**PRIMA Strategic Research and Innovation Agenda**

Version February 22, 2017

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*PRIMA Vision*

***Sustainable innovation in agri-food systems and water provisions strengthens Euro-Mediterranean cooperation and supports inclusive well-being and socio-economic development in Euro-Mediterranean societies***

To pursue such a vision, PRIMA promotes research and innovation across 3 pillars:

* Sustainable management of **water** for arid and semi-arid Mediterranean areas;
* Sustainable **farming systems** under Mediterranean environmental constraints;
* Mediterranean **food value chain** for regional and local development.

While specific areas of intervention and activities are suggested under each of these pillars, PRIMA will encourage research and innovation actions addressing the entire agri-food value chain in order to promote a sustainable use of the natural resources and market-competitive agriculture and food industry. This is a consequence, firstly, of the strong nexus between use of water and food productions. It also depends upon the need of innovation along the entire food value chain due to the deep social and environmental changes affecting the Mediterranean scenario.

The PRIMA goal is to develop innovative solutions and promote their adoption for improving the efficiency and sustainability of food productions and water provision in order to support an inclusive well-being and socio-economic development in the Mediterranean Area within the framework of a reinforced Euro-Mediterranean co-operation.

PRIMA relies on an ‘Open Innovation, Open Science and Open to the World’ approach, based on the active involvement of all components of the so-called Quadruple Helix (Universities and Research Centres, Small and Medium Enterprises -SMEs- and Large Industry, Government and Public Sector, and User Community and Lead Users), and the joint consideration of environmental, technical and socio-economic aspects.

The Programme presents a long-term orientation, and aims at avoiding fragmentation and duplications in R&I activities in the fields of food systems and water resources in the Mediterranean.

It will be implemented by a brand new and autonomous implementing structure, which will guarantee scientific, financial and management integration among initiatives in the field. At the same time, it takes advantage of experience, knowledge and feedback from previous European R&D programmes focused on the same topics.

PRIMA recognizes the value of basic research to deal with Mediterranean challenges in terms of climate change, loss of biodiversity, exploitation of natural resources, urbanization. At the same time, the Programme will act as a catalyser for developing and demonstrating innovative, sustainable and economically feasible technologies and management models.

The suggested sustainable innovations ought to be adopted by end-users and aimed at strengthening local agri-food systems. Novel and more efficient technologies, agronomical practices, as well as knowledge about the attributes that regulate the soil-ecosystem services are required, valorising biodiversity and biotechnologies for the production of improved and climate-proof plants and animals. New basic knowledge about plant and animal physiology and ecology is also needed, together with better understanding of the physical and biogeochemical processes currently limiting water availability and quality and food security, as well as of how to improve the management of land and available freshwater resources to prevent or recover pollution, erosion and ecosystem depletion.

The historical, nutritional, and charming flavour of the Mediterranean diet needs to be preserved and reinforced. The healthy value of the Mediterranean diet relies on Mediterranean food diversity, consisting of a broad repertoire of raw materials, as the result of many different genotype/environment combinations, and of a heterogeneous processing industry. In this regard, innovation must valorise typical productions of high nutritional and economic value, through labelling and traceability technologies. PRIMA considers innovation relevant not only to better promote nutritional values of the traditional Mediterranean food products but also to develop new products and business models able to respond to the rapidly changing market preferences and new challenges of climate change.

The most important feature of PRIMA is the participation of Countries from the three Continents around the Mediterranean rim according to principles of equal footing, mutual interest, shared benefits and co-funding.

This will allow PRIMA to strengthen cooperation among researchers and peoples of the Mediterranean. Shared governance will contribute to the promotion of food security, a more sustainable use of natural resources and new business opportunities in the agri-food sector based on local values, supporting the development of the area and job creation, particularly for younger citizens. Because its multiple dimensions, the implementation and the outcome of PRIMA will be monitored making reference to the Agenda 2030 framework and Sustainable Development Goals.

In short, Research and Innovation within PRIMA will be useful both to define technical and organisational solutions, and to promote wellbeing, economic growth and knowledge flows across the Mediterranean shores.

For these reasons, PRIMA could give a contribution also to deal with root causes of migration and to reinforce social stability of the area.

1. **Strategic Context**

**Overview of the current situation in the Mediterranean area**

Mediterranean countries share a number of characteristics related to geographical and physical features, which make productivity of agricultural, forest and natural ecosystems vulnerable to climate change. Today, these areas are characterized by the presence of large arid and semi-arid zones, where severe to moderate water scarcity and soil degradation processes are accompanied by increasing problems of salinity and thermal stress, as well as by novel stress agents such as anthropic pollution. These agro-ecosystems have also been the result of long-lasting cultural and commercial influences, which have shaped the landscape of agriculture and environment across all countries of the Mediterranean region. Many of the problems that the agriculture of these countries are facing today are therefore common, and need to be addressed collectively.

The population of Mediterranean countries has been steadily increasing over the last 50 years. It doubled from 250 million in 1960 to 513 million in 2015 mostly due to the demographic growth in countries of the Southern rim of the Mediterranean basin. This increasing trend will continue in the future: in 2025, the total population of the region is estimated to be around 600 million people (UN, World Population Prospects) with 2/3 of the population living in the Southern and Eastern Mediterranean shores. While the ageing population issue is becoming a cause of increasing concern in the North of the Mediterranean, in the South creating jobs and new job opportunities for the young people is today the main societal challenge. It has been estimated, in fact, that over the next two decades 30 to 40 million new jobs will have to be created just to maintain the current rate of employment in the Southern and Eastern Mediterranean Countries (SEMCs) (World Bank, 2012). The increase of population has mainly occurred in urban areas and in particular along the coasts, both in the Northern and in the Southern shore of the Mediterranean. Increasing urbanization along the shores increases civil water needs, in competition with agriculture. However, in SEMCs, rural population is still increasing, suggesting that the development of rural activities is a key issue to fight poverty.

The Mediterranean climate is characterised by infrequent rainfall (less than 100 days a year) that is unevenly distributed over time (long periods of summer drought) and sometimes quite sparse (about 300 to 500 mm per year in some semi-arid regions). Most climate change scenarios for the region call for decreased rainfalls and higher temperatures. IPCC forecasts for the Mediterranean area indicate a yearly temperature increase between 2 and 4°C and a decrease in rainfall between 4 and 30% by 2050. In the most pessimistic scenario, a significant decrease of more than 50% of water resources is predicted for Morocco, Algeria, Middle East and South of Spain (IPCC, 5th assessment 2013), while the frequency of extreme flood and drought events has already increased (IPCC). The impact of climate change on the precipitations concerns the whole Mediterranean area.

With food insecurity back in the world headlines, agriculture has once again become a crucial concern in international strategies. Everywhere in the world, food and water security are fundamental challenges. On a global scale, managing scarcity will be the main challenge for food and water supply in the 2030 perspective. Demand for food is expected to be 50% higher in 2030 than in 2008. The Mediterranean area magnifies these challenges. Indeed, the Mediterranean area presents, among the others, alarming demographic trends, strong socio-economic disparities (between generations, between coastal areas and hinterlands, including different access to work), highly vulnerable market stocks for the food commodities prices, lack of investments in agriculture and in rural territories, insufficient of misused natural resources (water, soils) and inefficient logistics systems and agri-food chains. Furthermore, the market opportunities of products coherent with the Mediterranean diet are not fully exploited, and this happens when the role of sustainable diets for the wellbeing of people is becoming more and more relevant in all countries. It is now widely recognised that this complex situation is at the basis of migratory flows, as is likely to increase migration in the coming decades. The current situation of social and political turbulence in the Mediterranean basin invites us to reflect upon the challenges facing economies in EU’s bordering countries and the potential leverage for sustainable development in the region. An improvement of living conditions is among the main demands of Mediterranean citizens, facing a multidimensional insecurity that plunges them in a highly vulnerable situation on a daily basis. The access to food and water is a determinant and interconnected challenge in this area and securing food and water availability is of crucial - political, social, economic - importance in the region. At the same time, innovative food systems can contribute to deal with social and environmental issues and promote sustainable development and economic growth.

Water scarcity and over exploitation of water resources

According to Plan Bleu 2010 report, 180 million persons are considered as *water poor* since they rely on less than 1000 m3/capita/year, while the UN alerts that the threshold is 1700 m3/capita/year. Plan Bleu forecasts that 80 millions of Mediterranean citizens could be in a shortage situation (less than 500 m3/inhabitant/year) by 2025. Water scarcity in the region arises from the pressure to meet the increasing food and domestic water needs, exacerbated by extreme climate variability. Increased cost of energy production coupled with water scarcity, misuse of irrigation water, deteriorated water quality and overexploitation of resources often result in deficit in food production. Consequently, it negatively affects economic conditions and produces various types of conflicts, ranging from social domestic conflicts to sectorial ones (from agriculture and aquaculture to urban areas, industry and tourism) and trans-boundary conflicts. According to the 2015 Global Risks Report of the World Economic Forum, water crises are listed as the number one risk that could undermine economic growth, impacting several countries or industries within the next 10 years. In the future, geopolitical tensions over access to strategic water resources could become more systemically impactful, and water shortage coupled with poverty and societal instability could weaken intra-state cohesion.

Due to its limited availability and the high connections with food systems and societal and economic challenges, addressing sustainable water management is vital in the region. In fact, many countries in the Mediterranean are overexploiting and intensively using their scarce water resources, resulting in a fall in water table and river levels, and emptying of falls, reservoirs and wetlands. These countries are therefore headed towards a serious national water crisis. For instance, Egypt, Israel, Malta, Jordan and Syria extract more than their total renewable water resources, raising serious environmental concerns and issues regarding water resources sustainability.

Within this context of high pressure on water resources, agriculture remains, by far, the largest water-consuming sector in the Mediterranean (70% of the total water consumed). The competition for water use between agriculture, drinking water and other uses, such as tourism-related activities, is more and more severe. Water used for irrigation represents 60% of the total water quantities used for human-related activities in the Mediterranean area, and this percentage extends to more than 80% of total water use in Morocco, Greece, Egypt, Cyprus, Syria, Tunisia and Turkey (FAO, 2015). At the same time, water is crucial for Mediterranean agriculture, as it ensures higher and stable productivity, as well as production diversity and it has a major role in securing food production and reducing poverty in the region. The demand for water is continuously increasing in response to population growth. The situation is aggravated by the increasing frequency of droughts, a consequence largely attributable to climate change. Therefore, the competition for water among different sectors of society (agriculture, urban and industry) will continue to grow, particularly during summer periods when supply is scarce and demand is high.

Water scarcity and the simultaneous overexploitation of water resources result in additional environmental and agriculture threats, such as the risk of soil salinization and desertification. The consequences of these two related processes have in addition a long-lasting risk, as it is extremely complex to regenerate degraded soil and water surface and underground water affected by salinization.

Agriculture as a condition for food security and rural development

Mediterranean agriculture is globally less and less able to provide sufficient amount of good quality, healthy food for its inhabitants. This is particularly crucial for the Southern shores, where the demographic trend is continuing at a high level. The total agricultural deficits of SEMCs increased from an average of 13 billion USD in 1980-2007 to an average of 48 billion USD in 2008-2013. Several Euro-Mediterranean countries and territories are also relying more and more on international markets to respond to basic food needs for their citizens. Although the Mediterranean area concentrates only 7% of the world’s population, it stands for 25% of the world’s cereal imports (WTO, 2015). Except for France, Morocco, Spain and Turkey, most Mediterranean countries and territories are importing cereals and the total amount of them doubled between 1980 and 2000. Imports can certainly compensate for a lack of production, but at the cost of high dependency on the international market and the social risks that have been already evidenced by the recent food crises, due to the price of food commodities in the world market. The fact that the Mediterranean region and, particularly, the Southern shore relies on imports for a large share of its food consumption is a major concern for policymakers, who view this as a threat to national food security and a source of political vulnerability.

Simultaneously, in the Mediterranean area agriculture is an important economic sector in terms of its capacity to generate employment and income for a large part of the population. As an example, in the Euro-Mediterranean countries, the role of agriculture to the economies has been renewed by the economic crisis of the last 10 years (i.e. in Greece), whereas in most of the SEMCs it is already providing employment for 20 to 30% of the population (e.g. Morocco, Egypt, Turkey and Tunisia). In the SEMCs, the cities are not able to absorb the growing demand for employment. Agricultural development can therefore contribute to maintain rural populations and to avoid migration.

In all the Mediterranean countries, agricultural policies have led, in the last decades, to a remarkable increase of agricultural production to cover food demand. However, this increase was not sufficient and imports have exploded. Although food self-sufficiency cannot be considered today as a realistic objective, achieving a greater food security is a major issue for economic, social and political stability. This implies that agricultural and food production should continue to increase. Nevertheless, in the past the increase in agricultural production has often been achieved through intensification based on irrigation, use of chemical inputs and breeds and varieties developed in Northern countries. The modernisation of production techniques has not sufficiently taken into account the specificities of Mediterranean natural ecosystems and climate, thus limiting the production efficiency. This trend has also led to overexploitation and degradation of the natural resources: water, soil, natural vegetation and to the loss of biodiversity.

This situation is not sustainable for the future years. Climate change, which affects dramatically the Mediterranean area and exacerbates this situation, calls for a drastic modification of the agricultural production development, modification that, however, should take into consideration the characteristics of localized agri-food systems. Localized agri-food systems, composed by SMEs and linked by their characteristics and operational ways to a specific territory, play in fact a very relevant role in the Mediterranean area. They are based on strong links between local resources, food and territory, and have the capability both to valorise local specific resources (included biodiversity and cultural identities) and to achieve their reproduction and renewal. In this regard, origin products, whose identities and specific characteristics are linked to a delimitated territory, are part of territorial capital and represent a very important asset for Mediterranean agriculture that can also be exploited as a basis for territorial diversification (rural tourism, provision of services). Origin products play a fundamental role in all Mediterranean countries that have set-up legal frameworks and institutions for the protection and valorisation of geographical indications.

Fisheries and aquaculture are also major sources of food and employment in the Mediterranean. However, they are facing multiple threats. The rapid growth of aquaculture is preoccupying, as it can be a source of conflicts of use and pollution. The fishing industry is facing several difficulties, such as competition for the use of maritime space, reduced stocks of certain species, as well as the deterioration of coastal ecosystems caused by the anthropic pressure and the impacts of climate change.

Rethinking food systems to provide healthy food to the Mediterranean

Increases in imports and trade balance deficits at the national level are accompanied by an increase in poverty at individual level and social instability in the Mediterranean basin, especially in rural arid and semi-arid areas, with the latter being the most vulnerable regions, exposed to multiple challenges. Within this context, the Mediterranean diet is considered as one of the most effective sustainable diets and a valuable example of healthy nutrition. Despite this well-known fact, the Mediterranean area shows a massive emergence of diet- and lifestyle-related chronic diseases. This is due to changes in lifestyles, urbanisation and development of food chains based on imported raw materials that have led to a change in food diets. Overweight and obesity are dramatically increasing both in Northern and in SEMCs. Data for people aged 15 years and older show high levels of overweight and obesity in most of the countries. In Egypt, levels of overweight are up to 74-86% in women and 69-77% in men (WHO). In the light of such evidence, the Mediterranean food systems, including food policies, food industries and the way they address consumers’ needs, should evolve in order to contribute to promote a healthier diet. Facing the urban demand, the traditional food sector has great difficulties in gaining access to commercial channels and to compete in terms of business organisation, logistics and costs with the agro-industrial sector. The current business models of the SMEs are not currently able to adapt to changes in demand and economic context. Small, low-cost entities produce a high proportion of staple foods (milk, meat, fruits and vegetables and processed products), often with unique qualities derived from local tradition. Yet, most of these small companies operate in an informal setting, with recurrent food safety-problems. An intense urban population growth asks for the organization of supply chains, which in many cases prove to be inefficient: the distribution of margins between producers, intermediaries and distributors and agents is often unbalanced against farmers and low innovation and lack of marketing and communication skills make difficult for SMEs to satisfy the requirements of consumers. This latter, added to unreliable safety standards, make local products uncompetitive with respect to imported products.

In such a context, supporting competitive and innovative businesses (both at single-firm and collective level) and efficient marketing chains able to promote local products while adapting to consumption models in line with changing lifestyles (through, among the others, convenient formulations and packaging solutions), is a major issue for sustainable development in the Mediterranean area. Hence, food industry research faces a threefold challenge: technological innovation in the enhancement and valorization of traditional products, nutritional and health quality of processed foods, and competitiveness of local products vis-à-vis imports.

PRIMA in relation with the Sustainable Development Goals

The objectives of PRIMA are well in line Agenda 2030, launched by the United Nations in September 2015. Among the 17 SDGs, 3 specific goals, dedicated to food security (#2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture), sustainable management of water (#6 Ensure availability and sustainable management of water and sanitation for all), as well as sustainable use of land (#15 Sustainable land use, forest and other terrestrial ecosystems), are of particular interest for PRIMA programme.

Because of the strong connections between food systems and water efficiency and the multiple dimensions of issues related to food and water, the PRIMA initiative could also generate a positive effect on other SDGs, such as:

* No poverty (SDG 1);
* Good health and well-being (SDG 3);
* Affordable and green energy (SDG 7);
* Decent work and economic growth (SDG 8);
* Reduce inequalities (SDG 10);
* Sustainable communities (SDG 11);
* Sustainable consumption and production (SDG 12);
* Climate action (SDG 13);
* Sustainable management of oceans and coastal areas (SDG 14).

Interactions with other European initiatives on Water Resources and Food systems

PRIMA will complement different joint programming initiatives launched at the European level.
The challenges addressed in JPI FACCE and JPI Water are particularly relevant to those to be addressed in PRIMA. In this case, PRIMA will complement the actions of JPIs, by considering the Mediterranean specificities that are not covered deeply in these ones. Regarding the FACCE JPI, the issues of climate changes to farming systems, resilience of food value chains and land and water management are of primary relevance in the Mediterranean Area. The issues of drought, water scarcity and the importance of the water used in agriculture, which are some characteristics of the Mediterranean Area, will be addressed in PRIMA, in complementarity with the Water JPI and in extension with the actions undertaken in the ERA-nets ERANETMED and ARIMNet that are currently setting the foundations for a longer-term initiative within the EU-Med region.

PRIMA will also complement, by focusing on the Mediterranean Area, other EU actions focused on Water and Agriculture, namely:

* The European Innovation Partnership (EIP) programs:
* On Water (EIP-Water) with the main objective to initiate and promote collaborative processes for change and innovation in the water sector across the public and private sector, non-governmental organizations and the general public;
* On Agricultural Productivity and Sustainability (EIP-Agri), aiming at fostering competitive and sustainable farming and ensuring a steady supply of food, feed and biomaterials preserving the natural resources on which farming depends.
* The European Neighborhood Partnership for Agricultural Development (ENPARD) aiming at improving rural livelihoods, increasing productivity and food safety, and developing organizational and institutional capacities;
* The Sustainable Water Integrated Management Program (SWIM) that provides technical assistance centered on the dissemination and effective implementation of sustainable water management policies and practices;
* The Mediterranean component of the EU Water Initiative (MED EUWI) which aims to assist developing countries of the region to meet water-related challenges for the achievement of the Millennium Development Goals and sustainability;
* The knowledge innovation communities (KIC) on Climate and Food, aiming to boost innovation and private companies business development within the climate services and food production sectors will be useful to connect in particular with the private sector involved in these two KICs initiatives.

**Main challenges that will be addressed by PRIMA**

Given the previous described problems and challenges to be tackled, the aims of PRIMA are:

* + To support the development of innovative solutions and induce their application to improve the efficiency and sustainability of food production and water provision in the Mediterranean basin, stimulating a stronger industry able to promote wellbeing and economic growth;
	+ To support stability and socio-economic development in the Mediterranean area, within the framework of a reinforced Euro-Mediterranean cooperation and the European Neighborhood Policy;
	+ To facilitate the creation of knowledge-based jobs and competences in the Mediterranean area.

Considering this general goal, PRIMA identified eight operational objectives (PRIMA proposal 2014):

* To develop smart and sustainable farming systems to maintain natural resources, to preserve biodiversity and to increase production efficiency;
* To test and stimulate adoption of context-tailored water-saving solutions, in particular in agriculture;
* To innovate in the Mediterranean food products based on Mediterranean diet heritage and cultural identities and to enhance the links between nutrition and health;
* To find context-adapted solutions to increase quality and recognizability of the products, food and water chain efficiency, and reduce losses and waste;
* To design and promote the adoption of novel approaches to reduce the impact of pests and pathogens in farming, including their consequences on human health;
* To conceive and implement innovative, quality oriented models in agro-business (included short and alternative food supply chains) as potential sources of new jobs and economic growth;
* To improve land and water sustainability in arid and semi-arid watersheds;
* To elaborate and stimulate adoption of new policies and protocols for the governance of water management systems.

Those 8 objectives have then been grouped and reorganized under the 3 scientific-technical pillars already mentioned, which constitute the backbone of PRIMA Strategic Research and Innovation Agenda:

* Pillar 1: Sustainable management of water for arid and semi-arid Mediterranean areas;
* Pillar 2: Sustainable farming systems under Mediterranean environmental constraints;
* Pillar 3: Mediterranean food value chain for regional and local development.

**Figure 1. – The 3 scientific-technical pillars of PRIMA Program**

**PILLAR 3**

**PILLAR 2**

**PILLAR 1**

**THEMES/TOPICS TO BE ADDRESSED:**

* Water resources availability and quality within catchments and aquifers
* Sustainable, integrated water management
* Irrigation technologies and practice
* Use of alternative water resources. Technologies and governance models

**THEMES/TOPICS TO BE ADDRESSED:**

* Valorisation of the nutritional qualities of Mediterranean foods and development of new healthy food products
* Enhancement of the links between nutrition and health
* Enhancement of organisation and coordination in the food chains
* Involvement of rural and industrial stakeholders to ensure both food security and regional development
* Promote the adoption of organisational innovations and more sustainable business models among firms

**THEMES/TOPICS TO BE ADDRESSED:**

* Adaptation to climate change, to drought and extreme events
* Developing Sustainable productive eco-systems
* Preventing the emergence of animal and plant diseases
* Developing farming systems able to generate income, to create employment and to contribute to a balanced territorial development
1. **Strategy**

**Pillar 1:**

**Sustainable management of water for arid and semi-arid Mediterranean areas**

**Scope**

Considering the water challenges faced by the Mediterranean basin, the general goal of this pillar is finding solutions to cope with increasing water demand and decreasing water availability. Such issues are considered by PRIMA as an urgent and fundamental priority for the Mediterranean arid and semi-arid areas. In this regard, achieving sustainable management of water requires 1) a better understanding of the processes affecting the water cycle, 2) the implementation of technical and water governance solutions to improve the resilience to water scarcity conditions, optimizing water use efficiency at the whole chain level and 3) the definition of new possibilities for increasing water availability and sustainable wastewater management, thus reinforcing the water circularly process and exploiting new conventional water resources.

More specifically, this pillar aims to contribute to secure water availability both in terms of quality and quantity, as well as to improve wastewater management, in order to develop innovative solutions and to stimulate their adoption to increase efficiency and sustainability of water provision in Euro-Mediterranean societies, providing environmental benefits and economic growth within the area and contributing to an inclusive, sustainable and healthy growth.

To achieve the main objective, the following important research and innovation areas have been identified:

* *Water resources availability and quality within catchments and aquifers*;
* *Sustainable, integrated water management*;
* *Irrigation technologies and practices*;
* *Use of alternative water resources. Technologies and governance models*.

**Research challenges & Priorities to be addressed**

Water resources availability and quality within catchments and aquifers

The ephemeral flow of rivers, the non-linear relationship between rainfall and runoff, the importance of extreme events, are major characteristics of the Mediterranean surface water resources. This makes river-flow extremely variable in time and space, difficult to exploit in natural conditions, and often a threat for the riparian population. Nevertheless, many intermittent rivers constitute important water resources for large areas in the Mediterranean Region: several reservoirs built in these catchments store water for multiple human uses (irrigation, drinking water, industry). Almost half of the 7,000 large dams existing in the EU are present in Southern countries. There is a need for such reservoirs and respective catchments to be accurately managed in order to store good quality water, reduce siltation, fulfil ecological flow requirement. With rivers in critical regions already exploited to capacity throughout the world and groundwater overdraft, as well as large-scale contamination occurring in many areas, we have entered an era in which multiple simultaneous stresses (chemical and biological) will drive water management, especially during drought periods. The peculiar characteristics of river systems in the Mediterranean area require that land management practices and adopted measures to reach chemical and ecological goals in River Basin Management Plans must be adapted.

Apart from a very small number of large rivers, aquifers are the most reliable source of water in the region, and are therefore essential for water supplying people and farming. However, contamination, seawater intrusion, salinization and overexploitation of groundwater are common problems in the Mediterranean.

In Mediterranean region, low permeability aquifers outcrop in large areas under different geomorphologic and climatic conditions and their groundwater resources supply water to small communities, plants or farms. If we add that in many countries, where low-permeability aquifers outcrop i) climate ranges from temperate to semi-arid, ii) the Water Exploitation Index is greater than 20% (EEA, 2003) and iii) General Circulation Models indicates a decrease of average precipitation in future, there are sound reasons for a thorough analysis of these aquifers.

Understanding the complexity of the system under present and future climatic and socio-economic conditions is of crucial importance for ensuring the long-term availability of water resources and for avoiding irreversible damages to the environment and the agricultural systems depending on land and water. At the same time, a detailed assessment of the current status and main criticalities affecting the water management cycle applied at national, regional and local level is required, in order to define and implement specific actions aimed at overcoming the existing issues and bottlenecks. In this regard, drought analyses and water accounting at regional scale should integrate the outputs of existing monitoring and forecasting systems at the Mediterranean level (downscaling global meteorological models and climate change scenarios) in order to plan and manage water supply systems considering climatic and anthropogenic changes and the need to cope with water scarcity. Long-term experimental observation are needed in the region, coordinating, networking, streamlining and promoting tangible and intangible infrastructure in support of research for the long term perspective on land and water in Mediterranean environments.

In this region, intermittent and ephemeral streams are very common fluvial systems. These rivers show a high rate of change in streamflow, high peak discharges, and low baseflow. Very often, there is a sensible lack of measurements and monitoring in small and intermittent rivers. A large part of their annual volume flows in a few days, delivering a great part of their sediment and nutrient loads. Basic research priorities for intermittent rivers include 1) methods for the estimation and restoration of natural ﬂow regimes, 2) illegal water abstraction detection, since reported data on water abstraction most probably underestimate the water uses for agriculture, mainly due to a high percentage of illegal and unrecorded abstractions, 3) diversity and seasonal dynamics of biotic communities, 4) resilience of biota to increased desiccation duration, 5) the role of a dry river bed as a corridor for terrestrial vertebrates, 6) hydrological and ecological monitoring schemes must consider and adapt to capture short-term processes and 7) specific BMPs must be evaluated to be applied in such basins.

Excess water during floods constitutes a danger and is a waste of resource. Using it for Managed Aquifer Recharge can save water resources and damages to property. Same goals can be achieved using Natural Water Retention Methods and floodplain renaturalisation.

Sustainable, integrated water management

A sustainable water management is crucial in the Mediterranean basin for ensuring efficient multiple water use in irrigation, animal production systems, drinking and industrial activities, as well as the preservation of natural ecosystems through consideration of the quantity and quality of water needed for the functioning of aquatic ecosystem services. That requires efficient governance at different levels: watersheds, districts, national. PRIMA intends to improve water governance, taking into consideration both the socio-economic context and the meteo-climatic trends of the Mediterranean basin. Both of them are considered as important drivers of current and future water resources management. The development of innovative governance strategies, advanced planning methodologies, appropriate and sustainable treatment technologies and monitoring tools have to take into account the huge number of physical, technological and socio-economic variables in water management in order to address the ever-growing need for water and food. In particular, the identification and the demonstration at small, medium and large scale of good water management practices has to be fostered within PRIMA initiative, through the development of local case studies, including measures aimed at limiting aquifers contamination and providing a sustainable wastewater management, also through the implementation of a circular economy approach based on resource and energy recovery along the water management cycle. Water infrastructure is ageing and this implies the opportunity to apply climate proof, sustainable and environmentally sound approaches (construction material, means of measures, bioengineering and reuse of material after lifetime) in the management and rejuvenation of ageing water infrastructures.

Irrigation technologies and practices

Irrigated agriculture, which uses 70% of water resources, today provides more than 50% of the food produced in the Mediterranean basin, even though it only takes up 15% of the total surface devoted to agriculture. A particular attention should be paid to the water-energy nexus related to all technical steps involved, including freshwater supply, specific wastewater treatments for unconventional water resources availability, water storage systems, and irrigation techniques. Modernizing irrigation systems has increased on-farm water efficiency but it has also led to an increase in energy consumption. The successful adoption of new irrigation strategies and technologies, as well as their integration into farm management practices and off-farm constraints, require an additional effort in improving the exchange of information and dialogue between end-users, farmers, policymakers, water management authorities and research teams, to facilitate the transfer of new knowledge and technologies and their practical implementation at field-level. In fact, despite the development of techniques, models and decision support systems (DSSs) aimed to promote a more efficient use of irrigation water, their actual use and implementation by farmers is rather limited.

Where irrigation modernization has already started through the replacement of surface irrigation with drip or trickle systems, new irrigation scheduling programmes to better match water application with real crop needs should be investigated and proposed. More energy efficient water pumping and distribution technologies and models need to be developed, as well as specific water and wastewater treatment systems aimed at ensuring the appropriate water quality for a long-term sustainability of the irrigation systems. Regulated deficit irrigation strategies will have to be implemented in those countries where chronic paucity of summer rainfall allows supplemental water to act as a major controller of growth, yield and fruit quality.

Conversely, in some countries of the Northern Mediterranean basin (namely part of Italy and France), now frequently experiencing temporary, yet still fairly occasional, summer drought, the major challenge is having physiological and/or agronomical decision-making tools to assess if the severity of water stress might justify supplemental watering. Presently, irrigation technical change in the Mediterranean has mostly taken place on large farms. However, smallholders, face considerable difficulties to adopt standardized new technologies. This innovation process responds to small farmers’ objectives mainly focused on labour and crop productivity rather than just water-saving issues. From a users’ perspective, the PRIMA approach should promote the acquisition of knowledge on the local experiences of Mediterranean countries, enhance this (informal) innovation process, and connect it to official national programmes dealing with water saving issues.

Use of alternative water resources. Technologies and governance models

In countries with scarce water resources where irrigation of farmlands accounts for more than 70% of water use, the competition for this resource is intensifying and will continue as long as the demand for water increases. Where water availability is not enough to fulfil the existing irrigated lands, the use of non-conventional water resources (as reclaimed and desalinated water) represents the only solution to satisfy agriculture water needs. Reuse of wastewater presents one of the main options to the water supply decision makers and an appropriate wastewater management has to be promoted especially in peri-urban areas, where uncontrolled effluent disposal is commonly practiced and a decentralised approach need to be fostered in order to ensure economic and environmental long-term sustainability. Although reclaimed water is commonly and successfully used in many countries (e.g. Israel, USA, Australia), in the Mediterranean, water reuse face numerous barriers. Among them, safety risks, economic concerns and social acceptance can be currently defined as the main barriers considering that 1) safety risks have been traditionally linked to the use of improperly treated wastewater, 2) cost is probably the first driven force in fresh produce production and 3) public acceptance of reclaimed water by the public varied according to its potential use.

Related to safety risks, technological advances focused on developing on-line monitoring systems currently demanded by growers, irrigation associations and even authorities as an effort to fulfil current requirements on microbiological criteria based on the enumeration of faecal indicator microorganisms such as *Escherichia Coli* and have been included in Good Agricultural Practices guidelines, quality assurance standards as well as the legislation of specific European Member States and Mediterranean countries. In an attempt to help growers to assure the microbiological quality of non-conventional water sources, such as reclaimed water, and to fulfil microbial criteria, novel technological tools, suitable to perform on-line monitoring of the microbiological quality of irrigation water, are still required. Such tools need to be properly coupled to the selection of the appropriate (waste) water treatment systems, including adequate disinfection techniques and specific tertiary treatments complying with the quality standards required according to the final water use. Searching for new technology should not preclude the possibilities of using more simple approaches based on natural wetlands and water stabilization ponds, which might also favour landscape management and the ecological status of water bodies. Injection of reclaimed water in aquifers under strict control and pumping should also be tested as an alternative for renaturalisation. In this regard, microbiological contamination is not the only issue to be taken into account, with other specific parameters such as solid content, salinity, organic matter, nitrogen, and other emergent pollutants (e.g. endocrine disruptors) to be considered of great concern.

Indeed, in addition to the microbial risks, treated wastewaters have the drawback of their salinity levels which might limit the mid, long-term crop productivity. As a consequence, energy-efficient desalinization treatments should be developed for treating both wastewater from municipal and industrial use and seawater. Finally, multidisciplinary studies should be enriched by the analysis of economic and environmental suitability of the current implementation of the system, taking also into account the agronomic validation needed for its implementation as well as the public acceptance. Under this proposed multi-actor approach, issues regarding the disposal and treatment of brines after seawater or wastewater treatment should be considered to ensure a low impact of water treatment on the environment or in the fishery practices.

In the light of the consideration above exposed, the present pillar identifies the following priority topics to be addressed:

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| **Priority Topic** |
| *Understanding groundwater processes and link with surface water for catchment/basin balance* The challenges now faced by water planners require a new generation of aquifer management models that address the broad impacts of global changes on aquifer storage and depletion trajectory management, land subsidence, groundwater-dependent ecosystems, seawater intrusion, anthropogenic and geogenic contamination of the whole water cycle, supply vulnerability, and long-term sustainability. The typical slow flow processes in the subsurface result in a relatively long elapsed time (years up to decades) from the pollution initiation at the surface and its detection in the groundwater by traditional monitoring wells. During this long period before pollution is detected in groundwater, large masses of pollutants accumulate in the subsurface. The vadose slow flow conditions limit clean up processes and the remediation action of polluted aquifers becomes therefore a very difficult task. Innovative technological applications are requested with reference to the methods for the determination of available groundwater resources of low-permeability aquifers, also under different climate scenarios, as well as new methods for tapping the resource in these low-permeability aquifers and implementation and application of new hydro-geologic, environmental and economic coupled models to some significant rural areas, also including experiment of an integrated approach to surface-ground water management.Quantitative analyses on ecosystem services require an in-depth understanding of the underlying processes. To meet this need, it is important not only to use adequate modelling methods, but also to apply effective monitoring tools and research on new methodologies to understand biogeochemicals cycles. Developing efficient simulation models in order to analyse future scenarios at the spatial scales to be used for natural resource planning and management, is necessary in order to identify cost-effective strategies and techniques for a rational use of water and protection of land and soil. In this sense, there is a need for developing early warning systems to detect potential pollution transport through the soils and deep vadose zone to groundwater. This research should provide the needed information to support decisions on remediation strategies.More research efforts are also needed to understand the nitrogen and phosphorous pollution sources and processes, in particular those related with anthropogenic activities such as agriculture in order to investigate the link between agronomic practices and surface water, groundwater and/or soil pollution. Assessment of the potential occurrence of natural nitrate attenuation and its quantification and identification of remediation strategies to minimize soil and water pollution, e.g. biostimulation of in-situ denitrification by addition of an organic amendment coming from agricultural/farming processing sub-products in areas where not relevant natural attenuation processes occurs, are needed. New methodologies to determine the origin of pollution and to quantify the evolution of pollution and the remediation actions are also required. |
| *Setting the limits for water use. Water accounting, water use efficiency and water governance* Water sustainability in the Mediterranean region should be ensured by improved technical tools coupled with socio-economic studies able to define the limits for water use in certain key regions under present and future global change scenarios. This implies the use of technologies and tools for water accounting systems, including new remote sensing capacities coupled with governance allocation structures based on socio-economic rules for setting the limits for water consumption. Moreover, a sustainable integrated water management should be promoted and a decentralised approach should be fostered, especially in peri-urban areas where uncontrolled wastewater disposal is commonly practiced. Indeed, such an approach should finally promote the adoption of measures for maximizing water use efficiency through the whole chain. |
| *Characterisation of the hydrological regime and morphological status of ephemeral rivers and floods.*Ephemeral and intermittent streams make up, approximately, 75% of all streams in Mediterranean regions. Ephemeral streams convey runoff from mountain headwaters to lowlands and contribute to recharge alluvial aquifers and to sustain water resources. Ephemeral streams provide the same hydrological and ecological functions as perennial streams by moving water and sediments throughout the watershed. However, the lack of surface water during long periods of time constitutes a problem to characterise the hydrological regime and the geomorphological and ecological status. New methods should be developed to characterise the hydro-geomorphological and ecological status and degree of human affection on ephemeral rivers. The methodology will address the hydrological regime, water and sediment connectivity, geomorphological conditions of river channels and river corridors, biogeochemical functions and the spatial structure of the plant and animal communities. In addition, in the semi-arid regions of the Mediterranean basins, floods are a natural hazard but also renewable water resources. Floods are also a way for geomorphological and ecological regeneration along river corridors. However, floodwater itself is not considered a sustainable water resource, when infiltrating alluvial aquifers is a source of water supply in Mediterranean areas. There is therefore a need to understand the hydrological processes for the assessment, management and use of floodwaters. PRIMA resources will be set up to quantify a) the processes controlling this recharge, b) long-term recharge quantities (decade to multi-decadal scales) that determine the sustainability of these water resources and c) to translate these results into specific management strategies for alluvial aquifers of ephemeral rivers in Mediterranean regions.  |
| *Water-energy-food nexus. Technology and governance models*The Water-Energy-Food nexus describes the complex and inter-related nature of our global resources systems. There are many synergies and trade-offs between water and energy use and food production, and a circular economy approach aimed at resource and energy recovery along the whole water management cycle may allow to improve the impacts in terms of overall energy consumptions and food security. However, research and policies have focused on some parts of this nexus, disregarding the others. In fact, using water to irrigate crops might promote food production but it can also reduce river flows and hydropower potential. The possibility of growing bioenergy crops under irrigated agriculture can increase the overall water withdrawals and jeopardize food security. As a consequence, land-water uses should be determined considering not only the water productivity but also the food specific food source-demand in a given area. Converting surface irrigation into high efficiency pressurized irrigation may save water but may also result in higher energy consumption. Recognizing these synergies and balancing these trade-offs is central to jointly ensuring water, energy and food security.  |
| *Technical and social aspects of water saving, on-farm water use efficiency and water management in agriculture* The solutions to be developed should be of common interest to all the target regions, involving both Mediterranean shores and in particular areas where agriculture is the main economic activity and the main water user in volume terms. The cross-border dimension should be related to the different techniques and technologies that can be adapted to different pedo-climatic and socio-economic constraints and implemented in different areas.* The adaptation of the technical solutions to the real local conditions should be addressed, and their adequacy to the diversity of cropping systems, sites and cultural practices has to be deepened. Adaptation strategies should include a) deficit/supplemental irrigation, b) application of more efficient water treatment and irrigation technologies, c) efficient irrigation scheduling protocols for precision irrigation practices and d) efficient water management protocols in animal production systems.
* Rain-fed agriculture needs to adapt to seasonal changes and long-term changes induced by climate change, while stable or increasing productivity likely depends on additional irrigation. Most countries have a large set of actual and indigenous knowledge concerning water harvesting technologies and a great potential of adaptability. However, more research is needed concerning the cost of those technologies in order to better assess the feasibility of their implementation.
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| *Water reuse and water desalination for use in agriculture and food production*Use of alternative water sources, e.g. treated wastewater or desalinated water, through efficient and competitive technologies (particularly in terms of energy content), is increasingly considered necessary to provide a complementary source of water in certain zones of the Mediterranean. Thus, integrating new unconventional water resources (desalination and treated wastewater) into water management systems should be studied and promoted taking into account the technical and environmental impact, economic efficiency, water governance rules and the local socio-economic context. PRIMA will address the problem of using non-conventional water resources through a holistic approach stimulating the joint collaboration between water treatment technology providers, water governing bodies, end-users and soil and water scientists. This will enable the consideration of water systems as part of a *circular economy approach* particularly for treated wastewater to be used for agriculture purposes. |

**Expected outputs**

A broad range of outputs is expected to be obtained by the present pillar in relation to the areas of research.

Water resources availability and integrated water management:

* Development of innovative tools/DSSs for planning and adaptation to global changes including public and private stakeholders’ involvement;
* Development of new modelling routines for determining the basic components of the water cycle, including economic, social and technical aspects (e.g. groundwater accumulation and storage);
* Improvement of remote sensing technologies and use of new technological devices for determining soil moisture conditions and evapotranspiration by surface energy balance, in order to assess water and energy budget;
* Implementation of monitoring and forecasting systems to support the water management under scarce condition, also taking into account any anthropogenic effect on the integrated water cycle;
* Assessment and identification of appropriate wastewater management systems in different contexts, and promotion of decentralized approach in peri-urban areas in order to allow long-term sustainability;
* Development of new methodological approaches to enhance public, stakeholders involvement and empowerment of civil society in water resources management;
* Protection of water resources quality for agriculture, livestock and aquaculture and the ecosystem functioning;
* Ensuring the water sanitation and detoxification from food production systems;
* Improvement of consistency between local farmers’ and entrepreneurs’ innovation process and national and public water saving programs;
* Implementation of monitoring and forecasting systems to anticipate droughts supporting DSSs water management during drought events;
* Improvement of knowledge about pollution sources and processes naturally attenuating in order to better assess water management policies and the impact of anthropogenic activities.

Irrigation technologies and practices:

* Development of irrigation technologies able to optimize the balance between soil evaporation and plant transpiration and to improve plant water status and productivity;
* Development of cost-effective and tested technological devices and sensors to support farmers in irrigation scheduling for increasing water use efficiency at farm level;
* Development of decision support systems for irrigation scheduling under different levels of water constraints and salinity;
* Development of new technologies and water allocation models and tools for optimizing the water-energy use efficiency at different water distribution complexity levels;
* Identification of appropriate water treatment technologies in order to comply with the specific irrigation requirements and to ensure the appropriate food security;
* Reduction of farmers’ resistance to the adoption of innovative technologies such as the application of regulated deficit irrigation precision irrigation.

Use of alternative water resources, technologies, and governance models:

* Improvement of the energy efficiency for wastewater and seawater treatment for unconventional water resource production;
* Identification of the best available technologies to be applied for the implementation of wastewater reuse practices for agriculture and aquifer recharge, better suited to the current legislation and able to ensure long-term economic and environmental sustainability;
* Integration of new resources production (desalination and treated wastewater) into water management system, providing specific economic and environmental impact assessment;
* Improvement of the knowledge on the evolution of the water quality in aquifers recharged with reclaimed water;
* Promotion of water governance framework and policies ensuring the adoption of sustainable water reuse practices in target countries;
* Raising awareness on the potential of wastewater reuse to enhance water management efficiency, support local economic growth, reduce water vulnerability and social welfare, and capacity building of local stakeholders with special focus on entrepreneurs in order to facilitate further market uptake of water treatment technologies and reuse products;
* Mitigation of the environmental impacts of seawater and wastewater treatment with special reference to brine management.

**Main Actions**

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| **Priority topic** | **Main actions** |
| *Understanding groundwater processes and link with surface water for catchment/basin balance* | * Research and innovation actions
* Scientific networks
* Training and mobility actions
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| **Specific examples or recommendations** |
| * Research and innovation activities linked to specific water catchments under extreme water scarcity conditions and water quality constraints
* Development of decision support systems for remediation strategies against groundwater contamination
* Research and innovation activities to improve hydro-meteorological forecasting and monitoring of drought events
* Modelling and meta-analysis of existing historical data linked with PhD student and young researchers exchange programmes
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| *Characterisation of hydrological regime and morphological status of ephemeral rivers and floods* | * Research actions
* Research and innovation actions
* Training and mobility actions
* Research infrastructures
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| **Specific examples or recommendations** |
| * Research actions for developing quantitative models for characterizing the hydrological regime and morphological status of ephemeral rivers
* Development of strategies for improving the efficiency of specific management strategies for alluvial aquifers
* Development of experiences on artificial recharge of alluvial aquifers
* Training courses for young researchers on hydrology models for ephemeral-river water flows, flooding dynamics and aquifers recharging
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| *Setting the limits for water use. Water accounting, Water use efficiency and Water governance* | * Innovation actions
* Scientific network
* Coordination and support actions
* Training and mobility actions
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| **Specific examples or recommendations** |
| * Pilot-demo studies in water catchments under different social and environmental constraints
* Landscape management actions including the showcase of local existing technologies to be exported to other areas with similar environmental constraints
* Network for remote sensing studies. Sharing models and image analysis
* Monitoring tools, model developments and attenuation technologies against saline intrusion in coastal areas
* Training courses on remote sensing for determinations of evapotranspiration and water accounting assessment
* Networking and training activities for further defining common water use efficiency and productivity indicators able to support achieving sustainable development goals related to water use and its quality
* Coordination and support actions for supporting climate open data, making climate information more accessible to farmers, agricultural advisers and enterprises
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| *Water-energy-food nexus. Technology and governance models* | * Innovation actions
* Awareness raising and knowledge dissemination actions
* SMEs actions
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| **Specific examples or recommendations** |
| * Multidisciplinary approach research projects linking energy and water use, including pilot-demo showing good water and wastewater management and treatment practices
* Pilot projects for showcasing water-energy efficient tools and ICT platforms
* Workshops and seminars grouping relevant stakeholders, energy providers companies and irrigators
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| *Technical and social aspects of water saving, on-farm water use efficiency and water management in agriculture* | * Research and innovation actions
* Innovation actions
* Training and mobility actions
* SMEs actions
 |
| **Specific examples or recommendations** |
| * Research projects devoted to determine on-farm evapotranspiration
* Long-term demonstration of effectiveness of irrigation practices
* Pilot studies where to show case irrigation scheduling technologies as well as appropriate water treatment technologies
* Network of agro-meteorological observatories and data. Standardizing data collections and storage for developing a Mediterranean platform for agro-meteorological data and irrigation recommendations
* Pilot projects on strategies to improve efficient water management in animal production systems
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| *Water reuse and water desalination for use in agriculture* | * Research and innovation actions
* Innovation actions
* Awareness raising and knowledge dissemination actions
* Training and mobility actions
 |
| **Specific examples or recommendations** |
| * Supporting a circular economy approach in wastewater treatment and seawater desalination, aimed at resource and energy recovery, including the beneficial use of renewable energy sources.
* Technologies for optimizing waste water treatment and desalination at urban and peri-urban level
* Demonstrative pilot for mid-long term use of waste water in agriculture, assessing social, economic and environmental sustainability
* Demonstrative pilot of natural and induced processes to improve the quality of reclaimed water
* Promotion of decentralized water management approach in order to improve sustainability
* Workshops for training waste-water managers and users
* Meta-analysis of data and results for technical legislations and for accomplishing the sustainable development goal # 6 for clean water and sanitation.
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**Expected impacts**

The pillar is intended to promote actions on both sides of the supply-demand water balance to cope with water scarcity in the Mediterranean basin. Having in mind that water management is not limited to only one sector of activity, and on the contrary, it is a cross-cutting aspect that affects social, economic, cultural, health, environmental or even gender issues, the Pillar will seek for integrated solutions to facilitate the adoption of appropriate measures at different levels including:

* Regional networking to enlarge the committed stakeholder community and to promote participatory approaches in decision-making processes;
* Demonstration actions (including local case studies) aimed at adapting and validating the proposed solutions for water management in the Mediterranean area, with specific reference to different contexts (urban, per-urban, etc.);
* Capacity building actions, aimed at transferring the needed skills in the selected regions;
* Evaluation of all relevant aspects for the real implementation of the proposed solutions;
* Dissemination for awareness rising on the need of implementing sustainable water management to increase availability and reduce vulnerability;
* Replicability to further implement sustainable water management technologies and tools in other regions in the near future.

More specifically, the water pillar expects to generate several socio-economic and environmental positive impacts, namely:

* *Reducing the current pressure on water resources and the water cycle*. The water systems in the Mediterranean regions will benefit from the several measures to be carried out at different spatial levels to alleviate the existing pressure on water resources. By better defining the limits of water use and standardizing the water accountings procedures and methodologies it will be possible to carry out an improved analysis of the water footprints. This should allow for identifying the critical processes and water uses to be considered when planning water management and where to invest for improving water use efficiency. In areas with high level of water stress on the aquifers, where it is compulsory to reduce the gap between uptake and recharge, increasing water use efficiency seems to be the straightforward means to comply with the local water policies. At a mid-term horizon, part of the saved water could be available for other environmental, agricultural, industrial and domestic uses;
* *Improving quality for surface and underground water bodies*. A more efficient water management, linked to studies devoted to set the limits to water use should have direct impacts on surface water bodies systems by increasing water flows. On the other hand, improved on-farm irrigation efficiency will reduce nutrients contamination particularly in underground water bodies;
* *Improving end-users competitiveness.* Farmers will be able to fulfil their obligation to save water while not increasing overall costs to the farmers. A return on investment for the cost of the actual system should be achievable within a short time especially in water demanding crops because farmers will reducing water and chemicals costs and in some cases increasing yields both in quality and quantity;
* *Increasing the safe and cost-effective use of non-conventional water resources.* The selection of appropriate and sustainable wastewater treatment and seawater desalination technologies will help agriculture to become less water dependent. The approach will make use of untreated marginal water sources and wastewater seeking to recover water and nutrients for irrigation and fertilisation. Sensor-controlled fertigation will reduce the total need for water and fertilisers and facilitate mixing marginal water with freshwater sources. Desalination technologies will increase the use of marginal (salt or brackish) water sources, and combined with disinfection will make municipal wastewater a valuable water and fertiliser source for use in fertigation. An improved desalination technology based on new membranes and the last advancement should contribute in reducing the energy costs for water desalination. This, coupled with the use of renewable energy resources and particularly solar energy, should indeed reduce the costs and the environmental externalities for water desalination. In coastal areas, the use of desalinated water will become a more attractive option to be considered in the water cycle;
* *Optimizing water governance systems and defining technical limits for improved legislation.* The outputs to be obtained during the execution of the PRIMA programme can be considered both a policy and economic instrument. As a policy instrument, the outputs to be obtained will allow to identify the best available wastewater treatment options that can deliver treated water for a particular application complying with national and/or international standards. The results to be obtained should allow policy makers to take more technically informed decisions about water regulations. As an economic instrument, the PRIMA outputs will be able to perform an analysis of the water resources available for agriculture and identify and quantify the need of alternative resources such as treated wastewater;
* *Improving Mediterranean water sector competitiveness.* The market introduction of the proposed technologies will strengthen the economic competitiveness of the participating SMEs, water and wastewater operators and farmers. Sensor providers together with climate open data will let information and communication technologies companies have the opportunity to incorporate new technologies in their products’ portfolio and therefore increase their competitiveness in the water management sector. The possibility of using remote sensing data and technologies should increase the opportunities to expand the companies’ activities beyond the Mediterranean area. This will have indeed positive impacts in terms of job creation particularly in the field of applied climatology, crop modelling and cyber-technology.

**Pillar 2:**

**Sustainable farming systems under Mediterranean environmental constraints**

**Scope**

In this text, agriculture refers to both plant and livestock system. Considering the context of climate change, the scarcity of the resources, the demographic growth, the contamination, desertification, degradation of arable lands and the loss of biodiversity, there is an urgent need to invest in improving the efficiency and the sustainability of agricultural farming systems, aquaculture and fisheries. Farms are expected to yield food and other products with high added values (economically, nutritionally) to cope with the progressively more pressing environmental constraints, to protect natural resources, and to face and mitigate climate change. In this perspective, the present pillar will focus on 4 major challenges: 1) adaptation of agriculture, aquaculture and fisheries to Mediterranean climatic constraints and climate change, 2) sustainable management of natural resources used by agriculture, aquaculture and fisheries, 3) prevention and sustainable fight to the emerging and outbursts of plant and animal diseases, securing healthy productions and 4) development of marine, aquatic and land farming systems able to generate income, to create employment and to contribute to a balanced territorial development.

**Research challenges & Priorities to be addressed**

Adaptation to climate change and associated expanding drought, warming, and extreme events

It is well-established that climate change is expanding those areas where agriculture is constrained by climatic limitations, and that solutions need to be found to adapt agricultural practices to, for example, rising temperatures and drought, or increasing occurrence of extreme events in temperate environments. This is clearly a challenge that requires pooling resources, knowledge and capacities into common programmes. Agriculture is indeed already limited by climate change all around the Mediterranean and this situation is predicted to worsen in the near future. Adapting to climate change is therefore a common necessity for the Mediterranean agriculture, as Mediterranean countries share similar climatic features that will change in the future. Specifically, the Northern part of the region is expected to experience similar conditions to those existing today in the Southern shore. For example, aridity today plagues agriculture and animal production management more in the Southern shore than in the Northern shore of the Mediterranean sea. However, the effect of decreased water supply, extended summer drought and mild winter, on resource management and agriculture productions will also extensively characterize agriculture of countries so far experiencing more temperate and humid climate, including those facing the North of the Mediterranean. Some crops, or agricultural practices, currently widespread in countries of the Southern Mediterranean rim, could become relevant also for the Northern shore in the future. Mediterranean crops like durum wheat, olive, grapevine, food and feed legumes (chickpea, lentil, fava bean), may increase their interest as healthy, productive and environmentally sustainable food sources for an expanding number of countries (in the EU and worldwide) in the next years.

The richness of Mediterranean biodiversity is an asset that can be valorised for producing products with a strong identity, thus allowing the preservation of biodiversity and of its related production ecosystems. Mediterranean biodiversity can also be used to restore or develop new varieties and hybrids, crops and breeds that are adapted to the environment and may be used for genetic improvement. It is still possible to take advantage of the spontaneous and domesticated biological diversity of Mediterranean crops and livestock for improving and making more our production systems more resilient to stress and adapted to climate change. Species that are currently used in the southern Mediterranean countries could be relevant for other locations, namely in the Northern shore, to adapt agriculture to the changing climatic conditions. In the Mediterranean area, the land has been cultivated for millennia since the very early stages of agriculture domestication and landscapes are thus the products of myriads of continuous interactions between human and their natural biotic and abiotic environment. The use of rustic local breeds or wild species as reservoir of phenotypic and genotypic diversity can have strong and positive inputs in the production of plants and animals with lower energetic requirement and/or able to better cope with stress while producing steadily, efficiently, and sustainably. The genetic bases for grains, legumes, seeds, fruit, nuts, dried fruit, vegetables, medicinal and aromatic plants and herbs are rather wide, but climate change can largely erode this biodiversity and traits associated to resistance and adaptation to biotic and abiotic stresses must be retrieved, and valorised, as they may yield new and valuable commercial production and a sustainable source of food for human nutrition.

Fish and seafood products are playing a large role in the Mediterranean diet, but are also directly threatened by global change. Marine and aquatic ecosystems are affected by climate change and contamination that are directly impacting the distribution and the availability of fish. Thus, there is a strong interest to adapt marine fisheries and aquaculture systems to increase the food security of the region through the development of new fishing/production systems able to cope with environmental constrains and that will ensure the durability of fish stocks. Selective breeding and the exploitation of new marine and aquatic species/resources can contribute to satisfy the existing demand from the population.

Rusticity and flexibility of the different components and the whole are major factors of resilience of the systems and are required to improve their competitiveness and sustainability. From this perspective, research is needed to i) better understand how Mediterranean plants and animals are adapted to environmental constraints from a genetic/phenotypic/physiological point of view and what are the mechanisms underlying this tolerance to biotic and abiotic stresses, such as drought, salinity, warm winter/high temperature, and other stress. A special focus on the interactions between genotype and environment (e.g. plant-microorganism interactions, breeds and type of fodder/vegetation available, indoor or outdoor rearing, how genome and epigenome forces interact) is expected, ii) create and select new varieties or breeds for their traits (e.g. robustness, growth rate, quality of the final products) suited for the Mediterranean conditions in a changing environmental context, and taking advantage of natural adaptation to extreme environments of local spontaneous and domesticated biodiversity and iii) develop molecular techniques and markers to assist selective breeding of the suited traits and avoid the appearance of metabolic disorders during the growth.

From this perspective, research is needed to:

* Understand how plants and their adaptations to climate change affects other soil ecosystem services such those provided by microbial-mediated processes, among them nutrient cycling and atmosphere emissions (i.e. climate change feedbacks);
* Better understand the physiological and genetic basis defining plant and animal resilience to environmental stresses;
* Create new genotypes, phenotypes, and cropping/farming systems suited to Mediterranean environmental conditions in a changing climatic context.

Developing sustainable and productive agro-ecosystems

A substantial proportion of agriculture in the Mediterranean area has been modernized and intensified via improved farming practices and systems. Improvements have also been achieved in the livestock and aquaculture area. However, yield increases are still insufficient to face the ever-growing food demand. Furthermore, unsustainable intensification of farming practices has often led to pollution (including greenhouse gases emissions), overexploitation of natural areas and resources, loss of fertility of agricultural land, soil erosion and runoff, and in some cases to enhanced desertification. Improper irrigation management have resulted into soil salinization and underground water contamination and pollution in several places.

Pollution and contaminations of the environment are a key problem in the Mediterranean, of course often linked to overpopulation and its pressures. Mitigation, remediation, restoration and novel approaches for sustainable exploitation of natural resources should be implemented. Chemicals and fertilizers use in agriculture should be reduced and their fate and impact on the environment should be better controlled. The reduction of greenhouse gas emission and the production of other gases potentially impacting human health deriving from agriculture and livestock farming should be also considered. Seafood provisioning (from fisheries and aquaculture) in the Mediterranean can also be critically endangered by the same factors affecting terrestrial productions, e.g. increased presence of bioactive molecules, xenobiotics, pollutants, toxins, new parasites and diseases. Furthermore, how climate change will affect sustainable agriculture and soil degradation processes remains largely unexplored.

Soil degradation (e.g. loss of organic matter, compaction and sealing, desertification, salinization, contamination) and erosion (e.g. aerial, fluvial), and the subsequent loss of fertility of agricultural lands, are critical issues and major obstacles to the sustainability of all forms of agriculture. In the Mediterranean region, arable land degradation continues. Intensified agricultural practices and pasture use, coupled with population growth and pressure, threaten these lands, lower productivity and lead to desertification.  Taking into consideration both the environmental and economic effects, the efficient use and cycling of nutrients, namely carbon, water nitrogen and other elements important for agriculture productivity still remains a priority in the region.

Soil, water and vegetation and their interactions must be viewed as a whole together with the agro-techniques used in the crop production processes. The way soil and plants are managed is crucial in regulating crop water requirements and the amount of water stored into the soil profile, but agricultural practices are often poorly planned in view of maintaining soil properties. Research is needed to understand causes and mechanisms of soil erosion at different spatial and temporal scales, as well as soil microbiology and mineral nutrient cycles and their impacts on plant growth and production. Degraded soils need remediation solutions to be found, and this is another important area where sustainable and natural solutions are urgently needed. For instance, ecosystem functions, services and benefits from pastoralism, should be taken into account. Livestock and pasture management studies are also expected to enhance the positive effect of livestock in mixed farming and to reduce the erosion or compaction of the soil systems under Mediterranean conditions.

The nexus between the main traits of agriculture productivity (plant-water-soil) must be also preserved when expanding our view to the spatial organisation of cultivated and natural lands, and to the role of agriculture in the conservation of natural resources and the environment. At this level, the spatial organisation of agriculture, forest and pastoral areas, has a strong influence on habitats, soil quality, water resources and biodiversity. Where this is not well managed, designing proper land management practices may allow maximising on-site resources and soil capacity to supply nutrients to crops.

Better integration of environmental natural regulation of biotic and abiotic stresses into farming systems, as promoted by the *agroecology* concept, could largely be developed in the Mediterranean, as farming is still a primary activity in the region. However, the agroecology approach requires research and innovation to take into account specific Mediterranean ecosystem assets and vulnerabilities, and to develop solutions that are based on general principles but are adapted to local needs (e.g. to a wide range of micro-climate, soils, and biodiversity, available across the Mediterranean region, and to different dietary requirements of population, dependent, in turn, on multiple factors, including social and religious ones). Today, the development of vast monocultures composed of very few species targeted to worldwide trade may not be suitable for the fragile and very diverse Mediterranean region, where it can cause well-recognized problems, such as loss of soil fertility, pollution of soil and water, development of highly virulent or pesticide-resistant pests/pathogens, fragmentation of habitats, and loss of biodiversity. On the other hand, the development of diversified and integrated systems that are equally efficient in water, plant nutrients and energy use and that ensure market competitiveness may sustain the farming sector while ensuring protection of natural and biological resources, particularly those that are scarce in the region.

Located at the intersection of tropical, arid and temperate influences, the Mediterranean area is a unique bio-geographical entity, considered one of the 34 hotspots of global biodiversity. The rich and varied natural environments of the Mediterranean region show high rates of endemism. Globally, the Mediterranean area supports 10% of known plant species and 7% of marine species (UNEP/MAP-Plan Blue, 2008). In addition, within the Mediterranean soil there is the potential to keep exploring rich germplasm of soil microbes of potential utility as fertility enhancer and crop protection tool. However, a very small part of this biodiversity is valorised in agriculture, production systems are often overspecialised and do not take into account the available species, breeds, varieties, germplasms as well as soil biota diversity. Biodiversity is clearly an asset for the region that should be preserved as a common heritage, and sustainably exploited through specific genetic and phenotypic selection and successive production of agricultural and food and non-food products, including those that help tackle new climate challenges, e.g. increasing water scarcity in the region and worldwide. Livestock has been often separated from agriculture, and crop research, with consequent negative impacts on the water and nutrient cycles and ecosystem services. Efforts are now required to pursue a greater integration of crop-livestock systems for a more appropriate use of lands by diversified ecosystems, and cross-valorisation of plant and animal products (e.g. manure, forage crops). This could also contribute to circular economy process favouring a better integration of agriculture and livestock farming by-products within the entire farming process.

The role of livestock systems in the circular economy must be promoted, including the beneficial use of manures in crops fertilization. In this context, it is important to delve into the knowledge of agrosilvopastoral Mediterranean systems, where it´s possible to link production and nature conservation. It should be valorised as an efficient way to diversify agricultural and livestock production with a minimum input of energy and materials. However, there are many threats to face as the dying-off many trees, soil erosion, regeneration of the tree layer, increase of grassland production.

Developing sustainable aquaculture should be based on adopting an ecosystem approach that seeks to optimise the supply of commercial services (production of foods and high value biochemical products) with environmental/ecosystem services that may also have a strong economic impact. This may ensure long-term sustainability of aquaculture production and its services by preserving water quality and biodiversity. In order to pursue this objective, there is a need for a better knowledge of farmed organisms and how they adapt to the different challenging farming conditions, linking the variety of available omic approaches with a systems biology perspective (e.g. genetic architecture of traits of interest, i.e. high-throughput phenotyping, physiology of sexual development and biological bases of domestication) and their production systems (integration in the environment, design of *mixed-farming* systems/integrated multi-trophic aquaculture (IMTA) systems embracing crops, livestock and aquaculture, to minimise environmental impacts or even improve their ecological footprint).

Fisheries should also improve their process and technology in order to reduce the by-catch and discards that is publically not acceptable and have a negative impact on the management of the fish stocks. The mapping of the resources would help to identify the suitable and functional habitats for fish populations and would allow developing management plans taking into account the impact of the fisheries on these habitats. In the view of maintaining the productivity of the area, there is a real need to develop fishing gear/systems for targeted species, reduce the energy consumption of the vessels and the wastes, develop an integrated model of fish and vessels movements with spatial management schemes (MPA, fishing regulations). The integration of the growing maritime traffic, the spread of alien species and the pollution that are major factors impacting negatively the fish stock, to a management plan are urgently needed.

At the same time the Mediterranean area is rich in *Globally Important Agricultural Heritage System* (GIHS, according the FAO definition) that should be preserved to future generations and in local ago-knowledge that deserves to be analysed scientifically. From the traditional agriculture profitable insights could be generated in sustainable use of lands, or domestication of wild species or in human diet. Taking advantage of the local agriculture and traditional uses, the implementation of agro-innovations will proceed faster.

Preventing the emergence of animal and plant diseases

The Mediterranean Region is a hotspot for biodiversity but it is also a rich and well-known centre of origin and dispersion for virulent plant and animal pests and diseases. These often propagate under the influence of climate change and of the intensification of commercial exchanges (e.g. caused by increased food exchange and tourism) between different regions. The recent outbreak of *Xylella fastidiosa* in olive groves in Southern Italy and the Balearic islands is a clear example of such kind of threat, but many other example are available where the invading species rapidly colonize the Mediterranean region. Plant and animal diseases and pests cause significant losses of yields of fruits, cereal crops, vegetables and animal productions, and are important economic and social problems. While the use of pesticides is now severely restricted by European laws and regulations, ensuring regional food security requires a more effective and prompt fight against pests and diseases. This includes novel pest management practices, e.g. the identification of plant resistance genes, the use of natural defences as deterrent o pests or for implementing multi-trophic interactions with predators or parasitoids able to protect crops, the use of microbial communities that help plant to overcome the biotic and abiotic stresses, or the implementation of agro-technologies and cropping systems management techniques that help limit disease spreading, development of resistances by pathogens, or loss of effectiveness of treatments.Biological diversity plays an important role in controlling animal and plant pests, both temporally (e.g. crop succession) and spatially, at various organisation levels (from a single plot/farm to the whole landscape). In the livestock sector, concentrations of human and animal populations, sometimes still uncontrolled use of antibiotics and other anti-parasitic products, difficulties in implementing effective health inspections, the low number of licensed veterinary medicines targeting some animal-pathogen groups the lack of adequate control and prevention tools (vaccines and diagnostic tools) and negative effects of climate change (warming) are all factors that favour invasion and chronic persistence of pandemic animal diseases, the resurgence of epidemics and the emergence of new pathogens. Not only does this pose a threat to human health, it also constitutes a major constraint on efficient agricultural, husbandry and economic practices in agricultural and livestock systems in the region. The issue of plant and animal health must be addressed in relation to the factors driving the emergence of new pathogens and vectors and adopting an Integrated Pest Management approach.

Importantly, when a new disease breaks out, it is already generally too late to find and implement effective solutions. Scientific knowledge has to be obtained in order to understand and foresee outbreaks and to develop preventive solutions or Integrated Pest Management activities. The emergence of many infestations or diseases also drives the need for a better understanding of the ecology of pests and pathogens, the interactions with host plants and the communication with other organisms that may find advantage from the infestations or disease spreading. Present scientific knowledge allows to effectively tackle these challenges with a *One Health* approach, but requires trans-disciplinary research, involving plant/animal health specialists (biology, physiology and ecology, entomology, plant pathology, and epidemiology), plant breeders, agronomists & zootechnicians, technologists (health product development and application, information scientists) and socio-economists (acceptability of systems, accompanying measures for innovation adoption). This issue has also strong interconnections with the quality and safety of food products and the consequences for human health (the case of mycotoxins and their strong carcinogenic effects is only one of the remarkable examples). Collaboration with other disciplines working in food sciences and nutrition is therefore needed.

Aquaculture and livestock are concerned by this sanitary problem as the use of antibiotics/chemicals to treat the diseases has a strong negative impact on the environment (development of resistance, presence of bioactive molecules in the water) and the level of acceptability of the treated products by the consumers. Alternatives to the use of antibiotics need to be boosted. The development of simple prevention and diagnosis tools, the selection of suitable breeds for their natural resistance against pathogens, the management of the animals and their *living space*, the control of the quality of the food/water and the recycling of contaminated/treated wastewater should be examined to propose a sustainable model of livestock and aquaculture.

Animal welfare should also be considered as stress and suboptimal rearing conditions affect the immune system and the quality of the products. This question is especially important to producers and other operators within the supply chain, when consumers include animal welfare standards amongst a package of other criteria in making purchasing decisions.

Developing farming systems able to generate income, to create employment and to contribute to a balanced territorial development

Agriculture (including coastal and continental aquaculture) provides food and non-food products and commodities generating remarkable incomes, but also creates employment, sustains rural livelihoods, delivers ecosystem services, and help reaching stable and sustainable economies.

Extensive agriculture is a model largely unrealistic in the Mediterranean region. On the other hand, the potential benefit of agriculture on employment and poverty alleviation should encourage in the Mediterranean the development of labour-intensive agricultural activities and the design of profitable farming systems for small-scale agriculture and successive integration into cooperative forms of aggregation, allowing reaching sustainable and efficient market capacity. The growth of rural employment is critical to fight rural poverty. Potential synergies among activities of the various economic sectors in rural areas should be enhanced, as well as rural/urban synergies. A balanced territorial development requires both to develop new products, technologies and production systems for different farm types (family or commercial) taking into account simultaneously the farm level and the agro-industry perspective, and to assess their environmental, social and economic impacts.

Despite efforts in education, a gender gap in economic activity still exists in non-EU countries. Reports of the FAO State of Food and Agriculture 2010-2011 and the World Bank’s World Development Report 2012 highlight the importance of gender equality in agriculture. In this respect, research related to women domain as the post-harvest handling and processing through simple and women-friendly technologies, that can be utilized on-farm conditions for value adding will help to save labour, generate income, improve nutrition and prevent losses. Women play a major role in the Mediterranean agriculture especially in family farming therefore gender sensitive/specific techniques/technologies should receive special attention in research and innovation.

The Mediterranean area is characterised by a rich biodiversity. The Mediterranean diet is based on the daily consumption of fruits and vegetables, grain (mostly whole), olive oil, nuts, beans, legumes, seeds, herbs and spices, all easily found across the region. These products have a significant importance in supplying carbohydrates, vegetal proteins, phytochemicals, many vitamins and minerals. In addition to their contribution to nutrition and health, many of the plants contributing to the Mediterranean diet have multiple uses in medicine, industry or agriculture, agroforestry and soil conservation, and they bring value to marginal lands in semi-arid environments and contribute to rural development. Some locally consumed wild or cultivated species with high added value (e.g. aromatic and medicinal plants used by food, cosmetic and pharmaceutical industries) can be evaluated in respect to their health properties and commercialised to widen the Mediterranean crop range. The demand for fresh or dried culinary herbs is increasing in the European market. Accompanying this, animal products have an important nutritional and cultural value in the Mediterranean diet. While the Mediterranean diet maintains undisputed nutritional and health value, current lifestyle and global food trade are eroding popularity and awareness of the health advantages of the Mediterranean diet, especially among young people, and across the entire Mediterranean basin. This calls for a renewed effort in characterizing and improving effectiveness of the Mediterranean diet, perhaps also mining biological resources that have been neglected over the year (e.g. because characterized by low productivity) but are instead rich of nutraceutical compounds and have other properties that can be valorised by the Med diet.

One further characteristic of the Mediterranean agriculture is the coexistence of abandoned areas or areas where agriculture is declining together with areas of overexploitation of natural resources, erosion and pollution. This unsustainable land use has become worse during the last decades, probably driven by over-urbanization of population and climate characteristics. A more balanced development should be pursued. Currently, new land use management, including aspects of environmental protection and social and recreational use produce new spatial patterns and new relationships between urbanised areas, agricultural areas, intensive and extensive agricultural land, pastoral areas and uncultivated zones. This implies that integration between agriculture, aquaculture, forests, wetlands and urban areas in coastal zones should be urgently attained

This objective could be met in a coordinated way by i) multidisciplinary approaches, including biotechnology, agronomy, food sciences, environmental, economic and social sciences for developing an integrated assessment and design of smart and sustainable agricultural systems and required public policies, ii) tools (best practices, decision support systems, models, discussion and co-development platforms etc.) that can assist farmers to improve their day-to-day decision-making management in a risky and uncertain environment, iii) participatory approaches for integrating farmers’ knowledge in the innovation process and iv) territorial approaches that analyse the diversity and spatial organization of farming systems and their environmental and social conditions in the Mediterranean in order to be able to develop site-specific solutions needed by the heterogeneity prevailing within and between the Mediterranean countries.

In the light of the consideration above exposed, the present pillar identifies the following priority topics to be addressed:

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| --- |
| **Priority Topics** |
| *Adaptation of agriculture to climate change*.This objective could be met by better understanding how plants, soil biota and animals adapt to environmental constraints and why certain varieties/breeds are tolerant or resilient to abiotic and biotic single or multiple stresses, such as aridity, high evaporative demand and multiple summer stresses, warm winters, salinity, etc. Primary focus should be on genotype-environment-management interactions (resulting in adapted and productive phenotypes), as well as on valorising local genotypes taking advantage of spontaneous and domesticated biodiversity in Mediterranean agricultural and animal husbandry systems. Moreover, production of new breeds/hybrids/varieties adapted to the Mediterranean conditions and able to face climate change should be pursued. |
| *Sustainable productive ecosystems*.This objective could be met by developing innovative cropping systems and livestock systems able to cope with environmental constrains. Soil, water, vegetation, livestock and their interactions should be viewed as a whole. The reduction of the inputs, through the development of new safe sanitary products and by optimizing fertilizers used in rainfed and irrigated agriculture, a better understanding of soil erosion and salinization at different spatial and temporal scales, the development of integrated production systems (IMTA), knowledge acquisition livestock management and on nutrients cycle are of major importance. Sustainable agro-ecosystems should be indeed studied through the integration of *green economy* strategies. |
| *Integrated animal and plant pest and disease management*. This objective could be met through the development of simple prevention and diagnosis and control tools, the selection of suitable breeds for their natural resistance against pathogens, the implementation of integrated pest management techniques, especially exploiting plant natural defences, the improved management of animals and their living space, the control of the quality of the food/water and the recycling of contaminated/treated wastewater in order to propose sustainable models of agriculture and aquaculture. |
| *Farming Systems able to create employment and territorial development*. This objective could be met in a coordinated way by i) multidisciplinary approaches, including biotechnology, agronomy, veterinary, food sciences, environmental, economic and social sciences for developing an integrated assessment and design of smart and sustainable agricultural systems and required public policies, ii) tools (best practices, decision support system, models, discussion and co-development platforms etc.) that can assist farmers to improve their day-to-day decision-making management in a risky and uncertain environment, iii) participatory approaches for integrating farmers’ knowledge in the innovation process and iv) territorial approaches that analyse the diversity and spatial organization of farming systems and their environmental and social conditions in the Mediterranean in order to be able to develop site-specific solutions needed by the heterogeneity prevailing within and between the Mediterranean countries. |

**Expected Outputs**

Adaptation to Climate Change:

* + Understanding how plants and animals, together with their microbial companions (plant-soil associated beneficial microbiomes), adapt to environmental constraints and the genetic, physiological, and ecological bases of adaptation/resilience of selected Mediterranean crop germplasm and animal breeds to abiotic and biotic single or multiple stresses (e.g. aridity, high evaporative demand, and multiple summer stresses, warm winters, salinity, and the combination thereof). Focus will be on genetic characterization, post-translational genomics, microbiome analysis, high-throughput phenotyping and timely assessment of impacts and responses of genotype x environment x management interactions on the main traits of plant and animal growth, primary productivity, secondary metabolites, and quality and quantity of end products (food and non-food) as well as other soil ecosystem services such C-sequestration and minimizing N-leaching;
	+ Development of new varieties, crops and breed species suited to and productive in Mediterranean climate conditions (aridity, warm winters, uneven rainfalls, and salinity). Emphasis should be put on species that maintain stable productions and are resilient to stresses;
	+ Exploitation of neglected spontaneous and domesticated biodiversity in Mediterranean agricultural, agro-forestry and animal husbandry systems, stalking genes and traits that may help producing organisms adapted to the environment;
	+ Design of sustainable farming systems matching the traditional agro-techniques and the insights from advanced technologies developed for the agricultural sector in different regions of the area.
	+ Development of molecular tools for selective breeding programs.

Sustainable productive eco-systems:

*In agriculture*:

* + Reduction and optimization of the use of resources that are scarce (water, energy, fertilizers) or potentially noxious (e.g. chemicals pesticides and fertilizers, antibiotics) in agriculture;
	+ Enhancement of the use of by products, integrated in a circular economy (e.g. agrarian by-products in animal feeding, manures in fertilization);
	+ Development of innovative cropping/livestock systems and aquaculture allowing sustainable use of resources while optimizing productions;
	+ Improvement of understanding of the nexus plant-soil-water, in particular control of soil erosion and improvement of soil fertility, organic matter content, soil microbiology, and mineral nutrient cycles in agricultural soils;
	+ Integration of the livestock in this soil system though the development of new techniques for manure and pasture management;
	+ Development of the integration between crop and livestock inside farming systems;
	+ Improvement of recycling of water and biomasses through on-farm reclamation treatments;
	+ Provision of knowledge and management recommendations for soil conservation (organic matter, biogeochemical cycles, erosion and salinization, plant cover, compost and livestock management), cropping and livestock systems;
	+ Valorisation of pastoralism and agro-forestry services;
	+ Promotion and development of a sustainable use of underexploited and new species, breeds or varieties of interest;
	+ Reduction of greenhouse gases emissions, through a better understanding of plant capacity to recapture greenhouse gases and animal enteric fermentation;
	+ Improvement of the efficient use of resources through precision technologies.

*In aquaculture and fisheries*:

* + Improvement of knowledge of farmed organisms (e.g. genetic architecture of traits of interest, physiology of sexual development, interactions between nutrition and genome, microbiome, epigenome and physiome and biological bases of domestication);
	+ Increasing of the sustainability of their production systems (integration in the environment, design of mixed-farming/IMTA systems embracing crops, livestock and aquaculture, to minimise environmental impacts or even improve their ecological footprint);
	+ Development of technical innovation in the fishing gear/vessels;
	+ Development of data sharing on fisheries, functional habitats, population status, water quality.

Preventing animal and plant diseases outbreaks:

* + Improvement of understanding of diseases/infestations invasions and outbreaks. This includes combined and interactive assessment of genetic/physiology/ecology of crops and animals, their enemies (pests or pathogens) and friends (microbial biocontrol agents, carnivorous predators or parasitoids) in their multitrophic interactions. Epidemiological and immunological studies should be implemented;
	+ Provision of integrated pest and diseases management solutions, for plants and animal systems;
	+ Surveying of plant and animal diseases, preventing their impacts on food safety and/or human health;
	+ Improvement of understanding and control of the effects of climate change and the associated risks for plant and animal health (including existing and emerging diseases, and adaptation of livestock systems);
	+ Creation of novel control tools against disease and infestation (remote and non-invasive monitoring of the health and growth performance of plants and animals, including new diagnostic tools for early and non-invasive detection of plant and animal diseases, biocontrol agents, vaccines, and innovative therapeutics), novel decision support systems, innovative and complete databases and gene banks (especially about pathogens and pests);
	+ Selection of varieties/breeds resistant or resilient to pathogens;
	+ Inclusion of welfare in the development of new housing /rearing systems to promote healthy and respectful production systems.

Developing Farming Systems able to produce employment and to contribute to a balanced territorial development:

* + Understanding of the technical, spatial and organizational dynamics of Mediterranean production systems;
	+ Understanding of the determinants for adoption of innovations by farmers;
	+ Implementation of tools (best practices, decision support system, models, discussion and co-development platforms etc.) that can assist farmers to improve their day-to-day or year-to-year decision-making management in a risky and uncertain environment;
	+ Design of public policies aimed at enhancing adoption of innovation suited to improve farmers’ livelihoods;
	+ Delivery of participatory approaches for integrating farmers’ knowledge in the innovation process;
	+ Development of training course for the use of new technologies.

**Main Actions**

This part will be described more in details in the PRIMA Implementation Plan Document. Here are first ideas as discussed during the elaboration of the SRIA:

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| --- | --- |
| **Topic** | **Main actions** |
| *Adaptation of agriculture to climate change* | * Research and innovation actions
* Training and mobility actions
 |
| **Some specific examples or recommendations** |
| * Transdisciplinary research projects for a better understanding of the genetic/genomic/physiological and ecological adaptation of plants, soil microbes and animals under biotic or abiotic stresses
* Network of infrastructures/Specialized platforms (5-6 for the Region) with outstanding equipment covering several high-level technologies (genotyping, phenotyping, bioinformatics, data mining, etc.) to carry out any possible joint activities (i.e. collaborative projects, host colleagues, organize courses, training for zootechnicians or breeders)
 |
| **Some specific examples or recommendations** |
| *Sustainable productive ecosystems* | * Research and innovation actions
* Training and mobility actions
* Demonstration projects
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| * Transdisciplinary research projects for the development of new production systems with an integration in the environment, design of mixed-farming systems embracing crops, livestock and aquaculture, to minimize environmental impacts or even improve their ecological footprint
* Network of greenhouses sharing compared trials as well as shared experiments on several in safe conditions
* Network of long-term agronomic trials for low-input cropping system
* Shared observatories and studies sites for erosion, salinisation (watershed level)
* Research projects addressed to a better use of agricultural and livestock by products
* Innovation and demonstration projects including technologies for improved livestock production, and precision or personalized agriculture
 |
| **Some specific examples or recommendations** |
| *Integrated animal and plant pest and disease management* | * Research and innovation actions
* Training and mobility actions
 |
| * Transdisciplinary research projects for a better understanding of the ecology of diseases and pests outbreaks, host pathogen interactions in order to provide new solutions for a better Integrated Pest Management and for innovative control of pest outbreak and consequences
* Implementation of disease plans including the development of biocontrol agents, vaccines, diagnosis tools, innovative therapeutics for plant and animal protection
* Research and disease surveillance networks in tight link with existing official networks such as the Euro-Mediterranean network for animal health (REMESA)
 |
| **Some specific examples or recommendations** |
| *Farming Systems able to create employment and territorial development* | * Research and innovation actions
* Training and mobility actions
* Innovation actions
 |
| * Research on the spatial organization of the production systems and the commercial trades
* Actions to bring together innovation actors: farmers, advisers, researchers, businesses, NGOs within rural development programs
 |

**Expected impacts**

The actions that will be supported by PRIMA in pillar 2 are expected to generate impacts at different levels:

* *Protection of the natural resources.* Mediterranean countries rely on a great diversity of incredibly valuable natural resources, i.e. biotic or abiotic materials that we can use but cannot create, such as water, air, soils or biodiversity, whose management is of vital importance for societies. However, the Mediterranean ecosystem is rather complex and fragile, threatened by climate and land use changes, overexploitation of resources by increasing population, soil erosion, compaction and salinization, water pollution, habitat destruction and fragmentation, and biodiversity loss. The future of the Mediterranean agriculture and more generally of Mediterranean societies relies on their ability to adopt a more sustainable way of managing natural resources. Agricultural systems are diverse and range from rain-fed low-input systems to highly intensive systems, but they all contribute to economic and sustainable development. Aquaculture, as coastal or as integrated with farming, also plays an important role in generating income despite some systems being controversial due to their polluting effect. The impacts of agricultural and aquaculture production systems on the natural resources, soil, water and biodiversity require to improve their environmental, social and economic sustainability at farm, regional, national, global or ecosystem levels. One major expected impact of the PRIMA programme will be to increase the protection of natural resources and thus the long-term sustainability of agricultural systems and aquaculture;
* *Strengthening the Agricultural Knowledge and Innovation Systems.* Adoption of innovations and achieving changes in farming practices is not only a question of finding technical solutions. It is also a question of social and economic conditions for realising investments and ability to get knowledge and experience, where public policies have a role to play, in providing economic incentives, information, training and advice. Research should translate into innovations and into socio-economic development. However, the way from research to innovation is not straightforward. It is not a linear process, that would go top-down from researchers to extensionists and then to farmers. Indeed, farmers and agribusinesses are also innovators, they are part of an innovation system, where innovation comes from interactions among the different actors. In agriculture, the AKIS concept (Agricultural Knowledge and Information Systems), helps describe the mechanisms from Research to Innovation. In particular, it enhances the fact that farmers and their organisations should be involved all along the Research system. In the EU Member states, the experience of Extension Services, the involvement of farmers and end-users in the advisory systems has proven their efficiency. This is not the case in most of the southern and eastern Mediterranean countries. In both cases, PRIMA will support Research and Innovation as a part of the AKIS, with particular attention to the involvement of farmers and other end-users in the whole process. That is the condition for new crops, techniques, or farming systems to be adapted to the diversity of Mediterranean environmental constraints, available resources, cultural habits of growers and to the heterogeneity of farming structures;
* *Support to small farmers.*While the average size of farms in 2013 in European countries was 16.1 hectares of utilized agricultural area (EUROSTAT, 2016), because of a limited agricultural area and fragmented land ownership, the average farm size in the SEMCs is lower than in the European countries, ranging from 1.4 hectares per farm in Egypt, Palestine and Lebanon to 3.5 hectares in Jordan. Focus on technologies and productions adapted to small farmers is one objective of PRIMA pillar 2, which should produce innovations able to improve livelihood of Mediterranean population.

**Pillar 3: Mediterranean food value chain for regional and local development**

**Scope**

This pillar aims at providing a contribution to deal with food insecurity growingly spreading throughout the Mediterranean basin. It also intends to valorise the identity, nutritional aspects and other properties of food based upon Mediterranean biodiversity, traditional knowledge and cultural heritage, in order to make food sector an engine of growth.

More specifically, the pillar will address the need for solutions enhancing organisation and coordination in the food chains to improve efficiency, lifetime and waste valorisation to increase quantity, sustainable quality and recognisability of the product, and to valorise and recognize the product on domestic and international markets.

Secondly, the pillar highlights the relevance of innovating the traditional Mediterranean foods through more sustainable production systems, protecting them by quality labels (included geographical indications) and guarantee systems, in order to consolidate an affordable and balanced Mediterranean diet based on healthy food that, within a broader context of increased understanding of what are the interlinkages between nutrition and health, is able to curb the always more spreading dietary-drift phenomena.

Thirdly, the pillar stresses the key role played by the socio-economic determinants of changes in food habits, namely the need for a greater involvement of rural and industrial stakeholders, also through tailored strategies, capacity building activities and policy and investments, to ensure both food security and regional development, by integrating small producers, often isolated, into formal supply channels, urban markets, but also local alternative food networks. In this context, the pillar highlights the need for organisational innovations, intersectoral integration and, more specifically, for business models, management systems, training, communication strategies, e-infrastructure for data sharing and integration, as well as performance measurement systems that, focusing on quality and sustainability, are able to improve competitiveness of both food firms, localized agri-food systems and value chains and, more broadly, are able to promote jobs and regional economic development.

Acting against food insecurity and promoting food as an engine of sustainable development and economic growth, the pillar pursues social finalities broader than food security, first of all the mitigation of socio-economic uncertainties at the basis of migratory flows and political instability of the area.

Finally, the pillar recognizes the key role played by food choices and habits of young generations in shaping the sector, as well as the opportunities that the food system offers them.

**Research challenges & Priorities to be addressed**

In order to pursue the abovementioned scope, several challenges at regional level must be overcome, challenges that call stakeholders to play a more active and coordinated role:

Valorisation of the cultural identity and nutritional qualities of Mediterranean food and the development of new, evidence-based, healthy food products based on the constituents of the Mediterranean Diet. Research areas should cover:

* Construction of a compositional database focused on the content of health-promoting bioactive compounds in fresh and traditional food products, also in relation with the culinary traditions;
* Protection of authentic fresh and traditional Mediterranean food products by reliable traceability methods based on omics approaches;
* Application of new processing and packaging technologies to traditional products, to improve their sustainable production in the Mediterranean constraints, while preserving their molecular and sensorial identity;
* Realization of inventories of Mediterranean traditional products linked to biodiversity, cultural heritage and other local specific resources, endowed with data on their respective nutritional value and carbon/energy/water footprint, and realization of dedicated marketing solutions to improve their profitable commercialization;
* Development of new nutritionally balanced Mediterranean food products processed by adopting technologies addressing sustainability, accessibility, affordability and convenience values, while enhancing the nutritional quality and potential health benefits;
* Transformation dynamics of diet and, at the same time, preservation of local resources as important elements of the Mediterranean cultural inheritance.
* Recovering and re-use of bioactive compounds from waste processing and by-products of Mediterranean crops as ingredient in functional foods.

Enhancement of the links between nutrition and health with the aim of preventing diet-related diseases in the Mediterranean area, while valorising regional productions. Research areas should cover:

* Strengthening of the link between the Mediterranean diet and health benefits characterising and quantifying the different active substances with evident positive effects contained in local products;
* Demonstration of the genetic, epigenetic and behavioural determinants of chronic diseases, specifically focused on regional basis, in order to prevent the risk of many non-comunicable diseases by stimulating the consumption of healthy food in vulnerable targeted population groups;
* Assessment of the eating habits, their heterogeneity and their determinants in order to stimulate particularly younger generations to adopt Mediterranean traditional eating habits and abandon imbalanced diets;
* Recovery of ingredients, environmental conditions, culinary traditions and practices, with revisiting of such in light of the new scientific knowledge.

Enhancement of organisation and coordination in the food chains, with the aim of increasing quality and recognisability of the products, improving the introduction of eco-innovations such as efficiency and waste valorisation in agri-food clusters and value chains, as well as integrating small producers into formal supply channels in order to better link them to urban markets, but also into local alternative agri-food systems able to valorise the specificities of origin products and to reduce post-harvest losses. Research areas should cover:

* Optimization of all processes along the whole food chain (from production to storage, passing through transportation and commercialisation) to minimize waste and losses and recycling biomasses within the Mediterranean production system;
* Development of recognized quality labels (included geographical indications) based not only on quality assurance systems, but also on the specific characteristics of the products and/or specific characteristics of the production environment/process;
* Harmonization of norms and standards throughout the sectors along the supply chain (covering, among others, areas such as hazards and risk assessment, assurance of food shelf life, control of storage and transportation conditions);
* Development and optimization of novel preservation and processing technologies to reduce both environmental impacts and food waste generated;
* New value chains from agriculture and aquaculture side- and by-products, as well as energy recovery from waste in the landfill;
* New production systems able to ensure spatial organization of land-uses that could improve the resources management and develop environmental services produced by agriculture;
* Development of models for hazards prediction and risk assessment from the primary production up to food storage, transportation and preparation in the changing (pedoclimatic and societal) environment to prevent food crisis and facilitate trading in the Mediterranean regions.

Involvement of rural and industrial stakeholders to ensure both food security and regional development by increasing sustainable production, to be pursued through the design of appropriate agricultural and food policies, increased public and private investments, as well as research activities. Research areas, in particular, should cover:

* Strategies that, by adopting organisational and technological innovations and appropriate legal and institutional frameworks, are able to increase quantity and quality of regionally-produced food production and demonstrate them on objective basis;
* Strategies aimed at supporting the competitiveness of localized agri-food systems and recommendations for public policies to support collective actions, horizontal and vertical integration;
* Policies aiming at supporting multifunctionality through diversification of farm activities, direct selling, rural tourism;
* Inter-professional supply-chain organizations and consortia;
* Capacity building for rural and industrial stakeholders, through easily-accessible dedicated training programmes aimed at facilitating the adoption of solutions for the sustainable improvement of food security, that are tailored on the structural and dimensional characteristics of the Mediterranean enterprises;
* Capacity building for public and private stakeholders to promote rural areas as experiential rural tourism destinations, strictly linked to traditional agri-food products.

Increase in the adoption of sustainable innovations (technological, organisational and cultural) and business models among firms with the aim to improve their competitiveness, promoting jobs and regional economic development. Research areas should cover:

* Innovative business models for quality and sustainability of Mediterranean food productions and competitiveness of businesses operating in the sector;
* Planning, management control and measurement systems to support the execution of sustainability and quality-oriented business strategies;
* Marketing strategies and tools able to valorise food identity;
* Organizational and cultural changes needed to support the adoption of technological innovation in the sector;
* Inter-regional and multi-country chains and business models for farms and food companies and networks;
* New solutions for market access in non-Mediterranean countries;
* Building of networks and infrastructures for disseminating knowledge and practices, promoting reliability of measurement data, harmonization, data integration & sharing and interoperability;
* Performance management and measurement systems for quality and sustainability of typical high value Mediterranean productions and agro-clusters and harmonization with the current EU certification schemes based on Life Cycle Assessment (LCA);
* Impact of different business models and management systems on jobs and development.

In the light of the consideration above exposed, the present pillar identifies the following priority topics to be addressed, priorities linked to one or more objectives of the pillar 3:

|  |
| --- |
| **Priority Topics** |
| *Orienting youth and industry towards sustainable competitive business models and reducing food waste in the whole value chain*Stimulating, by training and dissemination activities, both young generations of entrepreneurs and firms already operating in the sector at changing their perception of the sustainability-business relationship, and encouraging them to consider the incorporation of sustainability principles in their business models as a way not only to contribute to the improvement of both social and environmental conditions of the Mediterranean area, but also as a means to increase competitiveness and growth in the sector as a whole. |
| *Valorising food products from traditional Mediterranean diet*Increasing the quality of traditional foods through the improvement of both raw material composition and production technologies and procedures from one side, and preserving Mediterranean cultural inheritance through the respect of the range of agricultural and food products that have traditionally characterized the Mediterranean diet over history, also by means of geographical indications and other collective quality labels and the support to collective producers’ organizations, from the other side. Elaborating territorial strategies aimed at integrating agri-food production with other related activities, such as tourism and non-food artisanal products. |
| *Food safety in local food chains, health risk and hazards assessment*Elaborating and, above all, adopting innovative solutions aimed to improve quality control mechanisms and techniques throughout supply chains at both local and territorial levels in order to preserve food quality and safety along the entire food chain. Enhancing the links between place of origin, food processing and food quality & safety combining tradition, innovation, security and safety in food production and use. |
| *Organisation and coordination in the food chains for improving efficiency and waste valorisation*Elaborating and, above all, adopting innovative solutions aimed to create or, whether already existing, strengthen synergies and symbiotic networks among supply chains of different sectors, with the final goal of transforming waste generated in certain supply chains and by-products into added-value products for supply chains of other sectors. |
| *Integration of smallholders into formal supply chains*Facilitating formal supply chains and, in particular, improving the integration of small producers into formal supply chains, with the final goal, from one side, of overcoming existing geographical and logistical barriers that hamper the access of small producers to more structured commercial channels, therefore increasing their inclusion and, from the other side, to lay the bases to the formulation of harmonized standards for all agri-food supply chain relevant actors across Mediterranean. Elaborating strategies aiming at enhancing the competitiveness of Small and Medium Enterprises in localized agri-food systems, by means of public policies at territorial level (included provision of services, training activities) and support to collective action (such as territorial branding). Exploring innovative territorial pathways to integrate agri-food products and geographical indications, tourism, services, biomass production, etc. |
| *Health effects of the dietary shifts and promoting healthy and sustainable diet for the Med populations*Raising awareness among both Mediterranean population and agricultural producers about the key role played by the adoption of the Mediterranean diet for the prevention of chronic diseases, namely cardiovascular diseases, cancer, chronic respiratory disease and metabolic syndromes, as well as about the relationship between diet and health in the Mediterranean context, by characterising and quantifying the different active substances contained in local products with specific reference to a) the genetic, epigenetic and behavioural determinants of chronic disease, specifically focused on regional target populations, in order to prevent the risk of many non-communicable diseases and b) the eating habits, their heterogeneity and their determinants in order to stimulate particularly younger generations to adopt traditional eating habits and abandon imbalanced diets.  |
| *Technological and organizational innovation in the agri-food chain to promote suppliers and products with higher quality and sustainability level*. *Leadership role and solutions for competitiveness*Improving the overall supply chain performance, as well as to develop or strengthen, if already existing, the collaborations among supply chain actors though the introduction of technological and organizational sustainability and quality-oriented innovations recognizing, among the others, the role played by the supply chain leader, which has the task of both transferring knowledge to smaller producers and combining their needs to maximize business opportunities, acting as leader of change towards greater quality, safety and sustainability of agri-food productions. |

**Expected Outputs**

A broad range of outputs is expected to be obtained by the present pillar. In particular, outputs can be classified according to the following categories:

Outputs related to valorisation of the nutritional qualities of Mediterranean foods and the development of new functional food products based on the constituents of the Mediterranean diet:

* Better exploitation of the raw products and the biodiversity to increase the nutritional quality of food products or to produce stable nutritionally dense ingredients;
* Development of new products, bioactive extracts, and functional ingredients using side- and by-products from agriculture, which will target food, nutraceutical, pharmaceutical or environmental applications (natural additives, functional foods, bioenergy, biodegradable packaging materials);
* Selection and production of naturally fortified plant varieties (such as legumes and cereals) and friendly processed food products more convenient for the consumer;
* Development and optimization of innovative preservation and processing technologies including non-thermal technologies, smart packaging and non-cooling demand for the preservation of food;
* Proposition of *locally* processing solutions deriving from sustainable traditional recipes preserving the nutritional value of food.

Outputs related to improvements in the adoption of Mediterranean diet by the populations of the area through innovative solutions, both in terms of recipes and composition of products:

* New formulations of recipes (nutritionally adequate and compatible with other dimensions of sustainability) based on new ingredients, new processing methods or a combination of both factors;
* New Mediterranean diet-based healthy foods formulated or fortified to include health-promoting factors, such as polyphenols, anti-oxidants, bioactive peptides, resistant starch, polyunsaturated fatty acid (PUFA) and conjugated linoleic acid (CLA) enriched foods.

Outputs related to the enhancement of organisation and coordination in the food chains for efficiency, waste valorisation and integration of small producers into formal supply channels:

* Individuation of solutions to improve both horizontal and vertical coordination of food chains;
* Integration of all processes along the whole food chain to minimize waste and losses and recycling biomasses;
* Development of new modes of *locally* distribution and communication (relation between producers and consumers);
* Optimization of transportation and logistics in the food and water supply systems;
* Optimization of processing technologies and production lines able to reduced water and energy consumption;
* Effectively recovering energy from waste in the landfill, in composers as well as via biogas production from slurry;
* New norms and standards on hazards and risk assessment, as well as on minimum quality requirements, shared throughout the sectors.

Outputs related to the involvement of rural and industrial stakeholders to ensure both food security and regional development:

* New technology-based strategies aimed at increase quantity of regionally-produced food;
* New capacity building programmes for rural and industrial stakeholders based on the adoption of technological solutions for improving food security and safety;
* New agricultural and food policies aimed at increasing food security in the Mediterranean area;
* Increased public and private investments for improving food security, especially in rural areas.

Outputs related to the adoption of organisational innovations and more sustainable business models among firms for sustainability, competitiveness, promotion of jobs and regional economic development:

* Individuation of innovative business models for quality and sustainability, both at single-firm and at system of local players (producers, industries, tourism actors) levels;
* Individuation of innovative planning and management control systems for quality and sustainability, both at single-firm and value chain levels;
* Performance management and measurement systems for quality and sustainability, both at single-firm and value chain levels;
* Individuation of best practices in sustainable business models, in terms of ability to create employment and territorial development, as well as to enhance the emergence of young entrepreneurs in the agri-food sector;
* Satisfaction of policy needs (single policies and coordination among policy areas) to boost organisational innovation.
* Improved harmonization and interoperability and development of cooperation networks and new web based application and services based ondata integration and sharing.

**Main Actions**

In the light of the priorities indicated, key actions to be carried out, with the respective specific activities, are indicated in the following table:

|  |  |
| --- | --- |
| **Priority Topic** | **Main Actions** |
| *Orienting youths and industry* *towards sustainable competitive business models* | * Awareness raising and knowledge dissemination actions
* Training and Mobility actions
 |
| **Specific examples or recommendations** |
| * Promotion of the importance of the adoption of sustainable business models for multi-actor aggregations in the Mediterranean context. Special emphasis on the driving role of the agro-food industry in promoting a sustainable adaptation of the productive chain to afford the climate change challenges
* Training and information activities specifically oriented to reduce food waste
 |
| *Valorising food products from traditional Mediterranean diet* | * Research and innovation actions
* Awareness raising and knowledge dissemination actions
 |
| **Specific examples or recommendations** |
| * Evaluation of the impact of the climate change on the nexus between the environmental ecology and the food quality based on the Mediterranean diet principles
* Selection of culture varieties rich in bioactive compounds and optimizing production technology in order to obtain added value ingredients and recovery of ingredients, culinary traditions and practices, with revisiting of such in light of the new scientific knowledge
* Promotion of the importance of innovating Mediterranean culinary heritage to get to new and improved products and development of Geographical indications and other collective quality labels
* Elaboration of territorial strategies aiming at integration of agri-food production with other related activities, such as tourism and non-food artisanal products
 |
| *Food safety in local food chains,* *health risk and hazards assessment* | * Research and innovation actions
* Innovation actions
* Awareness raising and knowledge dissemination actions
* Training and mobility actions
 |
| **Specific examples or recommendations** |
| * Development of models for hazards prediction and risk assessment extended to food storage and transportation conditions, and suitable procedures for qualifying and classifying production sites and zoning
* Development of new systems and devices for food-safety monitoring along the entire food chain and definition of best practices for all the food value chain phases, including post-sales
* Development and validation of agronomic and phytosanitary bio-based protection practices, selection and characterisation of plant with protective characteristics and increasing of plant resistance barriers
* Development of innovative packaging for better controlling product deterioration, reducing the use of preservatives, the microbiological risk and/or extending the shelf-life
 |
| *Organisation and coordination in the food chains* *for improving efficiency and waste valorisation* | * Awareness raising and knowledge dissemination actions
* Innovation actions
 |
| **Specific examples or recommendations** |
| * Promotion of the importance of overcoming existing fragmentation in Mediterranean food value chains
* Improvement of supply chain management across different productive systems (e.g. energy, materials, agro-food) to create synergies among supply chains in order to design optimized processes for better a exploitation of side- and by-products from one sector to another
 |
| *Integration of smallholders into formal supply chains* | * Research and innovation actions
* Awareness raising and knowledge dissemination actions
* SMEs actions
 |
| **Specific examples or recommendations** |
| * Development of supply chain models with fast response and flexible adaptation to mutating societal and environmental condition in the Mediterranean area, specifically designed to reduce resource wastage and maintain quality standard in the mutating scenario; connection with policy
* Promotion of the importance of integrating smallholders into formal supply chains
* Support to SMEs in accessing to formal supply chains
 |
| *Health effects of the dietary shifts* *and promoting healthy diet for the Med populations* | * Research and innovation actions
* Awareness raising and knowledge dissemination actions
 |
| **Specific examples or recommendations** |
| * Evaluate how the societal and environmental mutations in the Mediterranean area will affect the affordability of a healthy diet and propose actions to contrast the adverse conditions or to mitigate their negative effect on agro-food productivity
* Promotion of the importance of the adoption of the Mediterranean diet in terms of both health and sustainability
 |
| *Technological and organizational innovation in the agri-food chain to promote suppliers and products with higher quality and sustainability level. Leadership role, solutions, competitiveness* | * Research and innovation actions
* Innovation actions
* Awareness raising and knowledge dissemination actions
* Training and mobility actions
* SMEs actions
 |
| **Specific examples or recommendations** |
| * Development of effective strategies, adoptable by network or chain organizations, to facilitate exchange of sustainable technologies and sharing and synchronization of relevant information along the multi-actor production chain (e.g. metadata models, web platforms) in order to guarantee competitive business models and safe-quality standards
* Development of coherent sustainability and quality performance systems to valorise typical high-quality Mediterranean production and pilot test it on a number of case studies
* Promotion of the importance of adoption of technological and organizational innovations in food value chain for greater quality and competitiveness of the sector
* Training and information activities specifically oriented to improve adoption of technological and organizational innovations in food value chain, especially among SMEs, for greater quality and competitiveness of the sector
 |

**Expected Impacts**

The present pillar expects to generate several socio-economic and environmental positive impacts, namely:

* *Increased opportunities for food industry and other SMEs*. For food industry, the most tangible impact will be a considerable in the economic performance, a better valorisation of resources, and increased revenues from sales of new products. With reference to food SMEs, it is fundamental to underline that they account for a large share of the total number of SMEs and have much innovation potential, but such potential is unequally distributed across the area. While, for example, about half of Spanish food SMEs and about 54% of all Italian food SMEs carry out product or process innovations (with 28% developing such activities on their own), these percentages are significantly lower in SEMCs due to the predominantly micro-character of the local food producing and processing companies, with restricted or no market access. Low level of innovations, on the other hand, can be considered at the basis of current situation of the fragmentation of Mediterranean: food industry, in fact, is not competitive in a market dominated by large food multinationals. It is therefore clear that the introduction and adoption of technological, organisational and management innovations will be able to make Mediterranean agri-food SMEs more competitive from multiple points of view (e.g. improved cost structures, better market access, increased sales figures or profit margins);
* *Improved livelihoods for farmers*. Farmers would be amongst the immediate beneficiaries of improved local and regional food chains. Improved performance, coordination and sustainability of food chains can alleviate poverty, create jobs and lower food prices. Moreover, R&I on a sustainable and competitive agri-food sector will provide incentives for young people to invest in sectorial entrepreneurship. In this regard, large, long-term R&I programmes could represent a means of attraction for potential young entrepreneurs through activities such as education and increased awareness with regard to sustainable agricultural practices and agri-food chain structure and functioning, capacity-building with regard to implementation of relevant education, especially with reference to organisational and management skills and financial instruments supporting access to land and entrepreneurial investments, as well as insurance coverage. This will result in the creation of new generations of educated young entrepreneurs, able both to use advanced technologies and to run their business on the basis of management and organisational skills. Improved productivity and profitability of firms will incentivize entrepreneurs to have a longer-term stake in their farmland, also in the light of a renewed consciousness of soil health and sustainability, as well as of the importance of R&I programmes to protect both the fertile but fragile Mediterranean natural resources and services these resources provide;
* *Larger scale economic impacts*. In the Mediterranean area, strong efforts are needed in product, processing and marketing innovation to succeed in competitive food markets (both locally and internationally). Many can be the positive impacts of the elaboration and adoption of innovations focused on food chain performance and sustainability. In this regard, many companies, and mostly SMEs, are developing products and services that can help business customers in pursuing a healthy diet, with positive effects on the reinforcement of mutual trust and consequent increase both in profitability of firms and search for quality for customers. Moreover, the implementation of innovations in (traditional) food products can contribute to job opportunities: product innovation in food SMEs, in fact, is significantly linked to employment, and process innovations do not necessarily reduce employment in the food industry. Additional market opportunities will be created for agricultural producers of raw materials for traditional food products;
* *Improved nutrition and health for the people of the Mediterranean area*. The activities identified by the present pillar are likely to have positive indirect impacts on nutrition and health in the Mediterranean area. In particular, developing and implementing innovative solutions for sustainable and quality-oriented food chains would likely lead to a significant improvement in both the productive processes used in manufacturing foods and the quality of food produced. Sustainably managed food value chains will also improve the livelihoods of farmers and create large-scale economic opportunities in the food industry and other sectors, improving nutrition and health status of the people of the Mediterranean area. More specifically, the establishment of clear links between food, nutrition and health in the Mediterranean would lead to positive effects on the diet of the population in the Mediterranean region towards health-promoting nutrition and agri-food value chain reorganisation;
* *Greater political stability and reduced internal and external migration*. It is now widely recognised that, at global scale, increased frequency and severity of droughts and storms, changes in rainfall patterns and losses of agricultural productivity are likely to increase migration in the coming decades. These, in fact, are putting at serious risk the economic survival of people living in the area, and are fostering migration flows. In this regard, addressing the challenge of more sustainable water provision and more competitive and profitable food systems through the deployment of innovative solutions able to tackle the adverse effects of environmental changes while improving socio-economic conditions of the area can have positive impacts on nutrition and health status for the people of the Mediterranean region, also providing them with significant opportunities to enhance their economic conditions. These improved conditions will contribute to greater political stability, which in return will reduce internal and external migration;
* *Positive environmental impacts*. Increased investment in cooperation on R&I with a long-term perspective, in line with a common defined strategic R&I agenda, focusing on food value chain for regional and local development, would create the appropriate conditions to develop and implement resource-efficient and cost-effective solutions in the Mediterranean area. This would bring benefits to the environment, reducing resource use and waste generation. The achievement of such positive environmental effects will certainly be reinforced by the frame of increased collaboration and exchange of knowledge and expertise among Mediterranean countries promoted by PRIMA initiative within which innovative solutions will be developed and demonstrated, framework in which all the Countries participating share the same challenges to the climate change, increasing population and social instability.
1. **Overall Impacts**

Impacts of economic nature

*Technological development*. PRIMA will allow the rapid integration of the R&I programmes and activities of the Participating States within the context of a jointly formulated strategic R&I agenda. This, in turn, will provide a comprehensive, long-term stable and predictable framework for all relevant stakeholders to tackle challenges of unsustainable managed water provision and food systems, which will ensure the best delivery of the scientific and technological outcomes, whether on the input side or on the output side.

*Economic Growth*. The focus that PRIMA will put on the deployment of investments on sustainable solutions to improve water provision and food systems across the Mediterranean region, ranging from the development of improved irrigation technologies and plant-management techniques to products, processing and marketing innovations and services, will help business customers raising productivity, and will render both Mediterranean agri-food businesses and agricultural producers of raw materials for traditional food products more competitive, through better valorisation of resources, increased revenues from sales of new products or access to markets, as well as improved cost structures and profit margins. This, in turn, will contribute to generate employment.

Impacts of social nature

*Working conditions*. Improved performance, coordination and sustainability of food chains on which PRIMA will focus will alleviate poverty, create jobs and lower food prices. This will provide incentives for young people to invest in sectorial entrepreneurship, representing a means of attraction for potential young entrepreneurs, especially in the light of foreseen education and capacity building activities on sustainable agricultural practices, agri-food chain structure and functioning, as well as on organisational and management skills often lacking among farmers. This will contribute to the creation of a new generation of entrepreneurs, able both to use advanced technologies and to run their business on the basis of management and organisational skills that will increase productivity and profitability. Improved productivity and profitability of firms, in turn, will incentivize entrepreneurs to have a longer-term stake in their farmland and, consequently, in protecting both fertile but fragile Mediterranean natural resources and services these resources provide;

*Public health and safety*. Sustainably managed water provision and food systems will also improve the nutrition and health status of the people of the Mediterranean area. Developing and implementing innovative solutions for sustainable and quality-oriented food agri-food chains, in fact, would likely lead to a significant improvement in both the productive processes used in manufacturing foods and the quality of food produced. Moreover, the establishment of clear links between food, nutrition and health in the Mediterranean would lead to positive effects on the diet of the population in the Mediterranean region towards health-promoting nutrition and agri-food value reorganisation through a multidisciplinary approach (agriculture, food technology, nutrition science, social sciences, economics, psychology, sociology, IT experts) and the involvement of a wide range of societal and value chain actors;

*Political stability and reduced migration*. Addressing the challenge of more sustainable water provision and more competitive and profitable food systems through the deployment of innovative solutions able to tackle the adverse effects of environmental changes while improving socio-economic conditions of the area will have positive impacts on nutrition and health status for the people of the Mediterranean region, also providing them with significant opportunities to enhance their economic conditions, but will also contribute to greater political stability, which in return will reduce internal and external migration. It is now widely recognised, in fact, that, as an effect of climate change, increased frequency and severity of droughts and storms, changes in rainfall patterns and losses of agricultural productivity are likely to increase migration in the coming decades. These, in fact, are putting at serious risk the economic survival of people living in the area, and are fostering migration flows.

Impacts of environmental nature

*Efficient use of resources and adaptation to climate change*. Increased investment on food value chain for regional and local development would create the appropriate conditions to develop and implement resource-efficient and cost-effective solutions in the Mediterranean area, bringing benefits to the environment and reducing resource use. The achievement of such positive environmental effects will certainly be reinforced by the frame of increased collaboration and exchange of knowledge and expertise among Mediterranean countries promoted by PRIMA initiative within which innovative solutions will be developed: all the participating Countries will share the same challenges due to the climate change, scarcity of some key resources with respect to populations’ demand and social instability. More specifically, positive large-scale impacts at the environmental level will be achieved by:

* *Improved water conservation* by developing (i) novel plant and animal varieties for irrigated and dry farming conditions, (ii) innovative irrigation technologies and user-centred water conservation processes; efficient water allocation between different economic sectors, (iii) user-centred water-saving processes and programmes and (iv) improved water governance, management and coherence between agriculture, water and energy policies;
* *Sustainable farming practices* by implementing innovative solutions for (i) reducing land conversion and habitat loss, (ii) improving water- and fertilizer-use efficiency, (iii) reducing soil erosion and degradation, including loss of organic matter and microflora, (iv) developing and using more environmentally-friendly fertilisers and pesticides and (v) increasing productivity of local crops and farm animals;
* *Recovery of water and nutrients from wastewater for agricultural use* by developing (i) new site-specific policies, (ii) user acceptance strategies and (iii) and innovative wastewater treatment and reuse technologies;
* *Water desalination* by developing (i) technological breakthroughs in energy consumption and desalinated water quality, (ii) brine disposal, (iii) integration into energy networks and local water management strategies and (iv) coordinated strategies for water reuse solutions and desalination as to close water loops;
* *Reduction of greenhouse gases (GHG) emissions*;
* *Reduction of harvest shocks due to droughts*;
* *Building of resilience and adaptation capacity in the Mediterranean area*.

**Monitoring of Impacts**

With reference to the monitoring process, the framework of Agenda 2030 and Sustainable Development Goals (SDGs) will be used to monitor impacts of activities encompassed within PRIMA. This framework includes three specific goals, among the 17 SDGs, dedicated to food security (# 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture), sustainable management of water (# 6 Ensure availability and sustainable management of water and sanitation for all) as well as sustainable use of land (#15 Sustainable land use, forest and other terrestrial ecosystems), for which there are several indicators that can be used to monitor the magnitude of the effects produced by projects under the PRIMA initiative. However, it should be taken into consideration that there are many other issues that can be positively affected by sustainable food production and water provision systems and that are linked to other SDGs. This means that, while improving the efficiency and sustainability of food production and water provision, the PRIMA initiative will also generate a positive effect on other SDGs, namely:

* No poverty (SDG 1)
* Good health and well-being (SDG 3)
* Clean water and sanitation (SDG 6)
* Affordable and green energy (SDG 7)
* Decent work and economic growth (SDG 8)
* Reduce inequalities (SDG 10)
* Sustainable communities (SDG 11)
* Sustainable consumption and production (SDG 12)
* Climate action (SDG 13)
* Sustainable management of oceans and coastal areas (SDG 14)

The selection process of feasible indicators for the monitoring systems will be carried out on the basis of specific criteria to be satisfied:

* *Cover most of SDGs*: starting from the SDGs about food security and water provision (the specific topics of PRIMA initiative), an improvement of the selected indicators should be able to positively influence the achievement of as many goals as possible;
* *Consider biophysical limits*: it is fundamental to have indicators that give information about the biophysical limits of the system, from both resource consumption and environmental loading point of view;
* *Consider the nexus*: food, water, and energy have a strong relationship with each other and play a crucial role in the achievement of SDGs. The use of indicators that can highlight the linkages among all three is needed;
* *Consider both national and sectorial systems*: some indicators have to monitor national systems (e.g. poverty, health, land use, GHGs emissions), while others shall monitor sectorial systems (e.g. agriculture, water services);
* *Be limited in number*: the indicators should be limited in number in order to have an effective tool that can easily support the monitoring process of projects under the PRIMA initiative;
* *Data availability* should be guaranteed frequently enough to be meaningful in the PRIMA time horizon.

As an example, a short-list of possible indicators (with their units) that can be suitable for PRIMA monitoring is reported:

1. Multidimensional Poverty Index
2. Population overweight (%)
3. Land Use (%)
4. GHG emissions (total and AFOLU – t CO2e)
5. Cereal Yield (kg/ha)
6. Agriculture Value Added (US$/worker)
7. Fertilizers consumption (kg/haarable land – available also at 5km x 5km scale)
8. Crop water productivity (kg/m3)
9. Proportion of total water used (% – available also at 5km x 5km scale)
10. Population using safely managed water services (rural, %)
11. Population using safely managed sanitation services (rural, %)
12. Amount of agricultural residues used for energy purpose (t/ha)

These indicators are reported in the table below, with the aim to show which SDGs are mainly affected by the improvement generated by the PRIMA initiative.



Furthermore, for these indicators a baseline has been calculated. Being the number of indicators small, a synthetic representation of the state and of the trends of a country such as radar (or amoeba) diagrams can be used, without using any *superindex* hiding precious information in an arbitrary weighing process.