies to remain competitive and allow technological innovation to occur in complete respect of the necessary requirements, to guide production systems towards technologies and practices that can prevent problems from arising, whilst taking into account the protection of the health and wellbeing of animals, plant health and the environment. This should be combined with the need to communicate risks effectively, rendering the various players responsible whilst promoting a climate of trust in the research system, in the controls system and in Italy's production system. Up until a short time ago, businesses limited themselves to respecting requisites without going “beyond” in investing in production safety; today there is instead awareness that reducing food contamination will increasingly be a strategic element, and that consumer trust can only be boosted by investing in safety. This change in vision in the production world is of great importance and may allow significant improvements, not just where health and safety are concerned, but also in terms of greater development and solidity in the sector. Research has to help the production system ensure it is “one step ahead” of legislation. It must provide the control system with the right analytical instruments, and must provide consumers with scientific evidence to make well-informed choices and adopt proper practices when using foods.

The topic of food safety often clashes with major contradictions: technological innovations that can reduce the risks introduced by new potential hazards to be examined (e.g. GMOs and nanotechnologies); productions which are closely linked to the natural systems (typical, traditional and local, on a small scale) which do not meet the regulatory requirements. In order to tackle the topic of food safety effectively, a multidisciplinary approach is required, but above all a far-reaching vision free from preconceptions is called for: chemistry has to be intended as the science
which can provide great benefits and should not be demonised. By the same token, organic farming is not necessarily “safe”. Research must involve every phase: from production to the end consumer (“from farm to fork”). It is necessary to reduce the amount of chemical and microbiological contaminants right from primary production, promoting the development and use of specific agronomic practices, the use “precision farming” techniques and forecasting models that aim to reduce the use of chemical substances and, where possible, replace synthetic active ingredients with molecules of natural origin with an antimicrobial effect, or which boost the natural defence systems. It is necessary to develop systems that act on processing technologies to reduce the quantities of residues in foods and fodders, or to detoxify them; and to use innovative packaging which effectively controls product deterioration whilst reducing the use of preservatives, reducing the microbiological risk and/or extending the shelf-life. The introduction of ICT technologies during the production, conservation and storage phases can provide considerable benefits in terms of guaranteeing safety, traceability, controlling and reducing deterioration and contamination phenomena. Food safety is today closely linked to innovation and sustainability in production systems, and is potentially the most important competitive element businesses have. Investing in safety means reducing the risks of a sudden loss of trust (in the brand or supply chain as a whole) for accidental events; this means preventing future issues from arising (persistent and bioaccumulable contaminants and emerging contaminants), steering technologies and production and control processes from the very outset. It also means placing products - or combinations of products - on the market which are gradually more wholesome and/or particularly suitable for wider consumption, particularly with regard to weaker sections of the population (e.g. pregnant women and toddlers) affected by particular illnesses or, products which are more suitable for particular lifestyles, consumption habits and types of diet. In order to translate the investment in safety into an element of competitiveness for businesses from the start, it is necessary to promote information and training which allows consumers to make well-informed choices, and to valorise products properly. This accordingly lays the foundations for a virtuous circle of supply and demand of increasingly wholesome, high quality products. Major benefits in terms of health, development of the agrifood sector and consolidation and expansion of markets can be achieved by combining the interests of the agroindustrial world and consumers, and by promoting business investments.

The “Food safety” Pillar is divided into six Core Themes. Some are of a transversal nature, such as those geared towards strengthening the metrological infrastructure or integrated risk management. Others specifically concern given production phases or issues:

2.1 Analytical methods, devices and systems.
2.2 Food fraud, authenticity, traceability and retraceability.
2.3 Reducing contamination of raw materials and products in primary production.
2.4 Improving and guaranteeing product safety during the preparation, transformation, packaging, transportation and distribution phases.
2.5 Emerging problems and risks.
2.6 Integrated management and communication of food safety.

Some topics must be tackled in close cooperation with other Pillars. In particular, food safety communication must be developed synergically and be shared with the other Pillars. In so doing, the consumer should be given as broad a vision as possible on the topics of quality, safety and sustainability. Indeed it is vital to give the consumer the necessary means of making well-informed choices, linking food safety with diet, habits and lifestyles, ethical principles, age and the consumer’s state of health. This accordingly promotes a food culture which can effectively counteract food crises often triggered by distorted, fragmented and alarmist information (often aimed more at hitting the headlines than on informing consumers properly).
CORE - THEME 2.1 - ANALYTICAL METHODS, DEVICES AND SYSTEMS

Challenge:

The reliability of measures linked to safety issues plays a key role, as the prevention and protection strategies adopted depend on the results of the measures taken, as do supervision and control measures and the resultant decision-making processes. It is necessary to boost this sector’s infrastructure, bringing basic research into new devices and measuring principles into line with the needs of industry and the inspection and control sector. It is necessary to develop new measurement tools that ensure measures can be compared and referred to. This is particularly the case with new Reference Materials (RM) specifically for the agrifood sector as in many cases these represent the only means available for ensuring the chemical and biological measures are reliable. It is also necessary to develop reliable methods for emerging contaminants and new technological solutions for early and immediate detection of physical, chemical and biological risks based on both “on-line” and “at-line” systems. It is necessary to start developing advanced new sensoristic technologies which can distinguish in real time between the different materials on the production lines, and which are flexible and selective enough to identify the presence of materials which do not conform with the matrices in question.

Indeed it is vital to achieve a sizeable reduction in the cost and time involved in analyses, promoting the implementation of industrial monitoring programmes, guaranteeing the possibility of checking of ensuring that food safety and processing criteria are respected, in compliance with regulations in force, whilst boosting control systems with resultant reduction in human exposure risks.

The analytical methods must be validated, and the performance criteria must be harmonised. This calls for developing new reference materials and suitable procedures for calculating the uncertainty to be applied to new methods of analysis, in particular for “untargeted” ones, those that make use of chemiometric techniques and those that adopt classifying properties (identity, homology, similarity, etc.).

The Core – Theme closely adheres to the following strategic documents:

- FoodDrinkEurope Document: Strategic Research Priorities for the European Food and Drink Industry – June 2015;
- S3 Emilia Romagna Region: “Industrial and innovative technologies and biotechnologies for the Food Industry (4.4)” and “Quality in safety (4.5)”;
- S3 Lombardy Region SCC3 “Safety of Citizens and the Community” (AG1.3 and AG 2.3);
- S3 Lazio Region “Agrifood and ICT Specialisation Areas”;
- S3 Independent Province of Trento “Safety and traceability of foods”.

Objectives:

Development of methods, devices and analytical strategies.

The main objective of the Core - Theme can be interpreted in terms of developing methods, devices, sensors and technologies for defining matrices and materials and processes used to identify foreign bodies and detect the amounts of chemical and microbiological contaminants in foods and raw materials, amongst others by adopting “in-situ” methods along the production lines. In addition to developing methods for emerging contaminants, particular attention needs to be paid to developing rapid screening methods and multi-analytical methods, the use of genomic
and proteomic techniques, and techniques that make it possible to define elemental or molecular profiles, or again to systems that make it possible to determine a number of parameters to be used to prove the authenticity and origin of products. In this sphere, promoting shared approaches and analytical methods and integrating resources within a given system is of strategic importance.

**Producing new reference materials.**

At the same time as methods and devices are developed, it is necessary to increase the availability of Reference Materials (RM) for the agrifood sector. These can be used for validating methods in inter-laboratory trials, for calculating uncertainty measurement, and for proving and comparing the quality and reliability of the analytical results. In particular, new agrifood RM matrices for specific supply chains (e.g. grains) to tackle emerging food safety issues are needed (e.g. modified mycotoxins, identification of “gene-editing” nanoparticles), not to mention RMs with innovative characteristics to be used with multiparameter techniques, or in specific phases or analytical circumstances.

**Definition and harmonisation of analytical performance and data analysis criteria.**

In keeping with the above goals, it is necessary to consolidate and share - with the various players involved in the supply chain - the definition of analytical performance criteria to be adopted, particularly as regards innovative target/untarget multi-analysis methods and screening methods. In addition, it is also vital to pursue the goal of harmonising chemometric techniques, and processing data which are increasingly essential for aids for the innovative analytical methods described above. Lastly, it is necessary to give public and private laboratories support in all matters concerning the quality of the analytical data, providing help with calculating uncertainty, technical manuals, information/training material and proficiency testing services.

**Expected outcomes:**

This Core – Theme will strengthen the metrological infrastructure of the agrifood sectors as a whole. in particular it will allow:

- the development and validation of both reference methods and rapid, innovative methods for identifying additives, chemical and biological contaminants, unauthorised substances and toxic substances which are of natural origin or which are produced while foods are cooked;
- the creation of new reference materials for the agrifood sector;
- to avail of rapid and highly versatile measuring devices/sensors, or which can be modulated on different matrices according to need (for identifying antibiotics, hormones and pesticides in foods as well as VOCs, markers for altering microflora etc...);
- the standardisation of diagnostic methods (including those of a quantitative-simultaneous type) for the species-specific and strain-specific identification of altering and pathogenic bacteria, for detecting and analysing bacterial toxins and viruses in foods and fodders;
- devising methods of reference (such as IRMS analyses), devices, sensors and technologies of an innovative nature for rapid screening (e.g. Raman spectroscopy, VIS and NIR) of authenticity and safety markers of agrifood products;
- drafting harmonised protocols for using both reference methods and screening in process checks run by businesses in the sector;
- the integration of new sensoristic technologies with an end to developing production lines using advanced systems for identifying and removing non-conforming materials from production lines, thereby heightening the safety of food products and protecting consumers.
The benefits of these activities can involve:

- a reduction in the number and impact of crises and alarms linked to food supply chains, whilst at the same time having an economically positive effect on the sector and preventing improper risk communication strategies;
- controlling the environment and its interactions/consequences in respect of the set of contaminants, with a view to increasing both the ecological and health-related aspects of the food industry at the same time;
- reducing food wastage, thanks to a more effective system for preventing, monitoring and mitigating risks affecting foods, thereby making it possible to increase yield whilst achieving a more sustainable use of planetary resources.
- a better use of instrumental resources and an increase in scientific cooperation.

Reference documents:

- S3 Regions of Emilia Romagna, Lombardy, Lazio and the Autonomous Province of Trento.

CORE - THEME 2.2 - FOOD FRAUD, AUTHENTICITY, TRACEABILITY AND RETRACEABILITY

Challenge:

The concept of "retraceability" of the paths followed by fodders, foods and their ingredients has been introduced by the White Paper on Food Safety [COM (1999) 0719 def.], as later confirmed by EC regulation 178/2002, in which "retraceability" was termed “the possibility of reconstructing and following the path taken by a food, fodder or an animal destined for food production, or a substance destined or suitable for becoming a part of a food”. Article 18 establishes the retraceability in every phase of production, transformation and distribution, and stipulates that professionals in the sector must be capable of identifying who supplied them with a given food, ingredient or fodder, and that they must have suitable systems and procedures that allow them to provide any information required by the authorities concerning the suppliers and businesses which in turn supplied their products, in keeping with an approach called "one step before - one step after".

The principle of product retraceability as an instrument for protecting consumer health has become the cornerstone of the European food policy, and in time has become an essential means of guaranteeing food safety and reliability of information given to consumers; first and foremost it has been developed in the sector of animal-origin foods.

Advances in knowledge, technologies and data processing systems have made it possible to identify markers and develop analysis systems and methods to prove the origin and authenticity of raw materials and products in an objective and measurable way, strengthening the control system whilst opening up the way to a new approach to retraceability. The new analysis techniques used to determine the origin of foods provide an independent means of verifying document traceability systems, and help enhance products and counteract fraud and adulteration, with important knock-on effects from the financial and social standpoints.

In this respect it is possible to distinguish between “product retraceability”, based on analysing product “markers” (namely the characteristics of a given product or ingredient which can be taken as tracers in the finished product), and “process retraceability”, based on analysing “process markers” (namely newly-formed species resulting from the
reactions triggered by processes or molecules which are naturally contained in the food and altered by processing). Product retraceability can refer both to the geographical origin strictly linked to primary production, and the biological origin concerning botanical or zoological origin and identification of GMOs. To this end, different types of markers can be used: chemical, microbiological and genetic.

Many producers today are showing considerable interest in defending their products using analytical sciences or other technologies which can classify the commercial food and provide an effective, reproducible and objective continuity in their production.

In particular, for the fish sector, instruments that demonstrate the production technique adopted (fished/farmed) and area of origin must be strengthened as these might prove crucial where food safety is concerned.

Lastly, there is ever-increasing interest in increasing the system’s capacity to identify and keep one step ahead of fraud, ensuring products with a high added value retain their integrity and sustainability.

The activities will be conducted in synergy with Pillars 3 and 6 which tackle the topic of retraceability respectively in terms of enhancing quality and the systemic approach to the supply chain.

The necessary new methods of analysis and reference materials will be developed in conjunction with the Challenge of Core - Theme 2.1, whilst actions to share, integrate data and strengthen “lateral” “paper trail” and product traceability strategies will be conducted in close cooperation with Core - Theme 2.6.

The Core - Theme closely adheres to the following strategic documents:

- Strategic Research Priorities for the European Food and Drink Industry – June 2015;
- Horizon 2020: EFSA’s Priority Research Topics – European Food Safety Authority supporting publication 2015: EN-727; Global Food Safety Initiative Position on Mitigating the Public Health Risk of Food Fraud - July 2014;
- S3 Molise Region: Driver “Innovation and sustainability in agrifood processes and products”;
- S3 Emilia Romagna Region: “SMART Agroindustry” (4.11);
- S3 Lombardy Region SCC3 “Safety of Citizens and the Community” (AG1.3);
- S3 Sicily Region areas “Sea Economy” and “Agrifood”;
- S3 Lazio Region “Agrifood and ICT Specialisation Areas”;
- S3 Calabria Region: “Pillar 2”.

**Objectives:**

**Identification of food authenticity markers.**

Knowledge and identification of new reliable chemical or biochemical markers must be extended to demonstrate and verify the authenticity of raw materials and finished products.

In particular, it is necessary to identify both primary markers (characteristic substances, features of the process or technology and/or the geographical production area) as well as secondary ones (element or molecular profiles and multi-parameter features that make it possible to group the products, according to origin, in an indirect manner). Some characteristic markers or profiles (fingerprints) can be closely linked to biological origin or the production environment, whilst other mainly refer to production factors such as farming and zootechnical practices (e.g. irrigation, fertilization, use of fodders), climate effects (e.g. temperature, rainfall), geological parameters (e.g. soil composition) and geographic parameters (e.g. altitude, latitude, distance from the sea).

**Selection of analysis strategies and reference materials.**
The analysis approaches to be applied differ according to the type of marker (microbiological, genetic, protein, metabolic, molecular, elemental, isotopic, olfactory imprint etc.). As a result, a variety of techniques can be used, from PCR and Real Time-PCR techniques to mass spectrometry, spectroscopic and separative techniques, cutting-edge planar chromatography for studying the metabolomic imprint of plant matrices - HPTLC, differential thermal analysis and sensorial analysis systems, which may also be used in conjunction with one another.

Alongside Core - Theme 2.1, all analytical strategies linked to both confirmation methods for legal requirements (such as IRMS, NMR, GC-MS, LC-MS, MALDI-TOF, ...) and rapid screening and/or “digital imprint” systems (e.g NIR/MIR, electronic nose, DART-HRMS, ...) need to be thoroughly “tested in the field” for ongoing industrial monitoring. At the same time, again alongside CT2.1, it is necessary to develop certified reference materials for the origin or to determine typicality.

**Tools for traceability and for enhancing document-based traceability approaches (“paper trail”).**

Many food descriptions and attributes linked to fraud have properties which cannot always be checked with a complete analysis, such as production date, batch number, owner, place and technologies for processing, ecological quality branding, organic production and sustainability.

To detect this type of fraud, it is necessary to adopt and reinforce traceability systems (bar codes, RFID), ensuring document-based approaches (“paper trails”) which gather and compare different synchronised and structured registrations and certifications to prove, for example, that for a given company or region, the declarations of incomings/ purchases/ imports correspond with declarations of outgoings/sales/exports. These activities are very much in keeping with those detailed in Core - Theme 2.6 and Pillar 6. The traceability of products based on data synchronisation might also promote integration with product sustainability issues, developing systems based on coherence between agronomic input data (water, seeds, fertilisers, etc.), weather and climate data and output data (products and waste).

**Sharing platforms and cooperation networks.**

The fight against food fraud and adulteration calls for gradually developing interdisciplinary expertise (chemical, microbiological, financial, sociological, etc).

Working in conjunction with Core - Theme 2.6, it is necessary to consolidate expertise and share data and strategies between the various players of the supply chain by implementing an integrated system for collecting updatable information regarding the analyses and methods adopted. This must be carried out in conjunction with the relevant protection authorities and bodies. The safety of the management system adopted must be extremely high.

**Expected outcomes:**

This Core - Theme will make it possible to:

- construct shared and updated databases which concern the solutions which can be adopted for each type of known risk or presumed fraud/adulteration;
- circulate information jointly on emerging risks, on known issues, on modelling risks and anticipating them, and on the corresponding anti-counterfeiting strategies and inspection or preventive risk-assessments to be adopted;
- develop interdisciplinary expertise in the agrifood sector and creation of academic-industrial training courses;
- develop advanced techniques for identifying varieties and genetic speciation;
- consolidate isotopic analysis techniques for the main bioelements (H, O, C, N, S) and identify the relationships between isotopic balances and environmental/genetic variables;
- identify markers of chemical origin (geographic, botanical, zoological) and create libraries containing markers linked to product origin and/or authenticity;
- implement secure, rapid and economical document traceability and analytical solutions concerning both raw
materials and finished products with regard to Italy’s primary supply chains (e.g. durum wheat-pasta, vine-wine, olive-oil, fish products etc.), with particular reference to PDO products or those linked to certified organic production systems;

• generate systems and technologies (computerised, packaging related, ...) to model and anticipate/forecast risks and to guarantee the anti-counterfeiting and authenticity control of food products;

• creating portable/non-destructive devices which can, in certain given circumstances, actually be handed over to the end consumer for a sort of “product self-assessment” even after purchasing.

The benefits of these activities can involve:

• strengthening the image of Italian products and heightening customer trust;

• countering fraud;

• internationalisation;

• greater control of the whole supply chain.

Reference documents:


o S3 Regions of Calabria, Molise, Emilia Romagna, Lazio, Lombardy and Sicily.

**CORE - THEME 2.3 - REDUCING CONTAMINATION OF RAW MATERIALS AND PRODUCTS IN PRIMARY PRODUCTION**

**Challenge:**

Increasing consumer awareness and development of regulations (e.g. National action plan for sustainable use of phytosanitary products) make it vital to develop agricultural production models which depend less on the use of chemical synthesis products, aiming instead to achieve sustainable use of resources and preserve plant and animal biodiversity.

Reducing content of chemical and microbiological contaminants means obtaining raw materials of increasingly high quality, placing the production system “one step ahead” of regulatory provisions. This would provide enormous advantages where production competitiveness and the image of the entire production system’s safety are concerned.

Bearing in mind that the sources of contamination in primary production can come from inside the production system (phyto-pharmaceutical residues, veterinary pharmaceuticals and fertilisers, etc.) or outside (environmental pollutants and contaminants of natural origin), it is necessary to take measures in the production sites (steps to safeguard sites, reclaim and enhance them), on the mechanisms which govern the transfer of environmental pollutants into the food chain, and on technologies and strategies to control pathogens, harmful insects and toxigenic micro-organisms.

The goals of this Core - Theme are included in strategic documents for agricultural research and innovation, and are pivotal in the Horizon 2020 agenda. They are in fact the object of specific calls currently open, as well as others due to be opened in the coming two-year period.
The Core - Theme closely adheres to the following strategic documents:

- S3 Tuscany Region: Smart Specialisation and Rural Development;
- S3 Sardinia Region: Thematic goal 3 “Promoting the competitiveness of small and medium businesses, the farming sector and fishing and aquaculture sector”;
- S3 Emilia Romagna Region: “Sustainable, precision agriculture which is integrated into the supply chain” (4.2);
- S3 Lazio Region “Agrifood and ICT Specialisation Areas”;
- S3 Piedmont Region: “Made in Piedmont (FARM OF THE FUTURE)”;
- S3 Sicily Region “Agrifood” area;
- S3 Marche Region: “Priority X”;
- S3 Calabria Region: “Pillar 1”.

Objectives:

Preventing environmental pollutants from transferring into the food supply chain, safeguarding and restoring farming land.

To prevent the contamination of farming products during their cultivation, it is necessary on the one hand to examine the relationships between the quality of the sites and the safety of the products and mechanisms that transfer pollutants from the environmental matrices (soil, water, air) to crops and, on the other hand, to develop suitable methods for qualifying and classifying production sites and zoning. At the same time, it is necessary to adopt strategies for analysing and managing the risk of environmental contaminants being transferred into the supply chain, based on identifying and defining the sources, assessing technologies for containing emissions, assessing the environmental destination of the pollutants and their mobility and bio-availability in relation to the pedoclimatic conditions and farming techniques used. It is equally important to carry out biorestitution and phytorestitution measures for demonstrative purposes on farm land, not least to have useful means of assessing effectiveness, analysing costs/benefits and planning mid-to-long term measures. This field of measures also includes studies geared towards bio-decontamination and detoxification in the field, in particular those aimed at preventing the growth of toxigenic fungi or breaking down mycotoxins using micro-organisms or natural origin substances.

Use of “precision farming” techniques and models to reduce contaminants in products used for human and animal food.

The use of technologically advanced systems and models (forecasting and simulation) today makes it possible to achieve an increasingly realistic and reliable definition of the risks of alien species spreading in new areas and the complex dynamics of pathogens and harmful insects, both in relation to climate variability and interactions with host plants. This makes it possible to develop holistic control strategies which have a solid ecological rationale along with spatial and time-related targets that provide a significant contribution towards sustainable and ecological management of phytosanitary defences, with positive effects on the wholesomeness of products and safeguarding the environment. Today, software which harnesses models that simulate crop and infesting species dynamics in relation to behaviours, physiology and climate conditions makes it possible to trace a map of the risk or to assess the spread of insects, whether invasive or otherwise, and to quantify the potential damage on a local level. The creation of a generalised software platform, supported by a suitable IT infrastructure capable of providing a prompt and effective local response to the many and varied complex ecological issues linked to global change (such as invasive phytophages and pathogens, not to mention unexpected infestations of parasites caused by climate variability) can provide a valid means of meeting an unprecedented challenge for Italian agrifood. Activities in this sphere also concern improving reliability and the scale level of models, and their integration with other networks and new systems for monitoring the field, particularly concerning highly technological methods, based on remote aerial and satellite detection and on GIS environmental modelling.
In addition to controlling the spread and damage caused by invasive insects, using models combined with cutting-edge technologies for monitoring and analysing data also makes it possible to develop integrated systems for controlling and managing chemical and biological risks in primary production. The possibility of creating integrated systems for controlling contaminants in milk which can manage risk sources from the fodders (cultivation, conservation, use and distribution), right up to milking and storage of the milk in cowsheds is of particular interest.

**Use of natural origin substances which eliminate microbes and parasites and have a phytotherapeutic effect to reduce the use of chemical synthetic products and counteract the resistance phenomenon.**

Plants and agroindustrial waste are a rich source of a wide variety of secondary metabolites, the composition of which can vary greatly according to the species and plant variety concerned. When these substances have a biocidal or phytotherapeutic effect, they can be used as an alternative, or in addition to, synthetic chemical products. In particular, natural plant origin substances can have an antimicrobial and/or anti-parasitic effect which prevents or cures illnesses and parasite infestations in farmed animal and cultivated plants. Their availability can help reduce the use of synthetic molecules, thereby countering resistance to useful molecules whilst at the same time ensuring the agrozootechnical products destined for human consumption are more wholesome. In this field, the activities to be conducted concern selecting and characterising phytocomplexes with an anti-parasite effect for containing parasites in animals and plants; assessing the effectiveness of phytoextracts as biocides, bacteriostatic and active bactericidal products which work against animal and plant diseases; selecting herbs and their antimicrobial extracts to be used as an alternative to synthetic antibiotics, in animal diets to contain technical pathologies which affect farms.

**Holistic approach to counteracting the resistance phenomenon.**

In zootechnics, a modern vision of preventing the risk of Antimicrobial Resistance (AMR) from developing consists of adopting a holistic approach in the primary production system. In all species which are farmed, the early stages of life are the most critical of all as regards the use of antimicrobial substances for containing gastric and respiratory diseases. Stimulating the organism's ability to respond to antigenic stimuli by promoting the development of the immune system lays the foundations for increasing the natural resistance of animals to illnesses, thereby reducing the use of antimicrobial molecules and, as a result, the selective pressure applied to the microbiota. Defining a zootechnical approach based on good farming practices, dietary strategies and vaccination plans is accordingly the cornerstone for reducing the use of antimicrobials and accordingly AMR.

The topic of antibiotic resistance, as well as safety problems, also raises issues concerning sustainability. These are tackled in Pillar 4 (Core - Theme 4.7).

**Reducing the use of phytosanitary products in agriculture, increases plant resistance barriers and boosts the effect of natural antagonists and their products on key harmful organisms.**

The “framework for community action for achieving sustainable use of pesticides” (Reg. (EC) n. 1107/2009) imposes the reduction in the use of phytosanitary products in agriculture, by promoting integrated cultivation techniques and alternative approaches to chemical defence. This calls for changes in phytosanitary defence practices, in order to reduce both environmental impact and undesirable effects on non-target organisms. This offers clear-cut benefits for the quality of the products in terms of lower residue content. The main activities in this area involve: studying interactions between plants and damaging organisms (pathogens and insects) and natural antagonists in order to identify new sources of plant resistance, whether direct or indirect; developing new biological control plans based on the use of natural antagonists and the molecules they produce; assessing the impact of phytosanitary defence protocols on useful organisms, particularly pollinators and natural antagonists; optimising genetic selection strategies to develop genotypes of plants that can withstand biotic and abiotic stress, which can provide the best response to growth and defence stimulation by beneficial micro-organisms of the rhizosphere; assessing the role of arbuscular mycorrhiza and beneficial micro-organisms for controlling plant diseases, and improved use of nutrients.
which, in the case of fodder monocrops, are also combined with a reduction in the risk of mycotoxins.

**Expected outcomes:**

The research and development activities of this Core - Theme will make it possible to:

- develop methods for classifying production areas and increasing knowledge of the incidence of the various contamination sources, the mechanisms whereby environmental contaminants are transferred to agricultural produce, and the efficacy of reclamation;
- developing and validating agronomic and phytosanitary defence practices with an end to reducing the contamination of products destined for human and animal consumption, and undesired effects on non-target organisms;
- set up computerised infrastructures for controlling phytophages and invasive diseases;
- select micro-organisms and natural plant-origin substances and assess their capacities in terms of : antimicrobial or insecticidal activity; capacity to break down chemical contaminants; biopesticides and biostimulants; heighten the effect of natural antagonists;
- obtain *cultivars* that are more resistant to biotic and abiotic stress.

The main impacts concern:

- improving the quality of farming areas and safeguarding them;
- reducing the transfer of environmental contaminants to the food chain;
- reducing the antibiotic resistance phenomenon;
- improving the wholesomeness of raw materials;
- reducing the use of synthetic chemical products;
- reducing undesired effects caused by sanitary practices adopted to control pathogens, harmful insects and toxigenic micro-organisms;
- preventing unexpected infestations of parasites and pathogens linked to climate variability.

**Reference documents:**

- Background paper Towards a long-term strategy for European agricultural research and innovation by 2020 and beyond June 19, 2015 EU Pavilion at Expo Milan.
- S3 Regions of Calabria, Marche, Molise, Emilia Romagna, Lazio, Lombardy, Piedmont, Sardinia, Sicily and Tuscany.

**CORE - THEME 2.4 - IMPROVING AND GUARANTEEING PRODUCT SAFETY DURING THE PREPARATION, TRANSFORMATION, PACKAGING, TRANSPORTATION AND DISTRIBUTION PHASES**

**Challenge:**

This Pillar focuses on phases which follow primary production (preparation, transformation, packaging, transportation and distribution) and also includes safety assessments during the phases of preparation and conservation in the home. Safety can be improved in these phases by optimising the process lines or by introducing new technologies for sanitising and disinfecting working environments, or during the processing and storage phases. The Challenge is that of improving health and hygiene quality in foods whilst increasing their shelf life and preventing food-origin infections, thereby reducing the use of chemical synthetic products and harnessing low-impact
One of the sectors with the greatest interest in improving safety during transformation stages is that of fish products. It is also necessary to support typical and traditional products, local small-scale produce and organic produce by optimising production protocols, in order to achieve suitable safety levels whilst maintaining the specific features and qualities of the products themselves.

The inclusion of the topic of after-sales safety is also deemed strategic, as it allows us to give continuity to the measures taken, and to provide effective protection for consumers. This boosts their trust in the research system whilst increasing the sense of responsibility and attention to food safety issues.

In order to guarantee an integrated approach to food safety (from field to table) this Core - Theme will be developed in close with both Core - Theme 2.3 which covers primary production, and with Core - Theme 2.6 which tackles the integrated management of the supply chain and food safety communication.

Given that this Core - Theme concerns safety during the processing phases, it will also support Pillar 3, guaranteeing a suitable assessment in terms of safety and health risks involved in the process innovations introduced.

The Core - Theme closely adheres to the following strategic documents:

- Horizon 2020: – FS37.2016- The impact of consumer practices in food safety: risks and mitigation strategies;
- Horizon 2020 – SFS45.2016- Increase overall transparency of processed agrifood products;
- S3 Lombardy Region: “SCC1 Smart Living” – (AG3.1 and AG4.2);
- S3 Tuscany Region: Smart Specialisation and Rural Development;
- S3 Emilia Romagna Region: “Innovative industrial technologies and biotechnologies for the Food Industry (4.5)” and “Quality in safety” (4.8) and “Innovative and sustainable packaging “ (4.9);
- S3 Piedmont Region. “Made in Piedmont (FOOD-CORE)”;
- S3 Puglia Region: “Man’s health and Technologies for Smart Communities;
- S3 Sicily Region “Agrifood” area;
- S3 Marche Region: Priority VI;
- S3 Lazio Region: “Agrifood Specialisation Areas” (“Mild technologies” for transformation);
- S3 Calabria Region: “Pillar 3”;
- S3 Independent Province of Trento “Safety and traceability of foods”.

Objectives:

**Use of biological (enzymes and micro-organisms) for biocontrol of microbiological contamination in food production and fodders and for detoxifying and developing predictive microbiology instruments.**

In order to improve product conservation, prevent food origin infections, reduce the use of synthetic chemicals and improve health and hygiene quality, it is important to promote the use of low impact industrial biotechnologies such as the following:

- the use of *starter* or protective cultures for improving safety in deli meat maturation processes and for reducing nitrates/nitrates in fermented meat products (deli meats);
- improving the health and hygiene and nutritional quality and preservability of plant products adopting lactic fermentation.

In addition, it is vital to analyse the phenomena involved in microbial kinetics by developing predictive microbiology both as regards existing relationships between food control factors and the responses of pathogenic and altering micro-organisms, and with regard to the interactions between pathogenic micro-organisms contained in foods and their natural microflora.

Research into both the direct use of biological agents or their use as food additives must be conducted bearing firmly in mind the safety evaluations and opinions given by EFSA and in particular the list of QPS (Qualified Presumption of
Safety) micro-organisms.

Use of natural origin active ingredients and “mild technologies” for sanitising and disinfecting environments and to render products safe during production and storage phases.

The main needs expressed by the production sphere in this area concern:
- sanitization of working environments and maturation/storage rooms for semi-processed foods (reduction of airborne micro-organisms and those contained in biofilm);
- the introduction of innovative low-impact systems for disinfection during the initial transformation and packaging stages;
- the application of ozone and electrolysed water for sanitising surfaces and work equipment;
- the application of High Pressure (HPP) technology to improve the health and safety quality of products and relevant shelf-life;
- the application of mild technologies (plasma gas, microwaves and ultrasound) to sanitise and pasteurise cooked and packaged vegetables;
- analysis of the real effects of certain provisions on safety (e.g. treatment of foods with ionising radiations) in the light of new knowledge and investigative technologies.

Optimisation of production protocols for typical and traditional products made on a small scale and for organic produce.

The aim is to increase levels of safety and the commercial lifespan of typical, traditional and organic produce by identifying the elements and phases involved in improving, optimising and validating production protocols. The protocols must be developed in relation to the type of product in order to maintain the typical qualitative characteristics of the product intact. Studies to identify microflora and select autochthonous starters will be particularly useful in this area.

Improvement and innovation of storage, packaging and distribution technologies.

The activities of greatest interest in this area concern:
- developing procedures to improve and guarantee the safety of agrifood products with reference to the allergenic content and/or to reduce the risks of cross-contamination;
- selecting natural biocides and developing procedures for incorporating them into packaging or activating them as required;
- implementing logistical systems dedicated to guaranteeing safety during distribution;
- assessing the effects of food safety on innovative food transportation, storage, packaging and distribution solutions.

Improving after-sales Safety.

In order to ensure the continuity and success of the measures taken to improve product wholesomeness and reduce risks for consumers, it is also necessary to consider after-sales safety, both with regard to the foodservice industry and domestic procedures. For this last aspect in particular, the activities will consist of assessing/validating conservation and preparation procedures (which may also involve different geographical areas, cultural traditions and ethnic backgrounds) within the more general framework of providing consumers support as regards food usage and conservation.
**Expected outcomes:**

The research and development activities of this Core - Theme will make it possible to:

- identify and characterise microbial enzymes with a protease effect for detoxifying foods, creating enzyme production systems;
- characterise new bacterial and fungal starters and draft new protocols;
- prepare validated production protocols which apply to typical, traditional and organic products with an end to increasing the safety standards of these foods, maintaining the qualitative characteristics of the product and extending commercial lifespan;
- develop low-impact approaches to sanitising and disinfecting working environments and ensuring products are safely processed and stored;
- develop innovative prototypes for monitoring and managing conditioning parameters during distribution;
- identify new transport solutions to preserve and guarantee product safety throughout the whole supply chain;
- develop guidelines to improve after-sales safety and support consumers.

The main impacts concern:

- improving safety during the transformation, distribution and preparation phases using “mild”; biotechnologies and technologies;
- supporting small-scale productions;
- preventing and reducing risks linked to the use of new technologies;
- Improving usage safety of products and increasing consumer confidence.

**Reference documents:**

- EFSA BIOHAZ Panel (EFSA Panel on Biological Hazards) - Statement on the update of the list of QPS-recommended biological agents intentionally added to food or feed as notified to EFSA. 2: Suitability of taxonomic units notified to EFSA until March 2015. EFSA Journal 2015;13(6):4138, 29 pp.
- S3 Regions of Calabria, Marche, Molise, Emilia Romagna, Lazio, Lombardy, Piedmont, Sardinia, Sicily and Tuscany.

**CORE – THEME 2.5 - EMERGING PROBLEMS AND RISKS**

**Challenge:**

The Challenge of this Core – Theme is two-fold: on the one hand making it possible to focus on certain food safety aspects, and on the other laying the foundations for developing a holistic approach to food safety issues.

There are a number of emerging risk problems. First of all are so-called emerging contaminants, namely contaminants of different origins highlighted in scientific literature as being found in food but as yet not covered by food safety regulations. Examples include: organostannic biocides, brominated flame retardants, organic perfluorurated compounds, pharmaceutical drugs and body care products.

Other emerging issues include modified mycotoxins, allergens, nanoparticles, substances that interfere with the endocrine system and the antibiotic-resistance phenomenon. **EFSA** has recently published a procedure for identifying emerging chemical risks in foods and fodders for an up-to-date overview of chemical substances in foods; it has also expressed new scientific opinions and published scientific reports and manuals on some of these issues.
Some of these aspects are tackled in the other Core - Themes, as solutions are provided in specific areas; this Core - Theme, however, tackles problems that call for a multidisciplinary and integrated approach.

For food-origin toxins, for example, the lack of in vivo toxicity data makes it difficult to make a complete risk assessment. In addition, most toxicity assessments have so far only addressed individual toxins. Whilst it seems unlikely that they work in an isolated manner, data describing potential effects triggered by exposure combined with other mycotoxins are extremely weak and insufficient to determine the nature of any combined effects. At the same time, the databank on the spread of mycotoxins is limited and, as a result, it is still difficult to produce reliable exposure estimates.

Accordingly it is increasingly necessary to make risk assessments linked to diet (amongst others) which take into account the actual toxicity of chemical contaminants, their contents and the relevant consumption of the individual foods, as well as cross-contamination of foods and fodders and other potential means by which they can be ingested in living and work environments.

An integrated approach is also needed to assess food safety risks and benefits linked to the use of new technologies such as biotechnologies and nanotechnologies. Modern biotechnologies are a valid means of correcting nutritional deficit in raw materials and derivative foods. Bio-fortified foods obtained from genetically modified plants are based on the manipulation of the plant’s metabolic pathways or the introduction of molecules which are absent in nature. In order to verify the real health benefits and level of acceptance in the public opinion, it is vital to assess the risks linked to these technologies. Nanotechnologies are also offering the agrifood sector major development potential, and food and farming industries are investing heavily in them. Yet using them calls for a series of considerations following thorough examination of the safety implications.

The Core - Theme closely adheres to the following strategic documents:

- FoodDrinkEurope Document: Strategic Research Priorities for the European Food and Drink Industry – June 2015;
- S3 Lombardy Region: SCC3 “Safety of Citizens and the Community” (AG2.3);

Objectives:

Emerging contaminants.

Tackling issues linked to emerging contaminants is important for preventing food safety issues from arising, and for preparing the production system for future regulatory provisions. Considering that one of the main means by which these contaminants enter the food chain is water (drinkable water, water used for irrigation and water used in processing phases), it would prove of great use to collect and analyse data to assess their actual presence, and examine the main risk factors of transfer to food matrices.

Amongst emerging contaminants, particular attention should be dedicated to endocrine disruptors, modified mycotoxins, substances in a “nano” dimension and contaminants released by contact materials, also taking into account NIAS non-intentionally added substances such as impurities and processing intermediates.

Integrated assessment of chemical risk through diet, and assessment of the risks/benefits of ingesting given products with a holistic approach.

To this end, integrated models will be developed to assess exposure of the population to chemical substances through diet (additives, food contaminants, ...) and studies will be conducted on given sections of the population (divided by age, social group, geographical area and ethnic background). The "contradictions" and interactions in
terms of the risks and benefits linked to consuming given foods, given the concomitant presence of contaminants and molecules with proven health benefits, will then be studied in synergy with Pillar 1. The packaging of food, taken as a unit of sale/consumption destined for the end consumer, is an intrinsic part of the food product. This extended risk/benefit assessment should also include issues concerning toxic substances released by contact materials or desirable molecules through dedicated “active packaging” solutions. As a result, a “holistic approach” needs to be developed in order to determine the real overall impact on human wellbeing of a food as a whole or of a dietary model.

Elimination of allergenic components from foods and obtaining “allergen-free” products.

The percentage of allergen-sensitive individuals is increasing amongst both adults and children. Amongst food allergies, wheat allergies are amongst the most widespread and complex. Reducing the effect of these allergens and identifying new categories is extremely important for the purposes of food safety. In wheats, the aims include isolating and defining new allergens (and studying those already known) using combined proteomic and genomic techniques. This would make it possible to identify wheat cultivars with a lower allergenic index and to devise systems to eliminate allergenic elements from the most commonly cultivated ones. All of which might lead to “allergen-free” products with obvious benefits to human health whilst also reducing the risk of sensitisation spreading still further.

Organic product safety.

The increasing popularity amongst consumers both inside and outside Italy of organic produce, which is seen as having added qualitative and health-enhancing value, can offer important opportunities for developing organic farming in some supply chains. This would have undoubted advantages in terms of the environmental compatibility and sustainability of the products. In order to allow organic farming to develop in full, it is necessary to fill in gaps in knowledge concerning organic produce safety, particularly as regards the problem of mycotoxins, microbiological safety and issues concerning increased concentrations of toxic elements in soils where compost has been used.

Counteracting the antimicrobial resistance phenomenon (AMR).

Excessive or inappropriate use of antibiotics has been linked to the onset and spread of micro-organisms which are resistant to them. This accordingly results in the reduced effectiveness of treatments, and serious public health risks. When AMR appears in zoonotic bacteria in animals and foods, it can also affect the ability of therapies to counteract infective diseases in humans and animals. In order to counteract the phenomenon of antimicrobial resistance appropriately, it is necessary to take action on a number of fronts. In addition to specific aspects tackled by the various Core - Themes (first and foremost amongst which are CT1 dedicated to primary production), it is necessary to combine the various monitoring, prevention and communication measures which this emerging risk involves.

Risks linked to new technologies.

As regards biotechnologies, it is necessary to adopt integrated genetic and proteomic approaches to assess the consequences of inserting the new gene in the plant (number of copies, stability of expression, interruption, activation or any endogenous gene mutations), and check to ensure the consented GMO threshold in the derivative food is respected.

To make sure the use made of nanotechnologies in the food sector is both safe and effective, it is necessary to ensure scientific knowledge in a variety of areas makes balanced and harmonious progress. In particular it is necessary to support studies and research conducted into the effects (on health and the environment) of mid and long-term exposure to nanoparticles, and enable nanometrology to develop suitably.

In order to manage the opportunities and risks of technological innovation to suitable effect, a far-sighted approach which takes the safety and sustainability issues into account is needed. The approach must also ensure the impact
new technologies have on consumers is managed properly.

**Expected outcomes:**

Research and development activities conducted in this Core - Theme will make it possible to:

- determine the importance of new mycotoxinogenic strains and the effects both in the field and of the food process on the evolution, co-presence and overall impact of mycotoxins in free and/or bound/modified form;
- understand the links between climate and development changes or alterations in both known and emerging contaminants (e.g. mycotoxins, pathogens, ...);
- the availability of integrated proteomic-genomic approaches and innovative chemical methods to: (i) isolate and define new allergens or new variations linked to anti-nutritional effects, (ii) assess the consequences of inserting new varietal genes and check to ensure the GMO threshold permitted in the derivative food is respected;
- identify varietal *cultivars* that are less allergenic. Identify new allergens or modified allergens in treated and/or processed foods and assess their allergenic levels both before and after gastro-intestinal digestion;
- the availability of alternatives to animal studies to check how effective fodder additives are at reducing mycotoxin and bacterial toxin contamination;
- identify the microbiota in fresh foods (ready-prepared vegetables, dairy products and meat products) with an end to reducing pathogenic micro-organisms which are antibiotic-resistant;
- identify biomarkers which can provide realistic indications of exposure and its consequences (immune-endocrine, toxic and neurological effects, ...);
- apply modelling techniques for the co-presence of raw material and food element/contaminants, and their destiny throughout the metabolic chain.

The main impacts concern:

- preventing the onset of safety problems;
- helping the production system to adapt to future regulations;
- preventing and reducing problems linked to food allergies;
- counteracting the antibiotic resistance phenomenon;
- improving safety in organic production;
- safe usage of new technologies and preventing the risks which are linked to them.

**Reference documents:**

- S3 Lombardy Region:
  - A systematic procedure for the identification of emerging chemical risks in the food and feed chain EFSA supporting publication 2014: EN-547.
- EFSA – Chemicals in Food 2015 - Overview of Data Collection Reports.
Core - Theme 2.6 - Integrated Management and Communication of Food Safety

**Challenge:**

Where food safety is concerned, the risk can generally be reduced, even significantly. In many cases, however, it cannot be completely eliminated, so management, control and communication play a key role. The management of risks in the supply chain and the use of integrated platforms which allow data and information to be shared throughout and between supply chains is particularly important, as is the introduction of advanced technologies and systems based on multisensory and data fusion techniques for identifying and handling non-conformities.

At the same time, it is necessary to adopt new food safety communication strategies; only effective and coherent communication of risks makes it possible to boost consumer trust in the measures being assessed and risk management, and to give consumers the means of making informed choices that suit their various nutritional, lifestyle and health-related choices. Failure to communicate the risk in a clear, transparent and coherent manner can result in ambiguous messages being passed. This can have serious consequences on the usefulness and quality of the official technical and scientific assessments. In order to make risk communication more effective and uniform in different countries, EFSA has recently published guidelines for effective risk communication. Food safety communication must be combined with communication concerning links between diet and health (Pillar 1) and must aim to provide instruments for proper risk management, including on an individual level. It is necessary to bear in mind that attitudes to food vary greatly, and varying degrees of importance are attached to the food/health relationship. Above all the perception of risk in different social groups and member States of the European Union tends to differ.

Accordingly the activities in this Core - Theme aim to implement integrated systems for making production lines and logistics systems safer, whilst guaranteeing traceability through the supply chain and integrated risk management by adopting advanced systems to identify and remove non-conforming materials.

New food safety communication strategies will also be developed in keeping with EFSA guidelines, studies and assessments of after-sales safety will be conducted and dietary education initiatives will be carried out.

The Core - Theme closely adheres to the following strategic documents:

- Strategic Agenda for Research and Innovation of the European Technological platform “Food for Life”; Chapter 2 - creating opportunities for a sustainable and competitive agrifood industry, through innovation in food processing - 2.3. Challenges in communication, training and technology transfer;
- PON 2014-2020 Investment priority 3b - Develop and produce new business models for SMEs, in particular for internationalisation;
- S3 Emilia Romagna Region “Management of the supply-chain in the agrifood sector” (4.10) and “SMART Agrifood Industry o-industry” (4.11);
- S3 Lombardy Region: SCC3 “Safety of Citizens and the Community” (AG 1.3, 3.3 and AG3.4);
- S3 Molise Region: Driver “Innovation and sustainability in agrifoods processes and products”;
- S3 Piedmont Region. “Made in Piedmont (TRACK-CHAIN)”;
- S3 Puglia Region: “Human health and Technologies for Smart Communities”;
- S3 Sardinia Region: Themed objective 3 “Promoting the competitiveness of small and medium enterprises, the farming sector and the fishing and aquaculture sector”;
- S3 Sicily Region “Sea Economy” and “Agrifood” areas;
- S3 Marche Region: Priority VI;
- S3 Lazio Region “Agrifood and ICT Specialisation Areas”;
- S3 Independent Province of Trento “Safety and traceability of foods”.

**Objectives:**

Developing and implementing procedures for integrated management of risks throughout the supply chain.

The integrated management of risks throughout the supply chain is particularly important for contaminants which can transfer to foods at various stages of the production process. In these cases, integrated management allows the reduction measures to be properly and coherently modulated, whilst at the same time ensuring checks can be geared towards the most important parameters identified with the Analysis of Critical Points. An analysis of supply chain risks and their integrated management is therefore particularly useful for: toxic elements, given that they can be transferred from environmental matrices and contact materials onto foods; tackling the problem of the cross-contamination of allergens suitably, given that this can occur during transformation, storage, preservation and sale; and managing the risk of mycotoxin contamination throughout the supply chain, taking into account the variety of influencing factors and the different phases involved.

**Integrated platforms for retraceability, standardisation and internationalisation.**

The use of integrated platforms which can manage, integrate and render data and information usable throughout and between supply chains can help the production system make considerable progress. The activities to be conducted in this area concern developing software and interfaces, along with the application of data aggregation and merger techniques. Accompanying products with data and information gathered throughout the production chain can allow the production lots to be traceable, and guarantee the traceability of raw materials and products. Sharing data between supply chains can also help get around problems linked to the fragmentation of the production system, encouraging harmonization, standardization and internationalization processes. For aspects linked to retraceability, this line of activity will be conducted in close conjunction with Core - Theme 2.2.

**Optimising and managing recall processes.**

In order to optimise the management of recall processes, the possibilities of introducing cutting-edge technologies to identify non-conformities throughout the production processes and techniques will be developed to minimise the impact of product recall operations.

**Product safety, minimum shelf-life period and expiry date.**

Clarifying the relationship between safety, minimum shelf-life and expiry date can prove extremely useful for protecting quality products, promoting food safety and internationalisation, whilst helping consumers make well-informed choices and reducing food wastage. In particular it is deemed useful to investigate safety issues linked to the consumption of foods past their minimum shelf-life period.

**Developing new strategies for communicating food safety, after-sales safety and dietary education.**

One of the most delicate aspects involved in communicating food safety involves providing guidelines which are as coherent as possible. The fragmentation of the research system and the extent to which the data varies often results in a variety of viewpoints which at times actually contradict one another. The “difference in opinions” is a positive attribute for the scientific world, and one that stimulates it to increase knowledge but, if not properly communicated,
it can lead to considerable confusion and cause a great deal of damage. Accordingly it is necessary to create and strengthen networks between research bodies and producers, and promote sharing of knowledge and methods whilst adopting a uniform approach to management strategies (linking with the information base created with the exposure studies of Core - Theme 2.5 and defining risk). It is also necessary to communicate the risk with a view to defining the health and hygiene standards of products in the Italian Agrifood sector scientifically, in accordance with internationally recognised criteria, the level of health and hygiene of Agrifood produce and its transformation processes, thereby helping to promote typical and traditional Italian produce worldwide. The main objective is to guarantee safety of consumers, helping them make informed choices through a process of transparency, information and knowledge sharing.

Another vital aspect of effective food safety communication is the involvement of the end user. Accordingly it is of vital importance to conduct activities for assessing after sales safety, helping consumers during the food preservation and preparation phases.

Food safety communication must be conducted as part of a wider food communication and education project which tackles the complex problems linked to childhood eating habits as a matter of priority, using an integrated and multidisciplinary approach.

**Expected outcomes :**

The research and development activities of this Core - Theme will make it possible to:
- develop integrated software and platforms for acquiring, processing and sharing data and information;
- develop methods for analysing supply chain risks;
- develop new strategies for reducing risks;
- develop new systems for recognising non conforming materials;
- create and strengthen networks between research organisations and production companies;
- develop new food safety communication strategies.

The main impacts concern:
- boosting consumer confidence;
- improving safety in production lines and during the marketing stages;
- improving safety in after-sales with increased consumer awareness;
- preventing food disturbances, promoting an increased awareness amongst the younger generations of the need to have a diet which is as healthy as possible whilst respecting the work of man, the environment and nature's rhythms.

**Reference documents:**
- Strategic Agenda for Research and Innovation of the European Technological platform “Food for Life”; Chapter 2 - creating opportunities for a sustainable and competitive agrifood industry, through innovation in food processing - 2.3. Challenges in communication, training and technology transfer.
- PON 2014-2020 Investment priority 3b - Developing and implementing new business models for SMEs, in particular for internationalisation.
- S3 Regions of Emilia Romagna, Marche, Molise, Lazio, Lombardy, Piedmont, Puglia, Sardinia, Sicily and the Autonomous Province of Trento.
Pillar 2 type of activity

- Research projects geared towards increasing the basic framework of knowledge, whilst making new technologies and methods available and implementing them;
- Pilot projects and demonstration activities that provide data and knowledge for developing regulations and technologies which are already mature on an industrial level;
- Developing networks for sharing and entering data, information, capacities, models and instrumental resources into the system.

PILLAR 2 MATRIX - S3 REGIONS TAKING PART IN THE CLUSTER CL.A.N.

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PILLAR 3

PRODUCTION PROCESSES FOR IMPROVED FOOD QUALITY

The joint challenges facing international scientific and economic environments include:

a. Promoting technologies and foods for maintaining/improving intrinsic properties of raw materials /ingredients;
b. Adapting foods to meet the cultural, hedonistic and service content requirements of the consumer, all of which are highly diversified and constantly evolving;
c. Creating technologies and foods which are sustainable for the planet.

All of this needs to be conceived with a collective effort involving vision and imagination, because none of us can actually forecast the scenario facing us in the coming decades (new diseases, climate change, conflicts).

Leaving aside aspects actually linked to primary production, which are also struggling under strategies that have already been adopted and are not altogether positive, technological processes can provide an unrivalled boost for solving problems, and are perfectly suited to the task of meeting those challenges.

The concept of “mild technology” has led to the development of technologies which respect food properties and sustainability to a greater extent. It can be adopted using new concepts and new strategies, for a more “global” vision of the “raw materials- food - consumer- environment” system.

There are many production supply chains to which mild dedicated technologies can be applied: the milk and dairy supply chain as well as that of grains and derivatives, preserved and transformed meats, preservation and transformation of fish products, fermented beverages, conservation of products of plant origin (fruit and vegetables) and fatty substances.

The first challenge is basically dictated by opposite emergencies faced by the “poor” and malnourished world, and the “rich” and obese one. In the first, the need was to use resources that were mostly internal and enhance them, developing inexpensive technologies and “enhanced” food formulas. In the latter, which is already technologically developed, the need was both scientific (devising balanced foods) and “cultural” (dietary education from childhood). Both cases can rightly refer to a multifunctional “diet” (nutritional, sensorial, cultural and health-related aspects.) instead of health-giving “foods”. This was the clear-cut indication given by Elke Anklam of the European Commission, to guide research towards and open and overall vision of the problem. From the standpoint of present-day scientific and technological knowledge, it is now possible to “steer” the food composition in the direction needed, with impoverishments (less fats and allergens) or enrichments (omega-3 and omega-6 fatty acids, fibre, probiotics or microbial cultures that can increase the bioavailability of specific nutrients and antioxidants). It is possible to modulate the technological process in such a way as to preserve the nutritional and sensorial characteristics of foods (e.g. treatments using microwaves and radio frequencies) or increase the bioavailability of bioactive components (e.g. some thermal treatments on the bioavailability of lycopene in tomatoes), or again to induce the formation of compounds with an antioxidant effect (e.g. roasting coffee).

The second challenge, which has already been tackled in the same terms in pharmaceutical field, is that of tailor-made foods. Foods built around the individual consumer call for a vision based on a series of single macro, micro or nano ingredients, which can be combined at will to tailor formulations. In this respect, the technology of the future might
be the a 3D printer which combines all the ingredients in a mixture and creates the programmed food. There are still many problems that need to be solved in order to industrialise this technology, but the need to use it on a larger scale is increasing.

The third challenge can only be overcome with a global reduction of waste, particularly those of an agroindustrial kind, and by inventing new completely compostable and/or biodegradable materials. Rolling these two processes into one means achieving a number of goals in one go: the agrifood industries are relieved of the problem of disposing of waste, which is a cost; transforming this cost into a resource to obtain new products; and significantly reducing the environmental impact of wastage and materials. The only direction which can be pursued is that of the “wholesale” re-usage of waste, as the method adopted until now for extracting the components of interest (e.g. lignin) from plant waste using chemicals has not always proven a winning strategy. This “whole” waste must then be reinserted into other matrices to make new materials. The “technological way”, on the other hand, exploits the waste as a whole, maximising every possible component, including by using biotechnological methods based on cultivating microbes which are selected before transforming what is left into biodegradable material. Research in these directions is already making good progress, although it needs further development to achieve industrialisation and prepare materials with properties that differ according to the different packaging needs.

This multi-functional approach must be geared towards increasing knowledge of the relationships between microstructure, process, product characteristics, technological innovation and identifying suitable process and product indicators that safeguard the quality and origin of products, as well as adapting to meet food regulations in order to ensure traditional Italian products are increasingly protected (Made in Italy) from commercial fraud (falsification). The latter includes the “Italian Sounding” phenomenon, which is worth 60 billion Euro, namely around half the total turnover of the Italian food industry and almost double the 29 billion in exports.

Based on previous considerations, the following Core - Themes have been identified as representing certain subjects of priority interest which are relevant to improving food quality in production processes:

3.1 Developing know how on interactions between microstructure, process, characteristics and product performance. Improving knowledge of process-structure-performance relationships in the production supply chain, with particular attention to micro-structural amendments.

3.2 Identifying/using process, product and traceability markers, developing on-line process control systems. The marker control systems must be flexible and easy to apply/manage, at costs which are within the reach of SMEs, for analysing and controlling the various phases of the technological line and distribution chain.

3.3 Development/evolution of thermal and non-thermal mild technologies. These types of technology aim to reduce the thermal, chemical, structural and sensorial damage of a food whilst safeguarding its naturally inbuilt properties.

3.4 Developing food products aimed at new and/or specific cultural and sensorial needs of consumers. These products, aimed in particular at consumers from Italy or countries with greatest potential for developing our exports, must be developed redefining the characteristics of the ingredients/raw materials, formulations, production technologies and consumption methods.

3.5 Developing know how on preserving food products and innovative packaging. The aim is to guarantee/increase the sensorial shelf-life and profile, with potentially positive knock-on effects on food safety, products for the domestic, European and overseas market. In addition, the aim is to reduce waste by supporting quality in logistics chains of a critical nature for time, temperature and moisture-related reasons.
3.6 Revising/updating the regulatory aspects concerning foods. These proposals must be the result of close interaction between food technology sciences with food law protecting product quality, transformation companies and consumers (regulations, production guidelines etc.).

CORE - THEME 3.1 - DEVELOPING KNOW HOW ON INTERACTIONS BETWEEN MICROSTRUCTURE, PROCESS, CHARACTERISTICS AND PRODUCT PERFORMANCE

**Challenge:**

The importance of the effect microstructure has on the quality of foods has been universally acknowledged. Most food production processes, from transformation of the raw materials to conservation and consumption, trigger microstructure changes which have a greater or lesser influence on the rheological, technological, nutritional and sensorial qualities of foods.

As a result, a thorough study of the microstructure changes which take place in the different production stages as a result of interactions between the various components and in relation with the different technical parameters used, can provide essential information about changes to the above properties in the resulting products.

Acquiring this knowledge is nonetheless still a challenge which has only just begun to take its first steps in recent years. Some authors have developed statistical correlation functions which can describe the microstructure of numerous materials (Torquato et al., 2002). These can include Linear-path distribution function, \( L'(z) \), Two-point correlation function, \( S_2(r) \), Two-points cluster function, \( C_2(r) \), etc.

Developing know how of micro structural interaction can have an impact on all foods and, as a result, it can constitute a powerful means of supporting breakthrough innovation and the competitiveness of the Italian food sector (Made in Italy linked to SMEs and large-scale industry), in order to identify ways of achieving greater international competitiveness linked to "ADDED VALUE" and not a price war (in which, for reasons which we are familiar with, we are at a disadvantage both where emerging countries and highly competitive nations are concerned).

The Challenges posed by Core - Theme 3.1 are:

- the qualitative and quantitative characterisation of the food microstructure regarding applied technological and biotechnology processes;
- the development of Food Design, taken as a set of processes and knowledge which can develop foods with specific nutritional, functional and sensorial properties by modulating and controlling the microstructure.

The Core - Theme closely adheres to the following strategic documents:

- JPI HDHL Strategic Research Agenda;
- JPI FACCE;
- S3 Emilia Romagna Region:
- S3 Lombardy Region:

**Objectives:**

The objectives of the Core - Theme are:

- determining the relationship between microstructure and formulation, chemical and microbiological stability and the rheological, sensorial and nutritional properties of the food products adopting standardised methods;
- using standardised methods to analyse which production processes can have the greatest influence on food microstructure;
• developing modified/integrated processes to improve the rheological, sensorial and nutritional properties of existing products, or to devise new products with specific characteristics and high added value.

The activities needed to achieve them are as follows:
• Implementing the use of Statistical Correlation Functions to provide a statistical description of food microstructures;
• Defining the “minimum” statistical information needed to describe food microstructure precisely;
• Correlating microstructure information with the rheological, sensorial, nutritional and stability-related attributes of foods, and the way they change according to the type of process and parameters applied;
• Rebuilding the microstructure of foods starting with limited instrumental information;
• Predicting the macroscopic properties (rheological and sensorial) of foods, using microstructure information;
• Re-examining the transformation and stabilisation treatments in terms of the effects they have on food microstructure;
• Applying know how developed to achieve significant and specific improvements with high added value for existing products;
• Applying know how developed to achieve innovative, specific products with high added value.

Expected outcomes:
The expected impacts actually concern every food category. Some examples involve:
• Tenderising meat, reducing the time meat is left to hand and the temperatures needed;
• The use of potato proteins for solid or semi-solid products that encompass/retain large amounts of gases and stable emulsions, with different rheological and sensorial characteristics;
• The effect of antioxidants from plant sources, fibres of different origins and sourdough on the structural, nutritional, sensorial and stability characteristics of bread;
• The effect of different types of starch, flours made from pulses /vegetables/grains without gluten and process variables affecting the structural, qualitative and sensorial characteristics of gluten-free pasta and baked produce;
• The use of phenol substances in suspension to increase vegetable oil oxidation stability;
• The sensorial perception of fat in foods with reduced fatty content for emulsifying and altering the microstructure properties;
• Innovative systems for controlling and producing foods based on new technologies (such as light-scattering dynamic, etc.).

Type of activity:
• Pre-industrial research and development project.

Reference documents:
- Strategic Agenda for Research and innovation for the European Technological Platform “Food for Life”.
**挑战：**

意大利的农业食品资产是其同类中独一无二的，无论是质量还是种类。意大利的美食文化和农业食品产品在全球范围内享有盛誉。因此，为了提高食品质量而发展和/or优化生产技术，需要定义适合的过程和产品指标。为了实现有效和创新的质量控制，以及确保产品的可追溯性，过程和产品指标需要紧密相连，同时使用过程标记和有效的文件控制。通过对原始材料到最终产品进行全面定义，可以监控过程、质量、可追溯性，并因此增加市场的价值。必需为贸易行业装备创新的分析系统来检测和监控质量标记。与此同时，也至关重要的是为供应链的专业人员和消费者提供快速和简便的使用方式。这些标记必须具有预测功能，采用数学建模技术（如“食品过程建模”，预测微生物学）。

这些过程和产品指标也将非常有用，用于与国际规则和协议合作，任何商业欺诈和“意大利发音”现象，以确保原材料和生产过程的质量完全透明。

**Core-Theme紧密遵循以下战略文件：**

- JPI HDHL战略研究议程；
- JPI FACCE；
- 国家技术平台“意大利食品生命”。2030年战略研究和创新议程。实施行动计划 – 六月2011；
- S3地区撒丁岛、莫利塞、艾米利亚-罗马涅、伦巴第、皮埃蒙特和西西里；
- TTIP“跨大西洋贸易和投资伙伴关系”。

**目标：**

- 确定新标记以建立改进的生产条件/新生产组合的方法。
- 制定具有预测功能的标记组，使用数学建模技术。
- 确定并验证用于评估包装食品的保存状态和监测保质期的标记。
- 开发传感器、生物传感器和其他快速系统和应用遥测系统来确定过程标记在-line，以及在新鲜/加工和发酵产品中特定感官属性。
- 确定生产中和分发中的关键点（到最终消费者）。
- 确定生物化学-分子标记，可以唯一标识所用成分。
- 确定标记和开发快速方法，用于验证食品的真实性，监测欺诈/假冒/意大利发音。
- 设计和验证预测的数学模型，模拟标记的定量水平的变化，以及从原材料到成品的微生物的可能发展。
- 开发快速且非破坏性分析系统，只要将成本控制在小型企业的范围内，可用于控制质量、真实性、一致性（外包生产）以及食物的化学、微生物和感官质量。
- 验证技术处理对营养和感官特征，以及生物活性化合物在典型意大利食物的生产中产生的影响。
**Expected outcomes:**

The expected impacts involve:

- Devising new control systems which are flexible and easy to apply/manage, the cost of which is within reach of PMEs, for analysing and controlling the different stages of the technological line and distribution chain;
- Enhancing the quality of food products by identifying process indicators and creating devices that are fast for supply chain professionals and consumers to use, to assess the preservation of products and ensure they have maintained their sensorial characteristics;
- Defining process and quality descriptors for fresh, transformed and fermented products;
- Developing sensors and biosensors to provide on-line monitoring of the qualitative parameters of fresh/transformed and fermented products;
- Improving competitiveness and modernise SMEs; creating new professional figures (young people and/or staff already employed by the company concerned which need to be retrained);
- Reducing the number and impact of food fraud (counterfeiting) and Italian Sounding’;
- Improving knowledge regarding the relationships between formulating, processing and maintaining the intrinsic qualities of food products;
- Improving the speed and efficiency of checks during processing (ICT) and increasing defence of national and typical products as well as certifications of specificity;
- Increasing the sustainability of production, improving traceability, monitoring quality and the use of products and valorising the areas of origin;
- Collecting and conducting a critical analysis of existing predictive models for the various production supply chains;
- Devising and validating functioning predictive models, even under non-stationary operative conditions;
- developing application software for PCs and Smartphones that provide predictive models, and developing Apps for end users (origin of raw materials, composition etc);
- reducing the technological damage to transformed foods and maintaining the intrinsic characteristics of the ingredients.

**Type of activity:**

- Research project.
- Technological transfer project.

**Reference documents:**

- ASTER (2014). S3 Emilia Romagna Region: Regional Agrifood Technological priorities.
- Committee on the Environment, Public Health and Food Safety, on the food crisis, fraud in the food chain and the control thereof (2013/2091(INI)).
CORE - THEME 3.3 - DEVELOPMENT/EVOLUTION OF THERMAL AND NON-THERMAL MILD TECHNOLOGIES

Challenge:
Mild technologies aim to reduce the thermal, chemical, structural and sensorial damage food undergoes, safeguarding the intrinsic properties it naturally contains. The idea of combining several low-intensity stabilisation treatments, as opposed to the traditional approach of making a food stable by using one single technology applied at high intensity, such as in the case of thermal sterilisation treatments, has allowed considerable process and product knowledge and innovation to be achieved.

The following Challenges can be identified:
- mathematical forecasting of the effects of multi-hurdles;
- mild technologies for improving sensorial quality;
- developing a green and eco-friendly approach to extending the shelf-life of agrifood products;
- mathematical prediction of multiple obstacles to the main deterioration reactions in foods, in order to identify the best ways, for each food, to apply mild technologies;
- modulating transformation and stabilisation treatments, both traditional and innovative, in order to improve the sensorial acceptability of finished products amongst consumers;
- mild food formulation: developing stable and safe food formulations by modulating ingredients with direct or indirect stabilising properties;
- using green antimicrobials with a low impact on the environment and consumer health;
- evolution of the "Mild Technology" principle towards a principle of process selectivity (i.e. "Dedicated Technology").
- "Low Scale Technology", with particular attention not only to applications for small and micro-businesses (bakers, patisseries, meat and fish, dairy, fresh pasta, beverages, ice-creams etc.) but also for domestic handling (juicers, microwaves, mixers, micro breweries and coffee machines).

The Core - Theme closely adheres to the following strategic documents:
- SRIA-Food for Life: Priority Challenge 5.1 – Creating opportunities for a sustainable and competitive agrifood industry, through innovation in food processing; Priority Challenge 5.2 - Health and safety of our foods;
- KET: biotechnologies for agriculture and food quality.
- S3 Regions of Emilia Romagna, Lombardy, Piedmont, Puglia, Sicily and Tuscany.

Objectives:
- Developing and perfecting new forms of mild technologies and new technology combinations which can improve food quality.
- Guaranteeing greater efficiency and sustainability with the same hygiene and quality conditions.
- Mathematical modelling of the effects of multiple obstacles posed to deterioration reactions.
- Analysis of the combination of treatments chiefly aimed at minimising any potentially negative impacts on sensorial quality.
- Extending basic knowledge of the stabilising properties of traditional and innovative ingredients.
- Analysing and devising innovative food formulations and mild technologies.
- Analysing the behaviour of the autochthonous microflora of food products when subjected to non-thermal or alternative approaches, such as microwaves, radio frequencies, ultrasound, high homogenisation pressure, assessing the intra and inter-specific variability and the possibility of forms of resistance and/or adaptation of arising.
• Analysing the working mechanisms of green and new formulation antimicrobials (such as essential oils, bacteriocins etc.) , assessing their bioactivity profiles against bacterial spores, fungi and the most resistant micro-organisms (lactic bacteria and suchlike, Gram negative alterations).
• Combination of physical and chemical approaches to adopt efficient combinations based on the use of the hurdle technology theory.
• Validation of treatments on foods, comparing effectiveness versus traditional treatments, analysing financial feasibility and assessing effects on the sensorial and structural properties of foods.
• Development of innovative forms of mild technologies to improve conservation and transformation of cooked ready-to-eat vegetables, making it possible to minimise thermal and oxidising damage.
• Analysis of single operations linked to cooking which can reduce and/or eliminate the concentration of unwanted molecules in baked products whilst ensuring the sensorial characteristics remain unchanged or are actually improved.
• Drafting and validating "Optimization Charts" of operative processing conditions, based on the process selectivity principle.

Expected outcomes:
The expected impacts involve:

• developing and new mild technologies for redefining the process of transforming products with improved preservability and sensorial and nutritional qualities;
• promoting industrial transfer of non-thermal technologies;
• optimising combined approaches (natural physical+antimicrobial treatments);
• creating a databank on the bioactivity profiles of green eco-friendly antimicrobials on autochthonous microflora which takes into account the inter- and intra-specific variability and type of the food product;
• mapping alternative physical approaches according to the type of micro-organism, raw material treated, degree of efficiency required and energy inputs;
• increasing shelf-life in line with product sale time frames, promoting their distribution on international markets;
• recuperating and reusing waste;
• implementing charts to optimise processes and validate them on an industrial scale;
• developing application software for PCs and smartphones to optimise processes;
• increasing economic potential and the benefits for the end consumer, with particular reference to foods which contain functional elements with a high service content and which are pleasing on a sensorial level.

Type of activity:

• Pre-industrial research and development projects with different expertise requirements (chemists, biologists, microbiologists, biochemists, food technologists, engineers, doctors, marketing professionals, ...).
• Technological transfer projects.

Reference documents:

- "Por per fare". Let's build the 2014-2020 Programme together. S3 Emilia Romagna Region, the Regional Technological Agrifood Priorities. Industrial and innovative technologies and biotechnologies for the Food Industry(4.5 p 33) January 2014. Document organised by ASTER and drafted within the framework of the High Technology Network of the Emilia-Romagna Region. fesr.regione.emilia-romagna.it.
**Challenge:**

In particular these are products aimed at consumers from Italy and countries with greatest potential for developing our exports to harness the potential of their highly positive sentiment for Italian-made products in full.

They also include cutting-edge tailor made and functional foods and are obtained by redefining the characteristics of the ingredients/raw materials, formulations, production technologies and consumption methods.

The globalisation of markets and significant migrations towards evolved countries have had a very negative effect on the opportunities and problems which SMEs and major industries in Italy are facing.

Problems include the price competition being staged by emerging countries (with low labour costs) and evolved countries (larger company sizes with significant scale economies), which can only be overcome with a high degree of added value in our products (quality, food safety, taste, shelf-life,...).

Opportunities include potential for expanding into ranges of products which until now had not been covered. In fact, the latest market trends are geared towards foods which are:

- “Tailor made” for cultural, hedonistic, sensorial and rheological needs as well as for their service content etc.
- “Nutritional” for specific consumer categories, such as foods with high nutritional value formulated to counteract malnutrition in the elderly.
- “Healthy” with fibre, antioxidants, omega 3, vitamins, minerals, pro- and pre-biotics, bioactive peptides etc.
- “Wellness” with lower calories, saturated fats, added sugars and salt.
- “Protein-rich” with higher protein content, with vegetable proteins etc.
- “Free-From”: free from gluten or lactose or individual allergens or synthetic colours or preservatives etc.
- “Natural” “Organic”, “locally sourced”, with preservatives/colours/natural aromas, etc.
- “Veg”: for vegetarians and vegans.
- “Halal and/or Kosher”, “Ethnic”, etc.

It is accordingly necessary to ensure current production patterns evolve, opening up to new raw materials, reformulations or new formulations and new processes whilst at the same time ensuring the outstanding sensorial characteristics and quality of the Italian product are wholly maintained and, if possible, even improved. It is also important to have a shelf-life which guarantees the excellence of the products until their expiry both on European and extra-European markets, with complex logistics and high temperatures and moisture levels.

**The Core - Theme closely adheres to the following strategic documents:**

- JPI HDHL Strategic Research Agenda;
- JPI FACCE;
- Strategic Agenda for Research and Innovation of the European Technological platform “Food for Life”;
- S3 Regions of Abruzzo, Emilia Romagna, Lombardy, Marche, Molise, Piedmont, Puglia, Sardinia, Sicily, Tuscany and Umbria.

**Objectives:**

- Identifying raw materials and processes that make significant amendments/improvements to current products, or creating new products with a highly innovative and service-based content, in line with the latest consumer trends.
- Identifying changes to products and processes that help increase added value for current and potential
international markets for traditional Italian products.

- Developing dedicated products with functional and sensorial properties in demand on the market and new consumer trends/needs.

**Expected outcomes:**

The expected impacts involve:

1-**Research and experimentation with new raw materials:**
   - Plant matrices and agrifood by-products for tailor made/functional foods with a high degree of sensorial acceptability, also using sustainable microbial bio-technologies.
   - Assessing the composition properties and technological potential of by-products for developing tailor made foods.
   - By-products of the milk-dairy and grain supply chains (whey proteins, lactoferrin, antioxidants, vitamins, complex carbohydrates, plant fibre etc.).
   - Innovative flours for the formulation of baked products and pasta.
   - Extraction/enhancement of molecules with a biological effect, such as vitamins, peptides, essential fatty acids, aromatic substances, micro-elements and polyphenol compounds to be used for developing new products (technological, structural and sensorial aspects).
   - Oils with a low saturated fatty acid content oxidation stability (altoleic sunflower, olive ...), potentially enhanced with anti-oxidants to reduce the development of carcinogenic/mutagenic molecules (acrylamide and Maillard products) or to increase their nutritional value (e.g. oils enriched with bioactive compounds for co-milling) or their own shelf-life as well as that of the products they are used in.
   - Raw materials for formulating foods with a low fat/added sugar/salt content but with highly appealing sensorial characteristics.

2-**Research and experimentation with new processes:**
   - Analysing techniques to recuperate low cost by-products and their functional components, with a low environmental impact.
   - Analysing process parameters to guarantee greater stability and retention of components with a biological effect.
   - Analysing processes to achieve sensorial attributes which are clearly defined and appreciated by consumers.

3-**Research, experimentation and assessment of new products:**
   - Development of new food products containing microbial *tailor-made* compounds or cultures which are appealing from a structural, sensorial and functional point of view.
   - Functional beverages as supplements for minerals, vitamins and anti-oxidants.
   - Bakery products with reformulated hardened fats.
   - Development of products with rheological and sensorial properties aimed at children and the elderly.
   - Assessment of the sensorial profile (descriptive tests) and preferences of consumers (consumer test) of innovative foods.
   - Determining sensorial variations (with descriptive/ discriminant/ dynamic tests) of tailor made foods purposely formulated for specific consumer needs.
   - Sensorial validation of the products obtained and the interaction between genetic and nutritional factors in groups of consumers with specific food needs.

**Type of activity:**

- Pre-industrial research and development projects requiring different expertise (chemists, biologists, microbiologists, biochemists, food technologists, engineers, doctors, marketing professionals, ...).
Challenge:

Extending the shelf-life of food products beyond that already achieved using current knowledge is an area which has been tackled for some time now, and is still the object of a considerable number of projects. The gradual but constant move from foods of long to short-to-medium shelf life has prompted the development of more advanced and refined technologies. For example, the constant and increasing success of ready-to-eat and ready-cooked produce has led to the development of new technologies, because these products are more exposed to alterations owing to the absence of stabilising heat treatment systems and the use of the cold chain, with the potential risk of inadequate transfer or preservation conditions before use.

The use of chemical preservatives in preservation systems has over time been restricted to a small section of the market, whilst new technologies aimed at countering the deterioration of foods using “natural” or physical/mechanical methods are being developed.

Lastly, the development of preservation technologies is closely linked to food safety, for which the principle of prevention calls for treatment systems that can guarantee there are no priority risks posed (toxins, pathogenic agents, etc.).

Another strategic aspect which increasingly affects the way packaging is designed involves the need to take the entire life cycle (LCA-Life Cycle Assessment) of food products into account, from producing raw materials and packaging to complete disposal of product waste.

Recent research has developed moisture regulators to be placed inside packaging for bakery products in order to prevent moulds from developing, or edible films containing natural antimicrobials which can be applied to a wide variety of foods (dairy products, fish products, fresh vegetables, ...). These applications make it possible to simplify packaging considerably, reducing its environmental impact.

As regards the recuperation and reuse of waste, it is still difficult to recuperate domestic waste, whilst it is far more feasible to recuperate waste from industrial processes. Recently a process to transform industrial plant waste into biodegradable materials with properties resembling cardboard but less moisture permeability has been developed.

To sum up, this Challenge sets itself the goal of globally managing the “packaging system”, viewing it both in terms of “usage” aspects, quality, safety, shelf-life and communication, as well as from the “management” angle, involving costs, logistics and environmental impact.
The production of packaging is highly consolidated worldwide (turnover worth 470 billion € in 2011). In Italy, over 70% is destined for the food industry. Its primary aim is to develop packaging which can maintain sensorial and nutritional quality as well as guaranteeing safety both in the domestic and international market, in terms of time frames, temperatures and the complex logistics of overseas markets.

The Core – Theme closely adheres to the following strategic documents:

- JPI HDHL Strategic Research Agenda;
- JPI FACCE;
- Strategic Agenda for Research and Innovation of the European Technological platform “Food for Life”;
- S3 Regions of Emilia Romagna, Lombardy, Marche, Piedmont, Puglia, Umbria, Tuscany and Sicily.

Objectives:

Preparing:

- pre-treatments of a physical/mechanical nature to prevent food alterations;
- new packaging processes and systems to safeguard and/or improve quality and sensorial characteristics, and prolong shelf-life whilst respecting environmental sustainability (LCA), food safety and economic competitiveness;
- processes for the sustainable reuse of agroindustrial waste on an integral scale.

Expected outcomes:

The main impact will involve guaranteeing/increasing shelf-life whilst maintaining the sensorial profile unchanged, with potential positive knock-on effects on food safety, for products on the European national and overseas market. In addition, the aim is to reduce waste by supporting quality in logistics chains of a critical nature for time, temperature and moisture-related reasons.

To this end, the research will focus on developing:

- conservation techniques which can guarantee a greater shelf-life and respect the utmost sensorial quality (using, when necessary, natural additives and natural anti-microbial substances and for bio-control crops);
- biodegradable/compostable materials;
- packaging which itself helps preserve food properly and/or extend its shelf-life (edible, active, intelligent packaging);
- packaging that makes it possible to reduce residual quantities at the end of the life cycle to a considerable extent;
- techniques with a limited or zero environmental impact for reusing agroindustrial waste (systems for co-milling virgin oils);
- disposable packaging not produced using vegetable waste with specific physical-mechanical characteristics (coffee silverskin, de-oiled orujo or solid olive waste ...);
- criteria/methods of analysis for identifying deterioration markers linked to consumer freshness perception and creating predictive chemometric models for determining the shelf-life of a product;
- Ingredients which are stabilized and standardized in terms of the titre of bioactive molecules with an antioxidant and/or antimicrobial effects, which can increase the preservability of the food product and protect/improve its sensorial characteristics.
### Type of activity:

Pre-industrial research and development projects requiring different expertise (chemists, biologists, microbiologists, biochemists, food technologists, engineers, doctors and marketing experts,...).

### Reference documents:

- Strategic Agenda for Research and Innovation and Implementation Action Plan “Italian Food for Life”.

### Challenge:

Proposing the introduction of a single regulatory container on the general principles, techniques and processes used on foods, in order to simplify the relationship with the authorities, control bodies and supply chain professionals. This should consider the following as a whole:

- rules of the food market and competition, particularly concerning typical and quality produce;
- food processing;
- food safety;
- food security and the relationship with agricultural production;
- food health and the relationship with pharmaceutical processing regulations;
- food nutrition;
- food product labelling;
- food waste.

These proposals must be the result of close interaction between food technology sciences with food law protecting product quality, transformation companies and consumers (regulations, production guidelines etc.).

1) Protection of brands and food quality designations in European and (above all) international markets, and working to stop counterfeiting and the Italian Sounding phenomenon

2) Revising current Italian legislation on grains and derivative products, milk and derivative products and food oils and fats; it does not take into account the way the sector has evolved in the last decades and the new products that have appeared on the market as a result of consumer demand for healthier products (wholegrain or gluten free products, etc.).

3) Using taxation as a tool to “re-educate” the eating habits of citizens.

4) Reducing rejects/waste/returns during the food distribution phase.

### Objectives:

**Points 1. and 2.**

- **a)** Create the institutional and regulatory conditions for protecting Made in Italy goods on a European and global level in the food sector.
- **b)** Assess common dairy product labelling problems regarding the lawful use (recently established in the EU) of milk powders and concentrated milk.
- **c)** Establish clear identification of the fatty and non-fatty components of butter made with the cream of various animal species, to provide legislators with the legal means of labelling mixed products.
- **d)** Make it possible to market cold pressed or virgin oils obtained from different substrates of olives by
introducing specific quality standards.

e) Provide knowledge support for issuing a new legislative framework which addresses the need to revise old rules on grain-based products (law 580/67 and subsequent laws) in the light of the current and potential future market situation and the drafting of new rules concerning new products of consumer interest

f) Define regulatory frameworks in line with emerging importer countries (e.g. China, India, Russia).

Point 3.
a) Steer citizens towards eating with awareness, with a more rational approach to portions and frequency which is suited to their lifestyles.
b) Provide tax breaks to health-friendly agrifood businesses which produce without using additives and/or pesticides and that have developed a system for managing the waste cycle in such a way that minimises environmental impacts.

Point 4.
a) Create the regulatory conditions for recuperating/reusing food rejects/returns/waste.

Expected outcomes:

Points 1. and 2.
a) Drawing up a draft document alongside a Food Code. This document would be aimed at Italian and European authorities and would be useful for the purposes of negotiating international agreements (TTIP etc).
b) Helping producers to respect EU regulations, and provide the technical means and scientific knowledge needed to protect products.
c) Drawing up guidelines and ensuring there is greater clarity and transparency for all professionals in the grain and dairy-cheese supply chains, as well as greater guarantees for consumers.
d) Reducing controversies and fines imposed on companies by the Italian Anti-Trust Authority (AGCM).

Point 3.
a) Defining a type of tax which might help re-educate citizens: identifying the requirements, passive subjects and goals to avoid recessive effects.
b) Defining business taxation which is health-friendly.

Point 4.
a) Reducing and re-using food rejects/waste/returns in the food distribution phase.

Type of activities:

Coordination/network activities which involve research organisations (authorities and Universities) which are active in food research (food technologists and legal experts), trade associations and industries in the sector and officials from the Ministries involved (Agriculture, Health and Economy).

Reference documents:

- Costato Luigi, Albisinni Ferdinando, European Food Law -CEDAM -Year 2012.
- Measures by the Anti-Trust Authority (AGCM) governing food products.
- 20% “fat tax” needed to improve population health”, in British Medical Journal, 14 May 2012.
- TTIP, “Transatlantic Trade and Investment Partnership”.

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## PILLAR 3 MATRIX - 53 REGIONS TAKING PART IN THE CLUSTER CL.A.N.

<table>
<thead>
<tr>
<th></th>
<th>Abruzzo</th>
<th>Emilia Romagna</th>
<th>Lombardy</th>
<th>Molise</th>
<th>Piedmont</th>
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<td>3</td>
<td>Production processes for improved food quality</td>
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<td>3.1</td>
<td>Developing know how of interactions between microstructure, process, characteristics and performance of products</td>
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<td>3.2</td>
<td>Identifying/using process, product and traceability markers, developing online process control systems</td>
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<td>Development/evolution of thermal and non-thermal mild technologies</td>
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<td>3.4</td>
<td>Developing food products aimed at new and/or specific cultural and sensorial needs of consumers</td>
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<td>Developing know how on preserving food products and innovative packaging</td>
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<td>3.6</td>
<td>Reworking/updating regulatory aspects of foods</td>
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it is estimated that by 2050, the world’s population will have reached 9.1 billion, 25% more than today. Food production will have to increase by 70% to meet the needs of the increasingly numerous populations of cities. Food will have to be produced on smaller areas of land, reducing the amount of natural resources such as water and soil even more.

Global food production methods have to change to minimise the environmental impact whilst supporting the world’s capacity to produce food in the future. Food production contributes towards climate change, water shortages, soil impoverishment and the destruction of biodiversity. It is estimated that 25% of greenhouse gas emissions are caused by animal and plant production, and by the reduction in forests. Agriculture and zootechnology use 70% of fresh water resources and, along with forests, occupy 60% of the terrestrial surface area.

At the same time, demand amongst citizens in Europe for food products that meet high standards of safety, quality and animal wellbeing is on the rise.

The challenge being faced by the food industry, which is tackled in this Pillar, consists of intensifying production whilst reducing the environmental impact and pressure on natural resources, whilst at the same time making products that are healthy and safe, and which give people a varied diet with a suitable and balanced combination of energy and nutrients for good health.

This Pillar has been prompted by the requests of the industrial food system, and constitutes an overview of its vision. The set of development processes identified to follow aim to promote a development model which achieves a balance between environmental, economic and social demands, whilst improving the agrifood sector’s competitiveness as a whole. The aim is to adhere to an approach which is integrated throughout the various production supply chains whilst increasing the level of integration and technological innovation in every link of the supply chain.

This Pillar comprises six different evolutionary processes (Core - Themes), which are integrated with one another:

4.1 Promotion of sustainable crop systems.
4.2 Sustainable animal production: innovative techniques for genetic improvement, increasing disease resistance, restoring the balance in the impact of milk and meat production, assessment of suitable sizes of tuna for the transformation industry.
4.3 “Smart grid”: electricity micro-grids, reduction of impacts and definition of a common approach for gauging sustainability.
4.4 Valorising rejects, waste and by-products for increasing the portfolio of finished products destined for consumption as food, fodders and agricultural purposes (compost), not least by modelling territorial and urban logistical networks for recovering food products that would otherwise be lost.

- FAO (2013). Healthy people depend on healthy food systems.
4.5 Developing innovative tools for advising consumers of the environmental and nutritional content of menus in the catering and foodservice sectors.

4.6 Innovative techniques for reducing the use of veterinary drugs, and preventing the risk of antibiotic resistance in farms.

**CORE - THEME 4.1 - PROMOTION OF SUSTAINABLE CROP SYSTEMS**

**Challenge:**
Identifying and promoting the adoption of new plant varieties and cultivation systems which are more efficient and sustainable, capable of improving the competitiveness of wheat and vegetable supply chains, re-assessing the role of agriculture and reducing the environmental impact.

**Objectives:**
1. Sustainability of wheat and vegetable supply chains, with measures geared towards making genetic improvements and selecting varieties in response to new emerging risk factors (product safety, resistance to abiotic stress and adaptation to climate change).
2. Optimising the use of water resources in agriculture.
3. Re-assessing existing agronomy techniques.
4. Developing and applying innovative systems for improving the efficient use of bio-fertilizers and bio-phytopharmaceuticals in order to reduce the input of chemical substances, the environmental impact and improve the competitiveness of businesses.
5. Developing an integrated system for efficient management of water and nutritional resources.

The Core-Theme closely adheres to the following strategic documents:
- S3 Emilia Romagna Region, Pillar 4.2;
- S3 Puglia Region, innovation areas 2.2.1 and 2.2.2;
- Strategic Plan for Innovation and Research in the Agricultural and Forestry Sector (2014-2020);
- JPI FACCE, core themes 3, 4 and 5.

**Expected outcomes:**

- **Objective 1** involves reducing the risk of mycotoxins (caused by susceptibility to wheat head fusariosis), increasing crop sustainability by increasing the efficiency of sulphur usage, and developing disease-resistant varieties, increasing milling yield and nutritional quality. Nowadays there is significant genetic variability for all these characters, and there is enough genome knowledge to provide a real impact on these aspects from a varietal standpoint. Some fusariosis-tolerant soft wheat varieties have already been released in Italy, whilst at the moment there are no durum wheat tolerant varieties on the market. There is evidence of genetic diversity in the response to nitrogen fertilising. Numerous disease-resistant genes have been described, yet the constant evolution of pathogens poses challenges that are continually changing. The milling yield is the fundamental parameter for measuring the efficiency of the conversion between the harvested seed and the finished product (bread, pasta). This characteristic largely depends on the size of the seed, an aspect which is influenced by genetic and environmental factors as well as nutritional quality. For the purposes of selecting genetically superior lines with the "seed weight" characteristic, it is possible to proceed using both natural genetic variability and by inducing a new genetic variability with a targeted and induced mutagenetic system; to this end TILLING populations are already available for many crops including wheat. The aim is also to study and characterise new genotypes resistant to abiotic stress which can adapt to climate changes.

- **Objective 2** involves maximising the efficiency with which water is used. Accordingly genetic improvement
strategies will be used to identify the candidate genes responsible for absorbing and using water, also in a way that complements objective 1; soilless cultivation in a closed system with sub-irrigation in channels using rainfall water and reusing nutritional elements from crop residues; assessing the production, physiological and phytoatric performance of plants farmed in the greenhouse-tunnel recently patented by CREA-ORT (No. TO2013A000494) which makes it possible to cultivate under mesh (a mechanical barrier to prevent insects from entering) without significantly affecting natural ventilation. Lastly, the objective aims to introduce technologies with a low environmental impact to improve foods that support their respective supply chains. These technologies make it possible to use Sensor-based irrigation management in soil-based and soilless cultivation systems in order to improve water use efficiency, adopting intelligent systems for rational water provision, even when this is of low quality, ensuring it meets the needs of vegetable and tree crops, such as vines.

• **Objective 3** aims to promote the adoption of more efficient and sustainable grain cultivation systems, based on the traditional method of multi-year crop rotation. The objective will make it possible to enhance these techniques and prove their validity in terms of both economic sustainability and of reducing the environmental impacts of farming activities. Besides having a positive impact on professionals involved directly in the supply chain, the implemented measures will have a positive knock-on effect on the areas involved, thanks to an increase in the economic downstream activities, the reassessment of local territories and development of the companies involved. The following measures will be implemented:
  1. Developing a method for assessing the characteristics of the different crop systems currently in use, and identifying and assessing specific alternatives for the given context.
  2. Identifying and assessing efficient and sustainable crop systems based on multi-year crop rotation, and on using decision support systems (DSSs) that make managing and using fertilisers within the individual area more efficient.
  3. Implementing experimental tests in the field to test the efficacy and feasibility of the model identified.
  4. Development of multi-stakeholder partnerships, based on involving raw material suppliers, research bodies, organisations of producers and transformation industries.
  5. Development of horizontal partnerships between complementary supply chains in order to allow farmers to develop crop rotation systems which are sustainable and cover a number of years, making it possible to reduce waste whilst guaranteeing a commercial outlet for all crops.

• **Objective 4** involves improving efficiency in how biofertilisers and (bio)phytopharmaceutical products are used, by developing products, processes, methods of use and protocols for applying micro-organisms useful to the rhizosphere, in order to reduce the input of chemical substances and the environmental impact of farming practices. The objective also involves increasing the efficiency of fertilisers (particularly those containing nitrogen), reducing phytoatric treatments for defending plants, increasing the sustainability of crop systems and the extent to which consumers appreciate vegetable and grain products. Lastly, the objective also involves reducing the use of chemical fertilisers and phytopharmaceutical products on ready-to-eat uncooked vegetable products. The latter pose problems linked to soil exhaustion phenomena and residue disposal, as numerous production cycles follow on from one another within a single greenhouse over the course of the year.

• **Objective 5** aims to define an integrated multi-sensory system to monitor the state of soil and vegetation constantly, in order to provide farm businesses with support in planning supplies of water and nutritional elements. The system can be adopted in open fields as well as in a controlled environment.

By quantifying water supplies through ongoing work to update the water balance in the soil (soil water-balance method), irrigation can be managed with a rational approach; nonetheless this does not take into account the state of crops which, even in water conditions that are not limiting, can display stress as a result of biotic and abiotic factors. Radiometric data can provide information quickly and in a non-destructive manner on the growth and state of the crops; the relationship between radiometric response and state of the crop must still be
calibrated, and further analyses are needed to identify the indicators that best represent the state of the vegetation. For this reason, combining measurements of soil water content with automated ecophysiology measurements on vegetation would be an innovation to help guide agronomic measures, making them prompt and effective and avoiding drops in yield and quality.

An integrated system must be set up to provide ongoing monitoring of the state of the soil and crop, based on capacitive probes and radiometric sensors. The capacitive sensors identify the state of water in the soil, whilst radiometric ones measure the radiation reflected in the wavelengths 531 and 570 nm to calculate the photochemical reflectance index (PRI) as an indicator of the crop stress conditions. Subsequently, specific analyses will be conducted to compare the water level in the soil with the vegetation level, in order to identify the most suitable spectral regions and vegetation indices for promptly defining the water and nutrition status of plants, focusing in particular on the red-edge region. It also aims to conduct an integrated assessment of energy/environmental inputs on a company and/or landscape level, using a spatial decision support system (sDSS).

The overall expected impacts are as follows:

• Improvement of vegetable produce, reduction of the water footprint and the “carbon footprint” (interaction with TR 4.3), and greater overall sensitivity as regards the production processes.
• Improvement of productions, reduction in the environmental impact of fertilisation practices and phytosanitary defences both in conventional and organic production, heightened overall awareness of production processes and increased safety for farm workers and consumers.
• Supporting quality agricultural products with high profitability levels by developing new, more efficient techniques for fertilisation and phytosanitary defences which can be used in the “organic” sector.
• Creation of a web system which incorporates advanced systems to a) provide remote monitoring and simulation models of the soil-plant-atmosphere system; b) short and mid-term weather forecasting for analysing potential scenarios.
• Analysis of the environmental and economic impacts of current cultivation systems in Italy.
• Identifying organisational models of the supply chain which ensure greater economic and environmental sustainability.
• Identification and promotion of crop systems based on successions of crops over a number of years which make it possible to reduce greenhouse gas emissions by 10% to 30%.
• Reduction of direct costs by up to 30% thanks to the use of DSS and more efficient management of fertilisers.
• Increasing appreciation of the farming profession and local areas, reducing the rate of abandonment of fields and unemployment thanks to the allied economies generated.
• Transferring know-how to farming staff through informative initiatives.

Type of activities:

• Research project to develop a generic, flexible method for assessing the particular features of different crop cultivation systems and the various alternatives.
• Research project to identify and design innovative IoT technologies for more efficient and sustainable cultivation systems.
• Technical and economic feasibility analysis, with assessment of potential costs and benefits.
• Pilot project to assess the method adopted. Collection of data, experimentation and comparison in batch trials replicated adopting different agronomic practices.
• Awareness-raising initiatives concerning research and development in farming.
Reference documents:
- FACCE – JPI Strategic Research Agenda FACCE; JPI First Biennial Implementation Plan 2014 – 2015; cap. 3, 4 and 5.
- ETP “Food for Life” Strategic Research and Innovation Agenda 2015-2020 and Beyond: Implementation Plan under Horizon 2020 (Chapter 2).

CORE - THEME 4.2 – SUSTAINABLE ANIMAL PRODUCTION: INNOVATIVE TECHNIQUES FOR GENETIC IMPROVEMENT, DISEASE RESISTANCE, RESTORING THE BALANCE IN THE IMPACT OF MILK AND MEAT PRODUCTION, ASSESSMENT OF SUITABLE SIZES OF TUNA FOR THE TRANSFORMATION INDUSTRY.

**Challenge:**

Improving the sustainability of animal production systems and farms by improving the longevity and resilience of milk cattle, increasing productivity of suckler cows (cow-calf line) in Italian bovine farms, increasing national quotas for the main Italian zootechnical products, defining a sustainable model for fishing tuna destined for the transformation industry.

**The Core - Theme closely adheres to the following strategic documents:**
- S3 Emilia Romagna Region, Pillar 4.2.
- Strategic Plan for Innovation and Research in the Agricultural and Forestry Sector (2014-2020);
- JPI FACCE, core themes 3, 4 and 5.

**Objectives:**

1. Developing innovative cross-breeding techniques for more balanced distribution of meat and milk production of milk cattle breeds.
2. Improving profitability of cattle farms with twin birth selection and by increasing the quality of products.
3. Increasing average longevity of milk cattle by improving level of hardiness and resistance to infection.
4. Genetic improvement of Italian zootechnical populations (including pigs), in order to allow greater diversification and adaptation to specific local farming systems.
5. Assessment of the most suitable tuna sizes for use by the transformation industry.

- Pursuing objective 1 is the most effective means of tackling the problem of impoverishment of Italy’s bovine stocks and the excessive reliance on foreign countries for milk and meat production. In Italy, very few animals
are reared for meat, in quantities which do not meet market demand. In fact an estimated 800,000 animals, which are genetically and physically foreign in origin, are in fact used in Italian meat cattle farms. The lack of calves is due on the one hand to the low profitability of meat farms, which have seen stable and marginal production levels for many years now. These farms depend on a variety of contributions provided by the Common Market Organisation and Regional Development Plans; on the other hand it is also due a shortfall in the production of calves by farms specialising in milk. The latter have seen a long period of extraordinary increases in efficiency and productivity, going from a production of 5,318 Kg per lactation in 1984 (average of 533,000 lactations completed in the year) to 8,767 Kg in 2014 (average of 796,000 completed lactations). Whilst milk production has proven highly successful, there has however been a deterioration in the vitality of the milk cows, a deterioration underscored by the reduced lifespan of the animals. In 2014 Italian Friesians farmed in stalls (88.0% of the total) had an average number of lactations of 2.40, whilst Pezzate Rosse (5.2%) had 2.90 and Brune Alpine (6.8%) had 2.86. Cows eliminated in the course of 2014 had produced an average of 2.9, 3.4 and 3.4 lactations respectively for Friesians, Brune Alpine and Pezzate Rosse.

With these vital parameters, the bovine milk population can provide around 800,000 male calves a year. 95% are calves which are largely unsuitable for meat production, and are used for producing veal meat This is a type of farming which does not yield a suitable income for farmers, whose only income is actually from milk production. Accordingly there is room for research which on the one hand improves the profitability of suckler cow farms (cow calf line) and on the other increases production of milk farm calves, improving their suitability for meat production at the same time.

- **Objective 2:** on the meat bovine farming front, restoring the cow-calf line combined with genetic selection geared towards enhancing the tendency to twin births of animals would allow Italian meat breeds to exploit marginal areas better with extensive farming techniques, combined with a later intensive phase in feedlots aimed at ensuring the animal acquires the qualitative characteristics required by major retail chains and Food-service. This can also be achieved by adopting targeted feeding strategies. These animals would replace those obtained abroad. Twin birth selection is a highly innovative approach aimed at grazing breeds which feature easy birthing and are predisposed to have a significant level of twin births.

- **Objective 3:** to achieve an increase in longevity, it is necessary to increase the hardiness and adaptability of cows. This objective can be achieved by crossing different milk breeds. In particular, a rotation-based cross breeding system can be used. In the simplest case, this involves using bulls from two different cross-bred cow breeds, and mating the latter with bulls of a different breed from their fathers. The aim is accordingly to obtain animals whose genotype is two-thirds that of the paternal breed, and one third that of the mother.

- **Objective 4:** Italian zootechnic production systems have diversified according to the species and breeds which they rear, the farming territories and the financial and production purposes for which the milk and meat are produced. As regards the quantitative and qualitative characteristics of the raw material, it is important to note that, in addition to issues concerning diet and management of the animals, genetic elements also play a part. These manifest themselves in the different breeds which are reared, in additional genetic variability within the breed itself, not to mention the dominant genetic variability in cross-breeds. This objective accordingly sets out to implement methods and schemes for achieving genetic improvements which aim to specialise certain populations with productive, quantitative and qualitative characteristics better geared towards extensive production systems, or of particular importance to the local economy.

- **Objective 5:** the objective in question is the result of the tuna preserving industry’s call for sustainability. It involves conducting a study to identify the size of fish which is biologically and industrially most suitable, and which permits:
  - proper reproduction of tuna in oceans to ensure they are not overfished;
  - better adaptation to the technological processing cycle.
**Expected outcomes:**
The expected impacts involve:

- improving the social and economic sustainability of Italian bovine farming;
- bringing Italian bovine production into line with the qualitative standards required by major retail chains and the catering sector;
- recuperating marginal areas in areas which have been abandoned or left to reforest naturally;
- improving living conditions of brood cows in view of a greater lifespan;
- identifying SNP markers and developing genotyping methods to be used as a diagnostic tool for identifying animals that are resistant or susceptible to disease;
- increasing fertility within the farm and the breed itself, and as a result increasing the economic value of the farm owing to an increase in production;
- improving sustainability of tuna fishing and its suitability for transformation in the Italian preserving industry.

**Type of activity:**

- Research project.
- Technological transfer in farms involving cross-breeding and genetic improvement techniques, identifying sample farms and herds.
- Distribution of results.

**Reference documents:**


**CORE THEME 4.3 “SMART GRID”: ELECTRICITY MICRO-GRIDS, REDUCTION OF IMPACTS AND DEFINITION OF A COMMON APPROACH FOR GAUGING SUSTAINABILITY.**

**Challenge:**
Reduction of the water and carbon footprints of the main Italian agrifood productions by adopting best practices based on Life Cycle Assessments (LCA) and adopting models for self-producing energy for farm businesses, in keeping with smart grid criteria.

**The Core – Theme closely adheres to the following strategic documents:**

- S3 Emilia Romagna Region, Pillars 4.6, 4.7, 4.8 and 4.10;
- S3 Puglia Region, innovation area 2.2.1;
- European Technological Platform “Food for Life”, chapter 5;
- JPI FACCE, core themes 4 and 5
- PNR;
  - Environmental enhancement and increase of competitiveness in the agrifood supply chains (FACCE-JPI – CT2 Environmentally sustainable growth and intensification of agricultural systems under current and future climate and resource availability – CT5 Greenhouse gas mitigation: N2O and CH4 mitigation in the agriculture and forestry sector, carbon sequestration, fossil fuel substitution and mitigating GHG emissions induced by indirect land use change) (DSU Gardena – intelligent growth. Sustaining the transition towards a low-carbon emission economy in all sectors ) (S3 Lombardy – Sustainable and competitive agrifood supply chain, and analogous strategies in other Italian regions) (PNR – Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy);
  - Definition of national guidelines to determine the environmental quality of the products from Italian agrifood supply chains of strategic importance (national Food for Life – Promoting sustainable and competitive food production – 3.1 Developing appropriate systems, instruments and forms of support for assessing the sustainability of the agrifood sector by adopting the LCA approach – strategic plan for innovation and research in farming, food and forestry – AREA 4. Quality and typicality of farm produce, safety of foods and healthy lifestyles– sustainable techniques);
  - increase in the capacity and propensity towards innovation of traditional agrifood supply chains (Food for Life – Creating opportunities for a sustainable and competitive agrifood industry, through innovation in food processing).

**Objectives:**

1. Development of a site-specific database for LCA applications to Italian agrifood supply chains, with specific emphasis on the zootechnical supply chain.
2. Optimising anaerobic digestion and composting processes using innovative technologies and biotechnologies to improve the agronomic value of organic fertilisers (substrates, biostimulants and manure fertilisers).
3. Identifying models for measuring and managing energy in farming, with the aim of optimising how energy is used in a given territorial context, and achieving energy self-sufficiency in farms or consortiums.
4. Adopting high efficiency energy technologies such as cogeneration for combined production of electricity and heat in farming.
5. Combining agricultural production and renewable energy by applying innovative photovoltaic, mini-wind turbine and anaerobic digestion technologies. Analysing and devising technologies for the Internet of Things (IoT) of an innovative nature, which enable integrated systems to monitor energy flows and optimise the use of energy.

- With reference to **Objective 1**, analyses of the life cycles of the agrifood supply chains of greatest social and economic importance will be conducted, particularly zootechnical ones (cow, pig and poultry), comparing the different farming and transformation techniques used for each supply chain. Measurements will be conducted in the field in order to compare the data obtained with those available in scientific literature. The results will be assessed based on potential criteria for allocation of the impacts and consumption in order to define a common Italian approach to these calculation criteria. This must also take into account the guidelines stipulated at EU level for environmental product declarations.

- With reference to **Objective 2**, innovative technological solutions will be assessed in aerobic and anaerobic digestion processes for organic products in order to respectively obtain organic fertilisers with high agronomic performance and a low environmental impact, and green energy in the form of biogas and biomethane.

- With reference to **Objective 3**, energy auditing techniques will be adopted along with advanced systems to measure energy sources, in order to introduce targeted solutions to reduce consumption rates.
With reference to **Objective 4**, innovative technological solutions concerning the following will be assessed: a) the adoption of small cogeneration plants specifically for use in farms, powered by biogas, methane or biomethane sources, in keeping with objectives 2 and 5 of this Core - Theme; b) heat pump systems that harness low enthalpy geothermal energy; c) sources of renewable energy (such as mini wind turbines and photovoltaic panels) combined with hydrogen production as an energy vector, using it to produce energy at a different time with respect to its production. These systems do not cause any direct emissions into the atmosphere. As a result they can help reduce the carbon footprint of many processes such as heating, cooling, drying, refrigeration etc. used in both farming and transformation businesses.

With reference to **objective 5**, innovative technological solutions in the photovoltaic, mini wind turbine and anaerobic digestion sector will be evaluated for the purposes of producing biogas for use as biomethane. The most promising **IoT** technologies will also be assessed to enable information to be shared (energy flows) in real time, and therefore make it possible to create autonomous systems that optimise energy consumption.

Innovation in the energy-environmental field is an essential requisite for increasing the competitiveness of the Italian agrifood system. The measures outlined in this Core - Theme aim to promote innovations of both an incremental and radical type.

**Expected outcomes:**

The expected impacts concern:

- standardisation of LCA analysis procedures for calculating water and carbon footprints of Italian agrifood supply chains;
- acquisition of specific knowledge on the actual impacts and consumptions of Italian agrifood supply chains, to identify areas for improvement and proper environmental communication within the framework of global competition;
- **Eco-designing** agrifood supply chains of greatest social and economic importance;
- reducing the carbon footprint of production by 10 to 20%;
- achieving a 10 to 20% increase in the use of renewable energy forms for production;
- achieving a 10% increase in co-generation systems;
- introducing innovative technologies in the energy sector for producing energy from renewable sources;
- introducing innovative **IoT** technologies for smart grids.

**Type of activities:**

- Research project to identify sectors and technologies that make it possible to reduce the above objectives.
- Analysis of technical and economic feasibility, with assessment of potential costs and benefits.
- Implementation of pilot projects to test the efficacy of the **best practices** identified.
- Distribution of results.
- Networking activities.

**Reference documents:**

**Challenge:**

Improving the efficiency and sustainability of the supply chain taking action on the food transformation, distribution and consumption phase in order to reduce food losses and increase competitiveness of transformation industries, also by developing intelligent logistics networks that make it possible to reduce losses and recuperate food products in the lower segments of the supply chain. Adopting innovative processes to exploit by-products, rejects and waste left over from agroindustrial processing, to be placed on the market as new products for the fodder and agricultural sector in keeping with the principles of the “Bio-based economy”.

**The Core- Theme closely adheres to the following strategic documents:**

- European “Food for Life Technological Platform”, “Ensuring material efficiency from farm to fork by reduced waste and increased utilization of by-products”;
- JPI Healthy diet for a Healthy life;
- FoodDrinkEurope “Strategic Research – Priorities for the European Food and Drink Industry” Cap. 2 point 1 “Primary Processing”;
- Coincides with the innovation area “Health of Man and Environment”, in particular in applying KET 3 (Industrial Biotechnology) and KET 6 (Advanced production technologies). In detail, in keeping with the ‘Biotechnological protocols for producing bioactive substances from by-products’ line (KET 3), ‘Plants for extracting bioactive substances’; ‘Technologies applied to producing functionalised foods with plant extracts which are typical of the local area’ and ‘Company biomass composting plants’ (KET 6);
- “Strategic Plan for Innovation and Research in the Agricultural and Forestry Sector”, chapter 2 area 1-2.

**Objectives:**

With regard to the Transformation Industry:

- identifying innovative technological processes aimed at making new products and processing intermediaries for the food and fodder industry, with particular attention to making ingredients and food products which are financially accessible, high in nutritional value, and with a long shelf-life; products designed to reach large urban agglomerates with a high level of anthropization and difficulties in obtaining fresh products distributed under controlled temperatures. With reference to the fish industry, processes to recuperate waste and by-products and put them to good use are geared towards flours and cooking broths, in order to obtain finished products destined for human and animal consumption whilst at the same time reducing waste sent for disposal;
- identifying technological processes aimed at recuperating nutritional substances and micro nutrients;

**CORE - THEME 4.4 - VALORISING REJECTS, WASTE AND BY-PRODUCTS FOR INCREASING THE PORTFOLIO OF FINISHED PRODUCTS DESTINED FOR CONSUMPTION AS FOOD, FODDERS AND AGRICULTURAL PURPOSES (COMPOST), NOT LEAST BY MODELLING TERRITORIAL AND URBAN LOGISTICAL NETWORKS FOR RECOVERING FOOD PRODUCTS THAT WOULD OTHERWISE BE LOST.**
• conducting studies to obtain foods and/or supplements for animal-origin foods;
• conducting studies on the disposal of production waste;
• creating microbe starters for different substrate mixtures (vegetable and meat sector) to optimise the process of anaerobic digestion of agrifood waste, and identify strategies for using digestates in agriculture;
• optimising composting processes to improve the agronomic value of organic fertilisers (substrates, biostimulants and manure fertilisers) made using refuse and other waste matrices, using innovative technologies and biotechnologies;
• Extracting bioactive substances from farming and food transformation by-products (vegetable, milk and dairy supply chain) using innovative and sustainable technologies;
• bio-treatment using micro organisms on plant-origin waste for recuperating monosaccharide fractions from complex polysaccharides, and using micro algae to enhance food by-products.

With regard to territorial distribution and logistics:
• identifying sustainable models for recuperating foods and reducing waste at every level of the supply-chain. Developing methods and models for integrated territorial planning between the urban and agricultural context, and integration between mobility of agrifood goods in urban and rural contexts;
• creating infrastructures, whether material or immaterial, aimed at facilitating new approaches to managing and distributing food in such a way as to guarantee access to a wide variety of food types for each section of the population and reduce the amount which is lost;
• creating models for mapping agrifood biodiversity throughout the area, and carrying out out targeted planning of logistical infrastructures for agrifood imports and exports;
• analysing the role of major markets in distributing agrifood products, supporting links with ports, freight terminals and transportation infrastructure;
• reducing environmental impacts linked to packaging caused by municipal waste and the transport saturation rate. Devising closed-cycle returnable packaging for all agrifood categories (dairy, beverages, bakery, fruit and vegetable);
• Developing Internet of Things technologies (IoT) which are innovative and enable local and urban logistics networks to develop to recuperate food products that would otherwise be lost.

The following measures will be implemented:
• Creation of communication and telecommunication networks which lend themselves to extensive use by local players, and promoting cooperative agreements between private parties and charities to recuperate and distribute foods to persons facing emergency or social and economic instability;
• Support in developing complex distribution systems which are highly differentiated as regards the types and quality of products;
• Backing urban farming initiatives and organising local foods markets, helping micro-logistics to spread as a means of supporting local production and consumption networks;
• Increasing the diffusion of existing distribution networks to guarantee access to fresh food products in suburban areas which are less well served;
• Assessing the capacity and saturation of existing transport infrastructures and supply channels from farming areas to those of consumption;
• Feasibility studies on applying inter-modal approaches in the agrifood sector, to reduce costs of transport and associated external environment factors;
• Planning closed-cycle networks to manage returnable packaging in all sectors and supply chains of agrifood;
• Definition of protocols for quality, cost, social and environmental sustainability that orientate or support
- Studying new sustainable production models to help personalise and customise foods.
- Definition of municipal regulatory frameworks (Food Councils & Food Policies) in line with new food management guidelines;
- Development of reliable forecasting methods for managing product flows and planning and coordinating work within the supply chains.

**Expected outcomes:**

The expected impacts concern:
- Obtaining new foods and/or fodders for zootchnical purposes, ingredients and/or bioactive compounds with a high nutritional value obtained from by-products and/or waste generated by the agrifood processing industries;
- Reducing disposal costs and finding new economic returns from agrifood by-products;
- Reducing and valorising waste produced by the anaerobic digestion process;
- Using algae biomass for potential use as a source of protein-based fodder for cattle;
- Producing and valorising quality composts; reducing the consumption of synthetic fertilisers and peat; increasing organic substances in farming soils; improving the hydrological characteristics of soils.
- Isolating micro-organisms for using in selective waste degradation and developing technological protocols to achieve specific high added value outputs;
- Developing innovative models and methods for integrated planning on territorial usage and transportation infrastructures that support glocal and sustainable agrifood supply chains, and planning urban intermodal networks for the integrated transportation of goods and people;
- Improving communication techniques and technologies between players at different levels of the food supply chains;
- Developing and consolidating alternative production-consumption networks with a short supply chain;
- Improving the ability of distribution networks to reach suburban areas to a greater extent;
- Reducing/valorisation of waste in agrifood supply chains.

**Type of activities:**

- Research project. Pilot plant for food transformation.
- Research project for analysing the regional territory, the needs and the initiatives already underway in the identified urban areas.
- Research project for developing integrated planning models and methods in the urban and rural context for developing sustainable agrifood supply chains.
- Research project to map and identify food corridors: analysis of macro flows of agrifood products on a regional, national, European and/or international level.
- Research project to develop models that optimise direct and inverse logistics processes for applying in agrifood supply chains in order to reduce/valorise waste, particularly with regard to fresh and/or perishable products.
- Work to for distributing information, educating and raising awareness on the role of logistics in improving agrifood supply chain efficiency.

**Reference documents:**

- European Technology Platform Food for Life, 2014. Strategic Research and Innovation Agenda 2015-2020 and Beyond: Implementation Plan under Horizon 2020; chap. 4, “Ensuring material efficiency from farm to fork by reduced waste and increased utilization of by-products”.
- FoodDrinkEurope “Strategic Research Priority for the European Food and Drink Industry” ed. June, 2015
CORE – THEME 4.5 DEVELOPING INNOVATIVE TOOLS FOR ADVISING CONSUMERS OF THE ENVIRONMENTAL AND NUTRITIONAL CONTENT OF MENUS IN THE CATERING AND FOODSERVICE SECTORS.

**Challenge:**

Development and diffusion of innovative methods and tools for calculating and communicating environmental values of recipes and menus by the end consumer and catering/food service sector, improving awareness of the importance of a sustainable and responsible diet which cares for people and the environment. Edutainment and infotainment are considered the new educational frontier in sustainable dietary habits. They can define divulgence approaches which respectively combine needs and techniques used in education and information – namely education and learning itself – with entertainment, geared towards leisure and fun. In other words, it is a return to the traditional ludendo docere, “education through play” which identifies means of communication that make education processes fun.

The Core - Theme closely adheres to the following strategic documents:

- European Technological Platform “Food for Life”, chapter 4;
- JPI Healthy diet for a Healthy life;
- FoodDrinkEurope “Strategic Research Priorities for the European Food and Drink Industry” Chap.2 Point 5 “Consumer Behaviour”.

**Objectives:**

- Developing an application for smartphones and tablets which makes it possible to assess the environmental impact of the dish chosen by the consumer, using indicators such as the ecological footprint. The application can be used by both end users and the catering sector.
- Developing a software which, based on data on the composition of food and/or recipes supplied by databases containing information on environmental impact, allows consumers to enter the details of what they are eating and turn them into environmental indications regarding their eating habits. The goal is to incorporate sustainable eating into the wider ecological concept of the individual, on a par with other
positive practices for living in an ecologically sustainable way.
- Defining a common strategy between the various catering trade players to calculate and communicate the environmental impact of the food offered.
- Training and awareness raising initiatives aimed at catering trade professionals, to encourage them to adopt menus and dishes with a low environmental impact.
- Creation of suitable communication tools (e.g. paper leaflets, tables and pages on websites of catering businesses, posters, printed paper napkins) to increase consumer awareness of the ecological footprint of their meal and the environmental commitment of the catering trade.

**Expected outcomes:**
The expected impacts involve:
- training catering professionals regarding environmental issues and the requisites needed to create ecologically sustainable dishes;
- increasing environmental awareness in consumers, who can make lifestyle changes using simple tools that are easy to understand, like immediately seeing one’s dietary choices as belonging to a symbol of the diet being nutritionally and environmentally suitable.

**Type of activity:**
- Research project.
- Research to identify suitable tools and software for each sector (catering, restaurants, public catering) for calculating environmental values.
- Producing promotional and information materials to support communication work.
- Initiatives to distribute information.
- Networking activities.

**Reference documents:**
Challenge:

Promoting the responsible use of veterinary drugs and alternative strategies that reduce the use of chemotherapy in Italian zootechnical supply chains, in line with consumer and food industry expectations concerning sustainability and animal welfare.

The Core - Theme closely adheres to the following strategic documents:

- Horizon 2020 – Work Programme 2016-2017. Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy;
- Coincides with S3 Emilia Romagna Region, Pillar 4.2.
- Coincides with S3 Puglia Region, area of innovation 2.2.2;
- Coincides with Strategic Plan for Innovation and Research in the Agricultural and Forestry Sector (2014-2020);
- Coincides with JPI FACCE, core themes 3, 4 and 5;
- FoodDrinkEurope "Strategic Research Priorities for the European Food and Drink Industry" –Chap 2 Point 3 "Food Safety";

Objectives:

1. Achieving good farming practices to minimise/eradicate the use of antibiotics in zootechnical production.
2. Increasing immune response in animals and using plant-based remedies in farming.
3. Genetic control and selection system in cow and buffalo cattle with an end to sustainable zootechnical production and assessing the metabolism of antibiotics with innovative techniques.

   - In relation to Objective 1, the idea has been prompted by consolidated scientific knowledge, according to which large-scale use of antibiotics is a highly risky practice for both animals and humans. With regards to zootechnics, the problem tends to be approached with a vision which is not always appropriate, focusing on the problem of residues in animal-origin products whilst underestimating the main aspect of a systemic and environmental nature. The results of the National Plan for Residue Research published in 2014 show that only 0.11% of the approximately 41,000 samples analysed came back with a non-conformity (antibiotic residues); on the contrary, cases of bacteria that proved cross-resistant to antibiotic molecules confirm that there is a problem of an environmental nature owing to the spread of resistant bacteria. Until a few decades ago, administering antibiotics for preventive purposes (prophylaxis) was not viewed as a risky practice. In fact they were actually used as “growth promoters”. Today, awareness of this issue has changed considerably amongst the authorities and the animal origin market itself. In fact the European Union is adopting increasingly restrictive measures to ensure antibiotics are only used for therapeutic purposes when there is a certain diagnosis. The main multinationals in the sector are adopting policies to use animal-origin products obtained from supply chains which make limited use of the drugs. Resistance to antibiotics is acknowledged as a global threat. Accordingly, the “Animal Production and Health Division (AGA)" of the FAO promotes the urgent adoption of measures to reduce antibiotic resistance and contain it to a minimum. The creation of supply chains with low antibiotic intensity based on positive farming practices is also a means of enhancing farm produce. It is an element of added value for Italian produce in the eyes of consumers, who are increasingly aware of their own health and animal welfare. Promoting responsible use of antibiotics in farms accordingly involves more than just food safety; it also constitutes an element of competitiveness and sustainability for the Italian zootechnic supply chain.

In pigs, the first three months of life see the period in which the highest number of treatments are administered. This is largely attributable to the natural immaturity of the piglet when it is born, leading to
its susceptibility to environmental pathogens. The need to manage numerous litters suitably not only aims to achieve good weaning performance levels, but also to promote proper development of the immune system, which is necessary to ensure a good level of resistance to illnesses. The management of numerous litters and hyperprolific sows is a topic of great interest for the supply chain. In fact the birth-weaning phase sees the highest mortality rate in the entire production cycle. It is for this very reason that considerable use is made of antibiotics, to contain bacterial diseases such as colibacillosis from Escherichia coli F4 and F18, amongst others.

As regards bovines, the creation of genetic improvement schemes aiming to increase natural disease resistance is possible. Nonetheless, this involves intervening in extremely complex systems, for which it is difficult to identify definite phenotypes and effective selection criteria as a result. One approach which seems to yield positive results involves selection against negative haplotypes: these are sequences which cannot be found or are found far less than the expected value in a homozygous state. Nonetheless, these are evidently extreme cases of lethal or sub-lethal haplotypes which do not have much to do with variability in disease resistance normally observed in farm animals. Other approaches of a typically physiological nature are instead geared towards resistance mechanisms at cell level, in the hope of identifying proxy characters or genetic variants to be used in appropriate selection programmes.

A new frontier worth investigating is that of micro-RNA.

With reference to Objective 2, the Europe-wide ban on using antibiotics as growth promoters in farms about fifteen years ago, and increasing fears regarding the risks of drug-resistance caused by widespread use of antibiotics for therapeutic veterinary purposes, have prompted research and use of complex biologically active plant substances, hydrolysed protein and pectin, extracts obtained from plants, by-products and waste from agroindustrial production processes as foods or supplements for their bactericidal, bacteriostatic and anti-inflammatory as well as immunomodulating effects. The scientific validation of the use of plant remedies for formulating commercial products for different purposes in zootechnics, including antimicrobial products as an alternative to synthetic antibiotics, requires the following steps:
- Chemical characterisation of plant remedies (metabolomic footprint) and producing a chromatographic profile for reference purposes.
- Studying antimicrobial activity in vitro.
- Determining the effectiveness of plant remedies (calculating dose and effectiveness in the field).
- Assessment of the effect of administering the plant remedy on physiological parameters of the treated animals.
- Assessment of the effect of administering the plant remedy at a cellular level (blood chemistry/protein serum and on the vitality of blood cell lines in treated animals)
- Assessment of the effect of administering the plant remedy on quality of milk and meat produced by treated animals.

Research should focus chiefly on containing gastroenteritis during weaning of farmed animals, helping to reduce the use of antibiotics in the supply and production chain whilst improving animal health, production efficiency and the sustainability of the production chain.

In addition, the aim is to investigate problems linked to the carry-over of veterinary drugs often used for mass therapies (metaphylaxis) on animals of zootechnical interest, in meats and in milk. In fact antibiotics can undergo chemical modifications in vivo, generating compounds which can at times prove to be more toxic than the parent compound. The application of advanced liquid chromatography - high resolution mass spectrometry platforms will make it possible to identify the presence of a large spectrum of antibiotics of interest in meats and milk, and to identify and characterise any products of transformation/deterioration caused by animal metabolism, defining the carry over processes in meats and milk.
In relation to **Objective 3**, infective diseases such as bovine paratuberculosis (Johne’s disease) and buffalo brucellosis are amongst the most common and worrying diseases in both Italian and European farms. Identifying genes that regulate the individual’s response to infective agents is one of the goals which research has set itself for combating these diseases. Independent Genome Wide Association Studies (GWAS) conducted with Illumina 50K-SNP chips have confirmed the existence of SNPs in the bovine species which is closely linked to resistance to the aetiological agent of Johne’s disease and probably in linkage disequilibrium with causative mutations. Finding markers directly in genes linked to resistance in both bovine and buffalo species could provide a means of diagnosis, and be applied to genetic selection programmes for disease control.

Studies on the genomic bases of paratuberculosis (Johne’s disease) seem very promising. This chronic gastroenteritis affecting ruminants is caused by Mycobacterium avium, which manifests itself with diarrhea, weight loss, reduction in milk produced and even death. A Genome Wide analysis of 100 sheep, half positive and half negative to the ELISA test (B. Moioli et al., 2015; Genomic scan for identifying candidate genes for paratuberculosis resistance in sheep. Animal Production Science [http://dx.doi.org/10.1071/AN14826]) made it possible to identify some significantly different markers between the two groups near genes which were involved in the immune response.

It is hoped that these genetic markers can be combined with protein biomarkers identified in animal biological tissues/fluids specific to the various physio-pathological states, for better defining the molecular processes involved with or linked to the disease.

Recently, a number of cytofluorimetric methods for immunophenotyping have been developed to assess the expression of certain surface markers in cow and buffalo milk (Scatà et al., 2015; Grandoni et al., 2015). These methods make it possible to assess immunological and physiological parameters that indicate the immune system’s ability to prevent and respond to stress, including the percentages of lymphocytes, monocytes, neutrophils, eosinophils and Natural Killer Cells, the CD4/CD8 ratio and the expression of certain adhesion molecules in phagocytes (neutrophils and monocytes) such as L-Selectina and β-Integrine. Literature has reported significant correlations between the ratio of T CD4⁺: CD8⁺ lymphocytes and subclinical mastitis, and between the percentage of Natural Killer cells and laminitis: it would be of great interest to study possible links between surface markers and the onset of Paratuberculosis.

There is little information available concerning the changes in the quality of animal-origin products which the organoleptic characteristics undergo in animals with resistance to these infective diseases compared with healthy animals.

Cytogenetics in animal reproduction is already reality in many European countries as well as in Italy, in part, given that chromosome anomalies are responsible for sterility (anomalies linked to sexual chromosomes, such as XX/XY mosaicism, X trisomy, X monosomy and sex inversion) or hypofertility (balanced autosomal abnormalities). In bovines, some anomalies (rob1;29 in particular) reach high frequencies (up to 70% in Portuguese breeds and 40% in Italian meat breeds). In buffaloes, the analyses conducted to date have revealed that around 20% of buffaloes with reproductive problems are carriers of chromosome anomalies linked to gender, and all are sterile owing to serious abnormalities in the internal genital organs. This results in serious damages for farmers who keep cows which will not yield any produce (calves and milk) for years.

**Expected outcomes:**

The expected impacts involve:

- the definition of Best Farming Practices for eliminating use of antibiotics with particular reference to pork and cow farms;
- analysing degradation and fermentation in the rumen of healthy and infected animals,
• identifying specific physiological productive and pathological indicators of animal welfare;
• stipulating markers for identifying products obtained from healthy, resistant and infected animals;
• determining protein markers and developing diagnostic methods for identifying animals which are resistant/susceptible to disease;
• enhancement of Italian products and heightening their competitiveness through the increase in added value perceived by consumers.

**Type of activity:**

• Research and demonstration project.

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**Reference documents:**

## PILLAR 4 MATRIX - 53 REGIONS TAKING PART IN THE CLUSTER CL.A.N.

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PILLAR 5

MACHINES AND PLANTS FOR THE FOOD INDUSTRY

The future of food productions will be oriented towards sustainable industries with a high technological content, to guarantee Food Security and Food Safety. These increasingly important concepts demonstrate that the challenge facing the food of the future involves meeting quality requirements in different environments, not only leading to a change in the way food is conceived, but also how it is produced, transformed and consumed.

The industrial technologies sector therefore plays a vital role in reaching these new goals, offering and analysing innovative solutions and methods for the food industries of the future.

Italy is a leader in the industrial technology sector, and it boasts global leadership and excellence in terms of technological innovation, quality of the products and services, not to mention its ability to act as a solution provider for its clients.

The main challenge facing this sector will on the one hand involve innovating the food produced, offering smart, sustainable and safe solutions whilst preserving the typically Italian values tradition and craftsmanship, whilst at the same time also making the new technologies available to SMEs as well which, due to the small size of the businesses, often find it difficult to innovate.

By implementing this Pillar, businesses will be able to achieve important goals, such as:

- **Increasing the sustainability of production.** The sustainability of agrifood productions, achieved amongst others by using innovative technologies, helps define and implement the three main pillars needed to achieve development which is economically, socially and environmentally sustainable.

- **Shortening supply chain distances.** Compared with the past, when producers and consumers came into contact with one another, the food supply chain today has placed considerable distance between when food is produced and when it is consumed. The introduction of new technologies within the production cycle brings the producer and consumer closer to one another again.

- **Improving the quality of products through in-line controls and traceability.** The new technologies and models for managing production geared towards control using automated and cooperation-based traceability and monitoring methods make it possible to increase product safety and quality. Consumers are attracted, and at the same time their trust is won over. The use of innovative systems permits constant control and vision in "clouds" of products and their certifications. This proves that it is a new frontier and a driving force for development in the food Industry.

In the light of these considerations, five Core - Themes have been identified:

5.1 **Innovative materials for producing machines and plants:** Machines and plants for the Food Industry made using innovative materials which are non-toxic compounds (e.g. PBS polybutylene succinate), both synthesised for the purpose and obtained by mixing existing polymers, in order to improve the diffusional, mechanical and optical properties of the components, whilst maintaining the processing properties intact in the usual transformation machinery.

5.2 **BATCO2. Technologies and types of plants with high energy efficiency and low carbon intensity:** The shift from an end of pipe solution to clear production, the application of BAT (Best Available Techniques) and the use of renewable and assimilated energy sources (e.g. heat recuperation), make it possible to maximise the energy and resource efficiency. Evaluations of the production system and the technology used by analysing the life cycle (LCA), economic analysis and environmental impact assessment are of crucial importance. The
following underpin work to improve the energy efficiency of the plant, the quality and the safety of the transformed product:
- monitoring of thermal, electrical and product energy flows;
- developing plant modelling techniques such as CFD (computational fluid dynamics), which make it possible to define the plant components used to treat food fluids, or energy hub techniques;
- developing numeric simulation techniques and producing dedicated software for controlling food transformation processes and for optimising energy systems, including multi-energy types, of the plants during the project (static) and whilst operational (dynamic).

5.3 Advanced mechanical design and hygiene design of the plants:
- mechanical design and construction of plants and machines for the food Industry by applying finite element methods (FEM, FEA and Multibody) as well as CFD (computational fluid dynamics) methods;
- mechanical design for making the mobile parts of food plants lighter, and applying structural gluing as opposed to traditional methods for joining parts;
- producing plants and machines for the food Industry in compliance with eco-design principles to which specific construction details that respect so-called “Hygienic Design” guidelines apply (Dir. 2006/42/EC)
- creation of innovative approaches for the plant cleaning and sanitation phases, which combine CIP (Cleaning in Place) systems diagnostics with global optimisation instruments, in order to reduce consumption rates and downtime whilst maximising process productivity.

5.4 Advanced plant management technologies:
- optimising systems used for production, with particular attention to innovative technologies for monitoring, simulation, automation and control during all processing phases;
- LEAN manufacturing techniques for optimised management of the production of plants, advanced techniques for identifying defects and preventing malfunctions from arising;
- new approaches for controlling the operating status of plants, and programming maintenance using predictive fault diagnostics methods that identify the onset, whether present or forthcoming, of malfunctions. All of which with an end to programming maintenance measures in advance, reducing their impact on production dynamics;
- development of advanced sensors for automating some working phases, condition monitoring, non-destructive testing techniques, non-invasive diagnostics and analysis of noise sources.

5.5. New frontiers: from sensors to 3D:
- creating new amperometric sensors, development of optical sensors and biosensors for detecting safety indicators and quality throughout the food production supply chain;
- combining conventional biotechnologies with innovative nanotechnologies for developing ultra-sensitive sensors (e.g. diagnostic lab-on-chip systems, electronic nose);
- advanced technologies for the traceability of food products and semi-finished products during and after production; techniques for identifying and reducing the dispersion of batches during the processing of loose products (grains, powders and fluids) and in continuous processes;
- introduction of 3D technology in machines and food plants in order to increase operative performance.
Challenge:
The materials and objects which come into contact with foods are those regulated by both national and EU measures. As regards EU guidelines Regulation (EC) n. 1935/2004 (framework regulation) stipulates the general requirements which all the materials and objects in question must answer to, whilst specific measures contain detailed provisions for individual materials (plastic and ceramic materials etc.). The Declaration of the Ministry of Health issued on 21 March 1973 governs some materials (plastic materials, rubber, stainless steel, glass etc.).

The Ministerial Decree passed on 21 March 1973 has been amended on a number of occasions by request of the businesses involved and to bring it into line with the European Union stipulations; in this case, the title of the measure passed at a national level quotes the directive concerned so that the nature of the update can be identified. The spirit of the regulation is based on what are known as “positive lists” of substances, which can be used for making these materials with potential limitations and restrictions, as well as on the methods for controlling suitability for contact with foods.

Other materials not included in the decree issued on 21 March 1973 have been covered by specific measures (tin plated sheeting, chrome painted sheeting, ceramics, aluminium).

Inclusion in the positive lists is subject to their suitability being ascertained. Accordingly, businesses must supply the necessary elements for assessment, based on the protocol detailed in Annex I of Ministerial Decree 21 March 1973, as replaced by Annex I of the Decree passed on 3 June 1994, no. 511.

As regards controls on materials and objects destined to come into contact with foods, the Ministry has drafted a number of memorandums which aim to ensure measures are targeted and uniform throughout the country. The notes were distributed both to official control bodies and to those involved throughout the supply chain (production, usage and marketing).

Whilst regulations have taken giant steps forward to guarantee consumers the utmost safety, a lot still needs to be done to analyse and create innovative materials with which to make food production plants.

Only in recent years has research turned to studying and producing new materials, some synthetised for the purpose and others obtained by mixing existing polymers. This makes it possible to improve the diffusional, mechanical and optical properties of the components whilst ensuring the processing properties remain unchanged in the transformation equipment used.

Objectives:
• Devising new high performing and safe materials.
• Offering companies that produce food machinery and plants solutions which are sustainable from the environmental and economic standpoint.

Expected outcomes:
Machines and plants for the Food Industry made using innovative materials which are non-toxic compounds (e.g. PBS polybutylene succinate), both synthetised for the purpose and obtained by mixing existing polymers, in order to improve the diffusional, mechanical and optical properties of the components, whilst maintaining the processing properties intact in the usual transformation machinery.
Reference documents:
- (EC) regulation no. 1935/2004
- Declaration of the Ministry of Health issued on 21 March 1973
- Decree No. 511 of 03 June 1994
- S3 Lombardy Region – Regional Strategy for Intelligent Specialisation in Research and Innovation “Smart Specialisation Strategy”.

### CORE - THEME 5.2 - BAT CO₂: TECHNOLOGIES AND TYPES OF PLANTS WITH HIGH ENERGY EFFICIENCY AND LOW CARBON INTENSITY

#### Challenge:

The challenge posed by climate change is a particular phenomenon whose extent and effects on the agrifood system, when compared with normal working conditions, make it essential to implement an adaptation strategy to continue to guarantee food, fibre and bioenergy production.

On the other hand, in an international but above all European context, where efforts are being focused on maintaining the global temperature increase below 2°C (by 2050), the agrifood sector is also being asked to make efforts to mitigate the greenhouse gas emissions released into the atmosphere. In fact, the production processes of the agrifood sector represent a source of climate altering emissions which can be mitigated by pursuing different production and management strategies.

In order to map out a longer-term strategy, the EU has adopted a specific schedule for shifting to a competitive low emission economy (COM(2011)112). This states that, by the 2050, the EU must have reduced its emissions by 80% on 1990 figures. The schedule involves stages that map out an economic path for achieving this goal (40% reductions by 2030 and 60% by 2040) and also proves that the main sectors responsible for emissions in Europe (energy production, industry, transport, buildings and constructions) can help in the transition towards a low-carbon emission economy.

The Italian agrifood sector needs to have an advanced system for assessing the environmental impacts of food production, implementing innovative and sustainable solutions for improving competitiveness in the sector whilst focusing on an ethical vision of development of crucial importance. This has been clearly defined in the Strategic Agenda for Research and Innovation for 2030 – Italian Food for Life.

The aims of the agricultural policies identified in the Ministry of Agricultural, Food and Forestry Policies - MIPAAF Research and Innovation Plan are three-fold: increasing production to guarantee food safety for the world’s growing population, mitigating greenhouse gas emissions and promoting the sector’s adaptation to changed climate conditions.

#### Objectives:

- 20% reduction in emissions, taking the renewable energy share in the energy mix to 20% and achieving a 20% increase in energy efficiency by 2020.
- Performing an energy analysis and quantifying the reduction of the environmental impact by applying BATs.
- Encouraging practices and plants with low energy consumption rates in businesses.
- Increasing the share of renewable energy exploited in production processes.

#### Expected outcomes:

The expected impacts involve:

- a shift from end of pipe solution to clear production;
- the application of BATs (Best Available Techniques);
- use of renewable and assimilated energy sources (e.g. from heat recovery systems);
- Evaluations of the production system and the technology used by analysing the life cycle (LCA), economic analysis and environmental impact assessment;
- monitoring of thermal, electrical and product energy flows;
- developing plant modelling techniques, such as CFD (computational fluid dynamics), or techniques based on the energy hub;
- developing numeric simulation techniques and producing dedicated software or controlling food transformation processes and for optimising energy systems, including multi-energy types, of the plants during the project (static) and whilst operational (dynamic).

**Type of activities:**

- Development of calculation systems for recuperating energy waste to reduce the plant's requirements.
- Development of models and software for assessing and optimising company energy performance levels.
- Development of cutting-edge hw-sw systems to monitor energy flows in food production processes.
- Pilot plants for demonstration purposes.

**Reference documents:**

- Strategic Agenda for Research and Innovation towards 2030 “Italian Food for Life”.
- MIPAAF Innovation and Research Plan.
- S3 Lombardy Region – Regional Strategy for Intelligent Specialisation in Research and Innovation "Smart Specialisation Strategy”.
- “Research and Innovation” work programme incorporated into S3 of the Region of Lombardy.
- Food and Agriculture Organization of the United Nations (FAO) (2013). Healthy people depend on healthy food systems.
- COM(2011)0571: Communication made by the Commission to the European Parliament, the council, the European economic and social committee, and the committee of regions. Table for work towards a Europe which makes efficient use of resources.

**CORE-THEME 5.3 - ADVANCED MECHANICAL DESIGN AND HYGIENE DESIGN OF THE PLANTS**

**Challenge:**

In the food sector, consumer demand is increasingly oriented towards high quality products with few preservatives, and properties and flavours which are as natural as possible. Moreover, whilst the preservatives and additives used have been reduced, products are expected to be safer and more stable than ever before. In order to meet these needs (reducing preservatives and increasing stability) which might at first glance seem to be at odds with one another, it is necessary to respect increasingly strict hygiene requirements. One of the key aspects involved in attaining these hygiene requirements consists of guaranteeing the cleanliness of contact surfaces, or those that
might come into contact with the product.

According to European legislation (EC/852/2004), the hygiene of equipment intended for producing foods is a legal requirement. In particular, the Machinery Directive (2006/42/EC), the first version of which dates back to 1989, details the obligatory basic criteria to be adopted for the hygiene design of food equipment.

To support the Machinery Directive, the ECS (European Committee for Standardization) and ISO (International Organization for Standardization) have drafted two specific documents (EN 1672-2:2009 and EN ISO 14159:2008) which have adopted the role of harmonised regulations; as a result they can be applied on a voluntary basis, but they make it possible to presume conformity with the directive itself.

By way of further support to the Machinery Directive, various international bodies have developed practical design guidelines; in particular the European Hygienic Engineering and Design Group has published 42 documents, which also include practical standardised tests for assessing the ability to clean, sterilise and waterproof food equipment.

In spite of the fact that the criteria contained in the legislation currently in force is of an obligatory nature, there is still considerable confusion in the food industry and the mechanical food sector regarding the real knock-on effects these requirement have on designing food equipment.

It is often thought that the only obligations borne by manufacturers concern the choice of materials, or that the only further requirement to be respected is that the average roughness of the contact surfaces is appropriate. Yet constructing a piece of machinery in stainless steel is not in itself sufficient to ensure that the machine is hygienic.

It must be possible to clean food equipment without any difficulties whatsoever; this is not only a legal requirement, but also an economic opportunity for the food Industry. Indeed improving the hygienic design of food equipment, above and beyond conformity with legal requirements, would also make cleaning and sanitising measures more sustainable and less expensive, thereby reducing the amount of chemical products used and production down time.

**Objectives:**

- Making more salubrious and environmentally sustainable products which are less expensive, for a market which is increasingly open and selective.
- Achieving a positive reduction in the environmental impact of production, cutting the amount of materials and additional service products consumed, not to mention the time taken by staff to clean and sanitise equipment. This in turn makes for a reduction in business running costs.
- Reducing or eliminating the risk that a production plant becomes a source of product contamination.
- Reducing washing, sanitisation and maintenance time, increasing the availability of the plants.

**Expected outcomes:**

The expected impacts involve:

- mechanical design and construction of plants and machines for the food Industry by applying finite element methods (FEM, FEA and Multibody) as well as CFD (computational fluid dynamics) methods;
- mechanical design for making the mobile parts of food plants lighter, and applying structural gluing as opposed to traditional methods for joining parts;
- developing new machine and material sanitisation systems which are compatible with regulations, the economy and the environment;
- producing plants and machines for the food Industry in compliance with eco-design principles to which specific construction details that respect so-called “Hygienic Design” guidelines apply (Dir. 2006/42/EC)
- creating innovative approaches for plant cleaning phases, which combine CIP (Cleaning in Place) systems diagnostics with global optimisation instruments, in order to reduce consumption rates and downtime whilst maximising process productivity.
# Type of activities:

Analysing the implementation of internal viewing and inspection systems in food plants (heat exchanger, pipeline).

## Reference documents:

- Machine Directive 98/42/EC

## Challenge - Theme 5.4 - Advanced Plant Management Technologies

Community regulations and national and regional measures concerning the food industry in Italy have led to deep-rooted changes in the structure of the food sector and the way it operates. The problem of controlling work to maintain plants and equipment remains the main problem facing many industrial businesses, not just regarding staff efficiency but also for identifying the areas most prone to faults, in order to manage any optimisation measures. As a result it is decisive to aim for optimising energy consumption in the individual procedures, raw materials and machinery to improve the plants' energy handling, improving the parameters for cost/timing/quality/safety in the specific production phases, automating production and transformation phases, appropriate selection of waste products suitable for recycling, prompt detection of factors that can affect the automation processes (such as light/temperature/moisture/vibration), production batch indicators or standards, parameters linked to storage, procurement and conservation conditions for sustainable and innovative Food Chain Management, planning, company strategy, logistics and distribution of food consumer goods.

Some aspects need to be taken into account to achieve sustainable and strategic development of Italy’s food industry, not least in relation and synergy with the objectives of the "ManuFuture Italia" Technological Platform and the Strategic Agenda for Research and Innovation for 2030.

## Objectives:

The application of innovative and non-invasive methods for managing and maintaining plants would accordingly pursue a two-fold goal:

- Increasing production whilst maintaining quality;
- preventing faults from arising on the production line which would slow down production and constitute a considerable cost for the company covering it.

## Expected outcomes:

The expected impacts involve:

- optimising systems used for production, with particular attention to innovative technologies for monitoring, simulation and control during all processing phases;
- developing LEAN manufacturing techniques for optimised management of the production of plants, advanced techniques for identifying defects and preventing malfunctions from arising;
- developing new approaches for controlling the operating status of plants, and programming maintenance using predictive fault diagnostics methods that identify the onset, whether present or forthcoming, of malfunctions.
- incorporating robotics into food technologies to automate some food production and transformation phases in...
preparing complex foods;

- development of advanced sensors for condition monitoring, non-destructive testing techniques, non-invasive diagnostics and analysis of noise sources.

- assessing the machine/product/process interaction in view of potential effects concerning working capacity performance, not to mention production yields, quality of the products and by-products (not least in relation to food safety), staff safety and the sustainability of the entire production cycle.

**Type of activities:**

- Cooperative Research.
- Creation of pools of expertise for analysing and examining all the engineering aspects linked to processes for transforming agrifood products.
- Technical round tables involving researchers and professionals involved in these areas: engineers, agronomists, food technologists and specialists in analysis techniques.
- Implementation of reference models for the plant, with the help of HIL/SIL simulation, which are used for monitoring the plant’s “Current Status” compared with its “reference” status.
- Models for statistical predictive analysis for a scheduled maintenance plan with a reduction of the MTBF, and resultant automatic scheduling of maintenance work.
- Auto-monitoring function to help diagnose faults and prevent breakages in the parts of the bottling plant.
- Integration of information concerning heat and energy data, flow speeds and information from sensors and image inspection system.

**Reference documents:**

- "ManuFuture Italia”. technological platform
- Strategic Research and Innovation Agenda for 2030.

**CORE - THEME 5.6 - NEW FRONTIERS: FROM SENSORS TO 3D:**

**Challenge:**

In our present-day social context, food product safety is a strategic issue of fundamental importance.

The Food Industry is increasingly insisting on the use of methods which can verify the simultaneous presence, in a short time and with high sensitivity levels, of more than one micro-organism in foods and processing environments. In this context, rapid and precise diagnostic systems such as biosensors or Lab-on-chip systems represent a particularly attractive solution offering enormous potential for development.

These systems make it possible to condense all the functions usually adopted in an analysis laboratory, using complex instrumentation and highly specialised staff, onto one small, inexpensive microchip. This combines conventional biotechnologies with innovative nanotechnologies for manufacturing ultra-sensitive sensors.

These must be backed up by cutting-edge technologies for the traceability of food products and semi-finished products both during and after the production phase. They must make it possible to identify batches precisely, and to reduce their dispersion in the processing phases. This aspect is particularly critical in the transformation of loose products (such as granules, powders and fluids), as well as in continuous processes where the absence of any valid technological solutions often means that companies have to produce batches in greater quantities than are actually needed. As a result of this approach, we have witnessed large-scale recall operations in recent years (which have a sizeable impact on companies) whereby the contamination of a single batch of one ingredient has at times resulted in
the need to recall huge quantities of the product.

Lastly, the application of innovative technologies, such as 3D technology, could provide a not insignificant innovation for the food sector, thereby taking machines and plants alike to a high standard of technology and performance.

Providing innovative, fast and reliable instruments for guaranteeing Food Safety is a vital challenge facing the food industry.

**Objectives:**

- Guaranteeing *Food Safety* in order to increase consumer trust.
- Limiting contaminations throughout the production process whilst controlling and tracing the composition of batches of products and semi-finished products with precision.
- Providing the food industry innovative, fast and precise means of detecting contaminants.
- Guaranteeing an improved ability to control the kinetic evolution of chemical, physical and structural properties of the product over the course of the process.

**Expected outcomes:**

The expected impacts involve:

- creating new amperometric sensors, development of optical sensors and biosensors for detecting safety indicators and quality throughout the food production supply chain;
- combining conventional biotechnologies with innovative nanotechnologies for developing ultra-sensitive sensors (e.g. diagnostic lab-on-chip systems, electronic nose);
- developing new technologies and systems for the traceability of products, by-products and semi-finished products during production; techniques for designing plants and optimal planning of production to reduce dispersion of batches and limit the potential impact of a recall beforehand;
- introducing 3D technology in food machines and plants in order to increase operative performance (non-contact 3D scanners, volumetric measurement of products during processing (leavening of bakery products, or changes in volume during cooking or drying), 3D design of packaging for foods and beverages.

**Type of activities:**

- Research projects, development of prototypes/pilot plants.

**Reference documents:**

- S3 Lombardy Region – Regional Strategy for Intelligent Specialisation in Research and Innovation "Smart Specialisation Strategy".
- Strategic Agenda for Research and Innovation for 2030 “Italian Food for Life”.
- S3 Lombardy Region – Regional Strategy for Intelligent Specialisation in Research and Innovation "Smart Specialisation Strategy".
## PILLAR 5 MATRIX - 53 REGIONS TAKING PART IN THE CLUSTER CL.A.N.

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PILLAR 6
ICT IN THE AGRIFOOD INDUSTRY AND TECHNOLOGICAL TRANSFER TOOLS

The family of technologies known as Information & Communication Technology (ICT) is unanimously referred to as one of the Key Enabling Technologies (KETs) that have not only proven themselves a consolidated development trend in the global economy, but also a widespread presence in a vast number of application fields (which of course include agriculture and agricultural industry) and specific knowledge intensive highly specialised activities (such as technological transfer).

The increasing availability of considerable amounts of data which are gathered and made accessible everywhere and using any means, not to mention the increasingly refined algorithms that allow these data to be used with a strategic and analytical approach, are exceptional potential resources for developing applications, models and systems that help different users (consumers, entrepreneurs and policy makers) to make well-informed decisions on a quantitative basis.

The gathering of ever-increasing amounts of data and their transformation into strategic and usable information, however, is not in itself enough to improve the rationale of economic decisions. It must be accompanied by a greater ability amongst economic and corporate players to harness the information generated in full.

From this standpoint, the farming and agrifood sectors are in the perfect position to harness the potential offered by ICTs to individual businesses and their production supply chains in full. This concerns both specific activities (procurement/supply chain, marketing, distribution, sales, agricultural and industrial processes/operations etc.), and supporting activities (such as technological transfer).

All of which explains the presence in the Roadmap for Research and Innovation of the National Agrifood Cluster (CL.A.N.) of Development Pillar no. 6 - “ICT in the agrifood industry and technological transfer tools”.

In particular it aims to enable more effective and efficient exploitation, for managerial and analytical purposes, of data made available in the production supply chain (for example starting with data collected during the product life cycle, and ending with the option of analysing them from multiple standpoints, or starting with the possibility of exploring said data using automated means so they can be correlated with feedback data from various user categories using an unstructured approach). This makes for a “natural” metamorphosis in the business models of companies in the sector, as well as production techniques and processes, resulting in a potential re-definition of relationships between the supply chain players whilst opening up possibilities not previously adopted in the sector (crowd sourcing/funding, social reputation and capital).

Given, however, that ICTs are enabling technologies which potentially apply to the other five Pillars of the Roadmap for Research and Innovation of the Cluster CL.A.N., Pillar 6 has been divided into five Core - Themes, three of which focus on ICTs but from a non-invasive standpoint, namely:

6.1 Applications for consumer behaviour models (to be developed in close conjunction with Core - Themes 1.5, 2.6 and 4.6 of the Roadmap).
6.2 Decision Supporting System (DSS) and Cooperative Platforms for sustainable agriculture and agrifood Industry.
6.3 Business models for the companies of the future.

The remaining two Core - Themes, on the other hand, focus specifically on the Technological Transfer itself:

6.4 Open platforms for technological Transfer and expertise certification.
6.5 Systems for non ICT technological transfer.

The decision to divide Pillar 6 into these 5 Core - Themes is based on the awareness that the parts of the national research system (comprising both Universities and Polytechnics as well as public and private research entities) which belong to the Cluster CL.A.N. contain the technical and scientific skills needed to develop them. Moreover, it is equally understood that businesses from the production fabric with a distinct leaning towards innovation, which are potentially well disposed towards adopting cutting-edge solutions in this field, form an integral part of the CL.A.N. Last
but not least, players which are links between the world of production and the research field are the third element of the CL.A.N. system, the result of negotiated Planning between State and Regional authorities (Framework Programme Agreements that have yielded Technology Districts, High Tech Districts and Public-Private laboratories). The detailed contents of each Core - Theme, outlined in the files that follow, have been developed bearing in mind the synergic principles between European funds for regional purposes, Italian funds and community funds, not to mention those between strategic contents of specific planning instruments.\(^\text{13}\)

### CORE - THEME 6.1 - APPLICATIONS FOR CONSUMER BEHAVIOUR MODELS

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<td>This Core - Theme (which will be developed in close conjunction with Core - Themes 1.5, 2.6 and 4.6) aims to developing specific ICT-based applications to automatishe analysis of agrifood product consumer behaviour, so as to involve them in making well-informed decisions. Literature shows that the shift in IT towards co-production can have considerable knock-on effects in agrifood, not just because consumers have developed considerable awareness of health and wellness-related food aspects, but also because there is a distinct tendency to focus on aspects linked to origin, processing, preservation, environmental impact and the energy impact of food. It has been widely noted that consumers have adopted buying habits affected by new variables, linked to the product’s intrinsic characteristics (origin, typicality, production method, impact in environmental and energy terms, health-giving properties and quality), but also to specific buying strategies which optimise the usefulness of the entire purchase portfolio instead of just assessing individual products on a separate basis. These adaptations can have considerable implications for price dynamics, distribution aspects, production processes and the ability to involve consumers in informed choices that help farm and food businesses improve the way the product/service being sold is qualified. The Challenge of this Core - Theme accordingly involves creating applications which can model these approaches. The positive way in which this Core - Theme overlaps with and complements Core - Themes 1.5, 2.6 and 4.6 will help ensure that consumers can be given a complete range of computerised applications to support their decisions by the national Agrifood Cluster. In particular, Core - Theme 6.1, as already highlighted, will develop applications that guide consumers towards proper purchasing strategies. Core - Theme 1.5 will help consumers adopt proper strategies for organising their daily food and diet, whilst Core - Theme 2.6 will help consumers adopt optimal approaches for preserving and using products already purchased with food safety in mind, identifying potential or real hazards, analysing risks and establishing “best practices”. Last but not least, Core - Theme 4.6 will help consumers adopt positive approaches with regard to the energy, environmental and ecological impact of the products bought and consumed.</td>
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<td>Consumers need new ICT-based technological systems and platforms to help them make well-informed choices for agrifood products, in keeping with parameters which specifically apply to them. In the light of the above, the macro-objective of this Core - Theme is to implement ICT-based platforms and applications which can instantly, precisely and easily provide consumers information they need to make a well-informed choice. These applications could adopt a series of robust, low-cost technologies to be used both “in pack” (inside the packaging) and “on pack” (on the package) of target products.</td>
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\(^{13}\) See Appendix 1 of Reg. (EU) n. 1303/2013 of the European Parliament and Council dated 17 December 2013 and filed as “Common Strategic Framework”, in particular principles 3.3 and 4.3, as well as Article 15 paragraph 1 lett. b), list point i); Article 65 paragraph 11, article 70 paragraph 2, Article 96 paragraph 3, and Article 67 paragraph 5 lett. b) of the Regulation itself.
The specific objectives consist of developing:

- ICT-based applications which can analyse and create consumer behaviour models to help Industry guide market choices;
- ICT-based applications which can involve consumers, meet their requests as a “partner” of the supply chain to make them aware and informed when they choose products (co-production: there is no longer a distinction between the producer and the user of goods or services. Instead the process is seen as a complex system in which all involved are both producer and users at the same time);
- ICT-based applications (mobile app) which can give consumers information concerning the authenticity and quality of the food products which is reliable and verifiable in real time.

**Expected outcomes:**

The expected impact of this Core - Theme consists of improving the level of quality which the consumer perceives in the products purchased. The consumers will have had a clear-cut perception of the characteristics of these products from the outset, and will also perceive that they have had the chance to take part in identifying these characteristics beforehand.

**Type of activity:**

- Pilot project to analyse consumer preferences linked to pre-determined aspects and characteristics of the products.
- Project to research the characteristics consumers hope to find in food products, divided into categories.
- Research project to produce applications and models that allow food businesses to manage this information strategically.

**Reference documents:**


**CORE - THEME 6.2 DECISION SUPPORTING SYSTEM (DSS) AND COOPERATIVE PLATFORMS FOR SUSTAINABLE AGRICULTURE AND AGRIFOOD INDUSTRY;**

**Challenge:**

Given that two of the cornerstones of the European food strategy are a) producing foods that are safe and in sufficient quantities and b) protecting the environment and ensuring an efficient use of resources, this Core - Theme aims to devise ICT-based Decision Support Systems. These can be implemented both with specific applications and by visiting cooperative platforms hosted on remote centralised servers and/or service centres that allow agricultural and agroindustry businesses, in view of existing conditions, to adopt rational business and economic strategies in terms of the following:

- economic and environmental sustainability of the individual business and/or supply chain,
- strategic management of both site-specific agricultural resources and transformation processes,
- food safety.

The gathering of relevant data by sensors, networks of sensors and/or other analytical tools which is also specific for molecular marker dosage, is the first step in a complex decision-making process, which could be highly automated using ICT-based applications/solutions. Different components such as databases and mathematical simulation and optimisation models, both device-embedded and real-time, must be combined to create an effective means of supporting decisions. The end result could be a recommendation, an interpretation or a prediction of the situation of
interest (for example, the treatment of farm crops, quality of the water, the proper execution of a transformation process, and/or the absence/presence of abiotic/biotic contaminants). The user of the solution/application will then be free to put it into practice. This could also give rise to specific cooperative platforms for agriculture and agrifood industry which can provide structured data on environmental conditions, on the distribution of products for getting a process underway (including transformation), on the dosage of markers that can distinguish its progress and/or to detect the absence of surrounding conditions that guarantee the safety of the resulting products. The more complex its nature and the greater the flow of data gathered, the harder it will be to plan the DSS to integrate them (data fusion) in the decision-making process.

This Challenge is based on the consideration whereby the primary problem does not so much lie in connecting diagnostic and/or analytical instruments within the network, but in their "mobility" and above all in defining interpretative models that allow the scientific data for an agrifood product to be used by all those linked to a network who are interested in understanding and using them.

This Challenge is in direct reference to Key Thrust 2 of the SRIA "Food for Life", in particular the Challenge "Tracking the future: developing traceability and retraceability with a systemic supply chain approach (Food Chain Approach)".

The Core - Theme closely adheres to the following strategic documents:
- ETP "Food for Life" Strategic Research and Innovation Agenda 2013-2020 and Beyond:
- ETP Plants for the Future - Strategic Research Agenda 2025.

Objectives:

The general objectives of this Core - Theme are:

• developing a network of biosensors and drones to acquire real-time information about the site-specific situation and traceability and retraceability;
• creating models of data interpretations and information obtained from sensors, drones, other analytical systems and/or from their networks and from IT systems, in order to provide useful analyses and predictions to farms and agrifood companies;
• creating software to support analyses which can be used in an SaaS (Software as a Service) logic;
• generating systems geared towards precision agriculture for targeted calculation and simulation of the nutritional needs of crops, and for localised treatments using agricultural pharmaceutical products with innovative tools (polymer substrates, drones);
• developing and creating hardware/software systems that can implement the prescribed plans drafted using precision agriculture procedures.

The specific objectives include:

• developing “intelligent” ICT applications to help farming and agrifood companies owners take rational, prompt decisions when given variables arise which are both exogenous and endogenous to the production process, and which make it possible to analyse the whole supply chain by importing operative nodal and flow data, logistical aspects and the georeferencing of the whole supply chain (models, algorithms and procedures);
• developing models to optimise company operations and logistics, including technical and economic aspects and sustainability issues;
• creating cooperative platforms/service centres which can be accessed ubiquitously and in a widespread manner (from PCs, smartphones and tablets), operating with an SAAS (Software as a Service) approach which make the data of interest available for processes with standard data structure and semantics;
• standardisation of data and sharing them on a cloud to avoid duplication of information.
**Expected outcomes:**

The expected impacts can be summed up as follows:

- improvement in the environmental sustainability and increase in the economic profitability of agricultural and agroindustrial entrepreneurs, by creating site-specific production protocols aimed at high quality production, with particular attention focused on environmental sustainability, optimising the use of nitrogen, adapting to climate change and mitigating the production footprint (GHG);
- overcoming individual problems linked to management by creating a “decision network”.

**Type of activities:**

- Technological Survey on sensors and other analytical instruments and Internet of Things technologies (IOT) for specific agrifood applications.
- Technological survey on applying ICTs for processing data and information (ontologies, no-sql database, Big Data & Analytics).
- Pilot project for developing a network of biosensors and drones.
- Pilot project for integrating a network of sensors and control units inside a greenhouse with an IOT interface which can display the data acquired on the web with web services which can be consulted with any device (smartphone, tablet or PC) connected to internet via an ordinary browser. This data acquisition and management platform will be used for controlling and managing several cultivation systems in clouds to assess the best energy efficiency solutions of the sustainable greenhouse systems.
- Scientific analysis and implementation of models for data fusion and data meaning (data interpretation), to create knowledge bases and DSS to be used in the agrifood sector.
- Pilot project for implementing an Advanced Service Centre for Agroindustry, also in the form of networks of laboratories for research and the Italian agrifood industry, using an inclusive approach within the Cluster.

**Reference documents:**

- ETP Plants for the Future - Strategic Research Agenda 2025.
CORE - THEME 6.3 - BUSINESS MODELS FOR COMPANIES OF THE FUTURE

**Challenge:**

Consumers have become accustomed to expecting all agrifood products to be available all year round, regardless of their geographical location, with a considerable market cost, respecting all safety/food quality standards. They avail of considerable information such as product origin, traceability of the production process and the environmental/energy impact of the production process concerned.

This has led to the need to combine production and distribution processes with automated work flows and to open the sector up to every channel of the global market.

Taking this as a starting point and to support these consumer needs, this Core - Theme, based also on a series of programme and plan guidelines, aims to develop ICT-based applications to redesign the business models of the agricultural and agroindustry business in all its processes.

The main Challenge is to develop appropriate ICT-based solutions that can be perfectly integrated and reproduced to scale, which make it possible to manage crucial aspects of the business strategically, such as those highlighted in “Smart management” by the Food ManuFuture project in terms of Business model, Food Chain Management, logistics and retail, sustainability and innovative business.

**The Core - Theme closely adheres to the following strategic documents:**

- National Technological Platform “Italian Food for Life”.
- Strategies for Research and Innovation for Smart Specialisation - Marche Region;
- “Smart Puglia 2020”.

**Objectives:**

The specific objectives of the Core - Theme include preparing specific mobile ICT-based applications for:

1. business intelligence, also with a view to internationalisation (for example developing Country/Market-specific applications and tools for local distribution chains/businesses etc);
2. the supply chain in terms of the procurement of raw materials and distribution;
3. internal organisation;
4. management of information flows;
5. food traceability, quality and safety;
6. logistics (predicting demand, managing orders, stores and transportation) and for controlling costs of processes and operations;
7. calculating the carbon and water footprint;
8. boosting entrepreneurship in agrifood businesses in general.

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14 See the “Italian food for life” technological platform; the Italian Quality experience multimedia platform; “Strategies for research and innovation for smart specialisation - Marche Region”; “Smart Puglia 2020”.

15 See the Manufuture project [http://foodmanufuture.eu/](http://foodmanufuture.eu/), Project Number KBBE-2011-5-289327
Expected outcomes:
The expected impact relates to the ever-increasing integration between the production and distribution processes of the agricultural and agrifood sector, with an end to linking businesses to the international market in a more structured and systematic manner. Broadly speaking, businesses would be enabled to manage relations with foreign companies and organised distribution channels effectively, thereby offering remote markets products of undoubted interest to consumers.

Type of activity:
- Research project for each element of the application identified beforehand in the specific objectives.
- Pilot project for implementing an Advanced Service Centre for Agroindustry, also in the form of networks of laboratories for research and the Italian agrifood industry, using an inclusive approach within the Cluster.

Reference documents:
- National Technological Platform “Italian Food for Life”.
- Italian Quality experience multimedia platform.
- Strategies for research and innovation for Smart Specialisation - Marche Region.
- Smart Puglia 2020.

CORE-THEME 6.4 - OPEN PLATFORMS FOR TECHNOLOGICAL TRANSFER AND EXPERTISE CERTIFICATION

Challenge:
One of the aims of Knowledge Innovation Communities (KICs) is to integrate all three sides of the “triangle of knowledge” namely higher education, research and businesses, by bringing the main players in these three dimensions together. The KICs due to be launched in 2016 include “Food4Future”. In addition, as suggested by the programme detailed in Hit 2020 “a truly open innovation calls for the construction of networks which all professionals can take part in on an equal footing [...] which is achieved by defining and implementing a shared strategy for accessing the results of the research of the public national competitive system whilst at the same time respecting intellectual property rights”. In this perspective and in keeping with other major initiatives programmed on a regional, national and community level16, this Core - Theme aims to implement ICT-based platforms to manage networks and knowledge which are aimed at rendering the technological transfer to agriculture and agrifood industry more effective and efficient, along with expertise and skill assessments and certification of those working on the process. They will be “open” platforms, both in the sense that they will include cooperative non-exclusive environments (into which a number of professionals can gradually be incorporated), and in that they can be scaled to size by adding functions, instruments and applications not initially incorporated.

Starting from the basis that the culture of innovation generates demand for specific competences needed for putting change into practice, it is necessary to implement technological platforms which act as innovation drivers for the agricultural and agroindustrial sector, and which are able to:

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16 See National Technology Platform “Italian Food for Life”– Strategic Agenda for Research and Innovation for 2030 (Communication, Training, Technological Transfer and Business and Business Creation); S3 Tuscany Region (Smart s. and human capital); S3 Sardinia Region (objective 10 “Investing in expertise, education and permanent learning); S3 Puglia Region (strategic lever aimed at valorising talents and expertise); S3 Piedmont Region (elements for strengthening the innovation ecosystem- the expertise); European 2020 strategy (2014-2020 programme).
• certify the various abilities/expertise introduced into a company in the sector as a result of a technology transfer;
• promote mapping of outstanding expertise available at various levels (regional, national and international) once the activity has drawn to a close;
• promote mapping of "technology incubators" on several levels, to help businesses that are as yet unstructured (start ups and spin offs) during the start-up phase;
• fill the gap between the lack of specific communication plans (organised to suit different targets) which can act on a “multi-player” basis between public and private researchers, entrepreneurs, policy makers and trade associations.

The Core - Theme closely adheres to the following strategic documents:
- National Technological Platform “Italian Food for Life”- Strategic Agenda for Research and Innovation for 2030 (section on Communication, Training, Technology Transfer and Business Creation);
- S3 Tuscany Region (Smart s. and human capital);
- S3 Sardinia Region (objective 10 “Investing in expertise, education and permanent learning);
- S3 Puglia Region (strategic leverage for valorising talents and expertise);
- S3 Piedmont Region (elements to strengthen the innovation ecosystem - the expertise);
- European 2020 strategy (programming from 2014 to 2020).

Objectives:
The general goals of the Core - Theme can be summed up as follows:
• helping policy makers conduct work to improve study programmes, in line with the evolution called for in corporate knowledge systems (the user-inspired approach);
• supporting entrepreneurial training, bringing the research system closer to the entrepreneurial one also using networks to promote technological transfer based on the pull approach of knowledge management (potential users require experts to possess knowledge of particular problems or challenges, qualified as such based on the prestige and centrality of betweenness);
• developing communities of entrepreneurs and researchers based on both territorial and operative proximity and on long international supply chains with the aim of making tacit expertise clear and encoding the organisational capacities according to a shared and non-hierarchical system for filing shared knowledge, based on tagging and folksonomies of content concerning tacit expertise, and the subsequent development of a semantic web architecture which can manage the dynamic evolution of the certifiable units of standard expertise;
• creating professional short-lists for certifying planning, managerial and communication expertise (see law 14 January 2013, n.4 Unregulated Professions) to support greater transparency in technological transfer work undertaken by consultants in the sector.

The specific objectives include:
• creating an open access computer platform for recording, filing and conducting full text searches on the scientific content of international papers or access to the results of research projects financed with public funding. These may also include items that are not publications, and must be supported with a market-driven communication and distribution plan;
• developing an open computer platform which creates and certifies the contents of training courses, and for verifying and mapping the professional and technical expertise acquired by participants as a result of technological transfer activities in companies from the agricultural and agroindustry sector;
• devising a set of new methods, emulating those from the world of design (infographics, graphic design), the performing media and visual arts (smart-mob, experience design, tag cloud live, editing audio-video), new media (social media strategies , Search Engine Optimisation, creation of opinion media-maker, community management, viral communication), journalism (instant blogging, photographic and video reporting, short
stories, (narrative), mobile technologies (mobtagging, geoblogging and georeferencing in general) and IT (apps for smartphones and tablets), for communicating knowledge and facilitating technological transfer in agriculture and agrifood Industry;

- development of technologies that can gather, analyse and systematise agriculture and agrifood's innovation requirements.

**Expected outcomes:**

The impact expected on research and researchers is that it will promote joint research planning initiatives with a user-driven approach, and on demand technological transfer, helping to align the research expertise with the basic problem types outlined above.

The expected impact on the business system is that of optimising the capture of tacit knowledge and technological transfer to SMEs. They must be encouraged to take an active part in the establishment of the "community of food knowledge and innovation", with the support of the platform. Accordingly it can close the "structural gaps" more efficiently with researchers who are developing new technologies.

The impact expected on society and education systems is to bring curricular training up to date, avoiding excessive specialisation (in the perspective of situation and problem-based learning) whilst promoting peer-to-peer cooperative learning activities (in keeping with the tendency of SMEs to learn from one another), also using innovative mixed learning approaches (flipped classroom).

**Type of activity:**

- Coordination/network activities by the Cluster CL.A.N. and regional Clusters.
- Two research projects respectively for specific objectives 1 and 2 geared towards mapping businesses and research groups which are involved in technological transfer activities, and the resultant training requirements which are generated.
- Pilot project to create a technological platform which contains:
  - a catalogue of past courses;
  - a selection of courses to be run based on the needs expressed following technological transfer activities;
  - a system to verify the expertise acquired, based on a mechanism set in place by an organisation other than the system created;
  - a section in which it is possible to insert and update the expertise mapped between companies involved in technological transfer activities.
- Pilot project for implementing an Advanced Service Centre for Agroindustry, also in the form of networks of laboratories for research and the Italian agrifood industry, using an inclusive approach within the Cluster.
- Pilot project for developing innovative technologies for detecting, analysing and systematising innovation needs in agriculture and agrifood Industry.

**Reference documents:**

- National Technological Platform "Italian Food for Life"- Strategic Agenda for Research and Innovation for 2030 (section on Communication, Training, Technology Transfer and Business Creation);
- S3 Tuscany Region (Smart s. and human capital);
- S3 Sardinia Region (objective 10 “Investing in expertise, education and permanent learning);
- S3 Puglia Region (strategic leverage for enhancing talents and expertise);
- S3 Piedmont Region (elements to strengthen the innovation ecosystem - the expertise);
- European 2020 strategy (programming from 2014 to 2020).
### Challenge:

This Core - Theme aims to conduct studies and pilot projects that make it possible to gain a better understanding of the reasons for both successes and failures in technological transfer models which are not ICT-based, and to compare them with one another to create open innovation systems for non ICT-based technology transfer which provide an efficient and effective way of governing the variables, such as industrial/intellectual property rights, organisational variables, variables in the donor/recipient/sponsor/society process etc.

The Challenge posed by the Core - Theme is two-fold. On the one hand it aims to overhaul systems for knowledge and innovation, not only in agriculture (such as AKIS), but also in the agrifood Industry, in keeping with the regional, national and community initiatives scheduled\(^{17}\). On the other hand, taking into account the fact that there is often a lack of willingness in public opinion to accept technological innovations, particularly in sensitive fields such as agrifood, it is necessary to identify Responsible Research and Innovation (RRI) approaches that make it possible to consider the ethical and social aspects and impacts of the innovations transferred from the right angle.

### Objectives:

The specific objectives of this Core - Theme include:

- developing technological transfer systems that involve the use of technical and scientific mediators (TSM) in Training and Dissemination Units (TDU) of the Food and Drink Federation (see. SRIA 2015-2020, Challenge 2.3);
- identifying a system of qualitative and quantitative indicators which can highlight how returns from the use of the transferred technology correspond with the initial technology demand (follow up);
- experimenting, as an alternative to the restrictions and penalty systems applied to intellectual/industrial property regulations, with new means of regulating the innovations and knowledge which can be accessed in the course of technology transfer. These can be inspired by an approach to knowledge as a common and relational good (commons), which can maximise non-opportunistic access and avoid congestion phenomena, thanks also to the contribution of direct communication between the parties enabled by mediator brokerage;
- modelling a system for monitoring and assessing the effectiveness of the brokering process and the mediated transfer product/service;
- creating a clear-cut link between investments in R&I, both private and public, and the social component.

### Expected outcomes:

Generally speaking, it is estimated that the impact of this Core – Theme consists of increasing the participation of all the players involved in the knowledge chain, by simplifying organisation and improving the coordination of the processes, whilst reconfiguring demand for technology and knowledge. In addition, an alignment of the research Pillars with innovation requirements as perceived by society is expected, along with the ability to defend intellectual/industrial property. All of which should help generate a relationship of trust with the citizen/user, placing all the innovations which answer precise social challenges at the disposal of the latter.

### Type of activity:

- Coordination/network activities by the Cluster CL.A.N. and regional Clusters;
- Two research projects, respectively on interactions between science, innovation and society and on promoting knowledge and an understanding of the RRI approach;
- Pilot project for developing proper instruments for communication governance (public evidence of investment of public funds in R&D by businesses);

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\(^{17}\) See by way of example area 6 of the Strategic Plan for Research and Innovation in the agricultural, food and forestry sector.
• Creation of national awards with competitions which directly involve citizens and cross-media funding campaigns, also adopting crowdfunding practices;
• Pilot project for implementing an Advanced Service Centre for Agroindustry, also in the form of networks of laboratories for research and the Italian agrifood industry, using an inclusive approach within the Cluster.
• Research project on rural social innovation with an end to promoting processes for orientating businesses in satisfying collective needs whilst guaranteeing its economic sustainability.

Reference documents:
- Ch. Hess, E. Ostrom (by), Understanding Knowledge as a Commons. From theory to practice, published by Bruno Mondadori, Milan 2009 (or. ed. 2007).

PILLAR 6 MATRIX - S3 REGIONS TAKING PART IN THE CLUSTER CL.A.N.

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