

PART III – SOCIETAL CHALLENGES

Societal Challenge 2:

“European Bioeconomy Challenges: Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research”

Specific objective:

The specific objective is to secure sufficient supplies of safe, healthy and high quality food and other bio-based products, by developing productive, sustainable and resource-efficient primary production systems, fostering related ecosystem services and the recovery of biological diversity, along side competitive and low carbon supply, processing and marketing chains. This will accelerate the transition to a sustainable European bio-economy, bridging the gap between new technologies and their implementation.

Over the coming decades, Europe will be challenged by increased competition for limited and finite natural resources, by the effects of climate change, in particular on primary production systems (agriculture including animal husbandry and horticulture, forestry, fisheries and aquaculture) and by the need to provide a sustainable, safe and secure food supply for the European and an increasing global population. A 70 % increase of the world food supply is estimated to be required to feed the 9 billion global population by 2050. Agriculture accounts for about 10 % of Union greenhouse gases emissions, and while declining in Europe, global emissions from agriculture are projected to increase up to 20 % by 2030. Furthermore, Europe will need to ensure sufficient and sustainably produced supplies of raw materials, energy and industrial products, under conditions of decreasing fossil carbon resources (oil and liquid gas production expected to decrease by about 60 % by 2050), while maintaining its competitiveness. Bio-waste (estimated at up to 138 million tonnes per year in the Union, of which up to 40 % is land-filled) represents a huge problem and cost, despite its high potential added value. For example, an estimated 30 % of all food produced in developed countries is discarded. Major changes are needed to reduce this amount by 50 % in the Union by 2030.

In addition, national borders are irrelevant in the entry and spread of animal and plant pests and diseases, including zoonotic diseases, and food borne pathogens. While effective national prevention measures are needed, action at Union level is essential for ultimate control and the effective running of the single market. The challenge is complex, affects a broad range of interconnected sectors and requires a holistic and systemic approach.

More and more biological resources are needed to satisfy market demand for a secure and healthy food supply, bio-materials, biofuels and bio-based products, ranging from consumer products to bulk chemicals. However the capacities of the terrestrial and aquatic ecosystems required for their production are limited, while there are competing claims for their utilisation, and often not optimally managed, as shown for example by a severe decline in soil carbon content and fertility. There is under-utilised scope for fostering ecosystem services from farmland, forests, marine and fresh waters by integrating agronomic, environmental and social goals into sustainable production and consumption.

The potential of biological resources and ecosystems could be used in a much more sustainable, efficient and integrated manner. For examples, the potential of biomass from

forests and waste streams from agricultural, aquatic, industrial, and also municipal origins could be better harnessed.

In essence, a transition is needed towards an optimal and renewable use of biological resources and towards sustainable primary production and processing systems that can produce more food and other bio-based products with minimised inputs, environmental impact and greenhouse gas emissions, enhanced ecosystem services, zero-waste and adequate societal value. A critical effort of interconnected research and innovation is a key element for this to happen, in Europe and beyond as well as a continuous dialogue between political, social, economic and other stakeholder groups.

Rationale and Union added value

Agriculture, forestry, fisheries and aquaculture together with the bio-based industries are the major sectors underpinning the bio-economy. This latter represents a large and growing market estimated to be worth over EUR 2 trillion, providing 20 million jobs and accounting for 9 % of total employment in the Union in 2009. Investments in research and innovation under this societal challenge will enable Europe to take leadership in the concerned markets and will play a role in achieving the goals of the Europe 2020 strategy and its Innovation Union and Resource Efficient Europe flagship initiatives.

A fully functional European bio-economy – encompassing the sustainable production of renewable resources from land, fisheries and aquaculture environments and their conversion into food, bio-based products and bioenergy as well as the related public goods - will generate high European added value. Managed in a sustainable manner, it can reduce the environmental footprint of primary production and the supply chain as a whole. It can increase their competitiveness and provide jobs and business opportunities essential for rural and coastal development. The food security, sustainable agriculture and farming, aquatic production, forestry and overall bio-economy – related challenges are of a European and global nature. Actions at Union level are essential to bring together clusters to achieve the necessary breadth and critical mass to complement efforts made by a single or groups of Member States. A multi-actor approach will ensure the necessary cross-fertilising interactions between researchers, businesses, farmers/producers, advisors and end-users. The Union level is also necessary to ensure coherence in addressing this challenge across sectors and with strong links to relevant Union policies. Coordination of research and innovation at Union level will stimulate and help to accelerate the required changes across the Union.

Research and innovation will interface with and support elaboration of a wide spectrum of Union policies and related targets, including the Common Agriculture Policy (in particular the Rural Development Policy, the Joint Programming Initiatives, including “Agriculture, Food Security and Climate Change”, “A Healthy Diet for a Healthy Life” and “Healthy and Productive Seas and Oceans”) and the European Innovation Partnership 'Agricultural Productivity and Sustainability', the Common Fisheries Policy, the Integrated Maritime Policy, the European Climate Change Programme, the Water Framework Directive, the Marine Strategy Framework Directive, the EU Forestry Action Plan, the Soil Thematic Strategy, the Union's 2020 Biodiversity Strategy, the Strategic Energy Technology Plan, the Union's innovation and industrial policies, external and development aid policies, plant health strategies, animal health and welfare strategies and regulatory frameworks to protect the environment, health and safety, to promote resource efficiency and climate action, and to reduce waste. A better integration of research and innovation into related Union policies will significantly improve

their European added value, provide leverage effects, increase societal relevance and help to further develop sustainable land, seas and oceans management and bio-economy markets.

For the purpose of supporting Union policies related to the bio-economy and to facilitate governance and monitoring of research and innovation, socio-economic research and forward looking activities will be performed in relation to the bio-economy strategy, including development of indicators, data bases, models, foresight and forecast, impact assessment of initiatives on the economy, society and the environment.

Challenge-driven actions focusing on social, economic and environmental benefits and the modernisation of the bio-economy associated sectors and markets shall be supported through multi-disciplinary research, driving innovation and leading to the development of new strategies, practices, products and processes. It shall also pursue a broad approach to innovation ranging from technological, non-technological, organisational, economic and social innovation to, for instance, ways for technology transfer, novel business models, branding and services.

Broad lines of activities

2.1. Sustainable agriculture and forestry

Appropriate knowledge, tools, services and innovations are necessary to support more productive, environmentally-friendly resource-efficient and resilient agriculture and forestry systems that supply sufficient food, feed, biomass and other raw-materials and deliver ecosystems services while at the same time supporting the development of thriving rural livelihoods. Research and innovation will provide options for integrating agronomic and environmental goals into sustainable production, thus: increasing productivity and resource efficiency, including water use efficiency, of agriculture; increasing the safety of animal and plant production; reducing agricultural greenhouse gases (GHGs) emissions; reducing the production of waste; reducing leaching of nutrients and other chemical inputs from cultivated lands into terrestrial and aquatic environments; decreasing dependence from international plant derived protein imports to Europe; increasing the level of diversity in primary production systems as well as fostering the recovery of biological diversity.

2.1.1. Increasing production efficiency and coping with climate change, while ensuring sustainability and resilience

Activities will enhance productivity as well as the adaptive capacity of plants, animals and production systems to cope with rapidly changing environmental/climatic conditions and increasingly scarce natural resources. The resulting innovations will help to move towards a low energy, low emission and low waste economy, and to reduced natural resources demand along the entire food and feed supply chain. In addition to contributing to food security, new opportunities will be created for the use of biomass and by-products from agriculture for a wide range of non-food applications.

Multi-disciplinary approaches will be sought to improve the performance of plants, animals, micro-organisms, while ensuring efficient resource use (water, land, soil, nutrients, energy and other inputs) and the ecological integrity of rural areas. Emphasis will be placed on integrated and diverse production systems and agronomic practices, including the use of precision technologies and ecological intensification approaches to benefit both conventional and

organic agriculture. Also urban greening will be promoted, with new forms of agriculture, horticulture and forestry in urban and peri-urban areas. These shall be considered by addressing new requirements for plant characteristics, cultivation methods, technologies, marketing and urban design, in relation with human health and well-being, environment and climate change. Genetic improvement of plants and animals for adaptation, health and productivity traits will call for all appropriate conventional and modern breeding approaches and for preservation and better use of genetic resources. Due attention will be given to soil management for increasing the productivity of crops. Bearing in mind the overall objective of ensuring high quality and safe food production, plant and animal health will be promoted.

Activities in the area of plant health and plant protection will increase knowledge and support the development of integrated environmentally-friendly pest management strategies, products and tools to prevent the introduction of pathogens, control pest and diseases and reduce yield losses at pre- and post-harvest levels. In the area of animal health, strategies for the eradication or effective management of diseases including zoonoses and research on antimicrobial resistance will be promoted. Integrated control of disease, parasites and pests will be strengthened, starting from a better understanding of host-pathogen interactions, to surveillance, diagnostics and treatments. Studying the effects of practices on animal welfare will help meet societal concerns. The above listed areas will be underpinned by more fundamental research to address relevant biological questions as well as to support the development and implementation of Union policies and supported by adequate assessment of their economic and market potential.

2.1.2. Providing ecosystem services and public goods

Agriculture and forestry are unique systems delivering commercial products but also wider societal public goods (including cultural and recreational value) and important ecological services such as functional and in-situ biodiversity, pollination, water regulation, soil functions, landscape, erosion reduction and carbon sequestration / GHG mitigation. Research activities will contribute to a better understanding of the complex interactions between primary production systems and ecosystems services and will support the provisions of these public goods and services, through the delivery of management solutions, decision-support tools and the assessment of their market and non-market value. Specific issues to be dealt with include the identification of rural and (peri-)urban farming/forest systems and landscape patterns likely to achieve these goals. Shifts in the active management of agricultural systems - including the use of technologies and change of practices - will increase GHG mitigation and the adaptive capacity of the agriculture sector to the adverse effects of climate change.

2.1.3. Empowerment of rural areas, support to policies and rural innovation

Development opportunities for rural communities will be mobilised by strengthening their capacity for primary production and delivery of eco-systems services as well as by opening avenues for the production of new and diversified products (including food, feed, materials, energy), which meet the increasing demand for low-carbon short-chain delivery systems. Socio-economic research and science and society studies along with the development of new concepts and institutional innovations is needed to ensure cohesion of rural areas and prevent economic and social marginalisation, foster diversification of economic activities (including service sector), ensure appropriate relations between rural and urban areas, as well as facilitate knowledge exchange, demonstration, innovation and dissemination and foster participatory resource management. Also, there is a need to look at ways in which public

goods in rural areas can be converted into local/regional socio-economic benefits. Innovation needs defined at regional and local levels will be complemented by cross-sectoral research actions at international, inter-regional and European levels. By providing the necessary analytical tools, indicators, integrated models and forward looking activities, research projects will support policy makers and other actors in the implementation, monitoring and assessment of relevant strategies, policies and legislation, not only for rural areas but for the whole bio-economy. Tools and data are also required to allow for proper assessment of potential trade-offs between various types of resource use (land, water, soil, nutrients, energy and other inputs) and bio-economy products. Socio-economic and comparative assessment of farming/forestry systems and their sustainability performance will be addressed.

2.1.4. Sustainable forestry

The aim is to sustainably produce bio-based products, ecosystems, services (including water-related and climate-mitigation services) and sufficient biomass, with due consideration to economical, ecological and social aspects of forestry as well as to regional differences. Overall, activities in the forestry sector will seek to promote multi-functional forests which deliver a variety of ecological, economic, and social benefits. Activities will focus on the further development of sustainable forestry systems which can address societal challenges and demands, including forest owners' needs, by putting in place multifunctional approaches that reconcile the need for delivering smart, sustainable and inclusive growth taking into account climate change. These sustainable forestry systems are instrumental in the strengthening of forest resilience and biodiversity protection and the need to meet the increased biomass demand. This will need to be underpinned by research on tree health and on forest protection and restoration from fire.

2.2. Sustainable and competitive agri-food sector for a safe and healthy diet

Consumer needs for safe, healthy, high quality and affordable food have to be addressed, while considering the impacts of food consumption behaviour and food and feed production on human health, the environment and the global ecosystem. Food and feed security and safety, the competitiveness of the European agri-food industry and the sustainability of food production, supply and consumption will be addressed, covering the whole food chain and related services, whether conventional or organic, from primary production to consumption. This approach will contribute to (a) achieving food safety and security for all Europeans and eradication of hunger in the world (b) decreasing the burden of food- and diet-related diseases by promoting the shift towards healthy and sustainable diets, via consumer education and innovations in the food industry (c) reducing water and energy consumption in food processing, transport and distribution and (d) reducing food waste by 50 % by 2030.

2.2.1. Informed consumer choices

Consumer preferences, attitudes, needs, behaviour, lifestyle, education and the cultural component of food quality will be addressed, and communication between consumers and the food chain research community and its stakeholders will be enhanced in order to improve public understanding of food production generally and enable informed choice, sustainable and healthy consumption and their impacts on production, inclusive growth and quality of life, especially of vulnerable groups. Social innovation will respond to societal challenges, and innovative predictive models and methodologies in consumer science will deliver comparable data and lay the ground for responses to Union policy needs.

2.2.2. Healthy and safe foods and diets for all

Nutritional needs, a balanced diet and the impact of food on physiological functions, physical and mental performance will be addressed as well as the links between diet, demographic trends (such as ageing) and chronic diseases and disorders. Dietary solutions and innovations leading to improvements in health and well-being will be identified. Chemical and microbial food and feed contamination, risks and exposures as well as allergens will be analysed, assessed, monitored, controlled and traced throughout the food, feed and drinking water supply chains from production and storage to processing, packaging, distribution, catering, and preparation at home. Food safety innovations, improved tools for risk and risk-benefit assessment and for risk communication and improved food safety standards to be implemented throughout the food chain will lead to enhanced consumer trust and protection in Europe. Globally improved food safety standards will also help to strengthen the competitiveness of the European food industry.

2.2.3. A sustainable and competitive agri-food industry

The needs for the food and feed industry to cope with social, environmental, climate and economic change from local to global will be addressed at all stages of the food and feed production chain, including food design, processing, packaging, process control, waste reduction, by-product valorisation and the safe use or disposal of animal by-products. Innovative and sustainable resource-efficient technologies and processes as well as diversified, safe, affordable and high quality products will be generated and underpinned with science-based evidence. This will strengthen the innovation potential of the European food supply chain, enhance its competitiveness, create economic growth and employment and allow the European food industry to adapt to changes. Other aspects to address are traceability, logistics and services, socio-economic and cultural factors, animal welfare and other ethical issues, the resilience of the food chain against environmental and climate risks, the limitation of negative impacts of food chain activities and of changing diets and production systems on the environment.

2.3. Unlocking the potential of aquatic living resources

One of the main features of living aquatic resources is that they are renewable and their sustainable exploitation relies on in depth understanding and a high degree of quality and productivity of the aquatic ecosystems. The overall objective is to manage aquatic living resources to maximise social and economic benefits/returns from Europe's oceans, seas and inland waters.

This includes the need to optimise the sustainable contribution of fisheries and aquaculture to food security in the context of the global economy and reduce the heavy Union's dependence on seafood imports (approximately 60 % of total European sea food consumption depends on import and the Union is the world's largest importer of fisheries products), and to boost marine and maritime innovation through biotechnologies to fuel smart "blue" growth. In line with current policy frameworks, in particular the Integrated Maritime Policy and the Marine Strategy Framework Directive, research activities will underpin the ecosystem approach to the management and exploitation of natural resources, while enabling sustainable use of marine goods and services, and the 'greening' of the sectors involved. Cross-cutting marine and maritime scientific and technological knowledge will be addressed with a view to unlock the potential of the seas and inland waters across the range of marine and maritime industries, while protecting the environment and adapting to climate change.

2.3.1. Developing sustainable and environmentally-friendly fisheries

The new Common Fisheries Policy, the Marine Strategy Framework Directive and the Union's Biodiversity Strategy call for European fisheries to be more sustainable, competitive, and environmentally-friendly. The move towards an ecosystem approach to fisheries management will require an in depth understanding of marine ecosystems. New insights, tools and models will be developed to improve understanding of what makes marine ecosystems healthy and productive and to assess, evaluate and mitigate the impact of fisheries on marine ecosystems (including deep sea). New harvest strategies and technologies will be developed which provide services to society while maintaining healthy marine ecosystems. The socio-economic effects of management options will be measured. The effects and adaptation to environmental changes, including climate change, will also be investigated along with new assessment and management tools to deal with risk and uncertainty. Activities will support research on the biology, genetic and dynamics of fish populations, on the role of key species in the ecosystems, on fishing activities and their monitoring, on fishing sector behaviours and adaptation to new markets e.g. eco-labelling on fishing industry involvement in decision making. The shared use of maritime space with other activities, particularly in the coastal zone, and its socio-economic impact will also be addressed.

2.3.2. Developing competitive and environmentally-friendly European aquaculture

Aquaculture has a large potential for the development of sustainable, healthy, safe and competitive products tailored to consumer needs and preferences as well as for environmental services (bioremediation, land and water management, etc) and energy production but it needs to be fully realised in Europe. Knowledge and technologies will be strengthened in all aspects of domestication of established species and diversification for new species while taking into account the interactions between aquaculture and the aquatic ecosystems in order to reduce its impact on the environment, and the effects of climate change and how the sector can adapt to them. Continuation of research efforts is particularly needed on health and diseases of farmed aquatic organisms (including prevention and mitigation tools and methods), on nutrition issues (including development of alternative tailor-made ingredients and feeds for aquaculture), and on reproduction and breeding which are among the main obstacles in the sustainable development of European aquaculture. Innovation will also be promoted for sustainable production systems inland, on the coastal zone and offshore. The specificities of the European ultra-periphery will also be taken into account. Emphasis will also be given to understanding the social and economic dimensions of the sector to underpin cost and energy efficient production matching with the market and consumer demands, while ensuring competitiveness and attractive prospects for investors and producers.

2.3.3. Boosting marine and maritime innovation through biotechnology

More than 90 % of the marine biodiversity remains unexplored, offering a huge potential for discovery of new species and applications in the field of marine biotechnologies, which is foreseen to generate a 10 % annual growth for this sector. Support will be given to further explore and exploit the large potential offered by marine biodiversity and aquatic biomass to

bring new innovative and sustainable processes, products and services on the markets with potential applications in sectors including chemical and material industries, pharmaceutical, fisheries and aquaculture, energy supply and cosmetic.

2.4. Sustainable and competitive bio-based industries and supporting the development of a European bio-economy

The overall objective is to accelerate the conversion of fossil-based European industries to low carbon, resource efficient and sustainable ones. Research and innovation will provide the means to reduce the Union's dependency on fossil fuels and contribute to meeting its energy and climate change policy targets for 2020 (10 % of transport fuels from renewables and a 20 % reduction of greenhouse gases emissions). Estimates conclude that a shift to biological raw materials and biological processing methods could save up to 2.5 billion tons of CO₂ equivalent per year by 2030, increasing markets for bio-based raw materials and new consumer products several-fold. Reaping these potentials requires building a broad knowledge base and developing relevant (bio)technologies, focussing mainly on three essential elements: a) transforming current fossil-based processes by resource and energy efficient biotechnology based ones; b) establishing reliable, sustainable and appropriate supply chains of biomass, byproducts and waste streams and a wide network of bio-refineries throughout Europe; and c) supporting market development for bio-based products and processes, taking account of the associated risks and benefits. Synergies will be sought with the '*Leadership in Enabling and Industrial Technologies*' specific objective.

2.4.1. Fostering the bio-economy for bio-based industries

Major progress towards low carbon, resource efficient and sustainable industries will be supported through discovery and exploitation of terrestrial and aquatic biological resources, while minimising adverse environmental impacts and water footprint. Potential trade-offs between the various uses of biomass should be examined. The development of bio-based products and biologically active compounds for industries and consumers with novel qualities, functionalities and improved sustainability will be targeted. The economic value of renewable resources, bio-waste and by-products will be maximised through new and resource efficient processes.

2.4.2. Developing integrated biorefineries

Activities will be supported to boost sustainable bioproducts, intermediates and bioenergy/biofuels, predominantly focussing on a cascade approach, prioritising the generation of high added-value products. Technologies and strategies will be developed to assure the raw material supply. Enhancing the range of types of biomass for use in second and third generation biorefineries, including forestry, biowaste and industrial by-products, will help avoid food/fuel conflicts and support economic and environmentally-friendly development of rural and coastal areas in the Union.

2.4.3. Supporting market development for bio-based products and processes

Demand-side measures will open new markets for biotechnology innovation. Standardisation and certification at Union and international levels is needed for, amongst others, determination of bio-based content, product functionalities and biodegradability. Methodologies and approaches to life-cycle analysis need to be further developed and continuously adapted to scientific and industrial advances. Research activities supporting product and process standardisation (including harmonisation of international standards) and regulatory activities in the field of biotechnology are considered essential for supporting the creation of new markets and for realising trade opportunities.

2.5. Specific implementation aspects

Beyond the general sources of external advice, specific consultations will be sought from the Standing Committee on Agricultural Research (SCAR) on a range of issues, including on strategic aspects through its foresight activity and on the coordination of agricultural research between national and Union levels. Appropriate links with the actions of relevant European Innovation Partnerships and the relevant aspects of the research and innovation agendas of European Technology Platforms will also be established.

The impact and dissemination of research results will be actively supported through specific actions on communication, knowledge exchange and the involvement of various actors all along the projects. Implementation will combine a wide range of activities, including substantial demonstration and pilot activities. Easy and open access to research results and best practices will be fostered.

The specific support to SMEs will allow for an increased participation of farms, fishermen and other types of SMEs in research and demonstration activities. The specific needs of the primary production sector for innovation support services and outreach structures will be taken into account. Implementation will combine a wide range of activities, including knowledge exchange actions where the involvement of farmers or other primary producers and intermediaries will be actively ensured in view of summarising the research needs of end-users. Easy and open access to research results and best practices will be fostered.

Support to standardisation and regulatory aspects will be used to help accelerate market deployment for novel bio-based goods and services.

Consideration may be given to support relevant Joint Programming Initiatives (JPIs) and relevant public-public and public-private partnerships.

Synergies with and further deployment by other Union funds related to this societal challenge, such as the Rural Development Funds and Fisheries Funds will be sought.

Forward looking activities will be undertaken across the sectors of the bio-economy, including the development of data bases, indicators and models addressing global, European, national and regional dimensions. A European bio-economy observatory shall be developed for mapping and monitoring Union and global research and innovation activities including technology assessment, developing key performance indicators, and monitoring innovation policies in the bio-economy.