Introduction

Today the Mediterranean region faces significant challenges in relation to food security and nutrition, which are expected to worsen further in the coming decades.

Even though the region has made significant progress in reducing undernutrition, the double burden of malnutrition, which refers to both micronutrient deficiency (hidden hunger) and over-nutrition (overweight and obesity) still affects a considerable part of the population. Furthermore, the demand for food is expected to increase by the mid-century, as a result of population growth and shift in dietary patterns. Structural changes in the demand for food in the Mediterranean countries will require a substantial increase in food supply in a scenario progressively weakened by the lack of two strategic resources for agricultural production – fertile land and water –, the impact of climate, and a greater price volatility and instability in the global food market. Moving from quantitative to qualitative aspects of food security, it is necessary to take into account that while higher atmospheric CO_2 concentration could compensate the negative impact of climatic changes on crop yields through the so called "CO_2 fertilization" effect, at the same time new research warns that rising CO_2 levels could drastically reduce the nutritional value of food by reducing the concentrations of essential minerals and protein in crops.

The challenges of the 21st century raise the question of whether the principles and objectives that shaped the Mediterranean food system in the 20th century need revision in order to provide simultaneously enough food, in quantity and quality, to meet the nutritional

needs of a growing population and to conserve natural resources for future generation.

Currently, the Mediterranean agri-food system is characterized by a deep structural weakness that renders it extremely vulnerable to current and future environmental stresses caused by global climate change in interaction with other environmental, political and economic trends, both global and local. This weakness emerged during the global food crises of the new millennium, when a number of factors, acting on both the demand and the supply side of the food equation, caused the sudden increase in international food prices, with all the socio-economic and geopolitical consequences that occurred in the Southern and Eastern Mediterranean Countries (SEMCs).

This awareness implies a paradigm shift towards food production and consumption systems based on the principles of sustainability able to contribute to a healthy food from a nutritional and environmental point of view. Changes in both food production and consumption are important to ensure sustainable food system and achieve food and nutrition security in the Mediterranean region. The Mediterranean agri-food sector has great potential in contributing to food security, promoting sustainable development, combating climate change in terms of both mitigation and adaptation, preserving natural resources and agrobiodiversity loss, enhancing landscape, cultural heritage and traditions. And it is on this confidence that the seeds of this volume have been planted.

In this report, we consider the Mediterranean food system as a coupled social-ecological system based on the co-evolution and interaction between natural and human factors, but also as a human-designed system characterized by a disproportioned influence and control of social factors over ecological elements and where multiple and complex environmental, social, political and economic determinants affect food security in all of its dimensions (availability, access, utilization, and stability). Reducing vulnerability of food security to disturbance has been usually measured via efforts to reduce hunger, minimize crop losses, and maintain economic productivity. These goals, fundamental to the social contracts that bind citizens and governments, focus largely on production and profit maximization, neglecting the multifunctional nature of food system, such as

the ecological processes and functions and longer-term integrity of the biophysical elements that are fundamental to support food system. In order to guarantee the system's capacity to achieve the core objective of food security for all, Mediterranean countries have to recognize the complementarities and synergies, as well as trade-offs, across temporal and spatial scales of the diverse socio-economic, cultural and ecological functions associated with food and agriculture and the necessity to increase sustainability (provision of resources for future generations) and reduce the sensitivity of shocks.

In such a context, we suggest that "diversity" – in both its biological (the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels) and socio-economic and cultural dimension (human activities and agricultural management practices, traditional and local knowledge, cultural factors) – is a key feature in meeting food security goals. It is from the inter-relationship between these two forms of diversity that agro-biodiversity, understood as the immense variety of domesticated plant species and animal breeds on which we depend, has been shaped. And it is by the coexistence of these two forms of diversity that the system's ability to respond to biotic and abiotic stresses improves. While animals, plants and microorganisms use their genetic variability to increase ecosystems' resilience, humans depend on their cultural variability to increase their adaptive capacity to a constantly changing environment.

This is the message that wants to emerge from this report. The goal has been to foster dialogue and debate between decision-makers, stakeholders and scientific community on both shores of the Mediterranean, on the current challenges of the agri-food system and on the opportunities offered by a paradigm shift towards green/blue and circular economy. In this lies the originality of this study: following an interdisciplinary and participatory approach, we have tried to take a first step towards the creation of a pluralistic and integrated knowledge system in which the universal and scientific knowledge does not exclude the local and traditional knowledge. Indeed, we have tried to ensure that these two forms of knowledge could enrich each other involving, in the knowledge creation and dissemination process, scholars coming from different scientific disciplines, local institutions, farmers and civil society.

Accordingly the volume has been structured into two sections. A general, more theoretical part, in which specific aspects related to food security and nutrition in the Mediterranean region have been elaborated. It aims to capture the complexity and heterogeneity of Mediterranean food systems through readings that are not necessarily coherent with each other, carried out with different disciplinary approaches, able to provide a kaleidoscopic overview of the issues currently most significant in terms of sustainability; some case studies and best practices part, in which examples of good policy, entrepreneurial success, and win-win local development models have been described. They have been chosen as possible virtuous lessons useful for "uniting" Mediterranean countries, or tracing possible paths towards sustainable food system in the Mediterranean region.

Entering more into details, Giovanni Canitano and Eugenia Ferragina, in their chapter *Food Security in a Context of Climate Change and Natural Resources Scarcity*, examine water and food security issues in the SEMCs and their geopolitical implications. Water and food security are of particular concern for the Mediterranean region where natural resources are under climate and population stress and agricultural production must cope with quality requirements imposed by consumers and their ever-changing preference patterns. How to feed an increasing population and, at the same time, safeguard natural resources for future generations is a great challenge for this area. Water is the key to food security because agriculture requires large quantities of water for irrigation and many production processes. The chapter provides an overview of the impact of global climatic change on water and food security in the SEMCs where climate unpredictability, linked to fluctuations in rainfall levels, affects lands used for cereal cultivation. Then, the discussion turns to the water-food nexus, stressing how water consumption in these countries is strictly linked to the production, consumption and trading systems of agri-food products.

In the Mediterranean region, climate change and environmental constraints make agricultural and food security particularly sensitive and call for the development of an agri-food system based on the principles of green and blue economy, were water, energy, food and other resources are interlinked in a web of complex relations. The

need for a paradigm shift in the Mediterranean agri-food system and the importance of an approach based on the water-energy-food nexus are the issues addressed in the chapter of Maria Rosaria Carli, *Promoting Green and Blue Economies: Implication for Food Security in the Mediterranean Region*. In the chapter, the historical roots of the concepts of green/blue and circular economy at the global and Euro-Mediterranean level are outlined, highlighting their importance in ensuring long-term food security in the Mediterranean region. Carli tries to detect the level of sustainability of the Mediterranean agri-food systems by the use of indicators able to capture the three pillars outlined in the 2015 BCFN Milan Protocol and included in the Sustainable Development Goals (SDGs): sustainable agriculture, nutritional challenges, and Food Loss and Waste (FLW). What emerges, is that significant advances have been made by the Mediterranean countries in incorporating the principles of green and blue economy within the food system, but there is still much to be done. Great opportunities in the SEMCs derive from the development of renewable energy in order to trigger a virtuous circle in the water-energy-food nexus as evidenced by the Sahara Forest Project.

The question of how to ensure an adequate level of food self-sufficiency in a context of natural resources scarcity has always plagued the governments of the Middle East and North Africa (MENA). As outlined by the chapter of Desirée A.L. Quagliarotti entitled *Food Security Strategies in the Arab World*, in the MENA Region, due to scarce resource endowments, domestic production of water-intensive food has never been considered an efficient way of using natural resources. Instead, countries have been generally forced to adopt a trade-oriented food security strategy based on the neoclassical theory of international comparative advantages. Nevertheless, achieving a certain level of food self-sufficiency has always been a national strategic goal, especially when it has been necessary to take into account considerations that go beyond mere economic analysis, including geopolitical and social concerns. The study is divided into three sections. The first analyses the food security status in the Arab countries at both national and household levels, discovering the agricultural potential and identifying factors that affect food demand and supply. In the second, the historical evolution of food security strategies in the Arab world are

traced, highlighting factors influencing strategic choices adopted by governments in different historical periods. In the last section, the author tries to identify a framework of appropriate policies and strategies to ensure long-term food security in the Arab world. The analysis shows that in the MENA region, food security is a very complex issue in which different variables interact with each other. As a result, to feed a growing population and, at the same time, mitigate countries' economic and environmental vulnerability, it is necessary to have an integrated and holistic approach that goes beyond a purely economic assessment to include political, social, and environmental factors that can affect food security in all its dimensions.

Achieving food security by overcoming natural resources loss requires transformative changes on both sides of the food equation. A selective emphasis on the demand-side issue for sustainability is the topic of the chapter of Elena Viganò, Laura Bravi, Federica Murmura and Elisabetta Savelli entitled *Sustainable Consumption of Agrifood Products*. Here, the concept of sustainability from an environmental and nutritious point of view is related not only to consumption trends but also to the consumer's choices. The authors underline the complexity and the different meanings of sustainable food consumption among various socio-economic systems, within which the problem of food and nutrition security coexists with an increasing diffusion of obesity and overweight issues. Accordingly, the evolution of lifestyles values and socio-cultural factors that affect individuals' behaviour cannot be neglected to define public policies aimed at promoting the diffusion of really sustainable models of production, trade, and consumption.

Agroecology as an effective response to the issue of climate change is the subject of Paolo Bàrberi's chapter. As the title suggests – *Agroecological Solutions for Climate Change. Mitigation and Adaptation* – the essay aims to show how agroecological solutions can tackle the issue of climate change mitigation and adaptation in the Mediterranean agricultural and food system. Starting from the consideration that organic food systems are not necessarily climate friendly, the author provides a working definition of agroecology and shows how an agroecological approach, associating a reduced use of external input in the production phase with the development of

short supply chains, has huge potential to mitigate CO_2 emissions and appears as the best way to meet the great challenges of humankind related to agricultural and food systems.

Agroecological models as possible solutions to the challenges affecting the Mediterranean agri-food system, also occur in the chapter *Agriculture, Environment, Nutrition and Human Health* of Salvatore Ceccarelli. The author states that environmental degradation and the spread of diet-related diseases require a shift from a uniformity-dominated agriculture, based on the use of synthetic chemicals, to a diversity-dominated agriculture based on agro-ecological principles. This transition implies the adoption of participatory and evolutionary plant breeding methods able to establish a direct correlation between agricultural production growth and agrobiodiversity enhancement, besides contributing to income creation, climate change adaptation and healthy food production. According to Ceccarelli, participatory plant breeding methods are not only more efficient than conventional plant breeding, but are also more suitable to develop varieties with more specific adaptation and to maintain the evolutionary potential of crops to cope with climate change.

In addition to terrestrial ecosystems, Mediterranean marine and coastal ecosystems also contribute to ensure food and nutrition security in the Mediterranean region thanks to their immense resources and ecological services. The wide variety of fish species that populate the Mediterranean Sea provides an essential source of high quality animal protein, micronutrients, and fatty acids without placing increased pressure on land and water resources. The chapter entitled *Mediterranean Fish Stocks on the Brink* by Vittoria Gnetti and Domitilla Senni, describes the great richness and heterogeneity of marine species and habitats that characterize the Mediterranean Sea, highlighting the key role played by the production of sea food for the economy and well-being of Mediterranean societies since the dawn of civilization. In particular, the authors review the state of Mediterranean fish resources, examine the socio-economic features of the fish sectors and the threats of sustainability of Mediterranean fisheries, identifying possible solutions and strategies to protect Mediterranean sensitive habitats, recover fish stocks and increase food security for coastal communities.

Complementary to this analysis is the chapter *World Fish Production between Sustainability and Growing Consumption: What Can Be Expected in the Mediterranean*, written by Luca Forte. It offers a detailed picture of fish production for both wild capture fisheries and aquaculture at both global and Mediterranean levels. The analysis discloses significant changes in the geography of world production for the period 2000-2015, underlying the sharp growth of China and other Asian countries to the detriment of American and European ones. The worst performance recorded in the Mediterranean basin proves that demographic pressure on coastal areas and difficulties in the management of fisheries resources could jeopardize natural resources and seriously damage the fishery industry. In such a scenario, production from fish farming is a necessary alternative to both relieving the pressure over natural fishery resources and ensuring adequate fish supply to consumers. Furthermore, a more effective cooperation among Mediterranean countries is needed in order to involve all countries that share fishing interests in the marine area.

A fundamental response to achieve long-term food system sustainability and improve the health status of populations bordering the Mediterranean comes from the Mediterranean diet. The chapter entitled *Mediterranean Diet as a Lever for Place Branding: Some Insights from the Italian Experience* by Chiara Aleffi and Alessio Cavicchi, aims to outline the multifaceted nature of the Mediterranean Diet, starting from its original conceptualization and describing the long path towards an international appreciation not only for its well-recognized implications for human health and the environment, but also for its cultural value. For all these features, the Mediterranean diet may act as a driver for tourism as two examples of attempts to promote destinations based on the immaterial cultural heritage in Italy clearly show.

Another important issue concerns the link between migration and agricultural labour. In the last years, several economic and political shocks have generated global instability and led to international migration flows coming into Europe from the East and from the South. The result has been a high proportion of irregular migrants in search of employment and better living conditions that too often have to endure discrimination, precarious and inhuman working conditions.

As it emerges from the chapter of Eduardo Barberis, Stefania Battistelli, and Paolo Polidori *Immigrations and Agricultural Labour Exploitation: An Attempt to Classify the Rules to Curb the Phenomenon*, the economic sector in which informal or undeclared work and serious forms of work exploitation are more recorded is agriculture. Using both theoretical and practical approaches, the main objective of the chapter has been to identify the parameters useful to design a map to classify the phenomenon of agricultural labour exploitation, but also to read the dynamics that the legislation produces when it is applied in term of movements in the direction of legality.

What emerges in the pages of the first section of this volume, is that the Mediterranean agri-food sector is at a crossroads and must find new paths and new approaches to be able to survive the challenges of the 21st century. Population growth, changes in consumption patterns, environmental constraints and the impact of climate change, are all factors that will concur to widen the gap between food supply and demand in the Mediterranean countries, especially in the Southern and Eastern coast.

But it is only a part of the story. The second section of this volume tells us another story made of a rediscovered balance between man and nature where human ingenuity has succeeded in transforming constraints into opportunities. And this journey through the discovery of good practices across the lands and the seas of the Mediterranean begins in Tunisia.

Leïth Ben Becher, after highlighting the strategic role played by the agricultural sector in Tunisia in terms of achieving food and nutrition security, conserving natural resources, preventing the effects of climate change and ensuring fair incomes for farmers, underlines the urgency of adopting a new model of agricultural development, based on the concept of multifunctionality, in order to improve the performance of the agricultural sector and reduce constraints.

The relevance of organic farming is the topic addressed by Diego Aluigi and Federico Gori. This essay describes the case study of Terra Bio, one of the largest and most important cooperatives of the Province of Pesaro and Urbino, a territory than can be considered the cradle of Italian organic farming. Terra Bio carries out two types of activities: the first one is the production and sale of raw materials;

the second one is the transformation of these raw materials in final products. The cooperative also provides many services to its members contributing to environmental protection and job creation.

The chapter by Christina Büns takes us to the Southern shore of the Mediterranean, in Egypt, where biodynamic agriculture has managed to make the desert bloom. It all started in 1977, when Dr. Ibrahim Abouleish decided to reclaim desert land into vital soil by organic and biodynamic agricultural methods. Thus the SEKEM Initiative came to life. Its mission is the development of a holistic approach that provides alternatives to the human, social systems we are living in. Besides its commitment to organic agriculture, SEKEM produces and processes food, natural health care products and textiles. With part of their profits the SEKEM companies co-finance the social and cultural activities of the SEKEM Development Foundation that runs different schools, a medical centre and other institutions.

The challenge of combining economic and social objectives under the constraint of environmental protection has prompted the Moroccan government to adopt the so-called "Green Morocco Plan". As specified by Mohamed Ait Kadi, Mohamed Badraoui and Abir Lemseffer, the Green Morocco Plan is the agricultural strategy implemented since 2008 to support the Moroccan agricultural sector, ensure food security and contribute to socio-economic development in rural areas. In order to achieve these goals, the Plan adopts the principle of heterogeneity in agriculture through the development of different forms of agriculture well suited to the local specificities.

At a time when a growing world population needs to be fed on limited resources in a changing climate, the conservation and sustainable use of agricultural biological diversity gains utmost importance. The crucial role played by the rediscovery of ancient fruits for both human and ecological systems is the focus of the essay of Anahi Elena Ada Bucchini, Laura Giamperi and Giovanna Giomaro. With this chapter, different aspects of apple cultivation are analysed and a case study of an ancient variety of Romagna apple (Abbondanza apple with red pulp) is described. After evaluating the polyphenolic and anthocyanin content and, on the basis of results concerning the antioxidant and anti-inflammatory activity, the authors assume that an intensification of this clone cultivation can be useful from an en-

vironmental, ecological, economic, and health point of view.

A perfect platform to enhance the sustainable use and conservation of agrobiodiversity is provided by the Farmer Field School (FFS). Suzanne Phillips and Johan Chermette Wagner describe the significant impact of the FFS approach in creating a space for community-level sustainable agriculture in the Mediterranean region. The FFS approach is designed to strengthen participants in three domains of learning: technical, practical and empowerment. The flexible and adaptable nature of the process allows producers to find the most suitable solution to their own local problems, including water scarcity, climate change, livestock productivity, conflict and migration. According to the authors, in the Mediterranean countries, a regional initiative linking sustainable agricultural production and marketing, youth and women employment, and social inclusion based on FFS could provide a promising solution to the challenges posed by increasing rural-urban and South-North migration, unemployment, food insecurity and climate change.

The integration of the principles of blue economy with the sustainable production methods of circular economy is the approach developed by the District of Fishery and Blue Growth of Mazara del Vallo, in Sicily. As stated by Maurizio Colletta and Giovanni Tumbiolo, the District has proved to be a paradigm experienced locally that can be replicated all over the Mediterranean region. It represents a virtuous model in which local stakeholders play a leading role in achieving a sustainable consumption of renewable biological resources and converting these resources and waste streams into value added products such as food, beauty products, bio-based products and tourism. Thanks to the development of training programs for youth and investment in innovation and research, the District of Fishery and Blue Growth demonstrates how traditional sectors of the blue economy can become an engine for job creation, addressing the root causes of migration and exploiting the potential for long-term growth and development in the Mediterranean region.

The case study described by Marianna Rizzo takes us to Cilento, in Southern Italy, where the origins of the Mediterranean diet lie. The author retraces the studies of Ancel Keys, a physiologist at the University of Minnesota considered the father of the Mediterranean

diet, who with his Seven Country Study compared the food model and the lifestyle of the Mediterranean populations with that of the United States and of Northern Europe. In Cilento the old alimentary model was still alive, essentially because there had been no economic growth and the process of industrialization did not arrive over there. Keys made ethnographic research on food, recording interviews with housewives, fishermen and peasants. And all this documentation inspired a book, titled *How to Eat Well and Stay Well. The Mediterranean Way* where for the first time the public became aware of the term "Mediterranean diet".

De Marco's case study closes this second part of the volume. The author investigates the current situation of forced labour in Italy, analysing the factors that cause work exploitation in agricultural supply chains. Subsequently she describes the characteristics of the Caritas's Presidio Project, aiming both at contrasting work exploitation and improving migrants' working and living conditions in Italy. As the author explains, the project has been designed to provide multilevel support to 10 different Italian regions affected by work exploitation with the goal of guaranteeing protection and assistance to migrant workers firstly by delivering necessity goods and offering health support and administrative advice to them.

It is perhaps from the description of these case studies and best practices that one can draw the greatest teaching to rethink the Mediterranean agri-food system. The Mediterranean cannot be considered only a region of environmental constraints, natural resources scarcity and climate change hot-spot. The peoples surrounding the Mediterranean Sea have a "hidden" value represented by the "Mediterranean identity", which means not only belonging to the same sea, the "Mare Nostrum", but above all it means diversity. The Mediterranean identity is a living example of "unity in diversity". Diversity, as being fundamental for social, economic and cultural progress in the Mediterranean, comprises several essential issues: natural and agricultural diversity, diversity in farming systems, in cultivation practices, in landscape and in knowledge systems. All these forms of diversity have been shaped over the centuries through a process of coevolution between man and nature. Perhaps, precisely those environmental constraints have stimulated human ingenuity and nature's

capacity to survive and so it has been that dry soils, groundwater reserves, uncultivated lands, barren landscapes, and inedible wild species have turned into beauty: beauty of agricultural landscapes, natural ecosystems, crop varieties, irrigation systems.

To give an effective response to the question of food security, it is necessary to valorise "diversity" in all its dimensions. This is the message. Destroy "Mediterranean diversity" makes alternatives disappear and the lack of alternatives threatens food security, especially in a climate and environmental crisis scenario.

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